Helmholtz Climate Initiative
‘Regional Climate Change‘ – REKLIM

2nd International REKLIM Conference

23 – 26 September 2019

Umweltforum Auferstehungskirche

Berlin, Germany

Programme and Abstracts

HELMHOLTZ
SPITZENFORSCHUNG FÜR GROSSE HERAUSFORDERUNGEN

REKLIM
Helmholtz-Verbund Regionale Klimaänderungen

Masthead

PUBLISHED BY:

REKLIM - Helmholtz Climate Initiative

Regional Climate Change

REKLIM Coordination Office

Alfred-Wegener-Institut, Helmholtz-Zentrum

für Polar- und Meeresforschung

Am Handelshafen 12

27570 Bremerhaven

Germany

PUBLISHED IN:

August 2019: doi.org/10.2312/reklim-proceedings-2019

EDITORS IN CHIEF

Klaus Grosfeld, Renate Treffeisen

PRINTER

Druckerei Girzig + Gottschalk GmbH

Hannoversche Str. 64

28309 Bremen

The REKLIM conference proceedings volume

was printed on 100 % recycling paper.

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Introduction

One of the declared goals of the Paris Agreement is to limit global warming to no more than 1.5 °C above pre-industrial levels, changing the context for policy-relevant research and posing a major challenge for researchers. In response, today's climate research is largely focused on analysing and understanding the regional effects of global climate change, especially to describe the impacts of climate change on a socially relevant scale.

This is where the Helmholtz Climate Initiative REKLIM comes in: since October 2009, experts from the nine centres in the Helmholtz Association's research field Earth and Environment have been collaborating on eight research topics. Working hand in hand with university partners, the Helmholtz Research Centres can effectively pool their regional climate change expertise. Regional observations and process studies, together with simulations, will help to refine regional and global climate models, which in turn provide a solid basis for informed climate-related decision-making. In addition, REKLIM fosters interdisciplinary regional climate research in Germany.

Looking back on ten successful years and looking ahead to the next funding period, REKLIM will host the 2nd International Conference

Our Climate – Our Future:

Regional Perspectives on a Global Challenge

in Berlin, Germany on 23 – 25 September 2019.

The conference's main goal is to provide a forum where scientists from around the globe can present and discuss the latest findings on regional climate research in connection with REKLIM's focus areas.

The following six research topics will be addressed during the conference:

- Coupled regional modelling
- Sea level rise in a warming climate: from global drivers to coastal impacts
- Land-atmosphere interactions: from measurements to modelling
- Atmospheric composition and climate: interaction between global and regional scales
- Extreme events across scales (past – present – future)
- Climate change adaptation as societal challenge

The scientific conference will be followed by a public engagement day on 26 September 2019, which will focus on promoting dialogue (in German) between scientists and decision-makers from the political and administrative sectors, and at professional associations.

The conference aims at providing a forum were scientists from all over the world can present and discuss new results from regional climate research in the context of the REKLIM research topics.

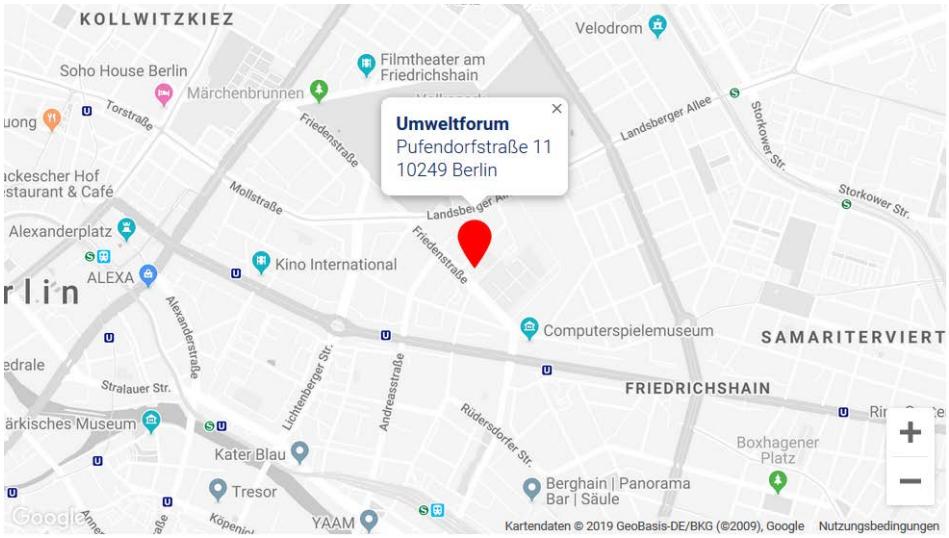
Conference venue, location map and conference office information

Venue

The 'Umweltforum' is located in the center of Berlin near the famous Alexanderplatz. The church, which is the main part of the building, is over one hundred years old. Beautiful ceilings, galleries and the organ loft make this venue an extraordinary event location. Being equipped with eco technology and the possibility of supporting events carbon neutral, make the 'Umweltforum' highly suitable for Green Meetings.

Address of the venue
Umweltforum Berlin
Pufendorfstraße 11
10249 Berlin
Germany

Location map



(map source: http://maps.google.de).

Contact conference office:
familie redlich AG
Agentur für Marken und Kommunikation
Gustav-Meyer-Allee 25 | Gebäude 13/5
13355 Berlin
E-Mail: kontakt@reklim-conference-2019.de

Research partner institutions of the Helmholtz Climate Initiative REKLIM

Alfred-Wegener-Institut Helmholtz-Zentrum für Polar- und Meeresforschung
www.awi.de

Deutsches Zentrum für Luft- und Raumfahrt in der Helmholtz-Gemeinschaft
www.dlr.de

Forschungszentrum Jülich GmbH
www.fz-juelich.de

GEOMAR Helmholtz-Zentrum für Ozeanforschung Kiel
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www.hzg.de

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www.gfz-potsdam.de

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www.helmholtz-muenchen.de

Karlsruher Institut für Technologie
www.kit.edu

Helmholtz-Zentrum für Umweltforschung GmbH
www.ufz.de

Partner Universities

Europa-Universität Viadrina, Universität Bremen, Universität Hamburg, Universität Heidelberg, KIT – University Sector, Universität zu Köln, Universität Leipzig, Technische Universität München, Universität Potsdam

Climate-neutral REKLIM conference

Calculation of the carbon footprint is an important building block in climate protection. The carbon footprinting of our conference involves calculating and reporting all relevant greenhouse gas emissions. This includes the emissions of the infrastructure (power consumption, heat energy, refrigeration), the journeys of the participants to the event, catering and lodging for the participants, and event-specific materials and waste. This data was recorded and the CO_2 consumption was calculated with the web-based software myclimate smart 3. The data entered was checked by myclimate to ensure that it is plausible, and at the end we received the climate-neutral label and an overview of the carbon footprint of your event.

The carbon emissions are compensated in high-quality myclimate climate protection projects throughout the world that fulfil the highest standards (Clean Development Mechanism (CDM), Gold Standard, Plan Vivo). The projects reduce the emission of greenhouse gases, thus directly protecting the climate. However, climate protection projects not only reduce climate-impacting emissions, they also contribute to sustainable development in the project region.

myclimate supports projects that use renewable energies, realise energy efficiency measures and cut methane emissions, as well as reforestation and new forest initiatives that reduce the pressure on forests and biodiversity ‘hot spots’. Climate protection projects result in lower CO_2 emissions whilst contributing significantly to sustainable development in the region.

myclimate's international projects are located in developing and emerging countries. The projects meet the highest standards and contribute to the UN's sustainable development goals (SDGs). International myclimate projects not only reduce greenhouse gas emissions but also promote social, ecological and economic development in the region (SDGs). For example, the local population benefits from a higher quality of life or health, the creation of jobs, empowerment as well as the transfer of knowledge and technologies. myclimate climate protection projects also carry out reforestation and new forest initiatives that reduce the pressure on natural forests and species diversity.

myclimate projects cover a total of eleven different technologies for climate protection: waste management, biogas, biomass, efficient stoves, energy efficiency, solar, transport, forests, water (cleaning and saving), water power and wind. myclimate works with selected local project partners, thereby strengthening local initiatives and the transfer of technologies. As a non-profit foundation, myclimate guarantees that at least 80 percent of compensation payments will be used directly in climate protection projects. The remaining maximum 20 percent is needed by the foundation to cover administration and internal costs. Only projects that meet the globally recognised, highest standards can successfully help protect the climate. So myclimate draws on the strictest, most independent quality standards (CDM, Gold Standard and Plan Vivo) when selecting and structuring its own climate protection projects. The foundation works closely with experienced and independent partners in the respective countries to implement climate protection projects. These local partners make sure that local projects are realised professionally, and they also regularly review the projects’ impact. In addition, climate protection projects undergo an annual review by another independent, external body.

More information on myclimate: www.myclimate.org

Scientific Steering Committee

Prof Peter Braesicke
Karlsruhe Institute of Technology, Germany

Prof Achim Brauer
Helmholtz Centre Potsdam GFZ German Research Centre for Geosciences, Germany

PD Dr Hendrik Elbern
University of Cologne and Forschungszentrum Jülich, Germany

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University of Hamburg/Helmholtz-Zentrum Geesthacht Centre for Materials and Coastal Research, Germany

Dr Annette Rinke
Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research, Potsdam, Germany

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Helmholtz Centre Potsdam GFZ German Research Centre for Geosciences, Germany

Dr Ingo Sasgen
Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research, Bremerhaven, Germany

Prof Hans Peter Schmid
Karlsruhe Institute of Technology, Garmisch-Partenkirchen, Germany

Dr Renate Treffeisen
Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research, Bremerhaven, Germany

Important information

Scientific topics and session titles

Topic 1: Coupled regional modelling

Topic 2: Sea level rise in a warming climate: from global drivers to coastal impacts

Topic 3: Land-atmosphere interactions: from measurements to modelling

Topic 4: Atmospheric composition and climate: interaction between global and regional scales

Topic 5: Extreme events across scales (past – present – future)

Topic 6: Climate change adaptation as societal challenge

Rooms

Umweltforum (UFO)

PH: Plenary Hall ('Großer Saal')

S8: Seminar room 8, 1st floor

S9: Seminar room 9, 1st floor

G: Gallery, 1st floor

Neue Mälzerei (M)

MP: Plenary Hall, 5th floor

MKS: Kuppelsaal Süd, 5th floor

MKN: Kuppelsaal Nord, 5th floor

MS: Seminar I+II, 5th floor

Conference Programme

Sunday 22 September	
17:00-20:00	**Pre-registration on site (Foyer UFO)**
18:00-20:00	Icebreaker with drinks and snack

Monday 23 September				
09:00-11:00	**Registration (Foyer UFO)**			
11:00-12:00	**Opening Plenary (PH)**			
	Regine Günther *(Senator for the Environment, Transport and Climate Protection, Berlin)* Prof Peter Braesicke *(Karlsruher Institut für Technologie KIT; scientific coordinator REKLIM)*			
12:00-13:00	**Plenary Session Keynotes (Room PH)**			
	'Toward process-level regional modelling and prediction of Arctic climate system' Prof Wieslaw Maslowski *(Department of Oceanography, Monterey, USA)*			
	'Tipping points in the Earth system: a perspective from the past' Prof Alan Haywood *(School of Earth and Environment University of Leeds, United Kingdom)*			
13:00-14:30	Lunch break (S8 and S9)			
14:30-15:45	**Parallel Sessions I**			
	Room PH	Room MKN	Room MP	Room MS
	Topic 5 Extreme events and their drivers, Part 1 **TP5-O-01 – TP5-O-05**		**Topic 1** Coupled regional modelling: atmosphere – hydrosphere **TP1-O-01 – TP1-O-05**	**Topic 3** Land-atmosphere interactions, Part 1 **TP3-O-01 – TP3-O-05**
15:45-16:15	Coffee break S8		Coffee break MKS	
16:15-17:30	**Parallel Sessions II**			
	Room PH	Room MKN	Room MP	Room MS
	Topic 5 Extreme events and their drivers, Part 2 **TP5-O-06 – TP5-O-10**	**Topic 6** Concepts of adaptation **TP6-O-01 – TP6-O-05**	**Topic 1** Coupled regional modelling: atmosphere – land **TP1-O-06 – TP1-O-10**	**Topic 3** Land-atmosphere interactions, Part 2 **TP3-O-06 – TP3-O-10**

Tuesday 24 September				
09:00-10:15	**Parallel Sessions III**			
	Room PH	Room MKN	Room MP	Room MS
	Topic 5 Lessons from the past, Part 1 **TP5-O-11 – TP5-O-15**	**Topic 6** Case studies of adaptation **TP6-O-06 – TP6-O-10**	**Topic 1** Coupled regional modelling: atmosphere – cryosphere **TP1-O-11 – TP1-O-15**	**Topic 3** Land-atmosphere interactions, Part 3 **TP3-O-11 – TP3-O-15**
10:15-10:45	Coffee break (S8 and S9)			
10:45-11:45	**Plenary Session Keynotes (Room PH)**			
	‘Evaporation happens at all scales: can we use the turbulent flux data improve our models?’ Dr Eleanor Blyth *(Centre for Ecology & Hydrology, Wallingford, United Kingdom)*			
	‘Community-based adaptation and disaster risk management – where climate meets society’ Prof Jakob. Rhyner *(University of Bonn, Germany)*			
11:45-13:15	Lunch break (S8 and S9)			
13:15-14:45	**Open Panel Discussion for conference participants and the public** **‘On the importance of Science Diplomacy in the Arctic realm’ (Room PH)**			
	Prof Rasmus Gjedssø Bertelsen (UiT The Arctic University of Norway, Norway) Embla Eir Oddsdóttir (Director, Icelandic Arctic Cooperation Network, Iceland) Dr Volker Rachold (German Arctic Office, Germany) Prof Maria Rentetzi (Technical University Berlin, Germany) Prof Veli-Pekka Tynkkynen (University of Helsinki, Finland) Moderation: Grace Dobush			
14:45-17:15	**General Poster Session**			
	Gallery 1st floor PH			
	Topic 1 Coupled regional modelling **TP1-P-01 – TP1-P-06** **Topic 2** Sea level rise in a warming climate: from global drivers to coastal impacts **TP2-P-01 – TP2-P-05** **Topic 3** Land-atmosphere interactions: from measurements to modelling **TP3-P-01 – TP3-P-07**		**Topic 4** Atmospheric composition and climate: interaction between global and regional scales **TP4-P-01 – TP4-P-02** **Topic 5** Extreme events across scales (past – present – future) **TP5-P-01 – TP5-P-21** **Topic 6** Climate change adaptation as societal challenge **TP6-P-01 – TP6-P-06**	
17:30	Departure to social event ‘EUREF Campus’ Berlin with guided tour and conference dinner			
18:00	**Social Event**			

Wednesday 25 September				
09:00-10:15	**Parallel Session IV**			
	Room PH	Room MKN	Room MP	Room MS
	Topic 5 Lessons from the Past, Part 2 **TP5-O-16 – TP5-O-20**		**Topic 5** Future extremes: scenarios and forecasting **TP5-O-21 – TP5-O-25**	**Topic 4** The large-scale perspective **TP4-O-01 – TP4-O-05**
10:15-10:45	Coffee break (S8 and S9)			
10:45-11:45	**Plenary Session Keynotes (Room PH)**			
	'Lessons for international action from the Montreal Protocol' Prof John Pyle *(University of Cambridge, United Kingdom)*			
	'Sea level rise - do we have to be afraid or just worried?' Prof Anders Levermann *(Potsdam Institute for Climate Impact Research, Germany)*			
11:45-13:15	Lunch break (S8 and S9)			
13:15-14:30	**Parallel Session V**			
	Room PH	Room MKN	Room MP	Room MS
	Topic 5 Long-term variability of extremes **TP5-O-26 – TP5-O-30**		**Topic 2** Sea level change **TP2-O-01 – TP2-O-05**	**Topic4** The regional perspective **TP4-O-06 – TP4-O-10**
14:30-14:45	Room change			
14:45-15:30	**Open Plenary Session for conference participants and the public** **'Main results of the IPCC Special Report on Ocean and Cryosphere in a changing climate' (Room PH)**			
	'Video conference call directly from Monaco' Prof Hans-Otto Pörtner (IPCC Co-chair, Working Group II) Further experts at conference – general discussion: Prof Anders Levermann (Potsdam Institute for Climate Impact Research (PIK), Germany), Lead author IPCC AR5 Chapter 13 'Sea Level Change' Prof Beate Ratter (University Hamburg and Helmholtz Centre Geesthacht, Germany), Lead author SROCC Chapter 6 'Extremes, Abrupt Changes and Managing Risks' Dr Ingo Sasgen (AWI), Topic Speaker REKLIM Topic 2 'Sea level change from global to regional and local scales' General discussion, press conference			
15:30-16:00	**Closing Plenary (Room PH)**			
	Closing remarks			
16:00-16:30	Coffee break (S8 and S9)			

Public day (in German language)

Thursday 26 September	
08:30-09:00	**Einlass und Registrierung (Foyer UFO)**
09:00-09:40	**Begrüßung (Umweltforum, Raum PH)**
	Dr. Michael Meister (Parlamentarischer Staatssekretär bei der Bundesministerin für Bildung und Forschung)
	Prof. Dr. Antje Boetius (Forschungsbereichskoordinatorin Erde und Umwelt der Helmholtz-Gemeinschaft; Direktorin Alfred-Wegener-Institut Helmholtz-Zentrum für Polar- und Meeresforschung) **Prof. Dr. Peter Braesicke** (Karlsruher Institut für Technologie; wissenschaftlicher Koordinator REKLIM)
09:40-12:00	**KIMAWANDEL VOR DER HAUSTÜR**
	Witterungsextreme und Insekten – Risiken und Risikomanagement in Brandenburgs Wäldern **Dr. Katrin Möller** (Leiterin Fachbereich Waldschutz und Wildökologie, Landesbetrieb Forst Brandenburg, Landeskompetenzzentrum Forst Eberswalde, LFE) **Klimawandel und Waldbrandgefahr im Land Brandenburg** **Frank Kliem** (Vizepräsident Landesfeuerwehrverband Brandenburg)
	Kaffeepause (30 Minuten)
	Dürre 2018 und ihre volkswirtschaftlichen Schäden **Dr. Andreas Marx** (Helmholtz-Zentrum für Umweltforschung UFZ, REKLIM Topic-Sprecher, Leipzig) **Landwirtschaft im Klimawandel – Dürre und Starkregen begegnen** **Dr. Claas Nendel** (Leibniz-Zentrum für Agrarlandschaftsforschung (ZALF) e. V., Müncheberg) **Regenwassermanagement in Berlin unter den Anforderungen des Klimawandels** **Dr. Carin Sieker** (Leiterin Strategie im Bereich Abwasserentsorgung der Berliner Wasserbetriebe BWB)
	Gesprächsrunde mit den Vortragenden
12:30-13:45	**Mittagspause mit Imbiss und Gelegenheit** zu Gesprächen im Foyer
13:45-15:30	**ZUKUNFT GEMEINSAM GESTALTEN**
	Impulsvortrag | Veränderungen wahrnehmen – Zukünfte gestalten: Der Klimawandel als soziale Herausforderung **Prof. Dr. Beate Ratter** (Universität Hamburg und Helmholtz-Zentrum Geesthacht; REKLIM Topic-Sprecherin)
	Podiumsdiskussion | Was bedarf es, um die Zukunft gemeinsam nachhaltig zu gestalten? **Raphael Fellmer** (SIRPLUS – Social Impact Startup gegen Lebensmittelverschwendung) **Prof. Dr. Maja Göpel** (Generalsekretärin Wissenschaftlicher Beirat der Bundesregierung Globale Umweltveränderungen, WBGU) **Prof. Dr. Beate Ratter** (Universität Hamburg und Helmholtz-Zentrum Geesthacht; REKLIM Topic-Sprecherin) **Martin Schmied** (Umweltbundesamt, Leiter Abteilung I 2 Verkehr, Lärm und räumliche Entwicklung) **Alexia Wolf** (Fridays for Future, Regionalgruppe Rostock) *Moderation: Hellmuth Henneberg (rbb Rundfunk Berlin-Brandenburg)*
ab 15:30	Gelegenheit zu Gesprächen bei Kaffee und Kuchen

Plenary Lectures

Monday, 23 September 2019

Umweltforum, Room PH, Plenary Hall (‘Großer Saal‘)

9:00 **Registration (Foyer)**

11:00 **Opening Plenary**

Regine Günther

(Senator for the Environment, Transport and Climate Protection, Berlin)

Prof Dr Peter Braesicke

(Karlsruher Institut für Technologie KIT; scientific coordinator REKLIM)

12:00 **Keynote Lecture 1 – Topic 1**

‘Toward Process-Level Regional Modelling and Prediction of Arctic Climate System’

Prof Wieslaw Maslowski (Department of Oceanography, Monterey, USA)

12:30 **Keynote Lecture 2 – Topic 5**

‘Tipping points in the Earth system: a perspective from the past‘

Prof Alan Haywood (School of Earth and Environment University of Leeds, United Kingdom)

Lunch break (Umweltforum, Room S8 and Room S9)

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Tuesday, 24 September 2019

…

Umweltforum, Room PH, Plenary Hall (’Großer Saal‘)

10:45 **Keynote Lecture 3 – Topic 3**

‘Evaporation happens at all scales: can we use the turbulent flux data improve our models?’

Dr Eleanor Blyth (Centre for Ecology & Hydrology, Wallingford, United Kingdom)

11:15 **Keynote Lecture 4 – Topic 6**

‘Community-based adaptation and disaster risk management – where climate meets society’

Prof Jakob. Rhyner (University of Bonn, Germany)

Lunch break (Umweltforum, Room S8 and Room S9)

13:15 **Open Plenary Session for conference participants and the public**

'On the importance of Science Diplomacy in the Arctic realm'

Prof Rasmus Gjedssø Bertelsen (UiT The Arctic University of Norway, Norway)

Embla Eir Oddsdóttir (Director, Icelandic Arctic Cooperation Network, Iceland)

Dr Volker Rachold (German Arctic Office, Germany)

Prof Maria Rentetzi (Technical University Berlin, Germany)

Prof Veli-Pekka Tynkkynen (University of Helsinki, Finland)…

Wednesday, 25 September 2019

…

Umweltforum, Room PH, Plenary Hall ('Großer Saal')

10:45 **Keynote Lecture 5 – Topic 4**

'Lessons for international action from the Montreal Protocol'

Prof John Pyle (University of Cambridge, United Kingdom)

11:15 **Keynote Lecture 6 – Topic 2**

'Sea level rise - do we have to be afraid or just worried?'

Prof Anders Levermann (Potsdam Institute for Climate Impact Research, Germany)

Lunch break (Umweltforum, Room S8 and Room S9)

14:45 **Open Plenary Session for conference participants and the public**

'Main results of the IPCC Special Report on Ocean and Cryosphere'

Video conference call directly from Monaco

Prof Hans-Otto Pörtner (IPCC Co-chair, Working Group II

Further experts at conference – general discussion:

Prof Anders Levermann (Potsdam Institute for Climate Impact Research (PIK), Germany), Lead author IPCC AR5 Chapter 13 'Sea Level Change'

Prof Beate Ratter (University Hamburg and Helmholtz Centre Geesthacht, Germany), Lead author SROCC Chapter 6 'Extremes, Abrupt Changes and Managing Risks'

Dr Ingo Sasgen (AWI), Topic Speaker REKLIM Topic 2 'Sea level change from global to regional and local scales'

General discussion - press conference

15:30 **Closing remarks**

Session Programme Topic 1

Coupled regional modelling

Programme Oral Presentations

Convener: Annette Rinke, Burkhardt Rockel

Regional climate system models consist of high-resolution and complex model components for the atmosphere, ocean, ice, land surface, soil, vegetation, and chemicals. Regional information on climate variability and climate change, though urgently needed, is often deemed unreliable. The application of regional climate modelling, which provides more accurate descriptions of regional-to-local scale climate phenomena and interactions, can help us interpret regional observational data and understand the causes of as well as trends in regional climate variability and change.

We encourage submissions that advance our understanding of the processes that determine regional climate variability and of feedback processes between various climate components. These include, but are not limited to, the hydrological cycle, aerosol-cloud-radiation feedbacks, atmosphere-ice-ocean and atmosphere-land surface interactions, and linkages with the ocean ecosystem. Further, we encourage submissions that concern the evaluation of regional models, the impact of regional forcings (e.g. land use, aerosol loading) and sub-grid-scale model parameterisations, and internal model variability, which assess the added value of high-resolution and coupled modelling and which discuss future regional climate projections. The session includes the simulation of extreme events such as storms and their effects (e.g. heavy precipitation or dust pollution) as well as their impacts on coastal erosion and ocean wave height.

Key questions include:

How does the development of the climate depend on the interaction between atmosphere, ocean, ice, and land surfaces? What are the key processes and feedbacks that determine regional climate variability and change?

Monday, 23 September 2019

Neue Mälzerei, Room MP, Plenary Hall, 5th floor

Coupled regional modelling: atmosphere – hydrosphere

14:30 TP1-O-01: Braesicke, P.: Advancing Earth System Modelling to address pressing challenges

14:45 TP1-O-02: Dreier, N., P. Fröhle: Effects of regional climate change on the wave conditions in the Western Baltic Sea and impacts on the coast

15:00 TP1-O-03 Strigunova, I.: Sensitivity of wave forecast model to parametrisations of planetary boundary layer

15:15 TP1-O-04: Rulent, J.: Application of high resolution coupled model to the spatial distribution analysis of coastal total water level (TWL) during extreme waves events

15:30 TP1-O-05: Bonaduce, A., J. Staneva, S. Grayek, A. Wiese, A. Behrens, J. Schulz-Stellenfleth, D. Jacob, C. Schrum: Coupling of ocean and atmosphere in GCOAST system through a dynamic wave interface

Neue Mälzerei, Room MP, Plenary Hall, 5th floor

Coupled regional modelling: atmosphere – land

16:15 TP1-O-06: Werchner, S., C. Hoose, A. Pauling, H. Vogel, B. Vogel: Impact of subpollen particles on ice nucleation in clouds: A modelling study using ICON-ART

16:30 TP1-O-07: Gadian, A.: Summer convective precipitation over the UK and Europe from a regional weather projection

16:45 TP1-O-08: García Rosales, A., R. Porfirio da Rocha, C. Junquas: Valley-mountain circulation associated with precipitation formation in the tropical Andes (Rio Santa Basin)

17:00 TP1-O-09: Rohde, A., S. Werchner, G. Hoshyaripour, H. Vogel, B. Vogel: The Impact of mineral dust on optical properties of snow during an extreme event

17:15 TP1-O-10: Schwob, A., A. Foehn, J. Fluixá-Sanmartín, D. Pasetto, G. De Cesare, J. García Hernández: Implementation of an Ensemble Kalman Filter to forecast extreme meteorological events in the Upper Rhone River Basin

Tuesday, 24 September 2019

Coupled regional modelling: atmosphere – cryosphere

Neue Mälzerei, Room MP, Plenary Hall, 5th floor

09:00 TP1-O-11: Khosravi, N., T. Semmler, T. Jung: Regional sea-ice according to the CMIP6 models in comparison to CMIP5 and satellite-based observations

09:15 TP1-O-12: Sumata, H., F. Kauker, M. Karcher, R. Gerdes: Covariance of optimal parameters of an Arctic sea ice-ocean model

09:30 TP1-O-13: Lelli, L.: Changes of top-of-atmosphere reflectance and cloud properties in the Arctic from 1996 to the present and its relationship to Arctic Amplification

09:45 TP1-O-14: Rex, M., M. Shupe, K. Dethloff, A. Sommerfeld, international MOSAiC Team: The Multidisciplinary drifting Observatory for the Study of Arctic Climate (MOSAiC)

10:00 TP1-O-15: Jaiser, R., E. Romanowsky, D. Handorf, K. Dethloff, M. Rex: Atmospheric mechanisms for Arctic-mid-latitude linkage

Programme Poster Presentations

General Poster Session

Tuesday 24 September 2019
14:15 – 17:15
Umweltforum, Gallery 1st floor

Session Programme Topic 2

Sea-level rise in a warming climate: from global drivers to coastal impacts

Programme Oral Presentations

Convener: Klaus Grosfeld, Birgit Hünicke, Peter Lemke, Ingo Sasgen

Sea-level rise is one of the farthest-reaching consequences of climate change, threatening densely populated coastal areas around the world. With a projected increase of over one metre within the next few centuries, sea-level rise will affect agricultural areas, large conurbations, industrial centres, habitats and the territories of many countries.

This session will present new research addressing sea-level change from global to local scales. We welcome contributions on global ice, ocean, and atmospheric drivers of sea-level change, on the propagation of the sources, and on changing local mean and extreme sea levels, tackling changes in any part of the world, and in the distant past, recent history and in the future.

Key questions include:

How can we consistently connect observations and simulations of sea-level rise and their impacts across temporal and spatial scales? How do global ice, ocean and atmospheric drivers, as well as land motion, influence mean and extreme sea levels along coastlines? What can we learn from the past? How do natural and anthropogenic sea-level variations affect (societal) coastal risks and ecosystem changes?

Wednesday, 25 September 2019

Neue Mälzerei, Room MP, Plenary Hall, 5th floor

13:15	TP2-O-01: Sasgen, I., F. Landerer, F. Flechtner: Observations of the individual contributions to global mean sea-level rise
13:30	TP2-O-02: Rückamp, M., A. Humbert: Projections of the Greenland Ice Sheet contribution to sea level rise – contribution to ISMIP6-projection-Greenland
13:45	TP2-O-03: Gerkema, T., T. Frederikse, M. Duran-Matute: Inter-annual and decadal variability of (seasonal) mean sea level and its sensitivity to wind climate
14:00	TP2-O-04: Bierstedt, S.,E. Zorita, B. Hünicke: Daily extreme sea level in South-East Asia: statistical downscaling with random forest.
14:15	TP2-O-05: Bagge, M., V. Klemann, M. Latinović, B. Steinberger, M. Thomas: The solid Earth structure as driver for viscoelastic relaxation and relative sea-level change during the last deglaciation

Programme Poster Presentations

General Poster Session

Tuesday 24 September 2019
14:15 – 17:15
Umweltforum, Gallery 1st floor

Session Programme Topic 3

Land-atmosphere interactions: from measurements to modelling

Programme Oral Presentations

Convener: Birgit Heim, Andreas Marx, Heidrun Matthes, Torsten Sachs, Hans Peter Schmid

The land surface contributes significantly to climate change and its regional differences. In addition, climate impacts mainly occur on the land surface, affecting its key ecosystem services and human well-being. This raises a number of questions concerning e.g. how future changes will influence the interaction between the land surface and the atmospheric boundary, which impacts are expected in relation to water, energy and material flows, and what ecological and socio-economic effects will be produced. That being said, the meteorological, hydrological, biophysical, biogeochemical, ecological, boundary-layer, and socio-economic processes that underlie the connections between weather/climate, land surface functioning (soil moisture, soil temperature, vegetation, snow, and frozen soil, biogeochemical cycling), and land-use change are not yet fully understood. The complexity of these processes and feedbacks, as well as the wide range of scales involved, are formidable challenges that must be met in order to consistently obtain useful, high-resolution observations.

This session welcomes contributions that improve our understanding of land surface–atmosphere interactions in the following regards:

- bridging spatial and temporal scales from ground observations towards operational Earth observation and modelling;
- the application and analyses of local and large-scale field data, observational networks (such as TERENO, ICOS, FLUXNET), and satellite observations for land-atmosphere studies;
- the linkages between land-cover and land-use changes and climate;
- the relations between land-use change and climate change, as well as the implications for ecosystem/climate services and socio-economic change.

Key questions include:

How do climate and land use affect ecosystems, water resources, agriculture, and forestry? What are the effects of global climate change on climate-sensitive regions (e.g. mountain areas, highly populated regions, arid/semi-arid regions, the Arctic, and permafrost regions)? How can our understanding of climate-relevant processes be advanced by new technologies and methods for measurement, data science, and modelling?

Monday, 23 September 2019

Neue Mälzerei, Room MS, Seminarroom I+II, 5th floor

Land-atmosphere interactions – Part 1

14:30 TP3-O-01: Kiese, R., K.Petersen, D. Kraus, P. Calanca: Impacts of climate change and land management on C and N dynamics of pre-alpine grassland ecosystems

14:45 TP3-O-02: Jehn, F., P. Kraft, L. Breuer: Discharge independent of storage deficit? The summer 2018 as a hydrological experiment

15:00 TP3-O-03: Moulin, T., P. Calanca: Modelling grassland biodiversity under climate change and implications for ecosystem services

15:15 TP3-O-04: Peichl, M., S. Thober, A. Marx: Impacts on winter wheat yield in Germany at 1.5º, 2º, and 3º global warming

15:30 TP3-O-05: Pütz, T., J. Groh, H. H. Gerke, M. Brunke, M. Ramati, H. Vereecken: The importance of dew or frost formation for the water balance of grassland sites

Neue Mälzerei, Room MS, Seminarroom I+II, 5th floor

Land-atmosphere interactions – Part 2

16:15 TP3-O-06: Matthes, H., A. Rinke: The relationship between Arctic air and soil temperatures mediated by snow – insights from observations and regional model sensitivity experiments

16:30 TP3-O-07: Stünzi, S., J. Boike, S. Kruse, U. Herzschuh, M. Langer: Modelling permafrost sensitivity in Arctic forest

16:45 TP3-O-08: Daloz, A. S.:Direct and indirect impacts of climate change on wheat yield in the Indo-Gangetic plain

17:00 TP3-O-09: Schrapffer, A., A. Sörensson, J. Polcher, L. Fita Borrell: Relevance of floodplains in a LSM for simulation of evapotranspiration over the tropical wetland Pantanal

17:15 TP3-O-10: Dieng, D., P. Laux, G. Smiatek, D. Heinzeller, H. Kunstmann: Climate change impact on agro-climatological indices across West Africa

Tuesday, 24 September 2019

Neue Mälzerei, Room MS, Seminarroom I+II, 5th floor

Land-atmosphere interactions – Part 3

09:00 TP3-O-11: Warren, R., P. Jeff, N. Forstenhaeusler: The potential for ecosystem restoration to contribute to achieving net zero greenhouse gas emissions in Europe by 2050

09:15 TP3-O-12: Lund, M., B. Samset: Secondary organic aerosols from projected future large-scale vegetation changes in low-emission scenarios

09:30 TP3-O-13: Goergen, K., C. Furusho-Percot, J. Keune, M. Eltahan, C. Hartick, S. Kollet: Integrated simulation of the terrestrial water cycle with the fully coupled Terrestrial Systems Modelling Platform (TSMP)

09:45 TP3-O-14: Bathiany, S., J. El Zohbi, A. Kriegsmann, S. Pfeifer, D. Rechid, K. Goergen: Developing innovative information products for a weather- and climate-resilient agriculture in Germany

10:00 TP3-O-15: Bayr, D., A F. Kolek, A. Straub, M. Plaza, V. Leier-Wirtz, M. Gökkaya, G. Hammel, J. Oteros, J. Buters, K. Toelken, S. Hilgers, V. Schwierzeck, S. Knoch, S. Bezold, I. Beck, N. Bounas-Pyrros, A. Todorova, S. Kaschuba, S. Seubert, M. Gerstlauer, C. Beck, C. Traidl-Hoffmann, S. Gilles, A. Philipp, A. Damialis: Thunderstorm asthma: an underestimated public health threat? Implicated aeroallergens and impact on allergic symptoms

Programme Poster Presentations

General Poster Session

Tuesday 24 September 2019
14:15 – 17:15
Umweltforum, Gallery 1st floor

Session Programme Topic 4

Atmospheric composition and climate: interactions between global and regional scales

Programme Oral Presentations

Convener: Peter Braesicke, Hendrik Elbern, Roland Ruhnke, Bärbel Vogel

The global atmospheric composition-climate system encompasses a broad range of scales and feedbacks. The full chain from global to regional challenges of applying models and atmospheric observations is explored. Chemical budgets are investigated, as well as stratosphere-troposphere exchange, tropopause structure, and aerosol impacts on the global scale. On smaller scales, one focus is on the interactions of clouds, precipitation, and composition; another is on the urban environment and its impact on atmospheric composition and climate, especially with regard to urban heat stresses and air quality including their impacts on humans and ecosystems. We welcome all contributions addressing these challenges.

Key questions include:

What are the dominant regional feedback mechanisms between atmospheric chemistry and circulation, including emissions and surface processes? What are the most important factors shaping interactions between regional climate change and atmospheric composition? What are the potential impacts of climate change and air-quality changes on human health and ecosystems?

Wednesday, 25 September 2019

Neue Mälzerei, Room MS, Seminarroom I+II, 5th floor

The large-scale perspective

09:00 TP4-O-01: Laeng, A.: On the unreported emissions of CFC-11: did the story started in 2012?

09:15 TP4-O-02: Speidel, J., G. Stiller, N. Glatthor, M. Kiefer: Water vapour transport through the Asian monsoon tropopause: Analysis of H_2O and HDO observations from MIPAS

09:30 TP4-O-03: Robrecht, S., B. Vogel, S. Tilmes, R. Müller: Impact of water vapour on ozone in the mid-latitude lowermost stratosphere in summer

09:45 TP4-O-04: Braesicke, P., J. Schröter, M. Braun, S. Wang, M. Weimer, R. Ruhnke: On the role of stratospheric ozone in the interactive chemistry-climate system

10:00 TP4-O-05: Vogel, A., H. Elbern: Optimised probabilistic forecasts for uncertain coupled parameters in chemistry transport modelling

Neue Mälzerei, Room MS, Seminarroom I+II, 5th floor

The regional perspective

13:15 TP4-O-06: Spindler, G., A. Grüner, R. Rabe, H. Herrmann: A twenty-six year long-term trend for particulate matter (PM) at the rural background in Germany – influence of air mass inflow and season

13:30 TP4-O-07: Fiehn, A., T. Klausner, M. Pühl, M. Mertens, P. Jöckel, A. Roiger: Urban emissions from the Berlin and Stuttgart areas: A case study using aircraft-based CO_2, CH_4, NO_2 and O_3 in-situ observations

13:45 TP4-O-08: Mei, L., J.P. Burrows, M. Vountas, L. Lelli, V. Rozanov: Aerosol optical depth variability in the Arctic during past decades (1980 - 2018) seen from satellite: achievements and perspectives

14:00 TP4-O-09: Muser, L., H. Vogel, G. Hoshyaripour, S. Gruber, S. Werchner, M. Weimer, C. Kottmeier, B. Vogel: Application of a new aerosol scheme to quantify the aging of aerosols emitted by the Eyjafjallajökull eruption

14:15 TP4-O-10: Yukhymchuk, Y., G. Milinevsky, V. Bovchaliuk, V. Danylevsky, P. Goloub, P. Dubuisson: Regional radiative forcing due to biomass burning aerosol pollution in Kyiv region

Programme Poster Presentations

General Poster Session

Tuesday 24 September 2019
14:15 – 17:15
Umweltforum, Gallery 1st floor

Session Programme Topic 5

Extreme events across scales (past, present, future)

Programme Oral Presentations

Convener: Achim Brauer, Frauke Feser, Michael Kunz, Ralf Tiedemann

Extreme meteorological and hydrological events can have various, far-reaching impacts on mankind and play a major role in Earth's evolution. Moreover, they occur on a wide range of spatial and temporal scales, from minutes to millennia. Combining climate data, palaeo-records, and model simulations allows us to identify and better understand extreme events, their long-term changes, and underlying mechanisms, which is in turn essential to predicting their future probability. This session invites contributions from different disciplines that address: the temporal and spatial variability of short-term extremes, their driving factors and how they develop under changing climate conditions; the relation between extreme events and large-scale changes in ocean-atmosphere circulation and feedback on a broad range of time scales from the decadal to palaeo; and identifying the dynamics, causes, and impacts of tipping points that produce critical transitions in the climate system.

Key questions include:

How and why has the severity and frequency of extreme weather events changed over the past few decades? How do we expect climate to evolve in the future? Which mechanisms, processes and regional climate patterns intensify abrupt climate changes during interglacials and glacial-interglacial transitions? How do these patterns differ compared to the last interglacial, the Eemian, when the average temperature was roughly 1–2 °C higher than it is now?

Monday, 23 September 2019

Umweltforum, Room PH, Plenary Hall ('Großer Saal')

Extreme events and their drivers, Part 1

14:30	TP5-O-01: Punge, H. J., K. Bedka, M. Kunz: Estimation of severe convective storm hazards using reanalysis-derived indices
14:45	TP5-O-02: Brix, H., C. Schütze, P. Fischer, U. Koedel, A. Wieser, Y. Voynova, The MOSES-Team: Exploring hydrological xxtremes across Earth system compartments: The Elbe as a case study
15:00	TP5-O-03: Tveit, T.: A whirlwind romance: The effect of hurricanes on fertility in early 20th century Jamaica
15:15	TP5-O-04: Marx, A., S. Thober, F. Boeing, L. Samaniego: The 2018 drought in Germany
15:30	TP5-O-05: Meyer, E. M. I., R. Weisse, B. Tinz, T. Möller: Reconstruction of the strong storm tide in March 1906 in the German Bight

Umweltforum, Room PH, Plenary Hall ('Großer Saal')

Extreme events and their drivers, Part 2

16:15 TP5-O-06: Grams, C. M.: Modulation of surface weather and extremes by weather regimes in the Atlantic-European region

16:30 TP5-O-07: Mohr, S., M. Kunz, J. Wandel, O. Martius: Severe convective storms in Europe and their relation to large-scale mechanisms

16:45 TP5-O-08: Kunz, M., D. Piper, S. Mohr: Large-scale flow and teleconnection patterns are important drivers for the temporal variability of thunderstorms in Europe

17:00 TP5-O-09: Somorowska, U.: Extreme soil drought events across Poland from 2003 to 2018: understanding the dynamics and drivers

17:15 TP5-O-10: Pandey, B. W.: Climate change adaptation and vulnerability assessment: A case study of lesser Himalaya

Tuesday, 24 September 2019

Umweltforum, Room PH, Plenary Hall ('Großer Saal')

Lessons from the Past, Part 1

09:00 TP5-O-11: Obreht, I., L. Wörmer, A. Brauer, J. Wendt, S. Alfken, M. Elvert, K.-U. Hinrichs: Forcing mechanisms behind the time-transgressive Younger Dryas cooling across the North Atlantic realm

09:15 TP5-O-12: Müller, D., R. Tjallingii, A. M. Noryśkiewicz, M. J. Schwab, M. Słowiński, M. Błaszkiewicz, A. Brauer: Climatic and environmental changes during the Younger Dryas cold period in Lake Gościąż

09:30 TP5-O-13: Blanchet, C., R. Tjallingii, A. Ramisch, J. Mingram, M. Frank, A. Brauer: Flood dynamics during the last Saharan humid period: clues from a laminated record from the Nile deep-sea fan

10:00 TP5-O-14: Lembke-Jene, L., R. Tiedemann, X. Gong, D. Nürnberg, J. Zou, X. Shi, G. Lohmann: Rapid changes in north Pacific climate over the past 12 ka: baseline decadal-millennial-scale variations vs. threshold changes

10:15 TP5-O-15: Neugebauer, I., M. Dinies, B. Plessen, N. Dräger, A. Brauer, P. Hoelzmann, R. Tjallingii, M. Engel: Humid northern Arabia during low-latitude early Holocene dry anomaly promoted by tropical plumes? – A suggestion from a unique varved lake record

Wednesday, 25 September 2019

Umweltforum, Room PH, Plenary Hall ('Großer Saal')

Lessons from the Past, Part 2

09:00 TP5-O-16: Ziegler, E., K. Rehfeld: Transient simulation of climate during the last 30,000 years with an energy balance climate model

09:15 TP5-O-17: Hérbert, R., U. Herzschuh, T. Laepple: Using a large database of pollen assemblages to quantify the centennial to multi-millennial vegetation

09:30 TP5-O-18: Hathorne, E., K. Thirumalai, K. Kerr, D. Gebregiorgis, W. Park, L. Giosan, B. N. Nath, P. Anand: .: Extremes of the enhanced South Asian monsoon during the last two interglacials reconstructed via individual foraminifer shell analyses

09:45 TP5-O-19: Mollenhauer, G., V. Meyer, M. Winterfeld, P. Köhler, W. Dummann, L. Lembke-Jene, J. Hefter, R. Tiedemann: Contribution of pre-aged carbon mobilized from thawing permafrost to rapid atmospheric CO_2 increases during the last deglaciation

10:00 TP5-O-20: Korn, D., A. Ghaderi, W. Kiessling: Ammonoid evolution and early warning signs for global warming during the end-Permian mass extinction

Neue Mälzerei, Room MP, Plenary Hall, 5th floor

Future extremes: scenarios and forecasting

09:00 TP5-O-21: Scoccimarro, E., P. G. Fogli, S. Gualdi: Extreme events of perceived temperature over Europe in the future: the humidity role.

09:15 TP5-O-22: Wilcke, R., E. Kjellström, E. Engström, T. Koenick, D. Matei, A. Moberg, E. Tyrlis: The extreme summer 2018 in Sweden – in historical and future context

09:30 TP5-O-23: Lind, P., D. Belusic, E. Toivonen, R. A. Pedersen, D. Lindstedt, F. Wang, A. Dobler, E. Kjellström: Future response of precipitation extremes over the Nordic region in a convection-permitting regional climate model

09:45 TP5-O-24: Weber, U., C. Schütze, Moses Team: MOSES: A novel observing system for highly dynamic events

10:00 TP5-O-25: Dafka, S., A. Toreti, P. Zanis, E. Xoplaki, J. Luterbacher: Future changes of Etesian winds from EURO-CORDEX models

Umweltforum, Room PH, Plenary Hall ('Großer Saal')

Long-term variability of extremes

13:15 TP5-O-26: Ludwig, R., A. Frigon, M. Leduc, J. Weismueller, M. Mittermeier, F. Willkofer, R. Wood, F. von Trentini: Assessing the impacts of climate change and natural variability on hydrological extreme events over Eastern North America and Europe

13:30 TP5-O-27: Ehmele, F., L.-A. Kautz, H. Feldmann, J. G. Pinto: Long-term trends and variability of heavy precipitation across Central Europe – past, present, and future

13:45 TP5-O-28: Lang, A., U. Mikolajewicz: Extreme storm floods in the German Bight - from past variability to future changes

14:00 TP5-O-29: Krueger, O., F. Feser, R. Weisse, D. Krieger.: Long-term storm activity and its uncertainty over the Northeast Atlantic and North Sea regions

14:15 TP5-O-30: Kabir, M. H., G. Kirchengast, K. Schroeer: Investigating climate warming-driven intensification of short duration extreme convective precipitation events in the south eastern Alpine forelands of Austria

Programme Poster Presentations

General Poster Session

Tuesday 24 September 2019
14:15 – 17:15
Umweltforum, Gallery 1st floor

Session Programme Topic 6

Climate change adaptation as societal challenge

Programme Oral Presentations

Convener: Beate Ratter, Reimund Schwarze

Climate change adaptation is more than a technical matter: it is a major societal challenge encompassing social, economic, and cultural aspects alike. Further, large research gaps and considerable uncertainties concerning political and governance aspects, as well as socio-cultural barriers to adaptation, still need to be addressed. However, it is the reluctance to take action, rather than a knowledge deficit with regard to climate change, that represents the most pressing issue.

The various environmental uncertainties in different societies must be addressed through regionally and socially embedded adaptation measures, disaster prevention, and mitigation strategies. What insights and advances have recently been achieved in climate change adaptation research? How can environmental corporate social responsibility be attained? How can scientific findings be transformed into societal action? As this session will show, adaptation involves overcoming a broad range of obstacles so as to support vulnerability reduction, enhance social resilience, and help minimise the negative effects of climate change.

Key questions include:

What societal risks does climate change entail? Which socio-cultural barriers to adaptation have to be overcome? How can adaptation measures, disaster prevention, and mitigation strategies be successfully combined to tackle climate change? How can scientific findings be transformed into societal action?

Monday, 23 September 2019

Neue Mälzerei, Room MKN, Kuppelsaal Nord, 5th floor

Concepts of adaptation

16:15 TP6-O-01: Döring, M., S. Mohr, B. Ratter, F. Feser, M. Kunz, T. Kunz-Plapp: The regional perception of extreme weather events in Germany. Part 2: An analysis of weather epistemologies in North Frisia

16:30 TP6-O-02: Kreibich, H., V. Blauhut, J. C. J. H. Aerts, L. M. Bouwer, H. A. J. Van Lanen, A. Mejia, M. Mens, A. F. Van Loon: Paired flood and drought event analyses to support climate adaptation

16:45 TP6-O-03: Haße, C.: How to tackle transboundary climate change impacts?

17:00 TP6-O-04: Schumacher, L.: The power of law: the potential of legal regulations and instruments to enable and promote climate change adaptation

17:15 TP6-O-05: Döring, M., B. Ratter, J. Fröhlich, B. Graf: From climate knowledge to climate action: Creating regional communities of practice against climate change

Tuesday, 24 September 2019

Neue Mälzerei, Room MKN, Kuppelsaal Nord, 5th floor

Case studies of Adaptation

09:00 TP6-O-06: Stupak, N.: Adaptation of Russian agriculture to climatic variability: The role of federal and provincial policies

09:15 TP6-O-07: Saroar, Md M.: Adaptive polder management for resilient socio-ecological systems in coastal Bangladesh

09:30 TP6-O-08: Kropf, B., H. Mitter, K. Karner, E. Schmid: Water-Energy-Land: A cross-sectoral perspective to foster long-term resource use efficiency under changing climate conditions

09:45 TP6-O-09: Foshag, K., N. Aeschbach, B. Höfle, R. Winkler, A. Siegmund, W. Aeschbach: Maintaining the viability of public spaces in cities under increasing heat stress in a warming climate – a transdisciplinary design

10:00 TP6-O-10: Gussmann, G.: Responding to rising seas? The Governance of relocations in the Maldives

Programme Poster Presentations

General Poster Session

Tuesday 24 September 2019
14:15 – 17:15
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General Poster Session

Tuesday 24 September

14:45 – 17:15

Umweltforum, Gallery 1st floor

Poster: Topic 1

TP1-P-01 Akhtar, N., B. Rockel: Mesoscale resolving high-resolution simulation of wind farms in COSMO-CLM 5

TP1-P-02 Dai, D.: Regional climate modelling over China's Haihe river basin: evaluation of the WRF Physics Ensemble using Multivariable Integrated Evaluation Approach

TP1-P-03 Buehler, J., C. Roesch, K. Rehfeld: Comparison of isotopic signatures in speleothem records and model simulations for the past millennium

TP1-P-04 Bresson, H., A. Rinke, V. Schemann, S. Crewell, C. Viceto, I. Gorodetskaya: Atmospheric Rivers over the Arctic with the ICON model

TP1-P-05 Teichmann, C., A. R. Remedio, K. Bülow, K. Sieck, L. Buntemeyer, E. Coppola, F. Giorgi, D. Jacob: The CORDEX-CORE Initiative: High resolution regional climate information for the world

TP1-P-06 Lu, Z., N. Yuan: Research on impacts of El Niño events based on phase transition of complex climate network

Poster: Topic 2

TP2-P-01 Fofonova, V., I. Kuznetsov, A. Androsov, K. Wiltshire: The changes in the North Sea tidal residual circulation induced by sea level rise based on FESOM-C

TP2-P-02 Krebs-Kanzow, U., P. Gierz, S. Xu, G. Lohmann: A surface mass balance scheme including the diurnal cycle of solar radiation for ice sheet simulations on long time scales

TP2-P-03 Sidorenko, D., Q. Wang, N. Koldunov, S. Danilov, P. Scholz, D. Sein, T. Semmler, T. Rackow, H. Goessling, N. Rakowsky, W. Cabos, T. Jung: North Atlantic climate in FESOM2-ECHAM

TP2-P-04 Salles, A., I. Sasgen: The mass balance response of Arctic glaciers to weakening jet stream dynamics

TP2-P-05 Timmermann, R.,T. Albrecht: Coupled ocean-ice simulation of the Weddell Sea Basin, Antarctica

Poster: Topic 3

TP3-P-01 Gustafson, A.: The influence of shrub and tree expansion in the forest tundra ecotone on land surface feedbacks and carbon cycling

TP3-P-02 Zheng, Z.: Changes in water resources since 21st century over China: From the perspective of terrestrial water storage

TP3-P-03 Haq, M. A., N. Chahal, G. Rahaman, P. Baral, N. T. Deepak, J. Akhtar: Understanding inter-relationship between environmental attributes in Himachal Pradesh in India using MODIS data sets and machine learning algorithms

TP3-P-04 Gottschalk, P., C. Wille, F. Koebsch, T. Sachs: Atmospheric carbon fluxes of a formerly drained fen up to 14 years after rewetting

TP3-P-05 Heim, B., M. Wieczoreck, A. Irrgang, B. Biskaborn, H. Matthes, G. Grosse, A. Haas, S. Westermann: ESA CCI+ Permafrost - Validation using international and national permafrost monitoring networks

TP3-P-06 Varchim, P., I. Nitze, B. Heim, S. Kruse, E. Dietze: Regional fire regimes and landscape interaction in boreal forests of central Yakutia, eastern Siberia, Russia

TP3-P-07 Haas, A.. B. Heim, A. Bartsch, A. Walter, C. Schäfer-Neth, F. M. Seifert: Permafrost-related research data - their accessibility, visualisation, and publication using GIS and WebGIS technology

Poster: Topic 4

TP4-P-01 Sonnabend, J., J.-U. Grooß, R. Müller: First steps to ICON/MESSy as an Atmospheric Chemistry Model: CLaMS trajectory calculations of trace species on ICON wind fields at the polar vortex region

TP4-P-02 Jensen, C. M., T. Erhardt, H. Fischer: First continuous high-resolution aerosol record from the East Greenland Ice Core Project (EGRIP), covering the last 9670 years

Poster: Topic 5

TP5-P-01 Garderen van, L., F. Feser, T. G. Shepherd: A Spectrally Nudged Global Storyline: attributing the effect of climate change in historical extreme events

TP5-P-02 Seidel, P.: Impacts of extreme weather events on plant pests and plant protection - does it matter?

TP5-P-03 Fischer, M., H. Rust, U. Ulbrich: Improving statistical modelling of extreme precipitation return-levels in Germany by using spatial and seasonal variations

TP5-P-04 Bouwer, L., C. Nam, K. Sieck, D. Rechid: Large climate datasets to support the development of Climate Services: examples from Digital Earth

TP5-P-05 Galfi, V. M.: An analysis of persistent extreme events based on large deviation theory

TP5-P-06 Ludwig, P., L. Mathias, J. G. Pinto: Synoptic-scale conditions and convection-resolving hindcast experiments of a cold-season derecho on 3 January 2014 in Western Europe

TP5-P-07 Schrum, C., F. Reith, T. Weigel, E. Zorita: HAICU-Local Unit AIM

TP5-P-08 Bagheri Dastgerdi, S., M. Werner, J.-L. Bonne, M. Behrens, M. Hörhold, G. Lohmann: Continuous monitoring of surface water vapour isotopic composition at Neumayer-III station

TP5-P-09 Stepanek, C., E. Samakinwa, G. Lohmann: The Mid Pliocene Warm Period as a test bed for future climate? Inferences from an Earth System Model

TP5-P-10 Adam, M.: Quantifying the similarity of globally distributed pollen records with paleo-climate networks

TP5-P-11 Fofonova, V., J. Rick, A. Androsov, L. Sander, C. Hass, I. Kuznetsov, K. Wiltshire: The analysis of the salinity variations in the Sylt-Rømø Bight during annual cycle

TP5-P-12 Rimbu, N., M. Ionita-Scholz, G. Lohmann: Interannual to millennial scale variability of river Ammer floods and its relationship with solar forcing

TP5-P-13 Gliwa, J., M. Wiedenbeck, M. Schobben, M.-B. Forel, S. Crasquin, A. Ghaderi, D. Korn: Oxygen isotope curves from the end-Permian mass extinction interval – influence of global warming on ostracod diversity

TP5-P-14 Grote, R., N. Ruehr, A. Buras, E. Rotenberg, D. Yakir: Semi-arid forest performance under future conditions: The role of increasing [CO_2] against dryer conditions

TP5-P-15 Bueler, D., R. Beerli, H. Wernli, C. Grams: Stratospheric influences on sub-seasonal predictability of European surface weather

TP5-P-16 Bonaduce, A., J. Staneva, A. Behrens, J. R. Bidlot, R. I. Wilcke: Wave climate change in the North Sea and Baltic Sea

TP5-P-17 Ionita-Scholz, M., V. Nagavciuc: The potential of predicting low flow periods for the central European rivers with a special focus on summer 2018

TP5-P-18 Caldarescu, D. E., A. N. Meckler, C. Andersson, H. Sadatzki: Clumped isotope signatures in modern bivalve shells contribute to seasonal upwelling reconstructions

TP5-P-19 Brenner, S., R. Koppe, A. Haas, C. Schäfer-Neth, P. Fischer, S. Immoor, P. Gerchow, B. Fritzsch, S. Frickenhaus: Automatic data quality control for understanding extreme climate events

TP5-P-20 Henkel, D., J. Greinert, H. Brix and the Digital Earth Steering Group: Earth Science meets Digital Science – Let's make sense of the mess

TP5-P-21 Schäfer-Neth, C., A. Haas, P. Fischer, R. Koppe, P. Gerchow, S. Frickenhaus. Elbe river flood and draught scenarios – the MOSES and Digital Earth initiatives

Poster: Session 6

TP6-P-01 Raßmann, H.: Mutual aid as a factor of disaster relief and climate resilience building - lessons from New Orleans and Yakutia -

TP6-P-02 Treffeisen, R., K. Grosfeld, T. Harms, N. Hillenbrand, N. Kulikowa, B. Muench-Epple: klimafit (climate-fit) – living lab and communities of practice for 'climate change and its impacts' in adult education

TP6-P-03 Michalek, G., I. Thronicker, Ö. Yildiz, R. Schwarze: Habitually green: integrating the concept of habit into the design of pro-environmental interventions at the workplace

TP6-P-04 Mohr, S., M. Döring, F. Feser, M. Kunz, T. Kunz-Plapp, B. Ratter: The regional risk perception of extreme weather events in Germany. Part 1: Street survey

TP6-P-05 Deka Baruah, U.: Perceptions and adaptation behaviour of farmers to climate change in the upper Brahmaputra valley zone, India

TP6-P-06 Moers v. J.1: Climate proofing urban water management – com-bined mitigation-adaptation approaches

Keynote Lectures

Topic 1 – Monday 23 September 12:00

Prof Wieslaw Maslowski

(Department of Oceanography, Monterey, USA)

Toward process-level regional modelling and prediction of Arctic climate system

The climate research community has been increasingly aware and supportive of the requirements to improve model physics at process levels, to advance regional climate modelling and prediction. At the same time, recent expansion of regional climate modelling for dynamical downscaling (e.g. the WCRP CORDEX Program) presents an opportunity to bridge the gap between the regional limitations of Earth System Models (ESMs) and the requirements by national to local stakeholders and decision makers to inform the development of future strategies and policies. Finally, the emerging exascale capability for high performance computing further motivates the process resolving fully coupled regional climate model configurations to improve model fidelity. The Arctic is one of the most challenging regions to model and predict climate change due to its complexity, including the marine and land cryosphere, small scale processes and interactions controlling its amplified response to global climate change. The Regional Arctic System Model (RASM) has been developed and used to better understand the past and present operation of the Arctic System at process scales and to predict its change at time scales from days to decades. RASM is a high-resolution limited-area model, consisting of the atmosphere, ocean, sea ice, land hydrology and river routing scheme components. Its domain is pan-Arctic, with the atmosphere and land components configured on a 50-km or 25-km grid. The ocean and sea ice components have four configuration options: 1/12°(~9.3km) or 1/48°(~2.4km) in the horizontal space and with 45 or 60 vertical layers. As a regional climate model, RASM requires boundary conditions along its lateral boundaries and in the upper atmosphere, which for simulations of the past to present are derived from global atmospheric reanalyses. This allows comparison of RASM results with observations in place and time to diagnose and reduce model biases, which is a unique capability not available with global ESMs. In this talk, we will focus on process-level simulations, improvements to model physics offered by dynamical downscaling and subsequently on producing internally consistent realistic initial conditions to reduce errors and uncertainties in prediction of the evolution of Earth System. We will discuss the need for high model resolution and fine-tuning of many present parameterisations of sub-grid physical processes in varying model configurations. We also investigate sensitivity of simulated sea ice states to scale dependence of model parameters controlling ocean and sea ice dynamics, thermodynamics, and their coupling. Finally, selected RASM results will be presented to demonstrate gains of dynamical downscaling in comparison with observations and with the global reanalysis and forecasts.

Wieslaw Maslowski is a Research Professor at the Naval Postgraduate School in Monterey, CA. He received his MS at the University of Gdansk, Poland, in 1987 and Ph.D. at the University of Alaska Fairbanks, in 1994, both in Physical Oceanography. For the past three decades, his research interests have focused on Arctic climate, ocean circulation and dynamics, sea ice and marine biogeochemistry. At the same time, he has heavily leveraged state-of-the-art high-performance computing, to advance Arctic science, modelling and predictive capability for the U.S. He has been and continues leading several multi-institutional projects, both research and computational, related to the development, improvements and use of the Regional Arctic System Model (RASM) for predictive understanding of the Arctic environment at time scales from weekly to decadal. Given that this region has become a new frontier for the U.S. Navy and Department of Defense, his research is of top relevance to help address the requirements and challenges for operating in a rapidly changing Arctic.

Topic 2 – Wednesday 25 September 11:15

Prof Anders Levermann

(Potsdam Institute for Climate Impact Research, Germany)

Sea level rise - do we have to be afraid or just worried?

Sea level rise projections show large uncertainties. On the long-term, we have to expect about 2.5 m for every degree of global warming. Without further adaptation that puts a number of coastal cities largely under sea level even if we keep the Paris Climate Agreement. What is the right response? Panic, despair or what else?

Anders Levermann is a professor of Dynamics of the Climate System at the Institute of Physics of Potsdam University & Potsdam Institute for Climate Impact Research, Head of the research domain Complexity Science at the Potsdam Institute and Adjunct Senior Research Scientist at the Columbia University in New York. He was a lead author of the sea-level chapter in the Intergovernmental Panel on Climate Change (IPCC-AR5, IPCC-AR6).His research focuses on the tipping of systems, i.e. abrupt large-scale changes with potentially strong impacts on nature and society. Developing a dynamic model of economic damage propagation for the global production- and supply network, he is scientific coordinator of zeean (www.zeean.net), a data portal to collect, harmonize and provide information on the vulnerability and adaption of the global economic supply network.

Photo: souce Karkow/PIK

Professor Levermann has published more than 110 scientific articles, and also advises government representatives, members of parliament, political parties as well as economic stakeholders and journalists pertaining to climate change. Anders Levermann is frequently giving presentations in the German Parliament and to other political and economic stakeholders (ca 20 talks per year). He is engaging in the public discourse on climate change through interviews (ca 50 per year) and articles in national and international newspapers (e.g. Washington Post, Huffington Post, Frankfurter Allgemeine Zeitung, etc.).

Topic 3 – Tuesday 24 September 10:45

Dr Eleanor Blyth

(Centre for Ecology & Hydrology, Wallingford, United Kingdom)

Evaporation happens at all scales: can we use the turbulent flux data improve our models?

The timing of the energy and water exchanges of the land surface in response to the atmosphere has a profound impact on weather and climate. The dominant timing can range from hours to weeks depending on the physics and structure of the vegetation, soils and land surface as well as the type of rainfall. This presentation will explore several case studies where direct observations of evaporation have been used to inform this range temporal response. It was also explore the modelling approaches to represent these time scales.

Photo: source Sarah Christopher

Eleanor Blyth is a hydro-meteorologist and is group leader for Land surfaces Science at the Centre for Ecology & Hydrology in Wallingford. She is Co-chair of iLEAPS Science Steering Committee. Her expertise is the role of the land surface in climate, meteorology and hydrology, with specialist expertise in Evapotranspiration and Land-Atmosphere Interactions.

She is known for developing understanding of the physics of the three components of evapotranspiration: interception, transpiration and bare soil evaporation using observations and models and for innovative methods for evaluating Land-Atmosphere models. She also has in-depth knowledge about state-of-the-art land surface modelling and manages the largest Land Surface Model development group in the UK for JULES (Joint UK Land Environment Simulator; see jules.jchmr.org) as well as developing the JULES UK community.

Topic 4 – Wednesday 25 September 10:45

Prof John Pyle

(University of Cambridge, United Kingdom)

Lessons for international action from the Montreal Protocol

The Montreal Protocol has been called the world's most successful environmental agreement. This talk will explore the scientific background to the agreement, its implementation and its subsequent adjustments. Evidence for the success of the Protocol will be discussed, with reference both to the ozone layer and the coincidental climate benefits. Current threats to the Protocol will also be discussed. The role played by the three expert assessment panels, which report to the Parties to the Montreal Protocol, will be described.

John Pyle obtained a BSc in Physics at Durham University. His DPhil was in Oxford where he helped to develop a numerical model for stratospheric ozone studies. He moved to a lectureship at Cambridge University in 1985. He was the Head of the Department of Chemistry from 2015-2018. He has been a co-director of NERC's National Centre for Atmospheric Science (NCAS) where he is the Chief Scientist. His research focuses on the numerical modelling of atmospheric chemistry and chemistry/climate interactions. He has published more than 250 peer reviewed papers. He played a major role in building an EU stratospheric research programme in the 1990s, coordinating several major field campaigns. He has contributed to all the WMO/UNEP assessments on stratospheric ozone since the early 1980s and is now one of the four international Co-Chairs on the Scientific Assessment Panel, responsible for these assessments. He was a convening lead author in the IPCC Special report 'Safeguarding the ozone layer and the global climate system', published in 2006. His work on stratospheric ozone was recognized by NERC's International Impact Award and Overall Impact Award in 2015, jointly with Dr Neil Harris. He was elected Fellow of the Royal Society in 2004 and an AGU Fellow in 2011 and made a Commander of the British Empire in 2017. Other honours and awards include membership of Academia Europaea (1993), Royal Society of Chemistry (Interdisciplinary award, 1991, and John Jeyes lectureship, 2008), the Royal Meteorological Society Adrian Gill Prize (2004) and the Royal Society's Davy Medal in 2018.

Photo: source Nathan Pitt

Topic 5 – Monday 23 September 12:30

Prof Alan Haywood

(School of Earth and Environment University of Leeds, United Kingdom)

Tipping points in the Earth system: a perspective from the past

The existence of tipping points, or tipping elements in the Earth system, has been the subject of scientific discussion for many years. Whilst the geological record provides little indication that sudden behavioural shifts in our climate system are truly irreversible, it does provide abundant evidence for rapid climate change. It appears entirely possible to shift the climate system into a new behavioural state which can be effectively considered irreversible within a societally meaningful timescale. Currently, there is an intense effort to better understand the thresholds of global temperature that should not be exceeded in order to avoid the consequences of dangerous climate change. An adequate understanding of the existence and dynamics of tipping points/elements is therefore central in this regard, as is an appreciation of the timescales over which certain global warming thresholds are to be avoided. Here the past climate record, and past climate simulation, can provide unique insights into the long-term sensitivity of the Earth system to variations in atmospheric carbon dioxide concentration, In addition it provides a way to see how tipping elements may be express themselves in the Earth system in the long-term. One interval in earth history which has received particular attention in this regard is the Pliocene epoch, specifically warm intervals within the late Pliocene. During these times the concentration of CO_2 in the atmosphere is estimated to have been ~400 ppmv. Therefore, an opportunity exists to examine the long-term response of the Earth system to approximately current concentrations of CO_2 in the atmosphere. In this talk we will review the evidence for large-scale climate and environmental tipping points during warm intervals of the late Pliocene, and what numerical models tell us about the dynamics of climate in a warmer world.

Photo: source (private)

Alan Haywood is a palaeoclimatologist working at the University of Leeds since 2007 and was appointed to Professor of palaeoclimate modelling in 2011. His principal research interests are the evolution and drivers of the global climate system over millions of years, climate variability (global/regional) over different time scales (orbital to decadal/sub-decadal/modes of variability), warm periods in Earth history and their relevance to future climate change. He produced the first realization of Pliocene climate using a fully coupled ocean-atmosphere climate model enabling the relative contribution of the oceans, atmosphere and ice sheets to be identified (HadCM3 and HadGEM2). He was the Co-Leader of the Pliocene Model Intercomparison Project Phase 1 between 2009-2014 and now Co-Leader of the Pliocene Model Intercomparison Project Phase 2 since 2015.

Topic 6 – Tuesday 24 September 11:15

Prof Jakob Rhyner

(University of Bonn, Germany)

Community-based adaptation and disaster risk management – where climate meets society

Community-based adaptation and disaster risk management have been widely discussed among scientists as well as practitioners, as a paradigm for locally appropriate solutions and ownership by the population. Yet the concept has remained somewhat elusive and hard to conceptualise. The presentation will try to shed light on community-based approaches by a couple of examples from different socioeconomic and cultural contexts, also juxtaposing community-based initiatives with top-down type approaches and considering the synergies and conflicts.

Since December 2018, Jakob Rhyner is professor for Global Change and Systemic Risks in the Faculty of Agriculture and Scientific Director of the Innovation Campus Bonn, a joint project with the Center of Development Research (ZEF), United Nation University (UNU-EHS), University of Applied Science (FH Bonn Rhein-Sieg), the German Development Institute (DIE) and the International Center for Conversion (BICC).

(Photo: source United Nations University)

In 1988 he received a PhD in theoretical physics from ETH Zurich and then joined the industrial research center of ABB Ltd., where he was active in the modelling of electrical networks and components. In 2001 he moved to the Swiss Institute for Snow- and Avalanche Research in Davos, as head of the department Avalanche Warning and Risk Management. His main responsibilities were the Swiss national avalanche forecast and the development of risk management guidelines. 2006 he became head of the institute. 2011 he changed to the United Nation University of Bonn, as vice rector and director of the Institute for Environment and Human Security (UNU-EHS). The main research directions of UNU-EHS were social vulnerability, environmentally induced migration and climate insurance.

Panelists – Tuesday 24 September 13:15

‘On the importance of Science Diplomacy in the Arctic realm’

Prof Rasmus Gjedssø Bertelsen (UiT The Arctic University of Norway, Norway)

Rasmus Gjedssø Bertelsen is Professor of Northern Studies and the inaugural Barents Chair in Politics at UiT-The Arctic University of Norway (Norway). His research interest is transnational flows of knowledge, talent and resources between USA, Europe, Middle East, East Asia and the Arctic. He studies the importance of elite socialisation, epistemic communities and science diplomacy for adapting Arctic governance within changing global governance. He studies brain circulation for human capital formation and transition from natural resources-based to knowledge-based economies in the Arctic and Gulf Cooperation Council states. He is Danish and grew up in Reykjavik so he has a deep personal and professional commitment to the Arctic. Rasmus studied in Copenhagen, Reykjavik, Geneva, Lausanne and Amsterdam. His Cambridge PhD (including a year at Sciences Po) analysed British and French elite perceptions of the international system between 1880s and 1930s. Rasmus was postdoc at the Harvard Kennedy School of Government on the soft power of American and French universities in the Middle East with field research in Lebanon, Egypt, UAE and Kuwait. At Harvard, Rasmus started parallel Arctic research. He continued as JSPS postdoc at United Nations University (Yokohama) and Tokyo Institute of Technology on Middle East, East Asia and Arctic research. Rasmus returned to Denmark to Aalborg University as postdoc and assistant professor researching Sino-Danish knowledge relations, especially in biotechnology and pharmaceutical industry, and the Arctic before UiT. Rasmus directs a workpackage developing European science diplomacy theory and strategy in H2020 InsSciDE.

Photo: source Michael Morreau

Embla Eir Oddsdóttir (Director, Icelandic Arctic Cooperation Network, Iceland)

Embla Eir Oddsdottir is the Director of the Icelandic Arctic Cooperation Network, a multi-stakeholder forum for cooperation on policy relevant issues in the Arctic. Embla has participated in domestic and international projects covering a diversity of topics, including climate change impacts, fresh water, risk and resilience, gender, and business mentorship and has experience working in both the private and public sectors. Embla has lectured on Arctic and northern issues at various Universities, conferences and meetings. Educational background is interdisciplinary, including socio-economic developement, anthropology, cultural geography, international relations, international law, indigenous and gender studies, rural development and political science. Embla holds a Msc in Law, Anthropology and Society from the London School of Economics and has completed diploma level courses in Polar Law.

Photo: source private

Dr Volker Rachold (German Arctic Office, Germany)

Volker Rachold is the Head of the German Arctic Office, which serves as an information and cooperation platform between German stakeholders from science, politics and industry. His functions include managing the dialogue between German Arctic players, supporting the federal ministries interested in Arctic matters, coordinating Germany´s scientific input to the Arctic Council and planning and implementing national and international Arctic-related events and projects. Before moving to the German Arctic Office in 2017, he served as the Executive Secretary of the International Arctic Science Committee (IASC) since 2006. Volker Rachold graduated as a geochemist from Göttingen University, where he also obtained his Ph.D. in 1994. Since then he worked with the Alfred Wegener Institute for Polar and Marine Research. His research focused on land-ocean interactions in the Siberian Arctic and he led several land- and ship-based Russian-German expeditions.

Photo: source K.Rolfes (AWI)

Prof Maria Rentetzi (Technical University Berlin, Germany)

Maria Rentetzi, Professor at the Technical University Berlin, Institute for Literature, Philosophy and History of Science and Technology, is an internationally acknowledged historian of science and technology who runs a 2 million ERC consolidator grant (2019-2024) on the history of radiation protection and nuclear diplomacy. Her research cuts across traditional disciplinary divides, bringing humanities closer to the physical sciences.

Photo: source D. Giantsiou

Prof Veli-Pekka Tynkkynen (University of Helsinki, Finland)

Veli-Pekka Tynkkynen is an Associate Professor in Russian Environmental Studies at the Aleksanteri Institute, University of Helsinki, Finland, and a Docent at the National Defence University in the field of Russia's energy and natural-resource policy. In 2011-2017, he was a professor in Russian Energy Policy at the Aleksanteri Institute. He leads several academic research projects and a team of dozen researchers (blogs.helsinki.fi/tynkkynen) that focus on energy and environmental policies, energy security, societal power and culture in Russia. He outlines his multidisciplinary take on Russia in his forthcoming book "The Energy of Russia. Hydrocarbon Culture and Climate Change" (E. Elgar, 2019).

Photo: source Academy of Finland project 'From Failand to Winland'

Moderation: Grace Dobush

Grace Dobush is a Berlin-based freelance journalist. Her work focuses on the intersection of tech, business and politics, appearing in publications including Fortune, Handelsblatt, Wired and Quartz. In addition to her editorial work, she has moderated panels and conferences in Europe and the United States. Born in the Rust Belt of the United States, Grace has been living in Berlin since 2017, bringing her total time in Germany up to five years.

Photo: source F+W Media

Open Plenary Session– Wednesday 25 September 14:45

‘Main results of the IPCC Special Report on Ocean and Cryosphere in a changing climate’

Prof Hans-Otto Pörtner

(IPCC Co-Chair, Working Group II; Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research)

Hans-Otto Pörtner studied at Münster and Düsseldorf Universities where he received his PhD and habilitated in Animal Physiology. As a Research and then Heisenberg Fellow of the German Research Council he worked at Dalhousie and Acadia Universities, Nova Scotia, Canada and at the Lovelace Medical Foundation, Albuquerque, New Mexico, USA. Currently he is Professor and Head of the Department of Integrative Ecophysiology at the Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research in Bremerhaven, Germany. He acts as an associate editor ‘Physiology’ for Marine Biology and as a co-editor of the Journal of Thermal Biology. He was Honorary International Associate Member of the Society for Integrative Biology, USA, between 2006 and 2013. He gave the Peter Hochachka Memorial Lecture at University of British Columbia in 2007, the Plymouth Marine Lecture in 2013, and the Bidder Lecture of the Society for Experimental Biology in Florence in 2018.

During the IPCC Fourth Assessment cycle Dr Pörtner served as Lead Author on the Working Group III Special Report on Carbon Capture and Storage, and during the Fifth Assessment Cycle as Coordinating Lead Author of Chapter 6 (Ocean Systems) of the Working Group II Report, as a member of the author teams for the Working Group II Summary for Policymakers and Technical Summary, and as a member of the Core Writing Team for the Synthesis Report. In October 2015 he was elected Co-Chair of Working Group II for the Sixth Assessment cycle. His research interests include the effects of climate warming, ocean acidification, and hypoxia on marine animals and ecosystems with a focus on the links between ecological, physiological, biochemical and molecular mechanisms limiting tolerance and shaping biogeography and ecosystem functioning.

Photo: source K. Rolfes (AWI)

Dr Ingo Sasgen

(AWI), Topic Speaker REKLIM Topic 2 ‘Sea level change from global to regional and local scales’

Ingo Sasgen is a senior research scientist at Alfred-Wegener-Institute Bremerhaven, in the division of glaciology. His research focus lies on monitoring the evolution of the ice sheets with satellite observations, as well as modelling glacial-isostatic adjustment and related sea-level change. Collaborative research projects engaged him at Jet Propulsion Laboratories, Pasadena, USA and Pennsylvania State University, Pennsylvania, USA. Ingo Sasgen is speaker of REKLIM Topic 2 Sea level changes from global, regional to local scale.

Photo: source K. Rolfes (AWI)

Prof Anders Levermann

(Potsdam Institute for Climate Impact Research (PIK), Germany), Lead author IPCC AR5 Chapter 13 'Sea Level Change')

Anders Levermann is a professor of Dynamics of the Climate System at the Institute of Physics of Potsdam University & Potsdam Institute for Climate Impact Research, Head of the research domain Complexity Science at the Potsdam Institute and Adjunct Senior Research Scientist at the Columbia University in New York. He was a lead author of the sea-level chapter in the Intergovernmental Panel on Climate Change (IPCC-AR5, IPCC-AR6).
His research focuses on the tipping of systems, i.e. abrupt large-scale changes with potentially strong impacts on nature and society. Developing a dynamic model of economic damage propagation for the global production- and supply network, he is scientific coordinator of zeean (www.zeean.net), a data portal to collect, harmonize and provide information on the vulnerability and adaption of the global economic supply network. He has published more than 110 scientific articles, and also advises government representatives, members of parliament, political parties as well as economic stakeholders and journalists pertaining to climate change. Anders Levermann is frequently giving presentations in the German Parliament and to other political and economic stakeholders (ca 20 talks per year). He is engaging in the public discourse on climate change through interviews (ca 50 per year) and articles in national and international newspapers (e.g. Washington Post, Huffington Post, Frankfurter Allgemeine Zeitung, etc.).

Photo: souce Karkow/PIK

Prof Beate Ratter

(University Hamburg and Helmholtz Centre Geesthacht, Germany), Lead author SROCC Chapter 6 'Extremes, Abrupt Changes and Managing Risks')

Beate Ratter is a geographer who has been engaged in island studies for 30 years. Her research mainly focuses on human-nature interaction in resource and environmental management, with special emphasis on cultural framings, perception, and political embeddedness of different regional cultures, especially on coasts and islands. She is Vice-President of the International Small Island Studies Association (ISISA) and has served as an expert for slow onset events in developing countries (especially small islands) for the United Nation Framework Convention for Climate Change (UNFCCC) and United Nations Environment Programme (UNEP) (2014). Her extended conceptual and empirical work on small islands is reflected in her recent book 'Geography of Small Islands – Outposts of Globalisation' published by Springer in 2018. Since September 2017 she is lead author for the IPCC Special Report on Oceans and Cryosphere (SROCC). Beate Ratter has in-depth experience of qualitative and quantitative empirical research and of moderation and mediation techniques. In the interdisciplinary project DICES (Dealing with change in SIDS, DFG - Project Ra 585/19-1) within the priority programme 'Sea level change and society' (SPP 1889), she addresses the cultural embeddedness of climate change perception and its linkages to societal feasible adaptation strategies on the Maldives.

Photo: source Beate Ratter

Abstracts of Oral Presentations and Posters

(Presenters of presentations are underlined)

Topic 1
Coupled regional modelling

Oral presentations

TP1-O-01

Advancing Earth System Modelling to address pressing challenges

Braesicke, P.[1]*

*E-Mail: peter.braesicke@kit.edu

[1] *Karlsruhe Institute of Technology (KIT), Institute of Meteorology and Climate Research - Atmospheric Trace Gases and Remote Sensing, Karlsruhe, Germany*

Earth System models have been developed in the last fifty to sixty years into fundamental tools to understand the earth system as well as interactions between its different compartments - how they influence each other, and thus providing useful instruments to study, comprehend and predict natural phenomena. Nonetheless, further steps are still to be made in order to significantly affect decision-making and offer solutions to urgent issues like climate change, food and water supply as well geo-energy resources and waste management. The project Advanced Earth System Modelling Capacity (ESM) was initiated in April 2017 funded by the Helmholtz Association with the objective to develop, evaluate and apply a world-leading Earth system-modelling framework to offer answers and solutions to pressing questions related to the earth system. By working on further model development, data assimilation, frontier simulations and strategic development, the ESM project merges the different expertise of its partners to develop an innovative and comprehensive approach to Earth system modelling. In this presentation, we will give an overview of the goals and structure of the ESM project as well as the contribution to Earth System modelling research, the highlights and results after two years of the project and briefly introducing the plans for the upcoming activities.

TP1-O-02

Effects of regional climate change on the wave conditions in the western Baltic Sea and impacts on the coast

Dreier, N.[1]*, P. Fröhle[1]

*E-Mail: norman.dreier@tuhh.de

[1] *Institute of River and Coastal Engineering, Hamburg University of Technology, Hamburg, Germany*

Future wind conditions from two regional climate models (Cosmo-CLM forced by ECHAM5/MPIOM and REMO/MPIOM forced by MPI-ESM-LR/MPIOM from EURO-CORDEX EUR-44) are used as input for the calculation of hourly wave conditions in the Western Baltic Sea between 1960-2100 based on the numerical wave model SWAN. The models have been forced by different future greenhouse gas emission scenarios from AR4 (SRES A1B, B1) and AR5 (RCP4.5 and RCP8.5) of IPCC. The changes of the future average wave conditions respectively extreme wave heights are analysed within time periods of 30 respectively 40 years until the end of the 21st century using moving averages respectively extreme value analysis. For both regional climate models, changes of the significant wave height up to +10% are found at westerly wind exposed locations and for the first realisation of the emission scenarios RCP8.5 and A1B. In contrast, the changes of the significant wave height are lower at easterly wind exposed locations, resulting in higher and lower values between -5% to +5%. Moreover, a general trend towards more wave events from W-NW and fewer events from N-NE can be expected, due to changes of the frequency of occurrence of the mean wave direction. No robust change of the significant wave heights with a return period of 200 years are found. Both increases and decreases of the extreme wave heights are possible within a range of -18% to +18% (-0.5 m to +0.5 m). The changes of the longshore sediment transport along the coast have been calculated based on the empirical CERC approach and the time series of wave parameter at selected locations. Significant increases of the sediment transport capacities up to +30% / +50% are found exemplarily for the 1st realisation of the emission scenario RCP8.5 / A1B at westerly wind exposed locations. The future changes of the average wave conditions and the longshore sediment transport can affect the efficiency of today's used protection strategies and methods against coastal erosion.

TP1-O-03

Sensitivity of wave forecast model to parametrisations of planetary boundary layer

Strigunova, I.[1]*

*E-Mail: ianastrigunova@gmail.com

[1] *Russian State Hydrometeorological University, Saint-Petersburg, Russia*

The influence of different versions of the planetary boundary layer parameterisation in the model of system 'wave – atmosphere' on the quality of wind wave simulation is investigated. The system consisting of components: WAVEWATCH (wave) / WRF (atmosphere) adapted for the Baltic Sea is described. The schemes of the planetary boundary layer parameterisation used in the WRF are considered. Two cases with stormy conditions observed in 2014 are presented: from 11 to 20 August and from 4 to 10 October. The comparison is produced by root-mean-square error of significant wave height simulation calculated according to automated FMI buoys. The sensitivity of significant wave height reproduction to different ways to PBL is evaluated. The selection of parameterisation with fewer errors in wind wave simulation is justified.

TP1-O-04

Application of high resolution coupled model to the spatial distribution analysis of coastal total water level (TWL) during extreme waves events.

Rulent, J. [1]*

*E-Mail: jrule@noc.ac.uk

[1] *Bangor University, Liverpool, UK*

Climate change has led to large variations in magnitude and distribution of coastal flooding. These events are closely related to the total coastal water level, which is itself determined by the interaction between various parameters, including waves, surges and tides. The use of coupled numerical ocean-atmosphere-wave models allows to more realistically reproduce such processes. A new state-of-the-art high-resolution regional coupled model recently developed at the MetOffice was here applied to better understand how the total water level (considered as the combination of surges, tides and waves) behaved at the coast during extreme wave events. The spatial distribution of water level components was analysed for the British and Irish coastlines. We saw that some regions appear to be strongly dominated by specific parameters, for example, the Bristol Channel and the English Channel were majorly impacted by the tides, while the signal on the west coast of Ireland was dominated by waves. The drivers are linked to intricate oceanographic and atmospheric dynamics that are not fully unravelled and will lead to a vast improvement in our comprehension of the impact of climate changes and our ability to mitigate it.

TP1-O-05

Coupling of ocean and atmosphere in GCOAST system through a dynamic wave interface

Bonaduce, A.[1*], J. Staneva[1], S. Grayek[1], A. Wiese[1], A. Behrens[1], J. Schulz-Stellenfleth[1], D. Jacob[1], C. Schrum[1]

*E-Mail: antonio.bonaduce@hzg.de

[1] *Helmholtz-Zentrum Geesthacht (HZG) - Centre for Materials and Coastal Research, Geesthacht, Germany*

The coupling of models is a commonly used approach when addressing the complex interactions between different components of earth system. In climate and forecasting research and activities, advanced models are needed and there is an urge towards the use of coupled modelling. This study presents the synergy between the satellite observations (e.g. Sentinel, CryoSat) with the high-resolution, coupled atmosphere, ocean and wave model system for the North Sea and the Baltic Sea, which is part of the Geestacht COAstal model SysTem GCOAST. We focus on the nonlinear feedback between strong tidal currents and wind-waves, which can no longer be ignored, in particular in the coastal zone where its role seems to be dominant. The proposed coupling parameterisations account for the feedback between of the upper ocean on the atmospheric circulation by accounting for the effects of sea surface temperature and the sea surface roughness. The performance is illustrated for the cases of several extreme events. For example, the inclusion of wave coupling leads to decreases strong winds through wave dependent surface roughness or changes sea surface temperature, the mixing and ocean circulation, leading to better agreement with in-situ and satellite measurements. The quality of the satellite data is evaluated and the focus is brought to the coastal areas, where altimeter data tend to get worse than in the open ocean. Satellite data of Sentinel-3, Jason-2 and CryoSat-2 performance is assessed, with respect to in-situ measurements and the GCOAST simulations. Analyses have been carried out, in which data from the satellite tracks are separated between onshore and offshore flights, with onshore flights passing from the ocean to the shore and offshore flights passing from the shore to the ocean. The differences have been also assessed between the satellite tracks under varying metocean conditions with focus on extremes. The prediction limits and applications for the combination of available satellite observations, in-situ data and coupled GCOAST system are also discussed.

TP1-O-06

Impact of subpollen particles on ice nucleation in clouds: A modelling study using ICON-ART

Werchner, S.[1*], C. Hoose[1], A. Pauling[2], H. Vogel[1], B. Vogel[1]

*E-Mail: sven.werchner@kit.edu

[1] *Karlsruhe Institute of Technology (KIT), Institute of Meteorology and Climate Research, Karlsruhe, Germany*

[2] *Federal Office of Meteorology and Climatology MeteoSwiss, Zurich, Switzerland*

Biological ice-nucleating processes, though being very efficient in nucleating ice, are not considered in numerical weather and climate modells due to their low effectiveness. This low effectiveness is caused by the size and mass of biological ice nuclei (e.g. pollen), since they cannot be transported into altitudes, in which biological ice-nucleating processes can take place in high numbers. This study investigates, whether the bursting of pollen can convert an efficient trigger into an effective one regarding ice nucleation. The smaller subpollen particles that are released by the bursting process are reaching higher altitudes in larger numbers and therefore be able to trigger biological ice nucleation. Therefore, subpollen particles could influence the overall ice nucleation in clouds. Here we are using ICON-ART to quantify the relative importance of this process. A parameterisation was developed, which transforms a fraction of pollen into the smaller subpollen particles and therefore simulates the bursting process. We found the generation of a new mode in the ice number concentration, which manifests itself at altitudes between 800 m and 4000 m, where the temperatures nearly exclusively allow only biological ice nucleating processes. Furthermore, a strong reduction in cloud droplets is observed in these heights, which can be explained by the impact the newly formed ice particles have on microphysical processes. Therefore, a strong influence of the composition of mixed-phase clouds is simulated at these altitudes. An additional effect is present at higher altitudes with lower temperatures, in which mostly non-biological ice nucleation takes place. Due to the heavy consumption of water caused by the biological ice nucleating processes a reduction in ice number concentration occurs.

TP1-O-07

Summer convective precipitation over the UK and Europe from a regional weather projection

Gadian, A.[1]*

*E-Mail: alan@env.leeds.ac.uk

[1] *National Centre for Atmospheric Science, University of Leeds, Leeds, United Kingdom*

Climate change caused by greenhouse gas emissions is now following the trend of rapid warming consistent with a RCP8.5 forcing. Precipitation observations are compared with the simulations for the (1990-1995) period and a simulation of a near future period (2031-2036) for a regional nested weather model. The convection permitting model, resolution ~ O (3 km), provides a good correspondence to the observational precipitation data and demonstrates the importance of explicit convection for future summer precipitation estimates. UK summer precipitation is reduced slightly (~10%) for (2031-2036) There is no evidence of an increase in the peak maximum hourly precipitation magnitude. A similar pattern is observed over the whole European inner model domain. The Kain-Fritsch convective parameterisation at a resolution ~ O (12 km), over estimates the summer precipitation by ~ 10% for the UK compared with the ~ O (3 km) simulations. In the future, the average precipitation rate per event increases, shorter heavier precipitation events increase, dry periods extend and wet periods shorten. As part of the change, 10 m winds of < 3 ms^{-1} become more common.

TP1-O-08

Valley-mountain circulation associated with precipitation formation in the tropical Andes (Rio Santa Basin)

García Rosales, A.[1*], R. Porfirio da Rocha[2], C. Junquas[3]

*E-Mail: jesusgarciabio@gmail.com

[1] *Institute of Astronomy, Geophysics and Atmospheric Sciences (IAG), Lima, Peru*
[2] *Institute of Astronomy, Geophysics and Atmospheric Sciences (IAG), São Paulo, Brazil*
[3] *Institute of Environmental Geosciences, Grenoble, France*

During the austral summer season, the precipitation in the Rio Santa basin, localised in the Tropical Andes, is strongly influenced by the interaction between large-scale circulations with local processes. However, this interaction has not been fully explored in the region. Therefore, the identification of the circulation patterns, and how occurs the interaction with local and regional-scale mechanisms influences the rainfall development is the main objective of this work. The analysis used fine resolution Weather Research and Forecasting (WRF) simulations nested in ERA5 reanalysis data. Different combinations of parameterisations were evaluated with a horizontal grid size of 5 km, in order to find the most suitable configuration for simulating the observed diurnal cycle of precipitation. Once identified the configuration, longer nested simulations (December 2012 until March 2013) with horizontal grid size of 6 km and 2 km were performed. Estimated (TRMM, CMORPH, PISCO, CHIRPS) and local observations were used to validate the simulations. The chosen WRF configuration consists mainly of the Goddard microphysics and the Betts-Miller-Janjic cumulus parametrisation. This configuration is able to simulate the main features of the observed diurnal cycle of precipitation, according to the in-situ data. However, the model still overestimates precipitation. In assessing, the circulation associated with the precipitation diurnal cycle it was identified as a westerly flow during the daytime, which is perpendicular to the Andes and enters through the north of the basin. This near surface flow is vital for the development of rainfall over the western slopes-highlands of the basin from noon to mid-afternoon. At same time, in eastern side of basin the coastal moisture transport converges with Amazon easterly flow over the mountains causing precipitation. On the other hand, between the late afternoon and early night, the rainfall predominates on the eastern slope associated with the upslope valley winds persisting in this period. These results contrast with most of studies that have indicated the Amazon basin as an exclusive source of moisture for the formation of precipitation over the Andes.

TP1-O-09

The impact of mineral dust on optical properties of snow during an extreme event

Rohde, A.[1*], S. Werchner[1], G. Hoshyaripour[1], H. Vogel[1], B. Vogel[1]

*E-Mail: anika.rohde@kit.edu

[1] *Karlsruhe Institute of Technology (KIT), Institute of Meteorology and Climate Research, Karlsruhe, Germany*

Light absorbing particles such as dust or soot can deposit on snow surfaces and lower the snow albedo especially in the visible range. The contamination of snow by aerosols leads to enhanced warming. Thin layers of snow can disappear, further reducing the albedo by making the darker surface below visible. Runoff is directly affected by the timing and intensity of snowmelt. The changed radiation fluxes at the surface change the energy fluxes of the atmospheric layer above and trigger further feedbacks. The aim of this study is the implementation of the impact of aerosol deposition on snow surfaces and the investigation of associated consequences in complex terrain with high resolution using ICON-ART. To simulate the aerosol effect on the optical properties of snow we modified the current snow model in ICON. We extended the snow model with a new prognostic variable, which describes the aging of the snow. The optical snow grain size mainly determines the albedo of pure snow in the near infrared region and significantly differs between fresh and aged snow. Our calculations include a natural snow metamorphism, which describes the growth of snow grains as a function of temperature, snowfall and rain. We performed Mie calculations for different optical grain sizes and implemented Mie coefficients into the model. The new optical properties distinguish between visible and near infrared band. We applied the new implementations in a simulation of a real dust event in March 2018. The results show that there are clear patterns of albedo reduction that match the patterns of accumulated dust deposition in Europe and Siberia. In certain locations, the reduction of albedo due to accumulated dust reaches values of more than 5% within two days. Changes in surface temperature patterns are caused by the modified snow albedo.

TP1-O-10

Implementation of an ensemble Kalman filter to forecast extreme meteorological events in the upper Rhone river basin

Schwob, A.[1*], A. Foehn[1], J. Fluixá-Sanmartín[2], D. Pasetto[3], G. De Cesare[1], J. García Hernández[2]

*E-Mail: anne.schwob@epfl.ch

[1] *Laboratoire de Constructions Hydrauliques (LCH), Ecole Polytechnique Fédérale de Lausanne (EPFL), Lausanne, Switzerland*
[2] *Centre de Recherche sur l'Environnement Alpin (CREALP), Sion, Switzerland*
[3] *Laboratory of Ecohydrology (ECHO), Ecole Polytechnique Fédérale de Lausanne (EPFL), Lausanne, Switzerland*

Reliable flood forecasts are a key aspect in flood risk management since they help reducing the destructive impacts of extreme events by optimising reservoir management and providing time for emergency preparations. Because the climate crisis increases the risk of extreme precipitation events, estimating future flood risks correctly becomes even more important. In mountainous areas, trustworthy hydrological modelling remains challenging. Reasons include the high spatial variability of rainfall and temperature as well as the difficulty to adequately model snowmelt driven and rain-on-snow flood events. Goal of the study is to optimise the performance of the operational flood forecasting system in the upper Rhone river basin in Switzerland by implementing the data assimilation method Ensemble Kalman filter (EnKF). Discharge simulations are computed with the semi-distributed hydrological model RS Minerve. Observed streamflow data in the basin is used to update various hydrological model state variables, among them the Snow Water Equivalent (SWE) and the soil saturation. Different EnKF configurations are tested by modelling past extreme meteorological events where the observed runoff is considered as a benchmark scenario to assess the performance of the forecasts. The ability to use this methodology to update the SWE in small mountainous subcatchments is investigated. The analysis provides a better understanding of local hydrometeorological drivers and the interactions between cryosphere and produced discharges during past extreme events in the basin. The importance of an ideal configuration of EnKF parameters is highlighted. This includes an appropriate definition of error assumptions as well as the choice of calibration metrics for the modelling of high flows. The data assimilation method shows to improve streamflow forecasts with a lead time of up to five days. In addition, an enhanced simulation of snow accumulation and melt is achieved.

TP1-O-11

Regional sea-ice according to the CMIP6 models in comparison to CMIP5 and satellite-based observations

Khosravi, N.[1*], T. Semmler[1], T. Jung[1]

*E-Mail: narges.khosravi@awi.de

[1] *Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research (AWI), Bremerhaven, Germany*

Over the past years the 5th phase of the Coupled Model Inter-comparison Project (CMIP5) has become a major player in assessment and evaluation of climate models and accordingly, in climate change research (e.g. IPCC, 2013). However, studies show that the observed strong trend of Arctic sea ice decline over the last few decades is systematically underestimated in CMIP5 while over Antarctica the situation is different. This implied that some feedback processes are not appropriately represented in the Arctic climate models. Subsequently, several studies investigated the underlying reasons of such difference in order to improve the outcome of the latest CMIP phase i.e. CMIP6, which became available recently, in April 2019. In the framework of this study, the regional sea-ice extent from climate models (low, moderate and high resolution) within the CMIP6 have been compared to measurements as well as to the respective CMIP5 results. Monthly averaged sea-ice extent over Arctic and Antarctica for September and March from CMIP6 models is in closer agreement to observations compared to CMIP5 models. Seasonally averaged, region-specific sea-ice concentration over the spring and summer months has also been compared to observations to assess local variability and short-term feedback mechanisms comparing to satellite-based measurements. For instance, it is of special importance to examine capability of the models to resemble local features related to Arctic amplification such as early sea-ice retreat in the Barents Sea during spring and accelerated ice-melt in the East Siberian Sea during summer.

TP1-O-12

Covariance of optimal parameters of an Arctic sea ice-ocean model

Sumata, H.[1*], F. Kauker[1], M. Karcher[1], R. Gerdes[1]

*E-mail: hsumata@awi.de

[1] *Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research (AWI), Bremerhaven, Germany*

Improvement and optimisation of numerical sea ice models are of great relevance for understanding the role of sea ice in the climate system. To improve and optimise Arctic sea ice-ocean simulation, we develop an objective parameter optimisation system for a coupled sea ice-ocean model based on a genetic algorithm. To take the interrelation of dynamic and thermodynamic model parameters into account, the system is set up to optimise 15 model parameters simultaneously. The optimisation is minimising a cost function composed of the model-observation misfit of three sea ice quantities (concentration, drift and thickness). The system is applied for a domain covering the entire Arctic and northern North Atlantic Ocean with an optimisation window of about two decades (1990 - 2012). It successfully improves the simulated sea ice properties not only during the period of optimisation but also in a validation period (2013 - 2016). A set of parameter optimisation experiments is performed to examine the uniqueness of the minimum of the cost function and the associated optimal parameter sets. All optimisations asymptotically reduce the value of the cost functions toward an apparent global minimum and provide strikingly similar sea ice fields. The corresponding optimal parameters, however, exhibit a large spread, showing the existence of multiple optimal solutions. A correlation analysis shows that the optimal parameters are inter-related and covariant. A principal component analysis reveals that the first three

(six) principal components explain 70% (90%) of the total variance of the optimal parameter sets, indicating a contraction of the parameter space. Analysis of the associated ocean fields indicates an importance of ocean properties to achieve a dynamically consistent view of the coupled sea ice-ocean system.

TP1-O-13

Changes of top-of-atmosphere reflectance and cloud properties in the Arctic from 1996 to the present and its relationship to Arctic Amplification

Lelli, L.[1]*

*E-Mail: luca@iup.physik.uni-bremen.de

[1] *Institute of Environmental Physics and Remote Sensing, University of Bremen, Bremen, Germany*

The phenomenon of Arctic Amplification describes the unexpectedly large increase in temperature at the surface in the Arctic over the past decades. This changes the areas of the cryosphere (ice and snow covered surfaces), land and ocean in the Arctic. Increases in the surface area of the ocean and the reduction in the area of the sea ice, imply that water vapour, entering the atmosphere, also increases. As a result of changes in surface type, the surface spectral reflectance changes, and directly impacts on the reflectance at the top of the atmosphere (R_TOA). Space-borne hyperspectral instrumentation making measurements of the up-welling solar radiation have the unique advantage that they provide spatially and spectrally resolved measurements of the R over the entire Arctic. To investigate changes in R_TOA, an harmonised time series of the R_TOA for selected wavelengths between 240 and 780 nm from the hyperspectral measurements of four satellite instruments GOME (1995--2003), SCIAMACHY (2002--2012) and GOME-2A/B (2007-present) has been created and temporal and spatial trends have been assessed. First R_TOA analyses show regional trends of distinct - and significant – magnitude, which can be attributed to seasonal sea ice decline (e.g. the Barents Sea and the circumpolar Arctic basin) or to an increase of brightness in sea-ice free regions, such as Siberia and Greenland. Auxiliary external data sets from satellites and from models are also correlated with R_TOA trends to further partition the relative contribution to its changes by clouds and snow, which will eventually change the radiative budget across the Arctic domain.

TP1-O-14

The Multidisciplinary drifting Observatory for the Study of Arctic Climate (MOSAiC)

Rex, M.[1], M. Shupe[2], K. Dethloff[1], A. Sommerfeld[1]*, international MOSAiC Team

*E-Mail: anja.sommerfeld@awi.de

[1] *Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research (AWI), Potsdam, Germany*
[2] *Cooperative Institute for Research in Environmental Science, University of Colorado and NOAA-ERSL, Boulder, United States of America*

The key element of MOSAiC is the drift of the icebreaker Polarstern frozen into the pack ice over an entire year. MOSAiC is an international initiative under the umbrella of the International Arctic Science Committee (IASC) designed by an international consortium of leading polar research institutes. Rapid changes in the Arctic lead to an urgent need for more reliable information about the state and evolution of the coupled Arctic climate system. This requires high quality observations and improved modelling over various spatial and temporal scales and a variety of disciplines. Observations of many critical parameters have, to date, not been carried out in the central Arctic for a full annual cycle. MOSAiC will be the first year-around expedition into the central Arctic exploring the coupled climate system. The drift of Polarstern starts in the Siberian sector of the Arctic in Sep. 2019. Around Polarstern, in an area representing the spatial scale of a typical climate model grid cell, a distributed regional network of observational sites will be established on the sea ice. The ship and the surrounding network will drift with the sea ice drift across the North Pole towards the Atlantic. The focus of MOSAiC lies on in-situ observations of climate processes that couple atmosphere, ocean, sea ice, biogeochemistry and ecosystem. These measurements will be supported by weather and sea ice predictions, and remote sensing operations to aid operational planning and extend the observational results in time and space. The observations will be used for the main scientific goals of MOSAiC: enhancing the understanding of the coupled Arctic climate system and the regional and global consequences of Arctic climate change and sea ice loss. In particular, the observations are needed to advance data assimilation and improve parameterisations of small-scale processes in numerical weather prediction models, sea ice forecasts, and regional and global climate models.

TP1-O-15

Atmospheric mechanisms for Arctic mid-latitude linkages

Jaiser, R.[1]*, E. Romanowsky[1], D. Handorf[1], K. Dethloff[1], M. Rex[1],

*E-Mail: ralf.jaiser@awi.de

[1] *Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research (AWI), Potsdam, Germany*

High latitude climate is changing more rapidly compared to other regions. However, Arctic Amplification interacts with the global atmospheric circulation. This leads to shifts in mid-latitude climate in particular in winter. They are driven by tropospheric and stratospheric pathways, which originate in the Arctic. We analyse these pathways with dedicated climate model simulations and implement advanced model components for the Arctic boundary layer and stratospheric ozone chemistry. Consequently, we improve our understanding of Arctic processes leading to better climate simulations.

Poster presentations

TP1-P-01

Mesoscale resolving high-resolution simulation of wind farms in COSMO-CLM 5

Akhtar, N.[1*], B. Rockel[1]

*E-Mail: naveed.akhtar@hzg.de

[1] *Helmholtz-Zentrum Geesthacht (HZG) - Centre for Materials and Coastal Research, Geesthacht, Germany*

The rapid development of offshore wind farms has raised concerns about the local environment and ecosystem. Wind farms influence the local meteorology by extracting kinetic energy from the wind field and by generating a large wake. The North Sea is one of the main regions of the world where the growth of offshore wind farms is rapidly increasing. In this study, we analyse the impact of large-scale offshore wind farms in the North Sea on local meteorology using regional climate model COSMO-CLM. For this purpose, the parametrisation for wind turbine driven by Fitch et al. (2012) and Blahak et al. (2010), previously implemented in COSMO-CLM v 4.8 at KU-Leuven (Chatterjee et al. 2016), has been implemented in the latest version 5 of COSMO-CLM. Here we present the first results of COSMO-CLM long-term simulations with and without wind farms using mesoscale resolving high-resolution horizontal atmospheric grid spacing (~ 2 km).

TP1-P-02

Regional climate modelling over China's Haihe river basin: evaluation of the WRF physics ensemble using multivariable integrated evaluation approach

Dai, D.[1*]

*E-Mail: daidq@tea.ac.cn

[1] *Institute of Atmospheric Physics, Chinese Academy of Sciences, Beijing, China*

A crucial step of the application of WRF in regional climate research is selection of the proper combinations of physical parameterisations. In this study, we perform experiments in WRF to assess the predict skill of various parametrisation schemes sets in simulating precipitation, temperature over the Haihe river basin. The experiments driven by ERA-INTERIM reanalysis data are performed for a period of summer (1 June to 31 August, 2016) in this domain with 13 km grid spacing. Fifty-seven members of physics combinations thoroughly covering five types of physics options are assessed against the available observational data utilising the multivariable integrated evaluation (MVIE) method. It is deduced that the best performing setup consists of CAM5.1 microphysics, MRF PBL, BMJ Cumulus, CAM Longwave / Shortwave radiation, and Noah Land Surface schemes. To identify the robustness of the optimal scheme set, the VFE diagram for displaying all simulations reveals that the optimal one is distinguished from others by higher Rv, smaller RMSVD. The model deviations spatially for the precipitation show a promising tendency that a strong overestimation about 5 mm/day for the default configuration evolves small biases of the optimal setup with a range between -1 and 1 mm/day, and the surface temperature forecasts have improved to some extent although not significant as that of precipitation. The temporally analysis of the spatial average of all simulations exhibits that for temperature the optimal setup is more approaching to the observational data, but for precipitation no remarkable difference between all simulation and the observations. Further analysis of the sensitivities of model output to different types of physics option suggests that, microphysics, PBL, and Cumulus schemes have more significant impact on the model performances measured by MIEI than radiation scheme and Land Surface schemes.

TP1-P-03

Comparison of isotopic signatures in speleothem records and model simulations for the past millennium

Buehler, J.[1*], C. Roesch[1], K. Rehfeld[1]

*E-Mail: jbuehler@iup.uni-heidelberg.de

[1] *Institute of Environmental Physics, Heidelberg, Germany*

Global changes in climate not only affect its mean, but also its variability, which mainly affects society. For better projections of future climate changes, it is crucial to improve the understanding of changes in both the mean, the variability and their relationship. Model-Data comparison between climate simulations and speleothem paleoclimate archives can test and validate the capability of different general circulation models (GCMs) to simulate changes in variability. However, the $d^{18}O$ values measured in climate archives do not directly represent temperature or precipitation but result from multivariate, non-linear processes on top of the dominant atmospheric controls on precipitation $d^{18}O$. We aim to assess a model's capability to simulate climate variability on timescales longer than those observable. Our strategy combines a Proxy System Model (PSM) for the relevant processes with isotope-enabled GCMs. We focus on speleothems, as they are precisely date-able and provide well preserved (semi-)continuous climate signals in the lower and mid-latitudes. We evaluate trends, correlations between different records and power spectral densities across a speleothem database, focusing on the past millennium. We compare proxy results to those obtained by forward models based on isotope-enabled HadCM3 simulations and PSM approaches of increasing complexity. We evaluate the sensitivity of results to parameter choices, and test options to constrain them. We find that some parameters e.g. transit times of water from the surface to the speleothem's cave, strongly influences the slope of the spectra in the PSM. Based on the ample proxy and model evidence for the past 1000ys, we test for realistic parameter ranges and the sufficient complexity of speleothem PSM for global application. Given a successful application on this more recent period, we envisage application on longer, millennial to orbital timescales, to provide estimates of low-latitude changes in climate variability.

TP1-P-04

Atmospheric Rivers over the Arctic with the ICON model

Bresson, H.[1*], A. Rinke[1], V. Schemann[2], S. Crewell[2], C. Viceto[3], I. Gorodetskaya[3]

*E-Mail: helene.bresson@awi.de

[1] *Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research (AWI), Potsdam, Germany*
[2] *Institute of Geophysics and Meteorology, University of Cologne, Cologne, Germany*
[3] *Department of Physics and CESAM, University of Aveiro, Aveiro, Portugal*

The Arctic climate changes faster than the ones of other regions, but the relative role of the individual feedback mechanisms contributing to Arctic amplification is still unclear. Atmospheric Rivers (ARs) are narrow and transient river-style moisture flows arriving from the sub-polar regions. The integrated water vapour transport associated with ARs can explain up to 70% of the precipitation variance north of 70N. However, there are still uncertainties regarding the specific role and the impact of ARs on the Arctic climate variability. For the first time, the high-resolution ICON modelling framework is used over the Arctic region (from 13 km down to ca. 2 km) to investigate processes related with anomalous moisture transport into the Arctic. Based on a case study for Svalbard, the representation of the atmospheric circulation and the spatio-temporal structure of water vapour, temperature, and precipitation and snowfall within the limited-area mode (LAM) of the ICON model is assessed. The impact on the surface energy budget will be calculated.

TP1-P-05

The CORDEX-CORE initiative: High-resolution regional climate information for the world

Teichmann, C.[1*], A. R. Remedio[1], K. Bülow[1], K. Sieck[1], L. Buntemeyer[1], E. Coppola[2], F. Giorgi[2], D. Jacob[1]

*E-Mail: claas.teichmann@hzg.de

[1] *Climate Service Center Germany (GERICS) Helmholtz-Zentrum Geesthacht (HZG) - Centre for Materials and Coastal Research, Geesthacht, Germany*
[2] *The Abdus Salam International Centre for Theoretical Physics (ICTP), Trieste, Italy*

The Coordinated Output for Regional Evaluations (CORE) simulation ensemble is an effort of the WCRP CORDEX community to provide high resolution regional climate change information for the major inhabited areas of the world and thus to generate the solid scientific basis for further research related to vulnerability, impact, adaptation and climate services. This is especially important in those areas in which so far only few high-resolution simulations or only comparatively coarse global simulations were available. The driving simulations were selected to cover the spread of high, medium and low climate sensitivity at a global scale. Initially, the two RCMs REMO and RegCM4 were used to downscale these global climate model outputs to a high spatial resolution of 0.22° (about 25 km). The aim of this study is to investigate and document the climate change information provided by the current CORDEX CORE ensemble with respect to mean climate change in different regions and in comparison to previously existing global and regional climate information. The focus lies on those global climate simulations used as boundary forcing for CORDEX CORE and to other existing CORDEX simulations. The analysis focuses on the mean temperature and precipitation changes in the IPCC-SREX regions and corresponding shifts in the annual cycle and frequency distributions. For selected regions, the differences of the climate change information at different resolutions are investigated.

TP1-P-06

Research on impacts of El Niño events based on phase transition of complex climate network

Lu, Z.[1*], N. Yuan[1]

*E-Mail: luzhengh@tea.ac.cn

[1] *Institute of Atmospheric Physics, Chinese Academy of Sciences, Beijing, China*

In this study, we used phase transition on climate network to study the impact of El Niño on surface air temperature field over the tropical Pacific. The results showed that El Niño leads an abrupt percolation phase transition on the SAT networks from stable to unstable or metastable phase state corresponding to the fact that the climate condition changes from normal to abnormal significantly during El Niño immediately. Furthermore, it was found that there is a fixed threshold named critical probability (Pc) to decide whether the phase transition will happen. By comparing, the networks constructed by CMIP5 coupled general circulation models (CGCMs) datasets and reanalysis datasets; it revealed that some models could simulate the phenomenon of abrupt phase transition with a critical probability Pc approaching the result of reanalysis dataset during El Niño while others failed. Accordingly, phase transition could be considered as a new metric to discover more about the impacts of El Niño on climate network.

Topic 2

Sea-level rise in a warming climate: from global drivers to coastal impacts

Oral presentations

TP2-O-01

Observations of the individual contributions to global mean sea-level rise

Sasgen, I.[1*], F. Landerer[2], F. Flechtner[3]

*E-Mail: ingo.sasgen@awi.de

[1] *Alfred Wegener Institute, Helmholtz Centre for Polar- and Marine Research, Bremerhaven, Germany*
[2] *Jet Propulsion Laboratory / California Institute of Technology, Pasadena, California, USA*
[3] *GFZ German Research Centre for Geosciences, Helmholtz Centre Potsdam, Oberpfaffenhofen, Germany*

Sea level rise is among others the most threatening consequences of global climate change, as the coasts belong to the most densely populated areas on Earth. Satellite observations have measured a sea-level rise of over three centimetres in the last ten years, with increasing tendency. On the global scale, the main causes of sea-level rise are the mass loss of glaciers and ice sheets, as well as in the volume expansion of the world's oceans because of global warming. The extent to which this increase will continue, level off or accelerate depends above all on the stability and future evolution of the ice sheets in Greenland and Antarctica. In this talk, an update on the mass balance of the ice sheets and sea-level rise from satellite observations is presented, along with latest projections of the long-term evolutions of the ice sheets for different CO_2 emission scenarios. First results and opportunities of the GRACE-FO satellite mission are discussed.

TP2-O-02

Projections of the Greenland Ice Sheet contribution to sea level rise – contribution to ISMIP6-projection-Greenland

Rückamp, M.[1*], A. Humbert[1]

*E-Mail: martin.rueckamp@awi.de

[1] *Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research (AWI), Bremerhaven, Germany*

The primary goal of ISMIP6 is to improve projections of sea-level rise via simulations of the evolution of the Greenland and Antarctic ice sheets under a changing climate, along with quantification of associated uncertainties. ISMIP6 basically forms the guidelines for sea-level projections during the CMIP6 phase for the next report of the Intergovernmental Panel on Climate Change (IPCC). We present our contribution ISMIP6-projection-Greenland performed with the Ice Sheet System Model (ISSM) with a high resolution unstructured grid and higher-order approximation to the Stokes equation.

TP2-O-03

Inter-annual and decadal variability of (seasonal) mean sea level and its sensitivity to wind climate

Gerkema, T.[1*], T. Frederikse[2], M. Duran-Matute[3]

*E-Mail: theo.gerkema@nioz.nl

[1] *NIOZ Netherlands Institute for Sea Research, EDS, and Utrecht University, Yerseke, Netherlands*
[2] *Jet Propulsion Laboratory, California Institute of Technology, Pasadena, United States of America*
[3] *Fluid Dynamics Laboratory, Department of Applied Physics, Eindhoven Univ. of Technology, Eindhoven, Netherlands*

Changes in local sea level affect coastal areas in various ways, such as the risk of flooding, the evolution of barrier island systems, or the development of salt marshes. Secular trends in these changes are partly masked by variability on shorter time scales, which mainly find their cause in atmospheric forcing. In this study, we quantify low-frequency variability in seasonal deviations from annual-mean sea level and look for drivers of this variability on multi-decadal time scales. The amplitude, as well as the temporal evolution of this multi-decadal variability shows distinct spatial variations: the largest low-frequency signals are found in the German Bight and along the Norwegian coast, while for the UK coastline, the multidecadal variability is much smaller. We find that the variability is strongest in winter and autumn and that it is mainly driven by wind and sea-level pressure anomalies associated with large-scale atmospheric patterns. For multiple stations around the North Sea, running mean 40-year trends for autumn and winter sea level often exceed the long-term trends in annual mean sea level. Removing the variability explained by atmospheric forcing vastly reduces the seasonal trends, especially in winter and autumn. Zooming in on the Dutch coast, we find that the inter-annual variability of mean sea level is largely explained by the zonal component of the net wind energy vector. Knowledge of the local correlations can then be used to correct values of annual mean sea for atmospheric effects, which reduces the margin of error for linear trends in sea level records. This study also implies that climatic changes in wind direction, or in the strength of winds from a specific direction, may affect local annual mean sea level quite significantly.

TP2-O-04

Daily extreme sea level in South-East Asia: Statistical downscaling with random forest.

Bierstedt, S.[1],E. Zorita[1], B. Hünicke[1*]

*E-Mail: birgit.huenicke@hzg.de

[1] *Helmholtz-Zentrum Geesthacht (HZG) - Centre for Materials and Coastal Research, Geesthacht, Germany*

Southeast Asia encompasses several coastal megacities, low-lying islands and delta regions highly vulnera-

ble for changes in mean and extreme sea level variations. Machine Learning methods can provide a model surrogate to compute more rapidly daily extremes in sea level from large-scale atmosphere-ocean fields. Here, we investigate the connections between the atmospheric and ocean drivers of local extreme sea-level in southeast Asia based on statistical analysis by Random Forest Models, driven by large-scale meteorological predictors and daily extreme sea level measured by tide-gauge records over the last few decades. First results show that in some areas extremes are driven by large-scale climate fields; in other areas they are incoherently driven by local processes. An area where random forest predicted extremes show good correspondence to observed extremes is found to be the Malaysian coastline. For the Indonesian coasts, the Random Forest Algorithm was unable to predicted extreme sea levels in line with observations. The study is part of the DFG funded project Asia-Floods (Extreme sea-level events along southeast Asian coast: past, present and future) within the SPP 1189 'Regional Sea level change and society'.

TP2-O-05

The solid Earth structure as driver for viscoelastic relaxation and relative sea-level change during the last deglaciation

Bagge, M.[1]*, V. Klemann[1], M. Latinović[1], B. Steinberger[1], M. Thomas[1]

*E-Mail: bagge@gfz-potsdam.de

[1] *Helmholtz Centre Potsdam – GFZ German Research Centre for Geosciences, Potsdam, Germany*

Modelling the relative sea-level change since last glacial maximum and the understanding of the underlying processes is of particular importance as well as a basis for understanding future sea-level change. The German climate modelling initiative PalMod aims at modelling the last glacial cycle including all relevant climate components. Glacial-isostatic adjustment (GIA) is one key-process considering relative sea-level changes over time scales of 10 to 100,000 years. During the last glacial maximum, the bedrock was depressed by several hundreds of meters (e.g. > 500 m in North America) due to ice-sheet loading. Since deglaciation, the viscoelastic relaxation causes uplift in former ice-covered regions, which continues today at a rate of more than 1 cm/a (e.g. Fennoscandia). Using the viscoelastic lithosphere and mantle model VILMA, we simulate the sea-level change since the last glacial maximum. While solving the sea-level equation we consider the conservation of mass between ice and ocean and geoid change due to mass redistribution. The model reconstructs the deformation of the solid Earth due to changes in surface loading (ice sheets and ocean). Focusing on the impact of the solid Earth, it is important to consider that dynamics of the solid Earth are governed by its viscosity structure. Traditional GIA models assume global Earth structures that vary with depth only, whereas seismic tomography models indicate temperature variations that could lead to lateral variations in viscosity exceeding three orders of magnitude. Here we implement a 3D geodynamically constrained global solid Earth structure, discuss how this can help to constrain 1D models and we identify regions, where the consideration of a 3D Earth structure is mandatory. For validation of the reconstructed relative sea-level during the last deglaciation we apply sea-level indicators such as sediment records, fossil organisms or morphological features. For example, in the tectonically active region of the Central Oregon Coast only a model implementing a 3D solid Earth structure can reconstruct a good fit between the modelled relative sea-level and the observations.

Poster presentations

TP2-P-01

The changes in the North Sea tidal residual circulation induced by sea level rise based on FESOM-C

Fofonova, V.[1]*, I. Kuznetsov[1], A. Androsov[1], K. Wiltshire[2]

*E-Mail: vera.fofonova@awi.de

[1] *Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research (AWI), Bremerhaven, Germany*
[2] *Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research (AWI), Sylt, Germany*

Shelf areas represent a critical transition zone between the terrestrial area and the deep ocean. These marine areas attract particulate attention due to high human activity there and its vulnerability to natural hazards. The coastal zones and deep ocean evolve in time as one entity. However, there is still substantial gap in understanding of the deep signal fate in the coastal areas. Making progress on this largely depends on the accurate representation of the physical environment in a coupled coastal-open ocean system. In current work, we present newly developed FESOM-C numerical solution and its application to the North Sea hydrodynamics under climate change pressure. FESOM-C is a coastal branch of the global Finite Element (VolumE) Sea-ice Ocean Model FESOM. It was developed to focus on smaller scales than FESOM and on physical and dynamical processes commonly not accounted in large-scale models. FESOM-C numerical core is created in a way to provide most efficient exchange of fluxes between coastal and global solutions. The model performance was evaluated based on hydrodynamics simulations for the southeastern part of the North Sea. The simulation results cover the period from January 2010 to December 2014 and show good agreement with data from autonomous observation stations, ferries and glider expeditions. We also made an analysis of the river tracers, which determines the temporal and spatial dynamics of zones affected by the different freshwater sources. The continuing sea level rise suggests significant changes in shelf hydrodynamics. Based on numerical simulations we present the sensitivity study of the North Sea dynamics to the changes of the sea level at the open boundary. The particular attention was paid to the changes in the tidal residual circulation, which largely defines the biogeochemical transport in the coastal zones.

TP2-P-02

A surface mass balance scheme including the diurnal cycle of solar radiation for ice sheet simulations on long time scales

Krebs-Kanzow, U.[1]*, P. Gierz[1], S. Xu[1], G. Lohmann[1]

*E-Mail: uta.krebs-kanzow@awi.de

[1] *Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research (AWI), Bremerha-ven, Germany*

We present a surface mass balance scheme for ice sheets, which only requires monthly mean short wave radiation, temperature and precipitation, but implicitly accounts for the diurnal cycle of short wave radiation. The scheme may be particularly suitable for long ice-sheet simulations of past and future climates. It is computationally inexpensive and can account for changes in the Earth's orbit and atmospheric composition. For evaluation, the scheme is applied to the Greenland ice sheet, forced by monthly reanalysis data from the ERA-Interim project. We then investigate the sensitivity of the surface mass balance to variations in the diurnal cycle for different continental ice sheets, using glacial and interglacial climate simulations as a forcing. Krebs-Kanzow et al..: Brief communication: An ice surface melt scheme including the diurnal cycle of solar radiation, The Cryosphere, https://doi.org/10.5194/tc-12-3923-2018

TP2-P-03

North Atlantic climate in FESOM2-ECHAM

Sidorenko, D.[1]*, Q. Wang[2], N. Koldunov[1,4], S. Danilov[1,3], P. Scholz[1], D. Sein[1], T. Semmler[1], T. Rackow[1], H. Goessling[1], N. Rakowsky[1], W. Cabos[5], T. Jung[1,2]

*E-Mail: dmitry.sidorenko@awi.de

[1] *Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research (AWI), Bremerhaven, Germany*
[2] *Institute of Environmental Physics, University of Bremen, Bremen, Germany*
[3] *Department of Mathematics and Logistics, Jacobs University, Bremen, Germany*
[4] *University of Bremen, Center for Marine Environmental Sciences (MARUM), Bremen, Germany*
[5] *Universidad de Alcalá, Alcalá, Spain*

Existing CMIP-type climate scenario simulations are known to be vulnerable to model errors which are most noticeable in the North Atlantic. These errors are generally attributed to the imperfectness of parameterisations and the lack of sufficient ocean model resolution. However, resolving ocean mesoscales globally requires high computational resources. An alternative is to use climate models operating on unstructured meshes, allowing one to vary spatial model resolution in a way that ocean eddy dynamics are explicitly resolved only in energetically important places. The FESOM-ECHAM climate model setup offers this variable-resolution functionality for the ocean. The new version of the Finite-volume Sea ice-Ocean circulation Model (FESOM v.2.0) has been recently released and is based on the finite volume approach with the cell centred placement of horizontal velocities (quasi-B-grid). It ensures a significant improvement in the computational performance of the ocean component (by a factor of more than 3 compared to the previous version). In the current work we validate the FESOM2-ECHAM climate model setup using the HighResMIP protocol and different ocean resolutions in the otherwise unchanged model configurations. In particular, we compare coarse and eddy-resolving ocean setups and analyse the related differences in the simulated climate.

TP2-P-04

The mass balance response of Arctic glaciers to weakening jet stream dynamics

Salles, A.[1]*, I. Sasgen[2]

*E-Mail: annette.salles@awi.de

[1] *Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research (AWI), Bremerhaven, Germany / University of Augsburg, Augsburg, Germany*
[2] *Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research (AWI), Bremerhaven, Germany*

Time series of mass variations of the glacier-covered regions across the Arctic were derived from the Gravity Recovery and Climate Experiment (GRACE) and subsequent GRACE-FO (GRACE Follow-on) missions from 2003 to 2019. After correcting for glacial isostatic adjustment, the fitted annual balances for northern Arctic Canada (ACN) and Svalbard were found to exhibit a pronounced anticorrelation; weak mass losses in one region contrasted with large mass losses in the other. Surface mass balance (SMB) calculations from the regional climate model RACMO2 were reconciled with the GRACE values, which allowed extending the study period back to the year 1958. Filtering the detrended and normalised SMB with a multi-year running average removed long-term variations while preserving the observed relationships. A simple categorisation into either positively or negatively correlated or anticorrelated mass balance years with respect to ACN and Svalbard was then undertaken. The mean circulation in the Northern Hemisphere during the melting season was calculated for each of the four categories using ERA5/ERA20C re-analysis data. Examining the geopotential height and temperature at different levels revealed a prevalence of rather zonal distribution for the correlated years in both regions. Meridional patterns and an intensified northward heat flux dominate the years with anticorrelated mass balances, which grow both in frequency as well as intensity from 1958 until 2015. The more frequent anticorrelation and the increase in mass balance variability are indicative of an increase in meridional jet stream flow across Arctic regions.

TP2-P-05

Coupled ocean-ice simulation of the Weddell Sea Basin, Antarctica

Timmermann, R.[1]*,T. Albrecht[2]

*E-Mail: ralph.timmermann@awi.de

[1] *Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research (AWI), Bremerhaven, Germany*
[2] *Potsdam Institute for Climate Impact Research, Potsdam, Germany*

The primary goal of ISMIP6 is to improve projections of sea-level rise via simulations of the evolution of the Greenland and Antarctic ice sheets under a changing

climate, along with quantification of associated uncertainties. ISMIP6 basically forms the guidelines for sea-level projections during the CMIP6 phase for the next report of the Intergovernmental Panel on Climate Change (IPCC). We present our contribution ISMIP6-projection-Greenland performed with the Ice Sheet System Model (ISSM) with a high resolution unstructured grid and higher-order approximation to the Stokes equation.

Topic 3

Land-atmosphere interactions: from measurements to modelling

Oral presentations

TP3-O-01

Impacts of climate change and land management on C and N dynamics of pre-alpine grassland ecosystems

Kiese, R.[1]*, K.Petersen[1], D. Kraus[1], P. Calanca[2]

*E-Mail: ralf.kiese@kit.edu

[1] *Karlsruhe Institute of Technology (KIT), Institute of Meteorology and Climate Research, IMK-IFU, Garmisch-Partenkirchen, Germany*
[2] *Agroscope, Zurich, Switzerland*

In pre-alpine regions, climate change is increasing the length of the growing season due to an earlier start in spring and later autumn senescence. Together with changes in soil water and nutrient availabilities, this can lead to significant changes in biomass development. Thus, instead of using fixed management dates for cutting and manuring events derived from current climate conditions it is necessary to dynamically fit the timing of management practices depending on actual plant development as affected by future climate conditions e.g. following RCP4.5 or RCP 8.5 scenarios. A new management module for the process-based biogeochemical model, was designed and implemented which fulfils this topic by dynamically imitating grassland management depending on simulated aboveground biomass development and detailed rule-sets derived from long-term data of the TERENO-preAlpine Observatory. At first, the module was calibrated and successfully validated for the time period of measurements i.e. 2012-2016 and second applied within climate change scenarios i.e. 90 years RCP4.5 and RCP8.5. Results show that climate change alters grassland growth dynamics mainly during the start of the growing season with significant earlier first cutting dates and overall one more cutting event particularly for RCP 8.5 scenario. Overall, our simulation show that grassland soil carbon and nitrogen stocks decrease with climate change highlighting a risk on soil fertility and thus productivity of montane grassland soils in the long term. However, our simulations also show that sensitivity of soil C and N stocks is even more depending on frequency, amount and particularly quality of manure application, thus adaptations in management practices can likely compensate for climate change induced C and N losses.

TP3-O-02

Discharge independent of storage deficit? The summer 2018 as a hydrological experiment

Jehn, F.[1]*, P. Kraft[1], L. Breuer[1]

*E-Mail: florian.u.jehn@umwelt.uni-giessen.de

[1] *Justus Liebig University Gießen, Gießen, Germany*

The summer of 2018 was one of the hottest and driest in the recorded history of Germany. This lead to catchments having much less discharge than usual. However, after only relatively little rainfall in the autumn of 2018, several catchments in Hesse flooded, even though their storages should be empty. To explore this behaviour, we calculated the storage change of 90 catchments in Hesse, by using measured discharge and interpolated precipitation and evaporation data. This allowed us to take a look on how the storage of the catchments changed over the year. We found that all rivers behaved similarly during the high precipitation of the winter and early spring of 2018, but showed a wide range of behaviours in the dry and hot summer. Some catchments had a temporary storage deficit of almost 300 mm (half of the annual precipitation), while other were barely affected. To find explanations for this we looked at the soil, hydrogeology and land use of the catchments. This showed that land use had no influence for the storage deficit, while soils and hydrogeology caused clear differences.

TP3-O-03

Modelling grassland biodiversity under climate change and implications for ecosystem services

Moulin, T.[1]*, P. Calanca[1]

*E-Mail: thibault.moulin@agroscope.admin.ch

[1] *Agroscope, Zurich, Switzerland*

Semi-natural, permanent grasslands represent the backbone of agriculture in mountain areas. They not only sustain dairy farming by providing quality feed for animals but are also hot spots of biodiversity, delivering important ecosystem services. Understanding how permanent grasslands respond to climate change is therefore essential to be able to inform society, in particular producers and policy makers, showing which options would potentially allow agriculture to fulfil its multiple tasks in a warmer and likely drier future. Many grassland models are available to assess climate change impacts on grassland productivity. They take into account the main biophysical and biogeochemical processes driving grass growth and are able to reliably represent how agronomic management modulates these processes. However, only a few of these models explicitly or implicitly represent the botanical composition of species-rich grasslands. This situation entails a gap in our understanding of the dynamic interactions between climate and the land surface in grassland dominated landscapes. In this contribution, we present results of an ongoing assessment of climate change impacts on grassland productivity and biodiversity in key mountain regions of Switzerland. Our work relies on simulations with DynaGraM, a new model that includes a dynamic representation of the competition between key species and/or functional groups, and the effects of disturbances induced by grazing and mowing. We look in particular at the potential implications of increasing drought

stress under different management regimes, comparing the model output with experimental data collected in recent years in various field experiments. Our work contributes to a wide range of activities coordinated by the National Centre for Climate Services (NCCS), aiming at establishing a web-based knowledge hub that supports climate-smart decision-making.

TP3-O-04

Impacts on winter wheat yield in Germany at 1.5º, 2º, and 3º global warming

Peichl, M.[1]*, S. Thober [1], A. Marx[1]

*E-Mail: michael.peichl@ufz.de

[1] *Helmholtz Centre for Environmental Research – UFZ, Leipzig, Germany*

Wheat is the second most common cereal in the world and Germany is the ninth largest producer. In this way, wheat produced in Germany makes a significant contribution to global food security. Here we estimate the effects of climate change on winter wheat in Germany for a 1.5, 2, and 3 K heating scenario. A special challenge for statistical approaches in the modelling of winter wheat variation is the long vegetation period. This usually leads to less predictability than for crops with shorter growing seasons such as maize. In addition to temperature measurements, which are used as standard in statistical approaches, we also consider extremes such as frost and soil moisture anomalies. The used extremes and their threshold values are derived and validated based on literature research and a co-production framework. Another focus is the modelling of the interaction between the individual growth phases. For this purpose we use machine learning methods, which are especially suited to model non-linearities. In addition, we apply model agnostics to obtain information on the importance of features and sensitivities of crop yield variation for the predictors. This matters to the design of adaptation measures, as knowledge of key factors is particularly important in this context. Models are fitted for sub-regions based on clustering for the period 1999–2018. For climate projections a new data set is used which has been generated within the EdgE and HOKLIM projects which consists of daily temperature and precipitation data as well as monthly soil moisture data with different soil layers on 5 km grid. Meteorological values, forced by three RCPs (2.6, 6.0 and 8.5), are obtained for the period 1950-2099 obtained from five CMIP5 GCMs. Those data are then used as input to a hydrological model (mHM) to simulate soil moisture. The global warming values for 1.5, 2, and 3 K are determined using a time sampling method.

TP3-O-05

The importance of dew or frost formation for the water balance of grassland sites

Pütz, T.[1]*, J. Groh[2], H. H. Gerke[2], M. Brunke[1], M. Ramati[3], H. Vereecken[1]

*E-Mail: t.puetz@fz-juelich.de

[1] *Institute of Bio- and Geosciences IBG-3: Agrosphere, Forschungszentrum Jülich (FZJ), Jülich, Germany*
[2] *Leibniz-Zentrum für Agrarlandschaftsforschung (ZALF), Müncheberg, Germany*
[3] *University of Maragheh, Maragheh, Iran*

Non-rainfall events such as dew or frost formation are often neglected in the water balance because their proportion is either assumed to be too low or their quantification requires time-consuming and difficult measurements. Dew formation provides considerable amounts of water in many arid regions, but its contribution to humid climate ecosystems is largely unknown. Depending on the model, climate change forecasts in Germany expect warming between 1.5 and 3.5 °C, lower precipitation and more frequent weather extremes. As part of the 'Space-for-Time' experiment TERENO-SOILCan, weighable monolithic precision lysimeters were filled on a forest meadow in the Eifel National Park and on the extensively used grassland site Rollesbroich. A part of these monolithic lysimeters were installed at the original sites Wüstebach and Rollesbroich and three of each of these lysimeters were moved to Selhausen in the Lower Rhine Börde landscape to expose the soils to a warmer and drier climate. The dew and frost formation for the two sites will be reported for the hydrological years 2015-2018. Based on preliminary investigations, dew formation and hoar frost formation varied between 42.1 and 67.7 mm annually, corresponding to about 4.2 - 6.0 % of the total annual precipitation. In drier months, dew and frost formation contributed up to 16.1% to the total monthly rainfall. In the winter months, dew formation and hoar frost formation contributed up to 38% to the total monthly rainfall. Our study suggests that dew and hoar frost formation are of ecological importance during both drier and colder periods. Dew and hoarfrost formation contribute significantly to the water balance of a low mountain range location.

TP3-O-06

The relationship between Arctic air and soil temperatures mediated by snow – insights from observations and regional model sensitivity experiments

Matthes, H.[1]*, A. Rinke[1]

*E-Mail: heidrun.matthes@awi.de

[1] *Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research (AWI), Potsdam, Germany*

Except for the short Arctic summer season, Arctic snow cover over land is one of the most important mediators between atmospheric and land processes. On the one hand, snow isolates the ground from atmospheric weather conditions and can have a warming or cooling effect on the ground, depending on the season. On the other hand, snow cover can built up and melt early or late in the year, masked by vegetation or darkened by aerosol. Therefore, the according high variability in the snow's impact on surface albedo influences the surface energy balance in the transition seasons under the presence solar radiation. This study uses in situ measurements of daily air and soil temperatures and snow depths from various meteorological stations throughout the Arctic to look at the relationship between atmosphere and ground processes under different snow conditions. These data are then used to evaluate a regional Arctic climate model and to assess the impact of modified snow albedo parameterisation in the model. The impact of changes in the snow parameterisation on air and soil temperatures as well as on atmospheric circulation are studied. The snow scheme used for this experiment is the standard scheme of the Community Land Model v4 (CLM4), incorporated into the regional Arctic climate

model HIRHAM-CLM. It contains representations of snow aging, complex interaction of vegetation and snow, and aerosol deposition. In a control simulation, the model was run for 15 years with all those processes switched on. Then each individual process was disabled separately in sensitivity runs. In order to separate dynamical changes from changes caused by the snow albedo parameterisation, CLM was also run in an off-line mode. In general, on the decadal-mean time scale (averages over 15 years), the impact of the changes in the snow description on the surface albedo, air and soil temperatures as well as on mean sea level pressure (as measure of atmospheric circulation) are small for all runs. However, there are distinct dynamical impacts, e.g. changes of circulation patterns and air temperature over the Arctic Ocean. We also find statistically significant changes in the cyclone tracks, which can be linked to changes in air temperature.

TP3-O-07

Modelling permafrost sensitivity in Arctic forest

Stünzi, S.[1,2*], J. Boike[1,2], S. Kruse[1,3], U. Herzschuh[1,3], M. Langer[1,2]

*E-Mail: simone.stuenzi@awi.de

[1] *Alfred Wegener Institute Helmholtz Center for Polar and Marine Research, Telegrafenberg A45, 14473 Potsdam, Germany*
[2] *Department of Geography, Humboldt-Universität zu Berlin, Berlin, Germany*
[3] *Institute of Earth and Environmental Sciences, Faculty of Sciences, University Potsdam, Potsdam-Golm, Germany*

Deciduous larch is a weak competitor when growing in mixed stands with evergreen taxa but is dominant in many boreal forest areas of Eastern Siberia. It is hypothesised that certain factors such as a shallow active layer and high fire frequency favour larch. Our aim is to understand how the interactions between the vegetation, permafrost and atmosphere stabilise the larch forests in Eastern Siberia. A one-dimensional land surface model (CryoGrid) is used to reproduce the energy transfer and ground thermal regime of permafrost ground and adapted for the application in vegetated areas. We implement a roughness sublayer turbulence parameterisation in a multilayer canopy to simulate an Arctic tree that responds to the local climate and permafrost conditions based on a scheme originally developed for the Community Land Model. The coupled model is capable of calculating the radiation budget, nitrogen and photosynthetic profiles, canopy turbulence and leaf fluxes of the canopy as well as the thermal conditions of the permafrost ground under several forcing scenarios.

TP3-O-08

Direct and indirect impacts of climate change on wheat yield in the Indo-Gangetic plain

Daloz, A. S.[1*]

*E-Mail: anne.sophie.daloz@cicero.oslo.no

[1] *CICERO Centre for International Climate Research, Oslo, Norway*

In the current context, Indian farmers must deal with a variety of risks: the competition with large landowners and food corporation, the price surges or the impacts of the changing climate. This article focuses on the climatic risk under the pessimistic scenario RCP8.5, taking the example of the Indo-Gangetic Plain and wheat. First, the Indo-Gangetic Plain climatic context is examined in regional climate simulations. Then the direct (via temperature and precipitation) and indirect (via irrigation) impact of climate change on wheat yield are derived with an agro-ecosystem model for five selected sites (Punjab, Haryana, Delhi, Uttar Pradesh and Varanasi). The results show a future mid-century decrease in precipitation during the first part of the growing season (November to January) followed by an increase during the second part (February to April), while maximum temperature is constantly increasing. These changes lead to wheat yield loss between -1% and -18% depending on the site examined and the irrigation system chosen. Except for the Delhi site, the yield losses are relatively small (around 5%). However, when limiting the number of irrigation, the losses become much higher, reaching 30% at all sites for the most extreme conditions.

TP3-O-09

Relevance of floodplains in a LSM for simulation of evapotranspiration over the tropical wetland Pantanal

Schrapffer, A.[1*], A. Sörensson[1], J. Polcher[2], L. Fita Borrell[1]

*E-Mail: schrapff.ant@gmail.com

[1] *Centro de Investigaciones del Mar y la Atmósfera (UBA-CONICET), Buenos Aires, Argentina*
[2] *Laboratoire de Météorologie Dynamique du CNRS/IPSL, École Polytechnique, Palaiseau, France*

Tropical floodplains have a significant influence on the regional water cycle and land-atmosphere interaction, but are still not always considered in Land Surface Models (LSM) and thus Earth system models. This study proposes to evaluate the importance of representing floodplains to enable a LSM to provide more realistic evaporations fluxes over these regions. The importance of floodplains in ORCHIDEE, the LSM of IPSL's regional and global Earth system model, will be assessed through the simulation of the world's largest wetland, the Pantanal, between 1961 and 2000, a large continuous period that includes both dry and wet decades. Atmospheric uncertainty is considered through the utilisation of three different forcing data sets, each one in two versions: the original dataset and then one where the precipitation has been adjusted with the daily rain-gauge gridded dataset CLARIS-lpb. Activation of the floodplain module results in a systematic improvement of intra-annual distribution of river discharge and more coherent values of extremes, independent of the atmospheric forcing. Compared to previous satellite studies, flooded area may be underestimated but have coherent temporal evolution and spatial distribution. Considering floodplains in the ORCHIDEE model allows the evaporation of the most flooded parts of Pantanal to have a negative water balance (evaporation larger than precipitation) since the floodplains allow for lateral transport of surface water so that rainfall at one gridpoint can evaporate downstreams. This last point has an impact on land-atmosphere fluxes repartition, crucial for coupled models. These sets of simulations further permitted to estimate a water balance over the region and deduce

total annual evaporation of the entire Pantanal to 1278 mm while precipitation only reach 1255 mm.

TP3-O-10

Climate change impact on agro-climatological indices across West Africa

Dieng, D.[1]*, P. Laux[1], G. Smiatek[1], D. Heinzeller [2], H. Kunstmann[1]

*E-Mail: diarra.dieng@partner.kit.edu

[1] *Karlsruhe Institute of Technology (KIT), Institute of Meteorology and Climate Research (IMK-IFU), Karlsruhe, Germany*
[2] *NOAA/OAR/ESRL/Global Systems Division, Boulder, United States of America*

With a wide range of ecological, climatic, and cultural diversities, West Africa is a rapidly developing region with a population equivalent of 5.08% (UN, 2018) of the world's population causing multiple problems for food security. The agricultural systems remain largely rainfed and underdeveloped, as the majority of the farmers are smallholders with restricted financial resources, limited access to infrastructure, and scientifically sound information (e.g. current weather and climate data) for crucial agricultural decisions such as the planting time or the choice of the crops to plant. Climate change adds another layer of complexity to this challenge. In view of this, our study aims at improving agricultural decision support related to climate change adaptation for three major staple crops, namely maize, sorghum and pearl millet across West Africa under rain-fed conditions under the German-African collaborative WASCAL (West African Science Service Centre on Climate Change and Adapted Land use) project. We conducted very high-resolution regional climate simulations using the Weather and Research Forecasting (WRF) model and the COSMO-Climate Limited area Modelling (CCLM), under the Representative Concentration Pathway (RCP) 4.5 scenario. Results shows that climate change may likely have severe implications for cropping strategies in the future. In particular, planting dates and the choice of crop varieties need to be reviewed because the onset, length of the rainy season, as well as the potential growing period are expected to change. Moreover, water availability is expected to change with strong regional differences, which may also require the adaptation to different crop types. Therefore, there is need to develop suitable adaptation strategies and farming practices to reduce the negative impact of climate change.

TP3-O-11

The potential for ecosystem restoration to contribute to achieving net zero greenhouse gas emissions in Europe by 2050

Warren, R.[1]*, P. Jeff[1], N. Forstenhaeusler[1]

*E-Mail: r.warren@uea.ac.uk

[1] *Tyndall Centre and School of Environmental Sciences, University of East Anglia, Norwich, United Kingdom*

The IPCC Special Report on 1.5°C warming last October found that in pathways that limit global warming to 1.5°C with no or limited overshoot, anthropogenic CO_2 emissions need to fall to zero globally by 2050. More recently, the UK Climate Change Committee has released a report calling for the UK's greenhouse gas emissions to reach net zero by 2050, while the EU has a long term to cut GHG emissions by 80-95% of its levels in 1990 by 2050. In the EU, protected areas already contribute significantly to carbon sinks, with negative emissions of 60,000 kt CO_2e in 2015. Since the EU Habitats Directive was established in 1992, the network of conservation areas has continuously expanded. Covering roughly 10.7% of the terrestrial extent in 1992 it reached 25% coverage in 2015, suggesting that the EU already reached Aichi Target 11 (IPBES, 2018). However, coverage within member states varies widely and ranges from 6% to 43% (numbers calculated from UNEP-WCMC and IUCN, 2018) and not all lands within these protected areas are 'natural' with some areas used for housing and some for agriculture. Thus, there are areas within some existing protected areas that could be restored. At the same time, there are proposals for CBD to increase ambitions for biodiversity protection by 2050, via protected areas, of 30% by 2030 and even 50% by 2050. Here, we explore the extent to which increasing protection for biodiversity in Europe could increase carbon sinks, (a) without considering other constraints (b) placing a constraint on maintaining existing/future levels of food production (c) allowing for the potential to use land for biofuel production.

TP3-O-12

Secondary organic aerosols from projected future large-scale vegetation changes in low-emission scenarios

Lund, M.[1]*, B. Samset[1]

*E-Mail: m.t.lund@cicero.oslo.no

[1] *CICERO Centre for International Climate Research, Oslo, Norway*

Changes to vegetation and land-use affect the climate through emissions of chemically reactive biogenic volatile organic compound (BVOCs), in addition to modifying carbon fluxes and surface albedo. Previous studies have found that the resulting changes to production of secondary organic aerosols (SOA) have contributed to the net climate impact of historical land-use change and deforestation. Here, we investigate the climate impact of increased and decreased SOA concentrations resulting from land use and vegetation changes likely associated with low global warming targets. Most scenarios for limiting global warming to 1.5-2°C rely on negative emission technologies, including large-scale deployment of bioenergy with carbon capture and storage (BECCS), as well as reforestation and afforestation. This in turn entails significant changes to the vegetation and land surface, such as increased expansion of energy crops. Once in the atmosphere, SOAs formed from BVOCs affect the energy balance, posing a cooling climate impact through interaction with radiation and clouds. However, the full consequences of changes to BVOC emissions following land-use perturbations in such scenarios are not well quantified. Building on existing literature and data about land-use change in the Shared Socio-economic Pathways (SSPs), we construct time-slice scenarios for future vegetation composition, focusing on the pathways with high assumptions for BECCS. The con-

sequent global and regional BVOC emissions and concentrations of SOA are simulated using the detailed chemistry-transport model OsloCTM3, separating the impact of vegetation changes alone and the combined effects of vegetation and climate change. Finally, we quantify the radiative forcing relative to the baseline, present-day vegetation case, thereby providing a broader picture of the climate impact of possible future land-use change beyond the carbon-only impacts.

TP3-O-13

Integrated simulation of the terrestrial water cycle with the fully coupled Terrestrial Systems Modelling Platform (TSMP)

Goergen, K.[1]*, C. Furusho-Percot[1], J. Keune[2], M. Eltahan[1], C. Hartick[1], S. Kollet[1]

*E-Mail: k.goergen@fz-juelich.de

[1] *Institute of Bio- and Geosciences (Agrosphere, IBG-3), Forschungszentrum Jülich (FZJ), Jülich, Germany*
[2] *Laboratory of Hydrology and Water Management, Department of Environment, Ghent University, Ghent, Belgium*

Water resources and security are intricately linked to complex interactions and feedbacks between the groundwater, land surface and atmosphere, and strongly affected by climate change as well as human water use. To better understand the drivers and processes behind hydroclimatic extremes (droughts, heatwaves), the related two-way feedbacks (soil moisture-temperature or precipitation coupling), and to lay the foundation for more informed adaptation and mitigation options, we use the multi-scale, fully coupled, physically consistent Terrestrial Systems Modelling Platform (TSMP) (COSMO + CLM + ParFlow, OASIS3-MCT) in EURO-CORDEX compliant experiments at 12km resolution over Europe. In coupled ERA-Interim driven TSMP sensitivity and process studies, with closed terrestrial water and energy cycles, a more realistic groundwater representation (full 3D groundwater vs. free drainage) leads, e.g., to altered soil moisture-temperature feedbacks, with an alleviation of air temperature extremes during the 2003 European drought and heatwave of up to 1K. An ensuing 30-year continental TSMP evaluation run shows, e.g., an improved representation of the spatio-temporal variability of RCM air temperature anomalies when compared to observations, complementing the existing EURO-CORDEX RCM ensemble. The associated pristine (i.e., no human interference) groundwater climatology, consistent with the atmospheric forcing, may serve as a baseline dataset to assess future hydro-climatic extremes and the impact of human water use. In a pilot study, using TSMP with and without human water use, systematic atmospheric feedbacks can be induced by groundwater abstraction and irrigation that lead to a change in the strength of the continental sink for atmospheric water and these feedbacks are in turn drivers for terrestrial water storage changes.

TP3-O-14

Developing innovative information products for a weather- and climate-resilient agriculture in Germany

Bathiany, S.[1]*, J. El Zohbi [1], A. Kriegsmann[1], S. Pfeifer[1], D. Rechid[1], K. Goergen[2]

*E-Mail: sebastian.bathiany@hzg.de

[1] *Climate Service Center Germany (GERICS) Helmholtz-Zentrum Geesthacht (HZG) - Centre for Materials and Coastal Research, Geest-hacht, Germany*
[2] *Forschungszentrum Jülich (FZJ), Jülich, Germany*

Agriculture is among the sectors that are most vulnerable to extreme weather and climate conditions and climate change. In Germany, the recent fluctuations between wet and dry summers have highlighted the importance of climate variability and associated impacts. In the project ADAPTER - innovative simulation-based products for weather and climate resilient agriculture - (short 'Adapt terrestrial systems'), funded by the Helmholtz Association, we are establishing and intensifying a dialogue with several agricultural stakeholders in Schleswig-Holstein and North Rhine Westphalia, like agricultural chambers, farmers, plant breeding companies and policy-makers. Our presentation will give a current overview of these stakeholders' requirements of weather and climate information, and necessary steps toward satisfying these requirements. For example, we discuss: what are the most relevant weather events for agriculture; what are worst-case scenarios? What are crucial climate envelopes and critical thresholds for typical crops, and what information do stakeholders need in order to make more informed management and adaptation decisions? How can such information and its presentation and dissemination best be tailored to meet the stakeholders' needs? Based on preliminary results from this dialogue, we will also present tools that can help analyse regional climate projections in order to extract the most relevant practical information, and promising ways to present this information in a user-friendly way and in user-tailored formats.

TP3-O-15

Thunderstorm asthma: an underestimated public health threat? Implicated aeroallergens and impact on allergic symptoms

Bayr, D.[1]*, F. Kolek[1], A. Straub[2], M. Plaza[1], V. Leier-Wirtz[1], M. Gökkaya[1], G. Hammel[1], J. Oteros[3], J. Buters[3], K. Toelken[1], S. Hilgers[1], V. Schwierzeck[1], S. Knoch[1], S. Bezold[1], I. Beck[1], N. Bounas-Pyrros[1], A. Todorova[1], S. Kaschuba[1], S. Seubert[2], M. Gerstlauer[4], C. Beck[2], C. Traidl-Hoffmann[1], S. Gilles[1], A. Philipp[2], A. Damialis[1]

*E-Mail: daniela.bayr@tum.de

[1] *Chair and Institute of Environmental Medicine, UNIKA-T, Technical University of Munich and Helmholtz, Augsburg, Germany*
[2] *Institute for Geography, Physical Geography and Climate Science, University of Augsburg, Augsburg, German*
[3] *Center of Allergy & Environment (ZAUM), Member of the German Center for Lung Research (DZL), Technische Universität München/Helmholtz Center, Munich, German*

[4] *Department of Pediatric Pneumology and Allergology, Children's University Hospital Augsburg, Augsburg, Germany*

Thunderstorm asthma has been reported after unusually high co-occurrence of asthma cases with thunderstorm events. To date, no determinative relationship among involved co-factors has been revealed worldwide. Very few times, it has been examined within a data-oriented framework and or for the full diversity spectrum of aeroallergens (pollen, fungal spores). The aim of this study was to investigate for relationships among asthma risk, aeroallergen occurrence and thunderstorm events. As part of the joint project: Climate Change and Health (fund: Bavarian State Ministry of the Environment and Consumer Protection and Bavarian State Ministry of Health and Care), retrospective analysis with a total timespan from 2015 to 2017 and at a daily scale was conducted on: A) lightning data and GFS analysis from NOAA, B) pollen data from monitoring stations in Augsburg and across Bavaria, C) daily asthma emergency cases. Moreover, detailed case studies were tested in order to identify different thunderstorm-asthma-implicated pollen types in Bavaria. It was found that there is a clear seasonal synchronisation of pollen incidence with lightning and asthma cases, every year and during the whole time series. Moreover, it was striking that additional pollen types, apart from the usual suspect, grass pollen, were implicated in asthma cases, like the also highly allergenic Artemisia, Plantago and Urticaceae. Across-Bavaria relationships were not as clear but there was still a connection between airborne pollen and thunderstorm asthma cases, especially in the warmer regions to the north-west. Thunderstorm asthma is a rare incident and, hence, it has not been thoroughly studied. As it may be life-threatening, retrospective and prospective investigations of the interaction effect of thunderstorms, aeroallergens and severity of symptoms of allergic individuals have to be integrated in the regular environmental and health urban monitoring and planning of policy and decision makers.

Poster presentations

TP3-P-01

The influence of shrub and tree expansion in the forest tundra ecotone on land surface feedbacks and carbon cycling

Gustafson, A.[1]*

*E-Mail: adrian.gustafson@nateko.lu.se

[1] *Department of Physical Geography and Ecosystem Science, Lund University, Lund, Sweden*

The Arctic is warming faster than the global climate, a phenomenon known as Arctic amplification. The increased temperatures in these harsh environments is acting to increase the rate of plant photosynthesis and growth. Observations of changes in size related traits, such as plant height and increased leaf area, of both plant communities and individual plants, have already been made in large parts of the Arctic (Björkman et al., 2018). Furthermore, densification and range expansion of taller shrubs and trees, replacing lower grasses and tundra vegetation, have been reported around the Arctic. The increased rates of plant growth would sequester carbon from the atmosphere into the biomass of plants. The changed characteristics of the vegetation and thus the land surface will have implications for the surface processes that feed back to the climate. There are many feedbacks to the climate system arising from changes in ecosystems and there are many interactions among feedbacks, not least when considering both biogeochemical and biogeophysical processes. It has been proposed that the effect of the carbon sink from the vegetation can be offset through a lower surface albedo. Furthermore, thawing permafrost and increased soil temperatures will likely lead to a larger carbon release from soils. Quantifying these processes is of great importance for climate adaptation and mitigation measures. In this study, we apply the mechanistic vegetation model LPJ-GUESS at the local scale. The model is forced with 50 m resolution observed and modelled climate data in Abisko, Northern Sweden, for a historic period of 1913 to 2000 and projected CMIP5 data for the years 2000 to 2015. We quantify the carbon balance for this landscape under two different climate scenarios and estimate the positive radiative forcing from denser and taller vegetation.

TP3-P-02

Changes in water resources since 21st century over China: from the perspective of terrestrial water storage

Zheng, Z.[1]*

*E-Mail: zhengzy@tea.ac.cn

[1] *Key Laboratory of Regional Climate-Environment Research for East Asia, Institute of Atmospheric P, Beijing, China*

As an important indicator of water resources, terrestrial water storage (TWS) can make comprehensive reflections on regional precipitation, evapotranspiration, runoff, groundwater and human withdrawals for hydrological research and water resource management. This study based on the monthly TWS products from Gravity Recovery and Climate Experiment (GRACE) satellites, together with multi-source datasets which include meteorological observed precipitation and temperature, the evapotranspiration and TWS from monthly Global Land Data Assimilation System (GLDAS 2.1), the water resources-related records from China Water Resources Bulletins (WRBs) and the water-related events from Emergency Events Database (EM-DAT) to comprehensively investigate the water resources variations in ten major basins in China during 2000-2016. The results show that due to the huge heterogeneity of geography, climate and anthropogenic intensity, there are significant differences in TWS and water resources trends between the northern and southern basins in China. The TWS and water resources in the southern basins with abundant precipitation and river streamflow show faster increasing trends, while the relatively dry northern basins generally exhibit downward trends. Most serious situations are located in the Huaihe River Basin and Southwest River Basins where the largest decreasing trends of TWS occurred during the study period, and the largest decreasing trend of TWS occurred in the Northern China Plain where the most human water withdrawal happened. From the perspective of TWS change, the water resources gap between the northern and southern basins are facing further enlarged threaten, which should be seriously considered in water

resources management and adaptation decision-making in future sustainable design and development.

TP3-P-03

Understanding inter-relationship between environmental attributes in Himachal Pradesh in India using MODIS data sets and machine learning algorithms

Haq, M. A.[1]*, N. Chahal[1], G. Rahaman[1], P. Baral[1], N. T. Deepak[1], J. Akhtar[1]

*E-Mail: anul.haq@niituniversity.in

[1] *NIIT University, Neemrana Rajasthan, India*

Support vector machines (SVMs) represent one the classes of supervised machine learning algorithms used for both regression as well as classification. We have applied SVM in this study for regression also termed as Support Vector Regression (SVR) to study the inter-relationship between environmental variables in Himachal Pradesh state in northern India. For this purpose, we have used MODIS data set between 2001 and 2017 to calculate three parameters; total sum of Normalised Difference Vegetation Index (NDVI) pixels and snow cover pixels and average land surface temperature (LST) values for each month from January 2001 until December 2017 for entire Himachal Pradesh. SVR was then used to predict the values of the three parameters in such a way that for each regression, two out of the three parameters were considered independent variables while the remaining parameter was considered as dependent variable. Monthly data from January 2001 until December 2017 was provided to train the model. A total of 18 SVR model runs with linear and radial basis kernels were carried out. Correlation coefficients obtained between actual and predicted values of dependent variables for SVR model runs showed that the prediction of dependent variables depend upon the parameters and kernels of the SVR models. The best predictions for SVR with linear and radial kernels were observed when total snow pixels and LST values were considered dependent variables respectively.

TP3-P-04

Atmospheric carbon fluxes of a formerly drained fen up to 14 years after rewetting

Gottschalk, P.[1]*, C. Wille[1], F. Koebsch[2], T. Sachs[1]

*E-Mail: pia.gottschalk@gfz-potsdam.de

[1] *Helmholtz Centre Potsdam – GFZ German Research Centre for Geosciences, Potsdam, Germany*
[2] *Universität Rostock, Rostock, Germany*

Drained and degraded peatlands constitute significant and long-term carbon dioxide sources and thus contribute to climate warming. In the northeast German state of Mecklenburg-Western Pomerania, an estimated 20-30% of the statewide carbon dioxide emissions are attributed to drained peatlands and one strategy to reduce national greenhouse gas emissions is therefore the rewetting of peatlands to restore their natural carbon sink capacity. However, the long-term evolution of carbon fluxes of rewetted fens are highly site specific and uncertainty remains of, whether and when such sites turn into carbon sinks. Within the Terrestrial Environmental Observatory Network (TERENO), surface-atmosphere fluxes of CO_2 and CH_4 were measured at the TERENO Northeast German Lowland Observatory eddy covariance site 'Polder Zarnekow' (Fluxnet ID: DE-Zrk), a formerly drained and rewetted rich fen located in the Peene River valley. Draining of the fen began in the 18th century and was intensified between 1960 and 1990, when the water table was lowered to > 1 m below the surface. Mineralisation of the peat caused the surface to subside to levels below the adjoining Peene River. The site was rewetted by inundation during the winter of 2004/2005 and a shallow lake with a fluctuating water table and depths of up to 1.2 m and an area of about 7 ha developed. A layer of organic sediment formed at the bottom of the lake, which originated from the fen's former vegetation and has since been annually replenished by dying aquatic plants and helophytes. A first observation period predating the establishment of TERENO infrastructure covers the years 2007–2009 and continuous monitoring has been ongoing since 2013. Results suggest that methane emissions are remaining high (28-39 g m-2 y-2) while CO_2 effluxes show a declining trend eventually turning the site from a CO_2 source to a CO_2 sink in 2018. We present time series of surface type specific carbon fluxes and annual carbon balances (excluding lateral transport) for 2008 and 2014 to 2018. Drivers of the turbulent fluxes are analysed on various time scales and the role of observed temporary summertime drying of the lake in the net carbon balance is analysed.

TP3-P-05

ESA CCI+ Permafrost - validation using international and national permafrost monitoring networks

Heim, B.[1]*, M. Wieczoreck[1], A. Irrgang[1], B. Biskaborn[1], H. Matthes[1], G. Grosse[1], A. Haas[1], S. Westermann[2]

*E-Mail: birgit.heim@awi.de

[1] *Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research (AWI), Potsdam, Germany*
[2] *University Oslo, Oslo, Norway*

The parameters required by GCOS for the Essential Climate Variable (ECV) Permafrost are depth of active layer and permafrost temperature. The ESA CCI+ Permafrost project, funded by ESA 2018-2021, will provide these two ECVs in the permafrost extent simulation, using a set of global satellite data products. Special emphasis in CCI+ is placed on validation with international and national monitoring networks and in cooperation with the scientific community and stakeholders. The validation and evaluation efforts will also innovatively consider high-mountain permafrost regions, using in-situ observations of ground temperatures, and permafrost creep, provided by national data-services such as PERMOS in CH. To validate the CCI+ Permafrost products, we are standardising ground data on permafrost temperature, active layer depth from permafrost programs and research groups, and national monitoring programs such as ROSHYDROMET (RU). The main validation product will be the database of the Global Terrestrial Network for Permafrost (GTN-P). Managed by the International Permafrost Association (IPA). We are going to present an overview of temporal and geographical coverage of the CCI+ Permafrost validation dataset. This comprehensive dataset includes variable timeframes from hourly over annually to sporadic measurements and covers a wide range of different vegetation and permafrost types. We present our steps of data mining,

standardisation, data optimisation and metadata completion. This optimised and standardised validation data set will be supplied within the CCI+ Climate Research Data Package (CRDP) and will thus be publicly available for validation for the broader climate science community.

TP3-P-06

Regional fire regimes and landscape interaction in boreal forests of central Yakutia, eastern Siberia, Russia

Varchim, P.[1], I. Nitze[2], B. Heim[2], S. Kruse[2], E. Dietze[2]*

*E-Mail: edietze@awi.de

[1] *Free University Berlin, Geography / Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research (AWI), Potsdam, Germany*
[2] Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research (AWI), Potsdam, Germany

Wildfires are key factors in boreal forest influencing regional biogeochemical cycles and land surface properties. Fire regimes characterised by fire frequencies, fire intensities, area and amount of biomass burnt, influence land surfaces by changing albedo and surface roughness, and vegetation compositions (e.g. fire-related functional traits). Fire is thought to play a major role in the vegetation-permafrost-climate feedback: small, frequent, low-intensity fires dominate in summer green boreal forest stabilising larch forest over permafrost, whereas evergreen boreal forest burns less frequently but with higher intensity, hence, with different effects on vegetation recovery. Yet, fire regime shifts under future climate change are difficult to predict, especially in the northern high latitudes, where in-situ observations are scarce. Here, we characterise the fire regime (frequency, area burnt) in an area between Yakutsk and Nyurba in Central Yakutia, using optical remote sensing data (Landsat, Sentinel-2) and products (e.g. Landsat-based 'Global Forest Change') that cover the last 20 years. We analyse environmental and climatic factors that influence regional fire regimes by comparing fire regime properties to existing land cover classifications, topography from digital elevation data, vegetation and moisture indices from remote sensing. This analysis will help to assess the directions and rates of land cover change induced by wildfires and their drivers.

TP3-P-07

Permafrost-related research data - their accessibility, visualisation, and publication using GIS and WebGIS technology

Haas, A.[1*]; B. Heim[1], A. Bartsch[2,3], A. Walter[1], C. Schäfer-Neth[1], F. M. Seifert[4]

*E-Mail: antonie.haas@awi.de

[1] *Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research (AWI), Bremerhaven, Germany*
[2] *Zentralanstalt für Meteorologie und geodynamik, ZAMG, Wien, Austria*
[3] *b.geos, Korneuburg, Austria*
[4] *ESA - ESRIN, Italy*

Permafrost regions are highly sensitive to climate changes. The monitoring of key variables and identification of relevant-processes is of topmost importance in these environments. ESA DUE GlobPermafrost (www.globpermafrost.info) provides a remote sensing data service for permafrost research and applications. This service was extended by permafrost modelling (time series), implemented in the new ESA CCI+ Permafrost project (2018-2021).

The service comprises of the generation of remote sensing products for various regions and spatial scales as well as the specific infrastructures for visualisation, dissemination and access to datasets - PerSys. PerSys is the ESA GlobPermafrost geospatial information service for publishing and visualisation of information and data products to the public. Data products are described and searchable in the PerSys data catalogue (apgc.awi.de), and data visualisation employs the AWI WebGIS-infrastructure maps@awi (http://maps.awi.de), a highly scalable data visualisation unit within the AWI data-workflow framework O2A, from Observation to Archive.

maps@awi WebGIS technology supports the project-specific visualisation of raster and vector data products of any spatial resolution and remote sensing origin. This is a prerequisite for the visualisation of the wide range of GlobPermafrost remote sensing products like: Landsat multispectral index trends (Tasseled Cap Brightness, Greeness, Wetness; Normalised Vegetation Index NDVI), Arctic land cover (e.g. shrub height, vegetation composition), lake ice grounding, InSAR-based land surface deformation, rock glacier velocities and a spatially distributed permafrost model output with permafrost probability and ground temperature per pixel. We established several WebGIS projects for the adaption to products specific spatial scales. For example, the WebGIS 'Arctic' visualises the Circum-Artic products. Highly resolved data products for rock glacier movements are visualised on regional scales in the WebGIS projects 'Alps', 'Andes' or 'Central Asia'. The PerSYS WebGIS also visualises the stations of the WMO GCOS ground monitoring networks of the permafrost community: the Global Terrestrial Network for Permafrost GTN-P managed by the International Permafrost Association IPA. The PerSYS WebGIS has been continuously adapted in close co-operation with user at user workshops and at conferences and the International Permafrost Association (IPA).

Topic 4

Atmospheric composition and climate: interactions between global and regional scales

Oral presentations

TP4-O-01

On the unreported emissions of CFC-11: did the story started in 2012?

Laeng, A.[1]*

*E-Mail: alexandra.laeng@kit.edu

[1] *Karlsruhe Institute of Technology (KIT), Institute of Meteorology and Climate Research, Karlsruhe, Germany*

This talk is an update of the talk given in March 2019 in UN Office in Vienna on 'CFC-11 Symposium' that was gathered after S. Montzka 2018 paper. Using 10-years record of global measurements of CFC-11 between 2002 and 2012 by MIPAS instrument, we provide evidences that unreported emissions of CFC-11, which are responsible for the slowdown of the expected decrease of concentrations of CFC-11 assured by the application of the Montreal Protocol, most likely have started around 2007.

TP4-O-02

Water vapour transport through the Asian monsoon tropopause: analysis of H_2O and HDO observations from MIPAS

Speidel, J.[1], G. Stiller[1]*, N. Glatthor[1], M. Kiefer[1]

*E-Mail: gabriele.stiller@kit.edu

[1] *Karlsruhe Institute of Technology (KIT), Institute of Meteorology and Climate Research, Karlsruhe, Germany*

We present a study of the water vapour transport through the Asian summer monsoon tropopause on basis of MIPAS/Envisat observations of H_2O and HDO. The analysis was done on lapse rate tropopause-related vertical coordinates in order to understand the role of overshooting convection versus slow uplift over the seasonal evolution of the monsoon system. Particle versus gas-phase transport was distinguished by analysing the content of heavy isotopologues of water vapour in the stratosphere, in particular the HDO/H_2O ratio, quantified by the value deltaD.

TP4-O-03

Impact of water vapour on ozone in the mid-latitude lowermost stratosphere in summer

Robrecht, S.[1]*, B. Vogel[1], S. Tilmes[2], R. Müller[1]

*E-Mail: sa.robrecht@fz-juelich.de

[1] *Institute for Energy and Climate Research, IEK-7, Forschungszentrum Jülich (FZJ), Jülich, Germany*
[2] *National Center for Atmospheric Research, Boulder, United States of America*

Stratospheric ozone absorbs UV-light and protects life on earth from considerable damage. Climate change and convective overshooting events, as they can occur the North American summer, can yield a moistening of the mid-latitude lowermost stratosphere and affect lowermost stratospheric ozone. Enhanced water vapour together with low temperatures can yield a heterogeneous chlorine activation and hence lead to a chemical ozone destruction. However, the likelihood of this chemical ozone loss process and its impact on ozone in the lowermost stratosphere for conditions today and in future is a matter of current debate. We present a study about the sensitivity of this chemical ozone loss process to the temperature, water vapour content, sulphate aerosols, and trace gases (as Cly and NOy) performing box-model simulations with the Chemical Lagrangian Model of the Stratosphere (CLaMS). Assuming several conditions, we estimate the impact of convective overshooting events today and the climate change or the potential application of sulphate geoengineering in future on ozone in the mid-latitude lowermost stratosphere in summer.

TP4-O-04

On the role of stratospheric ozone in the interactive chemistry-climate system

Braesicke, P.[1]*, J. Schröter[1], M. Braun[1], S. Wang[1], M. Weimer[2], R. Ruhnke[1]

*E-Mail: peter.braesicke@kit.edu

[1] *Karlsruhe Institute of Technology (KIT), Institute of Meteorology and Climate Research, Karlsruhe, Germany*
[2] *SCC, KIT, Karlsruhe, Germany*

Stratospheric ozone protects life from hard UV radiation. At the same time, it determines important aspects of the thermal structure of the atmosphere. In classic climate simulations, ozone is prescribed as a boundary condition. However, we know that the interaction of (stratospheric) ozone, radiation and circulation can be central for some aspects of climate change. A prominent example is the impact of the Antarctic ozone hole on surface climate. In addition, feedbacks involving ozone can affect climate sensitivity as well. Over the years, different groups have constructed a number of chemistry - or composition - climate models. Using these models, a number of mechanisms have been investigated in which ozone changes are central to climate change signals that would not be captured when prescribing an ozone climatology. Starting from a general overview, we will explore an exemplary model in more detail. We complemented the ICON modelling system of DWD and MPI-M with KIT's ART module for aerosols and trace gas composition. This ICON-ART configuration allows the

seamless exploration of interactions between stratospheric ozone and weather/climate. We start with the characterisation of the ICON-ART model in interactive (ozone is modelled) versus non-interactive (ozone is prescribed as a climatology) integrations. Doing this in a consistent way allows for an improved understanding of systematic model biases and allows the exploration of coupling mechanisms (laterally and vertically) and the potential role of ozone in this coupling. Moving on from the general model characterisation, we will look at the mechanisms driving ozone changes on smaller scales and how they are propagated across scales. This includes, for example, model integrations at high resolution in direct comparison to measurements. In addition, we use the model to look at the climate change signal induced by the ozone hole in idealised time-slice integrations with and without the ozone hole. Such simulations aid the understanding of observed change patterns and are informed by the model characterisation. We conclude that chemistry-climate models are indispensable tools to understand certain aspects of climate change and that idealised simulations can support detection of climate change signals. We can meet the challenge of modelling across scales and in-depth validation with highly resolved measurement data with new modelling systems like ICON-ART.

TP4-O-05

Optimised probabilistic forecasts for uncertain coupled parameters in chemistry transport modelling

Vogel, A.[1]*, H. Elbern[1]

*E-Mail: av@eurad.uni-koeln.de

[1] *IEK-8 Forschungszentrum Jülich (FZJ), Jülich, Germany / RIU University of Cologne, Cologne, Germany*

The high-dimensionality and complexity of atmospheric models requires a computationally efficient estimation of forecast uncertainties. However, reliable uncertainty estimations are crucial for interpreting the forecasts results and their uncertainties. Chemistry transport models have about O(100) prognostic parameters per grid point and numerous additional model and diagnostic parameters. Thus, these models rely on various input quantities, which make their forecasts highly sensitive uncertainties in input parameters. Analysing intrinsic correlation within the system, an Eigenmode-based approach for perturbation of uncertain parameters is developed. By substituting the stochastic sampling into an uncorrelated subspace, the degrees of freedom of the problem can be lowered significantly. Although this approach can be used for various uncertain parameters in atmospheric models, this study focuses on the application to regional chemical transport modelling. A sensitivity analysis indicates high uncertainties in biogenic emissions and deposition velocities as well as atmospheric dynamics. These quantities are influenced by a large number of processes inducing high sensitivity to various input uncertainties. Given these input sensitivities, coupled probabilistic distributions of the model parameters are generated using leading Eigenmodes. Preliminary results for a case study in northern Italy show high spatial correlations as well as cross-correlations between considered parameters. The results indicate that the major uncertainties can be described by a few leading Eigenmodes representing the largest coupled sensitivities of the model parameters. For example, isoprene emissions are found to be especially sensitive to soil moisture and land use information, which are represented by the two leading Eigenmodes. Based on this, the algorithm generates an ensemble forecast were standard deviations easily exceed mean concentrations.

TP4-O-06

A twenty-six year long-term trend for particulate matter (PM) at the rural background in Germany – influence of air mass inflow and season

Spindler, G.[1]*, A. Grüner[1], R. Rabe[1], H. Herrmann[1]

*E-Mail: spindler@tropos.de

[1] *Leibniz Institute for Tropospheric Research (TROPOS), Leipzig, Germany*

Long-term studies help to quantify the influence of decreasing emissions on the concentrations. The TROPOS research site Melpitz is located in the rural-background in Germany (12°56’ E, 51°32’ N, 86 m asl.). The highest annual mean temperature was registered in 2018 with 11.1°C (Trend since 1993 0.07 Ka^{-1}). The Melpitz station is representative for a large area in central Europe and is integrated in EMEP (European Monitoring and Evaluation Program) and ACTRIS (Aerosol, Clouds, and Trace gases Research Infra Structure Network). High-Volume (HV) quartz filter-samples for particles < 10 µm aerodynamic-diameter (PM10) were collected daily since January 1993. PM2.5 and PM1 were collected since January 2003. The determination of the particle mass was performed gravimetrically. The main water-soluble ions (Nitrate, Sulfate, Chloride, Natrium, Ammonium, Potassium, Magnesium and Calcium) were analysed by ion chromatography. The determination of organic (OC) and elemental carbon (EC) was measured by carbon analysers (thermographic and thermo-optical method). Spatial and seasonal influences of the daily means by air mass transport from a western sector (W, 210-320°, mostly marine origin) and a broad eastern sector (E, 35-140°, continentally influenced) were investigated using backward trajectories (96 h). The additional seasonal discrimination in winter (W, November-April) and for summer (S, May-October) resulted in four categories WW, WE, SW and SE covering 70.3% of the complete time. The PM10 concentration decreases since 1993 and remains constant in the last 18 years with 21.96 ± 3.15 $\mu g/m^3$. However, nitrate concentrations remained more constant. A strong decrease of sulphate was observed from 1993-2000. Afterwards, the decrease was less pronounced. Reasons were fast local emission reductions in the region during the first period and additional continuous emission reductions in Europe since 2000. The highest EC concentrations were found for WE (coal combustion and long-range transport). In general, EC and OC show a decreasing trend and only OC for WE remains constant.

TP4-O-07

Urban emissions from the Berlin and Stuttgart areas: A case study using aircraft-based CO_2, CH_4, NO_2 and O_3 in-situ observations

Fiehn, A.[1]*, T. Klausner[1], M. Pühl[2], M. Mertens[1], P. Jöckel[1], A. Roiger[1]

*E-Mail: alina.fiehn@dlr.de

[1] *German Aerospace Center (DLR), Munich, Germany*

Urban areas cover less than 3% of the terrestrial earth surface but currently accommodate more than half of the world's population, with a persistent increasing trend. This spatial concentration of human activities and high-energy consumption make cities a hotspot for air pollution and greenhouse gas (GHG) emissions. For the development of efficient mitigation strategies in order to keep the global temperature rise below 2 °C above pre-industrial levels (Paris Agreement) an improved quantification of the GHG budget is needed. Here we report on aircraft-based in-situ measurements in summer 2018 performed with the DLR Cessna Caravan within the Urban Climate Under Change [UC]2 project. Flights were conducted in Stuttgart with its unique topographic location in a basin and Berlin as largest German city. In and outside the Stuttgart basin, research flights were carried out twice a day to analyse the evolution of the polluted boundary layer. When crossing the Stuttgart basin within the boundary layer (PBL), enhancements of up to 30 ppb NO_2 several hundred meters above ground were measured in the mornings, strongly correlated with CO_2 and CH_4 enhancements. In contrast, during the afternoons a well-mixed and higher PBL was observed with only little variability in trace gas enhancements (ΔNO_2 = 1 to 2 ppb). In Berlin, flights were performed during the afternoon with flight transects up- and downwind of the city to apply a conventional mass balance approach and estimate GHG emissions. During two research flights (July 20th and 24th) a roughly 40 km wide plume with enhancements of CO_2 and CH_4 was detected downwind of Berlin (up to 4 ppm CO_2 and 21 ppb CH_4) in a generally well-mixed PBL. Although Berlin is considered a relatively isolated city, surrounding sources play a significant role. We estimate the GHG mass fluxes and compare them with current emission inventories. A discussion of the large day-to-day variability in the measured CH_4 flux and high measured ozone enhancements is presented.

TP4-O-08

Aerosol optical depth variability in the Arctic during past decades (1980 - 2018) seen from satellite: achievements and perspectives

Mei, L.[1]*, J.P. Burrows[1], M. Vountas[1], L. Lelli[1], V. Rozanov[1]

*E-Mail: mei@iup.physik.uni-bremen.de

[1] *Institute of Environmental Physics, University of Bremen, Bremen, Germany*

Better knowledge of aerosol information in the Arctic, especially the variabilities of aerosols in both large-spatial and long-temporal scales, is required for a better understanding of the Arctic Amplification and its feedback mechanism. Satellite observations offer unique ways to measure aerosol information in the Arctic. Currently, satellites can provide information of Aerosol Optical Depth (AOD), a parameter to describe aerosol loading, with good quality over cloud/snow/ice free regions in the Arctic. AOD research product over cloud/snow/ice covered regions is still under developing. In this study, we utilise the NOAA (National Oceanic and Atmospheric Administration) high-quality AVHRR (Advanced Very High Resolution Radiometer) PATHFINDER Atmospheres Extended (PATMOS-x) cloud product to minimise the potential cloud/snow/ice contamination in the aerosol climate data record during 1980 – 2018. A cloud/snow/ice contamination minimised AOD daily data record is then aggregated to a monthly data record. The AOD monthly data record is used to reveal the AOD variabilities over the whole Arctic ocean and selected regions (e.g. Fram Strait, Bering Strait, Barents Sea, the Northeast Passage) in the past decades to understand the contribution of local aerosol sources and aerosols due to transport in the Arctic. Potential factors including wind, temperature, sea ice extend, Chlorophyll concentration are analysed to understand the dominated factors of the AOD changes over the Arctic ocean during 1980 – 2018. The current achievements of this work will provide valuable information of aerosol over the Arctic for both satellite and model communities. In the long term, an Arctic seamless (including cryosphere) AOD data product is needed to have a better understanding of the changes of aerosol in the Arctic. Latest progress of the development of AOD-above-cryosphere satellite research product and its potential application perspectives will also be presented.

TP4-O-09

Application of a new aerosol scheme to quantify the aging of aerosols emitted by the Eyjafjallajökull eruption

Muser, L.[1]*, H. Vogel[1], G. Hoshyaripour[1], S. Gruber[1], S. Werchner[1], M. Weimer[2], C. Kottmeier[1], B. Vogel[1]

*E-Mail: lukas.muser@kit.edu

[1] *Karlsruhe Institute of Technology (KIT), Institute of Meteorology and Climate Research, Karlsruhe, Germany*

[2] *Steinbuch Centre for Computing, Karlsruhe Institute of Technology, Karlsruhe, Germany*

Aerosols emitted by volcanic eruptions are hazardous for aircrafts and influence weather and climate. State of the art global circulation models, such as ICON-ART, allow aerosol dispersion forecasts, but so far neglect the aging of aerosols. Here, aging means the modification of the chemical composition of particles by condensation and coagulation. We extended the ICON-ART modelling system by including the dynamic processes of secondary aerosol formation and aerosol aging. This is achieved through the development and implementation of the novel aerosol module AERODYN (AEROsol DYNamic). More specifically, a simplified OH chemistry scheme permits the conversion of volcanic SO_2 into sulphuric acid, which in turn can nucleate into sulphate particles or condense onto existing aerosol particles. The newly implemented aerosol aging processes allow particles to interact with each other through coagulation and to form internally mixed aerosols. First ICON-ART experiments using AERODYN were carried out for the Eyjafjallajökull eruption of May 2010. Results show the transformation of SO_2 into secondary volcanic aerosol

(sulphate particles) and the aging of ash particles. Gaseous water and sulphuric acid that condense onto ash particles within the volcanic plume dominate the aging of volcanic ash in our simulation. The resulting internally mixed aerosol has different optical properties as its single components. The new implementations in the scope of the AERODYN development describe these optical properties in ICON-ART. This allows us to compare our model results with remote sensing data, such as satellites and Lidar systems.

TP4-O-10

Regional radiative forcing due to biomass burning aerosol pollution in Kyiv region

Yukhymchuk, Y.[1]*, G. Milinevsky[2], V. Bovchaliuk[2], V. Danylevsky[2], P. Goloub[3], P. Dubuisson[3]

*E-Mail: juliyuhim@gmail.com

[1] *Main Astronomical Observatory of National Academy of Sciences of Ukraine, Kyiv, Ukraine*
[2] *Taras Shevchenko National University of Kyiv, Kyiv, Ukraine*
[3] *Laboratoire d'Optique Atmosphérique, Université de Lille1, Villeneuve d'Ascq, France*

The aerosol effect to the energy balance in atmosphere of Earth is widely recognized as one of the most significant and least known aspects of climate change. The main sources of atmospheric aerosols include urban/industrial emissions, transport pollutions, smoke, biomass burning products, secondary aerosol formation from aerosol precursors (variable components of the atmosphere that form aerosols by chemical transformations), sea salt, volcano eruption, dust. In our study we present the study of aerosol particles optical and microphysical properties and estimate aerosol influence on influence on radiative forcing in the atmosphere over Kyiv, Ukraine. The data were obtained by sun photometer of AERONET and lidar CIMEL370. Lidar and algorithm GAME (Global Atmospheric ModEl) have been provided by the Laboratory of Atmospheric Optics of the University of Lille. Radiative forcing as a flow change introduced by the presence of certain components of the atmosphere into the solar energy flow that enters the climate system. In the GAME models the equation of transfer of radiation is accurately resolved. The GAME calculates the radiation flow and direct radiation forcing. The radiation fluxes, the brightness and the rate of environment heating can be calculated for each atmosphere level in the spectral range from 0.2 to 3 µm (using the optimisation of the heterogeneous atmosphere divided by 50 flat homogeneous layers). In September 2015 in the north and west Ukraine were happen powerful wild fires. The aerosol pollution by product of biomass burning and them influence during that event was investigated. The vertical distribution of aerosol in the atmosphere was obtained by the lidar observation for the first time in Ukraine. This measurements with corresponding values obtained by the AERONET algorithm was use to calculate radiative forcing by GAME.

Poster presentations

TP4-P-01

First steps to ICON/MESSy as an atmospheric chemistry model: CLaMS trajectory calculations of trace species on ICON wind fields at the polar vortex region

Sonnabend, J.[1]* J.-U. Grooß[1], R. Müller[1]

*E-Mail: j.sonnabend@fz-juelich.de

[1] *IEK-7, Forschungszentrum Jülich (FZJ), Jülich, Germany*

ICON as a general circulation model provides a dynamical core which overcomes the problem of singularity at the pole regions with evenly distributed grid points. Especially in stratospheric winter and spring, the polar vortex is formed and is characterised by a strong transport barrier at its edge. The simulation of tracer transport in the vicinity of these barriers is a challenge as the diffusion across the transport barrier can be very low. We show first steps of Chemical Lagrangian transport simulation on the base of ICON meteorological wind fields and investigate the resulting tracer distributions near the polar vortex edge. These results are compared with those of the satellite data from measurements of the Microwave Limb Sounder (MLS) in the same time period. By applying the Lagrangian transport scheme to a wind field resolved on an icosahedral grid, stronger and more realistic gradients at the polar region are expected.

TP4-P-02

First continuous high-resolution aerosol record from the East Greenland Ice Core Project (EGRIP), covering the last 9670 years

Jensen, C. M.[1]*, T. Erhardt[1], H. Fischer[1]

*E-Mail: jensen@climate.unibe.ch

[1] *Climate and Environmental Physics, Oeschger Centre for Climate Change Research, University of Bern, Bern, Switzerland*

Ice sheets are reliable archives of atmospheric impurities such as aerosols and gasses of both natural and anthropogenic origin. Impurity records from Greenland ice cores reveal much information about previous atmospheric conditions and long-range transport in the Northern hemisphere going back more than a hundred thousand years. The seasonal variability of impurities and stable water isotope ratios can be employed to count annual layers in ice cores going back several thousands of years. Continuous analysis techniques, applied to soluble impurities and particles in ice cores, offer several benefits over discrete sampling approaches, including greater sampling resolution, simpler and more effective contamination control and greater sample throughput. The current continuous flow analysis (CFA) system used for ice cores analysis at University of Bern is capable of measuring conductivity, dust, sodium, calcium, ammonium, nitrate, hydrogen peroxide and acidity (pH). Here we present the data from the upper 905 m from EGRIP, revealing information about ocean sources, transport of terrestrial dust, soil and vegetation emissions as well as biomass burning, volcanic eruptions etc., covering the approximately past 9670 years. This newly uptrained data set is therefore unique

due to that it reveals information about several thousands of years of the mid-Holocene period in Greenland, that none of impurity recovers for the other deep ice cores have managed to cover before. This can contribute to further understand on the atmospheric conditions for the pre-industrial period. One of the proxies that will be measured for the EGRIP core is ammonium. Sources of ammonium in the ice are assumed to be both soil and vegetation emissions as well as biomass burning. Analysing the high-resolution EGRIP ammonium record will provide an insight in the inter-annual variability and the observed changes over time, also providing an understanding of the natural variability and what is assumed to be the anthropogenic contribution and influence. Further, the ammonium record, can provide us with a record of the frequency of wild fires for the Holocene period.

Topic 5

Extreme events across scales (past, present, future)

Oral presentations

TP5-O-01

Estimation of severe convective storm hazards using reanalysis-derived indices

Punge, H. J.[1]*, K. Bedka[2], M. Kunz[1]

*E-Mail: punge@kit.edu

[1] *Karlsruhe Institute of Technology (KIT), Institute of Meteorology and Climate Research, Karlsruhe, Germany*
[2] *NASA Langley Research Center, Hampton, VA, United States of America*

Severe convective storms (SCS) cause extreme meteorological conditions regarding wind speed in tornadoes and derechos as well as in precipitation of hail or excessive rain. The resulting damage to human assets and infrastructure makes them some of the most costly natural hazards. While the most destructive events regularly attract media attention, knowledge on the spatio-temporal distribution of the hazard is still rather limited. Direct modelling SCS in climate simulations is still a costly endeavour and restricted to limited spatial domains. Therefore, proxies for SCS based on large-scale modelled conditions are useful for climatology and temporal evolution of the hazard. The objective of this study is to evaluate a set of meteorological thunderstorm indices for their potential to describe the climatology of these phenomena. Automated detection of the overshooting cloud tops (OTs) linked to SCS in long-running geostationary satellite datasets provides an SCS climatology on continental scales for Europe, Australia and South Africa. By adding datasets and with the use of machine learning methods, we show how hail and rain events can be distinguished by their atmospheric environments from reanalyses. We evaluate a set of six different SCS-related indices against these satellite-derived frequencies, focusing on hail hazard. Statistical methods are used to test the performance of the indices for different con continents, quantify uncertainties and give recommendations on appropriate use cases of such estimates.

TP5-O-02

Exploring hydrological extremes across earth system compartments: the Elbe as a case study

Brix, H.[1]*, C. Schütze[2], P. Fischer[3], U. Koedel[2], A. Wieser[4], Y. Voynova[1], The MOSES-Team[5]

*E-Mail: holger.brix@hzg.de

[1] *Helmholtz-Zentrum Geesthacht (HZG) - Centre for Materials and Coastal Research, Geesthacht, Germany*
[2] *Helmholtz Centre for Environmental Research – UFZ, Leipzig, Germany*
[3] *Alfred-Wegener-Institute, Helgoland, Germany*
[4] *Karlsruhe Institute of Technology, Eggenstein-Leopoldshafen, Germany*
[5] *Helmholtz Association, Germany*

Recent global projections predict a 10–20% increase in the frequency and intensity of storm events with severe precipitation and floods for the northern hemisphere by the end of the century. In the past, major floods occurred at all large river systems in Central Europe. For the next decades, regionalised climate projections show a slight increase in wintertime precipitation and drier summers with episodic heavy rainfall. The latest and clearly recognisable extremes are the floods in the Elbe catchment area in 2002 and in the Elbe and Danube catchments in 2013. Similarly, series of disastrous floods caused by convective weather systems, but more localised on small river catchments, occurred in 2016 and 2017. In 2018, a widespread drought event impacted all mayor German river basins, halted commercial shipping and caused economic damage in agriculture, shipping and other industries. One focus of the Helmholtz Association's MOSES (Modular Observation Solutions for Earth Systems) project lies on investigating hydrological extremes. It joins forces from eight research institutes across all Earth Science fields to make progress observing and understanding the complex mechanisms leading to extreme events in a holistic system approach using the Elbe river catchment as a test case. These efforts are complemented through the Digital Earth project, which aids the investigations by applying sophisticated data science methods to existing and newly generated data sets. Here we present results from the first years of the project, highlighting the lessons learned from combining knowledge and researchers with highly diverse scientific backgrounds, sketching difficulties such as developing shared concepts, consistent workflows and data quality standards, coordinating and performing complex observation campaigns, as well as gathering, administering and analysing data in near real time or within days of collection, and outlining the opportunities that arise from our approach.

TP5-O-03

A whirlwind romance: the effect of hurricanes on fertility in early 20th century Jamaica

Tveit, T.[1]*

*E-Mail: thomas.tveit@vwi.unibe.ch

[1] *University of Bern, Bern, Switzerland*

Even in today's modern world storms where one can fairly accurately predict storms and their paths they are still the most expensive disaster type causing damages totaling USD 1330 billion in the period 1998-2017 according to the United Nations Office for Disaster Risk Reduction. However, in addition to these direct monetary costs, there are also indirect costs. A small number of papers - almost all of which focus on storms that occurred post 1990 - have looked at hurricanes and their seemingly varying effect on fertility. In our paper we examine the hurricane fertility effect in a historical perspective, in a time prior to remote sensing, storm buoys and advanced computer models, making the analysis better capture the effect that a sudden shock has on people's fertility decisions. We investigate the impact of

hurricanes in the Caribbean on fertility rates in Jamaica for the period 1901 to 1929. More specifically, we construct a hurricane destruction index derived from a wind speed model that we combine with data on more than 1 million births across different parishes in Jamaica. Analysing the birth rate following damaging hurricanes, we find a strong and significant negative effect of hurricane destruction on the number of births. Overall, hurricanes resulted in 10,201 fewer births, or roughly 1 percent of the total. Damaging hurricanes also reduce births for up to, and including, 17 months after the event but no evidence of a temporal displacement of births is found. In addition, we find no support for the Trivers-Willard hypothesis that birth of one sex becomes more prevalent than another. However, there is evidence that the fall in births is due predominantly to single mothers having fewer children relative to married couples, potentially showing the effect that having a strong support network has in times of need.

TP5-O-04

The 2018 drought in Germany

Marx, A.[1*], S. Thober[1], F. Boeing[1], L. Samaniego[1]

*E-Mail: klima@ufz.de

[1] *Helmholtz Centre for Environmental Research – UFZ, Leipzig, Germany*

The 2003 drought event in Europe had major implications on many societal sectors, including energy production, health, forestry and agriculture. The reduced availability of water accompanied by high temperatures led to substantial economic losses on the order of 1.5 Billion Euros, in agriculture alone. Furthermore, soil droughts have considerable impacts on ecosystems, forest fires and water management. The 2015 drought event showed that 75% of the German territory underwent drought conditions in July and finally resulted in 22% maize yield losses compared to the long term mean. Analysis of the 2018 drought event, which garnered broad media attention, shows that more than 95% of the German territory underwent drought conditions in November 2018, in the uppermost 25 cm soil horizon as well as in the total soil column. Regions such as North and East Germany however, have been particularly prone to drought conditions since spring 2018 and showed negative precipitation anomalies from the beginning of the year. As a result, crop losses occurred e.g. in winter wheat, and losses in maize yield are expected due to drought stress. Federal states reported crop yield based losses of more than 3 billion €. Comparisons with historical droughts based on a seasonal drought magnitude show that the 2018 event is the most severe drought event observed in Germany since 1951 in terms of its spatial extent, magnitude and duration. Information and data from our information platform www.ufz.de/droughtmonitor are widely used in the public and media. In 2018, the webpage was hit more than 200,000 times. Analysis of an ensemble of 60 hydrometeorological simulations in the C3S project EDgE and BMBF funded project HOKLIM showed that under a global warming of 3 K, times under drought would double in some parts of Germany.

TP5-O-05

Reconstruction of the strong storm tide in March 1906 in the German Bight

Meyer, E. M. I.[1*], R. Weisse[1], B. Tinz[2], T. Möller[2]

*E-Mail: elke.meyer@hzg.de

[1] *Helmholtz-Zentrum Geesthacht (HZG) - Centre for Materials and Coastal Research, Geesthacht, Germany*

[2] *Deutscher Wetterdienst, Hamburg, Germany*

In the night from 12 to 13 March 1906, a very severe storm tide occurred in the German Bight. Extremely high-water levels were caused by the coincidence of high astronomical (spring) tides and high surge levels caused by strong northwest winds. For large parts of the East Frisian coast, the high-water levels caused by this event are still the highest. Atmospheric data to investigate this event has been limited. Recently, such data has become available from century long reanalyses in which only surface data were assimilated. In this study we analyse the ability of wind and pressure fields from two global reanalyses, namely the Twentieth Century Reanalysis and the ERA-Clim reanalysis to reproduce the storm tide event. In addition, historical data from daily weather maps by the Deutscher Wetterdienst were digitised and isobaric maps were drawn. The latter comprise additional data that were so far not available for assimilation in the reanalyses. From these pressure maps geostrophic winds and subsequently near-surface marine wind speeds were calculated using a simple boundary layer parametrisation (Hasse, 1974). Wind and pressure fields from the reanalyses and the digitised data were used to drive a hydrodynamic tide-surge model (TRIM-NP) and to simulate the water levels of the 1906 event. Astronomical tides from FES2004 were used as lateral boundary conditions, so that tide-surge interaction is accounted for. For the simulation of the storm surge, a state-of-the-art tide surge model was used which underestimated the most extreme water levels during the event for all reanalyses. With the digitised data and new calculated wind speeds observed water levels could be reproduced. If the same parametrisation has been applied to 20CR_V2c pressure maps, the ensemble mean also captures the observed water levels. This suggests that weather situations that led to extremes at the beginning of the 20th century can be reasonably reproduced in 20CR pressure maps, while some caution should be applied to wind speeds.

TP5-O-06

Modulation of surface weather and extremes by weather regimes in the Atlantic-European region

Grams, C. M.[1*]

*E-Mail: grams@kit.edu

[1] *Karlsruhe Institute of Technology (KIT), Institute of Meteorology and Climate Research, Karlsruhe, Germany*

Weather regimes are quasi-stationary, persistent, and recurrent states of the large-scale extratropical circulation. In the Atlantic-European region, these explain most of the atmospheric variability on subseasonal time scales of several days to a few weeks. However, current numerical weather prediction (NWP) models struggle in correctly predicting weather regime life cycles. This

presentation highlights the modulation of surface weather and extremes by weather regimes. First, we focus on heavy precipitation events. Regimes characterised by blocking anticyclones importantly shift moisture transport and associated atmospheric river activity into Europe partly doubling the chances of extreme precipitation in specific regions. The millennial floods of June 2013 and a local Alpine flooding event in October 2011 exemplify this crucial role of the large-scale circulation in triggering extreme events. Next, we discuss multi-day variability of near-surface wind conditions imposed by weather regimes, and how this affects European wind power output. Current planning strategies do not consider these continent-wide wind patterns causing extreme volatility in wind power output that could be balanced by exploiting knowledge about weather regime-induced variability. With regard to temperature extremes we show evidence on the role of blocked regimes in Nordic and Central European heat waves and how weather regimes cause marine cold air outbreaks in the Nordic Seas with important implications for surface heat fluxes. The presentation closes with outlining our current research on a better understanding of the physical and dynamical processes governing weather regime life cycles such as diabatic outflow due to condensational heating or stratosphere-troposphere coupling and on their partly poor representation in NWP models.

TP5-O-07

Severe convective storms in Europe and their relation to large-scale mechanisms

Mohr, S.[1]*, M. Kunz[1], J. Wandel[1], O. Martius[2]

*E-Mail: mohr@kit.edu

[1] *Karlsruhe Institute of Technology (KIT), Institute of Meteorology and Climate Research, Karlsruhe, Germany*

[2] *University of Bern, Oeschger Centre for Climate Change Research and Institute of Geography, Bern, Switzerland*

Severe convective storms (SCS) and associated hazardous weather extremes such as heavy precipitation or hail frequently cause considerable damage to buildings and infrastructures in many parts of Europe. Despite the high relevance of questions regarding trends of such events, the role of natural variability and large-scale mechanisms on the persistence behind that are not well understood. In this work, we established a statistically significant link between atmospheric blocking located over the eastern North Atlantic and northern Europe and warm season thunderstorm activity over western and central Europe. This includes a discussion of how blocking modulates the relevant atmospheric processes that support or suppress the development of convective storms. To analyse the link between the two phenomena, lightning data from 2001 to 2014 were compared with blocking events based on the ERA-Interim reanalysis using the odds ratio to determine the strength of association. Two areas one over the eastern part of the North Atlantic and one over the Baltic Sea were identified, where blocking influences the occurrence of deep moist convection in parts of western and central Europe. Based on the mean ambient conditions on days with blocking in these two areas, well-known dynamic and thermodynamic mechanisms supporting or suppressing the development of thunderstorms were confirmed. The anticyclonic circulation of a block over the eastern part of the North Atlantic leads to a northerly to northwesterly advection of dry and stable air masses into Europe on the eastern flank of the block. In addition, these environmental conditions are on average associated with large-scale subsidence of air masses (convection-inhibiting conditions). In contrast, the southerly to southwesterly advection of warm, moist and unstable air masses on the western flank of a block over the Baltic Sea results in convection-favoring conditions over western and central Europe. Both blocking situations are on average associated with weak wind speeds at mid-tropospheric levels and with weak wind shear. As a consequence, thunderstorms related to atmospheric blocking over the Baltic Sea tend to be on average less organised.

TP5-O-08

Large-scale flow and teleconnection patterns are important drivers for the temporal variability of thunderstorms in Europe

Kunz, M.[1]*, D. Piper[1], S. Mohr[1]

*E-Mail: michael.kunz@kit.edu

[1] *Karlsruhe Institute of Technology (KIT), Institute of Meteorology and Climate Research, Karlsruhe, Germany / CEDIM, Karlsruhe, Germany*

Driving factors for the temporal variability of thunderstorms across Europe are still poorly understood. Due to a lack of long-term and consistent information about thunderstorm occurrence in Europe, we have developed a specific weather type classification that estimates thunderstorm probability from a combination of appropriate meteorological quantities on the mesoscale. Based on this approach, we investigated the temporal and spatial variability of convective predisposition over a 57-years period (1958-2014) using the high-resolution reanalysis data set CoastDatII. Time series of convection-favoring weather types starting in the mid-eighties show a positive trend for all European subareas. The trends are mainly governed by an increase in thermal instability, while large-scale lifting at the same time has decreased. To identify potential drivers for widespread convective days, typical upper-level flow patterns associated with a high convective predisposition were deduced using a multivariate approach. Our results suggest a strong link between large-scale flow and air mass properties, such as stability or moisture, and local-scale thunderstorm activity. The crucial role of large-scale flow is further studied by assessing the impact of northern hemisphere teleconnection patterns on days with widespread thunderstorms and convection-favouring weather patterns. It is found, for example, that positive phases of the East Atlantic pattern or negative sea surface temperature over the Bay of Biscay go along with a significant reduction of convective activity in most of the European regions investigated, which can be explained by anomalies in the temperature and flow fields. Some secondary teleconnection modes have a significant impact as well, such as the Scandinavian pattern with its positive phase leading to enhanced thunderstorm activity specifically in northern Germany.

TP5-O-09

Extreme soil drought events across Poland from 2003 to 2018: understanding the dynamics and drivers

Somorowska, U.[1]*

*E-Mail: usomorow@uw.edu.pl

[1] *University of Warsaw, Warsaw, Poland*

Recent global-scale satellite observations and model simulations reveal a widespread soil moisture drying observed in the root zone layer. This concerns also Europe with substantial differences among regions. Eastern Europe (including central Poland) is found to be one among most affected. Considering the growing recognition that adaptation to the changing conditions in the Anthropocene is required, there is an urgent need to identify and evaluate the severity and spread patterns of the recent past severe and extreme soil drought events. Here, using datasets produced by the GLEAM version 3.3 model, approximately spanning the 16-year period 2003–2018, the impact of main drivers on soil moisture drought conditions in Poland is investigated. Applying the soil moisture index normalised between minimum and maximum values, spatially and temporally distinct events are identified and characterised. Drought events in 2003, 2005, 2015 and 2018 are evaluated. Vulnerability of soil water to changing conditions is assessed using the general sensitivity framework introduced in hydrology, attributing the soil moisture variability to main climatic drivers operating in different land use land cover conditions. Questions addressed: (1) what is the evolution of recent soil drought events in terms of timing, severity and spatial extend at a country-scale and river basin scale, and (2) what is the regional sensitivity of soil moisture to warming and drying conditions? Beside the country-scale considerations, examples are elaborated to show distinct soil drought event evolution in selected river catchments of the Vistula river basin, and the propagation of soil drought into the hydrological drought. The daily threshold levels are based on the 80th percentile of the flow duration curves over a 30-day moving time window.

TP5-O-10

Climate change adaptation and vulnerability assessment: a case study of lesser Himalaya

Pandey, B. W.[1*]

*E-Mail: bwpdsegeo@gmail.com

[1] *Department of Geography, Delhi School of Economics, University of Delhi, Delhi, India*

This paper focuses on the techniques to characterise and monitor hazards in high mountain areas and sustainable development in the Beas River valley (Kullu valley, Himachal Pradesh). The paper demonstrates an approach to the identification, characterisation and mapping of hazards in the area, focusing on cloudburst, flash flood, debris flows and various types of water induced hazards. Climate Vulnerability Index (CVI) is being proposed to assess climate change vulnerability of communities with a case study. The index consists of household parameters of all the three dimensions of vulnerability such as exposure, sensitivity and adaptive capability. Exposure is defined by natural disaster and climate variability, however sensitivity by health, food, and water and adaptive capability by socio demographic profile, livelihood strategies, and social networks. Himalayas, due to their complex geological structure, dynamic geomorphology, and seasonal hydro-meteorological conditions experience very frequent natural hazards, especially water induced hazards. Climate change and land use degradation are accelerating the water induced extreme events such as cloud burst, flash floods, riverine floods and erosion during the monsoon. The escalation of risks and vulnerability has come about through population growth and land use intensification. The study reveals that natural disaster undermine the food security of the people being poor strategies. The strong social networks support resilience of the community is the need of the time to minimise the impacts and better adaptations of climate change and climate induced hazards.

TP5-O-11

Forcing mechanisms behind the time-transgressive Younger Dryas cooling across the North Atlantic realm

Obreht, I.[1*], L. Wörmer[1], A. Brauer[2], J. Wendt[1], S. Alfken[1], M. Elvert[1], K.-U. Hinrichs[1]

*E-Mail: iobreht@marum.de

[1] *University of Bremen, Center for Marine Environmental Sciences (MARUM), Bremen, Germany*
[2] *Helmholtz Centre Potsdam – GFZ German Research Centre for Geosciences, Potsdam, Germany*

The Younger Dryas (YD) was the final cold phase during the last deglaciation; it started with an abrupt cooling in the Northern Hemisphere within just a few years. However, the regional patterns of YD cooling in the North Atlantic realm were complex and mechanistically not fully understood. For example, the initial abrupt reorganisation of atmospheric circulation in Greenland preceded the abrupt climate shift in Western Europe by almost two centuries. To reveal and explain hydroclimate teleconnections and forcing mechanisms behind such time-transgressive regional cooling, we obtained lipid biomarker data at 200 µm resolution via Mass Spectrometry Imaging from a sediment section from the Lake Meerfelder Maar covering the Allerød-YD transition. The resulting subannually resolved fatty acid distributions serve as a sensitive indicator of the local vegetation response to climate change. Our fatty acid data indicate that initiation of Western Europe climate deterioration started ~135 years after the onset of Greenland cooling, and ~50 years before the establishment of full stadial conditions in Western Europe. During this ~135 years long period of time-transgressive cooling, fatty acid data exhibit a trend that corresponds to deuterium excess in Greenland ice core, a proxy of Greenland precipitation moisture sources, suggesting a coherent atmospheric forcing across the North Atlantic realm despite different climatic responses. We propose that the suppressed response of Western European climate was caused by the transition of the westerlies to southwest-northeastern track due to amplified sea-ice formation west of Greenland, forcing lower latitude milder air masses to reach Western Europe and prevent it from abrupt cooling. The delayed onset of climate deterioration in Western Europe was ultimately caused by a southward shift of the westerlies forced by the increased spreading of the sea-ice over the entire North Atlantic.

TP5-O-12

Climatic and environmental changes during the Younger Dryas cold period in Lake Gościąż

Müller, D.[1*], R. Tjallingii[1], A. M. Noryśkiewicz[2], M. J. Schwab[1], M. Słowiński[3], M. Błaszkiewicz[3], A. Brauer[1]

*E-Mail: daniela.mueller@gfz-potsdam.de

[1] *Helmholtz Centre Potsdam – GFZ German Research Centre for Geosciences, Potsdam, Germany*
[2] *Nicolaus Copernicus University, Faculty of History, Institute of Archaeology, Toruń, Poland*
[3] *Polish Academy of Sciences, Department of Environmental Resources and Geohazards, Toruń, Poland*

The last deglaciation in the northern hemisphere was interrupted by the abrupt and distinct Younger Dryas (YD) cold setback. This period provides valuable insights into climate and landscape evolution during rapid and extreme changes. Accordingly, high-resolution climate archives like annually laminated (varved) sediments are crucial for its investigation. Lake Gościąż (central Poland) provides one of the longest and best-preserved varved lake sediment records in Europe. For re-investigation ten new sediment cores have been obtained from the deepest part of the lake basin. A combination of high-resolution microfacies analyses, XRF element core scanning, µ-XRF mapping, analyses of organic carbon, carbonate, stable oxygen and carbon isotope and pollen was applied. After the deposition of glacial sands, lacustrine sedimentation commenced in the late Allerød, but was soon disturbed by a slump during the early YD. Continuous sedimentation pursued afterwards. Here, we present a first continuous varve microfacies investigation of the YD in Lake Gościąż. YD varves consist predominantly of diatom frustules, calcite, re-worked and re-suspended material, whereas the Preboreal and Allerød varves feature primarily calcite, rhodochrosite and dissolved organic matter. In general, the YD shows a more complex and variable varve composition than the Preboreal and Allerød, which is also supported by µ-XRF mapping. Further, we present XRF element records of Ca/Ti (relative calcite precipitation) and Si/Ti (diatom bioproductivity), as well as bulk relative calcite, stable oxygen (δ^{18}Ocarb) and carbon (δ^{13}Ccarb) isotopes. At the by pollen defined biostratigraphic YD transitions first changes in proxy response occur in Si/Ti, while the varve microfacies changes last. Here, we discuss causes and differences in proxy responses and what they imply in regard to the dynamics of environmental change during a major climate change.

TP5-O-13

Flood dynamics during the last Saharan humid period: clues from a laminated record from the Nile deep-sea fan

Blanchet, C.[1*], R. Tjallingii[1], A. Ramisch[1], J. Mingram[1], M. Frank[2], A. Brauer[1]

*E-Mail: blanchet@gfz-potsdam.de

[1] *Helmholtz Centre Potsdam – GFZ German Research Centre for Geosciences, Potsdam, Germany*
[2] *GEOMAR, Kiel, Germany*

Paleoenvironmental reconstructions have revealed the occurrence of large changes in precipitation dynamics in North Africa during the Holocene. Evidence from modelling approaches and sedimentary records suggests that these changes were linked to modifications of rainfall seasonality, which likely exerted a direct control on fluvial dynamics. There are, however, few continuous records of changes in seasonality, which hinders our understanding of underlying forcing factors. Here we propose to use a unique 5 m-thick section of finely laminated sediments deposited on the Nile deep-sea fan during the last Saharan Humid Period (10-7 ka BP). The core was retrieved at 700 m water-depth and sedimentation rates during sapropel deposition are in the order of several mm per year. Microfacies analysis and elemental micro-XRF scanning indicate that couplets of alternating dark- and light-coloured layers represent seasonal deposits of Nile discharge and marine hemipelagic sedimentation, respectively. Preliminary lamination counts suggest that couplets were deposited at an annual rate for most of the record, except during a short interval of bi-annual deposition between 9 and 8.8 ka (i.e., 2 couplets/yr). Increases in layer thickness is observed around 9.5 and 9.1 ka BP, followed by a gradual decrease until 8 ka. Careful examination of lamination structure and time-series analysis of layer counts will permit to further explore sub-annual changes in flood dynamics during the Saharan Humid Period. Finally, due to its high temporal resolution, our record has the potential to link reconstructions of Nile discharge to other regional archives of hydrological changes (e.g., speleothems, lakes) and thereby identify overarching forcing mechanisms.

TP5-O-14

Rapid changes in north Pacific climate over the past 12 ka: baseline decadal-millennial-scale variations vs. threshold changes

Lembke-Jene, L.[1*], R. Tiedemann[1], X. Gong[1], D. Nürnberg[2], J. Zou[3], X. Shi[3], G. Lohmann[1]

*E-Mail: lester.lembke-jene@awi.de

[1] *Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research (AWI), Bremerhaven, Germany*
[2] *GEOMAR Helmholtz-Zentrum für Ozeanforschung, Kiel, Germany*
[3] *First Institute of Oceanography – Ministry for Natural Resources, Qingdao, China*

The Pacific hosts the largest oxygen minimum zones (OMZ) in the world ocean, likely to intensify and expand under future climate warming, with consequences for ecosystems, biogeochemical cycles and living resources. Today, better-oxygenated subsurface north Pacific intermediate water (NPIW) mitigates OMZ development, but on instrumental time scales, data indicate decreasing NPIW ventilation, induced by surface freshening and increased stratification of seasonal thermocline water. However, longer variations in oceanographic boundary conditions were potentially large and hinder assessment of anthropogenic influences against natural background shifts. We previously provided evidence that modern well-ventilated waters underwent significant millennial-scale variations over the last ca. 12 ka, with a tipping point ca. 4.5 ka before present. Crossing this mid-Holocene threshold led to the Okhotsk Sea losing its modern ventilation source characteristics, although underlying forcing and physical boundary conditions remain largely enigmatic. A combination of sea ice loss, water temperatures, and remineralisation rates

may have conceivably induced a nonlinear switch into a different mean state in this region. To constrain these factors, we present surface ocean proxy records from Okhotsk Sea key study sites with multi-decadal resolution to assess changes in upper ocean stratification, nutrient characteristics and resulting mid-depth water ventilation. Our results imply that under assumed past warmer- than-present conditions, regional surface temperatures and upper ocean stratification were increased and changed in a nonlinear mode during the last ca. 6,000 years, associated with changing primary productivity patterns and biogeochemical feedback mechanisms. Complementary results from model simulations corroborate our results and provide evidence for close coupling the Okhotsk Sea and the North Pacific Subarctic Gyre, thus exporting marginal sea signals into large oceanic regions.

TP5-O-15

Humid northern Arabia during low-latitude early Holocene dry anomaly promoted by tropical plumes? – A suggestion from a unique varved lake record

Neugebauer, I.[1]*, M. Dinies[2], B. Plessen[1], N. Dräger[1], A. Brauer[1], P. Hoelzmann[2], R. Tjallingii[1], M. Engel[3]

*E-Mail: inaneu@gfz-potsdam.de

[1] *Helmholtz Centre Potsdam – GFZ German Research Centre for Geosciences, Potsdam, Germany*
[2] *Institute of Geographical Sciences, Freie Universität Berlin, Berlin, Germany*
[3] *Institute of Geography, University of Cologne, Cologne, Germany*

Precession-forced intensification of the low-latitude summer monsoons and northward migration of the associated rainfall belts during the Early Holocene Humid Period (EHHP) initiated the development of grasslands, wetlands and lakes in today's hyperarid Saharo-Arabian desert belt. Numerous model simulations and palaeoclimate records draw a consistent picture of the EHHP in North Africa. However, our knowledge about the magnitude, timeframe and moisture sources of the EHHP in Northern Arabia is only limited due to a lack of robust proxy data. Here we provide the first high-resolution and precisely dated multi-proxy reconstruction of the hydroclimatic variability during the EHHP for northern Arabia, retrieved from annually laminated (varved) sediments of the Tayma palaeolake record in NW Saudi Arabia. Our results indicate the existence of a shallow lake or wetland in the Tayma basin from ca. 9300 to 4200 years before present (BP), reflecting the typical scheme of increased humidity in the northern Afro-Arabian region during the early to mid-Holocene. However, maximum humidity in N-Arabia is only evident between ca. 8500 and 7900 years BP, when varves formed in the lake. This is considerably later and shorter than the EHHP over North Africa, which is typically defined from 10,000 to 6,000 years BP. Moreover, the length and timing of this peak humid phase in the N-Arabian Desert are congruent with a low-latitude, centennial-scale dry anomaly interrupting the EHHP. This 'cool poles – dry tropics' anomaly around the 8.2 kilo-years BP cold event caused a weakening of summer monsoons and Mediterranean winter rains. We suggest that the anomalous cooling of the North Atlantic and Mediterranean Sea during that time promoted frequent perturbations of the subtropical jet, which favours intrusions of rain-bearing, winter-spring tropical plumes towards N-Arabia. Today, such synoptic-scale climate patterns contribute significantly to extreme precipitation events in the Middle East. Our findings underpin a complex regional hydrological pattern during the EHHP, and challenge climate model simulations to better explain synoptic-scale regional and seasonal rainfall dynamics. This study is a contribution to the research project 'CLEAR – Holocene Climatic Events of Northern Arabia', financially supported by the DFG (https://clear2018.wordpress.com/).

TP5-O-16

Transient simulation of climate during the last 30,000 years with an energy balance climate model

Ziegler, E.[1]*, K. Rehfeld[1]

*E-Mail: eziegler@iup.uni-heidelberg.de

[1] *University of Heidelberg, Heidelberg, Germany*

Projected changes in climate are likely to affect not only its mean state but also its variability and thus the occurrence of extreme events. As such, improving our understanding of the spectrum of climate variability and how different feedbacks in the climate system influence it, is of vital importance. We perform a process-based examination of variability with respect to changing orbital insulation, carbon dioxide, ice coverage, and land/sea distribution during the last 30,000 years. To this end, we adapted a two-dimensional energy balance model [1] to run transient simulations. The model is forced by carbon dioxide, solar insolation changes following the orbital configuration and changes in ice distribution and land/sea mask according to sea level. We evaluate the model's ability to reproduce changes in local to global and seasonal to millennial temperature distributions during the last 30,000 years. We compare the simulated states and their transient evolution to those obtained by comprehensive coupled climate models in order to determine the impact on changes in atmospheric dynamics. Finally, we test the mean-state dependence of temperature variability over a large range of model configurations and discuss implications for future climate. References [1] Kelin Zhuang, Gerald R. North, Mark J. Stevens, A NetCDF version of the two-dimensional energy balance model based on the full multigrid algorithm, SoftwareX, Volume 6, 2017, Pages 198-202, ISSN 2352-7110, https://doi.org/10.1016/j.softx.2017.07.003.

TP5-O-17

Using a large database of pollen assemblages to quantify the centennial to multi-millennial vegetation

Hérbert, R.[1]*, U. Herzschuh[1], T. Laepple[1]

*E-Mail: raphael.hebert@awi.de

[1] *Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research (AWI), Potsdam, Germany*

Multidecadal to millenial timescale climate variability has been investigated over the ocean using extensive proxy data and it was found to yield coherent interproxy estimates of global and regional sea-surface temperature (SST) climate variability (Laepple and Huybers, 2014). Global Climate Model (GCM) simulations on the other hand, were found to exhibit an increasingly large

deficit of SST climate variability for increasingly longer timescales. Further investigation is needed to better quantify terrestrial climate variability for long timescales and validate climate models. Vegetation related proxies such as tree rings and pollen records are the most widespread types of archives available to investigate terrestrial climate variability. Tree ring records are particularly useful for short time scales estimates due to their annual resolution, but on the other hand they have been shown to underestimate variability at time scales above centuries. In the present work, we use a large database of pollen records covering the northern hemisphere in order to quantify vegetation and climate variability at centennial to multi-millenial timescales over the Holocene. Using principal component analysis, we extract signals of vegetation variability from the pollen assemblages and compare with an analogous analysis of plant functional type (PFT) proportions from GCM paleoclimate simulations which had a land surface scheme component implemented. The pollen assemblages indicate a strong scaling relationship of vegetation variability with timescales, which is found to be significantly higher than that of PFT proportions in GCMs. We also perform the proxy-model intercomparison in the climate space, i.e. after performing temperature and precipitation reconstruction using the pollen assemblages and similarly find a lack of climate variability in the GCM simulations at centennial time scales and above.

TP5-O-18

Extremes of the enhanced South Asian Monsoon during the last two interglacials reconstructed via individual foraminifer shell analyses

Hathorne, E.[1]*, K. Thirumalai[2], K. Kerr[3], D. Gebregiorgis[4], W. Park[1], L. Giosan[5], B. N. Nath[6], P. Anand[3]

*E-Mail: ehathorne@geomar.de

[1] *GEOMAR Helmholtz Centre for Ocean Research Kiel, Kiel, Germany*
[2] *University of Arizona, Arizona, USA*
[3] *The Open University, UK*
[4] *Georgia State University, Georgia, USA*
[5] *Woods Hole Oceanographic Institute, USA*
[6] *National Institute of Oceanography Goa, India*

The South Asian Monsoon (SAM) is a seasonal climatic phenomenon with distinctive inter-annual and decadal modes of variability that have significant impacts on humanity. With only a century of instrumental data at best for some regions we must look to paleoclimate proxy records to better understand past SAM variability and improve future predictions. As some planktonic foraminifera species calcify the major part of their shells within lunar cycles, the analysis of many single shells has the potential to reveal the range of conditions prevailing on sub-seasonal to inter-annual timescales. The SAM causes a strong seasonal salinity signal in the Bay of Bengal and Andaman Sea where the studied sediment cores were obtained. Conventional proxy records from the region have demonstrated that the SAM was enhanced during the mid-Holocene and Eemian. We have measured oxygen isotope compositions of many individual T. sacculifer and N. dutertrei shells and have modelled individual foraminifera pseudo-proxy data based on observational time series for these locations. The distribution of individual shell oxygen isotopes from a core top sample agrees very well with the modelled distribution This provides confidence in this technique to reconstruct past variability. The recent and last glacial maximum oxygen isotope distributions are relatively similar although the mean values are offset as expected. In contrast, the distributions in two samples from the early to mid-Holocene exhibit a significant skew towards negative values reflecting increased freshwater addition. Similar results are found comparing the Eemian and the preceding glacial (Marine Isotope Stage 6) where we have also extensively measured individual shell Mg/Ca ratios reflecting water temperature variability. These data reveal subtle temperature changes that had a minimal influence on the stable oxygen isotope distributions. Instead, the more negative skew and excursions most likely reflect freshwater addition via the SAM. Comparison with simulations made with the Kiel climate model (and other PMIP models for the Holocene case) reveal changes that are inconsistent with pure (external) insolation forcing and suggest that processes internal to the climate-system might have a greater role to play.

TP5-O-19

Contribution of pre-aged carbon mobilised from thawing permafrost to rapid atmospheric CO_2 increases during the last deglaciation

Mollenhauer, G.[1*], V. Meyer[2], M. Winterfeld[1], P. Köhler[1], W. Dummann[3], L. Lembke-Jene[1], J. Hefter[1], R. Tiedemann[1]

*E-Mail: gesine.mollenhauer@awi.de

[1] *Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research (AWI), Bremerhaven, Germany*
[2] *University of Bremen, Center for Marine Environmental Sciences (MARUM), Bremen, Germany*
[3] *University of Cologne, Cologne, Germany*

The last deglaciation was characterised by rising concentrations in atmospheric CO_2 (CO_2,atm) and a decrease in its radiocarbon content (Δ^{14}Catm). Mobilisation of ^{14}C-depleted terrestrial organic carbon, which was previously frozen in extensive boreal permafrost soils, might have contributed to both changes. Since parts of this potentially remobilised organic carbon was re-buried in marine sediments, records of accumulation of terrigenous biomarkers and their compound-specific radiocarbon ages can provide insights into the timing of, and controls on permafrost decomposition. We present data from marine sediment cores covering the last deglaciation that were retrieved from key locations (Sea of Okhotsk, Bering Sea and the Northwest Pacific) potentially receiving terrigenous material mobilised from hotspot areas of permafrost thaw. We find maxima in accumulation of pre-aged terrestrial biomarkers co-occurring with periods of rapid sea-level rise during the melt-water pulses, thus pointing towards mobilisation of this terrestrial organic matter along the coasts and from the extensive shelf areas of the Bering Sea and, by inference, the Arctic Ocean flooded during the using timing and ^{14}C signature of the observed maxima of accumulation as well as published estimates of carbon contents of permafrost deposits existing during the LGM on these shelves, we use a model to estimate the potential impact that their mobilization might have had on the atmospheric carbon records. Our carbon cycle model indicates that up to 50% of the rapid increases in CO_2atm observed at 14.6 and 11.5 kyr BP might have resulted

from the mobilisation of permafrost carbon from flooded shelves alone, while only little of the observed decrease in Δ^{14}Catm can be explained. This process together with deglacial inland permafrost degradation might thus have contributed significantly to the rapid increases in CO_2atm during the last deglaciation.

TP5-O-20

Ammonoid evolution and early warning signs for global warming during the end-Permian mass extinction

Korn, D.[1]*, A. Ghaderi[2], W. Kiessling[3]

*E-Mail: dieter.korn@mfn.berlin

[1] *Museum für Naturkunde, Berlin, Germany*
[2] *Department of Geology, Faculty of Science, Ferdowsi University of Mashhad, Mashhad, Iran*
[3] *GeoZentrum Nordbayern, Department of Geography and Geosciences, Universität Erlangen-Nürnberg, Erlangen, Germany*

The devastating end-Permian mass extinction (252 my ago) is regarded as the most severe biotic crisis of the last 500 million years. Profound and rapid greenhouse gas release by Siberian magmatism led to a tropical seawater temperature increase of eight to ten degrees led to a complete reworking of the biosphere (e.g. Joachimski et al. 2012; Schobben et al. 2014). Heating, loss of oxygen in seawater, and ocean acidification are thought to have caused the extinction of ca. 90% of marine animal species in a protracted time interval of perhaps less than 1,000 years. We challenge the view of a single extinction pulse, based on the latest Permian ammonoid record in Iran. Contrary to other parts of the world, this critical time interval is completely represented in the Julfa and Abadeh areas of Iran. Statistical analyses of stratigraphic confidence intervals led us to identify extinction pulses before the traditionally identified extinction horizon. In addition, the body size of ammonoids declined by orders of magnitude over the last 0.7 my years of the Permian period. Similar pre-mass extinction declines and disturbances of the carbon cycle have sometimes been reported from other regions, suggesting a widespread, but often overlooked environmental deterioration at a global scale, well before the traditional main extinction event (Kiessling et al. 2018). Ammonoids may thus help in the detection of environmental stresses that eventually led to the collapse of the marine palaeocommunities.

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TP5-O-21

Extreme events of perceived temperature over Europe in the future: the humidity role.

Scoccimarro, E.[1]*, P. G. Fogli[1], S. Gualdi[1]

*E-Mail: enrico.scoccimarro@cmcc.it

[1] *CMCC Foundation - Euro-Mediterranean Center on Climate Change, Bologna, Italy*

An increase of 2 m temperature over Europe is expected within the current century. In order to consider health impacts, it is important to evaluate the combined effect of temperature and humidity on the human body. To this aim, projections of a basic index – the humidex - representative of the perceived temperature, under different scenarios and periods, have been investigated based on a EURO-CORDEX high resolution multi-model approach. Projected extreme perceived temperature patterns are different from what we expect in terms of temperature only, mainly due to the humidity role.

TP5-O-22

The extreme summer 2018 in Sweden – in historical and future context

Wilcke, R.[1]*, E. Kjellström[1], E. Engström[1], T. Koenick[1], D. Matei[2], A. Moberg[3], E. Tyrlis[2]

*E-Mail: renate.wilcke@smhi.se

[1] *Swedish Meteorological and Hydrological Institute (SMHI), Norrköping, Sweden*
[2] *Max-Planck Institute for Meteorology, Hamburg, Germany*
[3] *Department of Physical Geography and the Bolin Centre for Climate Research, Stockholm University, Stockholm, Sweden*

The summer 2018 in Sweden and northern Europe has been exceptional warm, dry, and long. Historical observations in Stockholm reveal that May to August 2018 was unique in a 263-year perspective. The most extreme aspect of the extended heat wave across Sweden was its length and the number of warm days. The impact of heat and drought was felt throughout many parts of the society. Groundwater shortage, many extensive forest fires (requiring assistance on European scale), health impacts on people, drought related shortage of food for livestock leading to emergency slaughter in many regions. Here we want to describe the meteorological situation during the heat and drought event. Furthermore, we set it into context of past events and even give a possible view for the future, considering different future scenarios. Three grant ensembles of climate models, additionally to the CMIP5 ensemble, will support the probability analysis of such kind of event in the future as well as underlining the differences to the past climate.

TP5-O-23

Future response of precipitation extremes over the Nordic region in a convection-permitting regional climate model

Lind, P.[1*], D. Belusic[1], E. Toivonen[2], R. A. Pedersen[3], D. Lindstedt[1], F. Wang[1], A. Dobler[4], E. Kjellström[1]

*E-Mail: petter.lind@smhi.se

[1] *SMHI, Norrköping, Sweden*
[2] *FMI, Helsinki, Finland*
[3] *DMI Copenhagen, Denmark*
[4] *MET Norway, Oslo, Norway*

There is an increased need for more detailed climate information from impact researchers, stakeholders and policy makers for regional-to-local climate change assessments. In order to design relevant and informative planning strategies on these scales it is important to have reliable climate data and information on high spatial O(1km) and temporal (daily to sub-daily) scales. Such high-resolution data is also beneficial for climate impact modellers as input to their models, e.g. hydrological or urban models that operate on regional to local scales. It has been established that regional climate models (RCMs) provide added value compared to coarser global climate models (GCMs) or re-analysis (e.g. ERA-Interim). However, RCMs with standard spatial resolution O(10 – 50 km) still suffer from inadequacies in representing important regional-to-local climate phenomena and characteristics, both from the implied 'smoothening' effect within each grid cell which limits the representation of fine scale surface forcings, and the need to parameterise small-scale processes like atmospheric convection. The latter particularly invokes uncertainties in future climate responses of short-duration precipitation extremes such as flash-floods. Here, we compare 20-year simulations with a very high resolution (3 km grid spacing) convection permitting regional climate model (CPRCM) with a standard high-resolution (12 km grid spacing) convection parameterized RCM and their abilities to simulate the climate characteristics of the Nordic region in Europe, with particular focus on precipitation extremes. The study covers both recent past (with boundary data from ERA-Interim and the EC-Earth GCM) and the end of the 21st century (boundary data from EC-Earth using the RCP8.5 radiative forcing scenario). The high model grid resolution combined with the extensive simulated time period which enables assessment on climatological time scales makes this study one of very few for this region.

TP5-O-24

MOSES: a novel observing system for highly dynamic events

Weber, U.[1]*, C. Schütze[2], Moses Team[2]

*E-Mail: ute.weber@ufz.de

[1] *Helmholtz Centre for Environmental Research – UFZ, Bonn, Germany*
[2] *Helmholtz Centre for Environmental Research – UFZ, Leipzig, Germany*

MOSES (Modular Observation Solutions for Earth Systems) is a novel observing system developed by the Helmholtz Centres in the research field 'Earth and Environment'. It is designed to unravel the impact of short-term events on the long-term development of Earth and environmental systems. Heat waves and droughts, hydrologic extremes, abrupt permafrost thaw and ocean eddies are in the focus of this event-oriented observation and research initiative. The investigation of the long-term effects of such events is most acute as the impact of global and climate change on society becomes increasingly evident: The increase in extreme weather events is under intense debate, Arctic warming is accelerating and marine circulations and ecosystems are undergoing rapid change. The Helmholtz Association is investing €30 million to implement the new research facility, which is designed as a 'system of systems'. During the implementation phase from 2017 to 2021, the centers develop, miniaturize and automate sensor systems, which are combined into specific observation modules. These record energy, water, greenhouse gas and nutrient cycles on the land surface, in coastal regions, in the ocean and in the atmosphere – but especially the interactions between Earth compartments. MOSES aims at capturing events from their origin to their fading with high resolution observations. As such it complements and extends existing national and international monitoring networks like TERENO, ICOS or eLTER which are primarily designed for long-term Earth observation. We will here present the MOSES initiative focusing on the observing systems and operation concepts developed for hydrological extremes and droughts. MOSES test campaigns started in 2018 and will continue during the next three years. As it is a key issue to develop the event-driven observation concept in close cooperation with partners from research and practice, upcoming test campaigns are open for cooperation.

TP5-O-25

Future changes of Etesian winds from EURO-CORDEX models

Dafka, S.[1]*, A. Toreti[2], P. Zanis[3], E. Xoplaki[1], J. Luterbacher[1]

*E-Mail: Styliani.Dafka@geogr.uni-giessen.de

[1] *Justus-Liebig-University Giessen, Giessen, Germany*
[2] *European Commission, Joint Research Centre, Ispra, Italy*
[3] *Department of Meteorology and Climatology, School of Geology, Aristotle University of Thessaloniki, Thessaloniki, Greece*

The Etesians are the dominant synoptic-mesoscale winds observed in the eastern Mediterranean, usually during late spring and summer. The Etesians can be extremely intense as a result of the complex topography, and pose significant environmental hazards, especially over wildfire incidents. We assess the impacts of climate change on future Etesians by analysing the ensemble mean response of the most recent EURO-CORDEX regional climate simulations at the 12 km grid resolution over the 21st century. The mean model ensemble projects an increase of the Etesians frequency and intensity at the 21st century under two greenhouse gas concentration scenarios (RCP4.5 and RCP8.5). This is related/connected to an increase in the zonal wind at 200 hPa, a reinforcement of the mid-latitude westerly flow and a decrease in the wave amplitude which accelerate the eastward propagation of the circulation systems and amplify the ridge over central Europe and the Balkans. A strengthening and poleward shift of the subtropical jet

stream is also projected, connected with stronger subsidence over the Eastern Mediterranean. Projected changes will have profound environmental and societal implications, including the lengthening of the wildfire season, raising awareness of pollution in the region. Finally, the current estimate of future wind power potential for the Aegean Sea will be significantly increased by the end of the century.

TP5-O-26

Assessing the impacts of climate change and natural variability on hydrological extreme events over Eastern North America and Europe

Ludwig, R.[1]*, A. Frigon[2], M. Leduc[2], J. Weismueller[3], M. Mittermeier[1], F. Willkofer[1], R. Wood[1], F. von Trentini[1]

*E-Mail: r.ludwig@lmu.de

[1] *Ludwig-Maximilians-Universität München, Munic, Germany*
[2] *Consortium Ouranos, Montréal, Canada*
[3] *Leibniz Rechenzentrum, Garching, Germany*

The ClimEx project focuses on the effects of climate change on hydro-meteorological extreme events and their implications for water management in Bavaria and Québec. It employs HPC capacity of LRZ's SuperMUC to dynamically downscale 50 members of the CanESM2 over European and Eastern North American domains using the CRCM5 (0.11° resolution - 1951-2100 – 15,000 model years – 7,500 years in each domain). The unique single model ensemble is analysed to better assess the influence of natural climate variability and climatic change on the dynamics of extreme events. Hydrological assessment is performed using the process-based and spatially explicit hydrological model WaSiM in high temporal (3h) and spatial (500m) resolution. The simulations form the basis for in depth analysis of hydrological extreme events based on the inputs from the large climate model dataset. The specific data situation enables to establish new methods to assess climate change impacts on flood risk and water resources management by identifying patterns in the data which reveal preferential triggers of hydrological extremes. Hydrological application of this data set is exemplified for catchments in Bavaria, Germany, where hydrological modeling illustrates the capacity to better determine the recurrence periods of hydrological extreme events (e.g. HF100) under conditions of climate change. The regionally specific and non-linear impact of natural climate variability and climate change on extreme stream flows for the Bavarian catchments is discussed. Increases in flood frequency and intensity are described by significant changes in return periods, which, however, show interesting geographical patterns. It is further illustrated how the causes of flood extremes are changing and evermore dominated by previously unseen compound events.

TP5-O-27

Long-term trends and variability of heavy precipitation across Central Europe – past, present, and future

Ehmele, F.[1]*, L.-A. Kautz[1], H. Feldmann[1], J. G. Pinto[1]

*E-Mail: florian.ehmele@kit.edu

[1] *Karlsruhe Institute of Technology (KIT), Institute of Meteorology and Climate Research, Karlsruhe, Germany*

Widespread flooding events are among the major natural hazards in Europe. Such events are usually related to intensive and commonly long-lasting precipitation. Despite some prominent floods during the last decades (e. g. 2002 and 2013), extreme events are rare and associated with long return periods of more than 100 years. To assess the risks of such extreme events, reliable statistics of precipitation and discharge are required. Comprehensive observations, however, are mainly available for the last 50–60 years. This difficulty in risk estimation can be solved using stochastic data sets. One possibility towards this is to include climate model data or extended reanalysis. This study presents and discusses a validation of different century-long data sets, a large ensemble of decadal hindcasts, and predictions for the upcoming decade. Global reanalysis for the 20th century with a horizontal resolution of more than 100 km have been dynamically downscaled with a regional climate model (COSMO-CLM) towards a higher resolution of 25 km. The new datasets are first filtered using a dry-day adjustment. The simulations show a good agreement with observations for statistical distributions and quantities. Differences mainly appear in areas with sparse observation data. The temporal evolution during the past 60 years is well captured. Beside a possible trend during the last 100 years, which might be spurious, the results reveal some long-term variability with phases of increased and decreased heavy precipitation. The spatial distribution and the seasonal variations also match with observations and previous studies.

TP5-O-28

Extreme storm floods in the German Bight - from past variability to future changes

Lang, A.[1]*, U. Mikolajewicz[1]

*E-Mail: andreas.lang@mpimet.mpg.de

[1] *Max-Planck Institute for Meteorology, Hamburg, Germany*

Extreme high sea levels (EHSL) caused by storm floods are among the major hazards for low-lying coastal environments such as the German Bight. High-frequency observations from tide gauges show a marked variability during the last couple of decades, but are not sufficiently long to derive statistically meaningful relations with modes of climate variability on (multi-)decadal scales. Information about long-term variability and forcing mechanisms, though, could help to better assess future flood risks, which are typically only based on modeled or observed variability during the last couple of decades. Here we downscale a global 'Last Millennium' simulation using a regionally coupled climate system model to investigate long-term variability and associ-

ated large-scale forcing mechanisms in the climate system over 1,000 years, and use this information to infer potential pathways of future EHSL using idealised ensemble simulations. While the statistics of simulated EHSL compare well with observations from the Cuxhaven tide gauge record, we find that simulated EHSL show large variations on interannual to centennial timescales without preferred oscillation periods. Accordingly, EHSL variations are to a large extent decoupled from those of the background state, and mask any potential signals from solar or volcanic forcing. The high internal variability stresses the uncertainties related to traditional extreme value estimates based on shorter subsets, which fail to account for such long-term variations. This complicates the estimation of high-impact EHSL and may mask a theoretical increase due to a distribution shift with anthropogenic sea level rise. That is, EHSL variations as well as existing estimates of future changes thereof are likely to be dominated by internal variability rather than climate change signals. Thus, large ensemble simulations will be required to assess potential changes in future flood risks.

TP5-O-29

Long-term storm activity and its uncertainty over the Northeast Atlantic and North Sea regions

Krueger, O.[1]*, F. Feser[1], R. Weisse[1], D. Krieger[2]

*E-Mail: oliver.krueger@hzg.de

[1] *Helmholtz-Zentrum Geesthacht (HZG) - Centre for Materials and Coastal Research, Geesthacht, Germany*
[2] *Universität Hamburg, Hamburg, Germany*

Wind speed measurements are often too short or exhibit inhomogeneities that both make inferences about the storm climate difficult. On the contrary, the air pressure is a meteorological variable that is mostly homogeneous and thus suited for analyses of past storm activity. Further, measurements of surface air pressure are available on longer time scales, in some places for more than 140 years. We derive upper quantiles of geostrophic wind speeds from triangles of sea level pressure observations over the northeast Atlantic and the North Sea in order to analyse storminess from 1875 onwards on annual and seasonal time scales. We further assess the uncertainties inherent in storminess time series that relates to uncertainties in the pressure measurements. While the storminess time series show pronounced interdecadal variability, the uncertainty decreases over time, which coincides with improvements in the measurement routines and with the onset of coordinated measurement programs. Our analyses help to advance the understanding of the long-term storm climate over extratropical Atlantic regions and provide transferable knowledge useful, for instance, for the offshore wind energy sector or for the risk assessment of storm surges.

TP5-O-30

Investigating climate warming-driven intensification of short duration extreme convective precipitation events in the southeastern Alpine forelands of Austria

Kabir, M. H.[1]*, G. Kirchengast[1], K. Schroeer[2]

*E-Mail: mh.kabir@uni-graz.at

[1] *Wegener Center for Climate and Global Change, University of Graz, Graz, Austria*
[2] *Federal Office of Meteorology and Climatology MeteoSwiss, Zurich, Switzerland*

The expected intensification of short duration extreme convective precipitation events (SDECPEs) under a warming climate likely leads to an increase of flash floods and landslides in the southeastern Alpine forelands of Austria. Therefore, a deeper understanding of SDECPEs is crucial to avoid severe damage and aid a climate resilient society. We aim to assess the fingerprint of warming over the recent decades in SCECPE's sub-hourly and hourly rainfall intensities. To do this, high-resolution precipitation and temperature time series, and auxiliary data, are collected in the region from 20 gauges of the Austrian national weather service (ZAMG) and the Austrian hydrographic service (AHYD), in summertime over 1961 to 2018. In addition, precipitation and temperature data are included from the dense WegenerNetnetwork of 150 stations, available over 2007 to 2018. Complementary synoptic data (sea level pressure, 700 hPa wind velocity, convective available potential energy, 500 hPa geopotential) over the greater Alpine region from the European Reanalysis ERA5, and SST data over the Mediterranean Sea and Black Sea,help in convective-event weather typing and interpretation. Weather typing through principal component and cluster analysis methods and joint station analyses aid to assess the SDECPE changes from around 1970 (1961-1980) to the recent past (1999-2018). Basically we found that extreme summertime precipitation in this region is frequently of short-term convective type and its intensity increased due to temperature-mediated moisture increase. Sub-hourly and hourly SDECPE intensities scale at super-CCrates in the region (about 9–14 % per °C) We will present the latest results of our analysis of changes since the 1960s to present (1999-2018 vs. 1961-1980).

Poster presentations

TP5-P-01

A spectrally nudged global storyline: attributing the effect of climate change in historical extreme events.

Garderen van, L.[1]*, F. Feser[1], T. G. Shepherd[2]

*E-Mail: linda.vangarderen@hzg.de

[1] *Helmholtz-Zentrum Geesthacht (HZG) - Centre for Materials and Coastal Research, Geesthacht, Germany*
[2] *Reading University, Reading, United Kingdom*

Within climate-change science, we see that global changes in extremes, such as increasing numbers of heatwaves, provide an indicator of climate change.

However, every extreme event is unique, and aggregation achieves its statistical power by blurring over those differences. Rather than asking what extreme events tell us about climate change, we may ask what climate change tells us about extreme events that have happened. Extreme events are associated with unusual dynamical conditions. Whereas the thermodynamic aspects of climate change are clear, the signal-to-noise ratio of the dynamical aspects is small. We thus adopt the hypothesis that the historical record of dynamical conditions is largely accidental, i.e. it arose by chance, and would have been different in a different climate. In this work, we develop a method for estimating the effect of known, thermodynamic aspects of climate change on the meteorological consequences of those dynamical conditions. In particular, we simulate historical extreme events twice. The first time is in the world as we know it, with the events occurring on a background of changing climate forcers and the associated warming of sea-surface temperatures. The second time is in a 'counterfactual' world, where this background is held fixed over the past 100 years. The historical storyline of observed dynamical conditions is enforced through spectral nudging of the large-scale dynamical fields (vorticity and divergence) in the free atmosphere towards reanalysis data within the ECHAM6 atmospheric model. In this way the thermodynamic and surface properties of the model are free to respond to the climate forcing and global warming. Although such singular attribution has been performed for particular extreme events, usually with regional models, we are not aware of a previous application to the global historical record. Here we present some first results.

TP5-P-02

Impacts of extreme weather events on plant pests and plant protection - does it matter?

Seidel, P.[1]*

*E-Mail: petra.seidel@julius-kuehn.de

[1] *Julius Kühn-Institut, Institute for Strategies and Technology Assessment, Kleinmachnow, Germany*

Five years ago, we asked here: 'What do we know about impacts of extreme weather on plant pests – nearly nothing?' Surprisingly, the answer was 'yes'. Only a few facts were published in literature at that time. Why was this not in the focus of scientists' interest? Plant pests (plant pathogens, weeds and insect or other pests) cause significant economic losses in agriculture and horticulture under the current climate already. It will be expected that climate change will influence plant pests and plant protection and the frequency and intensity of some extreme events will become more. Now there are a bit more information. Using the mode 'Advanced search', we queried a combination of 'extreme weather terms + plant terms + plant pest terms' to find out the impacts of extreme events on pests and plant protection in wheat, barley, maize, beet, potato, rape, forage crops, wine, hop, apple and asparagus. Until today our monthly literature query in databases like 'Web of science', concerning literature published since 1910 includes more than 8.5 million single queries. Besides, we checked 'Grey literature'. After analysing the results, first conclusions seem to be feasible negative and positive impacts are possible - pests, the damage caused by pests and plant protection are affected. The following main effects of drought/dryness, heat, heavy rainfall, flooding, waterlogging, hail, storm, frost and increased solar radiation are reported in literature: 1. Impacts of extreme events on pest, damage caused by pests and plant protection (feasibility and effectiveness), 2. Impacts of measures to adapt to extremes on pest, damage caused by pests and on plant protection and 3. Effects of pest infestation on the adaptability of crops to extremes. This means it matters. But: the few known effects can only illustrate the complexity of the plant-pest-plant protection-extreme weather-system and its interactions. A valid risk assessment and risk management are not yet possible.

TP5-P-03

Improving statistical modelling of extreme precipitation return-levels in Germany by using spatial and seasonal variations

Fischer, M.[1]*, H. Rust[1], U. Ulbrich[1]

*E-Mail: madlen.fischer@met.fu-berlin.de

[1] *Institute of Meteorology, FU Berlin, Berlin, Germany*

Establishing adequate measures for disaster risk reduction regarding extreme precipitation events requires accurate estimates of rainfall amounts (return-levels) and associated exceedance probabilities (return-periods).They are indispensable for dimensioning hydraulic structures, such as urban drainage systems, bridges and dams. In addition, insurance companies, for example, need these data for their risk assessment. Return levels are estimated based on the generalised extreme value distribution (GEV). Instead of obtaining GEVs from annual rainfall maxima at individual stations, we use monthly maxima of daily precipitation sums. This approach has two advantages: a) a seasonal variation of extremes can be provided to stakeholders and b) the larger amount of data points and the exploitation of smooth variation throughout the year reduces the uncertainties of the return-level estimates. Exploiting also the smoothness of parameter variations in space provides estimates of ungauged sites and additionally reduces parameter uncertainty. As a result, we use one statistical model covering all sites and months. The seasonal cycle is captured by harmonic functions, the spatial variation is described with functions of longitude, latitude and altitude. Interactions between all dimension lead to a very flexible model, which is able to take different seasonalities at different locations into account. This approach is applied for Germany, considering monthly maxima of daily precipitations sums at about 5,600 stations. In the end, we provide more accurate (compared to gauge-wise models) return level estimates in time and space for gauged and ungauged sites.

TP5-P-04

Large climate datasets to support the development of climate services: examples from Digital Earth

Bouwer, L.[1]*, C. Nam[1], K. Sieck[1], D. Rechid[1]

*E-Mail: laurens.bouwer@hzg.de

[1] *Climate Service Center Germany, Hamburg, Germany*

The development of climate services, which provides actionable information for end-users, requires the generation, analysis, and integration of vast amounts of new data. To tackle the challenges related to dealing with fast growing multi-variable data, the Digital Earth project is currently being undertaken by eight Helmholtz Centers working in the research field of Earth and Environment in Germany. Data science techniques are employed to extract and visualise information from large volumes of high temporal and spatial resolution data in both modelling and observations. In this contribution, we will present experiences in developing climate data products using such data science techniques, to make better use of the vast amounts of data that are becoming available from state-of-the-art regional climate models. Novel techniques are required to extract relevant information from these data, that can then be used by end-users, for instance with the aim of informing risks and opportunities. Here we use different datasets generated by the regional climate model REMO, provided by the Climate Service Center Germany (GERICS) in Hamburg. In the first example, we identify and track heavy precipitation events in REMO from hourly climate data. For this purpose, we analyse extreme rainfall amounts over space and time at different durations and frequencies across Germany and the European domain. The tracking algorithm allows the comparison of present threat and future projected changes in rainfall related flooding potential. In a second example, we use a large ensemble (up to 1,000 years), for current and future climate under levels of global warming of 1.5 and 2 degrees compared to pre-industrial levels, from the HAPPI-DE project. The large ensemble allows us to reduce uncertainties associated with the estimate changes of extreme events for the European domain. We provide examples for temperature and rainfall extremes, including drought. These results are useful for engineers and urban planners, for estimating plausible future changes of urban flood risks and for designing resilient drainage systems.

TP5-P-05

An analysis of persistent extreme events based on large deviation theory

Galfi, V. M.[1*]

*E-Mail: vera.melinda.galfi@uni-hamburg.de

[1] *Universität Hamburg, Hamburg, Germany*

We study temporally persistent and spatially extended extreme events of temperature anomalies, i.e. heat waves and cold spells, using large deviation theory. We consider a simplified yet Earth-like general circulation model of the atmosphere and numerically estimate large deviation rate functions of near-surface temperature in the mid-latitudes. We discover that the obtained rate function is able to describe spatially extended and temporally persistent heat waves or cold spells, if we consider spatially averaged temperature. According to this point of view, heat waves (or cold spells) can be interpreted as large deviations of spatially averaged temperature, provided that the spatial averaging length corresponds with the spatial scale of the event. This is a new way to assess the existence of specific dynamical mechanisms, which lead to the presence of organised structures in the form of persistent weather patterns, with possible applications for estimating return times of persistent extreme events based on numerical model output.

TP5-P-06

Synoptic-scale conditions and convection-resolving hindcast experiments of a cold-season derecho on 3 January 2014 in Western Europe

Ludwig, P.[1]*, L. Mathias[2], J. G. Pinto[2]

*E-Mail: patrick.ludwig@kit.edu

[1] *Karlsruhe Institute of Technology (KIT), Institute of Meteorology and Climate Research, Karlsruhe, Germany*

[2] *MeteoLux, Administration of Air Navigation, Findel, Luxembourg*

A major linear mesoscale convective system caused severe weather over parts of Europe on 3 January 2014. The storm was classified as a cold-season derecho with widespread wind gusts exceeding 25 ms^{-1}. While such derechos occasionally develop along cold fronts of extratropical cyclones, this system formed in a postfrontal air mass along a baroclinic surface pressure trough and was favoured by a strong large-scale air ascent induced by an intense midlevel jet. Given the poor operational forecast of the storm, we analyse the role of initial and lateral boundary conditions to the storm's development by performing convection-resolving limited-area simulations with operational analysis and reanalysis datasets. The storm is best represented in simulations with high temporally and spatially resolved initial and lateral boundary conditions derived from ERA5, which provide the most realistic development of the essential surface pressure trough. Moreover, simulations at convection resolving resolution enable a better representation of the observed derecho intensity. This case study is testimony to the usefulness of ensembles of convection-resolving simulations in overcoming the current shortcomings of forecasting cold season convective storms, particularly for cases not associated with a cold front.

TP5-P-07

HAICU-Local Unit AIM

Schrum, C.[1], F. Reith[1], T. Weigel[2], E. Zorita[1]

E-Mail: fabian.reith@hzg.de

[1] *Helmholtz-Zentrum Geesthacht (HZG) - Centre for Materials and Coastal Research, Geesthacht, Germany*

[2] *Deutsches Klimarechenzentrum, DKRZ, Hamburg, Germany*

The Helmholtz-Association initiated the Helmholtz Artificial Intelligence Cooperation Unit (HAICU). This future-oriented network for applied Artificial Intelligence will develop, implement, and disseminate methods of Artificial

Intelligence for purposes including the analysis of complex systems in the fields of energy, transport, climate, and health. HAICU consists of an internationally visible, central unit in Munich and five local units at further Helmholtz Centers that focus on specific HGF research areas. This poster will present an overview of the objectives, structure, foreseen functioning of the Local Unit for Earth and Environment. To boost the broad application of new powerful Machine Learning algorithms to Earth System Science, the HAICU local unit 'Artificial Intelligence Innovation for Earth System Analytics and Modelling (AIM)' has been established at the Helmholtz-Centre Geesthacht (HZG) and the German Climate Computing Centre (DKRZ) in Hamburg. AIM consists of a Young Investigator Group (YIG) and an AI Consultant Team. The YIG will be based within the research unit System Analysis and Modelling (head Prof Corinna Schrum) at the Institute of Coastal Research in Geesthacht. A focus of the YIG will be on deep learning for improving predictions of extremes and climate change. Further topics are application of machine learning for data assimilation and reduced-complexity models. The application-oriented research will be conducted in close collaboration with other research departments at HZG, including the Climate Service Center Germany (GERICS) in Hamburg, as well as other collaborating institutions.

TP5-P-08

Continuous monitoring of surface water vapor isotopic composition at Neumayer-III station

Bagheri Dastgerdi, S.[1]*, M. Werner[1], J.-L. Bonne[1], M. Behrens[1], M. Hörhold[1], G. Lohmann[1]

*E-Mail: saeid.bagheri@awi.de

[1] *Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research (AWI), Bremerhaven, Germany*

Understanding the processes influencing the stable water isotopic composition and variability of the atmospheric vapor under different climate conditions is essential for a more accurate interpretation of Antarctic ice core isotopic data as a temperature proxy. This can be achieved by a combination of direct observation of the isotopic composition of the water vapour and climate modelling simulations of the isotopic composition of Antarctic precipitation. A Cavity Ring-Down Spectroscopy analyser has been installed in January 2017 at the Neumayer-III station (on the Ekström ice shelf within the Weddell Sea) in Antarctica for high frequency continuous in situ observations of the water vapor isotopic composition. We present results of two year-round observations (Feb 2017 - Feb 2019) of surface water vapor isotopic composition recorded at this location. δ18O and δD are very well correlated with each other (R=0.99) and they show a high correlation with temperature (R=0.86) and humidity (R=0.82). The relation between δ18O and temperature is $\delta^{18}O$ [per mil] =0.55 T [°C] – 25.06. Observations have been compared with the simulated isotopic composition of vapour from ECHAM5-wiso, an atmospheric general circulation model (AGCM) equipped with water isotope diagnostics. The model correctly captures the seasonal and synoptic variability of $\delta^{18}O$ and δD with a high correlation between observed and modelled values (respectively R=0.74 and R=0.75). Moisture sources have been estimated for our observation period based on air masses dispersion simulations with the FLEXPART Lagrangian transport and dispersion model. Most of the moisture was transported to the station by cyclonic circulation patterns, with significant seasonal variations (dominant source from the north-west in spring, from the east in fall and from the west in winter).

TP5-P-09

The Mid Pliocene Warm Period as a test bed for future climate? Inferences from an Earth System Model

Stepanek, C.[1]*, E. Samakinwa[2], G. Lohmann[2]

*E-Mail: christian.stepanek@awi.de

[1] *Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research (AWI), Bremerhaven, Germany*
[2] *Oeschger Center for Climate Change Research, Bern, Switzerland*

The Pliocene, and in particular the Mid-Pliocene Warm Period (MPWP, about 3.3-3.0 Million years ago), is the most recent time in geologic history when climate was characterised by temperatures that persistently were above modern conditions - with significantly reduced ice sheets, elevated sea level, and substantially reduced sea ice in comparison to today. Owing to the fact that the Pliocene is a relatively recent epoch, the MPWP's land surface was very similar to today: The major continents were already at their present location and, with small exceptions, ocean gateways had already reached their current state. Hence, the Pliocene provides a rare example where past and modern climate can be compared relatively easily as atmosphere and ocean dynamics are influenced by a similar set of geographic boundary conditions. Concentrations of carbon dioxide of the Pliocene were relatively similar to today (about 400 parts per million). Furthermore, reconstructed and modelled global average surface temperature anomaly with respect to the modern state is in the range of conditions that are likely to occur until the end of this century - even if one assumes that emissions will follow an optimistic pathway (RCP4.5), where humankind is expected to manage reduction of carbon dioxide after peak emission at around 2040. With these ideas in mind, the Pliocene has been suggested as one accessible past analogue for future climate. This is a particularly useful circumstance as studying a past climate state enables us to base our scientific inference both on models and on evidence from geologic records, that provide independent information, whereas studying the climate of the future is naturally restricted to employing models alone. In this presentation we will illustrate similarities and differences between simulated MPWP and future climate. Based on our results we will estimate the extent to which our findings may be relevant for quantification of future mid- to high-latitude climate.

TP5-P-10

Quantifying the similarity of globally distributed pollen records with paleo-climate networks

Adam, M.[1]*

*E-Mail: madam@iup.uni-heidelberg.de

[1] *Institute of Environmental Physics, Heidelberg University, Heidelberg, Germany*

Globally consistent natural evidence on past climate evolution is indispensable for climate model evaluations and forecasts. However, it has rarely been investigated quantitatively whether large sets of globally distributed pollen records with limited dating resolution can be statistically linked. This could facilitate the identification of global in contrast to regional climate change signals on millennial to orbital time scales. We consider a global set of time-irregular pollen records for a joint analysis of spatial similarity on different time scales during the last glacial. Making use of measures suitable for irregular time series and by application of a spatio-temporal stochastic model, we examine significant commonality between pollen records. We quantitatively assess the resulting paleo-climate networks while respecting the spatially heterogeneous and sparse proxy archive layout. The network configurations are compared to synthetic proxy networks, which mimic different real-world record impairments. We find strong commonalities of well resolved Chilean, North Pacific and European records on orbital to millennial time scales. They reveal partly inverted deglaciation signals for westward exposed coastal tree vegetation. Such signals are consistently observable for several mid-latitude records, probably indicating equatorward shifts of westerly circulation structures during the last glacial. Surrogate data suggests that a notable part of total records might be insufficiently resolved to detect statistically significant record similarity at least when classical correlation-based measures are utilised. We compare the results to temperature and precipitation signals in PMIP3 models.

TP5-P-11

The analysis of the salinity variations in the Sylt-Rømø Bight during annual cycle

Fofonova, V.[1]*, J. Rick[1], A. Androsov[1], L. Sander[1], C. Hass[1], I. Kuznetsov[1], K. Wiltshire[2]

*E-Mail: vera.fofonova@awi.de

[1] *Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research (AWI), Bremerhaven, Germany*
[2] *Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research (AWI), Sylt, Germany*

The Sylt-Rømø Bight is one of the largest tidal catchments in the Wadden Sea characterised by a chain of near shore islands, separated by tidal inlets. Since the beginning of the last century, two artificial causeways connect the mainland with the islands of Sylt and Rømø, thus creating a back barrier environment. This coastal lagoon exchanges almost 50% of its water volume with the open German Bight during each tidal cycle and thus the pelagic community is strongly triggered by both local and open water influence. Since the early seventies, the SYLT ROADS LTER pelagic time series have also included information about physical and hydro-chemical parameters in the Sylt-Rømø Bight. The measurements of those have been performed twice a week. The development of physical measures (e.g. salinity, SST) usually has well predicted character within the year. However, sometimes abrupt changes are monitored. The purpose of the current work is to explain such abrupt variations of the physical parameters, which might have fundamental impact on the composition of the pelagic communities. As a numerical solution, the FESOM-C model was used (Androsov et al., 2019). It solves three-dimensional primitive equations for the momentum, continuity, and density constituents, and uses the terrain following coordinate in the vertical. FESOM-coastal works on mixed unstructured meshes composed of triangles and quads, which combine geometrical flexibility and numerical efficiency.

TP5-P-12

Interannual to millennial scale variability of river Ammer floods and its relationship with solar forcing

Rimbu, N.[1*], M. Ionita-Scholz[1], G. Lohmann[1]

*E-Mail: norel.rimbu@awi.de

[1] *Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research (AWI), Bremerhaven, Germany*

The relationship between observed and proxy river Ammer (southern Germany) and solar forcing is investigated. A composite analysis reveals that the observed river Ammer flood variability is related to large-scale extreme precipitation and temperature patterns. The upper level atmospheric circulation associated with floods, which resemble the synoptic scale Rossby wave breaking over Europe, is enhanced during low solar activity periods. Furthermore, a composite analysis reveals enhanced blocking activity in a region stretching from Greenland to western Russia during low solar irradiance summers. From the synoptic scale perspective, the observed out-of-phase relationship between solar forcing and river Ammer floods, as presented in previous studies, is related to blocking anomalies associated with solar forcing which favors upper level wave breaking over western Europe, a more unstable atmosphere and more floods. A singular spectrum analysis of a flood layer record from lake Ammer and a total solar irradiance reconstruction, going back in time to the mid-Holocene, reveals coherent variability at ~900 years and ~2,300 years. We argue that similar cycles should dominate the millennial scale variations of blocking activity in the east Europe-west Russia as well as the extreme precipitation and floods over central and west Europe.

TP5-P-13

Oxygen isotope curves from the end-Permian mass extinction interval – influence of global warming on ostracod diversity

Gliwa, J.[1]*, M. Wiedenbeck[2], M. Schobben[3], M.-B. Forel[4], S. Crasquin[4], A. Ghaderi[5], D. Korn[1]

*E-Mail: jana.gliwa@mfn.berlin

[1] *Museum für Naturkunde, Leibniz Institute for Evolution and Biodiversity Science, Berlin, Germany*
[2] *Helmholtz Centre Potsdam – GFZ German Research Centre for Geosciences, Potsdam, Germany*
[3] *Marine Palynology and Paleoceanography, Utrecht University, Princetonlaan, Utrecht, Netherlands*
[4] *CR2P, MNHN-SU-CNRS, Paris, France*

[5] *Department of Geology, Faculty of Science, Ferdowsi University of Mashhad, Mashhad, Iran*

The end-Permian mass extinction event as the most severe biotic crises in Earth history is still a matter of debate regarding the responsibility of several environmental factors, such as ocean acidification, widespread marine anoxia and global temperature rise. In our study, we focus on the detailed reconstruction of a possibly global climate changes and its biological responses. For this purpose we analyse the ostracod diversity of the northwestern Iranian Aras Valley section as well as oxygen isotope values ($\delta^{18}O$) of ostracod shell calcite, which give a hint on the ancient ambient sea water temperature. This combination of geochemical and the palaeoecological approaches allows us to evaluate the role of temperature during the end-Permian mass extinction event. With the application of a new method – measuring the oxygen isotope proportion of ^{18}O and ^{16}O of ostracod shell calcite by application of SIMS technology – we are able to propose a detailed oxygen isotope curve. The data indicate a drastic temperature rise of nearly 10°C during the extinction interval. The comparison with other temperature reconstructions, which for example used conodont apatite, shows that ostracod shell calcite yields reliable results with similar trends. Ostracod diversity patterns show a restructuration of the community from low diverse assemblages in the pre-extinction phase to assemblages with higher diversity in the direct post-extinction phase. The extinction horizon itself is marked by a monospecific assemblage and a subsequent complete faunal turnover. The combination of these palaeontological results to the reconstructed temperature curve indicates a diversity drop, taking place during the initial phase of the temperature rise.

TP5-P-14

Semi-arid forest performance under future conditions: The role of increasing [CO_2] against dryer conditions

Grote, R.[1]*, N. Ruehr[1], A. Buras[2], E. Rotenberg[3], D. Yakir[3]

*E-Mail: ruediger.grote@kit.edu

[1] *Karlsruhe Institute of Technology (KIT), Institute of Meteorology and Climate Research, Karlsruhe, Germany (IMK-IFU), Garmisch-Partenkirchen, Germany*
[2] *Technical University of Munich, School of Life Sciences Weihenstephan, Freising, Germany*
[3] *Weizmann Institute of Science, Rehovot, Israel*

Semi-arid forests have an important role in the global carbon (C) sink, but are assumed to be especially sensitive to projected climate change. In particular, forest trees growing under extremely dry conditions, such as the Yatir forest, a large Aleppo pine planation within the Negev desert. However, up to now we know little on the forest's sensitivity to expected future conditions, in particular the responses of increasing [CO_2] under hotter and drier conditions. Here, we applied a process-based ecosystem model (LandscapeDNDC), which was parameterised and initialised with species and site-specific data. The model was evaluated with ecosystem gas exchange observations (2010–2015) and forest inventory data. To study the responses of the pine plantation under predicted future conditions, we derived [CO_2], temperature, precipitation, relative humidity and radiation data from three climate model scenarios (based on CMIP5) for two major representative concentration pathways (RCP 8.5 and RCP 4.5) in daily resolution (1970–1999, 2010–2029 and 2070–2099 We used this data to run the LandscapeDNDC model and evaluated the effects of climate change scenarios with and without [CO_2] increase on GPP and tree stem growth responses. The climate models showed a clear trend in decreasing annual precipitation, while annual temperatures are predicted to increase strongly (4–6°C between 2000 and 2100 at RCP 8.5) at the forest site. This trend of hotter and drier conditions was reflected in reduced GPP and lower growth rates (lower stem volume). However, we found elevated [CO_2] to largely offset this decrease, resulting in slight or none reductions of GPP and tree stem biomass under predicted future conditions. We refer this strong [CO_2] sensitivity of the model to water savings caused by a larger water-use-efficiency (WUE) under increasing [CO_2], due to lower stomatal conductance (gs) at similar to higher C uptake.

TP5-P-15

Stratospheric influences on sub-seasonal predictability of European surface weather

Bueler, D.[1]*, R. Beerli[2], H. Wernli[3], C. Grams[1]

*E-Mail: dominik.bueeler@kit.edu

[1] *Karlsruhe Institute of Technology (KIT), Institute of Meteorology and Climate Research, Karlsruhe, Germany*
[2] *AXPO Solutions AG, Switzerland, and IAC, ETH Zurich, Zurich, Switzerland*
[3] *Institute for Atmospheric and Climate Science, Swiss Federal Institute of Technology in Zurich (ETH Zurich), Switzerland*

Surface weather variability on sub-seasonal timescales influences various socio-economic sectors such as the energy industry or agriculture. The state of the stratospheric polar vortex (SPV) is thought to be an important source of sub-seasonal predictability in winter, because long-lasting periods of positive or negative phases of the North Atlantic Oscillation (NAO) often follow anomalously strong or weak SPV states, respectively. However, only little is known on how this relationship ultimately affects the predictability of surface weather in different European regions. Here, we investigate the skill of sub-seasonal numerical forecasts of surface weather for individual European countries dependent on the state of the SPV. To this end, month-ahead forecasts of country-averaged 10 m wind, 2 m temperature, and precipitation from 20 years of ECMWF extended-range ensemble reforecasts provided by the Sub-seasonal to Seasonal (S2S) Prediction Project Database are verified. We generally find a substantial dependence of model skill on anomalous SPV states at forecast initial time and the subsequent respective NAO-like patterns throughout the forecast, but only for those countries that are particularly affected by the NAO-related anomalies. Forecasts initialised during the strongest SPV states have significantly enhanced skill compared to forecasts initialised during normal SPV states for most of these countries. In contrast, forecasts initialised during the weakest SPV states, which are mostly associated with sudden stratospheric warmings (SSWs), have a wide range of skill that is on average mostly lower than for the strongest SPV states and for specific countries even lower than for normal SPV states. To better understand

this asymmetric skill behaviour, we further investigate the specific large-scale flow situation, as depicted by Atlantic-European weather regimes, around anomalous SPV states and how well these regime life cycles are represented in the sub-seasonal forecasts.

TP5-P-16

Wave climate change in the North Sea and Baltic Sea

Bonaduce, A.[1]*, J. Staneva[1], A. Behrens[1], J. R. Bidlot[2], R. I. Wilcke[3]

*E-Mail: antonio.bonaduce@hzg.de

[1] *Helmholtz-Zentrum Geesthacht (HZG) - Centre for Materials and Coastal Research, Geesthacht, Germany*
[2] *European Centre for Medium-Range Weather Forecasts (ECMWF), Reading, United Kingdom*
[3] *Swedish Meteorological and Hydrological Institute (SMHI), Norrkoping, Sweden*

Wave climate change by the end of the 21st century (2075 - 2100) was investigated using a regional wave climate projection under the RCP8.5 scenario. The performance of the historical run (1980 - 2005) in representing the present wave climate was assessed when compared with in situ (e.g. GTS) and remote sensing (i.e. Jason-1) observations and wave hindcasts (e.g. ERA5-hindcast). Compared with significant wave height observations in different subdomains, errors on the order of 20-30% were observed. A Principal Component (PC) analysis showed that the temporal leading modes obtained from in situ data were well correlated (0.9) with those from the historical run. Despite systematic differences (10%), the general features of the present wave climate were captured by the historical run. In the future climate projection, with respect to the historical run, similar wave climate change patterns were observed when considering both the mean and severe wave conditions, which were generally larger during summer. In particular, we focus on the characterisation of the extremes in the wave climate projection, through statistical methods, with respect to the present climate. The range of variation in the projected extremes (±10%) was consistent with those observed in previous studies both at the global and regional spatial scales. The most interesting feature was the projected increase in extreme wind speed, surface Stokes drift speed and significant wave height in the Northeast Atlantic. On the other hand, a decrease was observed in the North Sea and the southern part of the Baltic Sea basin, while increased extreme values occurred in the Gulf of Bothnia during winter.

TP5-P-17

The potential of predicting low flow periods for the central European rivers with a special focus on summer 2018

Ionita-Scholz, M.[1*], V. Nagavciuc[2]

*E-Mail: monica.ionita@awi.de

[1] *Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research (AWI), Bremerhaven, Germany*
[2] *Faculty of Forestry, Stefan cel mare University, Suceava, Romania*

During the last decades, several low flow periods, at European level, occurred with severe impacts not only on the river itself but also on the civil society. Low flow periods affect navigation, hydropower production and the environment. A hot, dry 2018 summer has left the central European rivers and lakes at record low water levels, causing chaos for the inland shipping industry, environmental damage and billions of euros (dollars) in losses. Similar to floods, low flows are natural events, which can considerably restrict different uses and functions of the river and impact water quality and the aquatic ecosystem. Moreover, it is expected that climate change will to lead to drier summers in Western Europe and therefore possibly to more frequent and more severe low flows in rivers in the future. The results presented here show that the summer 2018 low flow situation, over the Rhine river, could have been predicted one season ahead using previous months sea surface temperature, sea level pressure, precipitation, mean air temperature and soil moisture. Moreover, the statistical model was able to predict more than 85% of the water levels for August 2018 on month ahead. The lagged relationship between the monthly and/or seasonal streamflow and the climatic and/or oceanic variables vary between 1 month (e.g. local precipitation, temperature and soil moisture) up to 6 months (e.g. sea surface temperature). Given that all predictors used in the model are available at the end of each month, the forecast scheme can be used to predict extreme events and to provide early warnings for upcoming low flow periods.

TP-P-18

Clumped isotope signatures in modern bivalve shells contribute to seasonal upwelling reconstructions

Caldarescu, D. E.[1*], A. N. Meckler[1], C. Andersson[2], H. Sadatzki[3]

*E-Mail: diana.caldarescu@awi.de

[1] *Department of Earth Science, University of Bergen, Norway*
[2] *NORCE Norwegian Research Centre, Norway*
[3] *Department of Earth Science, University of Bergen, Norway*

Oxygen isotope-based thermometry has been a key tool in reconstructing past temperatures since the 1950s. This thermometer is commonly applied to biogenic carbonates like corals, foraminifera and mollusks, however, it has one important challenge: it requires an assumption about the isotopic composition of the water. In contrast, clumped isotope (Δ47) thermometry is built upon the fact that a multiply substituted isotopologue of m/z 47 (^{13}C-^{18}O-^{16}O) of relatively small abundance contains a bond between two heavy stable isotopes, which makes it thermodynamically more stable at low temperatures. The variation in m/z 47 abundance inside the carbonate crystal matrix not only reflects temperature changes, but it is also independent on water composition the organisms lived in.

The Gulf of Panama represents a case of hydrodynamic heterogeneity in which seasonal upwelling of cold, nutrient rich thermocline water cools the eutrophic layer and promotes primary productivity. Taking advantage of the seasonal temperature dichotomy, this study reconstructs the growth temperature of two modern bivalve

shells and assesses the reliability of the obtained temperature variation by comparing it to available data. Combining Δ47-based temperatures in biogenic carbonates with classical oxygen isotopes allows reconstructing the isotopic composition of the water and thereby estimating the salinity of the water. The results from this study show that seasonal temperatures and salinities obtained from the bivalves are comparable within analytical errors to measured values in the Gulf of Panama.

This novel technique is therefore appropriate for paleoenvironmental reconstructions based on bivalves in seasonal upwelling regimes. When applied to fossil shells, it offers better constraints on past temperatures, upwelling intensities, thermocline stability and paleodepths, and it could aid in understanding the regional implications of the closure of the isthmus of Panama around 3Ma.

TP5-P-19

Automatic data quality control for understanding extreme climate events

Brenner, S.[1*], R. Koppe[1], A. Haas[1], C. Schäfer-Neth[1], P. Fischer[1], S. Immoor[1], P. Gerchow[1], B. Fritzsch[1], S. Frickenhaus[1]

*E-Mail: brenner.silva@awi.de

[1] *Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research (AWI), Bremerhaven, Germany*

The understanding of extreme events strongly depends on knowledge gained from data. Data integration of multiple sources, scales and earth compartments is the focus of the project Digital Earth, which also join efforts on the quality control of data. Automatic quality control is embedded in the ingest component of the O2A, the observation-to-archive data flow framework of the Alfred-Wegener-Institute. In that framework, the O2A-Sensor provides observation properties to the O2A-Ingest, which delivers quality-flagged data to the O2A-dashboard. The automatic quality control currently follows a procedural approach, where modules are included to implement formulations found in the literature and other operational observatory networks. A set of plausibility tests including range, spike and gradient tests are currently operational. The automatic quality control scans the ingesting data in near-real-time (NRT) format, builds a table of devices, and search - either by absolute or derivative values - for correctness and validity of observations. The availability of observation properties, for instance tests parameters like physical or operation ranges, triggers the automatic quality control, which in turn iterates through the table of devices to set the quality flag for each sample and observation. To date, the quality flags in use are sequential and qualitative, i.e. it describes a level of quality in the data. A new flagging system is under development to include a descriptive characteristic that will comprise technical and user interpretation. Within Digital Earth, data on flood and drought events along the Elbe River and methane emissions in the North Sea are to be reviewed using automatic quality control. Fast and scalable automatic quality control will disentangle uncertainty raised by quality issues and thus improve our understanding of extreme events in those cases.

TP5-P-20

Earth Science meets Digital Science – Let's make sense of the mess

Henkel, D.[1*], J. Greinert[1], H. Brix[2] and the Digital Earth Steering Group[3,4,5,6,7,8]

E-Mail*: dhenkel@geomar.de

[1] *GEOMAR Helmholtz Centre for Ocean Research Kiel*
[2] *Helmholtz-Zentrum Geesthacht - Centre for Materials and Coastal Research, Geesthacht, Germany*
[3] *Alfred Wegener Institute Helmholtz Center for Polar and Marine Research (AWI), Bremerhaven, Germany*
[4] *Helmholtz Centre Potsdam – GFZ German Research Centre for Geosciences, Potsdam, Germany*
[5] *German Research Center for Environmental Health Helmholtz Zentrum München*
[6] *Forschungszentrum Jülich (FZJ), Jülich, Germany*
[7] *Helmholtz Centre for Environmental Research – UFZ, Leipzig, Germany*
[8] *Karlsruhe Institute of Technology (KIT), Institute of Meteorology and Climate Research, Karlsruhe, Germany*

Every day, the scientific world is generating a flood of measured and modelled data - whether from the atmosphere, the ocean or from land - to understand and describe the state of our planet. Handling and processing of these large and heterogeneous data sets has reached a limit where computer based, sometimes automated workflows are essential for an integrative analyses and interpretation. As part of the large-scale joint project 'Digital Earth', funded by the Helmholtz Association's research field Earth and Environment, Earth and Data scientists from eight Helmholtz Centres are working together to combine expertise, discuss different approaches and establish centre overarching groups of experts.

Within 'Digital Earth', data from field studies and models are analysed across different disciplines of Earth science with the aim of utilizing existing workflows and algorithmic/visual solutions to create new workflows and jointly developed software solutions to accommodate a number of common, Earth Science typical objectives. These are i) to guide data acquisition through better and faster analyses of field and model data including predictions in space and time (Smart Monitoring), ii) to advance capabilities and competence with respect to visual and computational data analyses and synthesis (Data Exploration), and iii) to establish structures for sustainable collaboration among the different Helmholtz Centres and external experts in data science to spread knowledge, reduce redundancies and enable sustainable development in data science.

We will present how 'Digital Earth' will help exploit synergies through better coordination of ongoing data science activities. Furthermore, we will introduce the first tools and products that have been generated as well as their applications for the wider Earth Science community.

TP5-P-21

Elbe river flood and draught scenarios – the MOSES and Digital Earth initiatives

Schäfer-Neth, C.[1*], A. Haas[1], P. Fischer[1], R. Koppe[1], P. Gerchow[1], S. Frickenhaus[1]

E-Mail*: christian.schaefer-neth@awi.de

Numerous research institutes are active in climate research by modelling and analysing climate scenarios within their fields of expertise. Climate change, however, acts across many compartments of the earth system and thus requires an integrated approach across earth science disciplines. The integration of climate-relevant variables across earth compartments has been improved over the last decades allowing validated predictions for global or large-scale climate scenarios today. However, ongoing research and climate reality show that global scale climate changes increasingly also trigger local climate changes and enhance extreme weather events. Although their occurrence is (still) not predictable, extreme weathers may affect the region of occurrence tremendously and can come with a great potential of causing disasters including effects on geomorphology, vegetation, rivers, as well as infrastructure (e. g., cities, roads, railroads) which can be damaged by extreme weather events.

Both MOSES and Digital Earth focus on the Elbe river system use case that addresses floods and draughts within climate change. Performing test campaigns in the entire Elbe system, the eight Helmholtz Centres of the Sector Earth and Environment of BMBF are currently clustering their expertise within the framework of MOSES and Digital Earth to establish a Modular and Mobile Sensor Network. MOSES will measure short, medium, and long term effects of floods and draughts in the river Elbe, and Digital Earth will process and model the data in real-time. Both projects combine their outstanding expertise including the necessary data integration and processing steps across scientific disciplines and will provide the required IT-expertise and infrastructure to ensure the seamless data flow from the sensor network to real-time analysis and visualisation. This includes the automatisation of access to data from very diverse sources, related validation and transformation processes, as well as the installation of further processing and/or analysing routines. It comprises of a mixture of powerful hardware, automatisation scripts, and applications to administer all of it.

Here we will focus on the Sensor Network and the IT infrastructure part (Digital Earth WP1, WP2) showing O2A, AWI's data flow framework that covers all infrastructure units from observation, via analysis and visualization to archive (SENOR.AWI.DE, MAPS.AWI.DE DASHOARD.AWI.DE, DATA.AWI.DE, PANGAEA.DE)

Topic 6

Climate change adaptation as societal challenge

Oral presentations

TP6-O-01

The regional perception of extreme weather events in Germany. Part 2: an analysis of weather epistemologies in North Frisia

Döring, M.[1]*, S. Mohr[2], B. Ratter[3], F. Feser[4], M. Kunz[2], T. Kunz-Plapp[5]

*E-Mail: doering@metaphorik.de

[1] *Institute of Geography, University of Hamburg, Hamburg, Germany*
[2] *Karlsruhe Institute of Technology (KIT), Institute of Meteorology and Climate Research, Karlsruhe, Germany*
[3] *University of Hamburg, Hamburg, Germany*
[4] *Helmholtz-Zentrum Geesthacht - Centre for Materials and Coastal Research, Geesthacht, Germany*
[5] *Center for Disaster Management and Risk Reduction, KIT Karlsruhe, Karlsruhe, Germany*

Humans and the societies in which they live have always tried to understand the causes of weather situations surrounding them handle the effects and manage associated risks. Traditional cultural beliefs, social practices and scientific endeavours mirror these attempts and have contributed to explaining exceptional weather phenomena and weather patterns. This also applies to extreme weather events (EWEs) which have been associated and framed by science and society as a direct consequence of anthropogenic climate change. Hence, EWEs such as hailstorms, storms surges, heavy rain events or heat waves represent the regional materialisations of large-scale changes in the climate system. The social need to comprehend and explicate what has happened on the regional scale becomes in many cases imperative and a culprit has to be found to be made responsible for what has meteorologically occurred. Such interpretations can be seen in the cultural and contemporary history of weather which offers a vast of account of such blame narratives and other explanations for abnormal meteorological phenomena. The study takes these insights as a starting point to empirically explore the social perception of EWEs and to conceptually systematise them in terms of regional weather epistemologies. The approach is applied to qualitative interviews conducted with inhabitants in the northernmost district of Germany (North Frisia) and interpreted against the background of quantitative data collected during five street surveys in EWE hotspots in Germany. The aim of the study is twofold: to empirically investigate the regional processes of meaning making underlying regional weather epistemologies in terms of EWEs and to conceptually explore the implications of such an analysis for raising risk awareness and manage associated risks.

TP6-O-02

Paired flood and drought event analyses to support climate adaptation

Kreibich, H.[1]*, V. Blauhut[2], J. C. J. H. Aerts[3], L. M. Bouwer[4], H. A. J. Van Lanen[5], A. Mejia[6], M. Mens[7], A. F. Van Loon[8]

*E-Mail: heidi.kreibich@gfz-potsdam.de

[1] *Helmholtz Centre Potsdam – GFZ German Research Centre for Geosciences, Potsdam, Germany*
[2] *University of Freiburg, Freiburg, Germany*
[3] *Vrije Universiteit Amsterdam, Amsterdam, Netherlands*
[4] *Helmholtz-Zentrum Geesthacht, Hamburg, Germany*
[5] *Wageningen University, Wageningen, Netherlands*
[6] *The Pennsylvania State University, University Park, United States of Amerika*
[7] *Deltares, Delft, Netherlands*
[8] *University of Birmingham, Birmingham, United Kingdom*

For the development of sustainable, efficient climate adaptation strategies for the hydrological extremes of droughts and floods, it is essential to understand the temporal changes of impacts, and their respective causes and interactions. To achieve scientific advancement in this area we suggest the approach of comparative analyses of paired event case studies (Kreibich et al. 2019, DOI: http://doi.org/10.1080/02626667.2018.1558367). A pilot study revealed, that reduction of vulnerability is key for improved risk reduction (Kreibich et al. 2017, DOI: http://doi.org/10.1002/2017EF000606). The approach is analogous to the concept of 'paired catchment studies'. Its advantages are that it allows detailed context-specific assessments based on the paired-event analyses, and reveals general conclusions based on the comparative analysis of various case studies. In the framework of the Panta Rhei initiative of IAHS, we collect and analyse a large number of paired-event studies of floods and droughts from different hydro-climatic and socio-economic settings around the world.

TP6-O-03

How to tackle transboundary climate change impacts?

Haße, C.[1]*

*E-Mail: clemens.hasse@uba.de

[1] *German Environment Agency (Umweltbundesamt – UBA), Dessau-Roßlau, Germany*

Most climate change assessments studies focus on the domestic impacts of climate change. But up to now, they widely ignore transboundary impacts, meaning impacts arising from climate change in other parts of the world. Recent studies conclude, that especially for industrialized countries like Germany, transboundary impacts might pose a similar or even greater threat than the domestic impacts. For example, a recent research study on behalf of the German Environment Agency analyses the exposure of German foreign trade to global climate change and estimates the relevance of imports and exports per product group. So examine possible transboundary risk is a necessary first step. But who should take actions on transboundary impacts? And what are the right solutions? This presentation will give key insight into the mentioned study and reflect on how this

knowledge can support better decision making for policy and business.

TP6-O-04

The power of law: the potential of legal regulations and instruments to enable and promote climate change adaptation

Schumacher, L.[1]*

*E-Mail: schumali@uni-bremen.de

[1] *University of Bremen, Center for Marine Environmental Sciences (MARUM), Bremen, Germany*

Despite the prevailing evidence that demonstrates the severity of climate change and the extent to which it will affect human populations, current mitigation and adaptation actions are far from being sufficient. Thus, mechanisms that enable and promote these actions and, ultimately, aid the transformation towards resilient and sustainable societies are necessary. This paper will analyse how the law can be a key instrument of transformation and presents its potential as a pacemaker for adaptation. First, this paper will explain how legislation can be used as an adaptation tool, using examples concerning adaptation to rising sea levels to illustrate this. Looking at coastal adaptation in particular promises valuable insights, since human population and the global economy are largely concentrated in coastal areas and many coastal communities already experience direct climate change impacts, such as increasing coastal erosion. Second, this paper will analyse the legal requirements for sustainability in spatial planning decisions or regulations that require adaptive action, e.g. flood-resistant design for buildings in flood-prone areas. In addition, this analysis will include spatial planning instruments that can promote risk avoidance, e.g. through limiting development in (future) hazard prone areas. Third, the paper will analyse the requirements for flood risk assessment and management required by the EU-Floods Directive (Directive 2007/60/EC). This precedent is as an example of legal obligations that require the responsible authorities to take into account sea level rise as a specific impact of climate change. In conclusion, it will become evident that legal interventions are necessary to provide a framework that enables adaptation to climate change impacts and incorporates a sustainable long-term strategy, while also permitting a flexible, robust approach that promotes resilient communities.

TP6-O-05

From climate knowledge to climate action: creating regional communities of practice against climate change

Döring, M.[1]*, B. Ratter[1], J. Fröhlich[1], B. Graf[1]

*E-Mail: doering@metaphorik.de

[1] *Institute of Geography, University of Hamburg, Hamburg, Germany*

While climate science represents a well-established field of research, socio-scientific research on the framing of climate change has only recently come of age. It has been revealed that the abstract entity of climate change is connected to and mediated by the immediate life-world of the public. This means that ascribing meaning to, generating 'knowledges' about, developing attitudes towards and acting against global warming is influenced by everyday experiences, social relations, media usages and climate-related policies. Although the relevance of scientific information has constantly bee emphasised by climate services and climate communication, their aim to raise awareness for and instigate climate protective actions has only partly been successful as the interconnection between socio-cultural and scientific forms of climate 'knowledges' and climate-related activities still lie in the dark. Our study aims at elucidating this relation by investigating the social dimensions of climate 'knowledges' in adult education courses (klimafit) in Germany and their potential to prompt local action. The approach is theoretically based on the concept of communities of practice (CoP) applied to data taken from participatory observation during three complete courses in Emden, Eckernförde and Hamburg and 18 follow-up interviews (6 per location) conducted with participants. The aim of the paper is threefold: to empirically analyse varying climate 'knowledges', to theoretically assess their role in creating CoP and to practically reflect upon the implications and potentials of CoP for initiating climate protective activities. Above all, we intend to show that abstract scientific knowledge and information play a subordinate role in the socio-cultural fabrication of climate 'knowledges' and that social learning and sociality is crucial for getting active in the climate debate.

TP6-O-06

Adaptation of Russian agriculture to climatic variability: the role of federal and provincial policies

Stupak, N.[1]*

*E-Mail: nataliya.stupak@thuenen.de

[1] *Thünen Institute of Farm Economics, Braunschweig, Germany*

This paper draws on the example of Tyumen Province, a federal subject of the Russian Federation, to explore the role that policies play in hindering agricultural producers' adaptation to climate change. Its objective is to contribute to a better understanding of maladaptation at the policy level. The discourse analysis method is used to explain perceptions of climate variability in Tyumen Province and its impact on agriculture. The document analysis method is used to assess agricultural policy in Tyumen Province and its implications for producers' adaptation to climate change. The results suggest that although agricultural producers and policymakers are acutely aware both of climate variability and the resulting loss of agricultural output, provincial agricultural policy generally fails to encourage better adaptation by agricultural producers or to support their greater economic security. The public authorities of Tyumen Province desire self-sufficiency in food production. They evidently believe that increasing agricultural output will serve to attain this and subsidise production costs. This simple logic guiding the actions of the public authorities does not appear to consider limiting the losses caused by climate extremes. The present reasoning persists because the amount of food produced in the province currently exceeds food demand as calculated by the authorities. Once the scope of agricultural losses starts to undermine efforts to attain production targets, the logic currently applied will prove dysfunctional. Currently,

both Russian and foreign studies suggest that the Russian Federation will benefit from climate change in the long term. They thus provide the federal and provincial public authorities with a comforting belief - yet one that pays insufficient attention to the likelihood and impact of climate variability. Ignoring the interplay of climate change and climate variability reinforces the idea that the climate change phenomenon belongs to a distant future. The lack of discussion around such climate change manifestations as weather unpredictability and interannual variability impedes recognition of the fact that climate change is a present and pressing issue.

TP6-O-07

Adaptive polder management for resilient socio-ecological systems in coastal Bangladesh

Saroar, Md M.[1]*

*E-Mail: saroar.mustafa@yahoo.com

[1] *Khulna University of Engineering and Technology (KUET), Khulna, Bangladesh*

The climate change induced hydro-meteorological events have posed formidable challenges for the resilience of polder (low-lying tracts of land enclosed by earthen embankments) socio-ecological systems in coastal Bangladesh, yet the issue is little researched. There exist scanty of literature about the history and the role of polders to protect the land and settlements from the tidal flooding and salinity intrusion. This research fills the knowledge gaps in three ways. First, it tries to assess the vulnerability of coastal socio-ecological systems to hydro-meteorological events; second, it examines the adaptive measures taken by various stakeholders including polder management committee to enhance the resilience of polder ecosystem. Finally, it identifies the challenges and barriers that need to address to harness the full potentials of adaptive polder management. This research is conducted taking polder 30 in Khulna as a case. This research is heavily draws on qualitative inquiry; data and information was collected during January-April in 2018. The modified DPSIR and Earth System Governance Framework (in part) were used as the basic analytical framework. The finding shows that there are both functioning and non-functioning polder (and sub-polder) water management committee. However, their roles are very loosely defined; confined with meeting only. Elite capture has been appeared as the dominant cause of non-functioning of polder management committee. As hypothesised, the most marginalised group comprised of landless/functionally landless, smallholder/peasant farmers, fisher folks and the female has been appeared as the worst victim of vulnerable socio-ecological system of polders. Various physical (e.g. river siltation, changing weather), technological (lack technical know-how); social (conflicting interests), governance (illegal dike excavation, lack of maintenance) and institutional factors (lack of investment) that put challenges to adaptive polder management are identified. Finally in line with the findings suggestion are made to build resilient polder socio-ecological system.

TP6-O-08

Water-Energy-Land: A cross-sectoral perspective to foster long-term resource use efficiency under changing climate conditions

Kropf, B.[1]*, H. Mitter[1], K. Karner[1], E. Schmid[1]

*E-Mail: bernadette.kropf@boku.ac.at

[1] *Institute for Sustainable Economic Development, Vienna, Austria*

Recent socio-economic and environmental developments, such as population growth and climate change increase pressure on the natural resources water, energy and land. A cross- sectoral perspective is required to deal with the interlinkages and interdependencies of these resources and to facilitate the coherent planning and implementation of management and policy measures to foster long-term resource use efficiency. We aim at revealing trade-offs and synergies which may emerge from potential mitigation and adaptation measures within the Water-Energy-Land nexus (WEL nexus) of the case study region Seewinkel. The Seewinkel region is a semi-arid agricultural production region in Eastern Austria, where multiple conflicting demands for land and water exist, e.g. settlements, agricultural production and irrigation, tourism and nature conservation due to a regional national park. In a series of workshops with regional stakeholders representing the water, energy and land sectors, we systematically investigate the regional WEL nexus under climate change by applying a cognitive mapping approach. In a first workshop, representatives of provincial and regional institutions illustrated their individual perceptions by indicating influencing variables on the interlinkages of the regional WEL nexus as well as potential adaptation and mitigation measures. The four derived cognitive maps are aggregated to one regional cognitive map, which are discussed and validated in a second stakeholder workshop and complemented with a narrative describing the perceptions of the participants. The semi-quantitative analysis provides a holistic view on the Seewinkel WEL nexus and reveals synergies and trade-offs within and across sectors emerging form mitigation and adaptation measures. The complexity of the cognitive map for the Seewinkel highlights the importance of a regional perspective across sectors to facilitate the implementation of coherent policies that correspond to the defined needs.

TP6-O-09

Maintaining the viability of public spaces in cities under increasing heat stress in a warming climate – a transdisciplinary design

Foshag, K.[1]*, N. Aeschbach[2], B. Höfle[3], R. Winkler[4], A. Siegmund[5], W. Aeschbach[6]

*E-Mail: kathrin.leutz@iup.uni-heidelberg.de

[1] *TdLab Geography, Institute of Geography / Institute of Environment, both Heidelberg University, Heidelberg, Germany*

[2] *TdLab Geography, Institute of Geography, Heidelberg University / Heidelberg Center for the Environment, Heidelberg, Germany*

[3] *3D Geospatial Data Processing (3DGeo) Research Group, Institute of Geography, Heidelberg University, Heidelberg, Germany*

[4] *City of Heidelberg, Office of Environmental Protection, Trade Supervision and Energy, Heidelberg, Germany*
[5] *Research Group for Earth Observation / UNESCO Chair, University of Education Heidelberg, Heidelberg, Germany*
[6] *Institute of Environmental Physics, Heidelberg University / Heidelberg Center for the Environment, Heidelberg, Germany*

The increase in the number and severity of heat stress events in cities requires the urgent development of adaptation measures in order to protect the health and well-being of inhabitants as well as the social function of public places of future sustainable cities (cf. Sustainable Development Goals (SDG´s) 3 and 11). There is extensive evidence that climate change – observed and modelled – already does and increasingly will raise the frequency and intensity of extreme heat events, especially in urban regions and their public areas. Heat extremes can be detrimental to human health, including dehydration, discomfort or exhaustion and increase the likelihood of heat-related mortality. Public open spaces and squares will become increasingly unusable in the future without successful adaptation measures to the changing climatic conditions. With our approach, centring on the cooperation between scientists and stakeholders, we have developed a novel integrated transdisciplinary set of methods to co-design climate change adaptation measures in public places of cities. We found that a successful development of measures could only occur with the involvement of the relevant stakeholders: users of the sites, city planners, experts from research, local experts such as interest groups and initiatives and city government. Developing effective and feasible measures means incorporating physical parameters, human perception and practical requirements. Measures that have a regulating effect on the microclimate of public squares are in accordance with the citizens' suggestions for changes that would increase their subjective well-being and contribute to sustainable urban development. Our dataset, collected in a pilot study in Heidelberg, Germany, consists of climatic and meteorological measurements, modelling of solar potential of current and future situations at public squares, surveys and mind-maps. We have established that it is imperative to overcome disciplinary and institutional boundaries to make comprehensive use of these approaches.

TP6-O-10

Responding to rising seas? The governance of relocations in the Maldives

Gussmann, G.[1]*

*E-Mail: geronimo.gussmann@globalclimateforum.org

[1] *Global Climate Forum, Berlin, Germany*

The Maldives are among the most vulnerable countries to coastal risks and sea-level rise. For now, in-situ adaptations are the predominant response to increasing coastal risks. However, against the backdrop of potentially substantial amounts of sea-level rise, relocations will become inevitable. Yet, there is little empirical knowledge about the governance of relocations. While the literature often highlights risks and benefits of relocations, it remains unclear how they are organised and which effect they have on coastal risk reduction in small islands. Therefore, we analysed the historical context of relocations from 1943-2016 and conducted two in-depth case studies of recent post-tsunami relocations in Laamu atoll. We used the theoretical lens of historical institutionalism and borrowed from policy change frameworks to trace the underlying relocation governance mechanisms. To gather data, we conducted semi-structured interviews with respondents (n=22) involved in the process of planned relocations and relocated individuals. Interview data was complemented with a desk review of relevant laws, historical records and literature. We find 34 relocation cases, in the 73-year period. Interestingly, no legal basis for relocations existed until 2010, which led to informal arrangements that influenced relocation selection and outcomes. Furthermore, we find disasters and regime changes to be the main events that opened up windows-of-opportunity for relocations. Yet, these relocations have not considered coastal risks and even increased hazard in the two case studies. The study highlights the risk of relying on relocations as an adaptation-option of last resort in the small island context.

Poster presentations

TP6-P-01

Mutual aid as a factor of disaster relief and climate resilience building - lessons from New Orleans and Yakutia -

Raßmann, H.[1]*

*E-Mail: hannes.rassmann@posteo.de

[1] *Viadrina European University, Frankfurt (Oder), Germany*

Global warming and climate change increase both the frequency and severity of extreme weather events and natural disasters. When the category 5 hurricane Katrina hit New Orleans in 2005, it caused widespread destruction and triggered a state of emergency. The catastrophic proportions of lost human lifes and destroyed livelihoods were partly due to failures of the flood-control systems, which had been build by the US army. While disaster response from different governmental structures and part of the media coverage have faced criticism over racialised news coverage and misguided and violent policing strategies, there have been numerous examples of community-led disaster response. Where no timely help from the officially responsible institutions could be expected, especially people of colour and volunteers in the most neglected neighbourhoods engaged in mutual help. Examples reach from self-organised evacuation, medical treatment by qualified volunteers and free public kitchens to the self-directed rebuilding efforts and even the creation of resilient structures to mitigate future floods. The case of New Orleans is, however, not an exception in otherwise passive scenarios, which would be characterised by a wait-and-see attitude of people who are exposed to natural disasters. Rather, the presenter argues, mutual aid and solidarity are possible and do in fact occur in regularly during natural disasters. The question, which is pursued in this presentation, is what the necessary conditions for such behaviour are and what, on the contrary, might impede or stall mutual aid and what can be learned from such community-lead and decentralised approaches. The (poster) presentation elaborates in detail on the nitty-gritty of those community-led disaster responses by means of

comparatively looking at two different natural disasters - hurricane Katrina and the flood which destroyed significant parts of the Russian city of Lensk in 2001.

TP6-P-02

klimafit (climate-fit) – living lab and communities of practice for 'climate change and its impacts' in adult education

Treffeisen, R.[1]*, K. Grosfeld[1], T. Harms[2], N. Hillenbrand[1], N. Kulikowa[2], B. Muench-Epple[2]

*E-Mail: renate.treffeisen@awi.de

[1] *Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research (AWI), Bremerhaven, Germany*
[2] *World Wide Fund For Nature, Berlin, Germany*

Without knowledge, there can be no climate protection: in keeping with this simple logic, REKLIM and its partners launched an unprecedented project. klimafit is a new course format offered at community colleges, intended to train normal citizens to become climate multipliers in their own communities. It introduces participants to the scientific fundamentals of the climate and climate change, equips them with the skills they need in their new role, and especially focuses on regional climate change. The format combines classroom teaching and online work, while also giving participants the chance to speak with climate researchers and get in touch with local climate protection initiatives. klimafit is accompanied by local / municipal climate protection representatives. The target groups: On the one hand, those who want to help make their cities and communities more climate-friendly. This includes architects, energy consultants, green-space planners, craftspeople, heating installers and town council / municipal council members. On the other, the course addresses parts of the workforce that are especially affected by the regional impacts of climate change, e.g. those working in agriculture and forestry. But all citizens who simply want to learn more about regional climate change are also warmly invited to attend. The concept: Evening sessions combine expert presentations, group discussions and digital learning, giving the participants the chance to talk with leading experts on climate change at the global, regional and local level. A moderator who is familiar with the region guides the group through the content; in turn, the community's climate protection representative shares information on local challenges. By the end of the course, the participants hopefully see themselves as multipliers for climate protection in their communities, and know a great deal more about the effects of global climate change in their own backyard, and what they can do in response.

TP6-P-03

Habitually green: integrating the concept of habit into the design of pro-environmental interventions at the workplace

Michalek, G.[1], I. Thronicker[1], Ö. Yildiz[2], R. Schwarze[1]

E-Mail: gabriela.michalek@ufz.de

[1] *Helmholtz Centre for Environmental Research – UFZ, Leipzig, Germany*
[2] *ADVYCE GmbH, Düsseldorf, Germany and Technische Universität Berlin, Berlin, Germany*

In the course of sustainability strategies, many enterprises and organizations have implemented measures to promote pro-environmental behaviours at work, including sustainable resource use. This task, however, often represents a challenge because many daily behaviours of the employees are based on habits and routines that are very difficult to change. This following article discusses pro-environmental behavioural interventions in the corporate environment with a particular emphasis placed on habit formation. Based on a thorough analysis of the case studies from the recent literature, we discuss how to design and implement habit-enabling interventions at the workplace. The identified habit-enabling adjustments can be used to achieve a permanent reduction in the negative environmental impact of companies and thus become an integral part of Corporate Social Responsibility (CSR) and Environmental Management System (EMS) strategies.

TP6-P-04

The regional risk perception of extreme weather events in Germany. Part 1: Street survey

Mohr, S.[1]*, M. Döring[2], F. Feser[3], M. Kunz[1], T. Kunz-Plapp[1], B. Ratter[2]

*E-Mail: susanna.mohr@kit.edu

[1] *Karlsruhe Institute of Technology (KIT), Institute of Meteorology and Climate Research, Karlsruhe, Germany*
[2] *University of Hamburg, Institute of Geography, Hamburg, Germany*
[3] *Helmholtz-Zentrum Geesthacht - Centre for Materials and Coastal Research, Geesthacht, Germany*

Damages to buildings, infrastructure and even human life caused by extreme weather events (EWEs) such as severe storms, storm surges, hail, floods, heat waves or droughts have increased during the last decades. This has happened due to the interaction of several factors such as amplification in assets, in vulnerability of infrastructure, or changes in patterns and the frequency of extreme events. Seen from a social perspective, this increase is basically connected to and framed as a direct consequence of global warming. Hence, extreme weather events are phenomena, which call for an inclusion of the social dimensions in the context of reliable mitigation and adaptation as well as measures and risk actions to be taken in the case of extreme events. Within the frame of the interdisciplinary project 'Regional risk cultures of weather extremes', emphasis was put on the social perception and assessment of EWEs as well as on protective and preventative actions taken. The aim of the project consisted in gaining a better and regionalized understanding of the socio-cultural dimensions of risk in the context of EWEs. For this to be achieved, five comprehensive street surveys were conducted in locations affected by different types of hazards in Germany (Storms & storm surges: Tönning & Island of Amrum; Floods: Cochem on the Moselle river; Hail: Reutlingen; Heat Waves: Karlsruhe). Results taken from our analysis of the five surveys show that experience of EWEs plays a relevant role in perceiving and assessing dangers and risks on a local and regional level. The severity of an EWE is important for the perception and interpretation of different events, while protective and preventative actions taken regarding differ-

ent EWEs con- and diverge among regions. Hence, participants of the surveys converge in conceiving EWEs as an indicator of climate change while protective and preventive measures taken differ with regard to region and social stratification. In sum, the aim of the poster is threefold: it investigates the socio-cultural perception and assessment of EWEs in different locations in Germany, it reveals the protective and preventative measures taken with regard to social class and it reflects on the potentials of an interdisciplinary investigation of EWEs.

TP6-P-05

Perceptions and Adaptation Behaviour of Farmers to Climate Change in the Upper Brahmaputra Valley Zone, India

Deka Baruah, U.[1]*

*E-Mail: udbmail@gauhati.ac.in

[1] *Department of Geography, Gauhati Universit, Guwahati, India*

To better understand how farmers perceive and adapt to climate change, climate trends and a survey of farmer attitudes and behaviour in the upper Brahmaputra valley zone (UBVZ) of India were analysed. Rainfall and temperature trends were estimated in combination with the results from a detailed questionnaire of 384 farmers across 20 villages in rain-fed areas of the UBVZ. From 1971-2007, the annual mean temperature in the UBVZ increased by 0.15°C / decade while summer rainfall decreased markedly. Multiple logit regression was used for modelling the perceptions and adaptation behaviour of farmers.

TP6-P-06

Climate proofing urban water management – combined mitigation-adaptation approaches

Moers v. J.[1]*

*E-Mail: j.moers@ekbo.de>

[1] *University of Groningen, Netherlands*

In this paper I study the reactions in urban water management to climate change and its impacts. The research is focussed on success factors and strategies to overcome the challenges to effective initiation and implementation of urban climate policies and on the most relevant drivers for this process. Three sets of factors could be derived from scientific publications: incentives, ideas, and capacities. Two case studies were employed to identify windows of opportunities, processes and innovative solutions to overcome the known obstacles to policy implementation. Both case studies feature very different baseline conditions, but have a surprising number of success factors in common. To avoid bias the collected primary and secondary data was triangulated from policy documents and scientific publications, newspaper articles and interviews and crossreferenced.

The combination of climate change related issues and the intermediate global socio-economic trends pose a great challenge to planners. Usually climate policies are either related to mitigation or adaptation approaches. Though policy makers recognized, that both mitigation and adaptation are needed, they were seen as complementary but disconnected approaches (Biesbroek 2009). Around 2007 the discourse changed and the benefits and synergies of combining mitigation and adaptation approaches gained attention (Parry et al 2007).The recognition of the link between mitigation and adaptation has initiated a shift from climate change as a central problem towards a broader transdisciplinary and sustainable development perspective (Nelson et al 2007). Although the need to mainstream mitigation and adaptation policies has been recognised this has not contributed to integrated and coordinated climate policies (Biesbroek 2009) and policy implementation (Shipper 2010). So this paper took the opportunity to look at two of the very first cities employing integrated holistic policy approaches to adress mitigation of and adaptation to climate change.

To some extent findings from international studies regarding pitfalls and obstacles to policy building and its implementation in the urban context could be confirmed. Furthermore, interesting differences could be identified from the two case studies. Whereas Rotterdam was driven to act due to exposure. Stockholm got involved because sustainability was a societal issue. These different incentives resulted in different processes to policy building and implementation. Also, the strategies employed differed greatly due to Rotterdams linear metabolic flow approach versus the circular metabolic flow model applied in Stockholm. Regardless of the differences, several common factors for success could be found and identified as essential.

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