World Climate Research Programme's Grand Challenge on **Weather and Climate Extremes**

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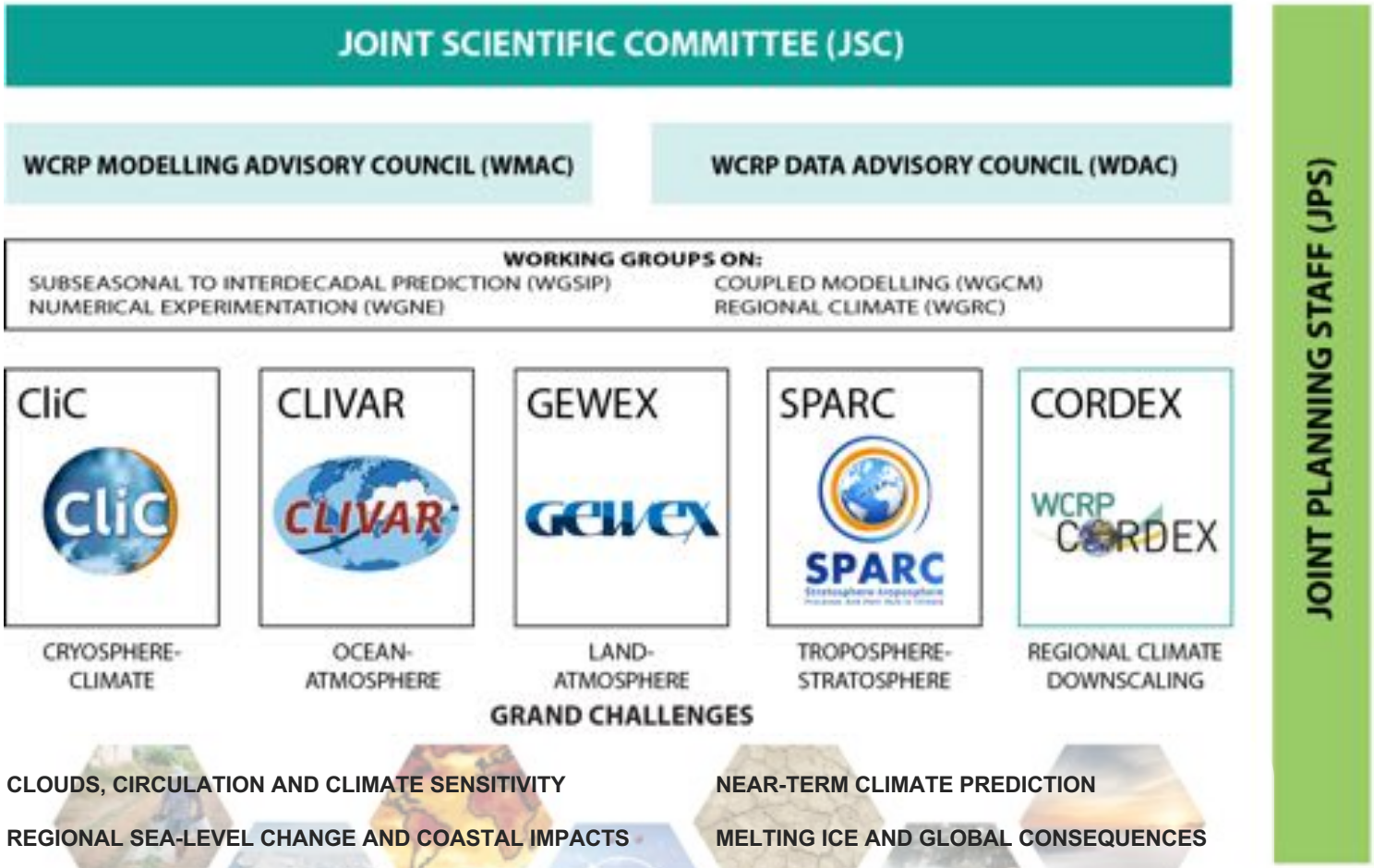
WCRP Structure



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Grand Challenges

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Weather and Climate Extremes

- ***service perspective***: What are frequency and magnitudes of various impact-causing extremes in the near and long term?
- ***science perspective***: causes and mechanisms of variability and change in extremes, how to improve the prediction of change
- Essential link to users

WCRP Grand Challenge on

Weather and Climate Extremes

4 main extremes, 4 overarching themes

Are existing observations sufficient to underpin the assessment of extremes?

What are the relative roles of large-scale, regional and local scale processes, as well as their interactions, for the formation of extremes?

What are the contributors to observed extreme events and to changes in the frequency and intensity of the observed extremes?

Are models able to reliably simulate extremes and their changes, and how can this be evaluated and improved?

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Weather and Climate Extremes

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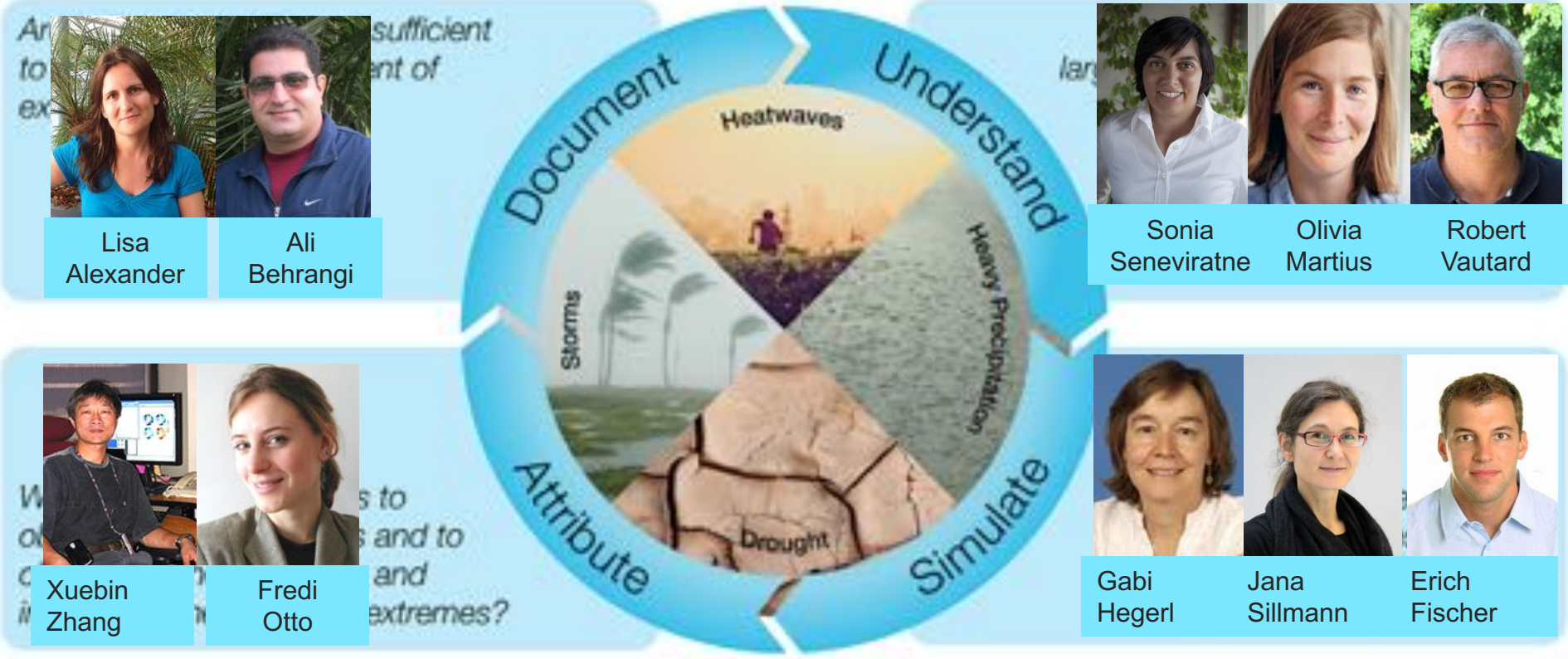

Lisa Alexander | Ali Behrangi

Sonia Seneviratne | Olivia Martius | Robert Vautard

Xuebin Zhang | Fredi Otto

Gabi Hegerl | Jana Sillmann | Erich Fischer

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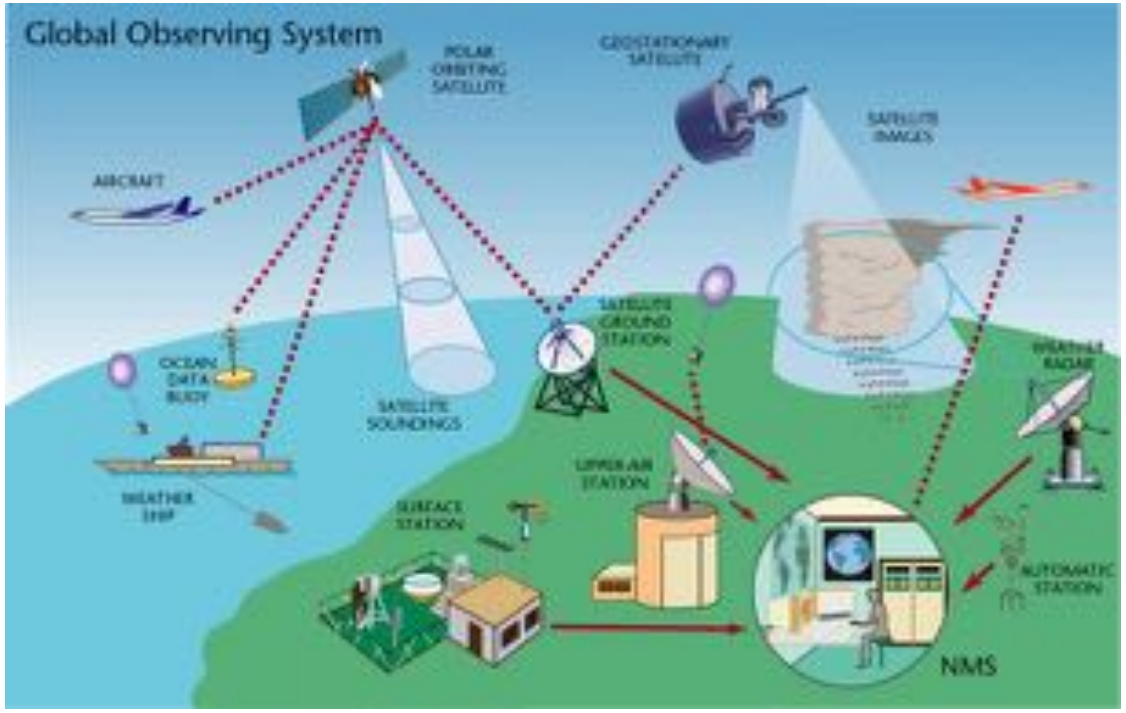
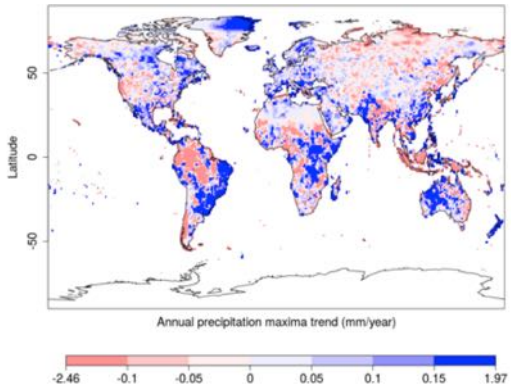
Observations crucial for understanding change and evaluating models, but critical gaps exist in the amount, quality, consistency and availability, especially for extremes



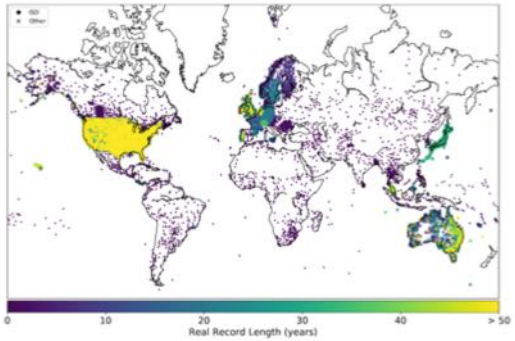
Theme Document

Coordination and dataset development

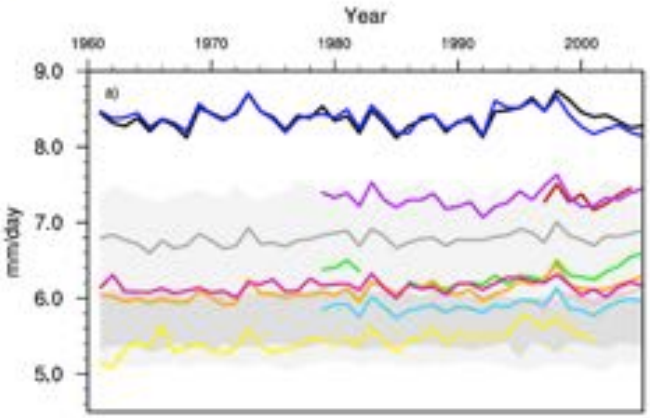
REGEN > 135000 stations so far

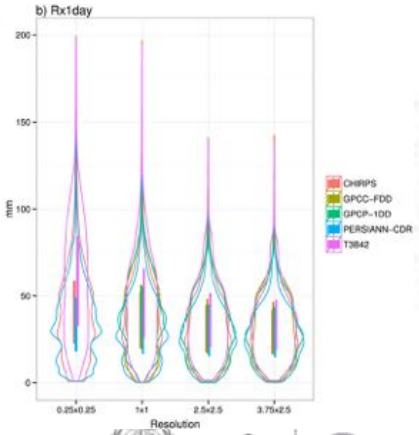


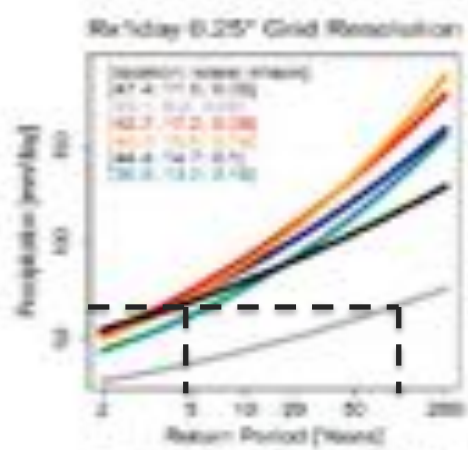
INTENSE > 25000 stations so far



Intercomparison and scaling







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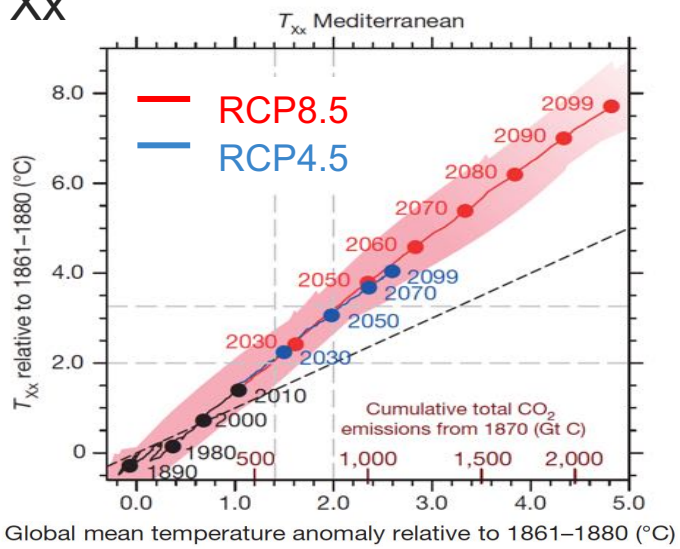
Theme

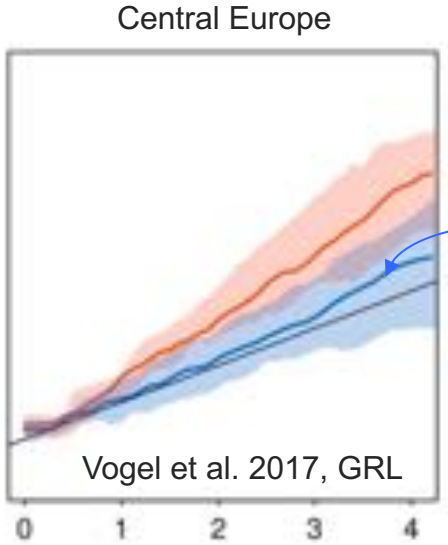
Understand

Interaction between large-scale phenomena (weather types, modes of variability) and regional-scale land-atmosphere feedbacks or forcing is critical

Global scale vs regional scale drivers

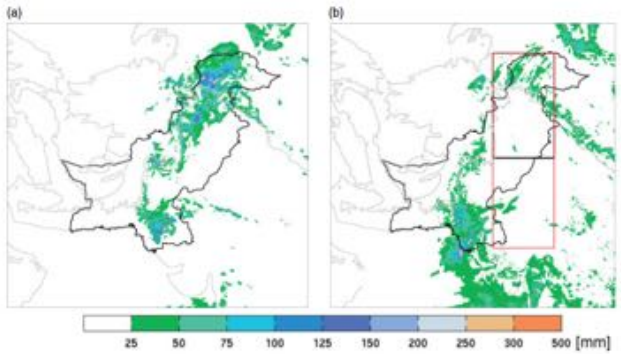
TXx





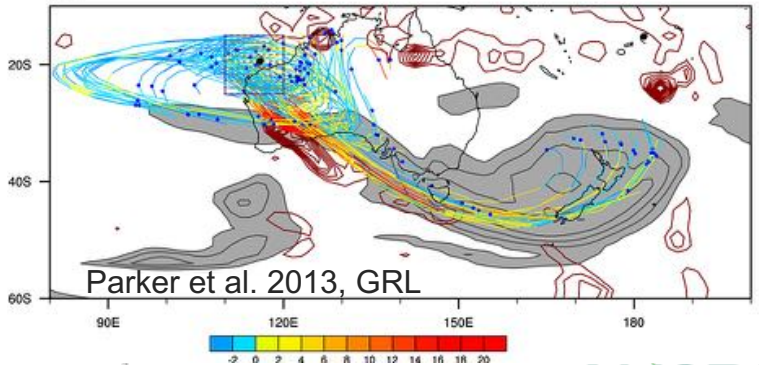
Soil moisture set to present-day conditions

Land moisture sources strong contributor to 2010 Pakistan flood-inducing rainfall events



Martius et al. 2013, QJRMS

Links between TCs and heatwaves



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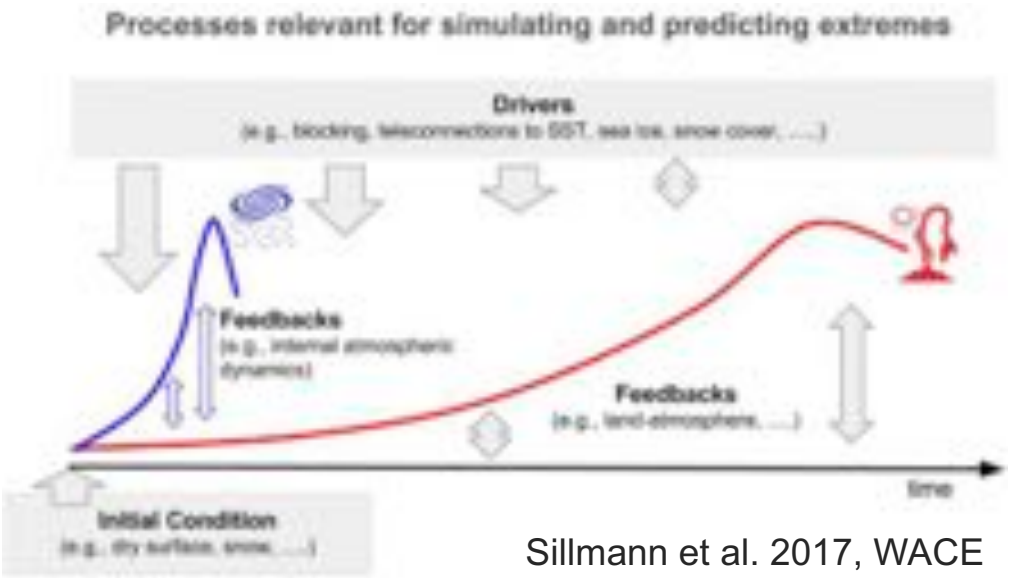
Theme
Simulate

Do the models simulate extreme events for the right reason?

How to use both statistical methods for tails and knowledge about mechanisms/storylines?

What phenomena are GCM and RCM simulations credible for and how can simulations be improved?



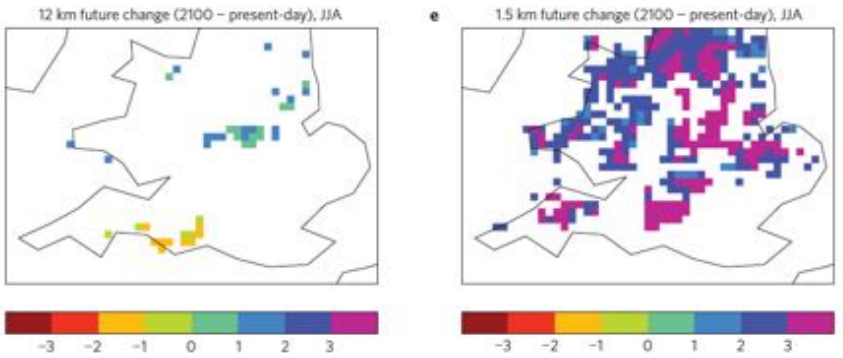
Sillmann et al. 2017, WACE

Theme
Simulate

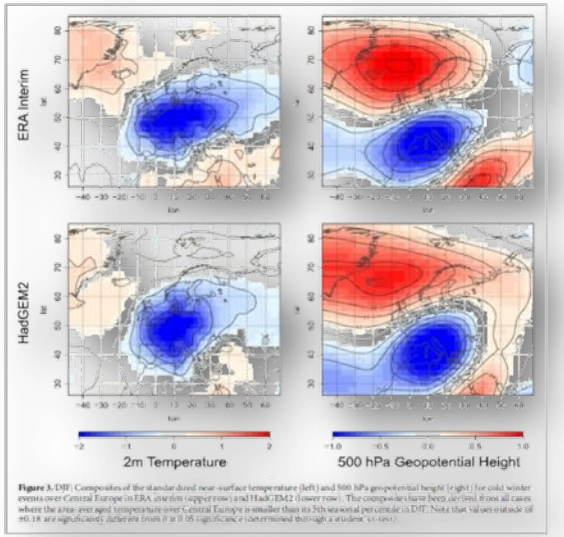
Different issues between small-scale short-lived extremes (heavy precipitation, wind storms) and large-scale long-lived extremes (heatwaves, droughts)

High-resolution more critical for first kind of extremes

Land processes strong constraint for 2nd kind of extremes



Kendon et al. 2014, Nature Climate Change



Krueger et al. 2015, ERL

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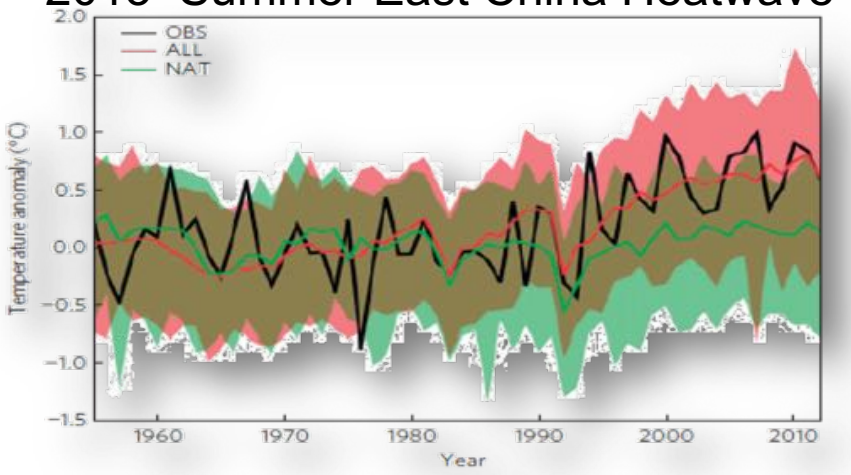
Theme

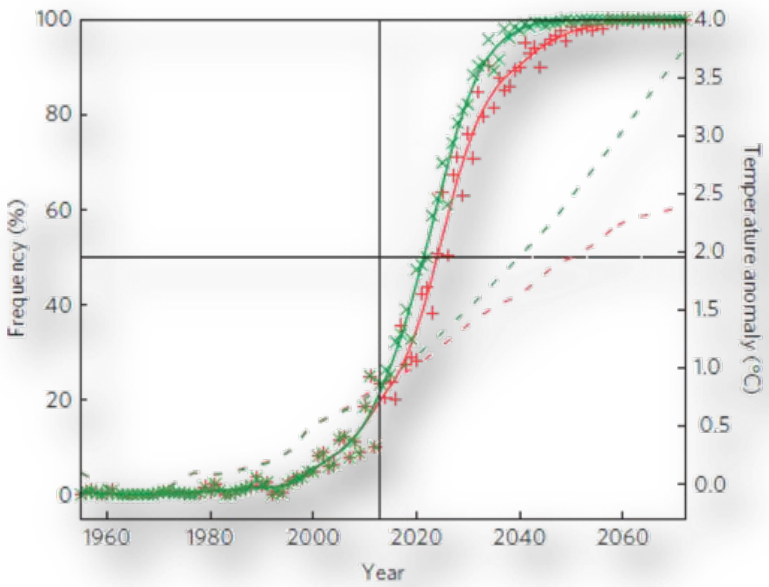
Attribute

A key challenge is to understand the extent to which humans are responsible for changes in extremes and the likelihood of individual extreme weather events

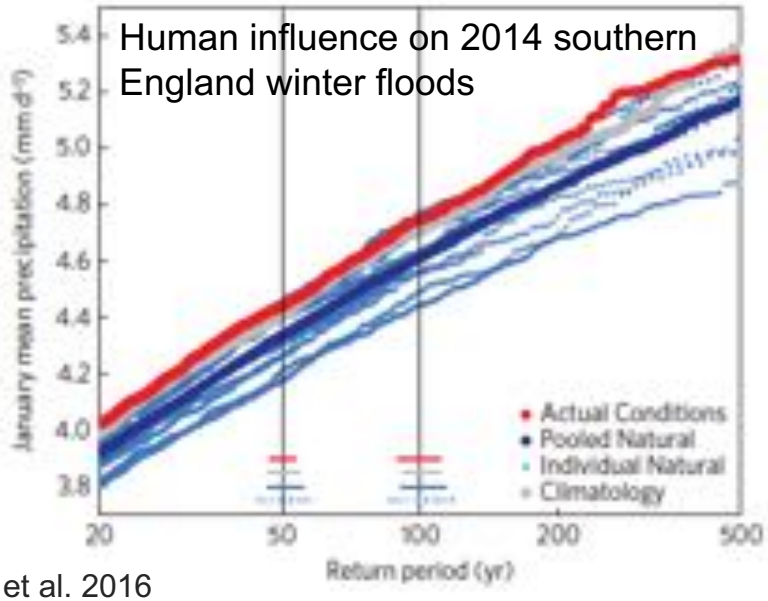
Theme
Attribute

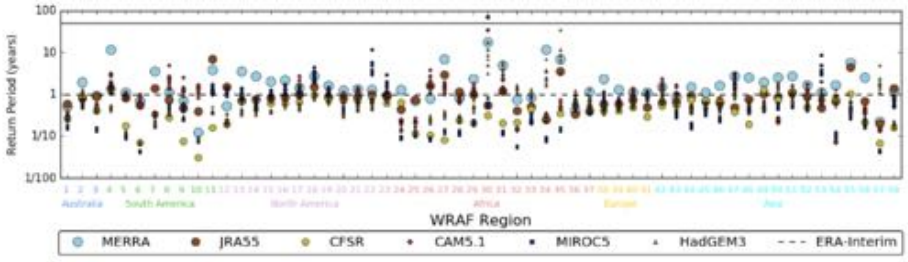
2013 Summer East China Heatwave





Human influence on 2014 southern England winter floods





Angelil et al. 2016

Schaller et al. 2016

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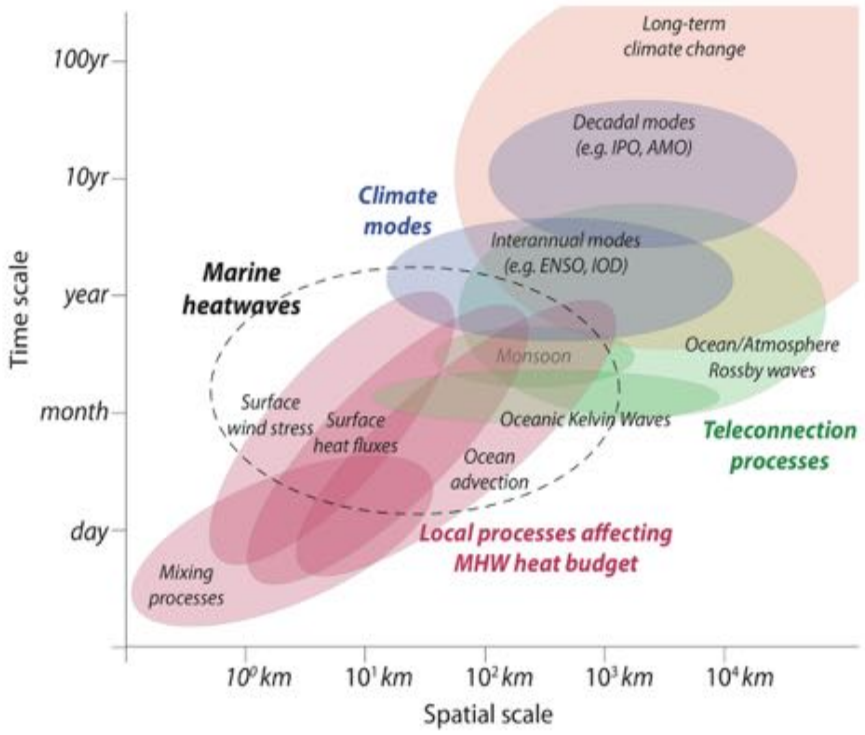
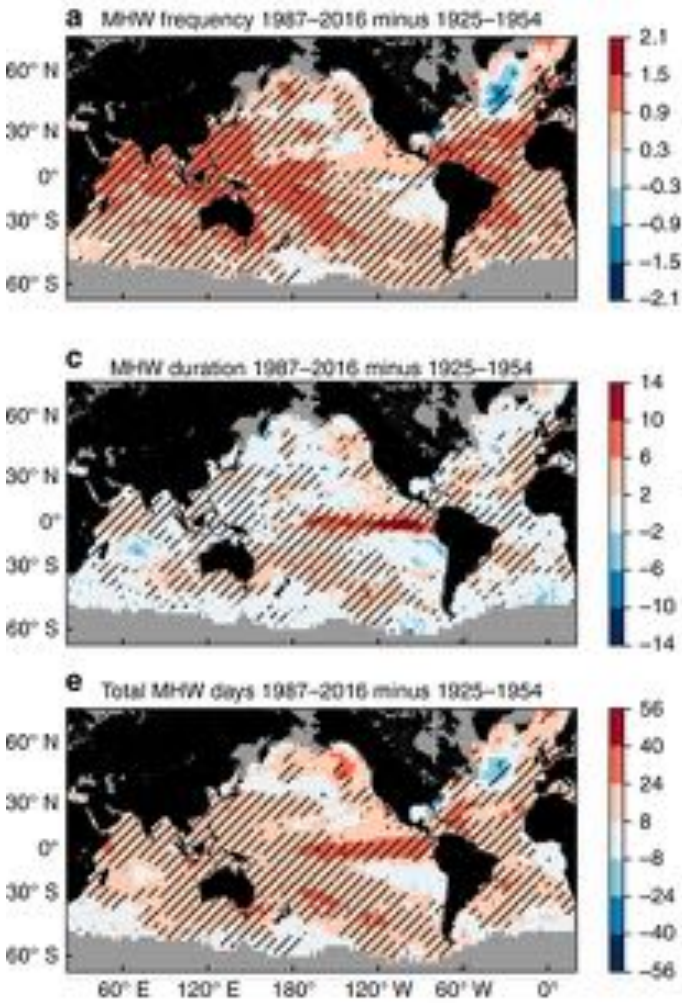
Marine Heatwaves



Holbrook et al. 2018, submitted



Oliver et al. 2018, Nature Clim Change

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Achievements - summer schools

2015
Special Issue in *Weather and Climate Extremes* – 7 papers led by students

Achievements – this meeting!

GEWEX OSC, May 2018

- Large gathering, multiple sessions on all four themes (160+ abstracts on extremes alone)
- Side meetings on Compound Events and on RISK KAN
- Discussions with WWRP

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Extremes: A unifying theme

Some common themes: compound events, documenting extremes, modeling

GC-Extremes

Compound Events

(outcome from workshop, Zurich, April 2017)

GEWEX

Workshop on Addressing the Challenge of Compound Events

ETH Zurich, Switzerland
19–21 April 2017

Jakob Zscheischler[1], Seth Westra[2], Bart van den Hurk[3], Philip Ward[4], Andy Pitman[5] and Sonia I. Seneviratne[1]

[1]Institute for Atmospheric and Climate Science, ETH Zurich, Zurich, Switzerland; [2]University of Adelaide, Adelaide, Australia; [3]KNMI, De Bilt, The Netherlands; [4]Vrije Universiteit Amsterdam, The Netherlands; [5]University of New South Wales, Australia

What is a compound event to you?

(Zscheischler et al., submitted)

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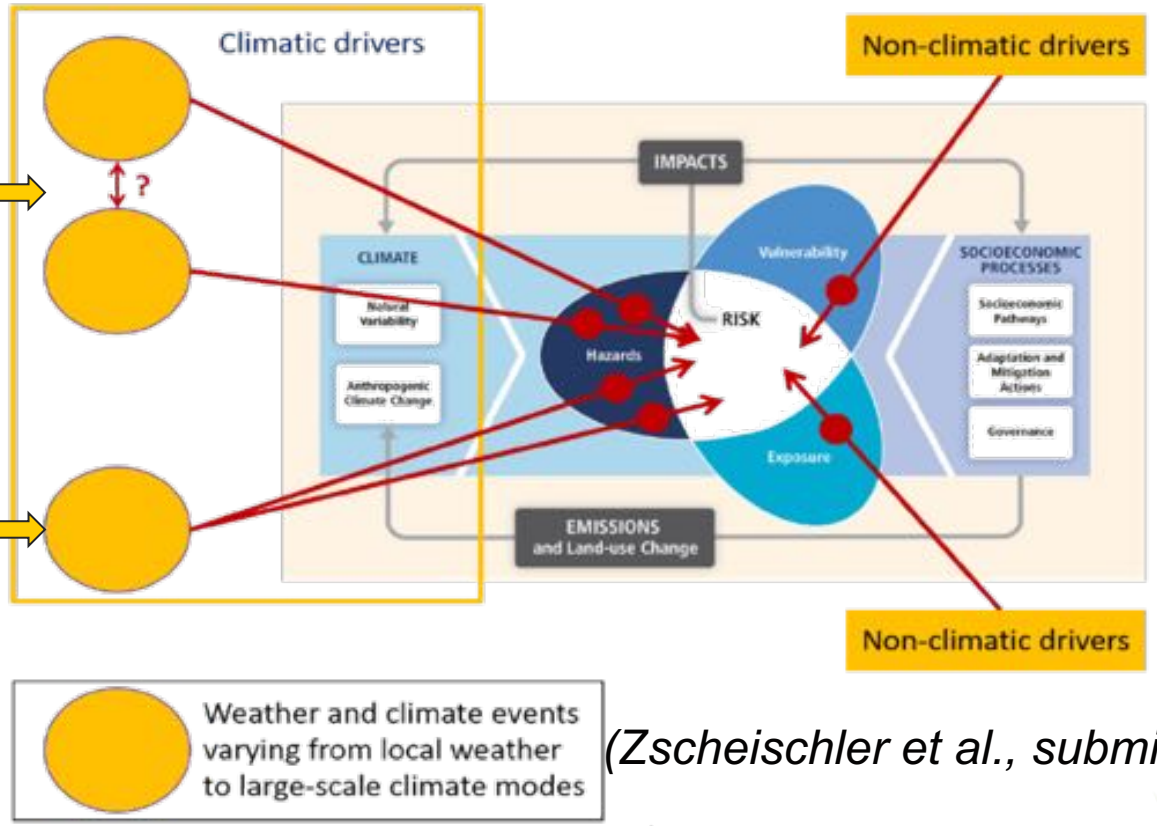
GC-Extremes

Compound Events

(outcome from workshop, Zurich, April 2017)

Multiple drivers contributing to single hazard

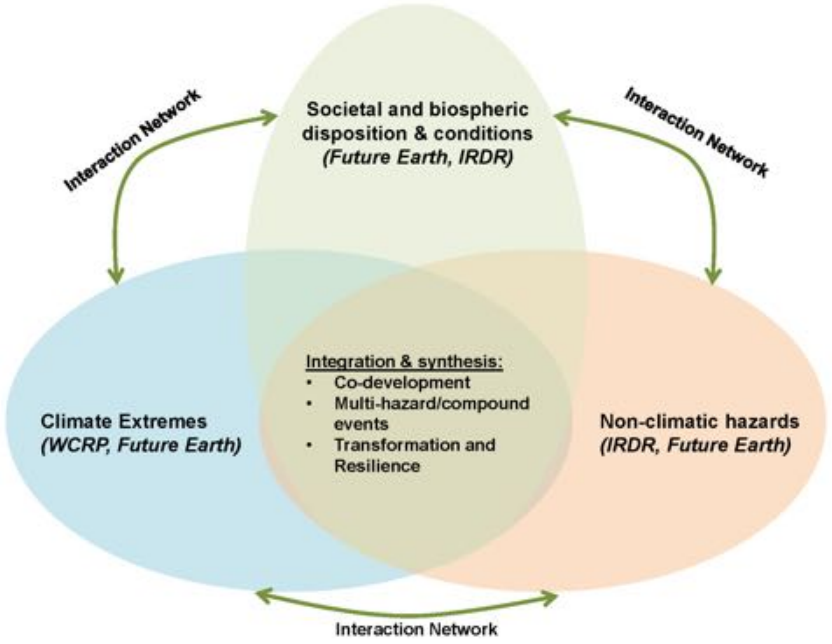
Single driver causing multiple-hazards



(Zscheischler et al., submitted)

Knowledge Action Network on Emergent Risks and Extreme Events (RISK-KAN)

- Supported by ICSU
- Three partners: Future Earth, Integrated Research on Disaster Risk (IRDR), WCRP
- global network of interdisciplinary science excellence
- Solution oriented research for disaster risk reduction under global environmental and societal change
- Jointly identifies priorities on research in systemic risk and interaction between climate change-related and other disasters



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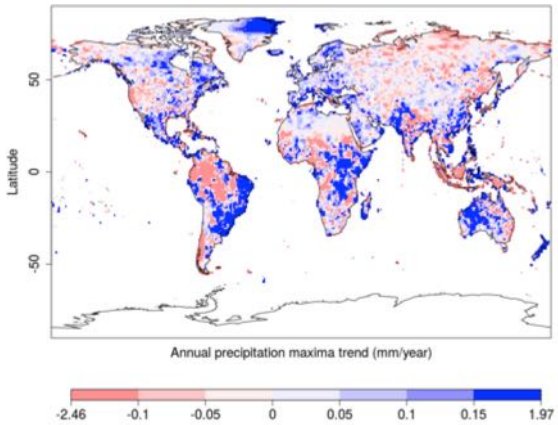
RISK-KAN status

- WCRP involved in scoping and vision development
- Scoping workshop (Nov. 2017, Tokyo), RISK-KAN is an open network
- Open call for members of Development Team (April 2018)
- RISK KAN side event at GEWEX OSC
- To meet in Paris to to establish Development Team and to define ToR etc. (June 2018)

Looking Forward

Data update

- ***Joint workshop with GEWEX Data Assessment Panel (GDAP)*** Jul 2018
  - Focus on International Precipitation Working Group (IPWG) global precipitation assessment contribution on extremes
  - Guidance and best practice documents
  - Coordination for IPCC AR6 especially re remote sensing
- **New/updated datasets**
  - 'HadEX3' planned by end 2018/early 2019
  - Daily global land 1º x 1º gridded precip 1950 onwards almost complete
  - INTENSE - sub-daily precipitation indices



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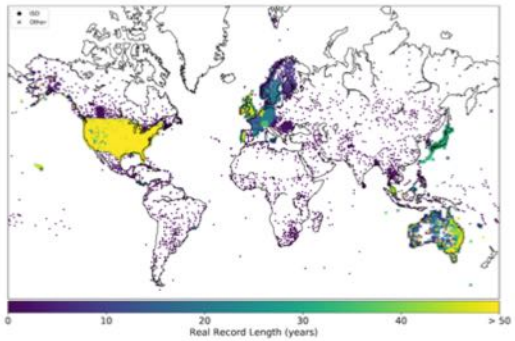

Contributions to IPCC AR6 Assessment

- GC-leads are among CLAs (3), LAs (3) and RE (1) for various chapters
- IPCC Expert Meeting on Assessing Climate Information for Regions, May 2018, Trieste, Italy
- Workshops to coordinate contribution [e.g. Offenbach meeting in July]

GC-Extremes

Institute of Advanced Studies in Climate Extremes and Risk Management

(Direct Contribution to New WCRP SP/IP)

- WCRP contribution to RISK-KAN
- Aiming at improving communications between WGI and WGII communities
- 30 students (senior PhD/Post-doc) + 10 lecturers from both WGs
- Involve Future Earth and IRDR
- **NUIST WMO Training center, Fall 2019**

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GC-Extremes summary

- Some science advances
  - high resolution / convection permitting modelling
  - physical understanding and modelling:
    - increase in intensity of strongest tropical cyclones;
    - Intensification of heavy rainfall associated with tropical cyclones (a human influence has been suggested, e.g., for Harvey rainfall)
    - Exacerbate impact of storm surges due to sea level rise (eg Sandy)
- Extremes continue in headlines and raise new research questions
  - Recent intense fire seasons, very active TC season and heat waves/droughts
  - event attribution science developing strongly and being important; needs to connect to adaptation research
- Main themes and main questions of the GC remain
  - but GEWEX OSC represents end of our current Implementation Plan

2-year strategy

- **Learning from users and addressing their needs**
  - Addition of compound events
  - RISK-KAN
  - Institute of Advanced Studies in Climate Extremes and Risk Management
  - Development of guidance document on future projection of extremes to be released after the conclusion of IPCC WGI AR6 report
  - Suggestions for other proposals ?

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Thank You