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WCRP Grand Challenge

Understanding and Predicting Weather and Climate Extremes

Lisa Alexander, Gabi Hegerl, Sonia Seneviratne, Xuebin Zhang

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Current Status

- Implementation plan Dec. 2014 (still evolving)
  - 4 main extremes, 4 over arching themes
- Early successes
  - WCRP Summer School on Climate Extremes (Trieste, July 2014) and associated special issue
  - Workshop on GC-Extremes data requirements (Sydney, February 2015)
  - Workshop on Understanding, modeling and predicting weather and climate extremes (Oslo, October 2015)

Driven largely by service needs

- From ***service perspective***: What are frequency and magnitudes of various impact-causing extremes in the near and long term?
- From ***science perspective***: How can we better understand the causes and mechanisms of variability and change in extremes, and improve the prediction of changes in extremes?
- Implementation needs to be focused

4 main extremes, 4 over arching themes

Document → Understand → Attribute → Simulate

Implementation plan: 4 themes

improved quality of ground-based and remote-sensing based datasets for extremes
DOCUMENT

interactions between large-scale drivers and regional-scale processes
UNDERSTAND

role of external (e.g. anthropogenic) forcings vs internal variability for changes in extremes
ATTRIBUTE

Evaluate and improve models for simulations of extremes
SIMULATE

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Leads


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Document → **Understand** → **Attribute** → **Simulate**


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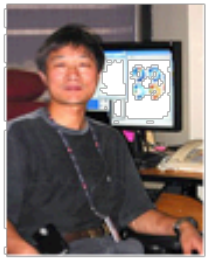
Xuebin Zhang


Fredi Otto

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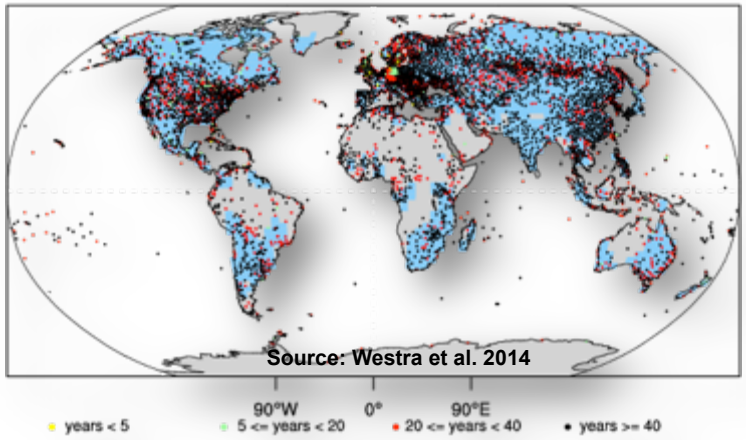
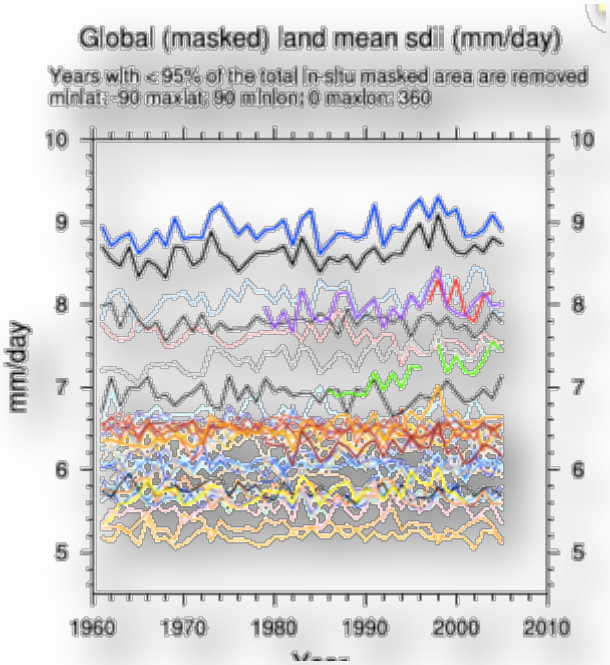
Document

Observations provide crucial underpinning but are often not well-constrained and critical gaps exist in the amount, quality, consistency and availability, especially for extremes

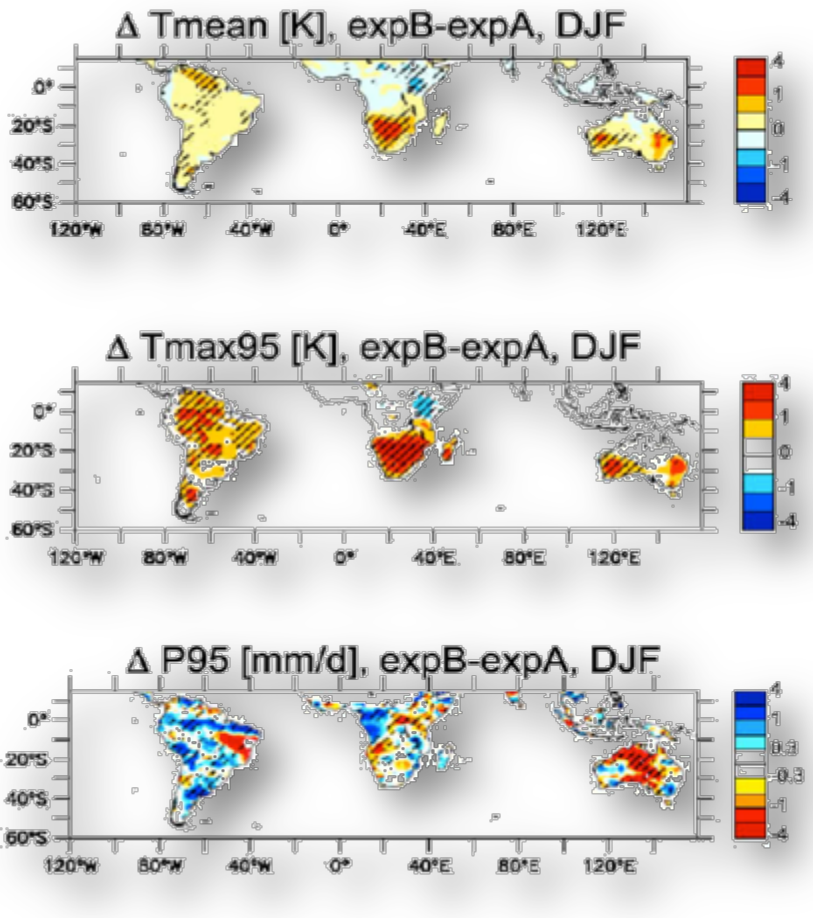
Sub-daily precip stations (HadISD) and SDII coverage (HadEX2)





Understand

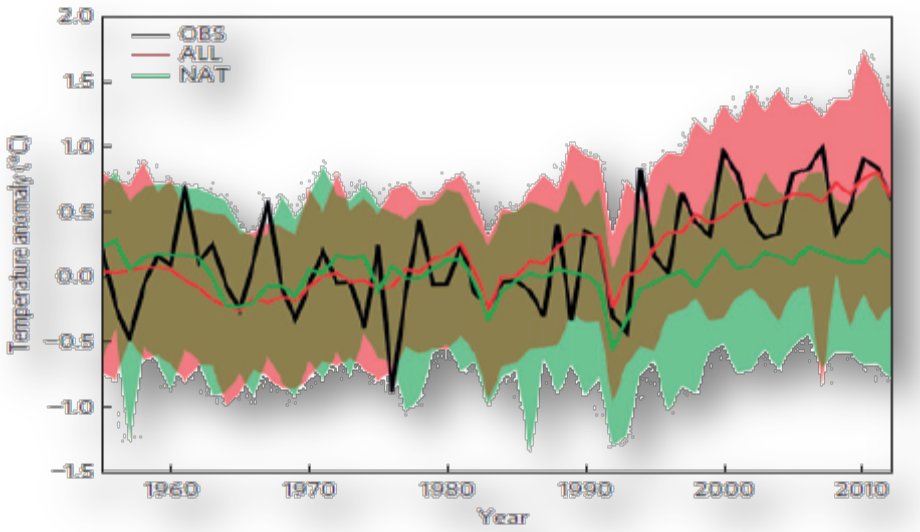
Interaction between large-scale phenomena (weather types, modes of variability) and regional-scale processes (e.g. land-atmosphere feedbacks or forcing) can be critical

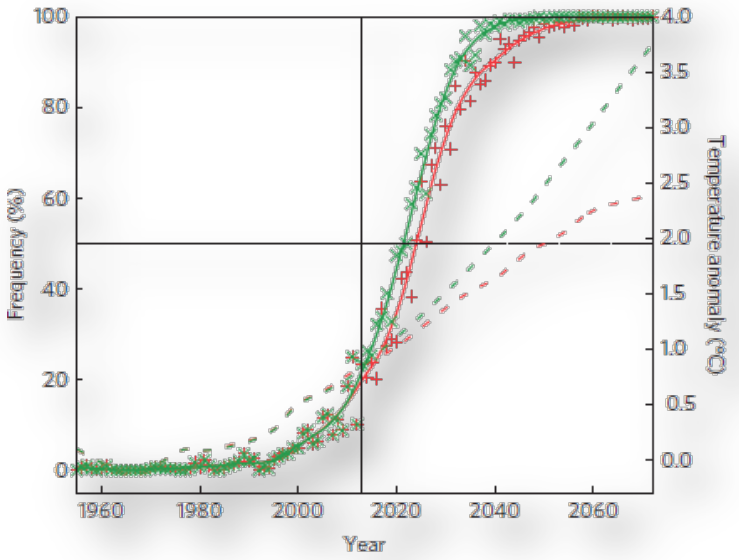


Attribute

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

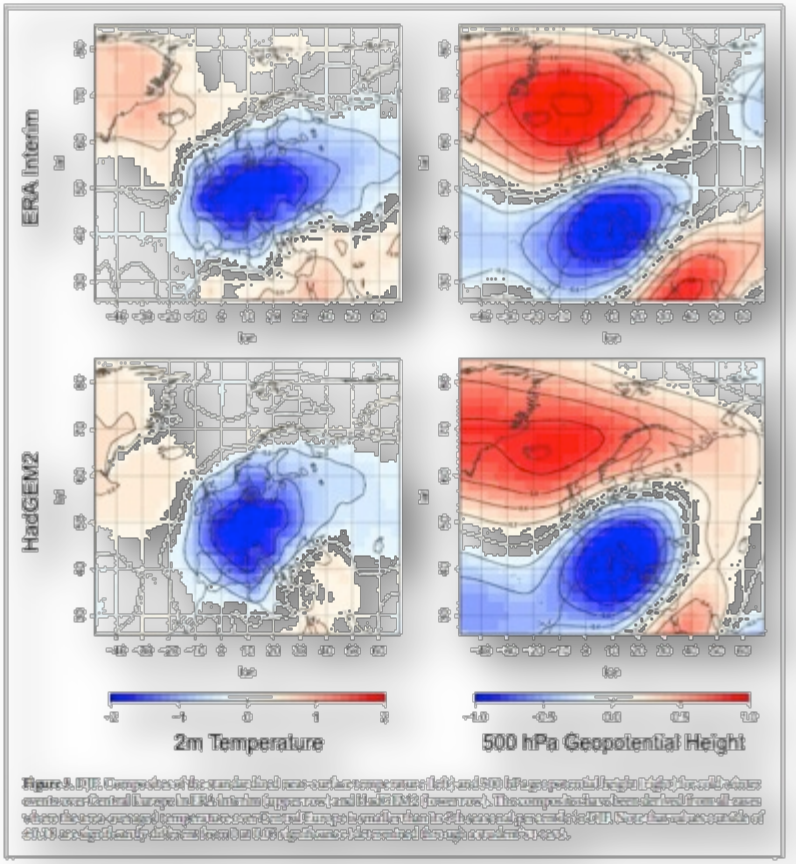
2013 Summer East China Heatwave





Simulate

To understand types of events that current GCMs and RCMs can credibly simulate and to identify key processes for weather and climate extremes that can be credibly simulated to improve prediction of large scale phenomena (weather types, modes of variability)



Source: Krueger et al. 2015

Early Successes:
WCRP-ICTP summer school

236 applications for 35 places. About half of the attendees from developing countries.

A special issue of "Weather and Climate Extremes" with 7 articles led by students

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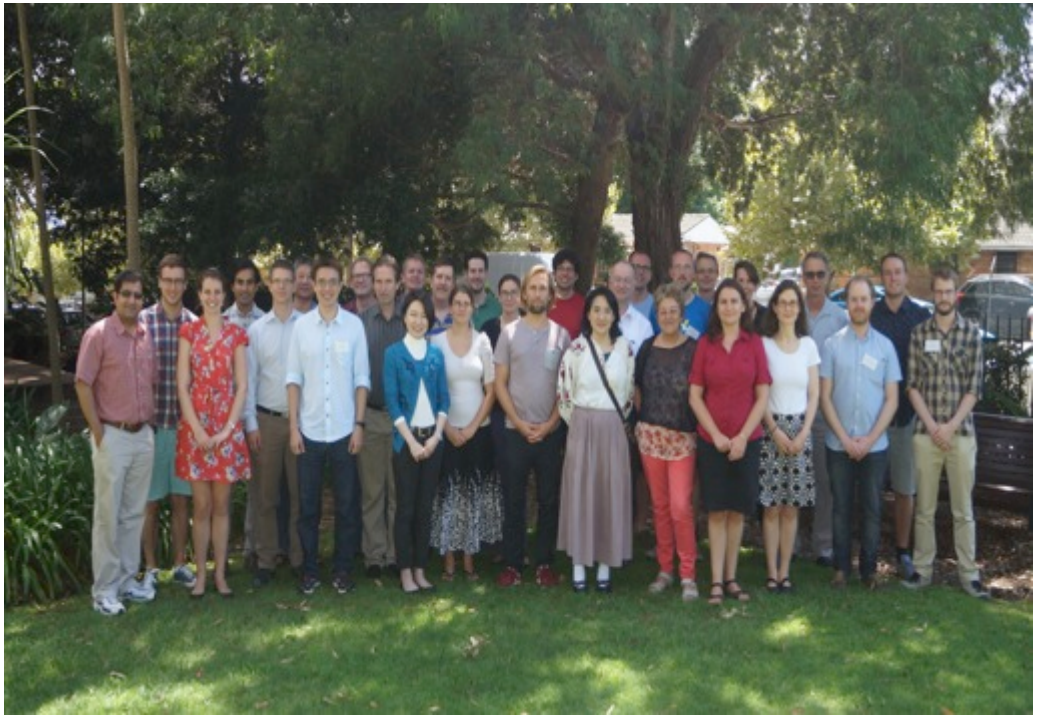
Workshop on GC-Extremes Data Requirements



Improving the collation, dissemination and quality of observations and assessing what new observations are required for extremes

Representation from major international data centres

Deliverables set over the next 3 years

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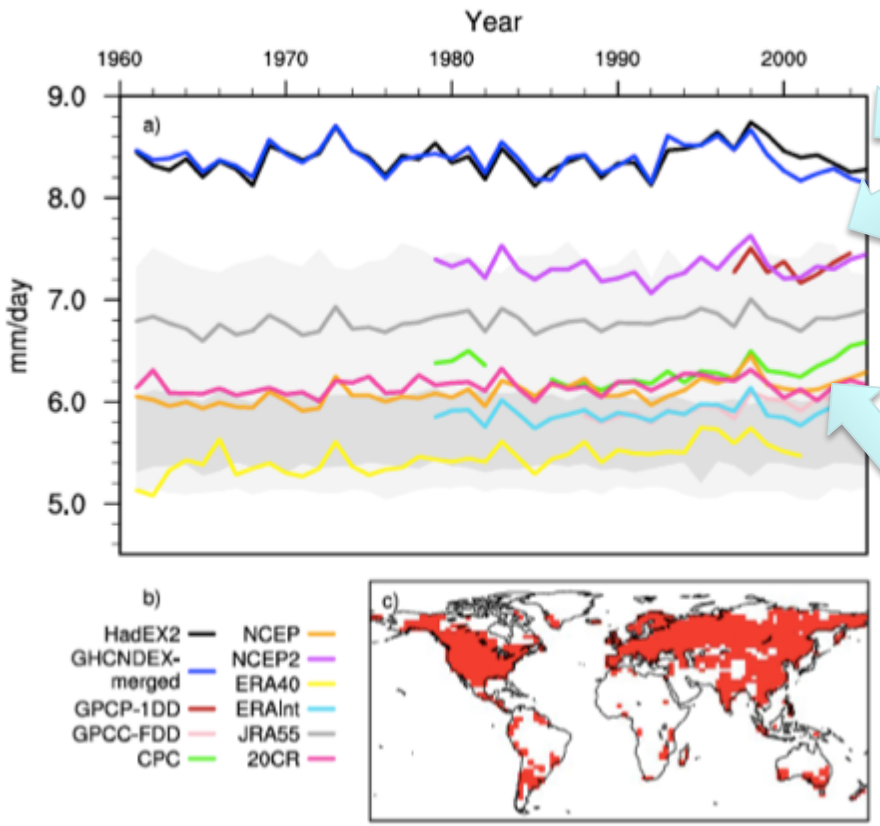
Main issues (before we even start science…)

- Permanent destruction of old records
- More data undigitised than digitised (especially pre WWII)
- Many institutions unwilling or unable to exchange data
- Data quality and homogeneity

The *dreary state* of precipitation observations

~3mm/day difference in annual estimates of daily precipitation intensity



HadEX2

GPCP

Full CMIP5 range

Interquartile range

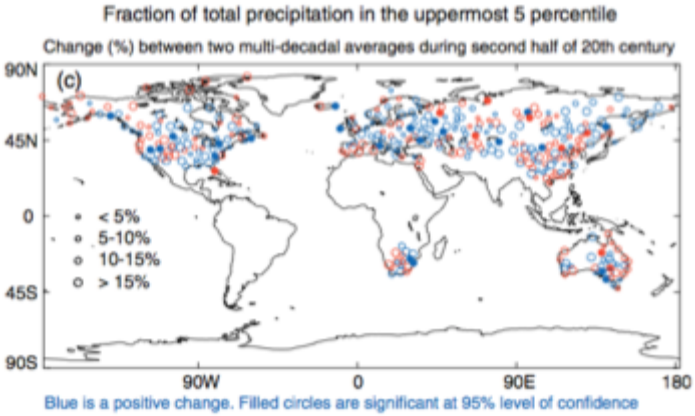
GPCC

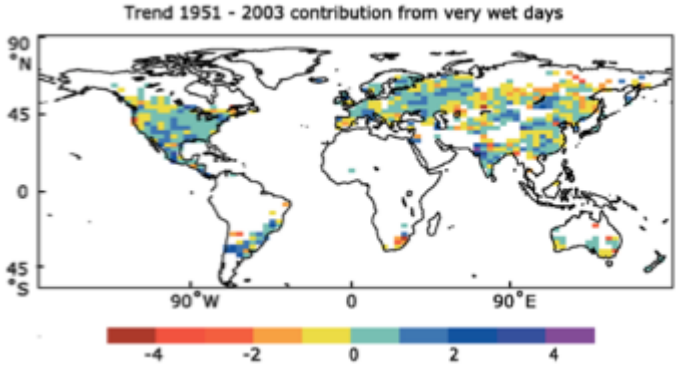
Scaling issue with HadEX2 and GHCNDEX

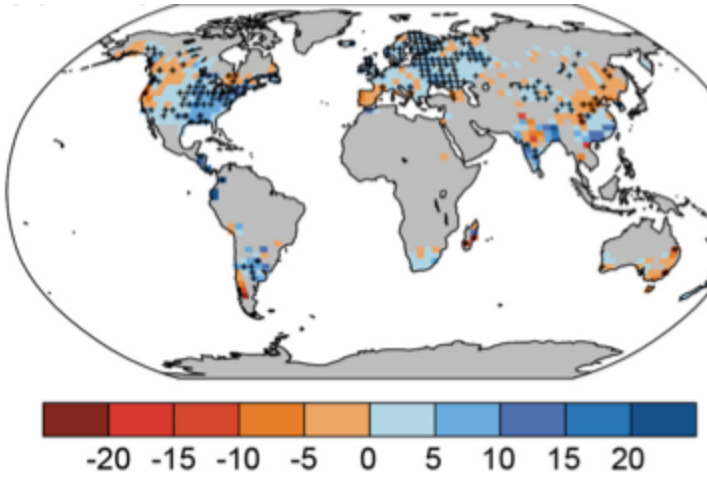
Herold et al. 2016, GRL

Masked to where all datasets have data

IPCC assessments – data improvements?







Big gains for small coordination effort between in situ, remote sensing, reanalysis communities

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Workshop on Understanding, simulating and predicting extremes

Identified key issues in simulation of extremes

Distinguishing between small-scale extremes (heavy precipitation, wind) and large-scale extremes (droughts, heatwaves), which require different approaches

First planning for ExtremEX experiments

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ExtremEX experiment (theme Understand)

(coordination: S.I. Seneviratne, R. Vautard, O. Martius)

- **Investigation of 2010-2015 extremes**
- Sensitivity experiments assessing relative role of drivers:
  - **Atmospheric circulation patterns, sea surface temperatures, soil moisture**
  - Anthropogenic vs Pre-industrial conditions

ExtremEX experiment (theme Understand)

(coordination: S.I. Seneviratne, R. Vautard, O. Martius)

Participants (tbc):

- CESM (ETH), UKMO, MIROC, IPSL, HadGEM, CCCMA, ACCESS, EC-EARTH

Timeline:

- Planning: on-going
- Preliminary tests: until February 2016 (ETH, CESM)
- Simulations: March-December 2016
- Workshop: End of 2016, Paris

ExtremeX experiment

REFERENCE SIMULATIONS (2010-2015)

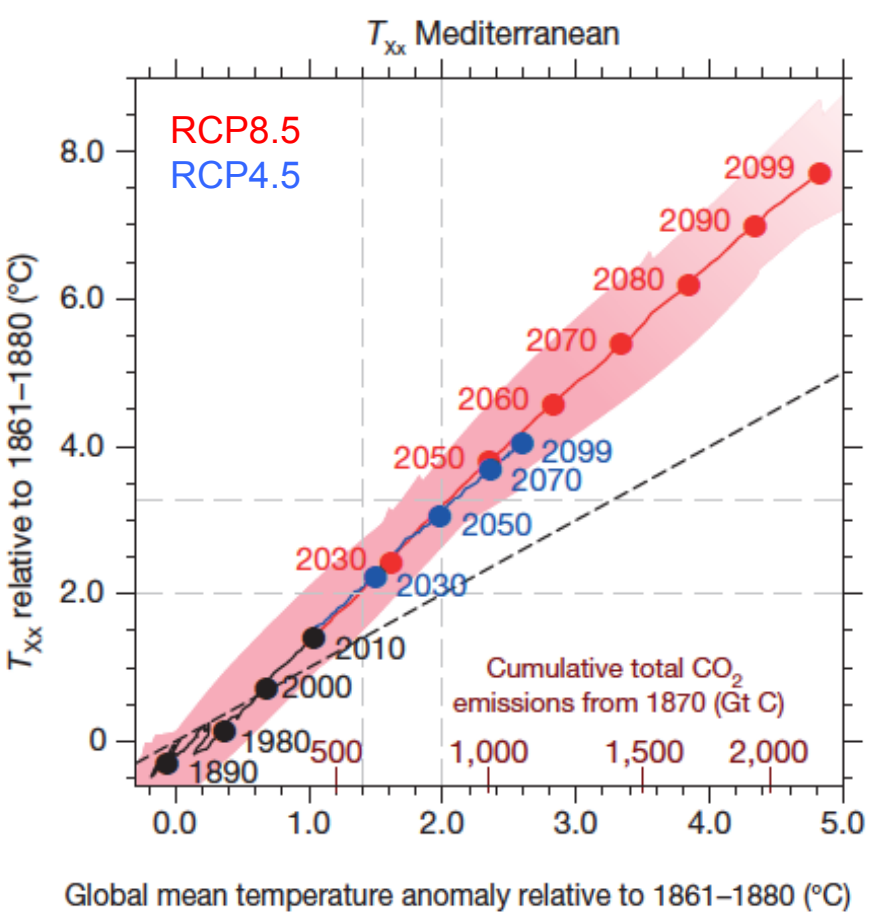
	REF_ATM	REF_SST	REF_SM
Atmospheric circulation	Prescribed ("obs", 2010-2015, ERA-interim)	Interactive	Interactive
Sea surface temperatures	Interactive (Initialization: Obs 01/2010)	Prescribed (obs, 2010-2015, HadSST)	Interactive (Initialization: Obs 01/2010)
Soil moisture	Interactive (Initialization: Obs 01/2010)	Interactive (Initialization: Obs 01/2010)	Prescribed ("obs", 2010-2015, obs-driven land surface model)
Sea ice	Interactive (Initialization: Obs 01/2010)	Prescribed (obs, 2010-2015, ?)	Interactive (Initialization: Obs 01/2010)
Greenhouse gases	Obs (2010-2015)	Obs (2010-2015)	Obs (2010-2015)
Number of ensemble members	3	15	15
Total number of simulation years	18	90	90

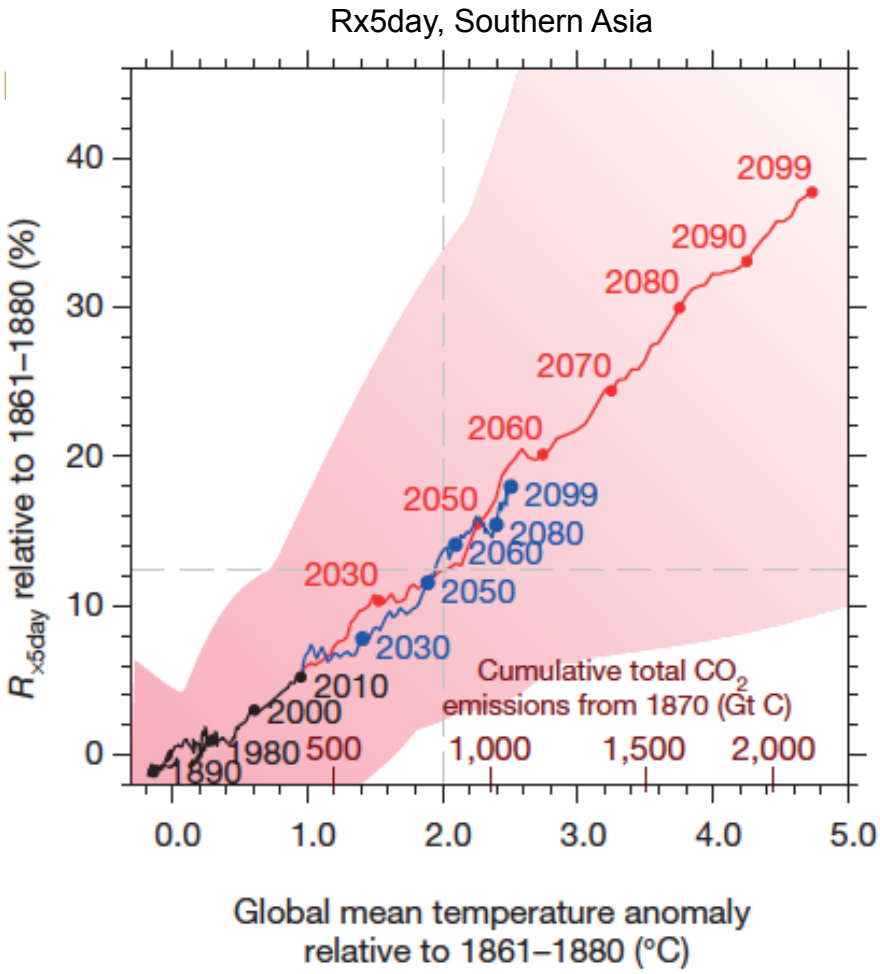
ExtremeX experiment

PRE-INDUSTRIAL SIMULATIONS

	PI_ATM	PI_SST	PI_SM
Atmospheric circulation	Prescribed ("obs", 2010-2015, ERA-interim)	Interactive	Interactive
Sea surface temperatures	Interactive (Initialization: "PI_SST" 01/2010)	Prescribed ("PI_SST", 2010-2015 = Obs-deltaSST)	Interactive (Initialization: "PI_SST" 01/2010)
Soil moisture	Interactive (Initialization: "PI_SM" 01/2010)	Interactive (Initialization: "PI_SM" 01/2010)	Prescribed ("PI_SM", 2010-2015: Obs-deltaSM)
Sea ice	Interactive (Initialization: "PI_SeaIce" 01/2010)	Prescribed ("PI_SeaIce" = Obs-deltaSeaIce)	Interactive (Initialization: "PI_SeaIce", 01/2010)
Greenhouse gases	PI	PI	PI
Number of ensemble members	3	15	15
Total number of simulation years	18	90	90

T° targets vs regional extremes





(Seneviratne et al. 2016, Nature)

Planned 2016 activities

2016: Planned workshops:

- Blocking, April 2016 (with SPARC) – 2.5K
- E3S conference Berlin – 1.5K
- Data Rescue workshop – 1.5K
- High-impact weather, Sep 2016 (with WWRP) – 2K
- 13th International Meeting on Statistical Climatology and Banff Statistics and D&A meeting, June 2016 – 5K
- ExtremeX workshop, December 2016 (Theme: Understand) – 5K

IDAG 2016: Paper writing meeting (overview article planned in high-impact journal; contact taken with Nature Geoscience) – 5K

- Total requested – 22.5K (without writing workshop funding 17.5K)

WCRP Open Science Conference on Extremes, 2018?

- A milestone for the climate research community to report their progress
- Major input for the 6th Assessment
- Overlap with other WCRP plans?

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Thank You

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