WCRP Grand Challenge
Understanding and Predicting Weather and Climate Extremes

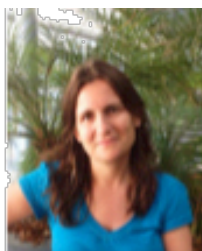**Lisa Alexander, Xuebin Zhang, Gabi Hegerl, Sonia Seneviratne**

Current Status

- Draft Implementation plan Dec. 2014 (still evolving)
  - 4 main extremes, 4 overarching themes
- Early successes
  - WCRP Summer School on Climate Extremes (Trieste, July 2014) and associated special issue
  - Data workshop (Sydney, Feb. 2015)
- A long list of activities (workshops, meetings, etc.) being coordinated
- Open Science Conference on Climate Extremes planned in 2018

4 main extremes, 4 overarching themes

Leads

Lisa Alexander   Ali Behrangi   Gabi Hegerl   Erich Fischer   Jana Sillmann

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

Sonia Seneviratne   Olivia Martius   Robert Vautard   Xuebin Zhang   Fredi Otto

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 land climate feedbacks
UNDERSTAND

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

Evaluate and improve models for simulations of extremes
SIMULATE/PREDICT

Early Successes:
WCRP-ICTP summer school

Summer School on Attribution and Prediction of Extreme Events

Trieste, Italy   21 July - 1 August 2014

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

A special issue published in "Weather and Climate Extremes"

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

"ExtremEX" simulation plan

(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

Participants (tbc):

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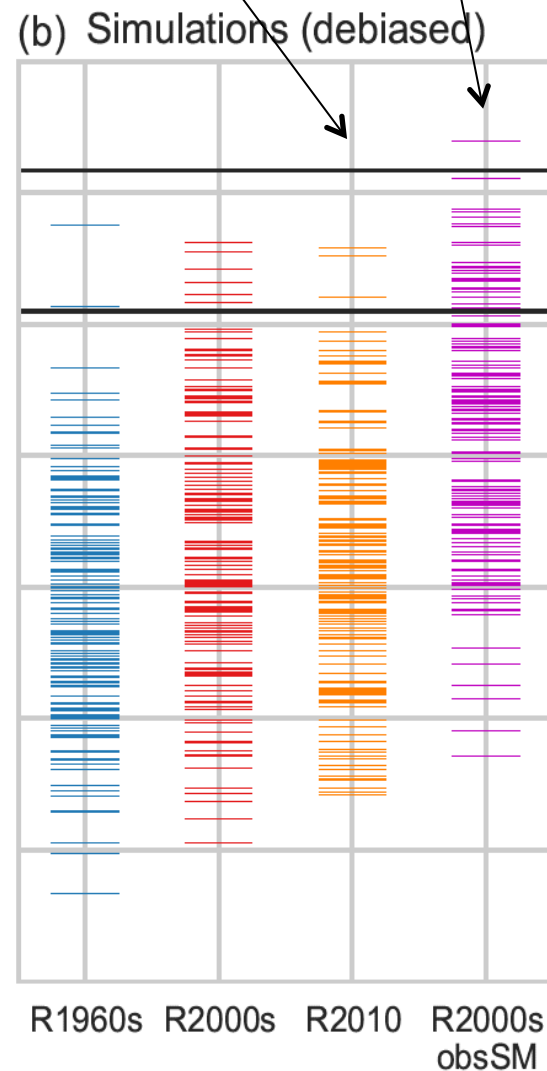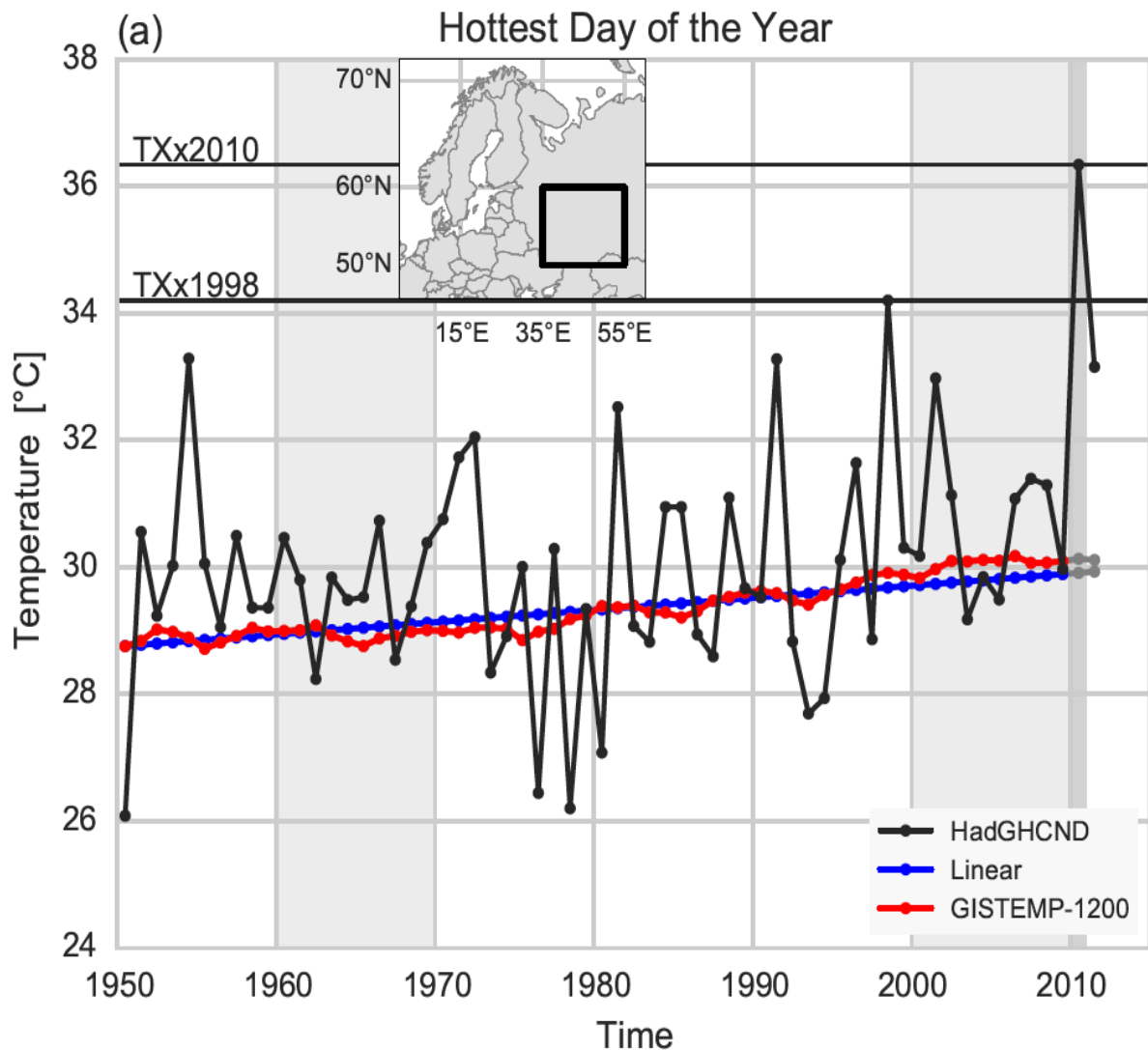
Timeline:

- Planning: on-going
- Preliminary tests: until dec 2015 (ETH, CESM)
- Simulations: Jan-May 2016
- Workshop: End of 2016, early 2017
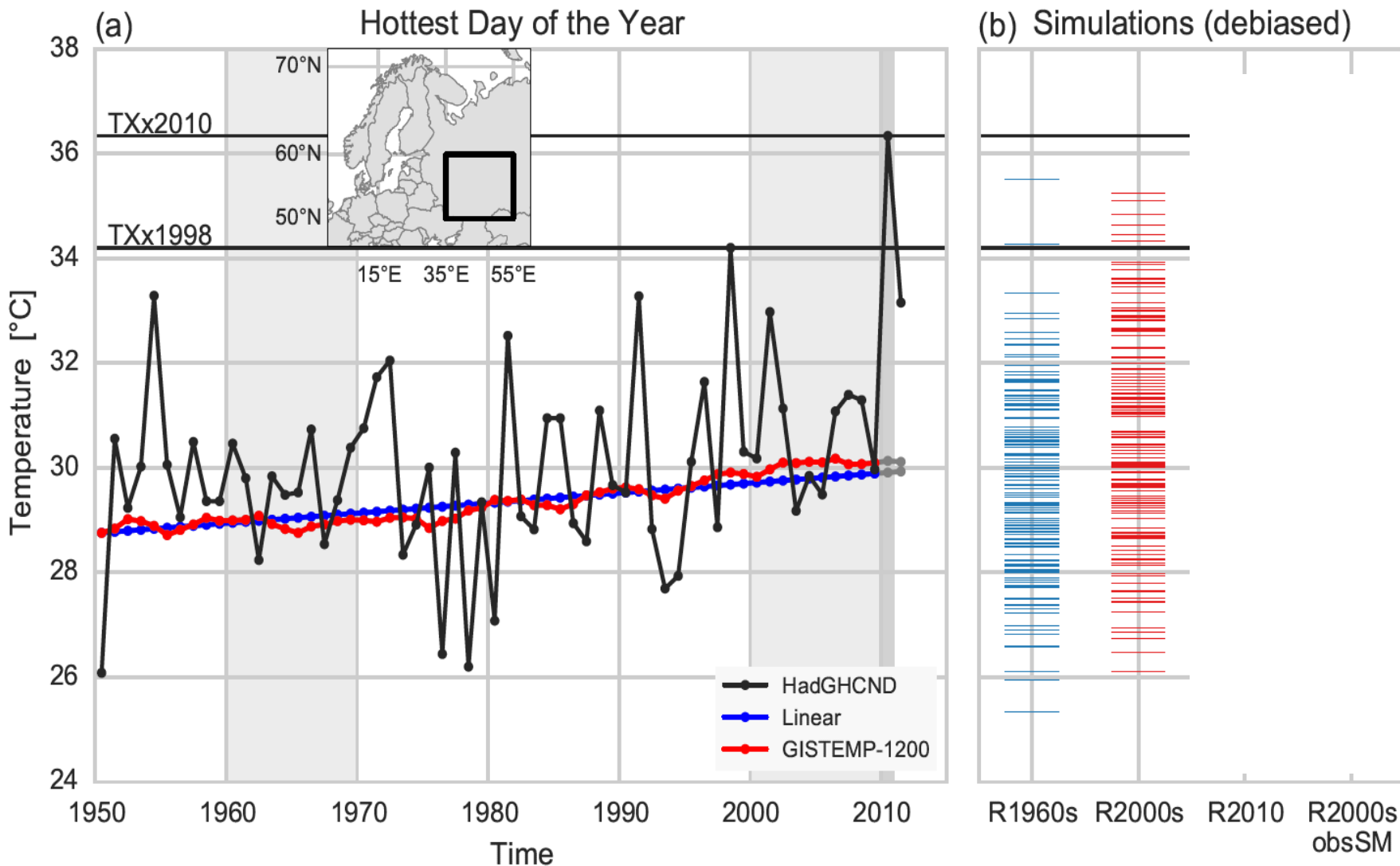
(Hauser et al., in prep.)

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Thank You

Workshops and Meetings: Bringing diverse communities together

- **M-CLIX workshop, Oslo Oct 2015: Process understanding, model validation**

Other events:

- GDIS drought workshop Pasadena Dec 2014
- IDAG meeting Jan 2015
- IUGG/M22 sessions, Prague Jun 2015
- EUCLEIA meeting, Paris Jul 2015: event attribution
- ETCCDI work planning meeting, Paris Jul 2015
- Swiss Climate Summer School on Extremes, Ascona Aug 2015
- Land modeling meeting, Zurich Oct 2015

Workshops and Meetings: Bringing diverse communities together

- High Impact Weather joint WCRP/WWRP (Columbia University, 2016): focus on TCs, ETCs and severe local storms

- 13th International Meeting on Statistical Climatology (Canmore, Jun 2016): major session on statistical analyses, methods/tools for extremes,

- "Uncertainty modeling in the analysis of weather, climate and hydrological extremes" (Banff, June 15-19 2016)

- **Modeling Workshop (TBA, 2016 or 2017): synthesizing results of first modeling experiments and dedicated analyses, and planned special issue and review article**

WCRP Open Science Conference on Extremes, 2018

- A milestone for the climate research community to report their progress

- Major input for the 6th Assessment

- Still some time to fill in Gap for the 6th Assessment

White paper: 8 key questions

1. Improved quality of ground-based and remote-sensing based datasets for extremes *(GEWEX: GHP and GDAP)*

2. Improved models for simulations of extremes *(WCRP-wide theme)*

3. Interactions between large-scale drivers and regional-scale land surface feedbacks affecting extremes *(GEWEX: GLASS)*

4. Role of external (e.g. anthropogenic) forcings vs internal variability for changes in intensity and frequency of extremes *(ETCCDI/IDAG/CLIVAR*

White paper: 8 key questions

5. Factors contributing to the risk of a particular observed event *(ACE/ETCCDI/IDAG/CLIVAR)*

6. Causes of drought changes in past and future *(GDIS/ GEWEX/CLIVAR)*

7. Predictability of changes in frequency and intensity of extremes at seasonal to decadal time *scales (WGSIP/ CLIVAR/GEWEX)*

8. Role of large-scale phenomena (monsoons, modes of variability) for past and future changes in extremes *(CLIVAR/GEWEX Monsoon panel)*
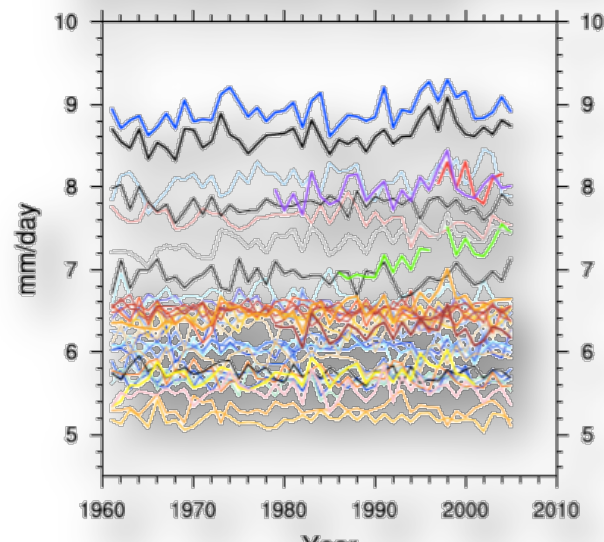
Document

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

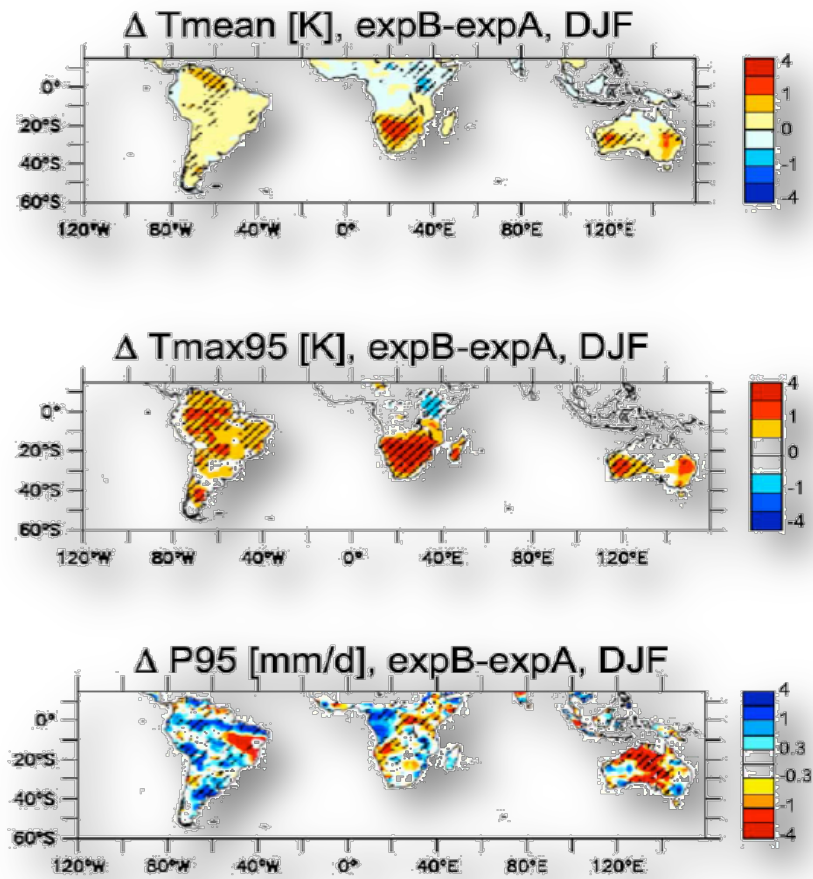**Sub-daily precip stations (HadISD) and SDII coverage (HadEX2)**
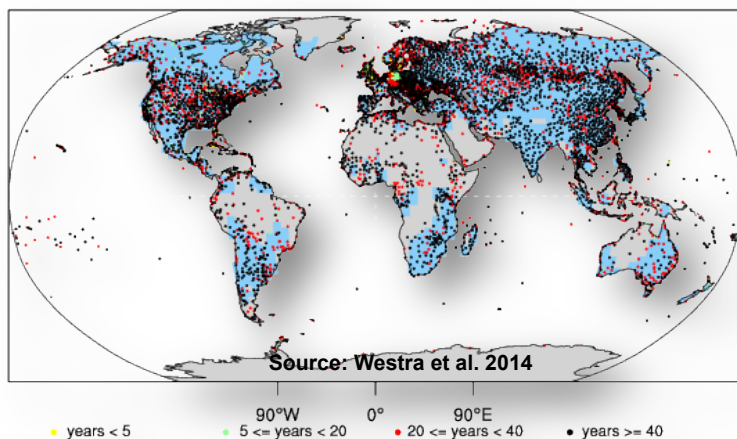
Source: Westra et al. 2014

Understand

Interaction between large-scale phenomena (weather types, modes of variability) and regional-scale 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
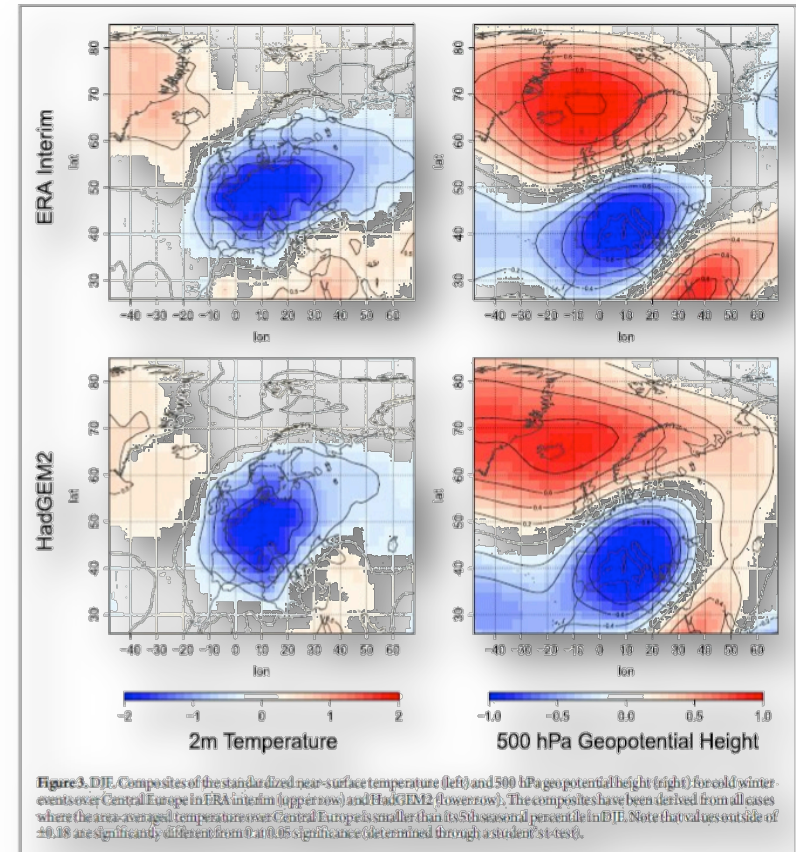
2013 Summer East China Heatwave
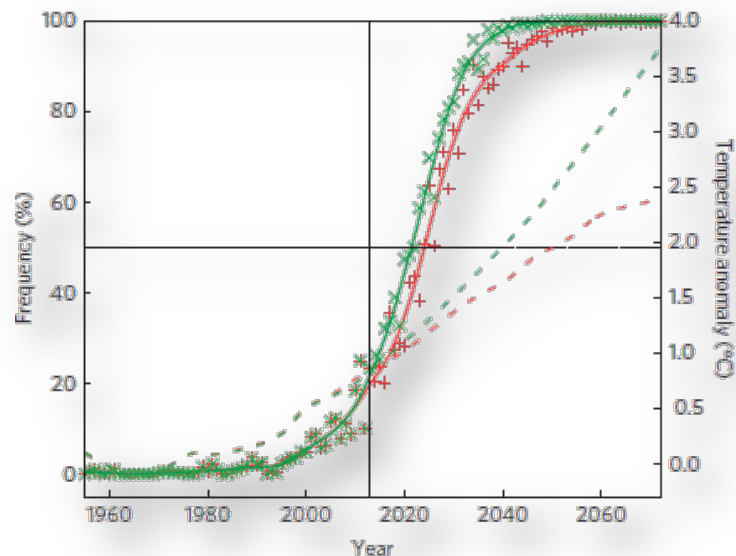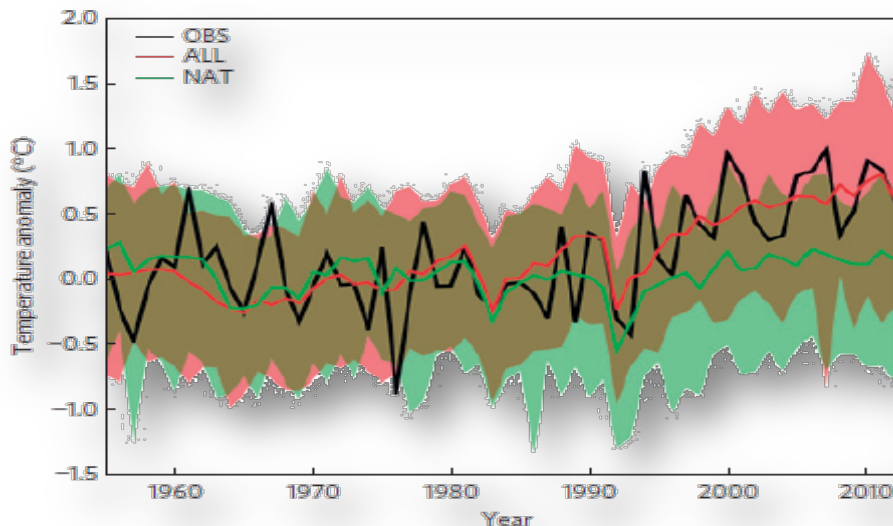
Simulate

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)

Figure 3. DJF. Composites of the standardized near-surface temperature (left) and 500 hPa geopotential height (right) for cold winter events over Central Europe in ERA interim (upper row) and HadGEM2 (lower row). The composites have been derived from all cases where the area-averaged temperature over Central Europe is smaller than its 5th seasonal percentile in DJF. Note that values outside of ±0.18 are significantly different from 0 at 0.05 significance (determined through a student's t-test).

Source: Krueger et al. 2015