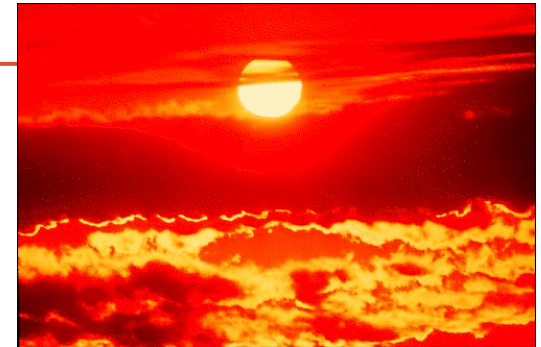
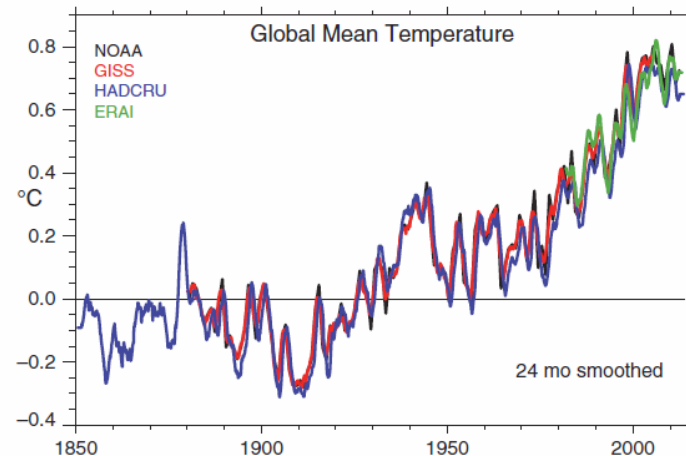


- Beyond the Mean -

Temperature extremes during the recent warming hiatus

Jana Sillmann (CICERO)





hi • a • tus

A gap or
interruption
in space, time,
or continuity

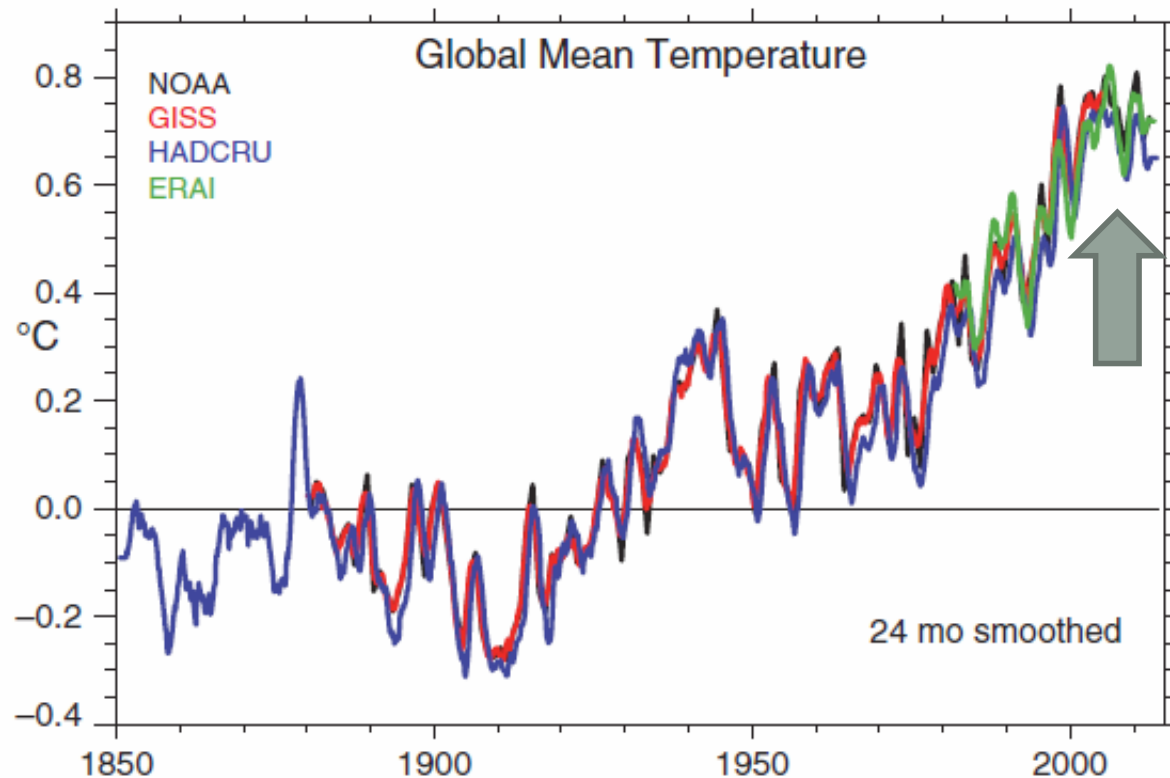
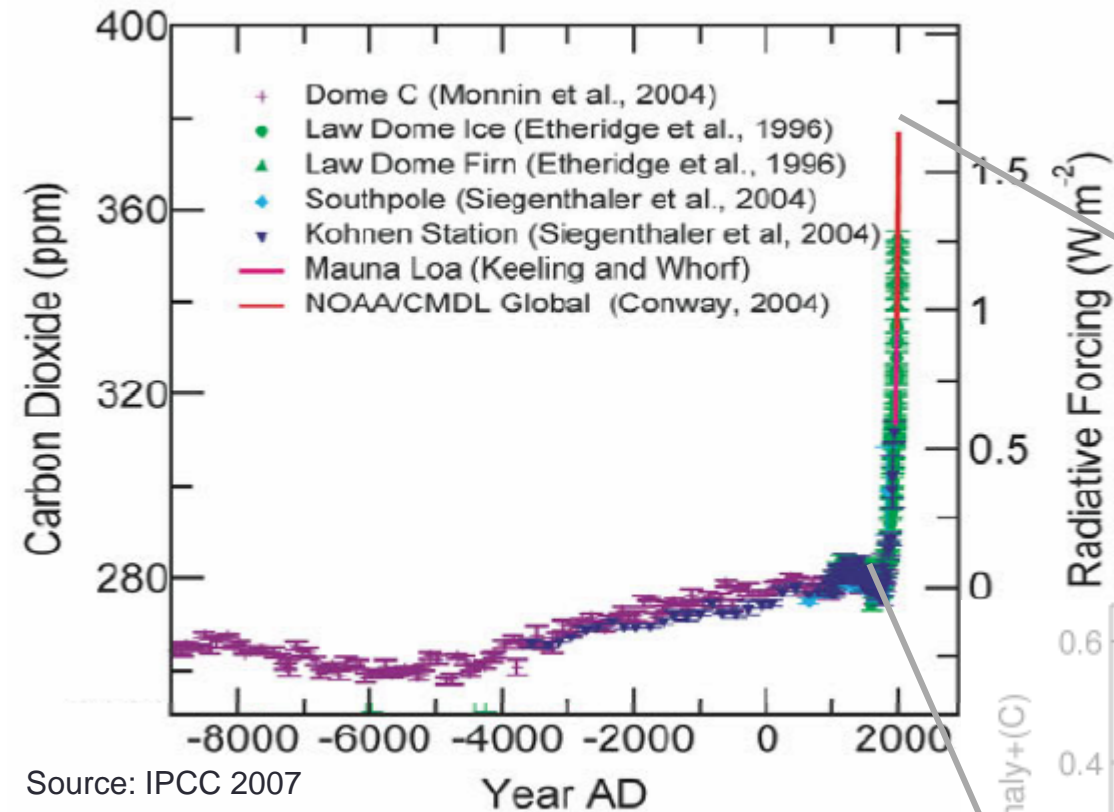


Figure 2. Global mean temperature time series as 24 month running means from several sources: NOAA NCDC, GISS, HADCRU3, and ERA-I. ERA-I was offset by 0.54°C. Here the base period is 1900–1949.

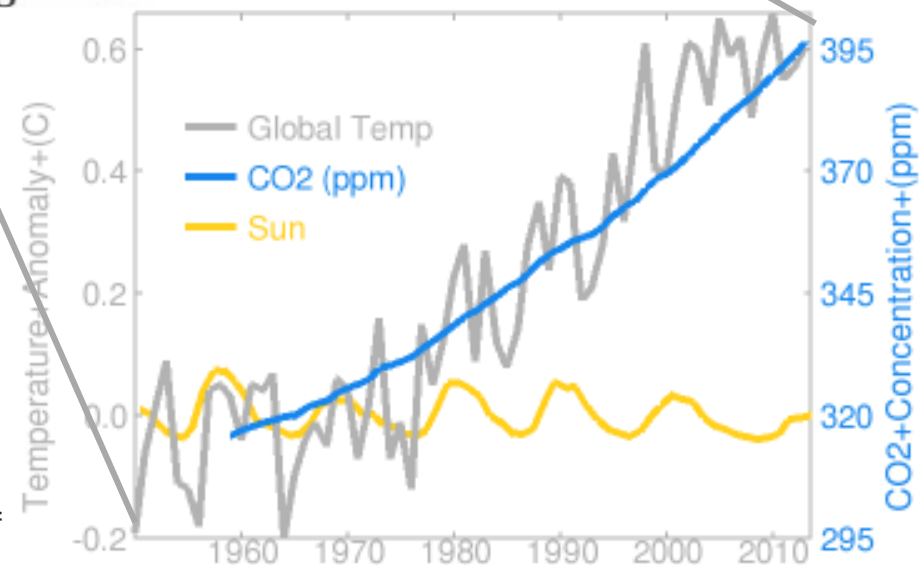
From Trenberth & Fasullo 2013, Earth's Future

Rise in CO₂ over last millennia



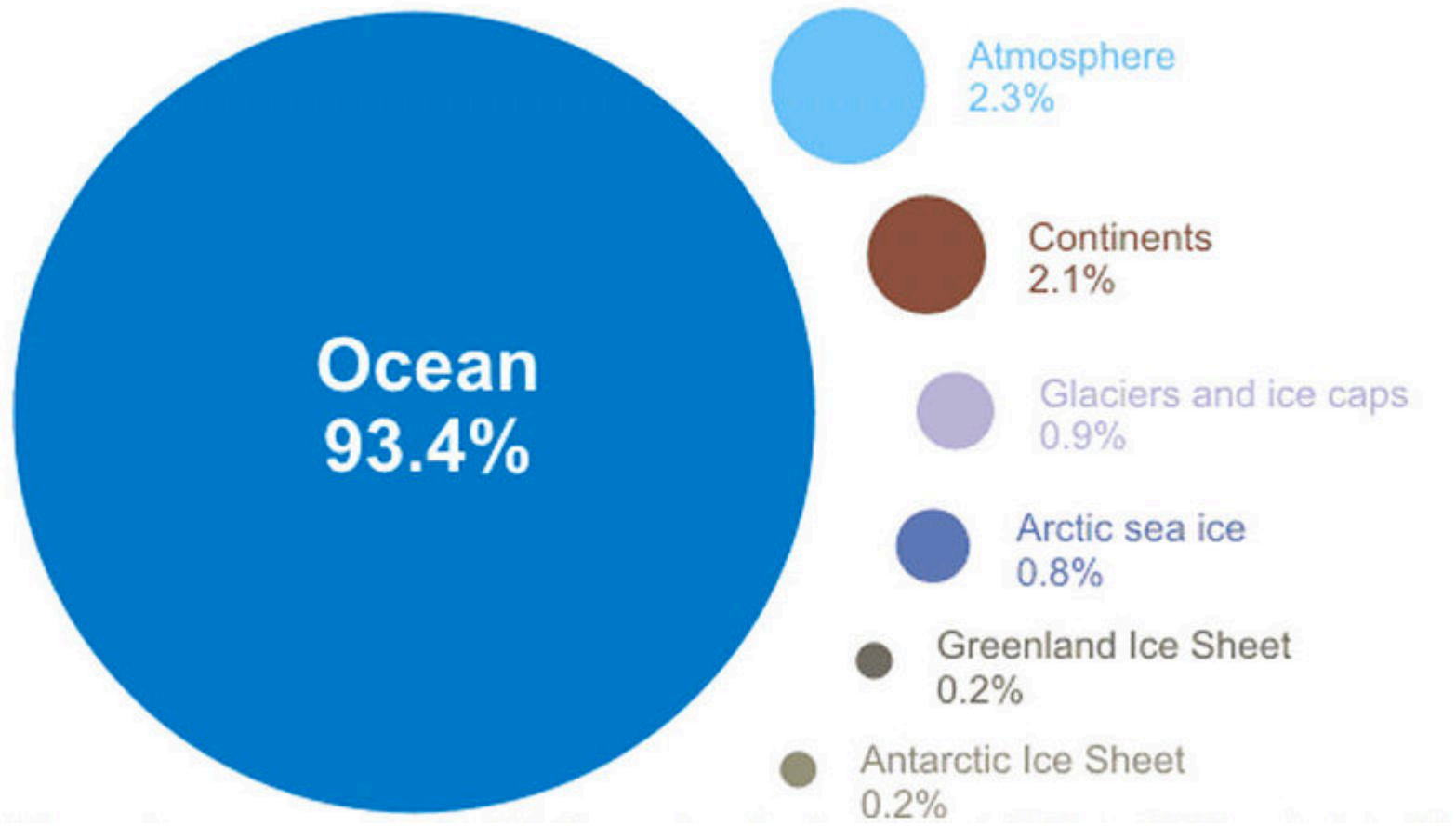
Source: IPCC 2007

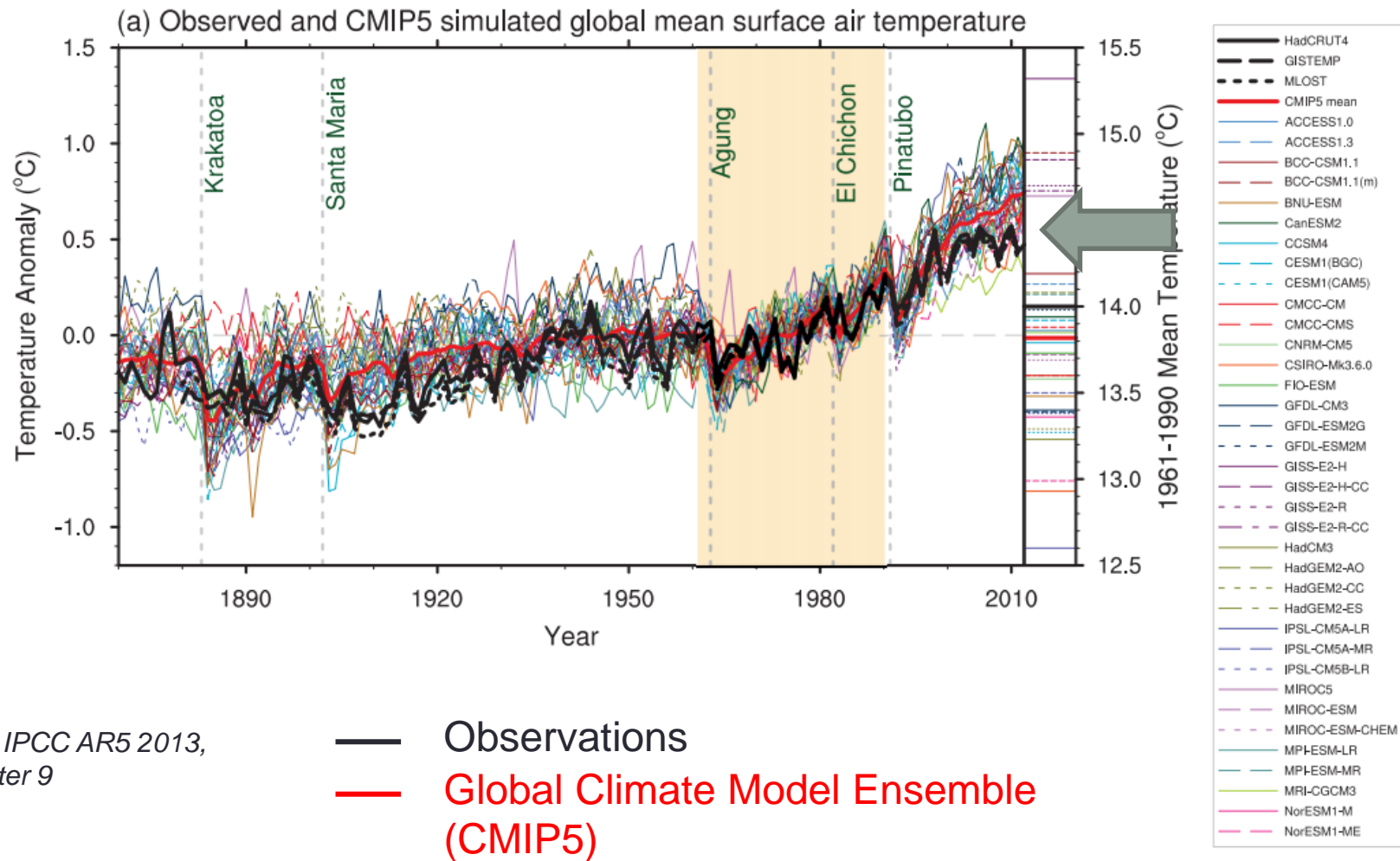
...and over last decades



Source: Stefan Rahmsdorf

Where is global warming going?





From IPCC AR5 2013,
Chapter 9

Extreme Events



What are climate extremes?

Rare events with high impact

What are climate extremes?

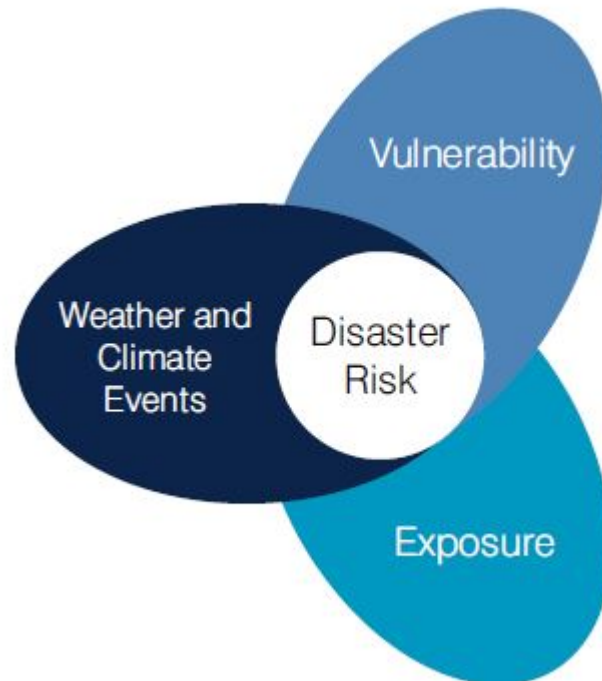
Rare events with high impact

Statistics of Extremes [*Gumbel* , 1954]:

"However big floods get, there will always be a bigger one coming"

What are climate extremes?

Rare events with **high impact**



Source: SREX 2012

The challenges with climate extremes

- Extreme events are rare in space and time
- Universally valid definitions
- Lack of observational data
- Scaling mismatch between observation and model output

Addressing challenges on a global scale ...

Climate Extremes Indices as defined by the WMO joint CCI/CLIVAR/JCOMM Expert Team on Climate Change Detection and Indices (ETCCDI)

- Statistically robust
- Globally valid
- Easy to understand

Examples: Frost days ($T_{\min} < 0^{\circ}\text{C}$)

Coldest night in a year (annual min. daily T_{\min})

Warmest day in a year (annual max. daily T_{\max})

Addressing challenges on a global scale ...

Climate Extremes Indices as defined by the WMO joint CCI/CLIVAR/JCOMM Expert Team on Climate Change Detection and Indices (ETCCDI)

Publicly available **data bases** for

Observations (HadEX2): www.climdex.org

Climate model simulations (ETCCDI indices archive):
<http://www.cccma.ec.gc.ca/data/climdex/>

Addressing challenges on a global scale ...

CLIMDEX

Datasets for Indices of Climate Extremes

MAIN MENU

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- [Climate Extremes Indices](#)
- [Datasets](#)
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- [CLIMDEX Software](#)
- [Development of CLIMDEX](#)
- [Project Team](#)
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CLIMDEX

www.climdex.org

frequency of warm days

View or download movie [[flv](#)] [[webm](#)] [[ogg](#)] [[mov](#)] [[mp4](#)] [[ipad-mp4](#)] [[avi](#)] [[wmv](#)]

The CLIMDEX project aims to produce a suite of *in situ* and gridded land-based global datasets of indices representing the more extreme aspects of climate. The project also aims to develop software tools to allow users to access the resulting datasets via a Web interface.

COMMENTARY:

No pause in the increase of hot temperature extremes

Sonia I. Seneviratne, Markus G. Donat, Brigitte Mueller and Lisa V. Alexander

Observational data show a continued increase of hot extremes over land during the so-called global warming hiatus. This tendency is greater for the most extreme events and thus more relevant for impacts than changes in global mean temperature.

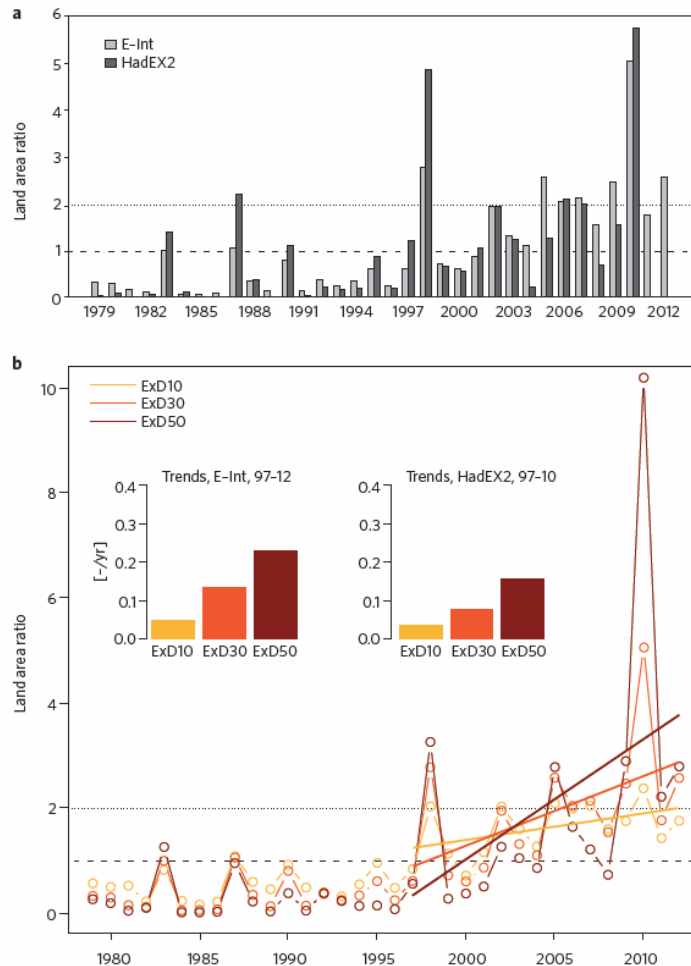


Figure 1 | Time series of land area affected by exceedance of hot temperature extremes. **a**, Ratio of land area affected by exceedances of 30 extreme warm days per year relative to the 1979-2010 average in ERA-Interim (E-Int, light grey) and HadEX2 (dark grey) datasets. The grey dashed line indicates a ratio of 1. The grey dotted line indicates a ratio of 2 (that is, a doubling of the affected area compared with the reference period). The Spearman correlation between the two time series over the time period 1979-2010 is 0.92. **b**, Time series of the ratio of land area affected by exceedances of 10, 30 and 50 extreme warm days per year relative to 1979-2010 average (ExD10, ExD30 and ExD50) in ERA-Interim (E-Int). The respective tendencies over the time period 1997-2012 are overlaid on the time series (trend lines) and displayed in the left panel of the inset plot. The corresponding values over 1997-2010 for HadEX2 are provided in the right panel of the inset plot. (See Supplementary Information for details.)

Addressing challenges on a global scale ...

Climate Extremes Indices as defined by the WMO joint CCI/CLIVAR/JCOMM Expert Team on Climate Change Detection and Indices (ETCCDI)

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Climate Extremes Indices as defined by the WMO joint CCI/CLIVAR/JCOMM Expert Team on Climate Change Detection and Indices (ETCCDI)

HadEX2 gridded observational dataset

Alexander et al. 2006, updated version by Donat et al. 2013 (www.climdex.org)

Reanalysis

ERA40 (Uppala et al. 2005)

ERAinterim (Dee et al. 2011)

NCEP/NCAR 1 (Kalnay et al. 1996)

NCEP/NCAR 2 (Kanamitsu et al. 2002)

Coupled Model Intercomparison Project Phase 3 and 5 (CMIP3 and CMIP5)

<http://cmip-pcmdi.llnl.gov/index.html>

CMIP3 (Meehl et al. 2007)

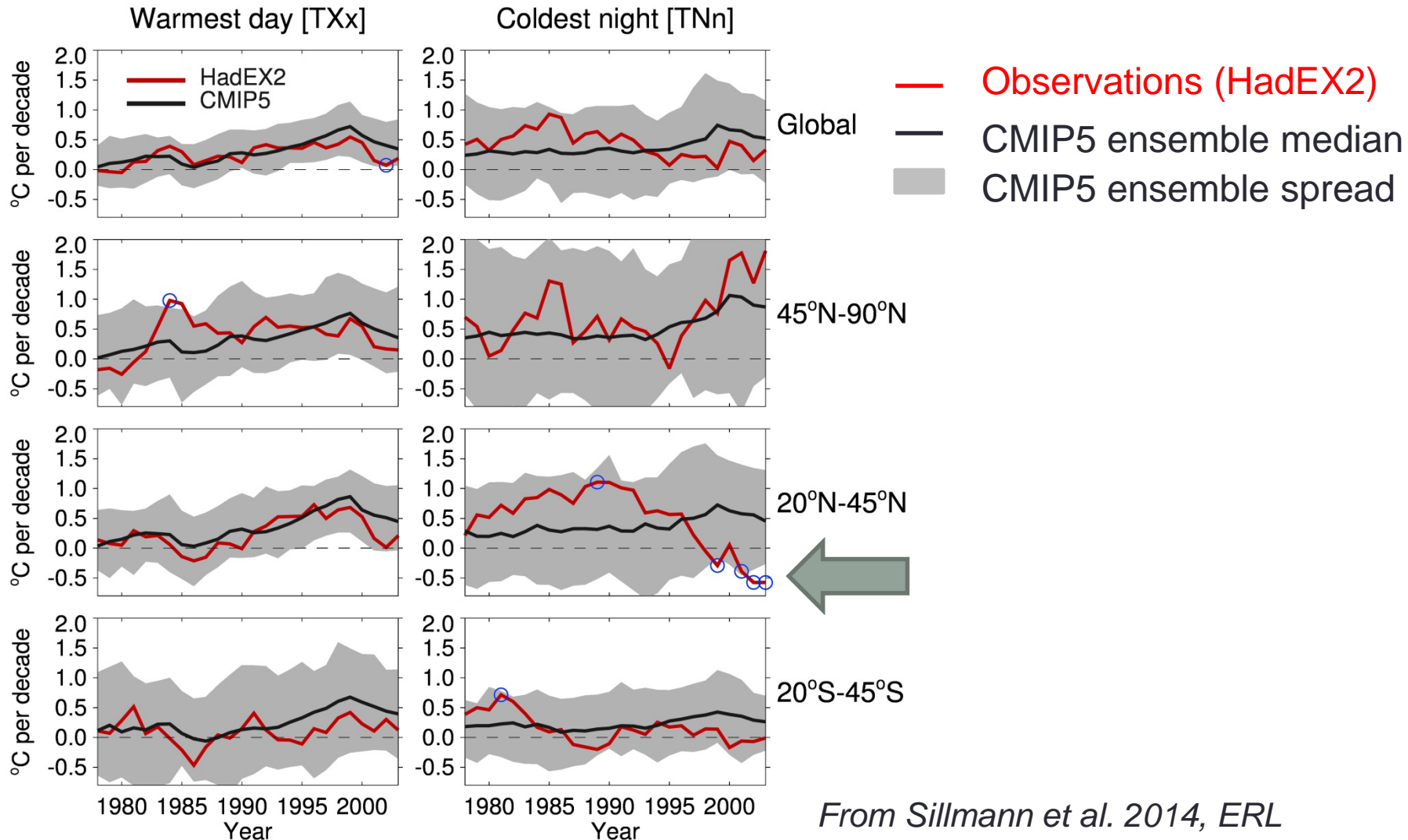
CMIP5 (Taylor et al. 2011)

indices  archive

<http://www.cccma.ec.gc.ca/data/climdex/index.shtml>

Sillmann et al. 2013 a, b JGR-Atmosphere

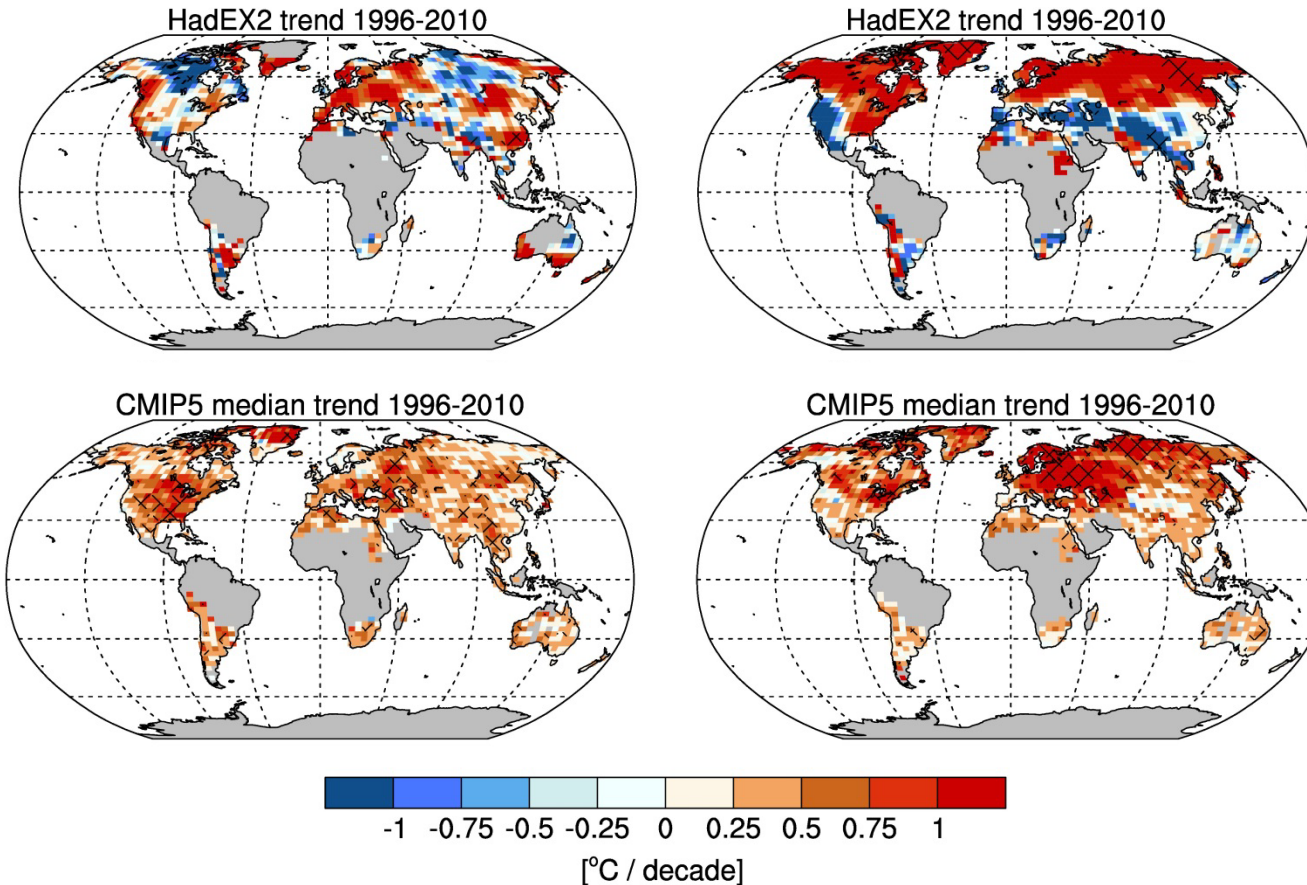
Are simulated trends consistent with observed trends?



From Sillmann et al. 2014, ERL

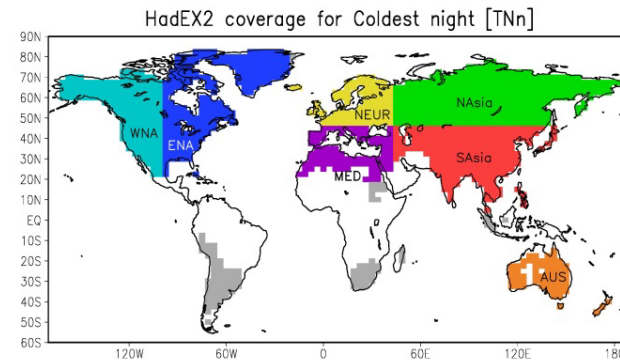
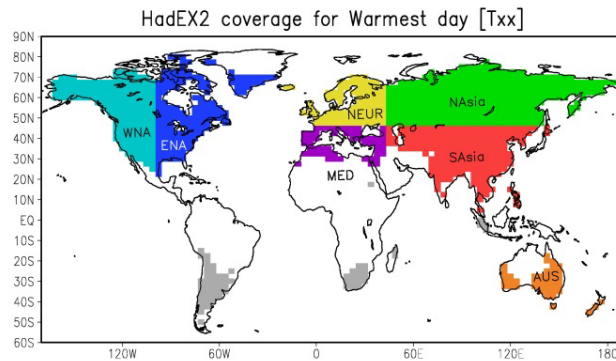
(a) Warmest day [TXx]

(b) Coldest night [TNn]

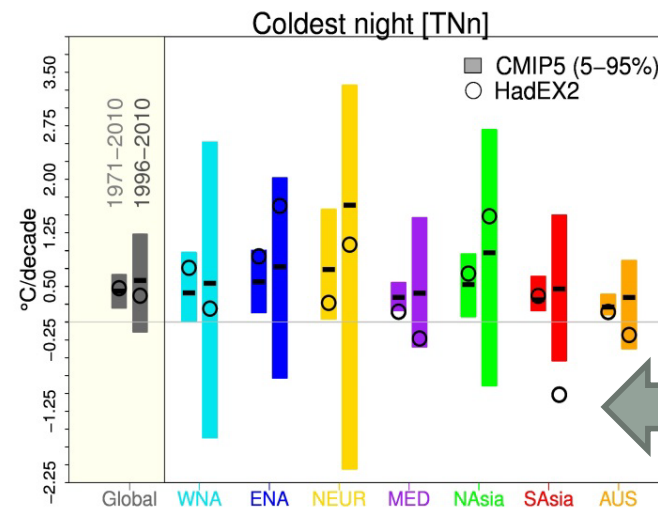
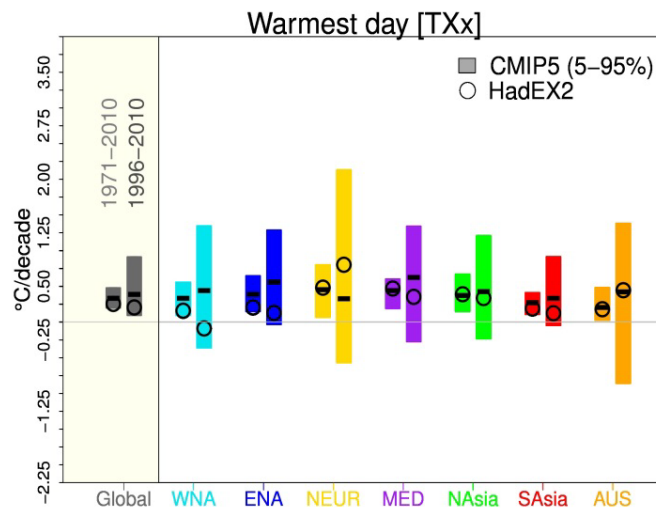


Are simulated trends consistent with observed trends?

(a)



(b)



A decade of weather extremes

Dim Coumou and Stefan Rahmstorf*

The ostensibly large number of recent extreme weather events has triggered intensive discussions, both in- and outside the scientific community, on whether they are related to global warming. Here, we review the evidence and argue that for some types of extreme — notably heatwaves, but also precipitation extremes — there is now strong evidence linking specific events or an increase in their numbers to the human influence on climate. For other types of extreme, such as storms, the available evidence is less conclusive, but based on observed trends and basic physical concepts it is nevertheless plausible to expect an increase.

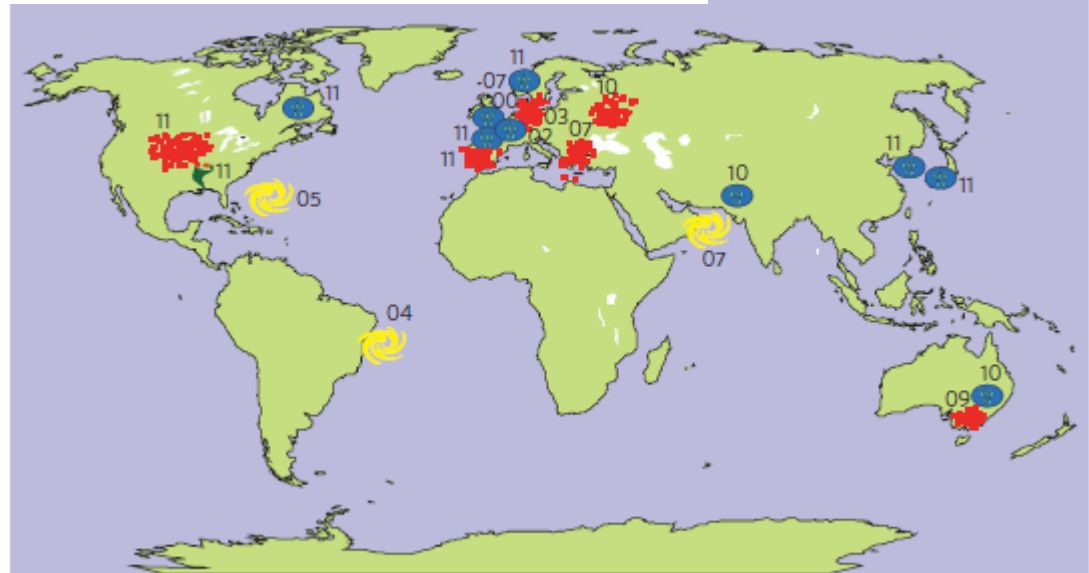
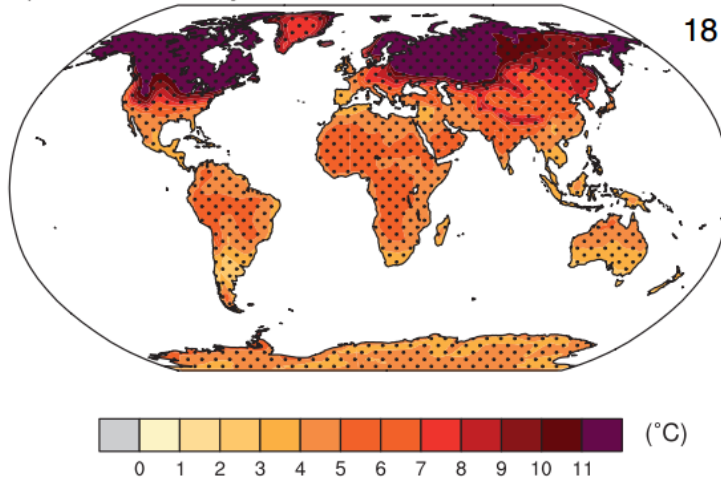


Figure 1 | World map showing the record extremes listed in Table 1.

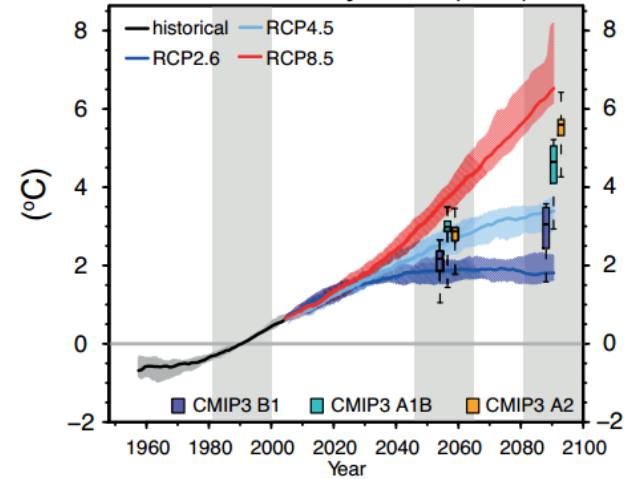
Long-term Climate Change: Projections, Commitments and Irreversibility

IPCC AR5 WGI (2013) Chapter 12, Figure 12.13

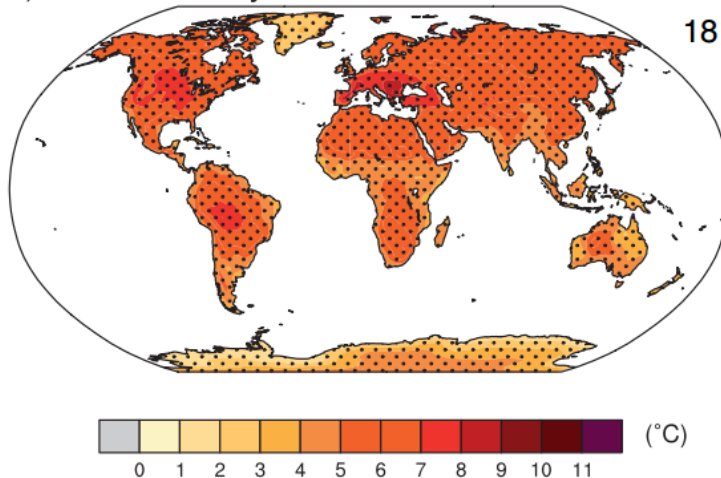
a) Coldest daily Tmin RCP8.5: 2081-2100



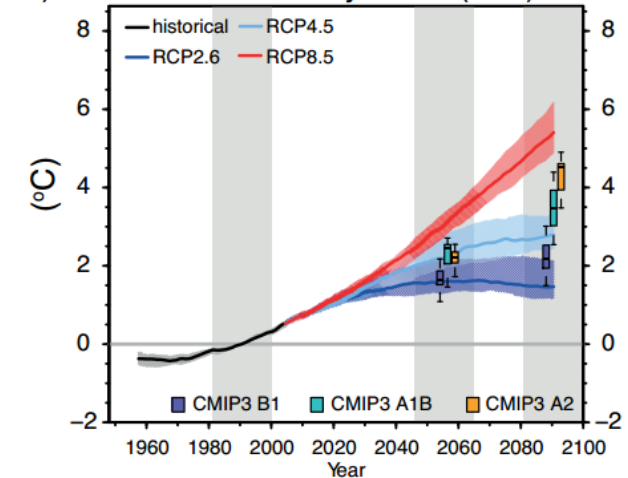
b) Coldest daily Tmin (TNn)



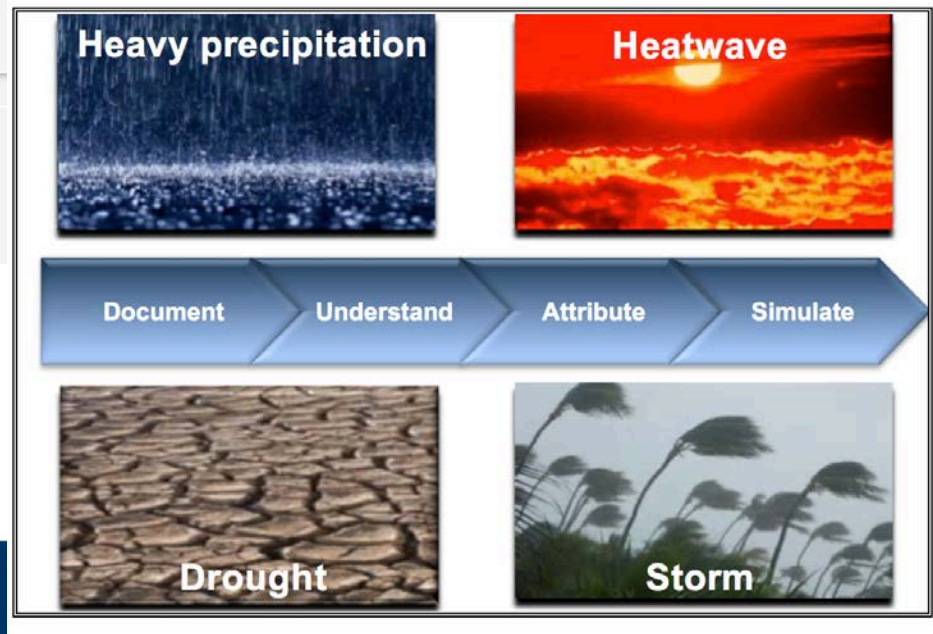
c) Warmest daily Tmax RCP8.5: 2081-2100

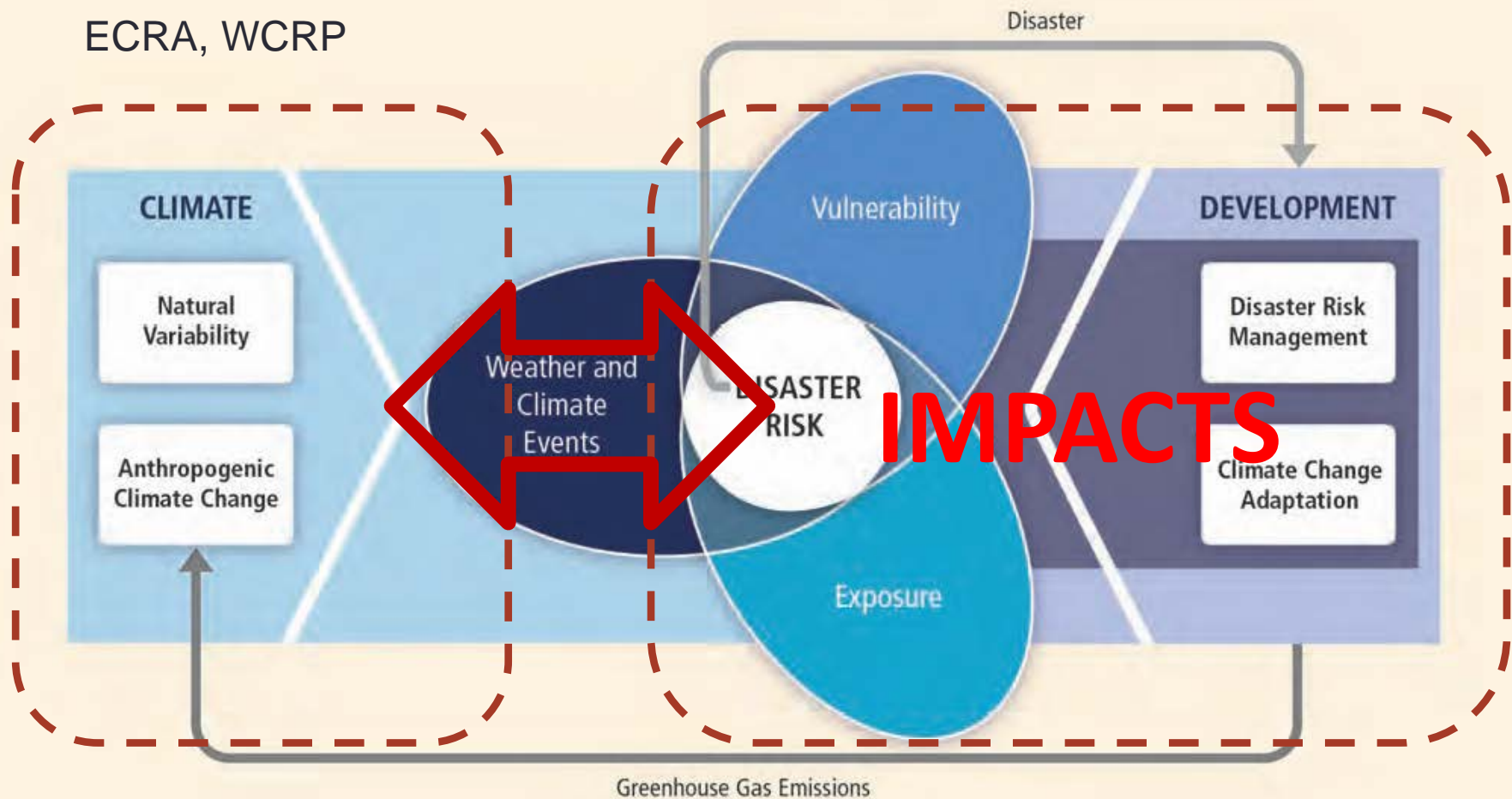


d) Warmest daily Tmax (TXx)



Understanding and Predicting Weather and Climate Extremes





THANK YOU!