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Characterising the current climate: No room for surprises left?

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Institute of Geography
University of Bern

ERA CLIM 2

EUSTACE

Future climate change

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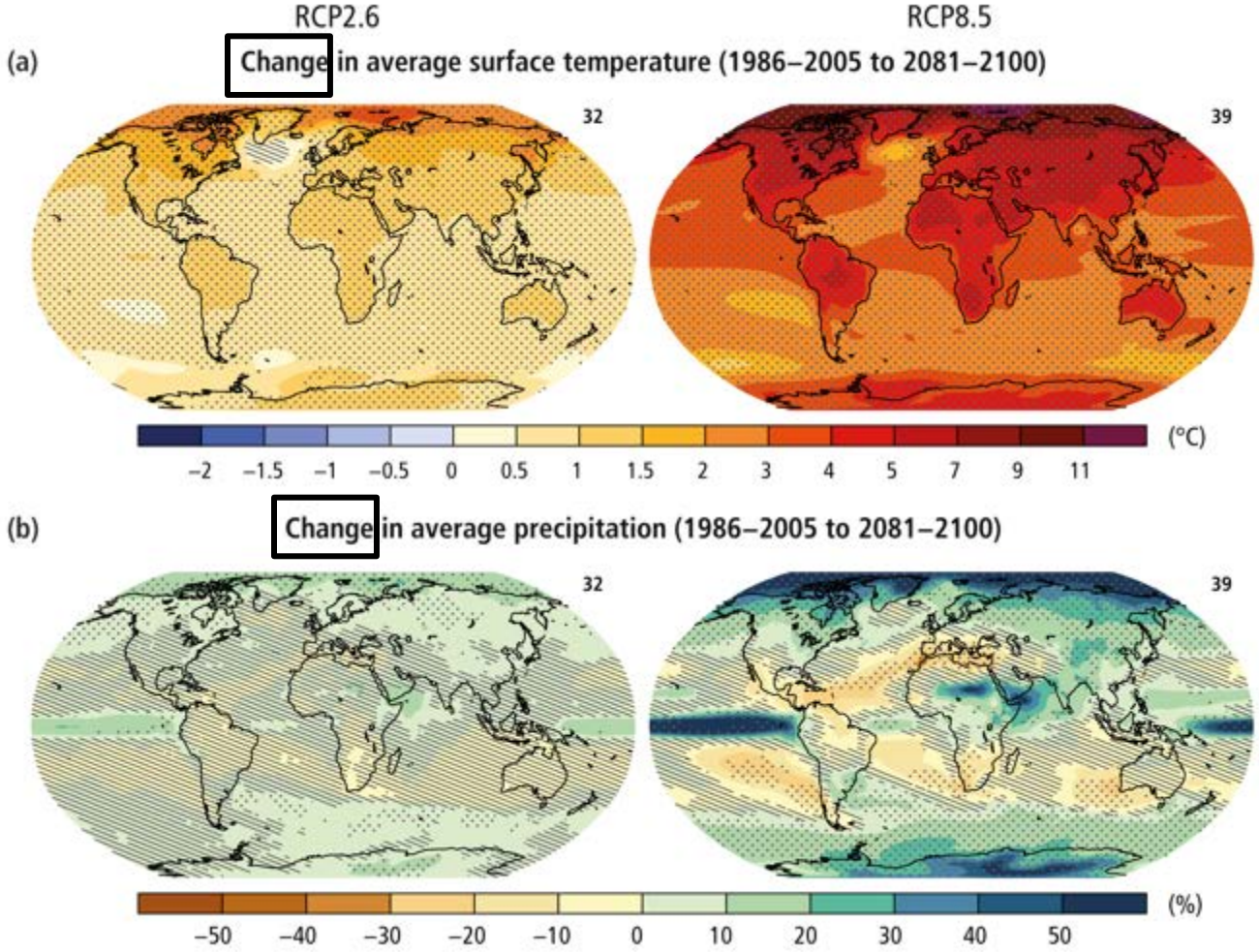

IPCC AR5

Change from what?

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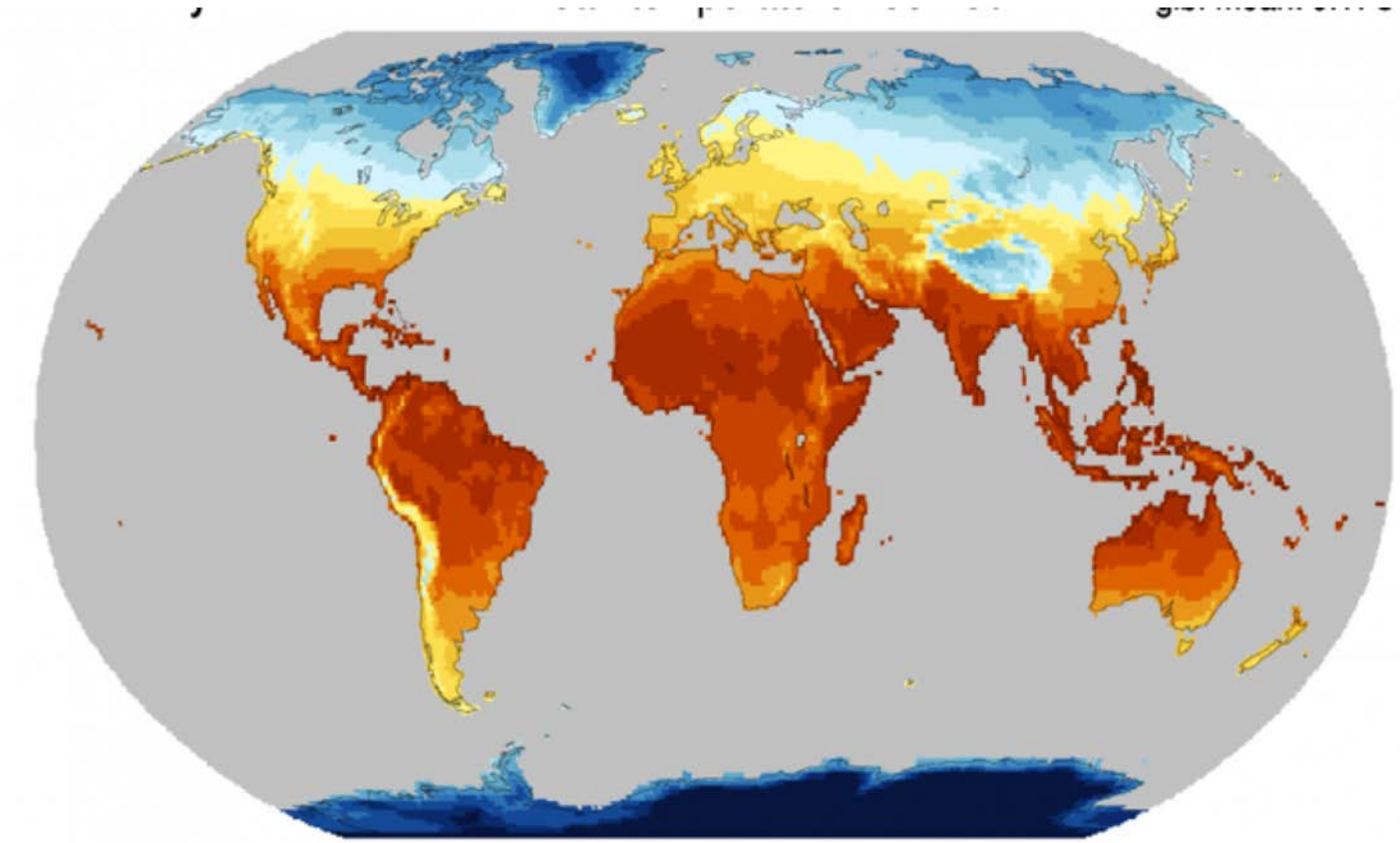
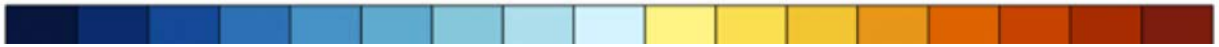


figure credit: National Center for Atmospheric Research, climatedataguide.ucar.edu (D. Schneider)



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Are we adapted to the current climate?

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How well do we know return periods?

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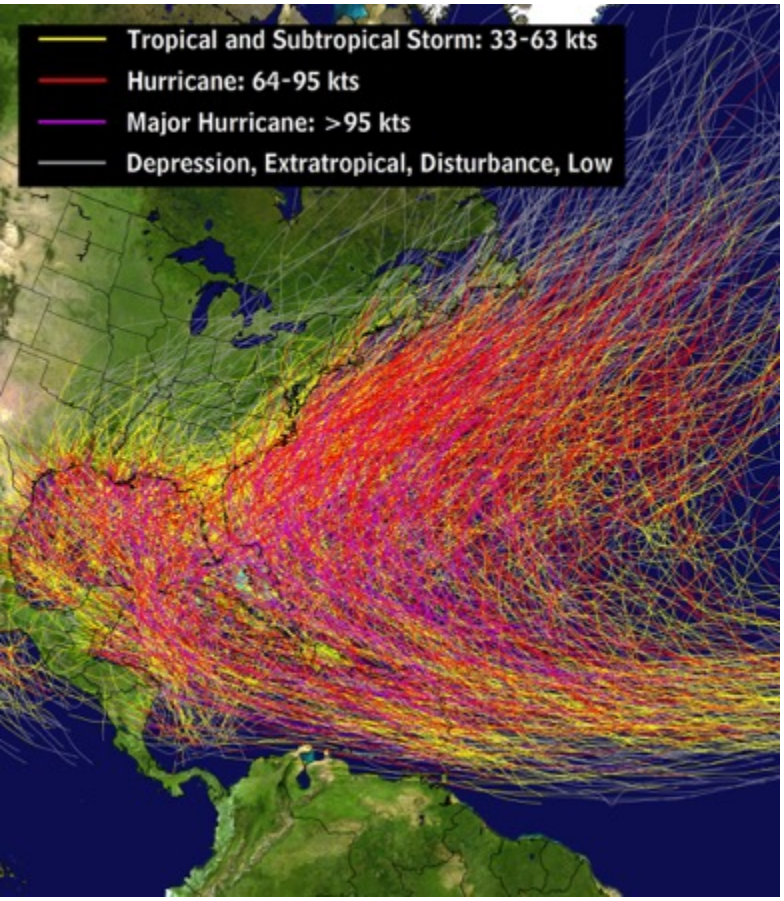

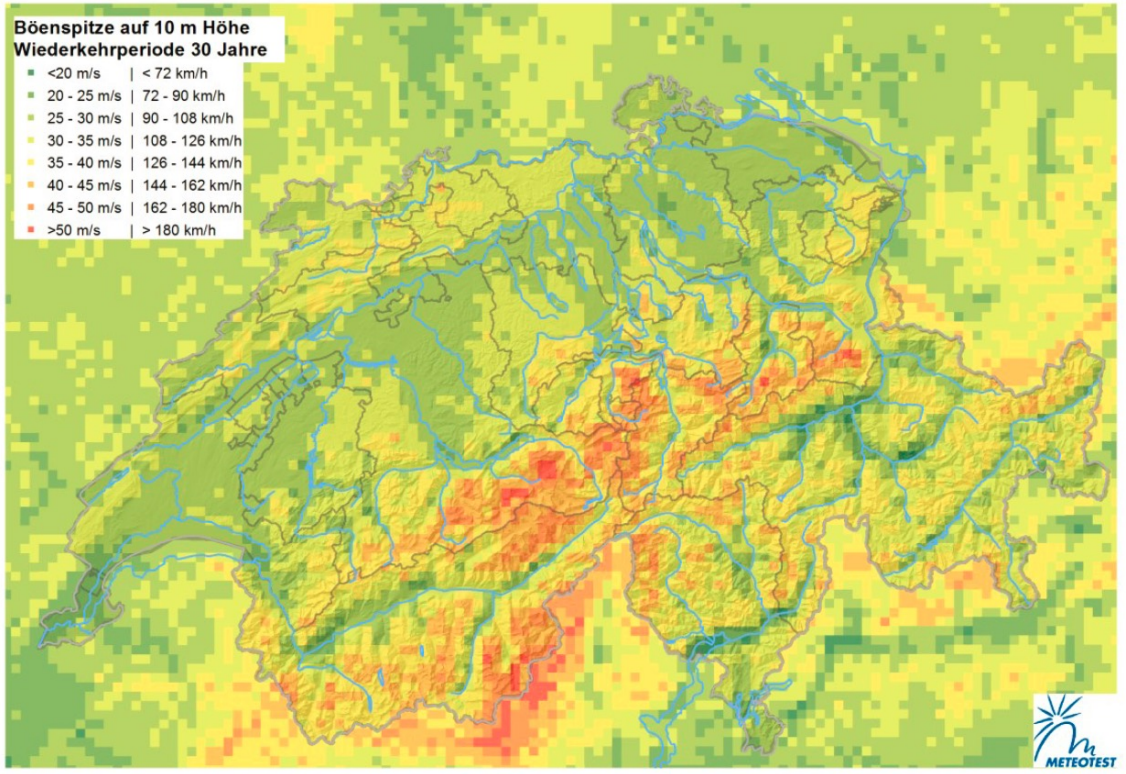

Dierer et al. 2013

Questions

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- So, how well can we characterize current climate?
- How well can we characterize changes over the instrumental period?
- How useful are reanalysis data?

How do we characterise current climate?

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Observations over time

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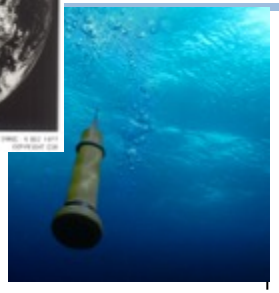

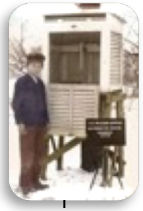

How do we characterise current climate?

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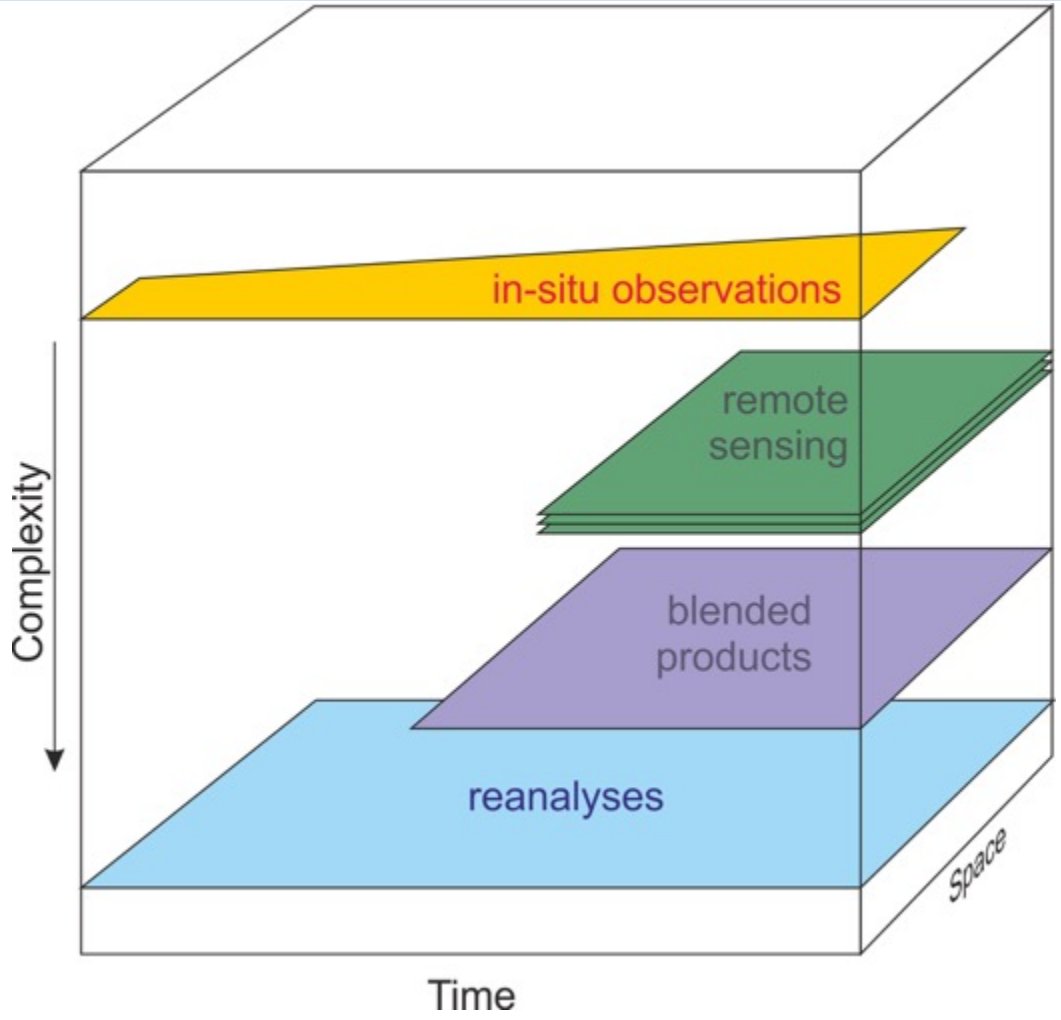

Reanalysis products

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Reanalysis	Observations	Assimilation method	Start year	Resolution at equator
NCEP/NCAR R1	All	Statistical Interpolation	1948	320 km
ERA-40	All	3D-Var	1957	125 km
JRA-25	All	3D-Var	1979	190 km
JRA-55	All	4D-Var	1957	60 km
MERRA	All	Gridpoint Statistical	1979	75 km
ME				km
ER				km
CFSR	All	3D-Var Spectral Statistical Interpolation	1979	50 km
20CR, Vers. 2c	Air pressure	Ensemble Kalman Filter	1851	320 km
ERA-20C	Air pressure, wind	4D-Var	1900	125 km
CERA-20C	Air pressure, wind, SST	4D-Var, 3D-Var	1901	125 km
ERA5	all	4D-Var	1950	31 km

Hugely successful
Approaching 50,000 citations

Temperature

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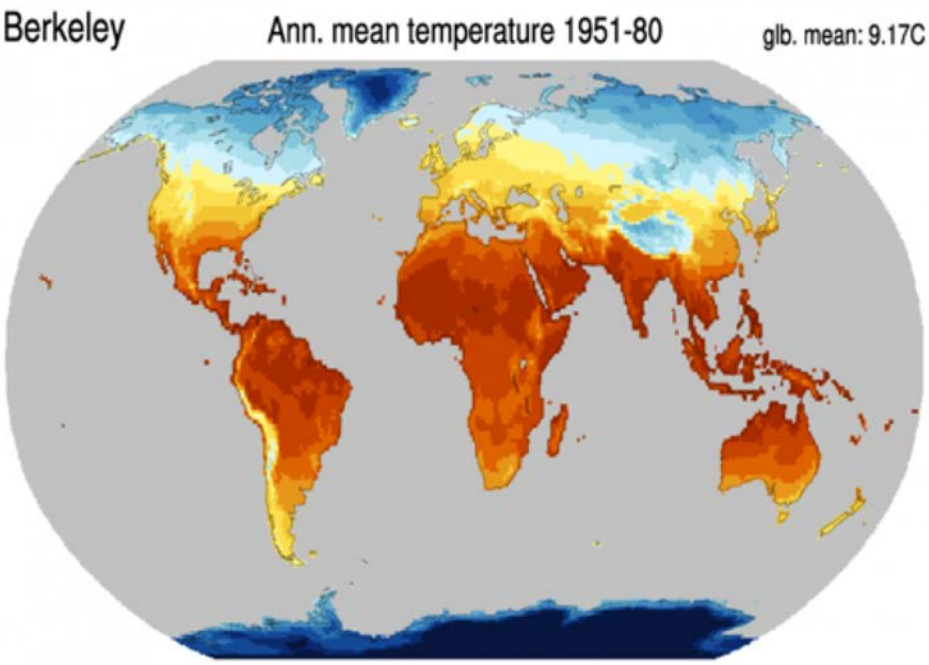

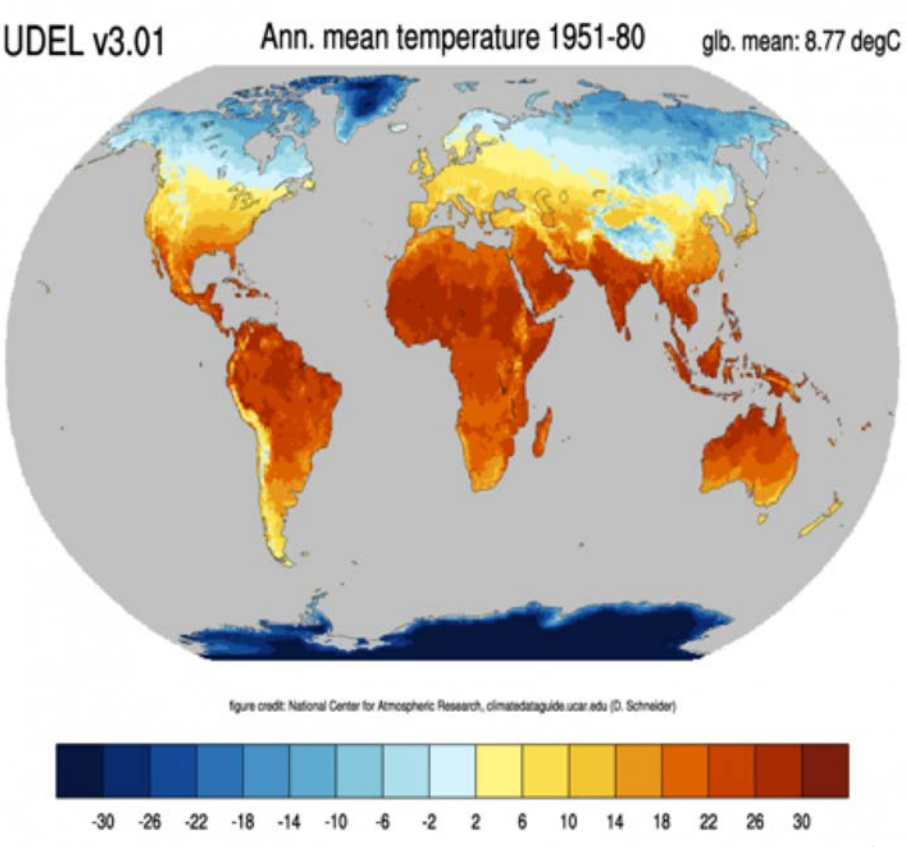

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Global Mean Temperature: Changes well depicted

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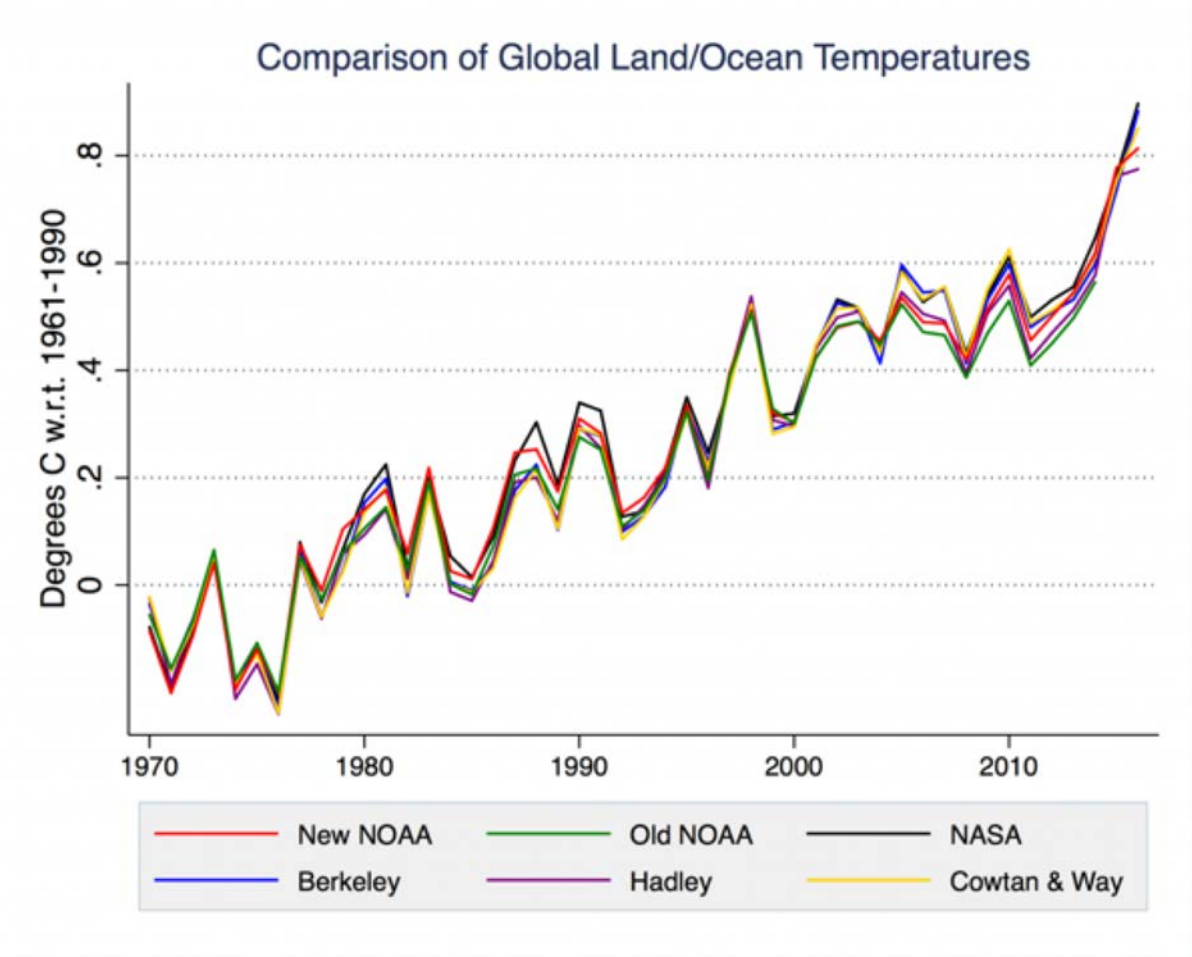
- Temperature



Global (land/ocean) temperature

Zeke Hausfather

Inhomogeneitities

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- Changes in instrument shelters
- Changes in measurement procedures
- Changes in locations

Quality issues?

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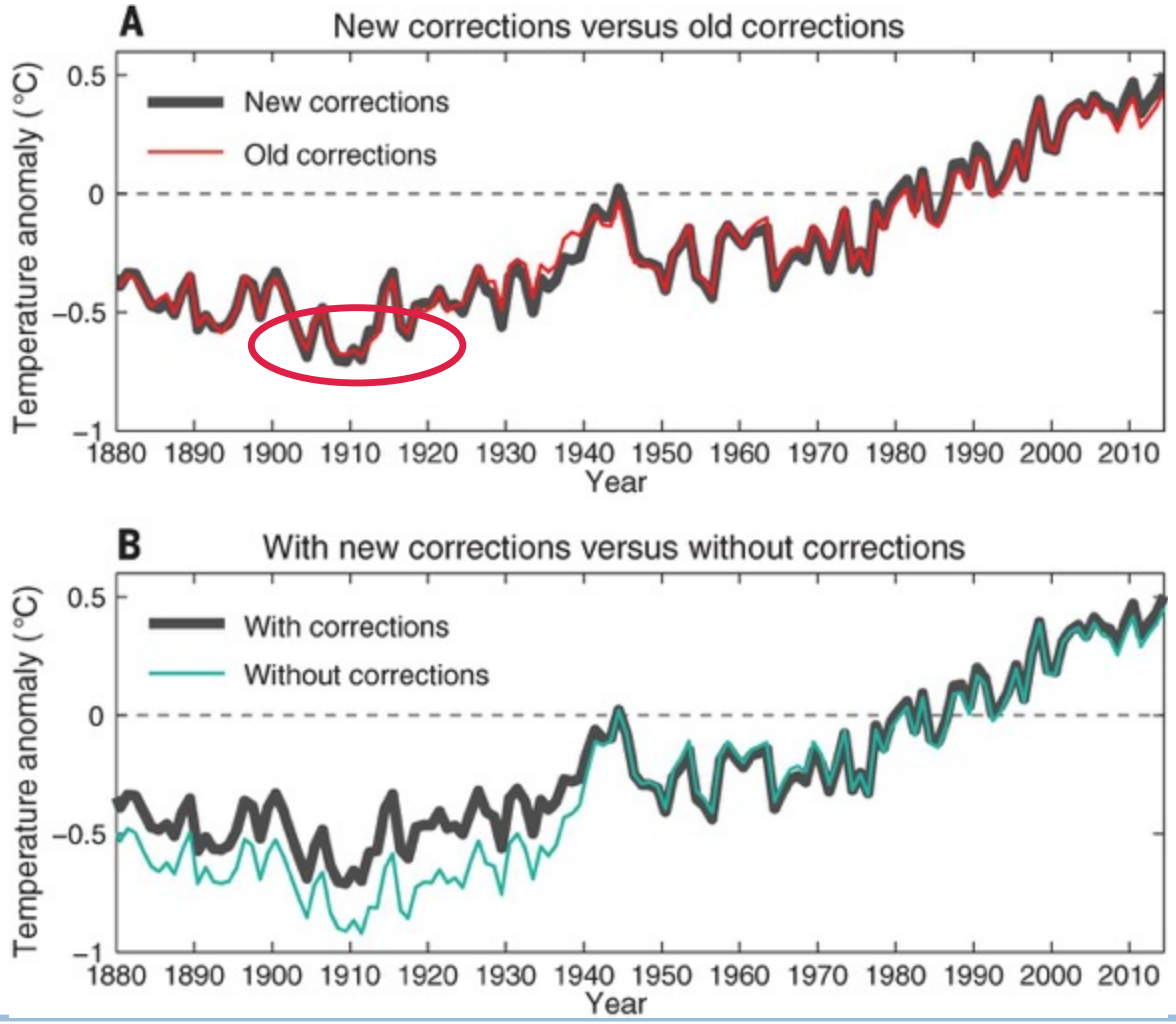

Global (land/ocean) temperature (Karl et al. 2016)

Surface temperature

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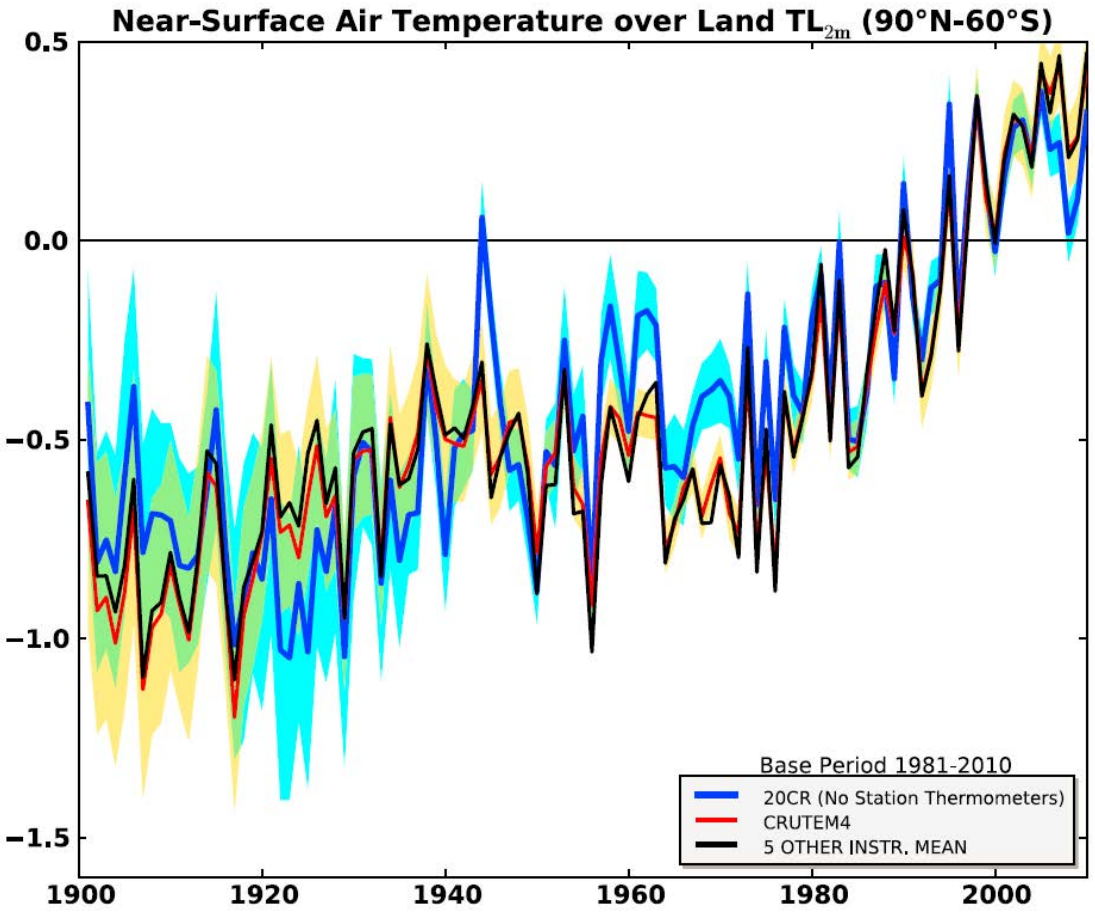
> Surface-only reanalyses reproduce temperature well



Compo et al. 2013

Surface temperature

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- How well can we characterize surface temperature?
  Increased understanding of uncertainties, gaps inevitable (e.g. over ice in the past)
- How well can we characterize temperature changes over the instrumental period?
  Good agreement since 1950s (little room for surprises)
- How well do reanalyses represent surface temperature?
  Good agreement since 1950s

100 hPa temperature

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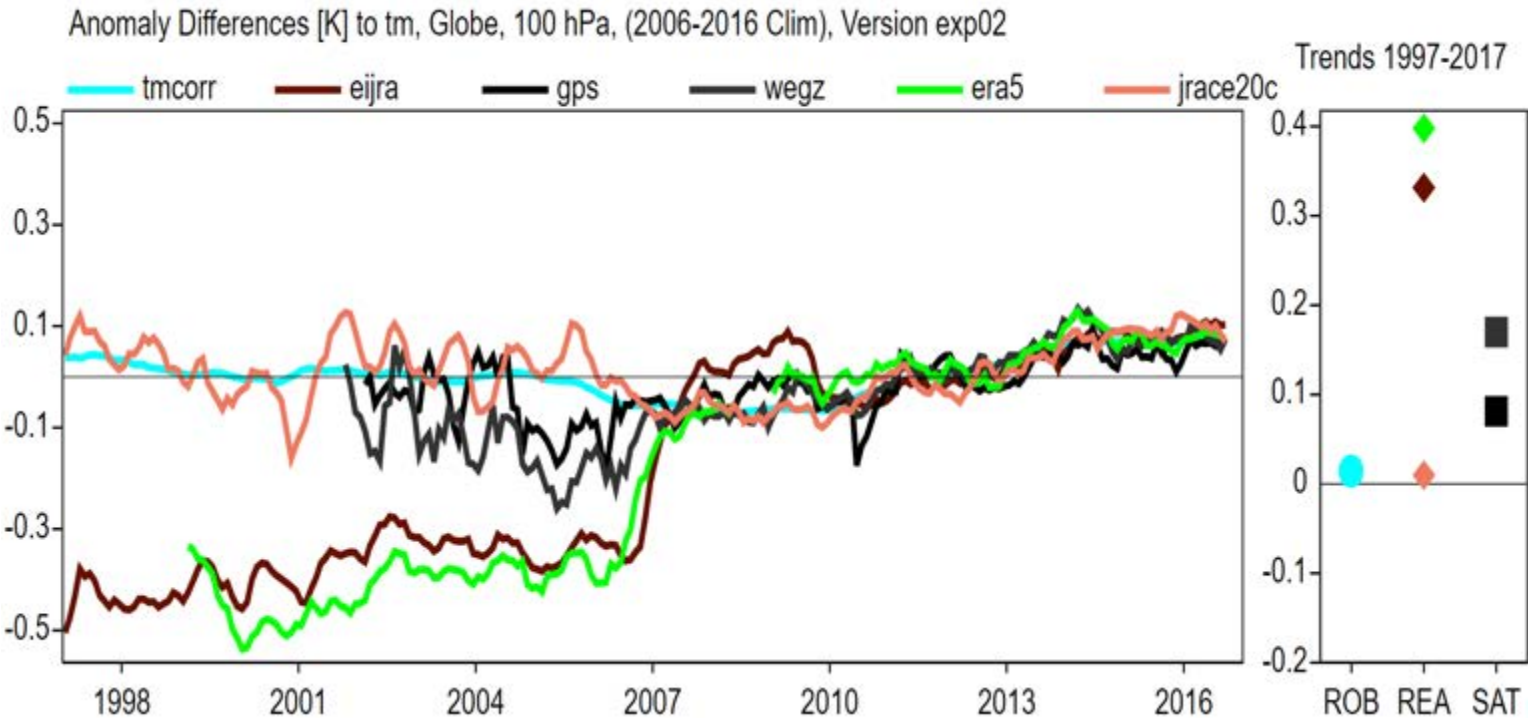

- GPS-Radio Occulation from CDAAC (Boulder) and Wegener Center (Graz)
- ERA-Interim cooler than CHAMP RO data until 2007, ERA5 has the same problem
- JRA55 slightly warmer than RO during CHAMP period
- Excellent agreement after 2007

Leo Hi berger

Precipitation: Mean 1981-2010

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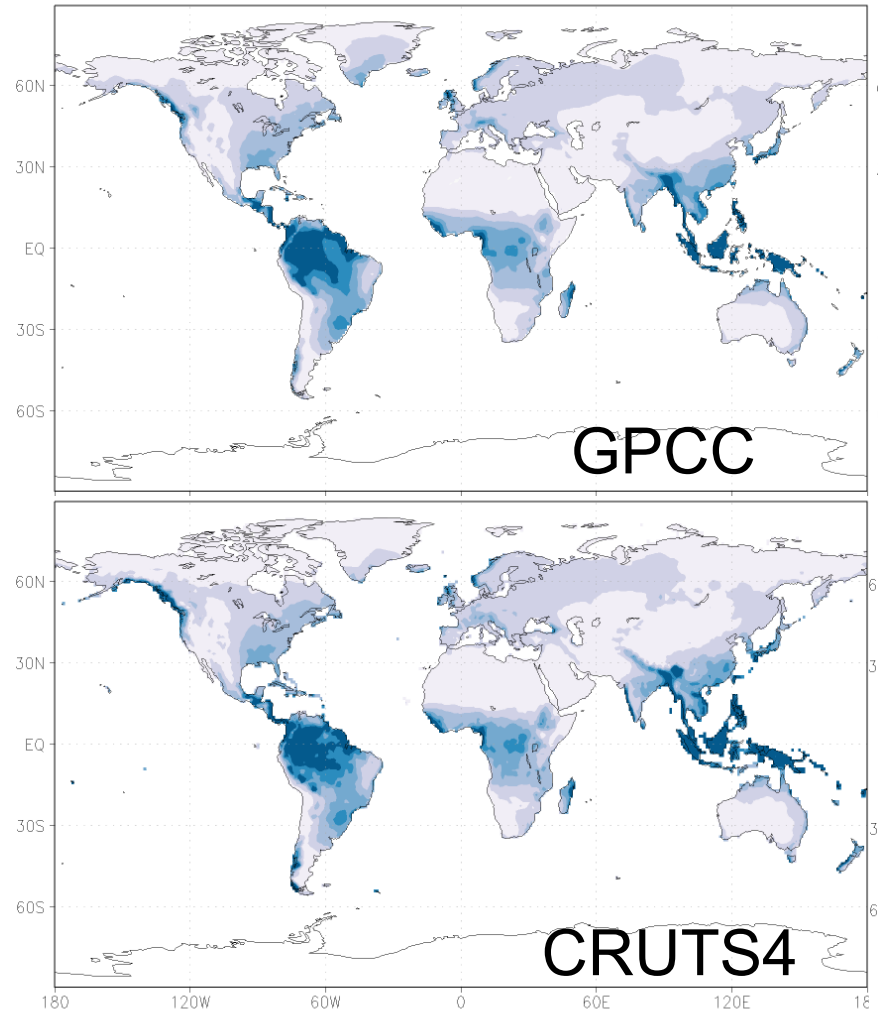

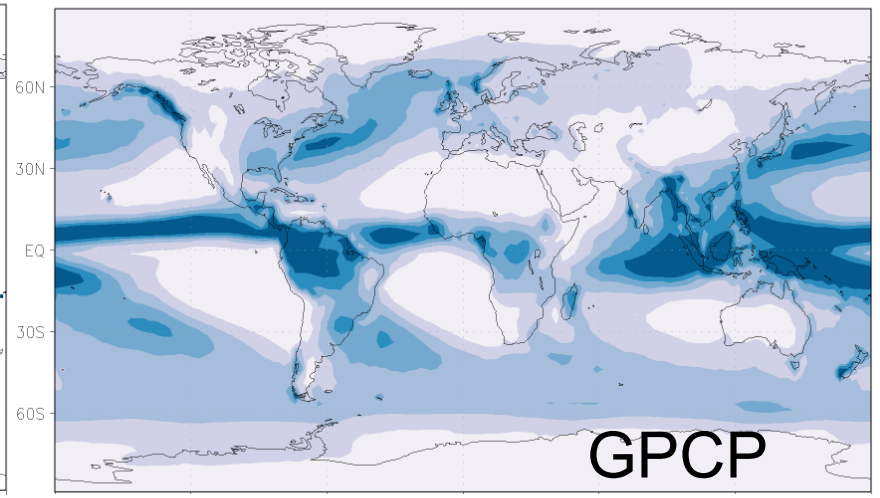

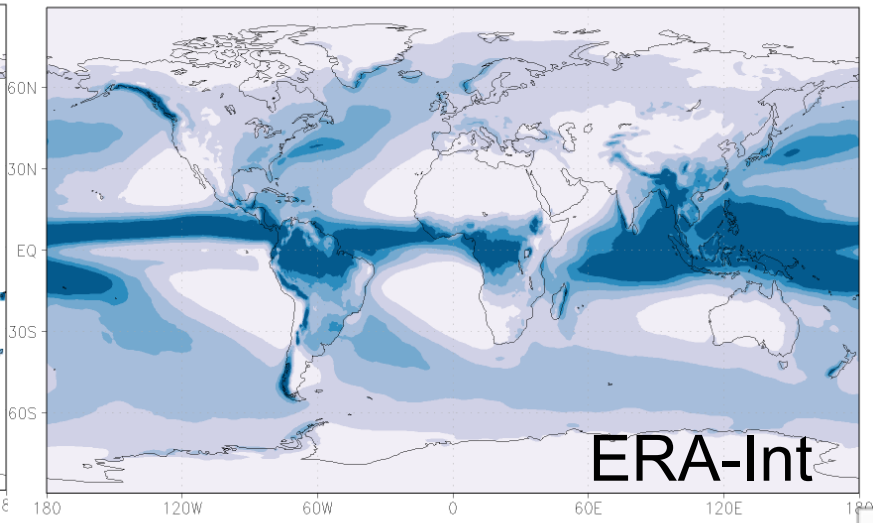

Continental Mean Precipitation

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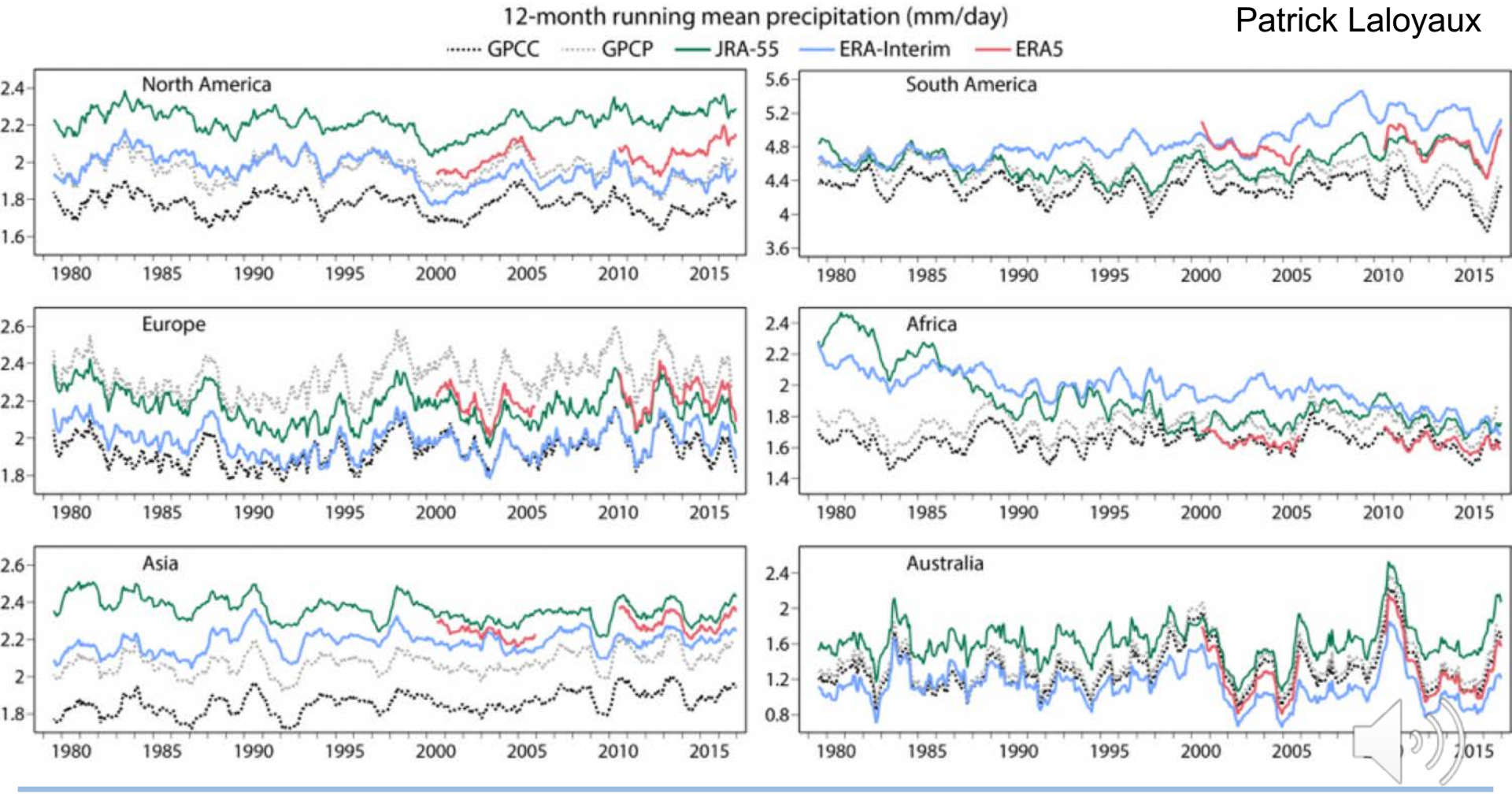
Patrick Laloyaux



Local precipitation

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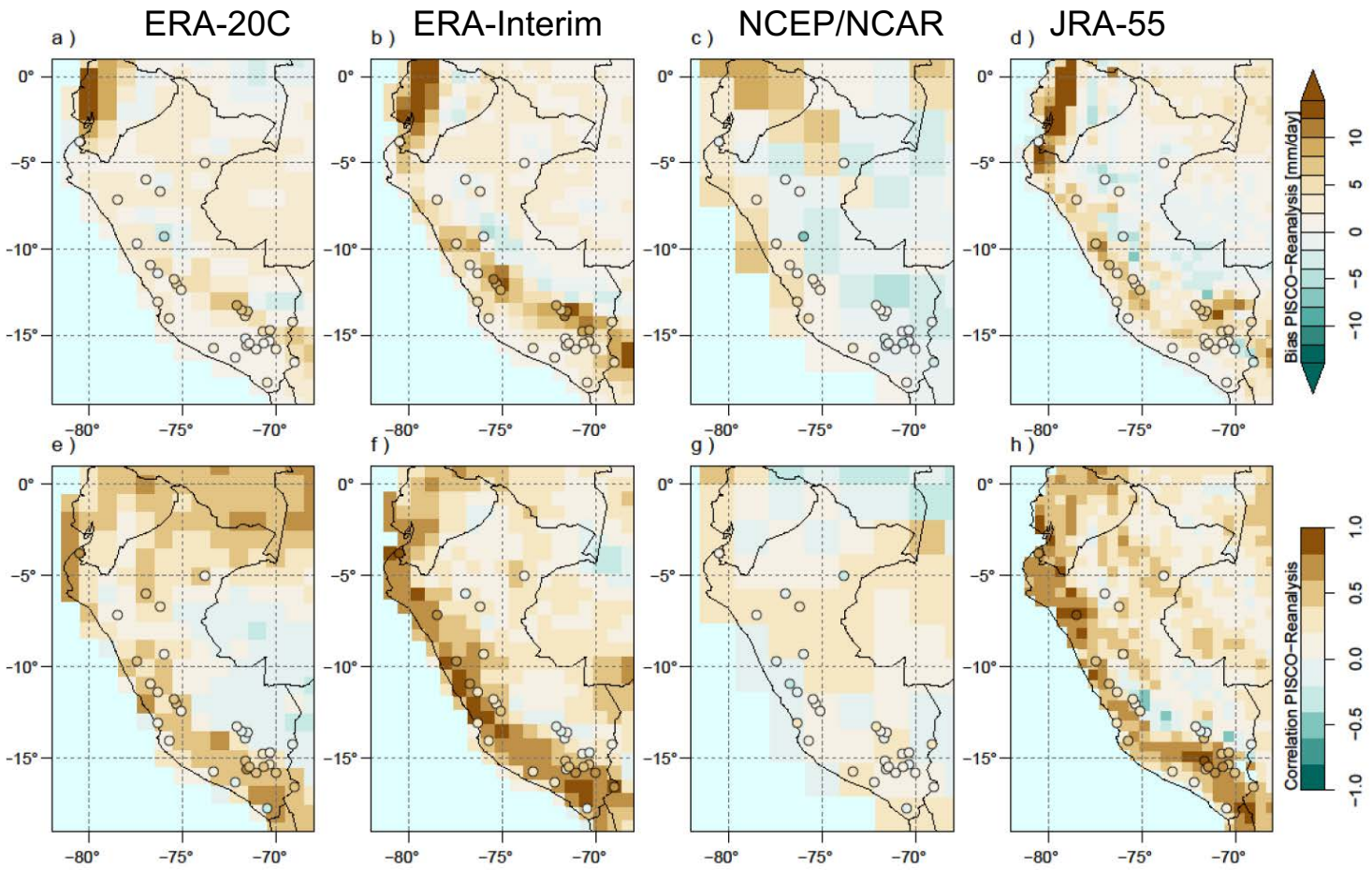

Imfeld et al.
(in r sion)

Precipitation

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- How well can we characterize current climate?
  Global patterns well captured, local deviations can be large
- How well can we characterize changes over the instrumental period?
  Changes agree well in most (large-scale) regions over the past 40 years
- How well do reanalyses represent precipitation/water cycle?
  Big improvement

Atmospheric Circulation and Extremes

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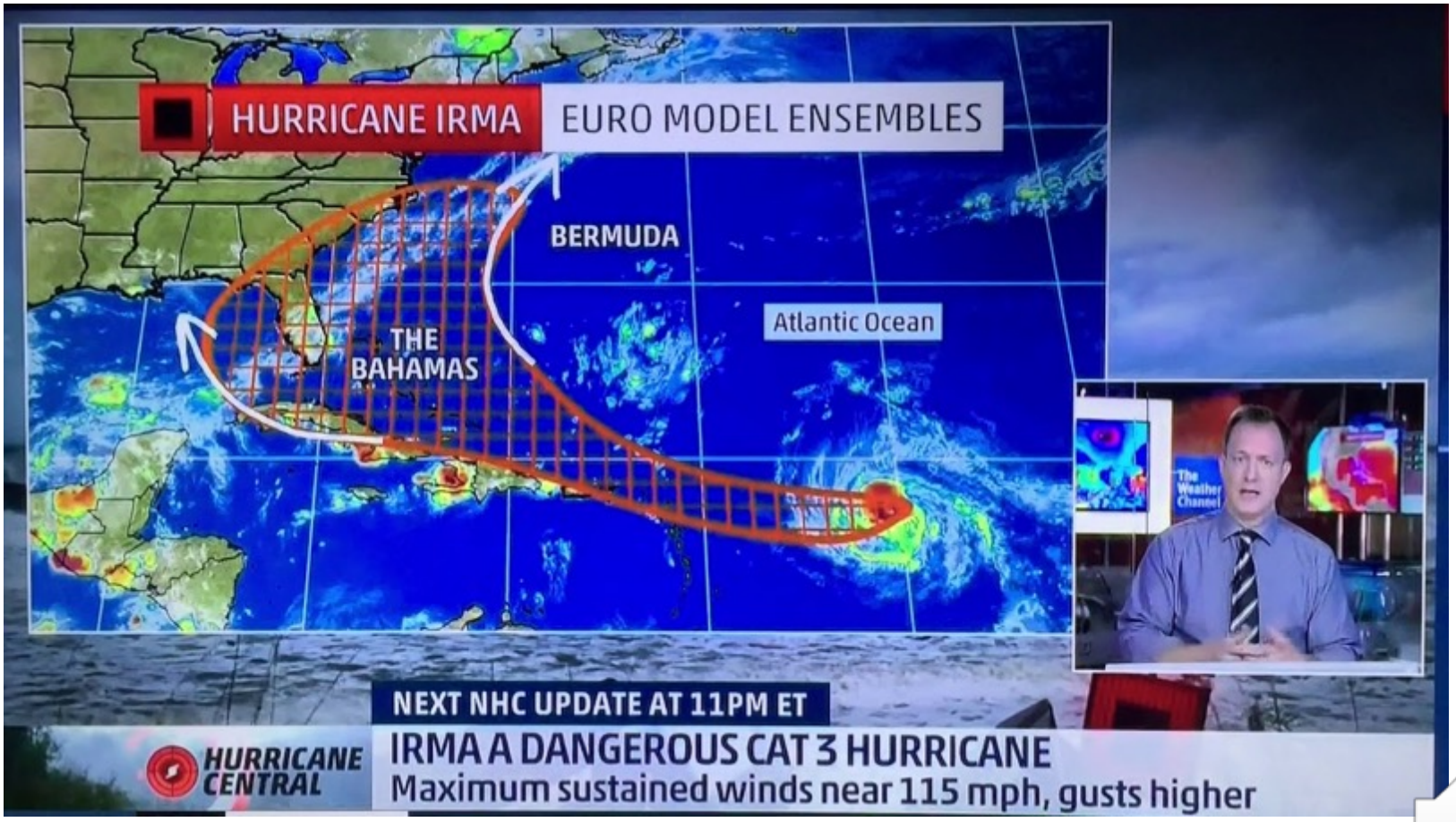

Zonal mean meridional streamfunction (DJF)

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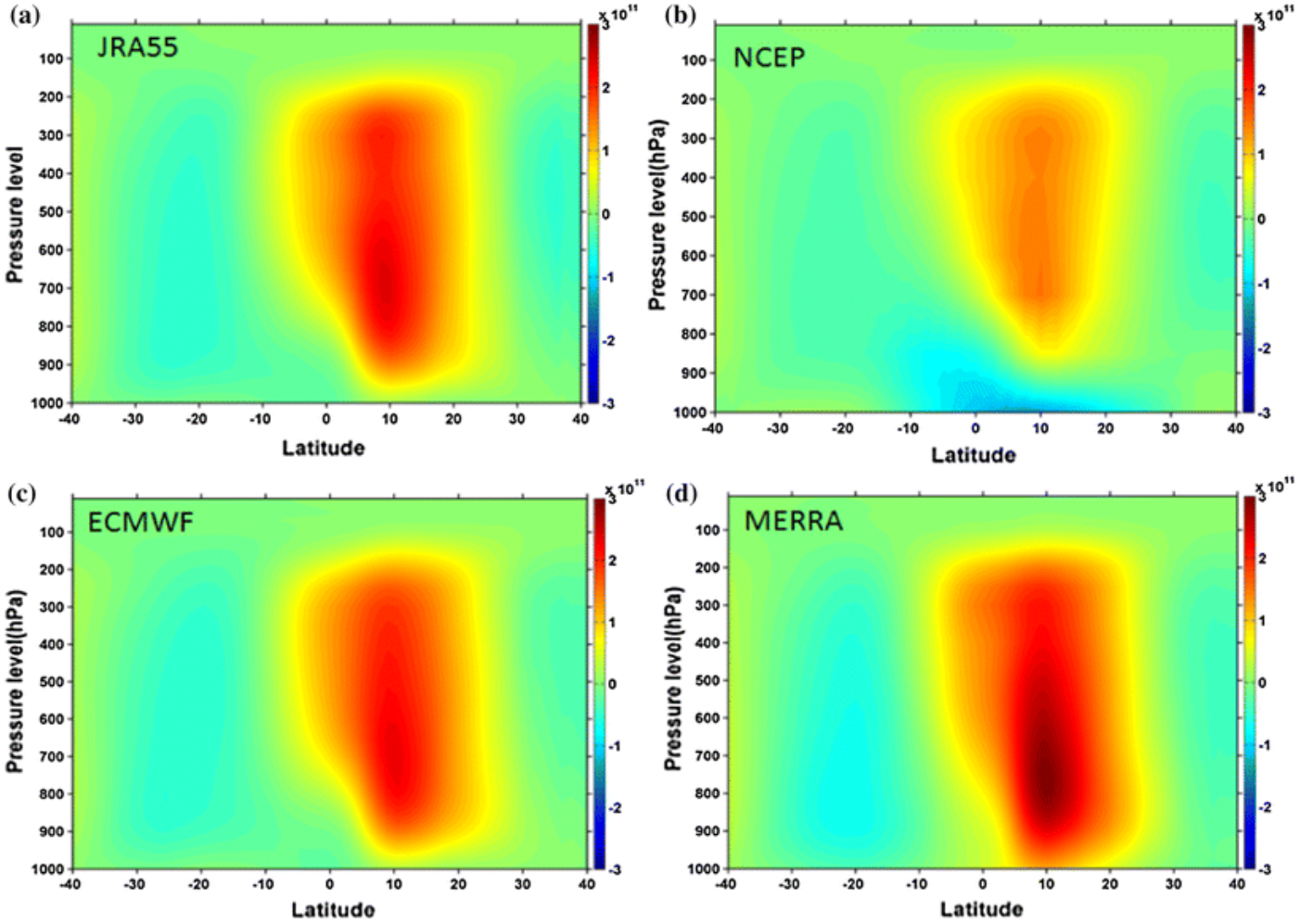

Mathew et al. 2016

Atmospheric Circulation Indices

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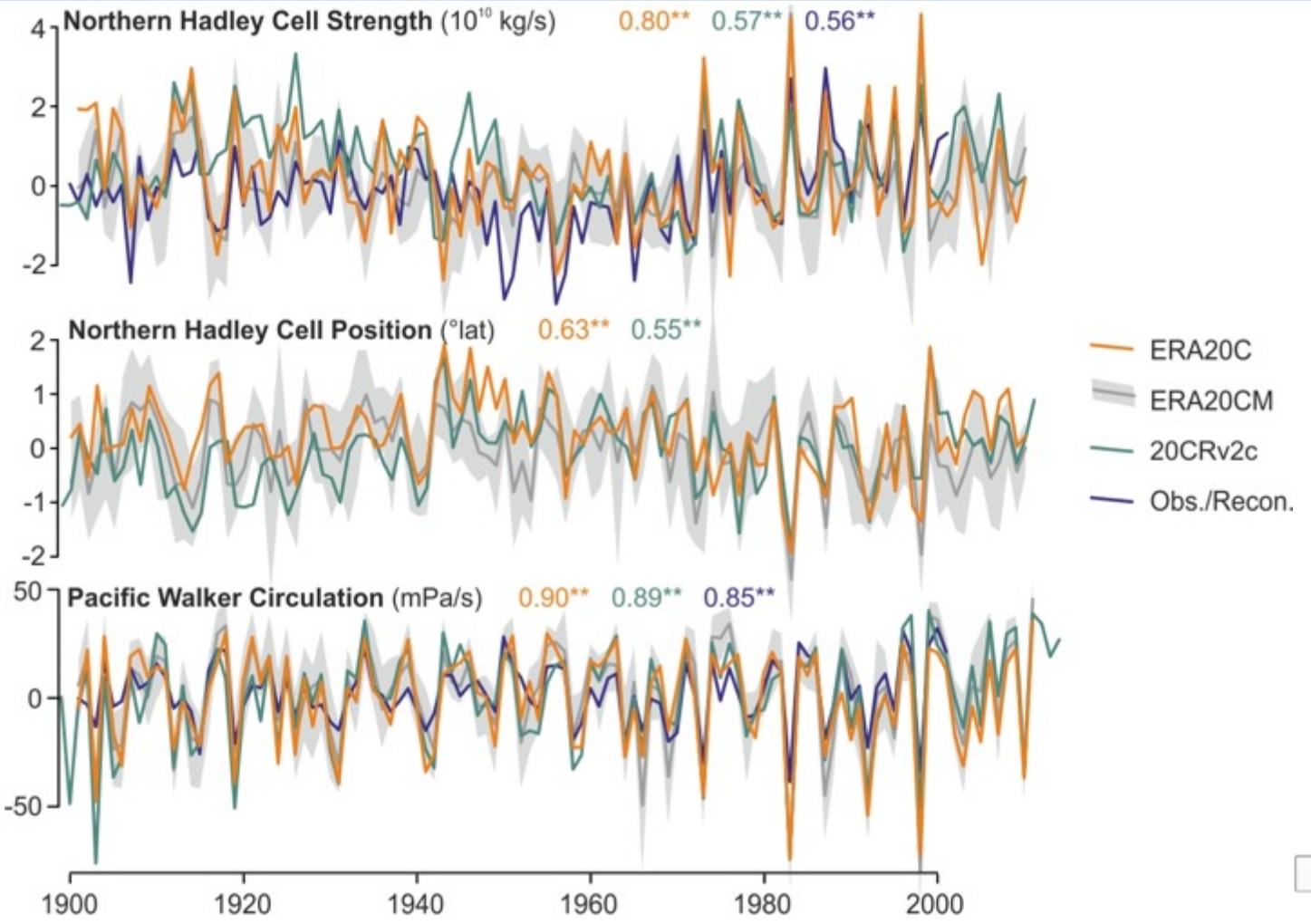

Temperature and Precipitation Extremes

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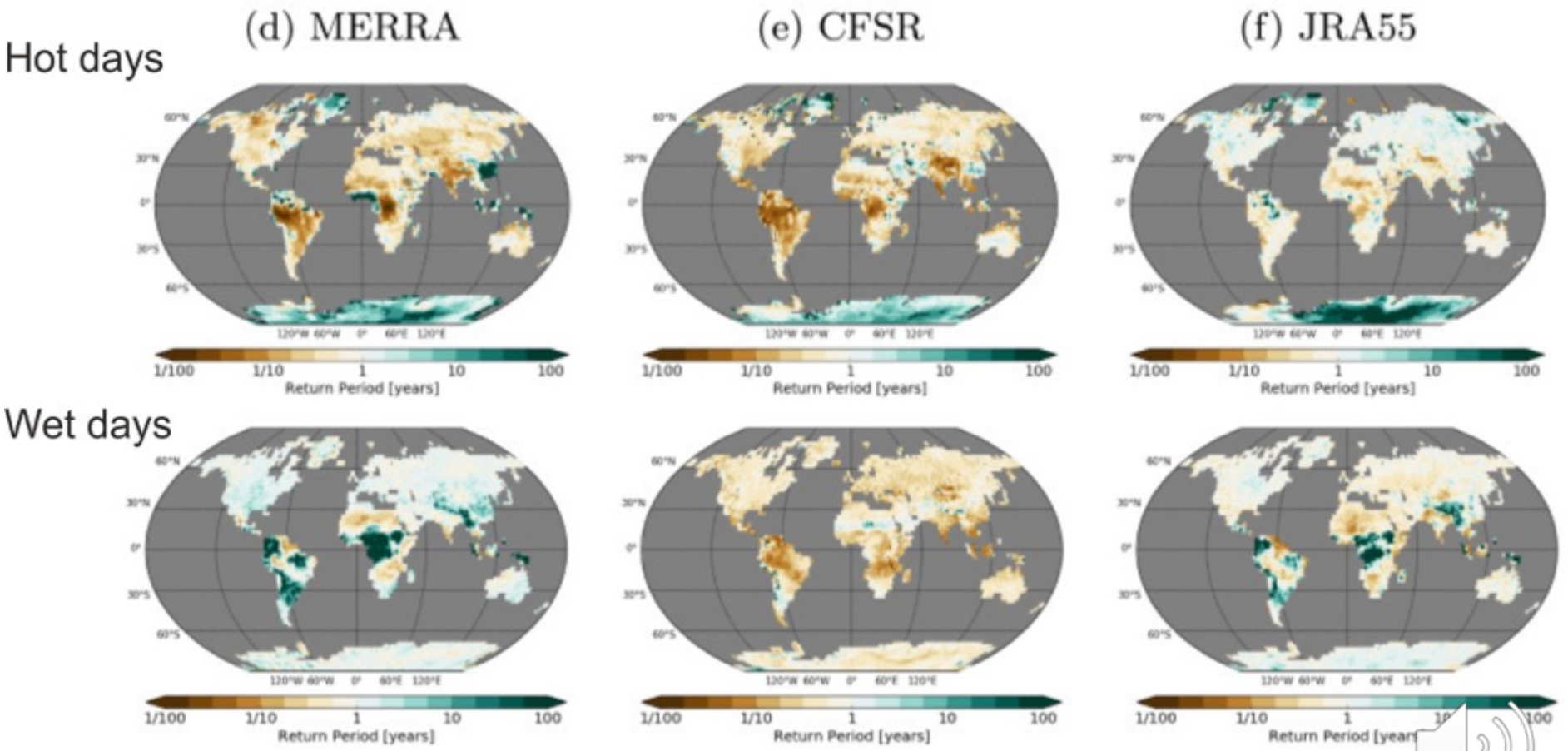

Angelil et al. 2016

Winter wind storms

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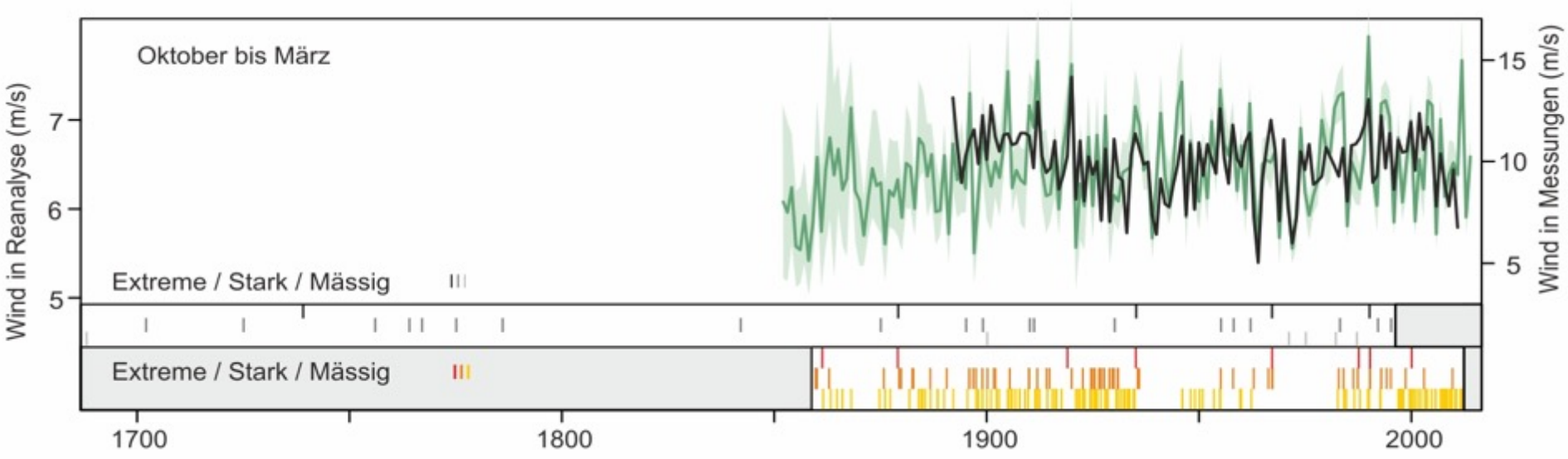
Winter wind storms (98 percentile) in Zurich/Switzerland



Circulation and extremes

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- How well can we characterize current climate extremes?
  Biases may be large
- How well can we characterize changes over the instrumental period?
  Changes not always agree well, variability does
- How well do reanalyses represent atmospheric circulation/extremes?
  Relatively well in «easy» regions, more difficult in others

Climate measurements and society

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What do you see here?

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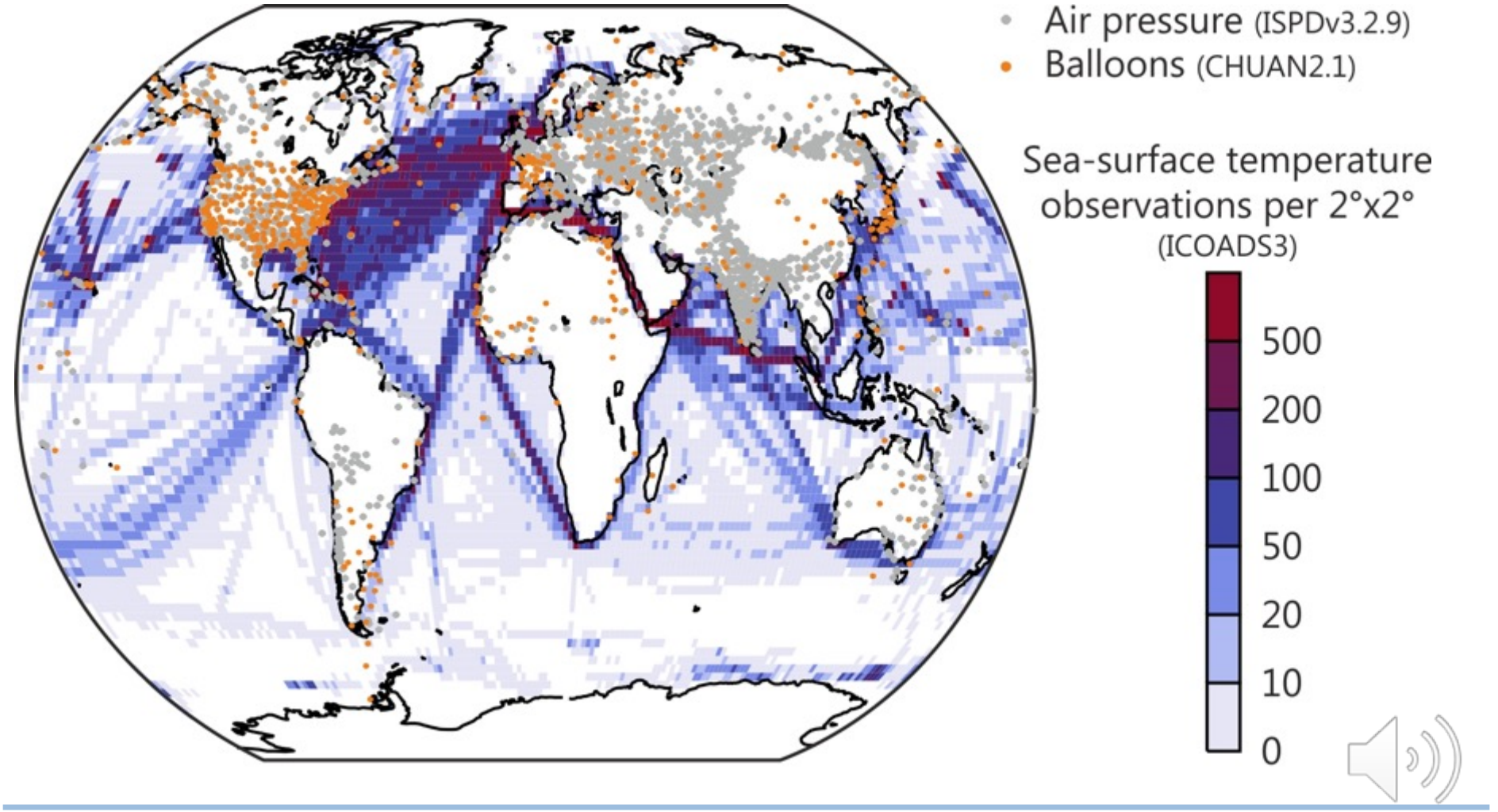

Conclusions

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- Characterising current climate as a basis for global change approaches
- Current climate is is well characterised on large-scale for temperature, less well locally for precipitation
- Some of the trends are well characterised
- Reanalyses are suitable for some, unsuitable for other applications (they are not observations and they are subject to model biases)
- Observations are also a societal products

Are we adapted to current climate?

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...or climate of our recent (observed) past?

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Precipitation

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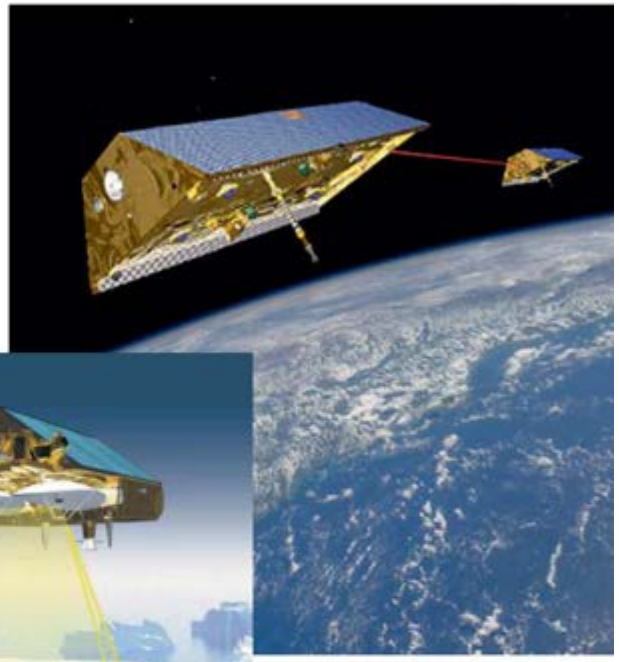
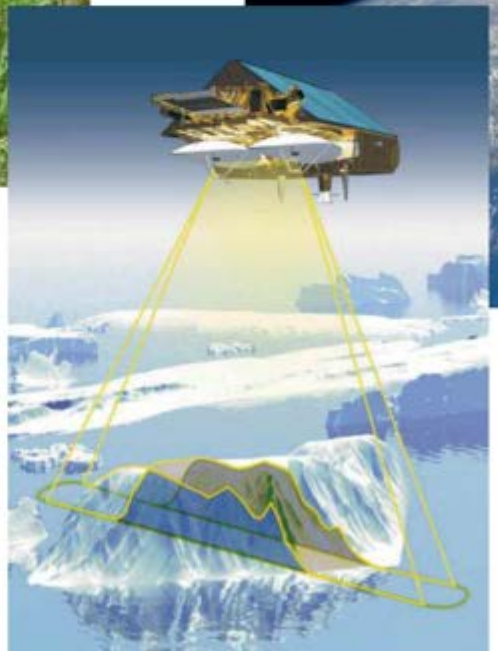


GRACE



CRYOSAT2

Blended products

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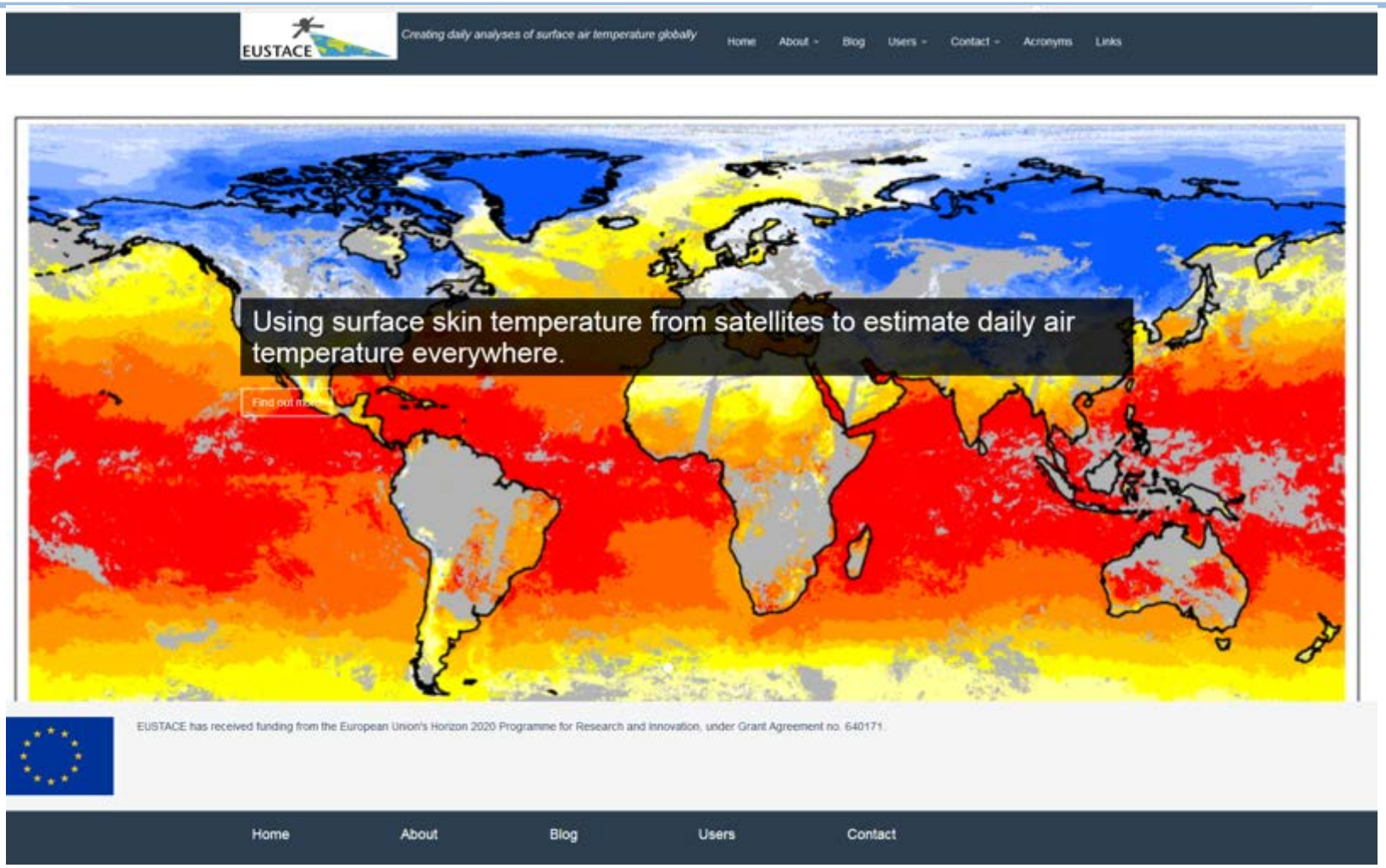

Climate Change Adaptation

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Spatial coverage

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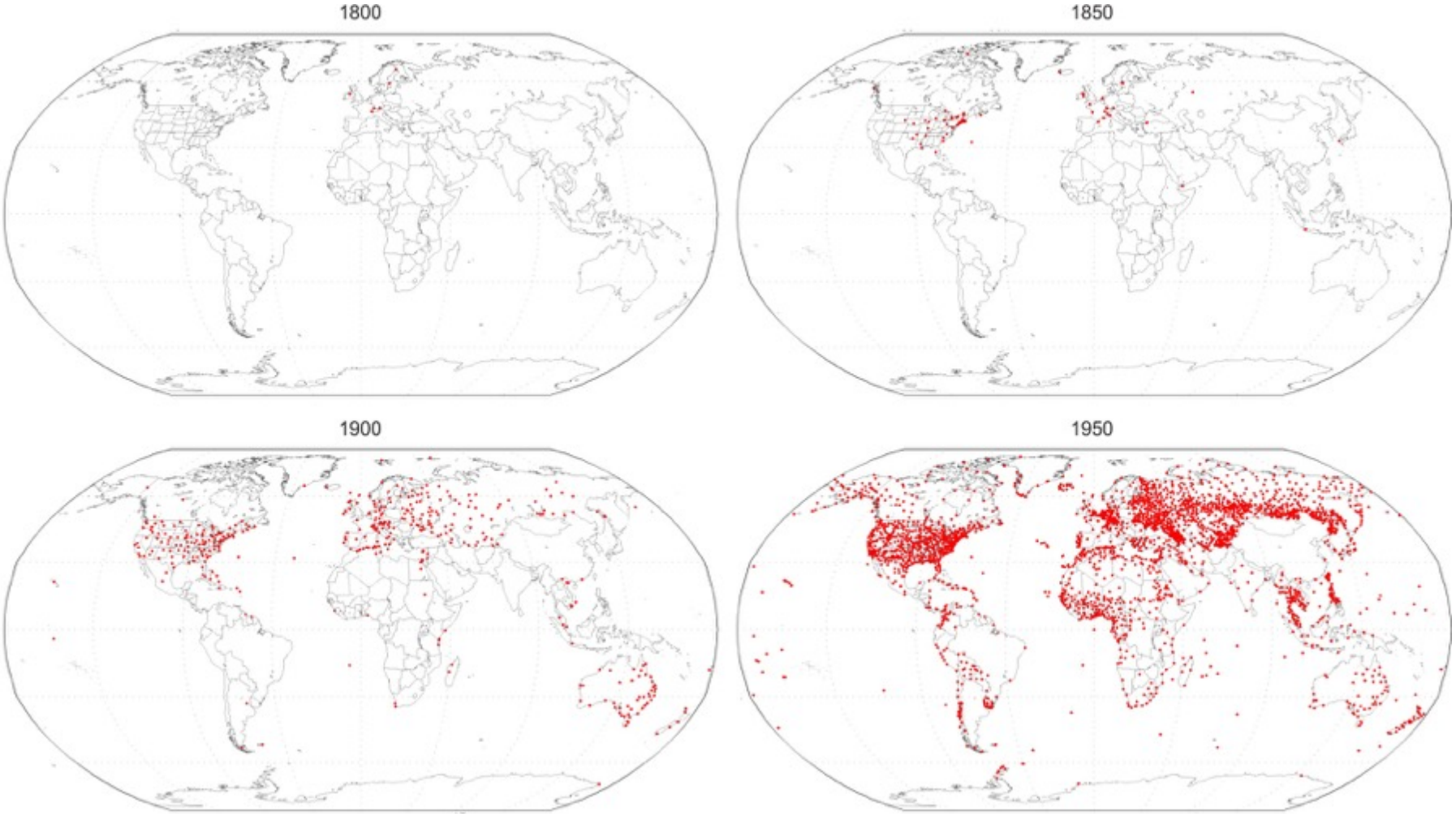

Multiple lines of independent evidence

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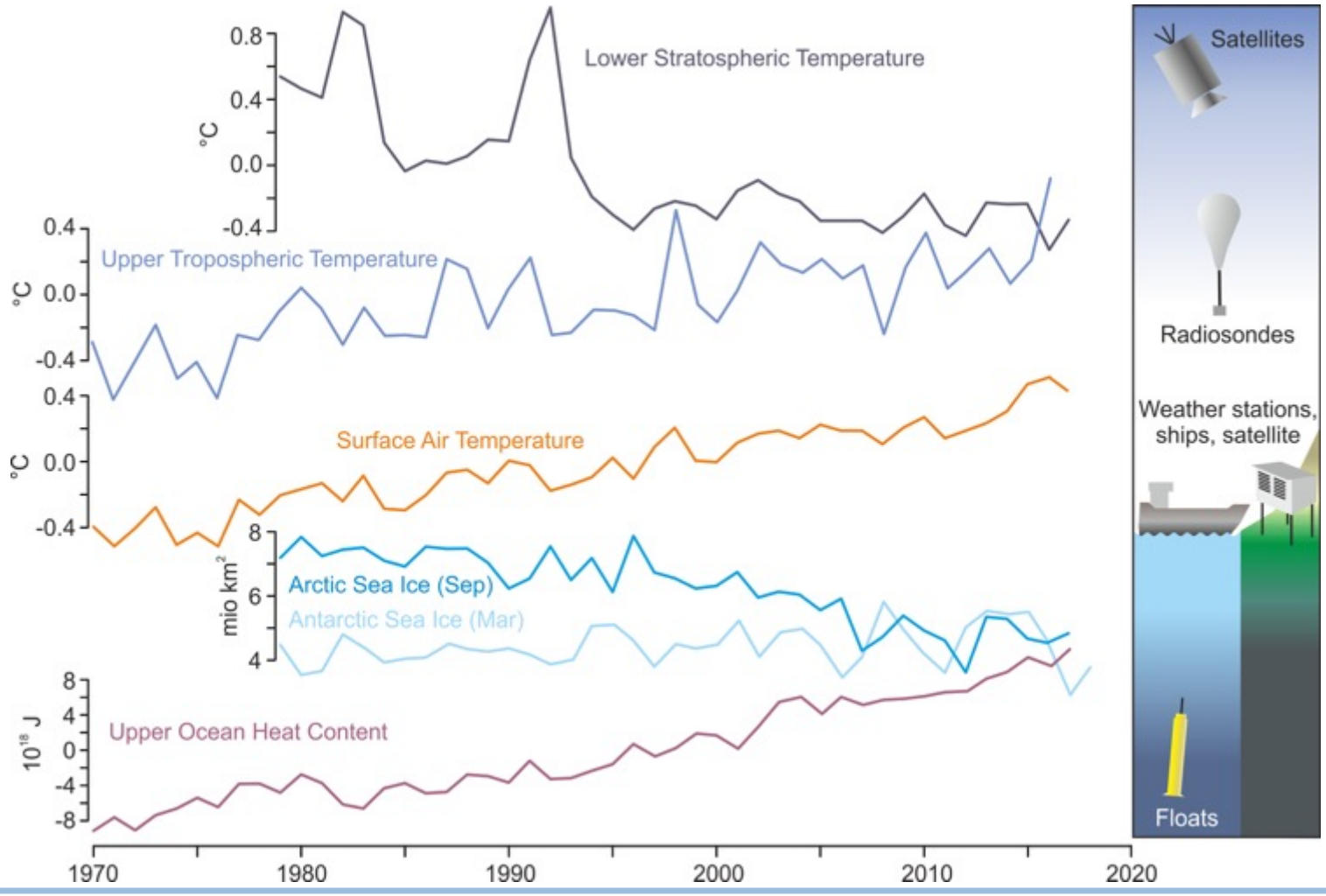

Diagnostics of water cycle: Evaporation minus precipitation

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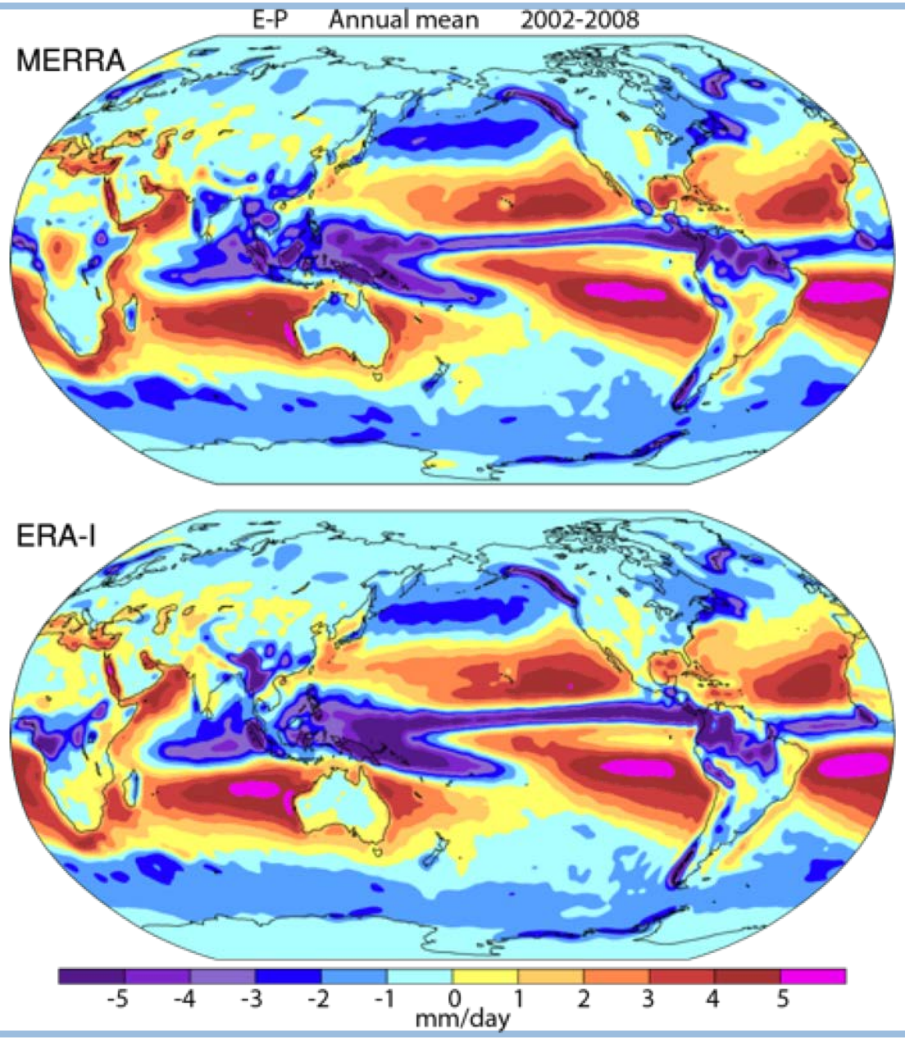

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Global networks/global data dissemination: A cold-war product?

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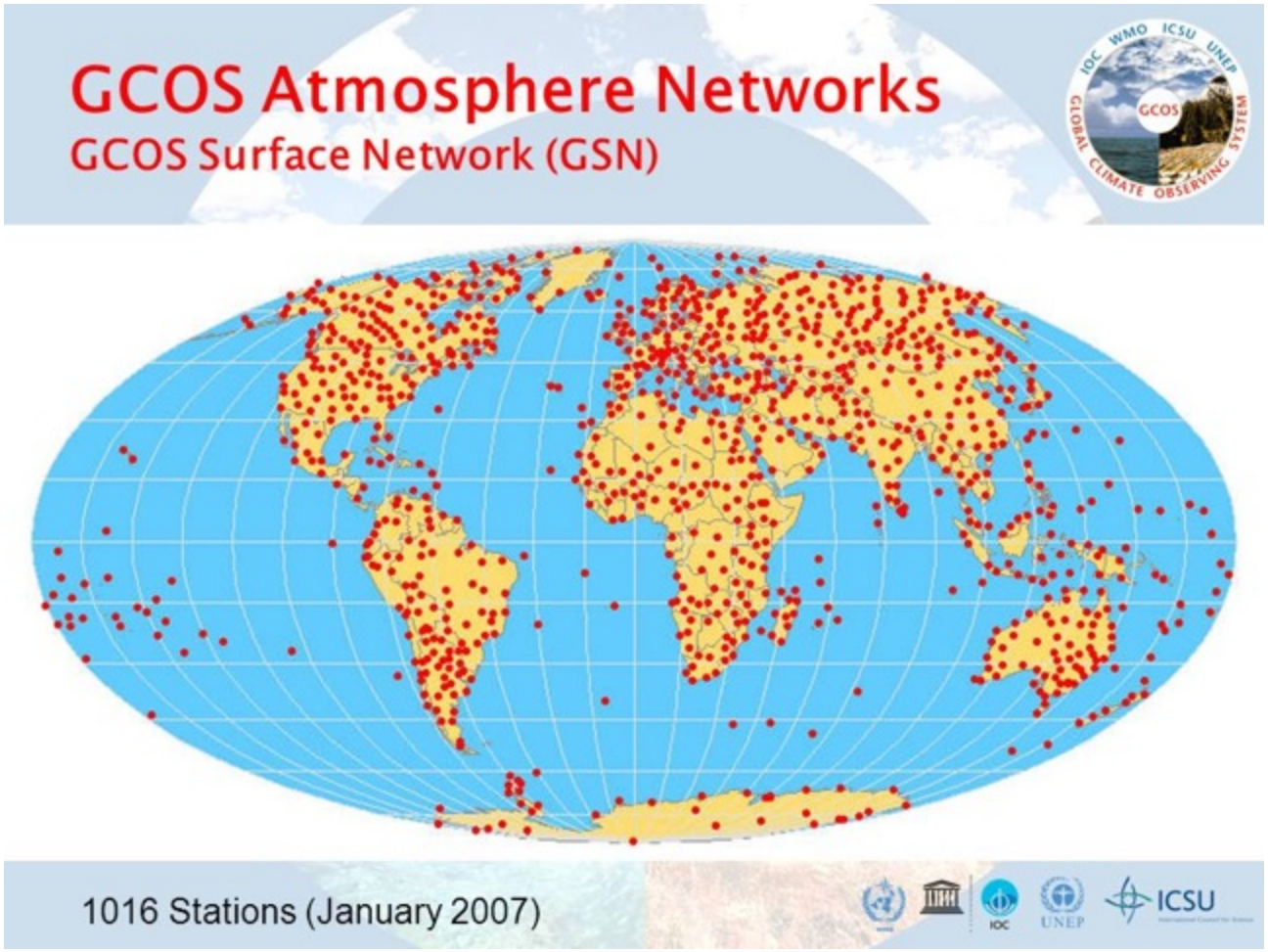

Future Data maps: Global Communication?

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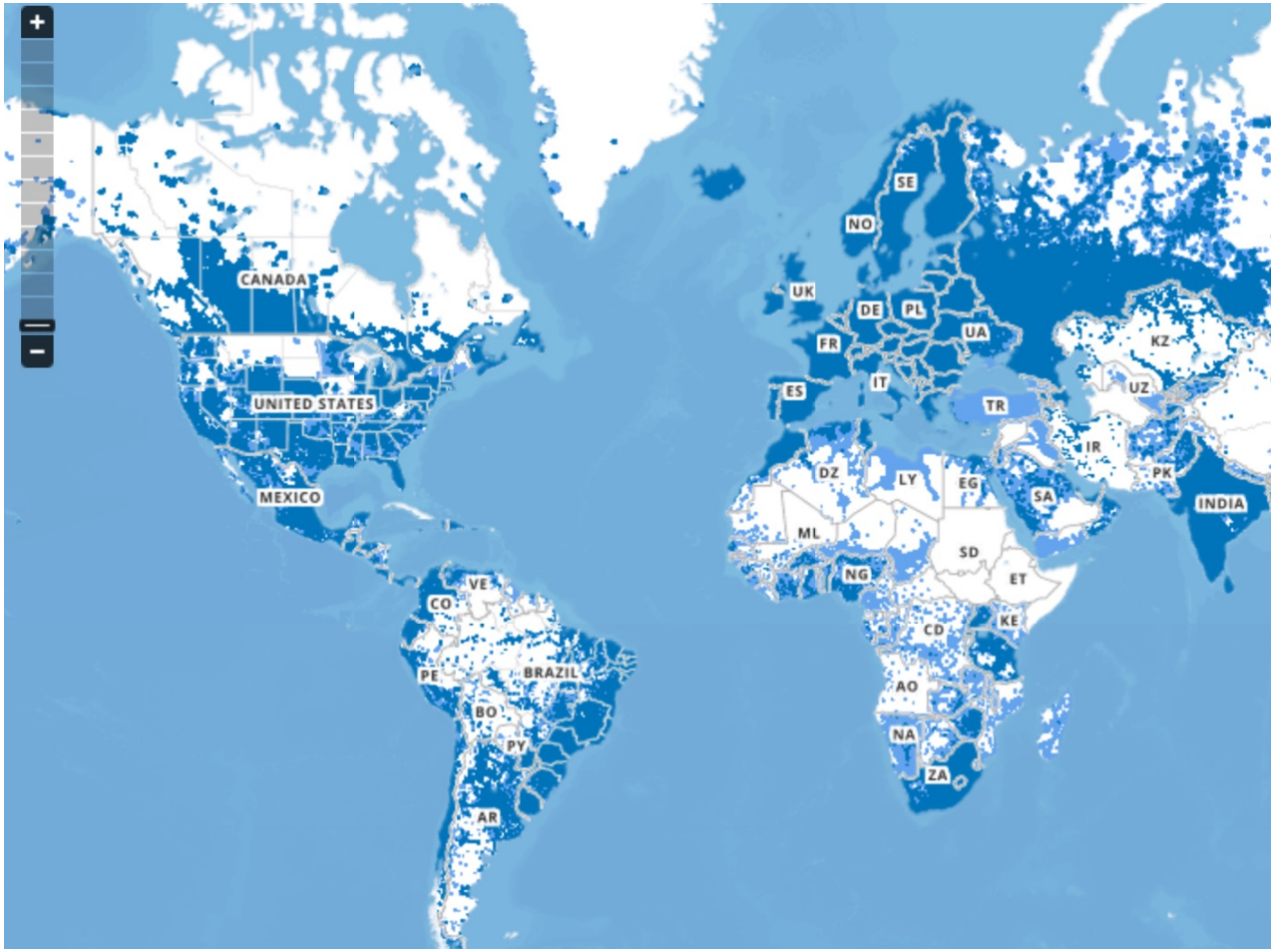

Stratospheric water vapour

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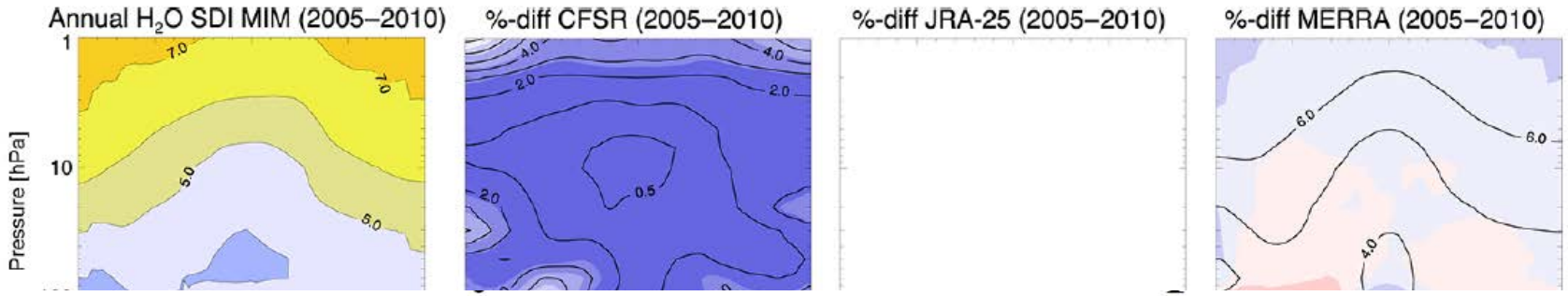
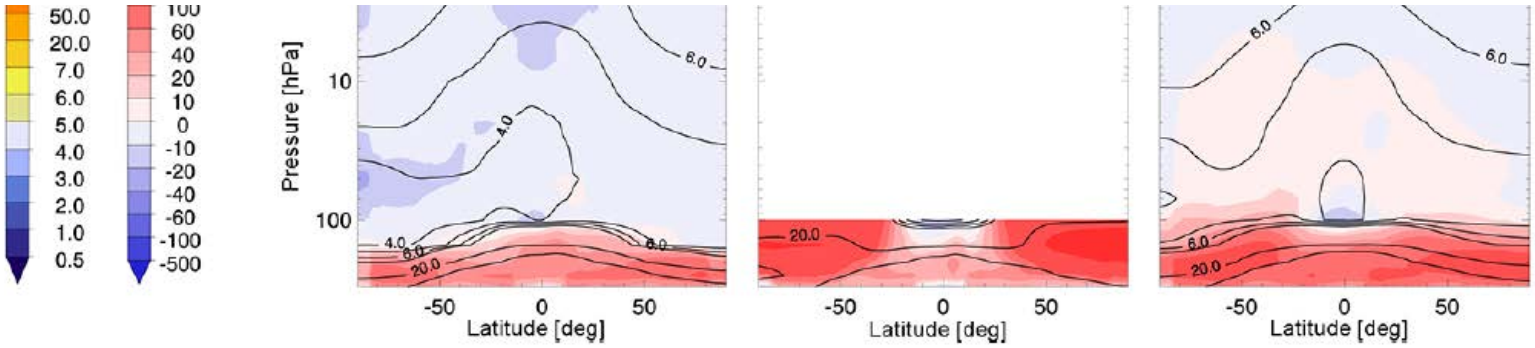


stratospheric WV products from the current generation of re-analyses should generally not be used in scientific studies.



Davis et al. 2017

Stratospheric ozone

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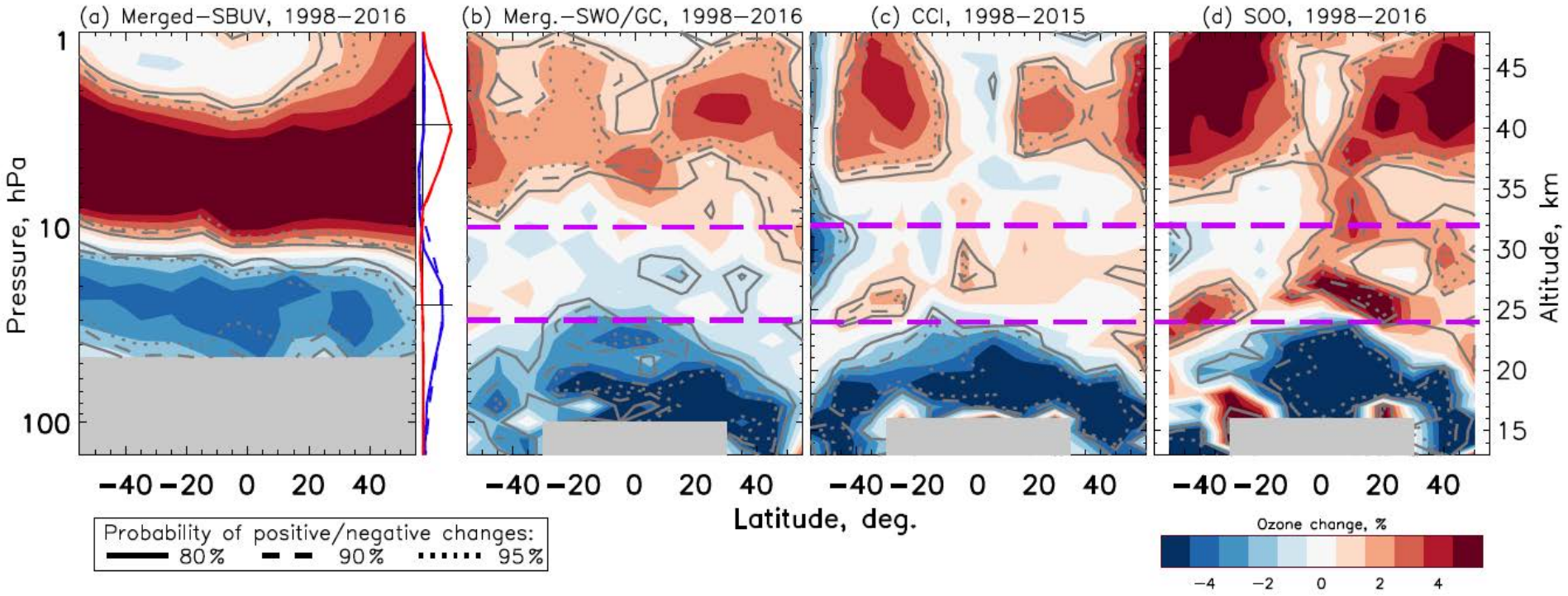

Ball et al. 2018

Stratospheric ozone

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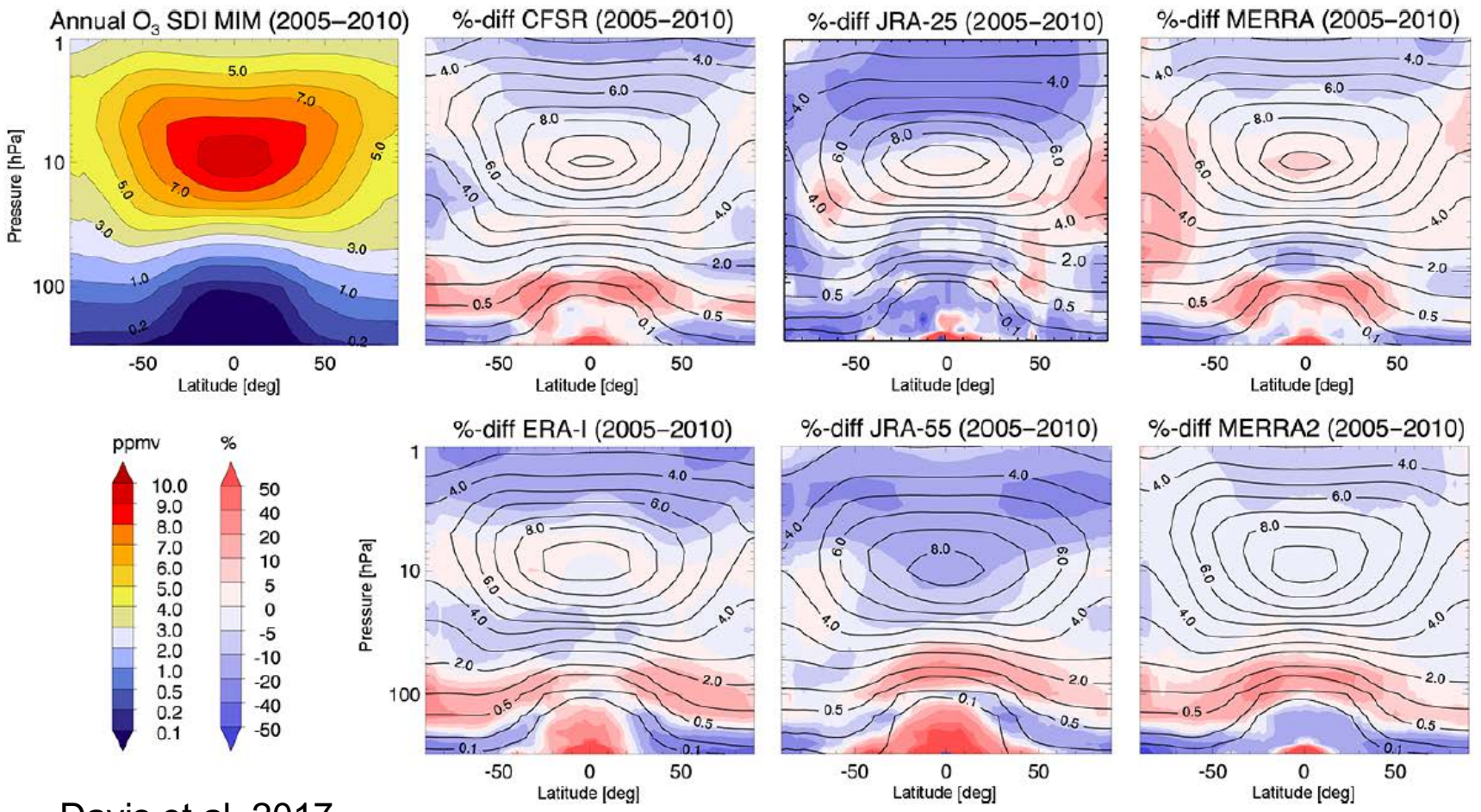

Davis et al. 2017

Sea-surface temperature

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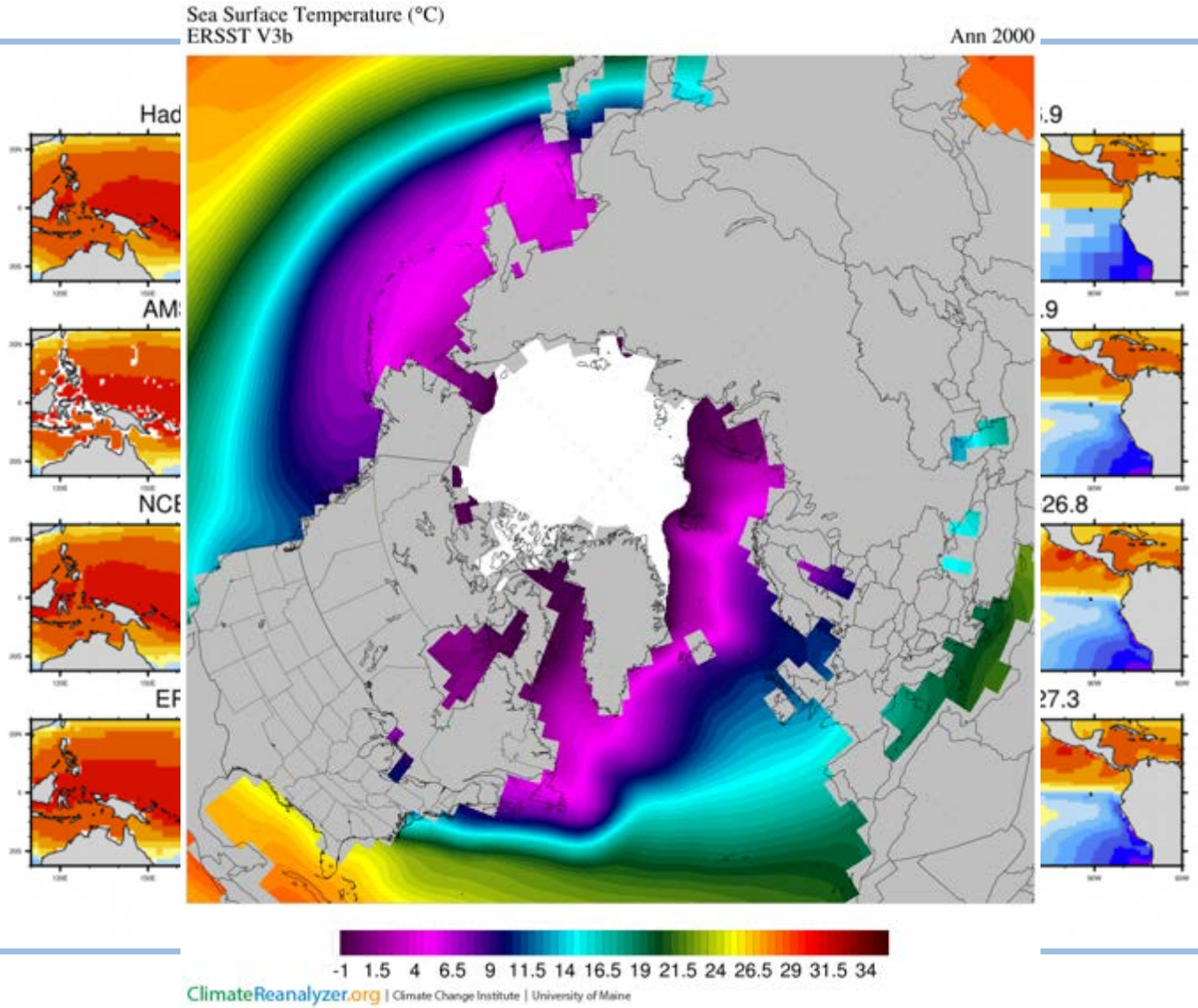

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Reanalysis

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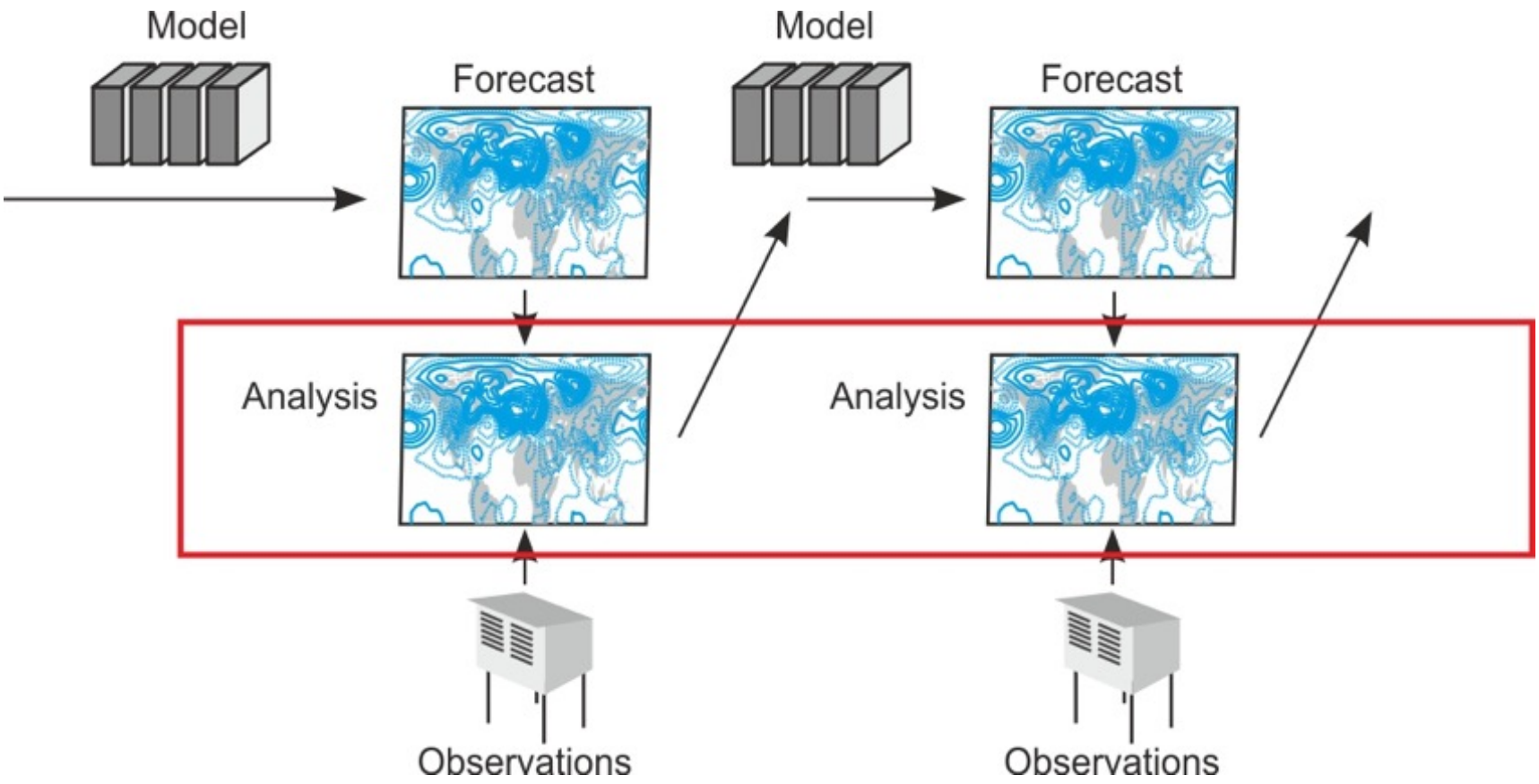

CERA-20C

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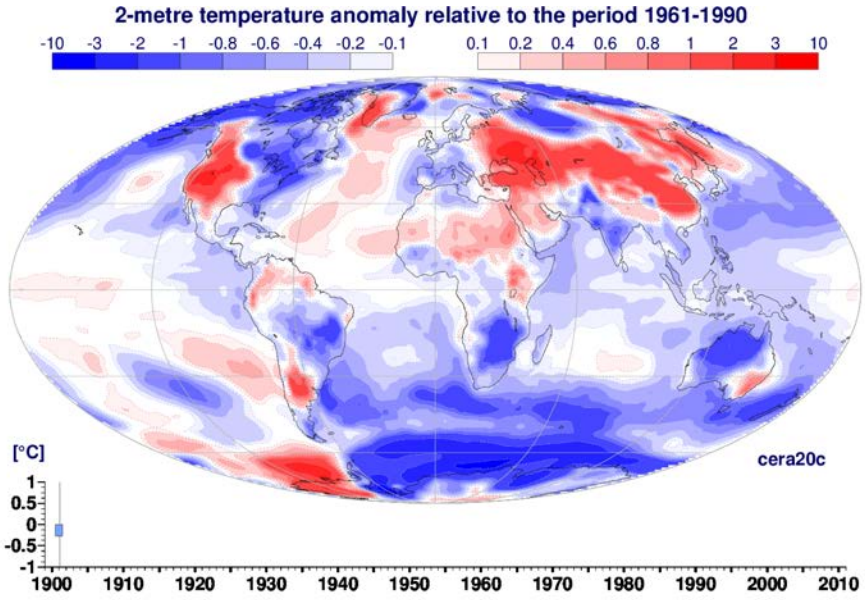

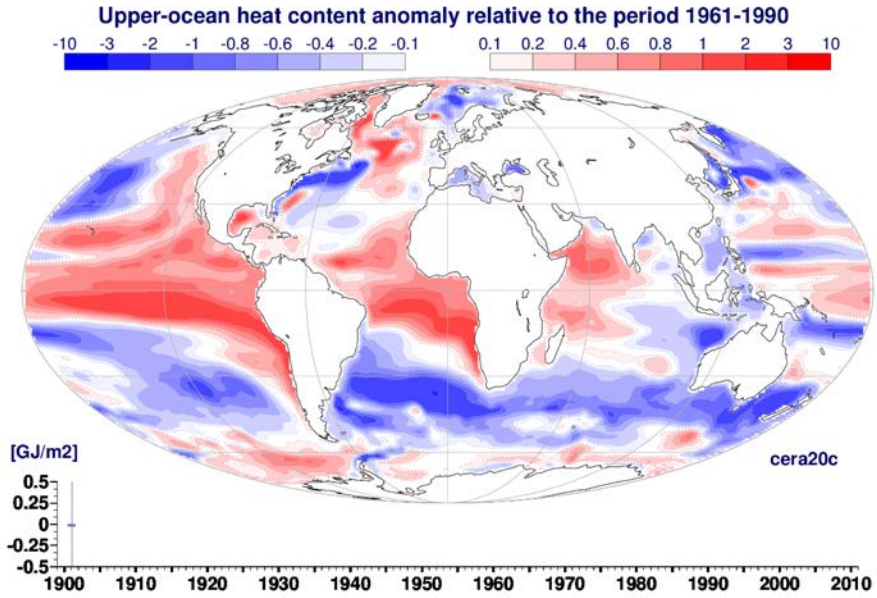

CERA-20C global average temperature anomaly with respect to 1961-1990 period

Patrick Laloyaux