Low frequency variability and trends, Reanalysis Intercomparison

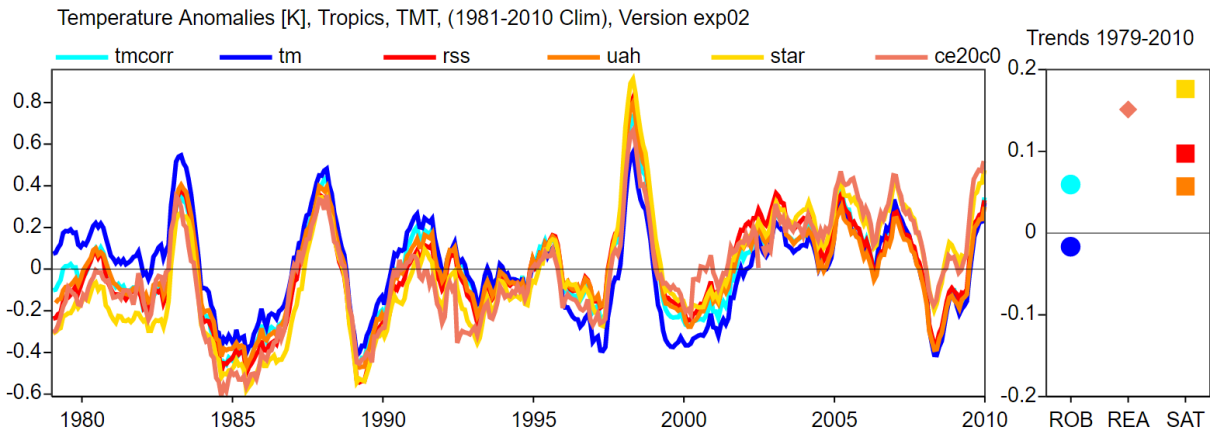
Thanks to Stefan Brönnimann, Eric Boisseson, Patrick Laloyaux, Michael Mayer, Elke Rustemeier, Dinand Schepers, Markus Ziese

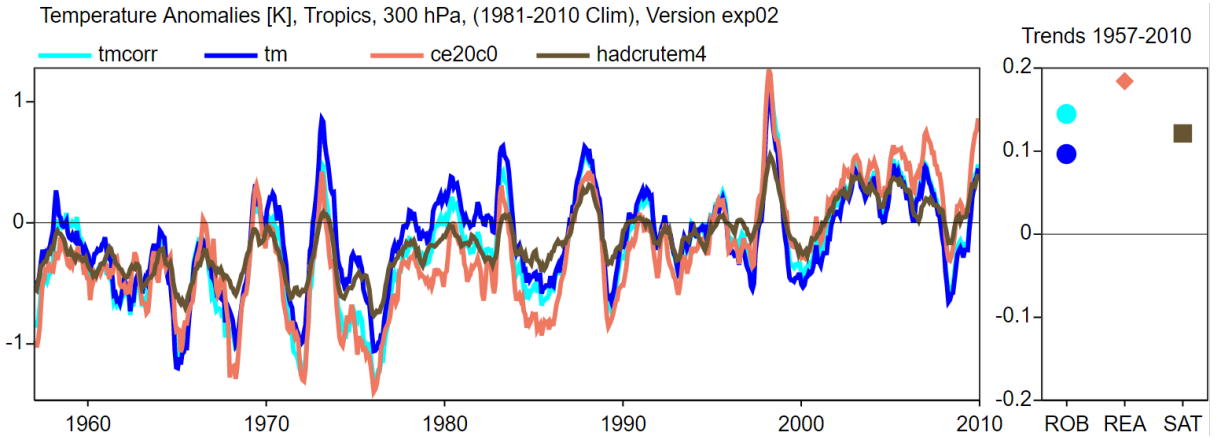
Der Wissenschaftsfonds.

Motivation, Outline

- Accurate Description of low frequency variability and trends is one of the main motivations for reanalysis.
- We will look at ENSO, NAO, QBO, Effects of volcanic eruptions
- At the same time:
- Compare CERA20C, (CERA-SAT) with observation data sets and other reanalyses
- Focus on upper air, atmospheric circulation

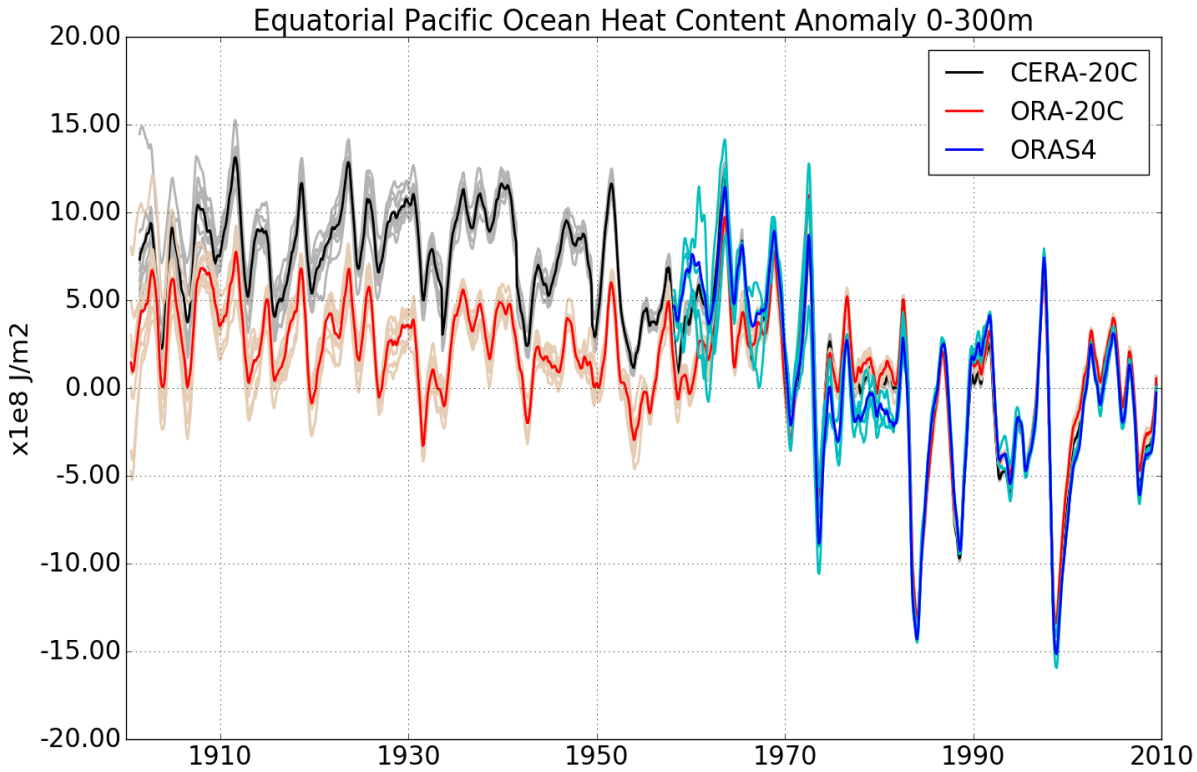
Tropical Mid Tropospheric Variability





- CERA20C quite consistent with MSU MT, warming relatively strong
- Excellent depiction of ENSO
- Amplification of surface variability and similar to radiosondes,
- Amplification of trends stronger in CERA20C ~1.8 vs 1.2

Tropical (5S-5N) Heat Content in ocean reanalyses



10^9 J/m^2 = 0.8K

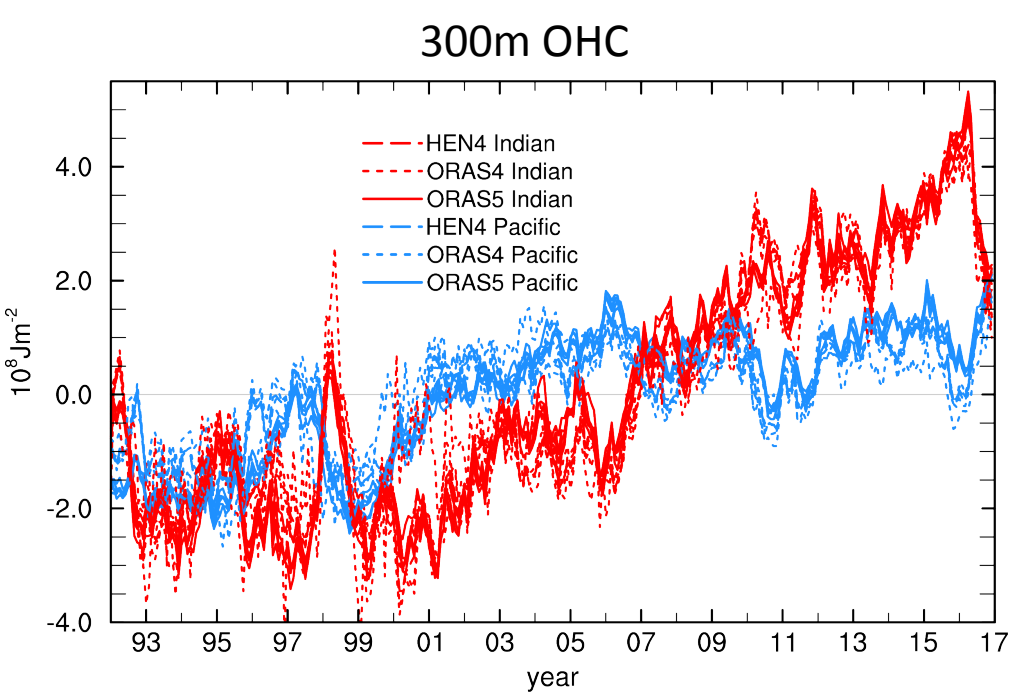
Equatorial Pacific anomaly: High consistency back to 1958.

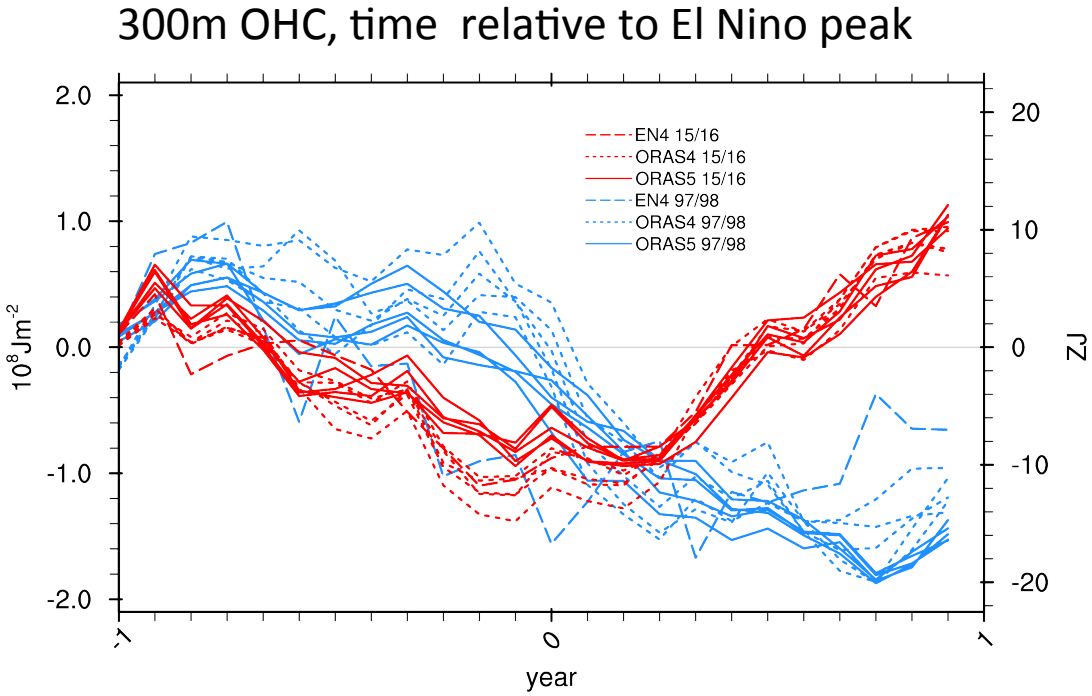
Quite warm state before 1958? Realistic?

1940-42 El Nino has weak signal here

Relatively little spread compared to differences before 1950

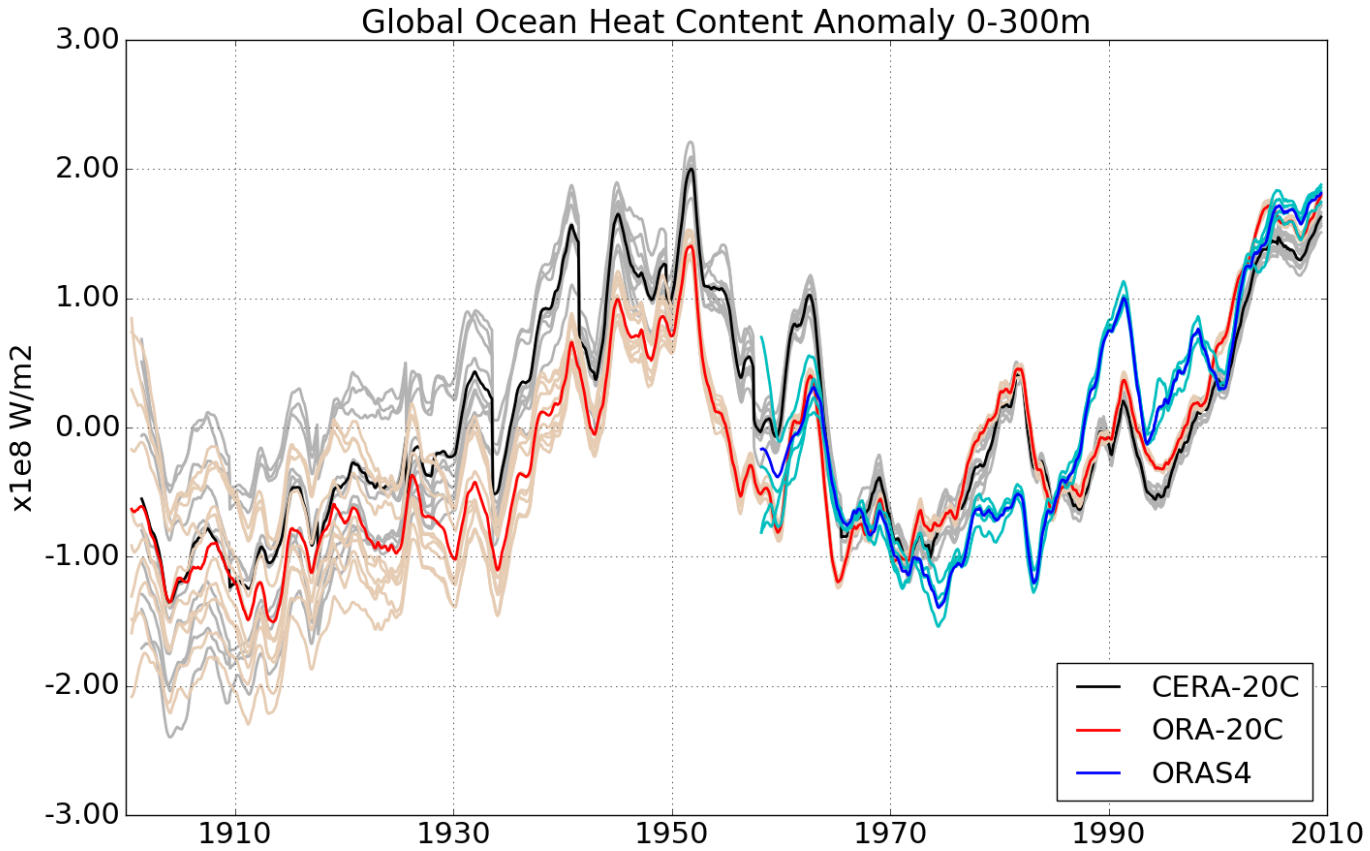
1997/98 and 2015/16: Very different strong El Ninos





- Strong buildup of heat in Indian Ocean prior to 2015/16 El Nino
- Heat loss in Pacific stops very early, heat uptake already 2 months after peak phase
- Indonesian Throughflow (not shown) almost stopped in 2015/16

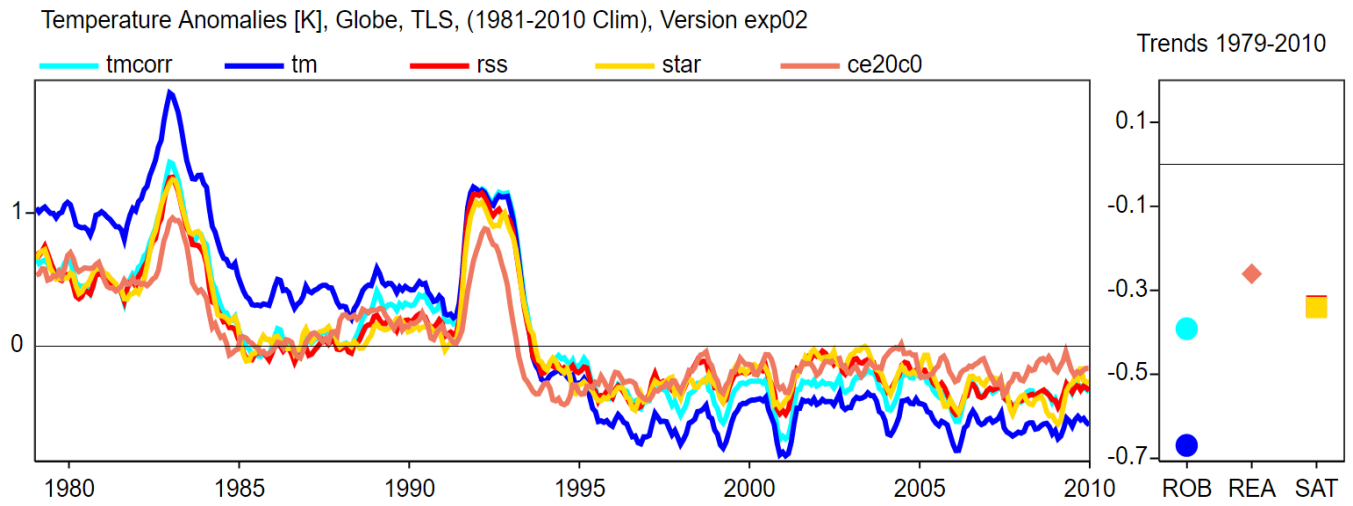
Global Oceanic Heat Content

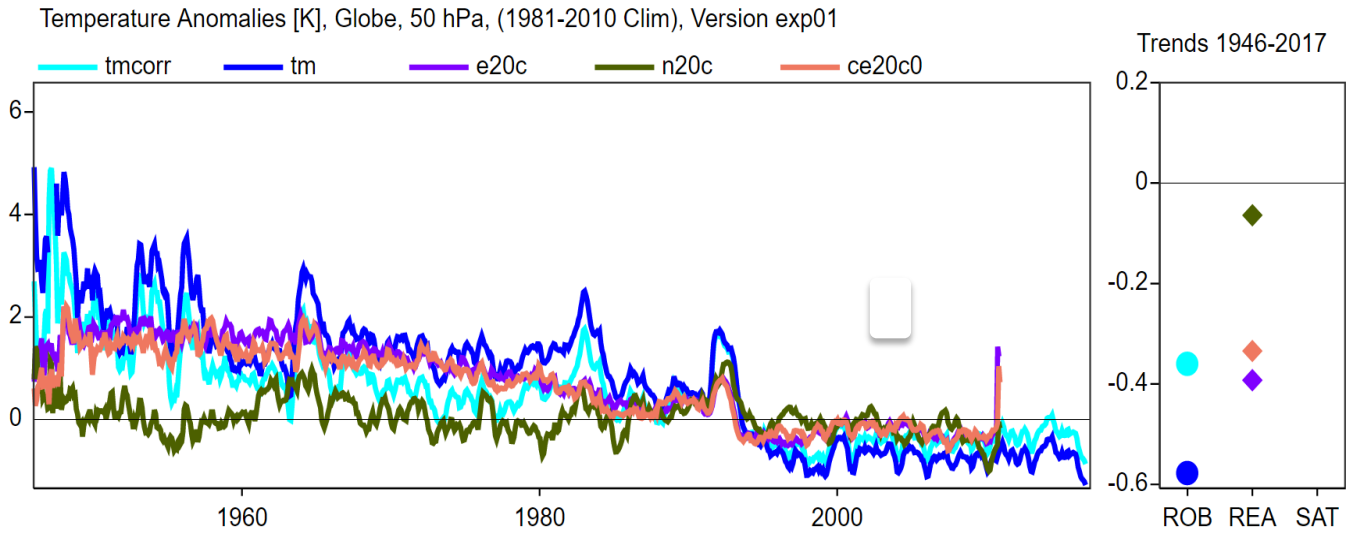


- Better overlap of ensembles
- Volcanic signals responsible for cooling since 1950?
- Several >=VEI4 eruptions in 1950s:
- 1950 Ambrym 4+, 1951 Mount Lamington 4, Kelud 4, 1925 Begana 4, 1953 Mount Spurr 4, 1955 Carran-Los Venados 4, Bezymianny 5, 1963 Agung 5

- Novarupta 1912 no signal?

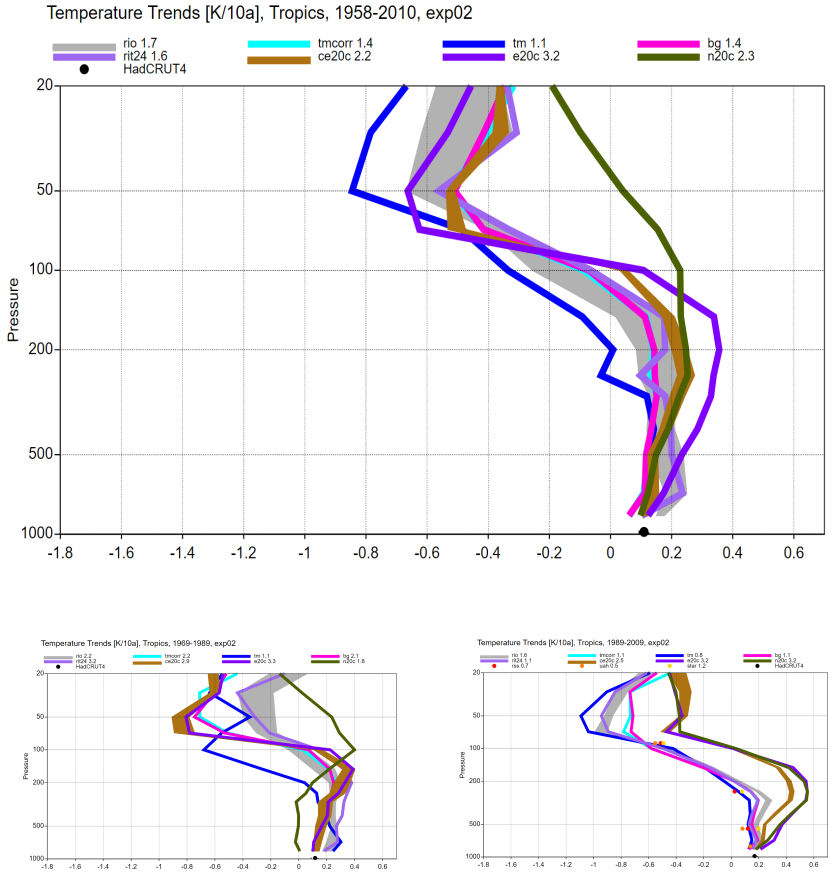
Lower Stratospheric Temperatures

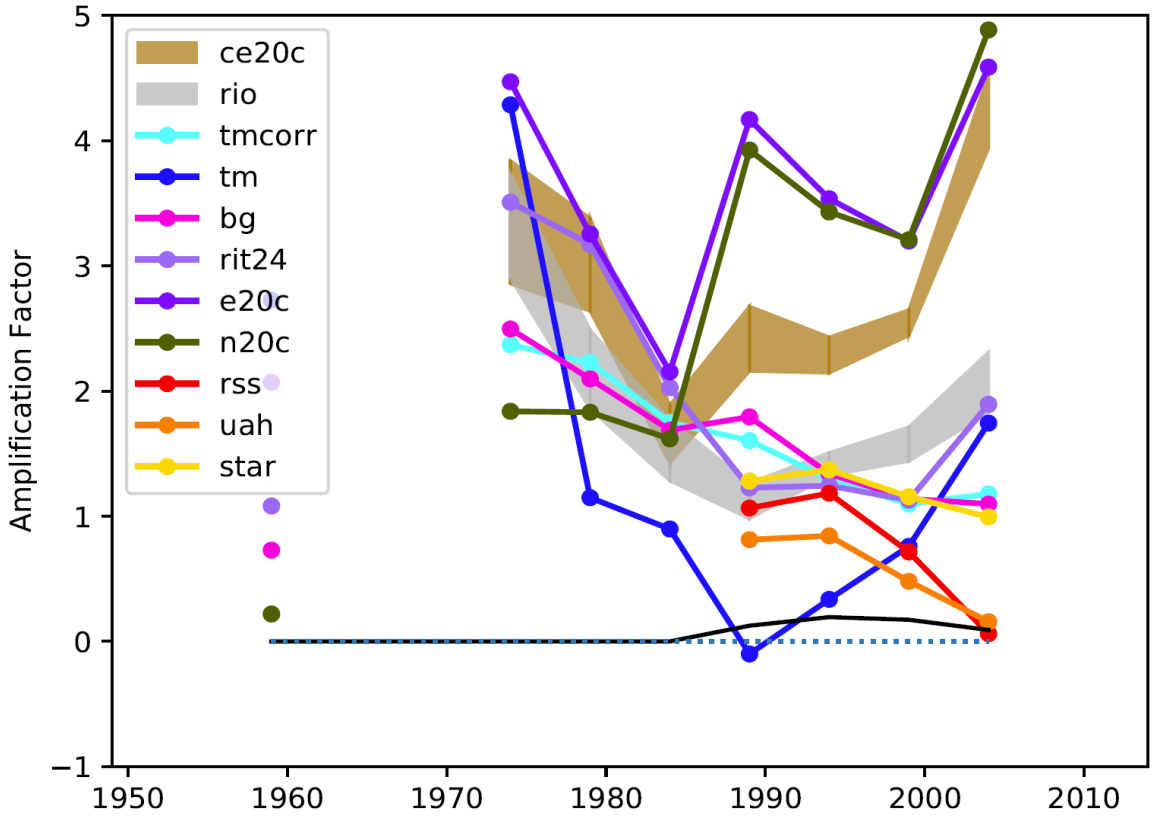




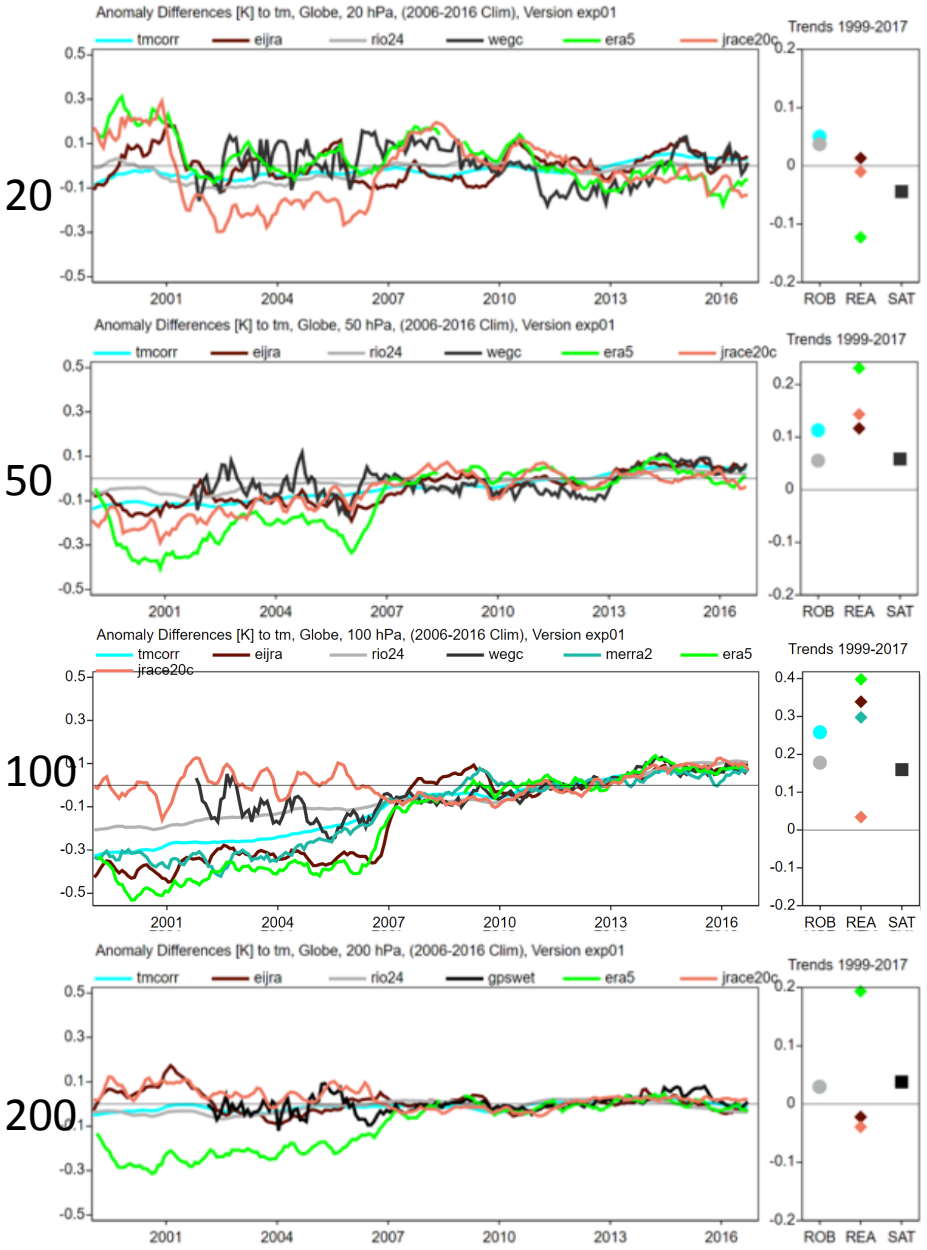
- Good agreement of CERA20C with MSU LS time series
- CERA20C shows slightly less cooling,
- CERA20C has weaker response to Volcanic eruptions
- Back to 1948: Good agreement of ERA20C, CERA20C with adjusted radiosondes
- Weaker response to volcanic forcing than in Radiosondes. Peaks in radiosondes before 1958: Volcanic eruptions???
- NOAA-20CR shows no cooling of lower stratosphere

Tropical trend profiles and amplification





Global T, the most recent years

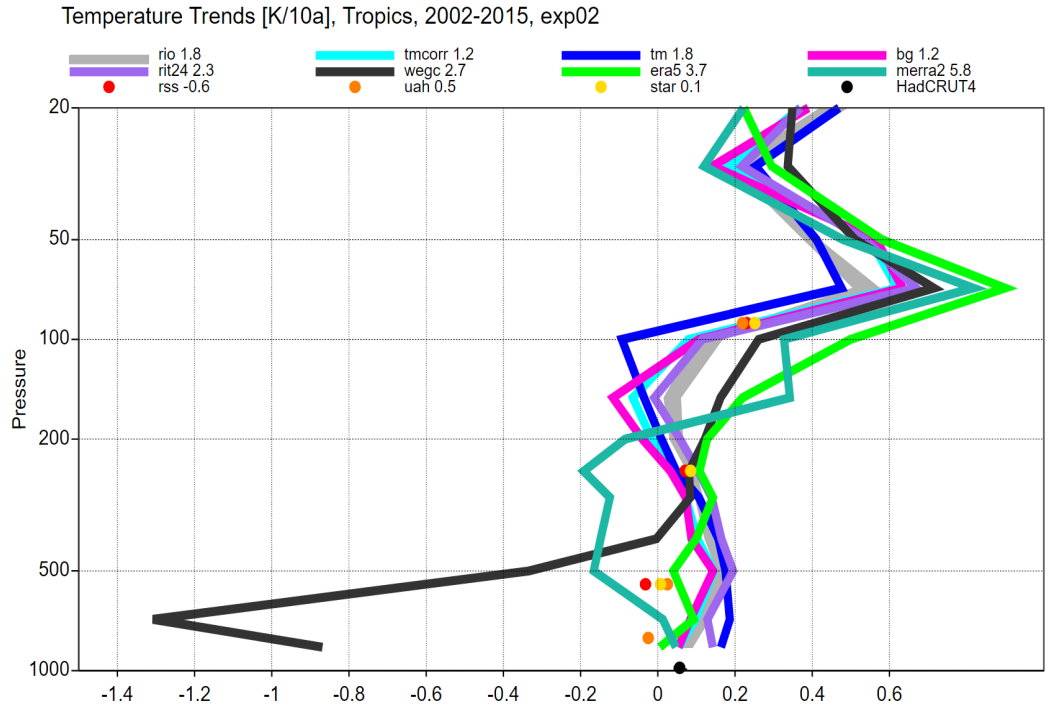


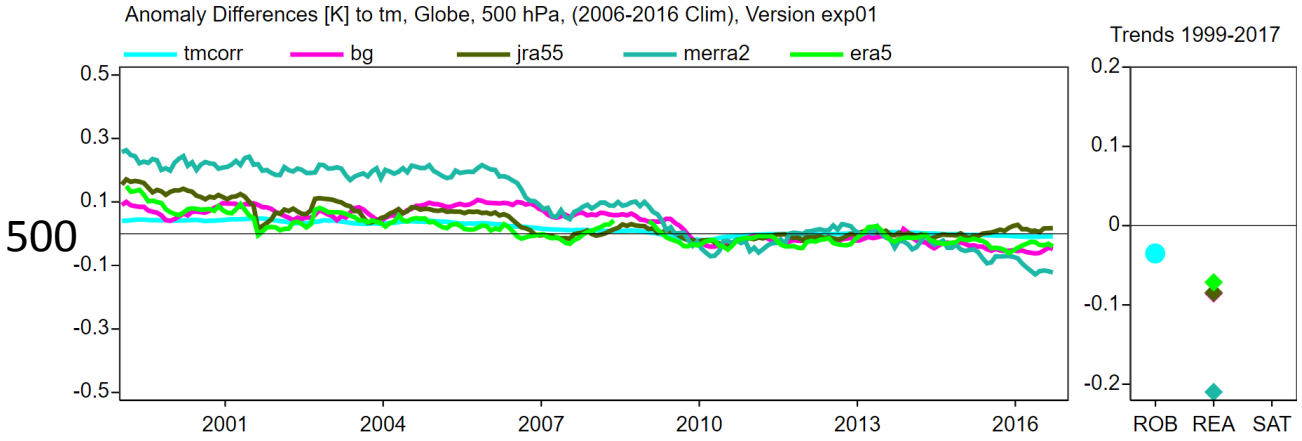
20

50

100

200



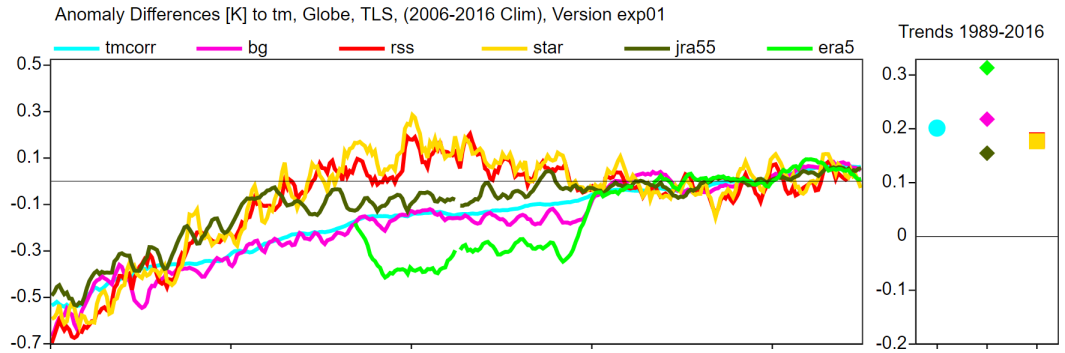


500

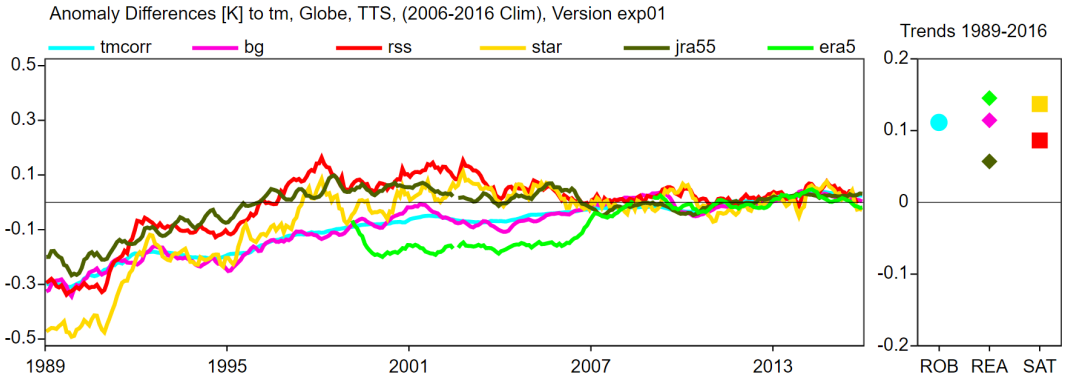
- MERRA2 spurious midtropo-spheric cooling?

Comparison with MSU Brightness temperatures

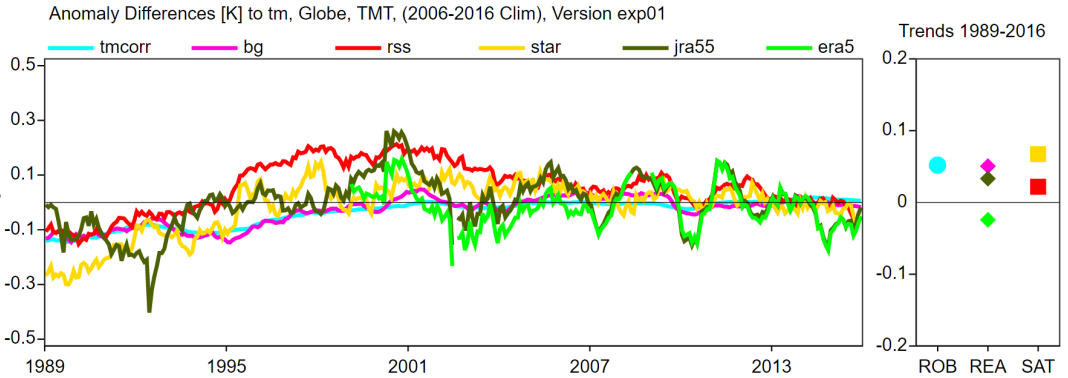
TLS



TTS

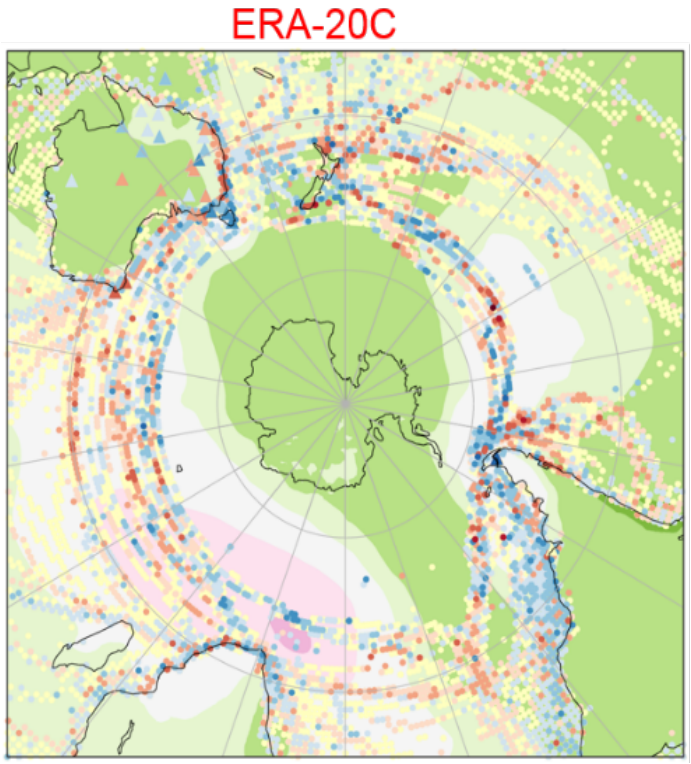


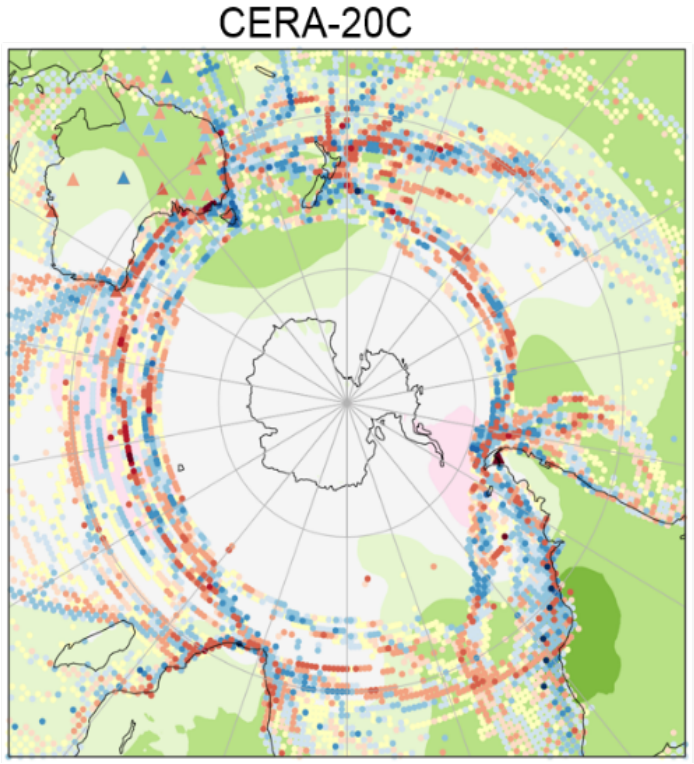
TMT

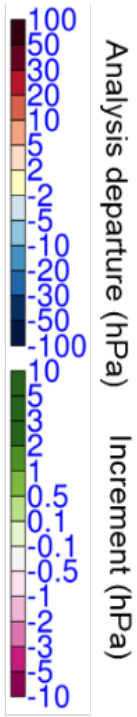


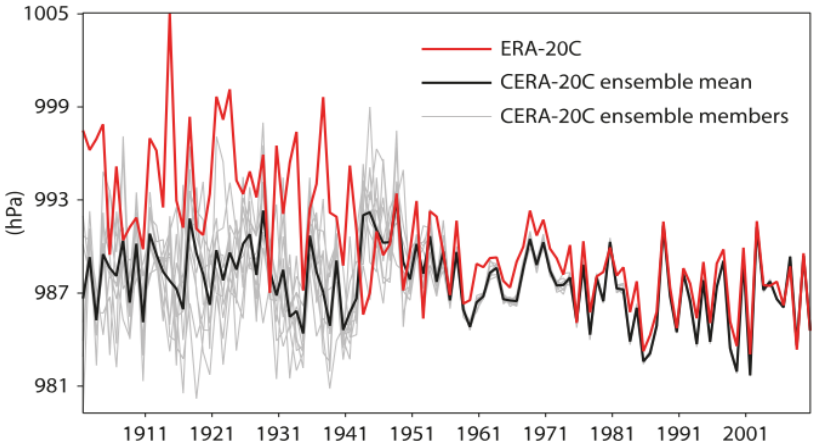
- Satellite temperatures warmer ~1996-2005
- Why?
- They show cooling of mid-troposphere (2002-2017)

Decrease of surface pressure in SH Extratropics

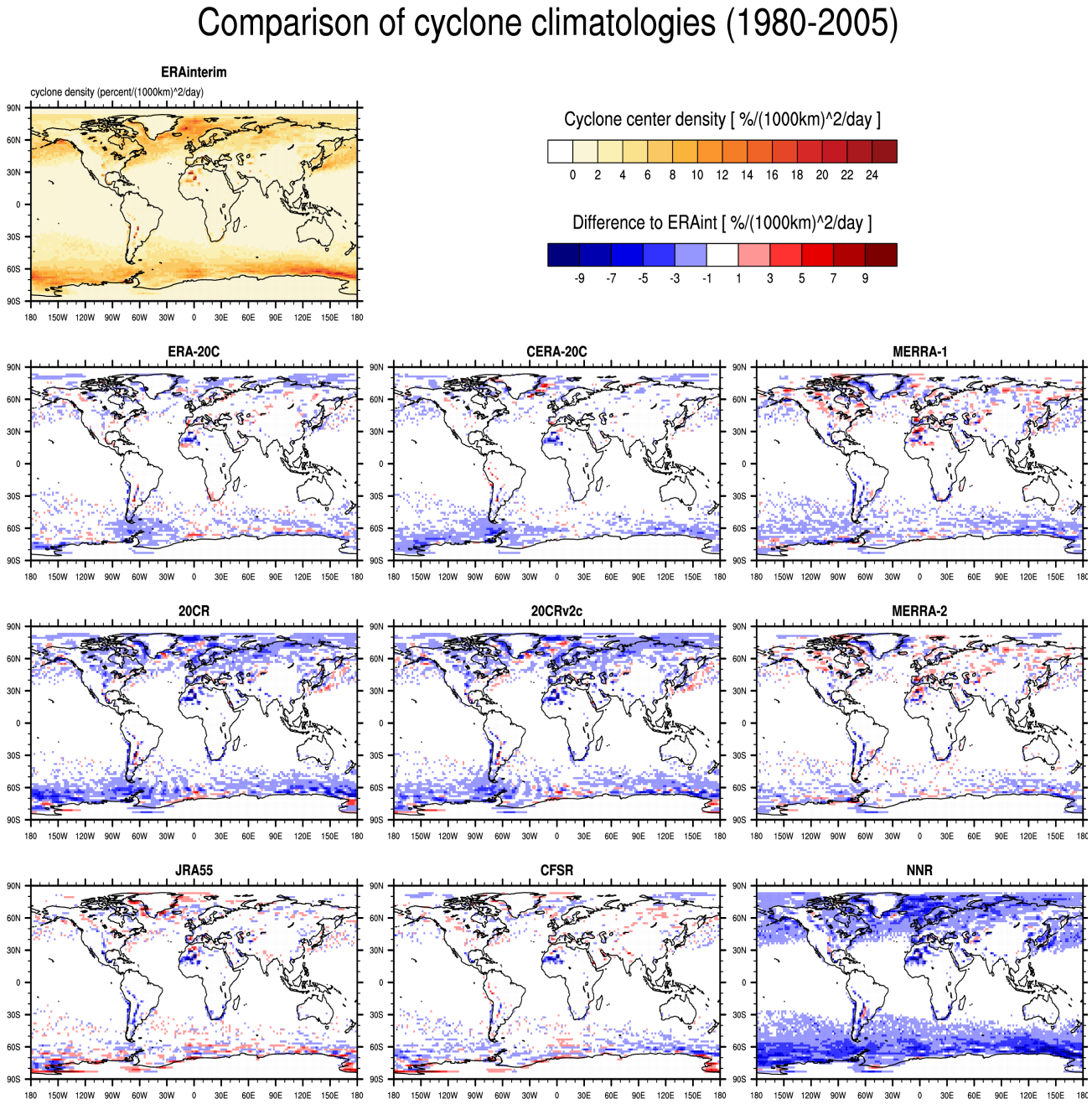








Observation error has been increased for early period -> larger departures, less bias over Antarctica

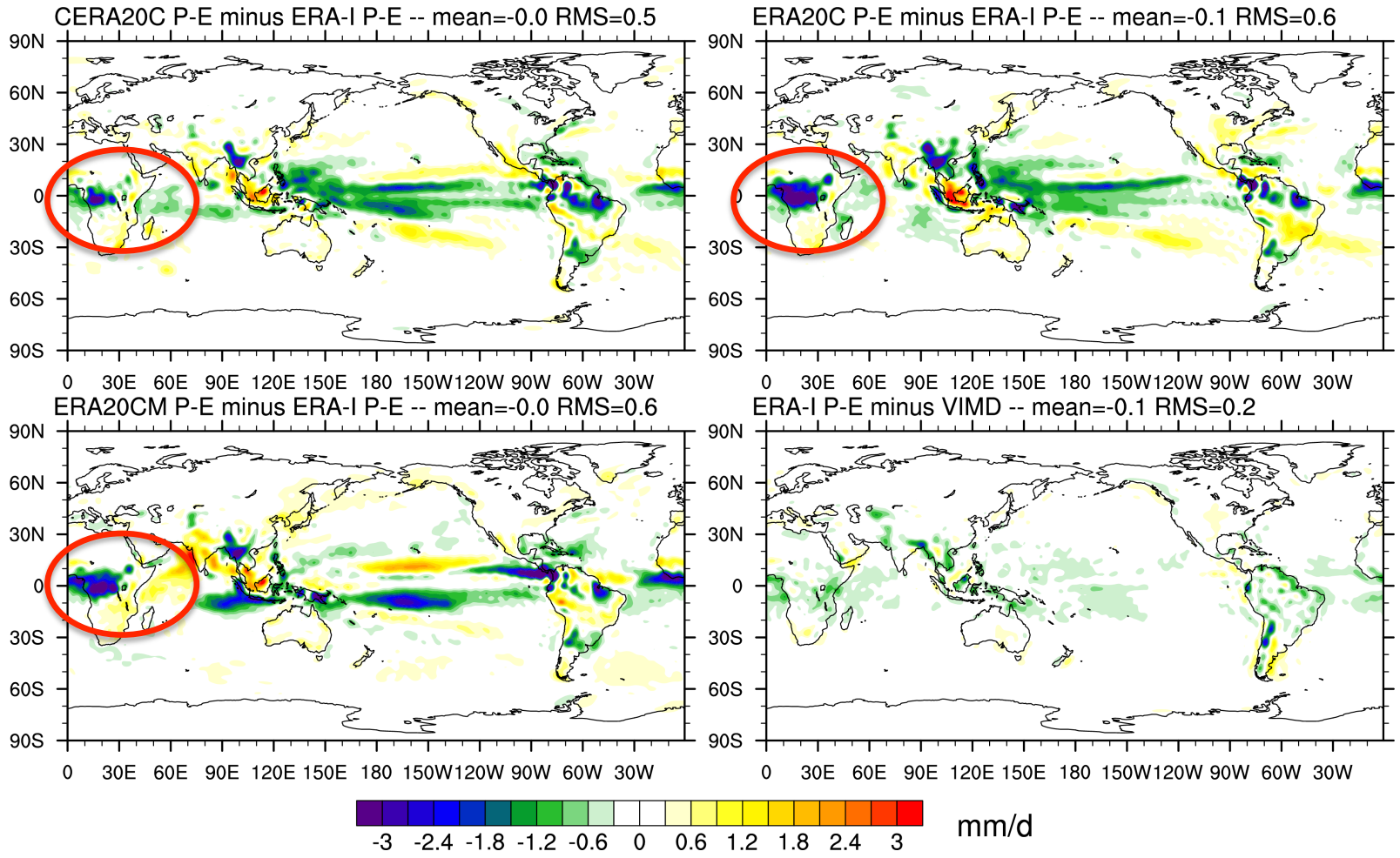


Cyclone climatology

- CERA20C most similar to ERA-Interim, JRA55 among all surface data only reanalyses

Rohrer et al. 2017

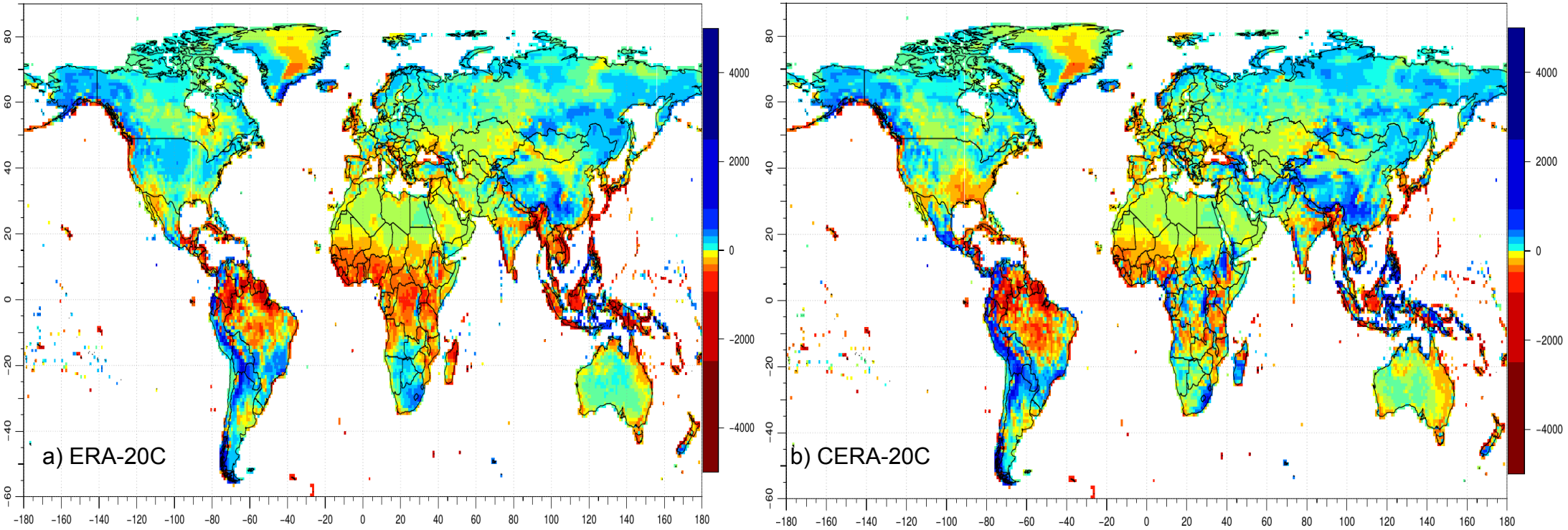
Surface data only P-E compared to ERA-Interim



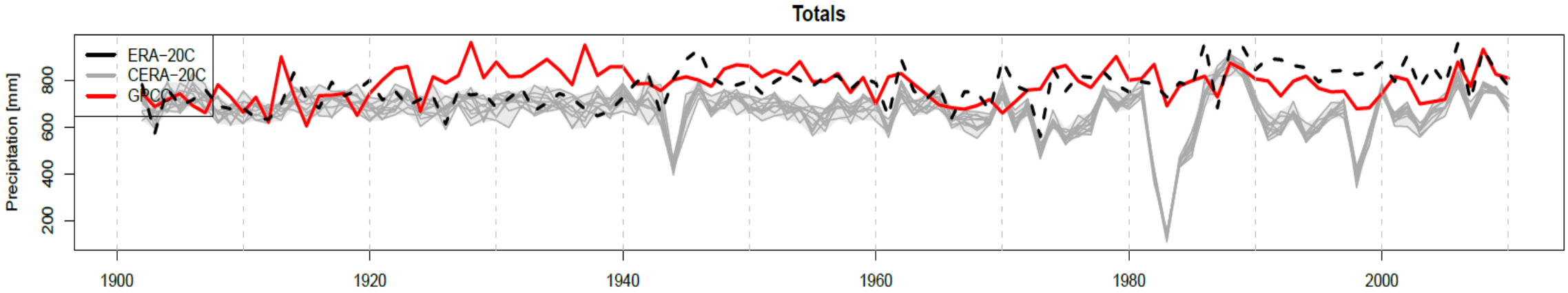
- Improvement in Central Africa
- Still dry bias over Amazonia
- ITCZ too weak

Precipitation differences 1901-2000

- Difference to GPCC

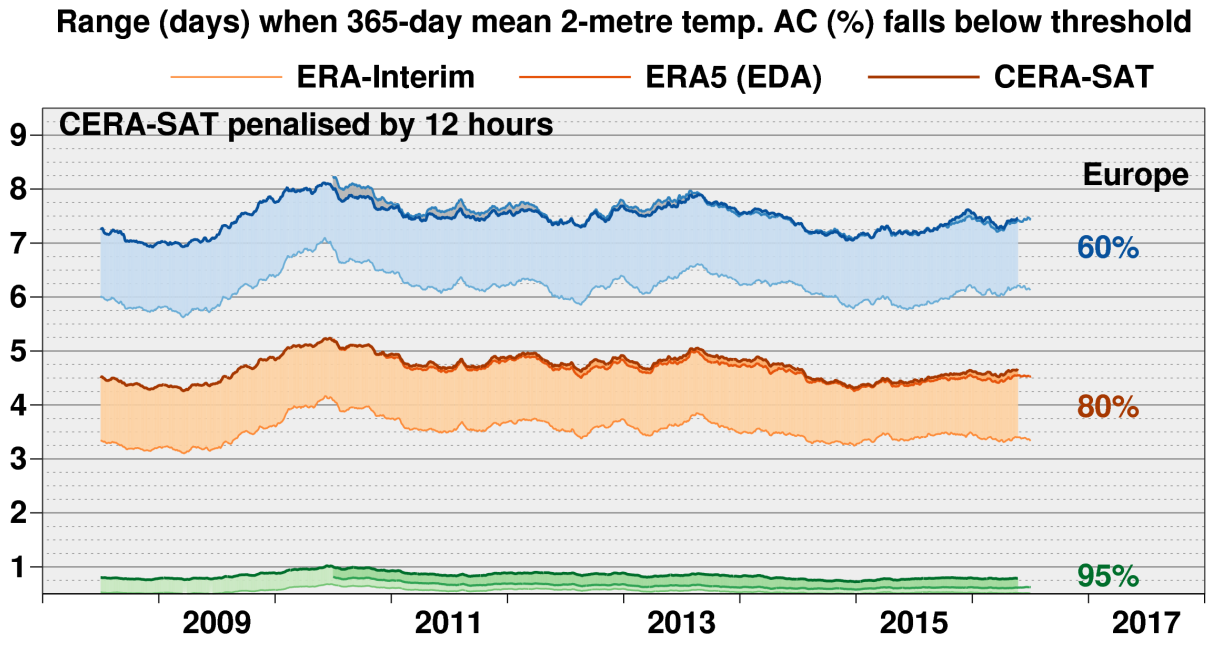


Western Amazonia Precipitation



Seasonal DJF Precipitation time series over western Amazon region (19^{o}S,66^{o}W-3^{o}S,57^{o}W) from ERA20C(black), CERA20C ensemble(grey) and GPCC. Major El Nino episodes 1942, 1982/83, 1997/98.

CERA-SAT skill scores



- Excellent forecast skill scores , very close to ERA5-EDA
- Further evaluations will follow

Conclusions

- Intercomparisons ongoing, External evaluation of CERA-SAT has just started
- Impressive performance of CERA-20C in terms of upper air temperatures
- Several other problems evident in ERA20C have been fixed or are better understood
  - Surface pressure
  - Precipitation
- Effect of Volcanoes in the stratosphere appears underestimated
- Ocean reanalyses and coupled reanalyses open new opportunities for in depth process studies
- Effect of early 20th century volcanoes on OHC?
- Ensemble spread appears too small for precipitation, upper air trend, OHC uncertainty
- If someone has an intercomparison plot that should be included in D4.10 – please send it to me!!