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BERN**

**OESCHGER CENTRE  
CLIMATE CHANGE RESEARCH**

# Results from ERA-preSAT

## Chances and challenges of assimilating pre-IGY upper air data

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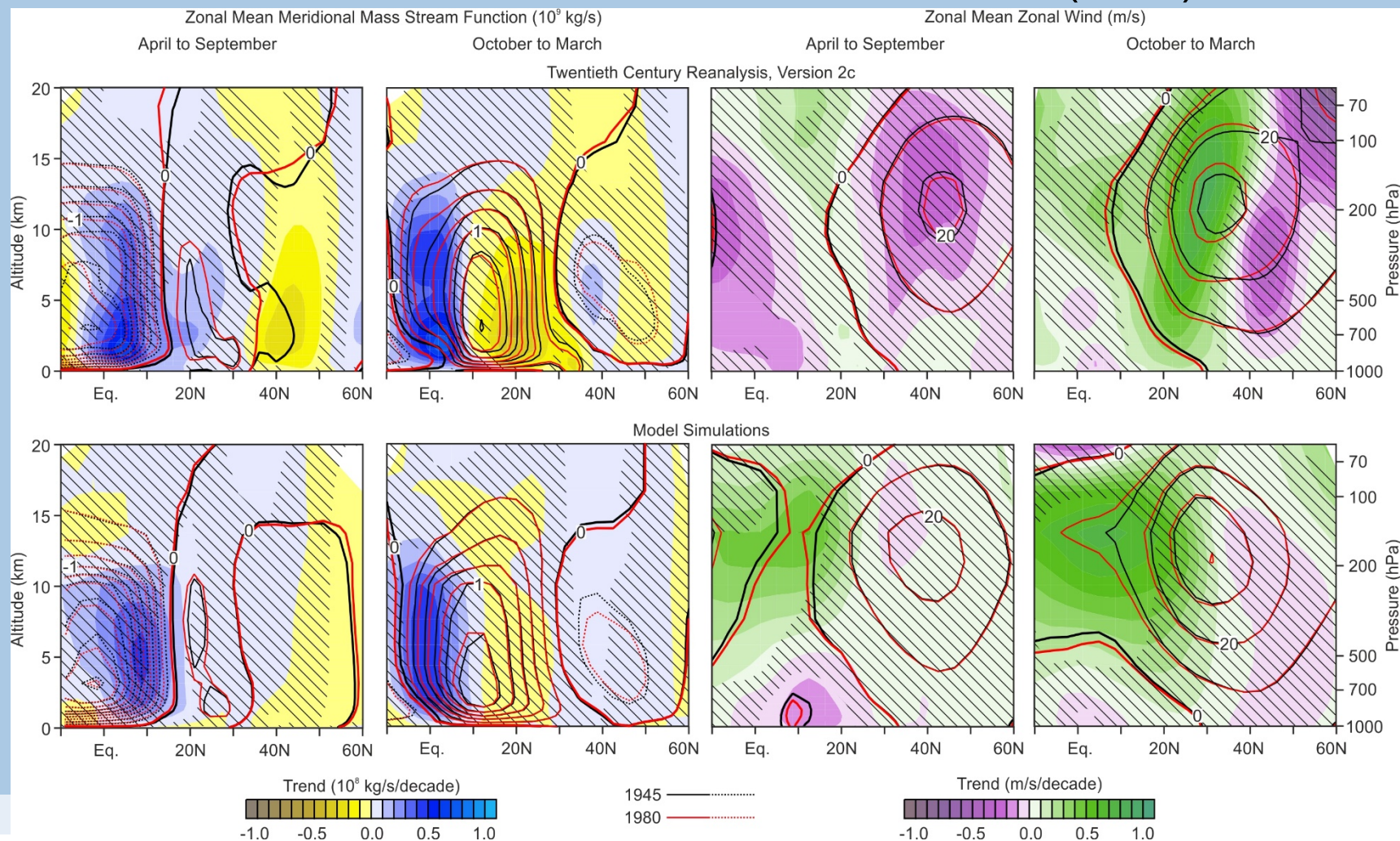
ECMWF,UBERN,UNIVIE

# Outline

- > ERA-preSAT was an experimental assimilation run at ECMWF for the years 1939-1967
  - Assimilating model as used for ERA-20C
  - In addition to surface pressure data, early upper air data have been assimilated
  - All upper air data collected in ERA-CLIM have been assimilated, in particular CHUAN v1.7
  - SSTs, sea ice as in ERA-20C, only one realization
- > Aims:
  - Feedback on quality of early upper air data
  - Impact of early upper air data
  - Detect problems in preparing/reading those data

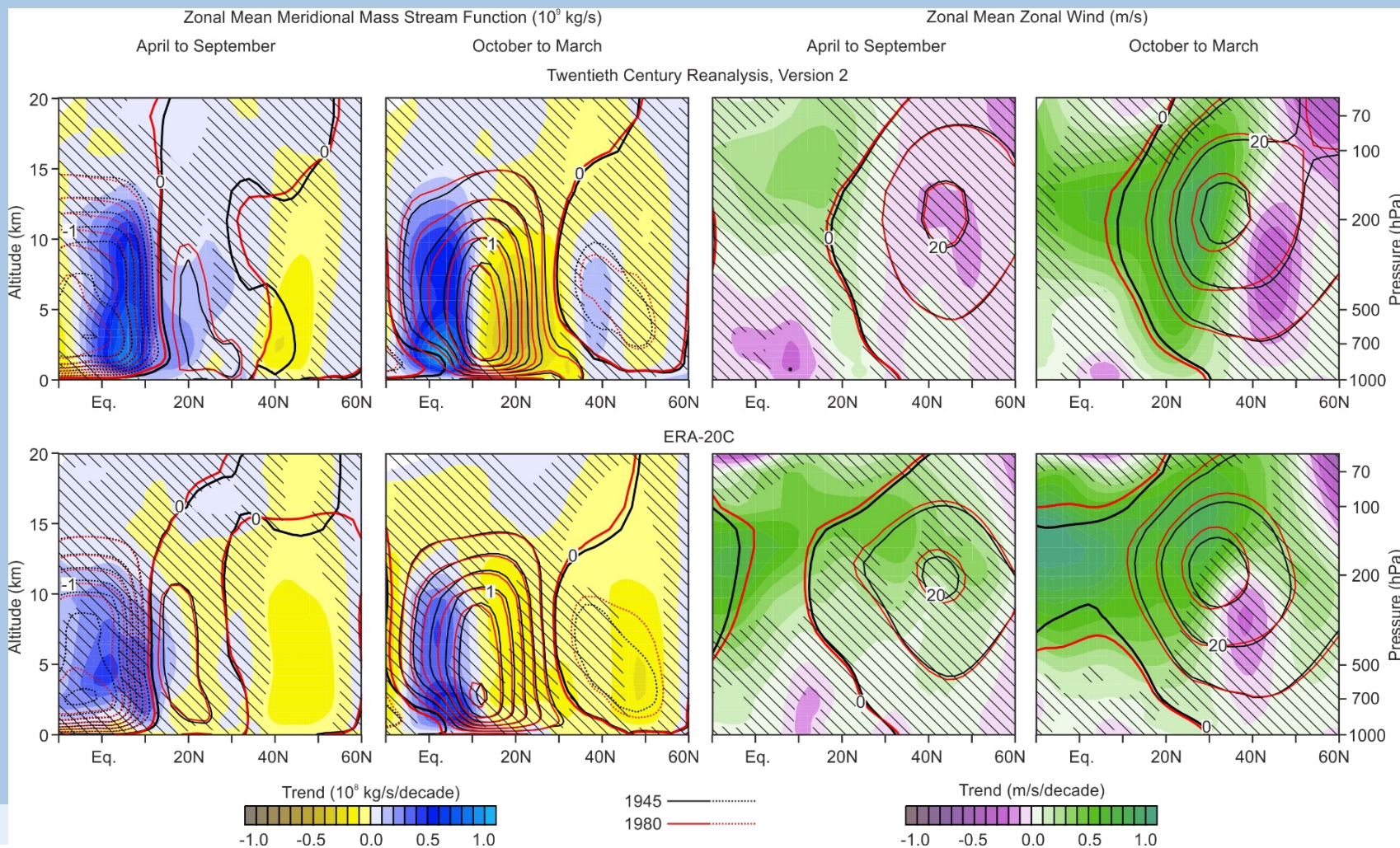
# Much can be done with ERA-20C

## > Vertical Cross Section of 20CRv2c and AMIP («all») model



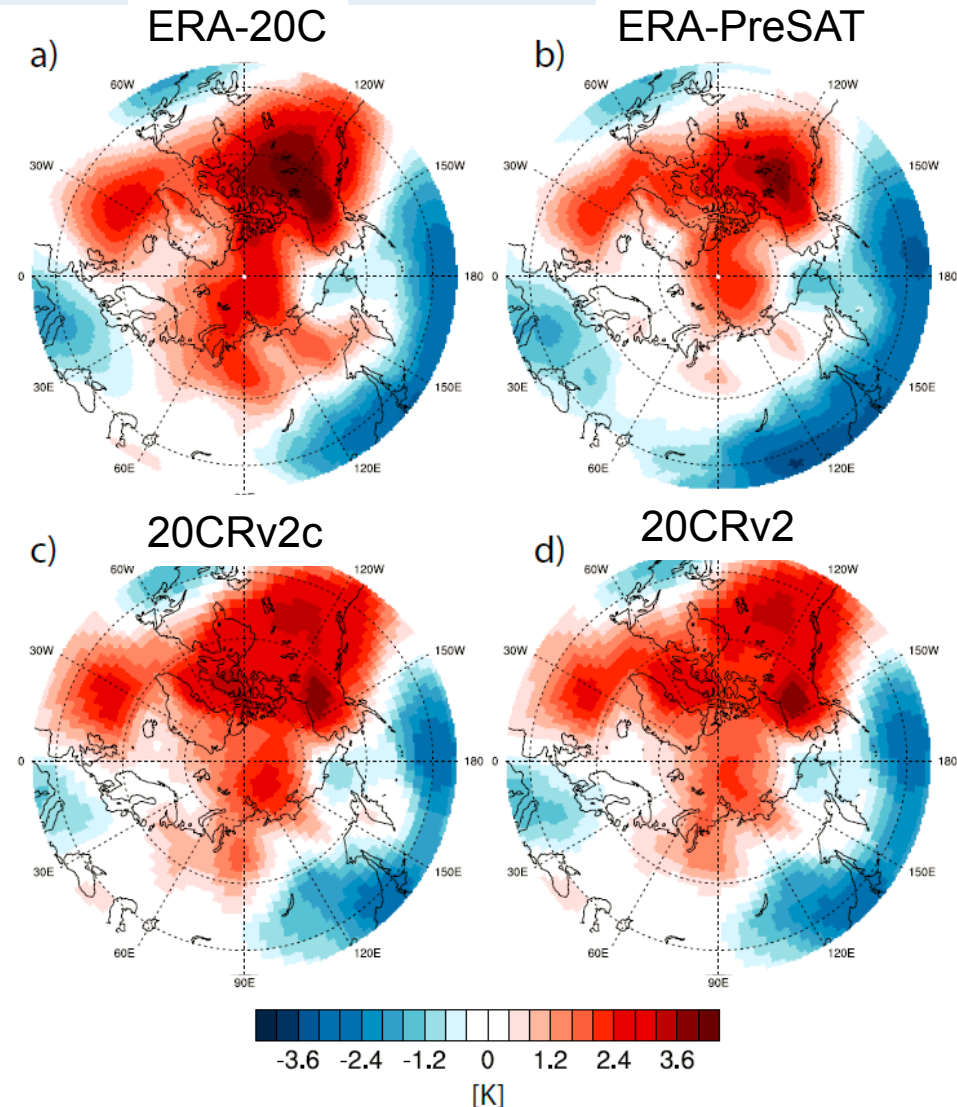
# Results

## > ERA20C and 20CRv2: Similar



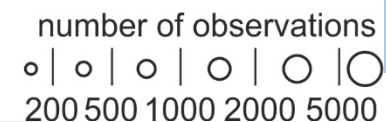
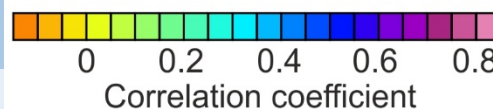
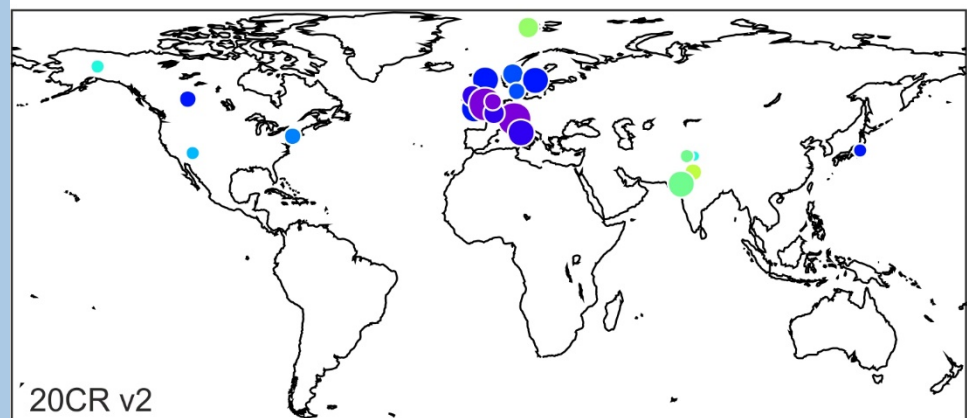
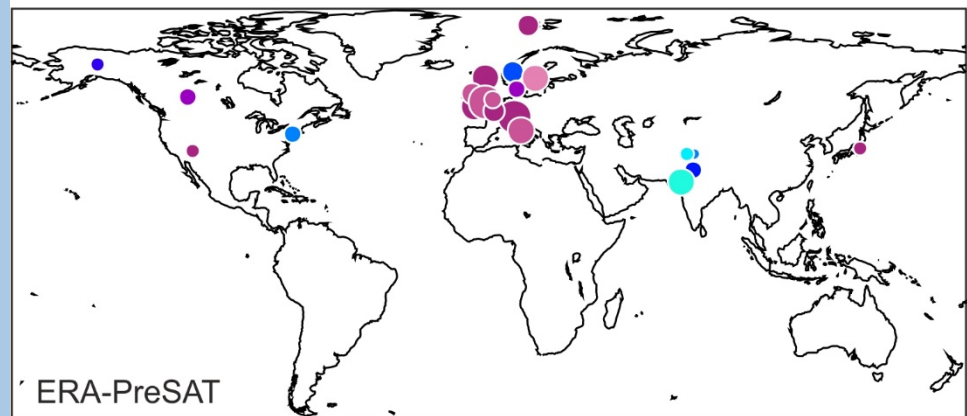
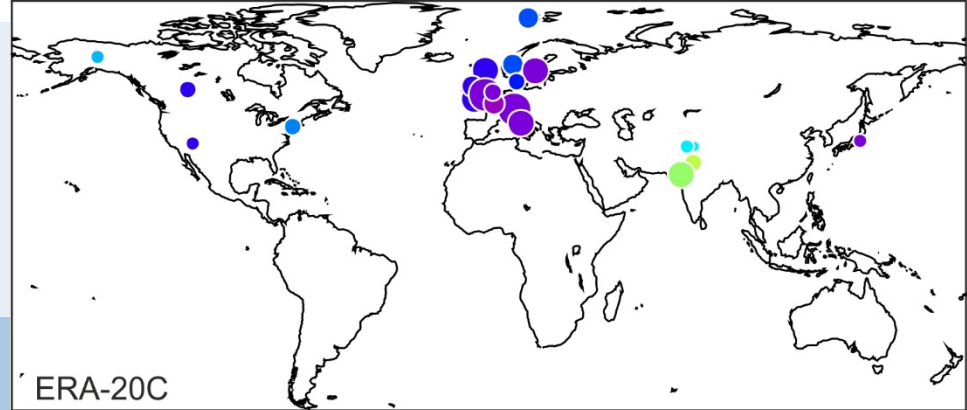
# Reason for Arctic temperature «jump»

- > Anomalies 1943-46 minus 1948-51, 700 hPa T
- > Difference ERA-20C and ERA-PreSAT in **North American** sector
- > Due to assimilated data?



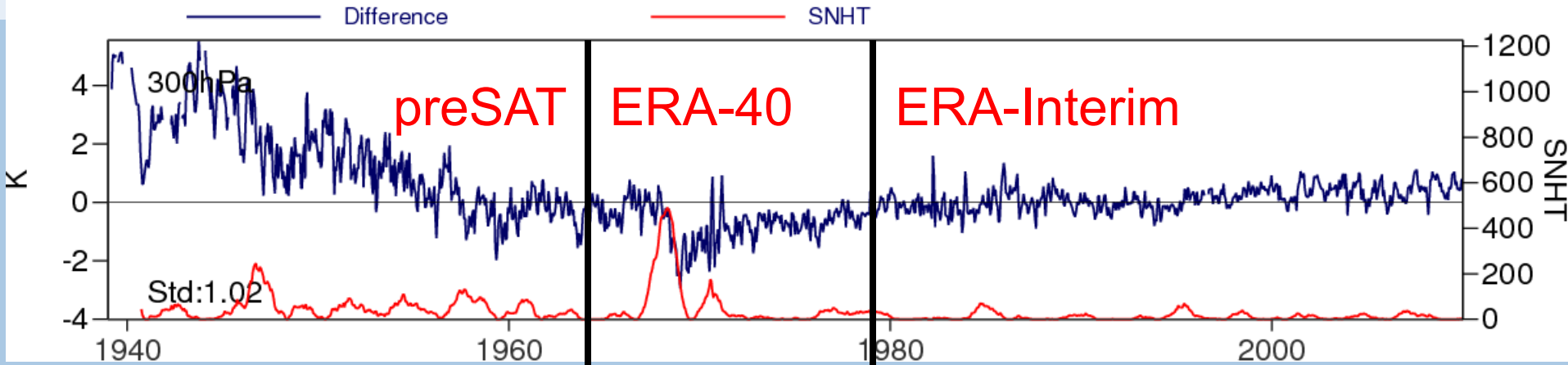
# Total ozone day-to-day correlations 1939-1963

- > Correlations of 0.6-0.8 between historical total ozone observations and reanalyses
- > ERA-PreSAT clearly the best of all reanalyses

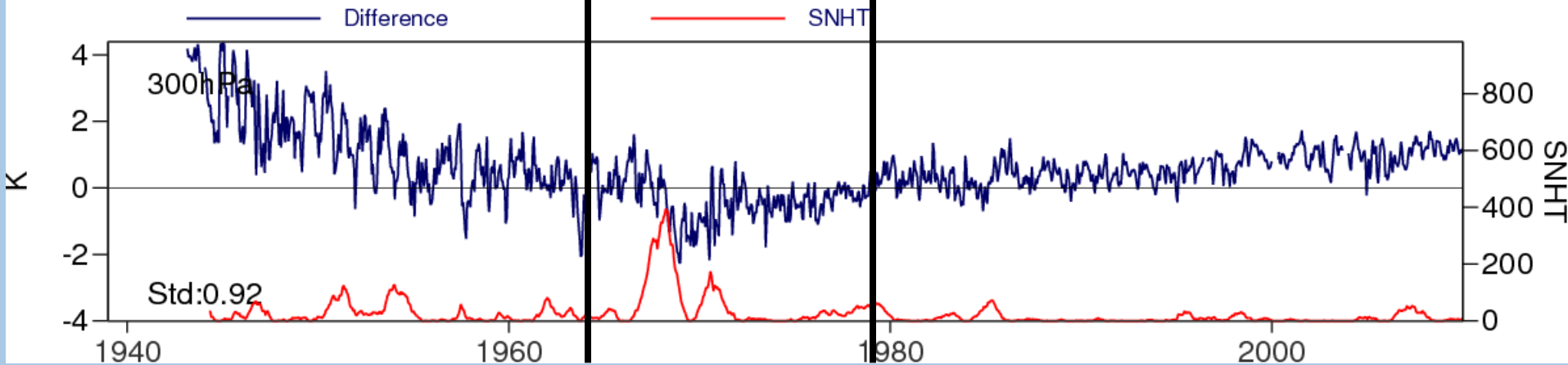


# Moscow obs-ERA-presat

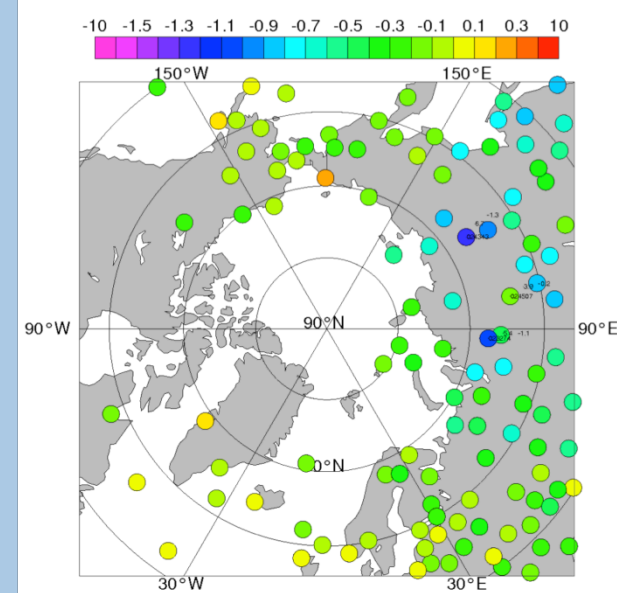
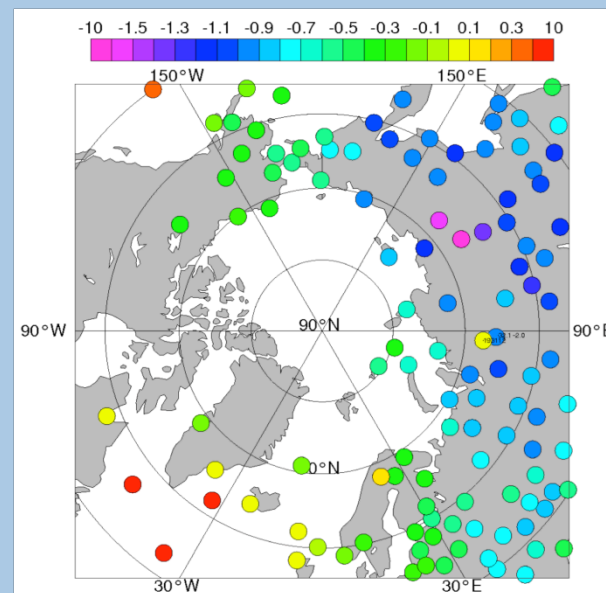
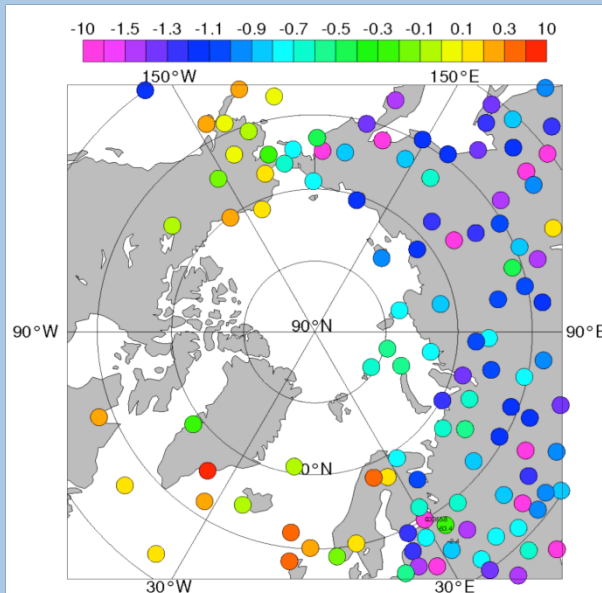
Background departures, 27612, 00h



Background departures, 27612, 12h



# Adjustment of early RS-temperatures



Unadjusted

RAOBCORE adjusted

RICH adjusted

- Radiosonde T-trends 1954-1974, at 300 hPa.
- Reference Series ERA-preSAT (-1967), JRA55 (1968-1979)
- Improvements due to digitized FSU data, ERA-preSAT observation feedback archive
- Part of D4.1

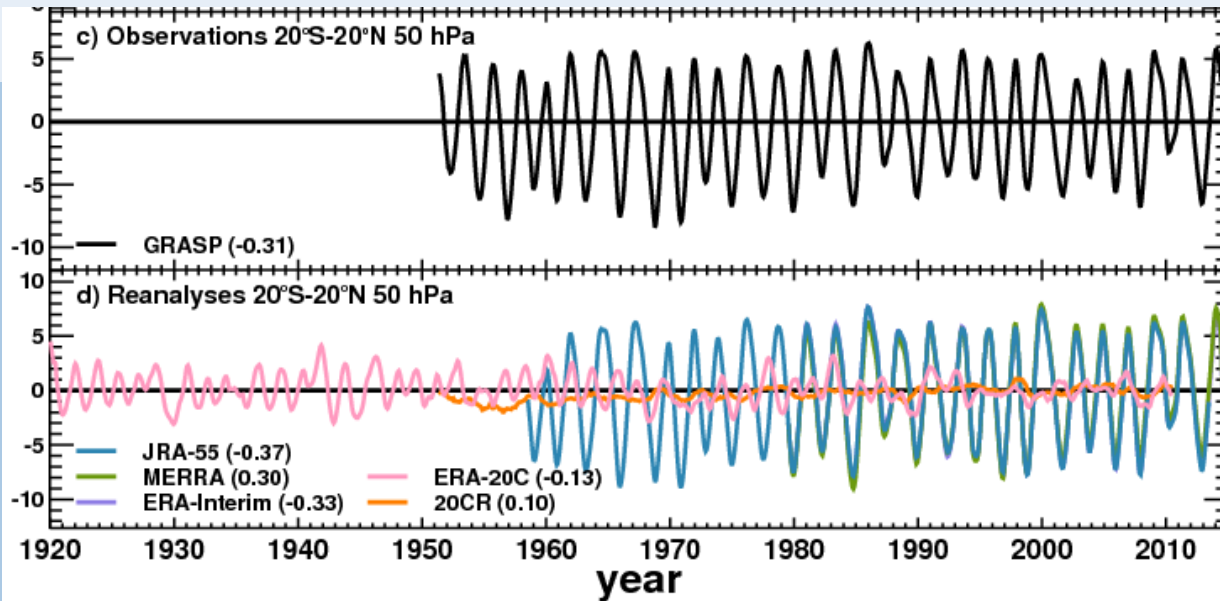


# Upper air winds

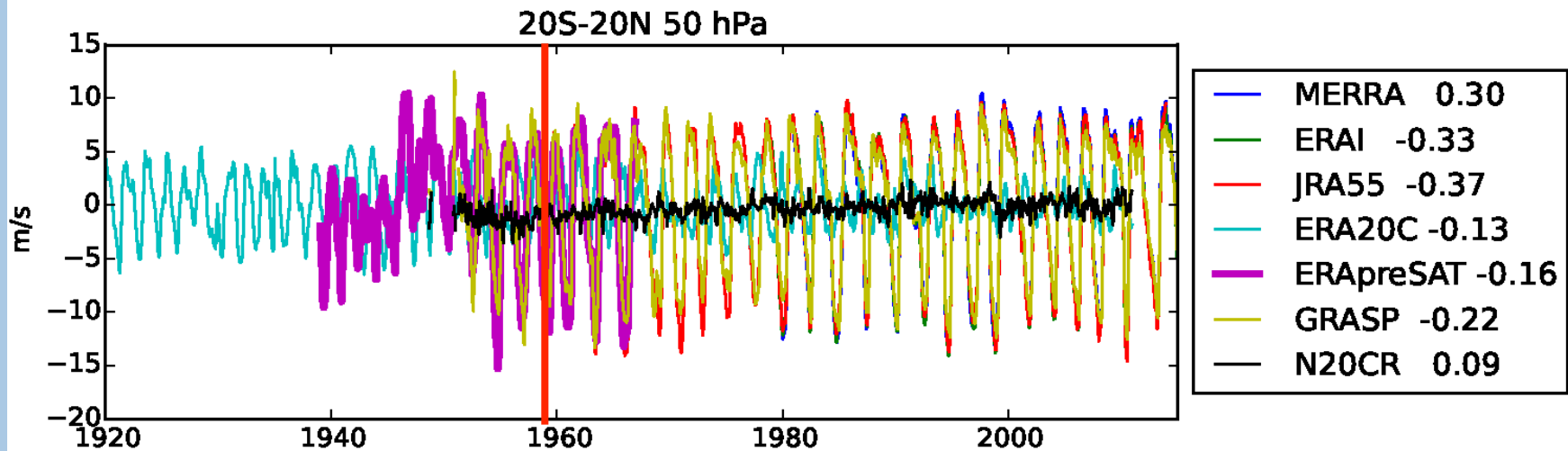
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- > BAMS state of the climate 2014
- > Extension of realistic QBO in reanalyses feasible back late 1930s?
- > ERA-preSAT ok back to mid-1940s.



## Issues detected

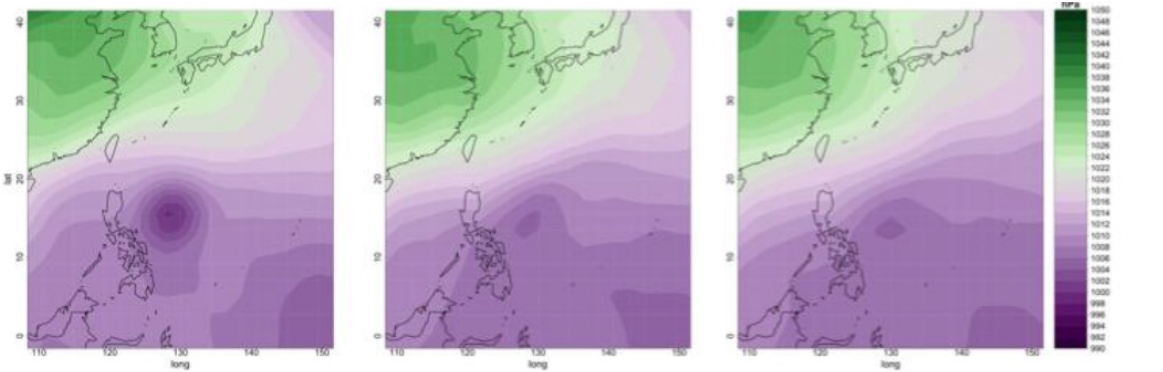
- > Some data missed (cyclone track data)
- > Some data assimilated twice (bias-corrected and unadjusted versions of CHUAN)
- > Inhomogeneities in boundary condition data sets
- > Strong changes of inter-hemispheric gradients and fluxes

# Data issues

20CR v2

ERA-20C

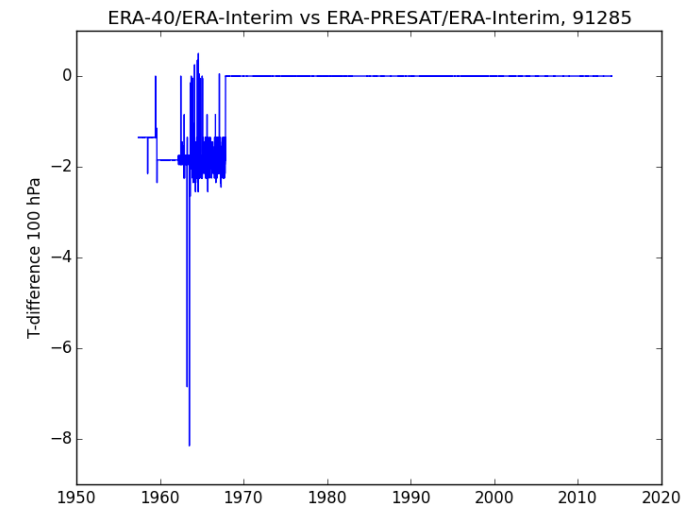
ERA-PreSAT



18 Dec 1944

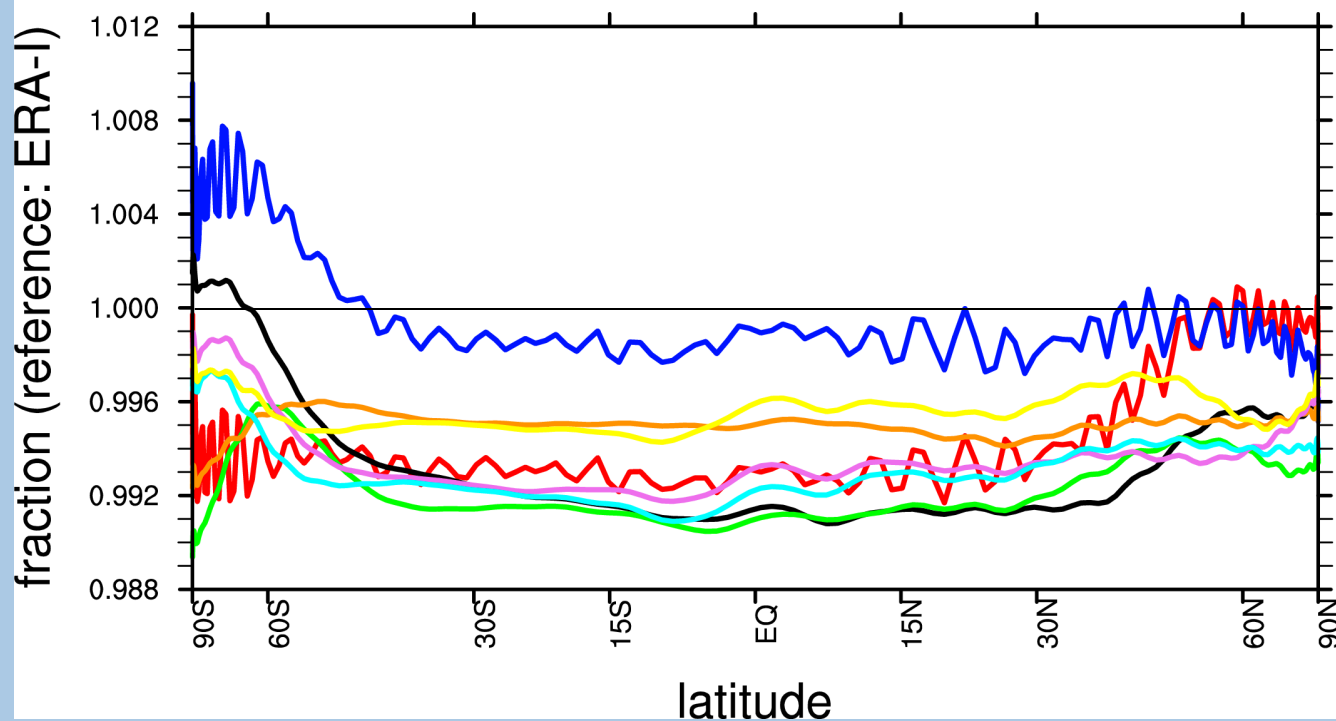
Typhoon COBRA  
Cyclone track data not  
assimilated

- T-observations in ERA-preSAT 2K lower than in ERA-40.
- Due to bias correction in CHUAN v1.7
- Not documented in assimilation.



# Differential warming

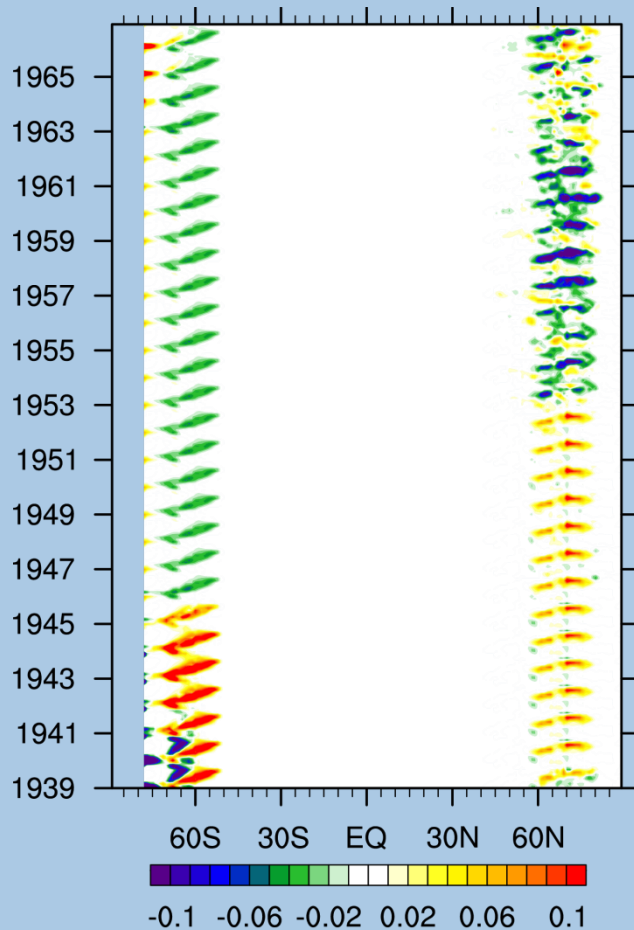
## Total energy



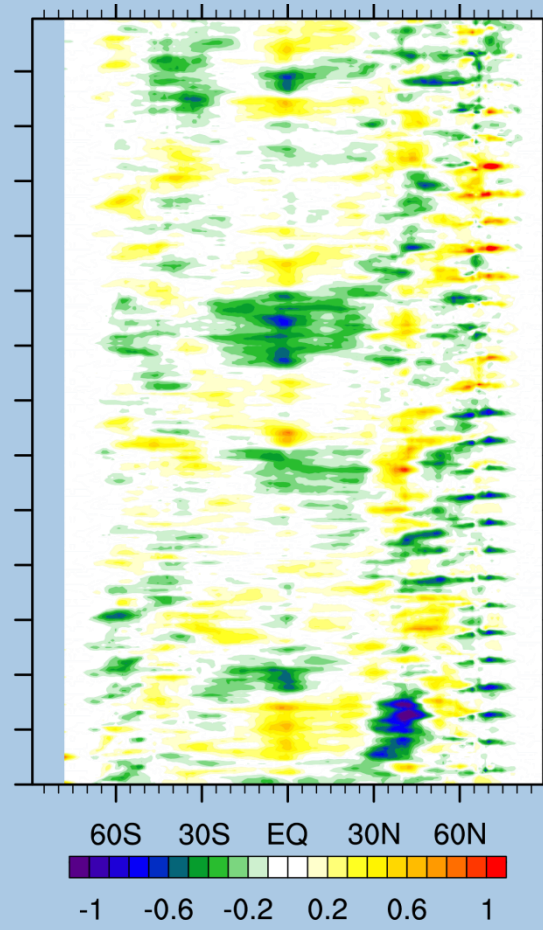
1%=2.5K

# Boundary conditions and fluxes

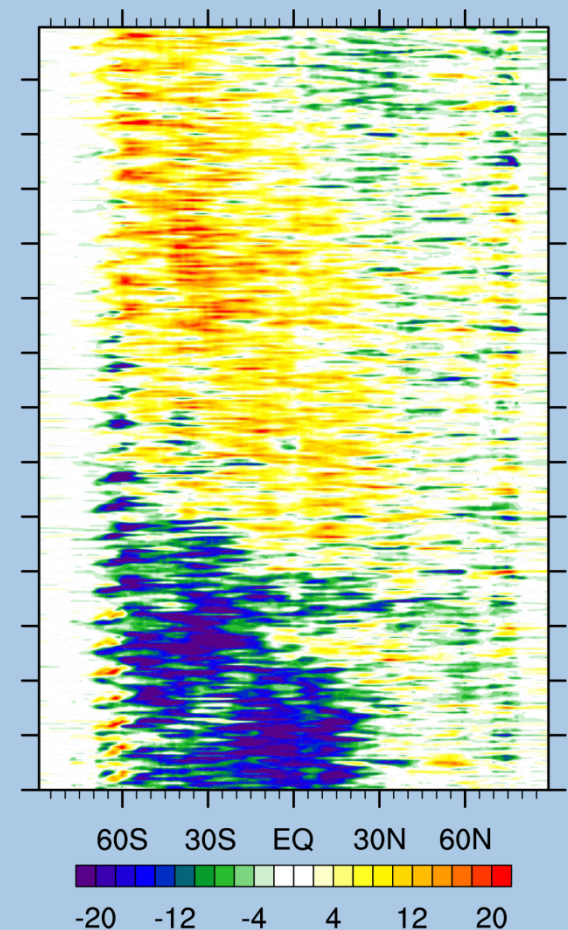
## Zonal mean sea ice (%)



## Zonal mean SST (K)



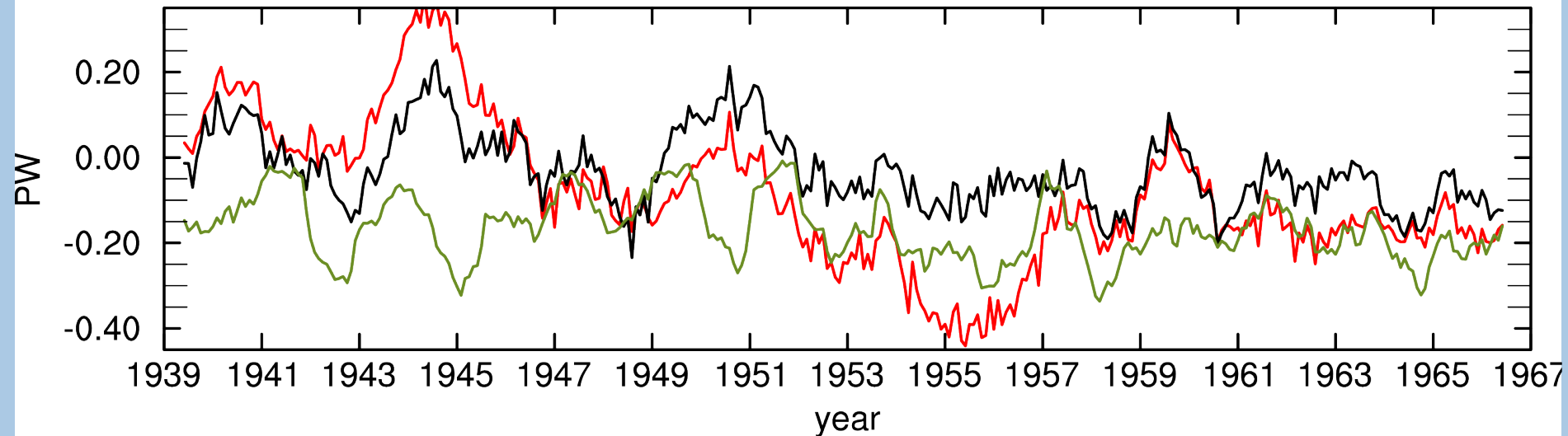
## Zonal mean $F_S$ ( $Wm^{-2}$ )



# Cross-equatorial total atmospheric energy flux

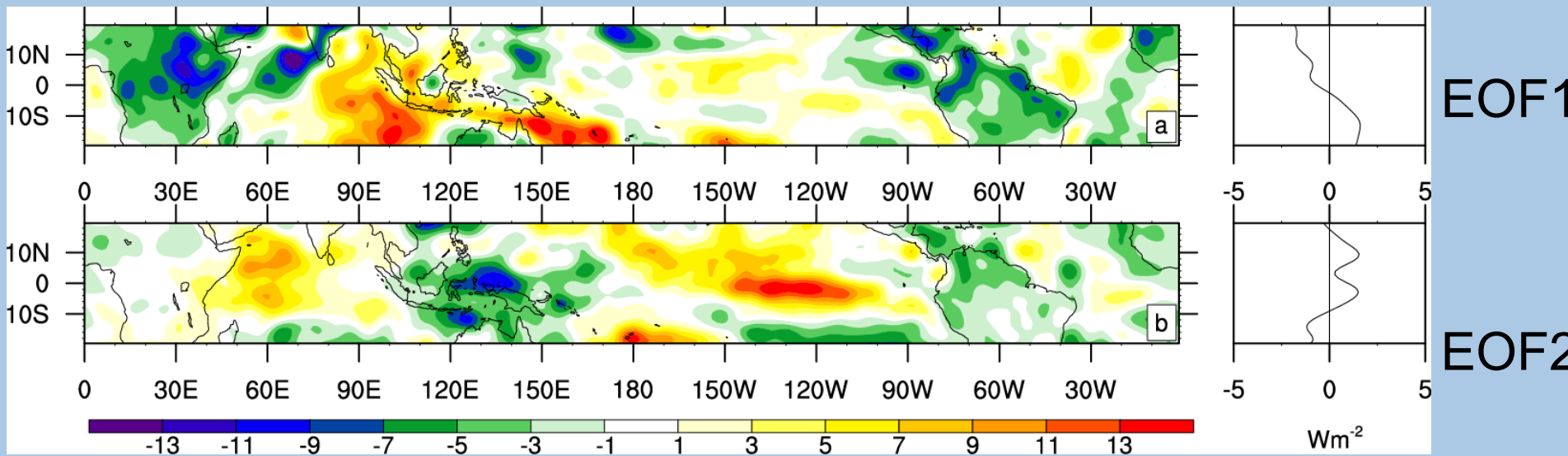
flux across equator [ERA-I:-0.2]

— ERA20CM  
— ERA20C  
— ERA-Presat



# EOF analysis of tropical belt

## Horizontal energy flux divergence anomaly

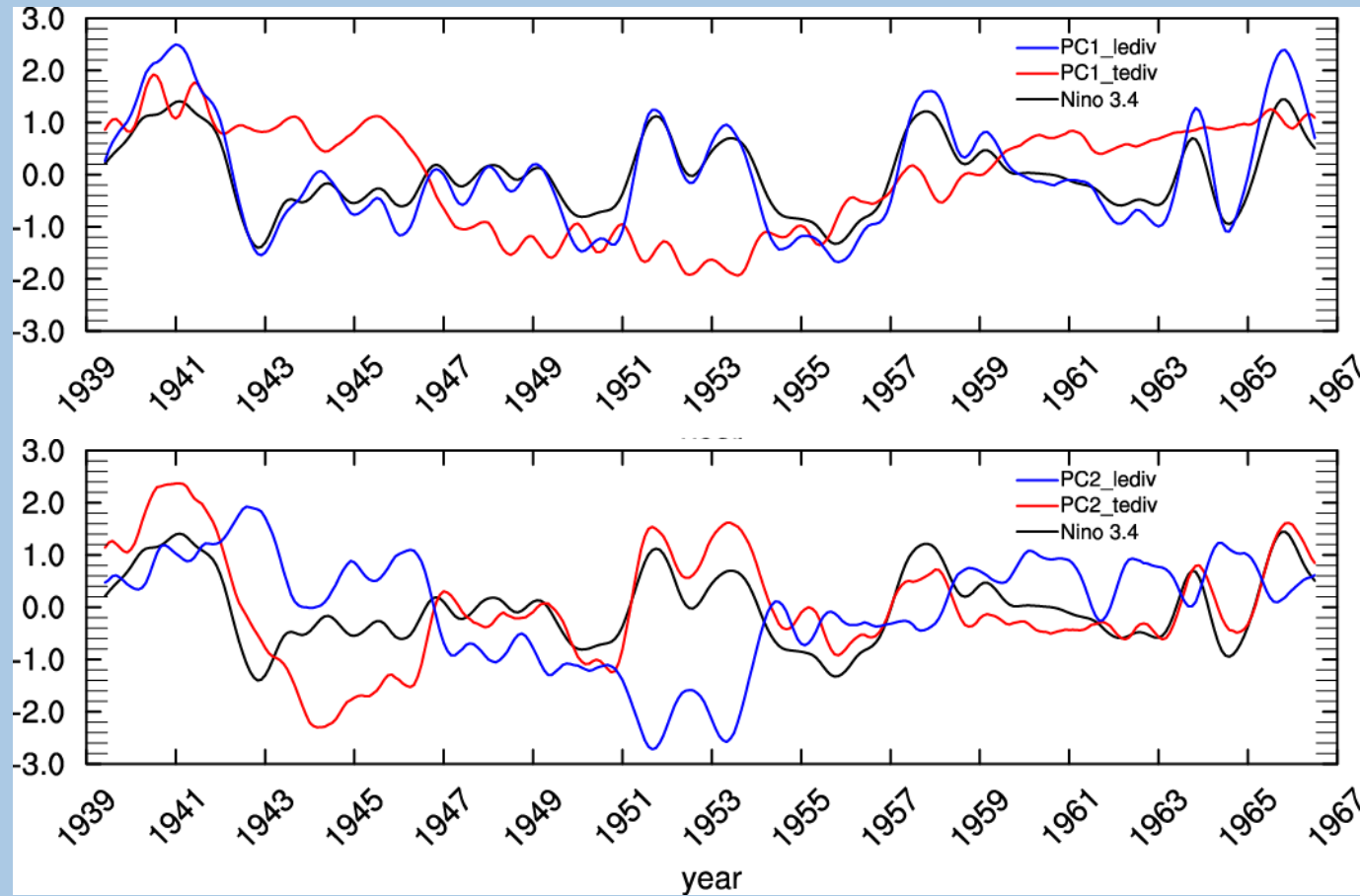


1939-1967

EOF1 is zonal mean change of gradient of energy fluxes

EOF2 is ENSO pattern

# PCs of tropical mean energy flux divergence





# Conclusions

- > Upper air data are of quite high quality. Yes, there are biases but the variance of background departures is small
- > Some issues in assimilation in ERA-preSAT that are not too hard to fix
- > No recent ECMWF assimilation of UA data 1967-1978, only JRA55
- > **STRONG RECOMMENDATION:**  
Repeat ERA-PreSAT  
(correct hurricanes, radiosonde ingestion, extend time frame to 1918-2017: ERA100)

Knowledge of the great climatic changes of the past can help in the development of a system of long range weather forecasting. But the work of collecting, and putting into order, sufficient data on a worldwide scale is only just beginning.

Lamb 1969, Nature

Lamb described ERA-CLIM, ERA-CLIM2, ERA-CLIM3?

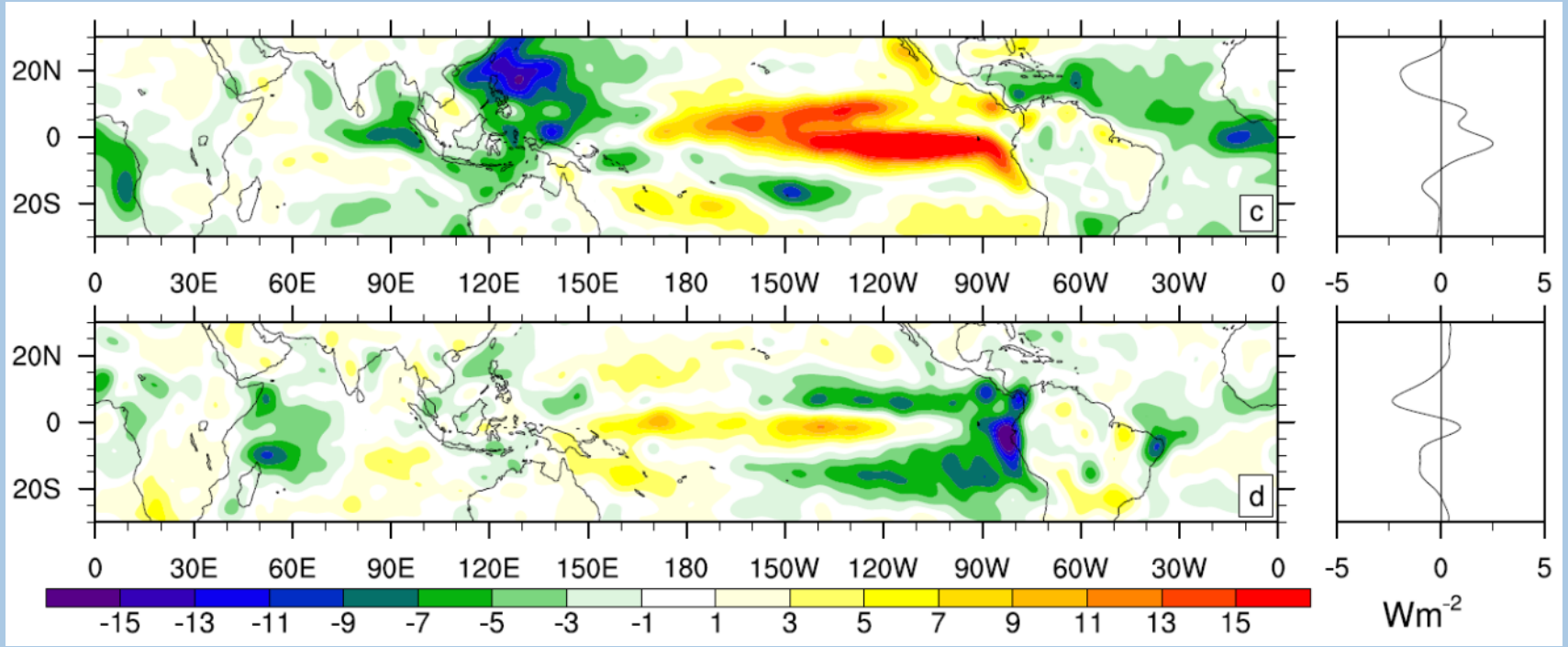


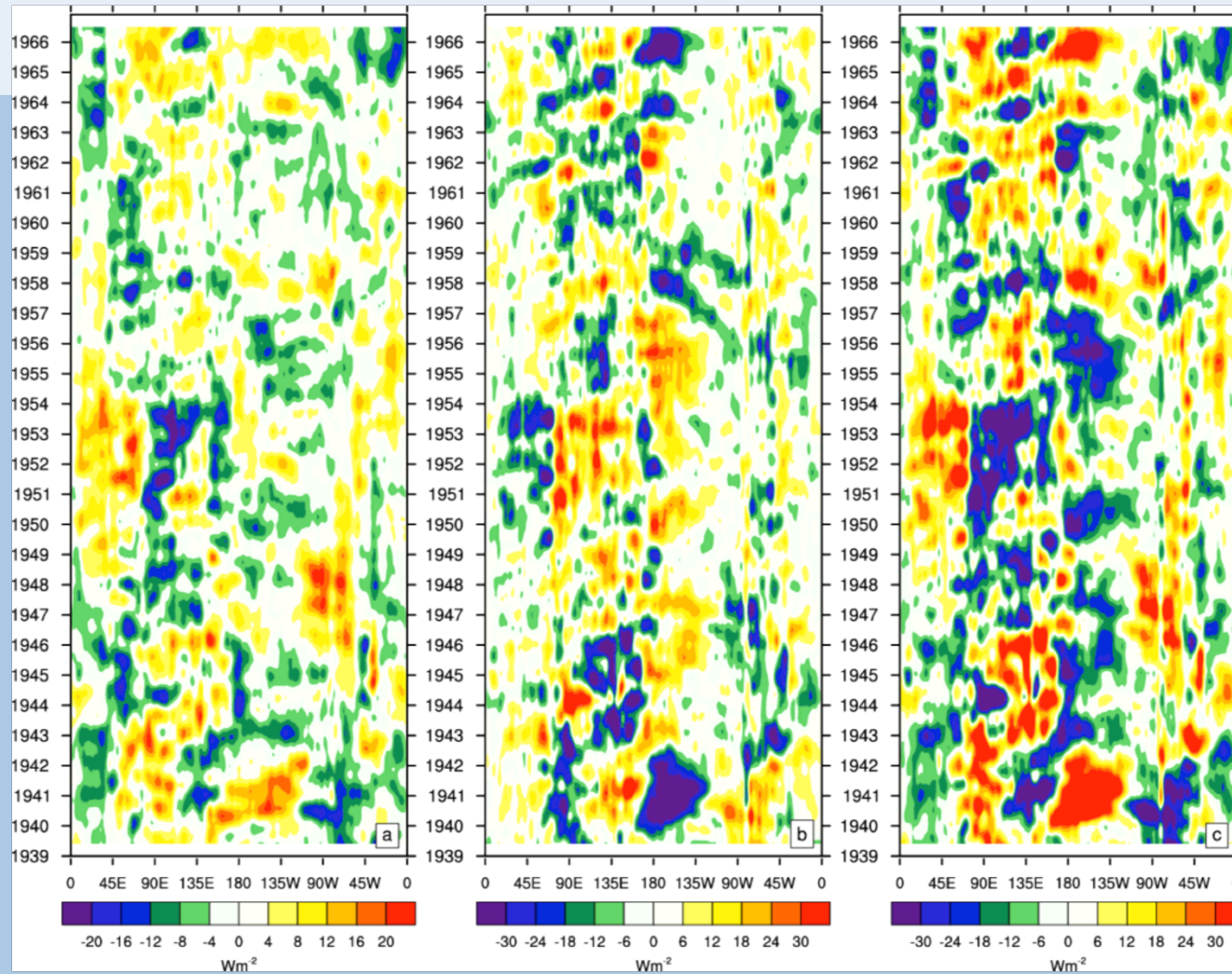
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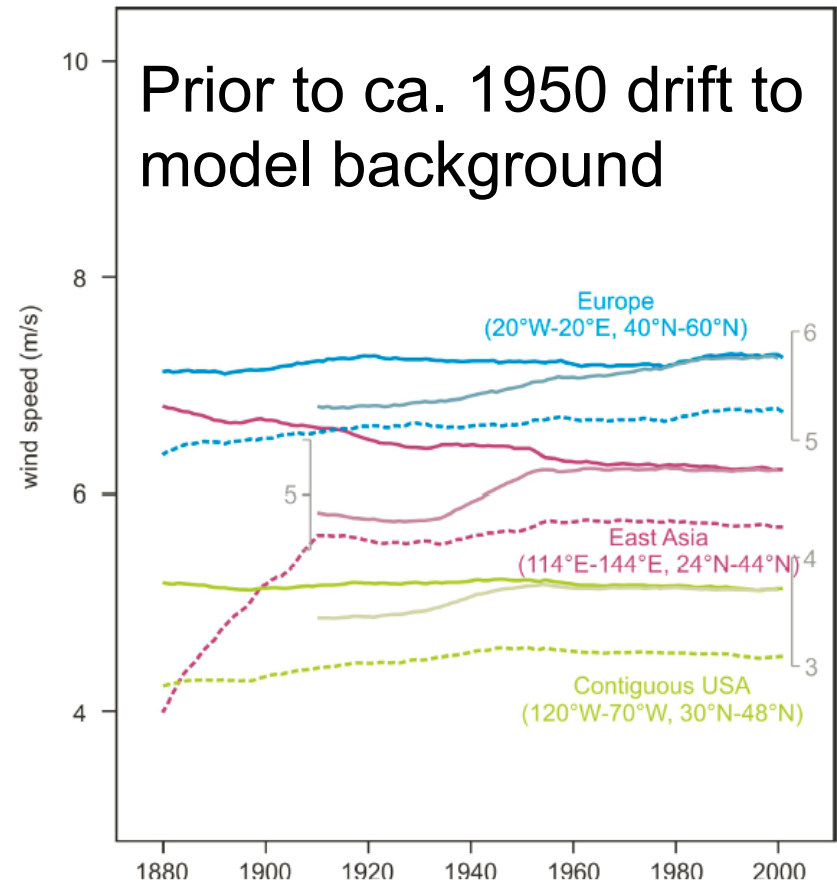
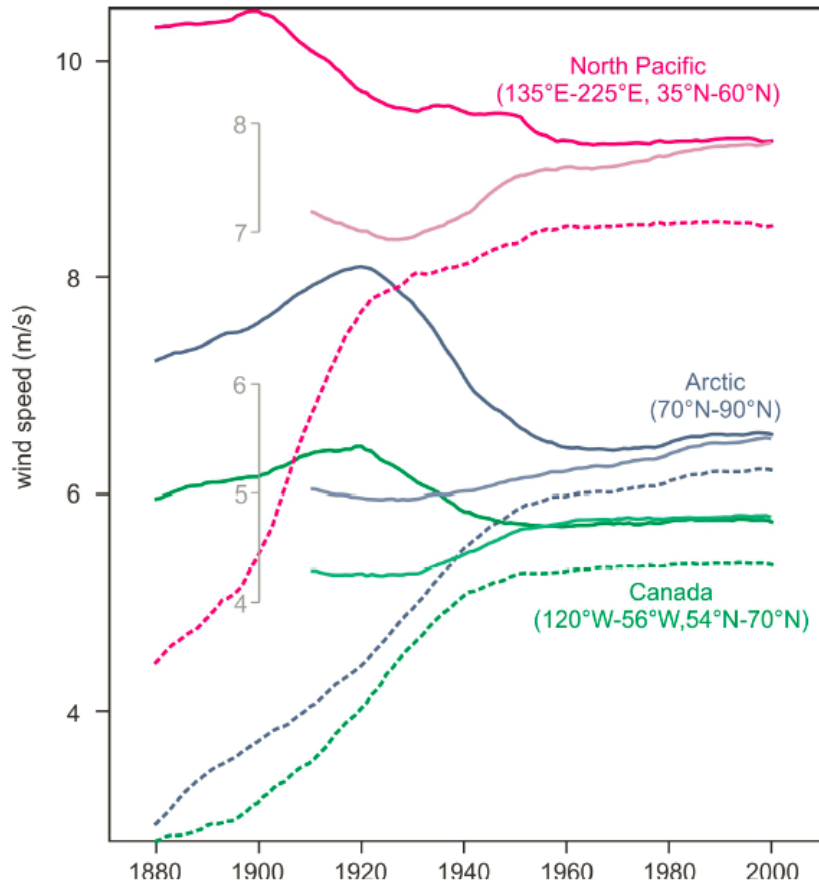
# EOFs 1979-2013





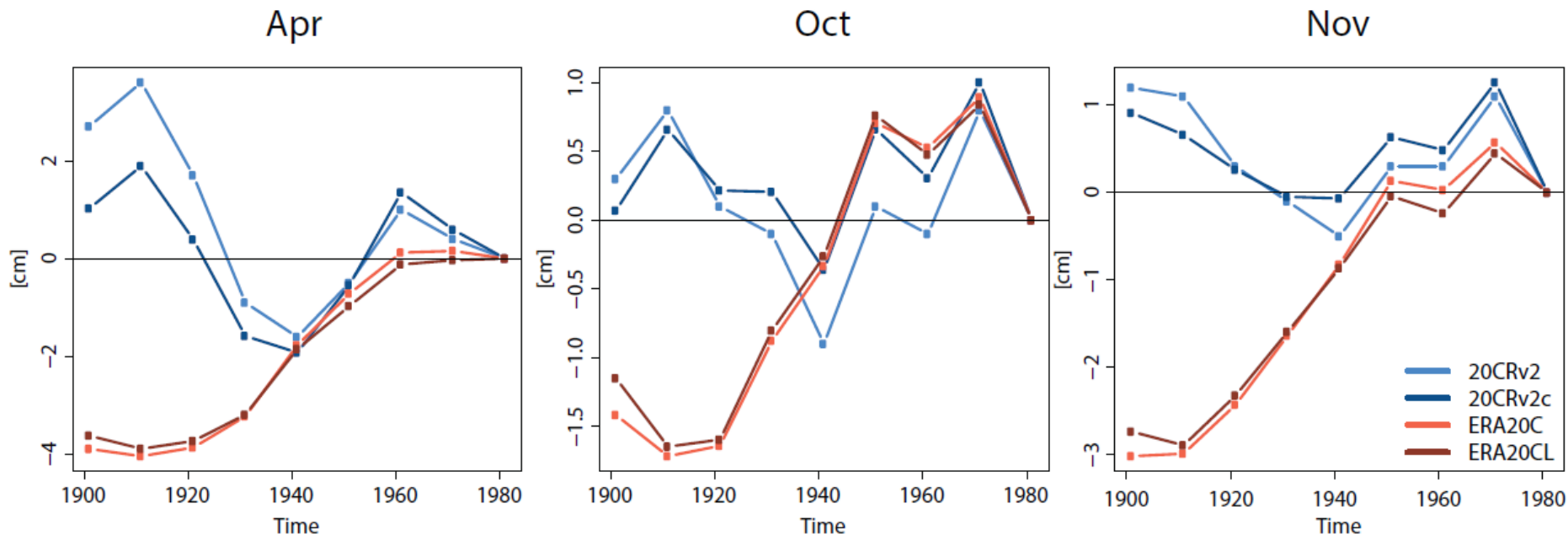
# Wind speed

- > Wind speed of ensemble mean (dotted) and ensemble mean of wind speed (solid), for 0.995 sigma in 20CRv2 (darker colours) and for 10 m wind in ERA20C (lighter colours, different scale), 20-yr smoothed



# Snow cover: Anomalies of 30-yr climatologies

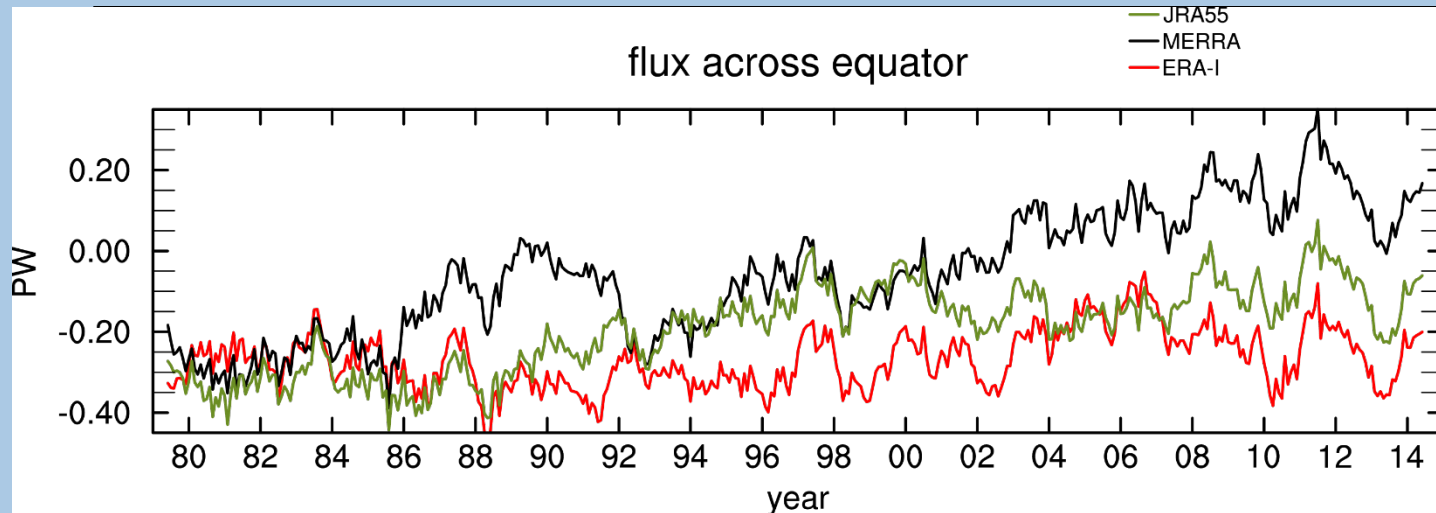
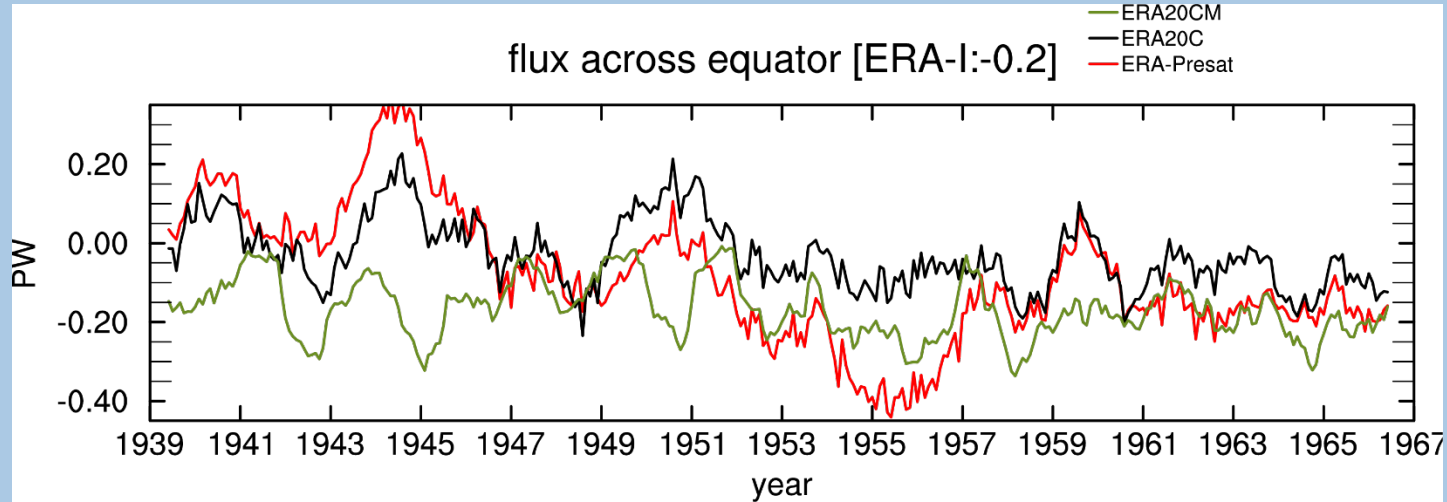
- > Anomalies of 30-yr climatologies (w/r to 1981-2010) of snow depth over northern Russia (60-75N, 50-150E)
- > 20CRv2/20CRv2c and ERA-20C/ERA-20C\_LAND go towards different background climatologies prior to 1950



# Outline

- > Comparison and Analysis of ERA-20C:  
Southwardshift of Tropical Belt 1945-80
- > Comparison and Analysis of ERA-20C:  
Arctic climate
- > ERA-PreSAT
- > Conclusions and outlook

# Cross-equatorial total atmospheric energy flux





# Arctic 700 hPa temperature, DJF

