Trends in a Conventional Observation Reanalysis (CORe) and other Reanalyses

Progress over the last 10 years: 2012 vs 2022

Wesley Ebisuzaki[1], Li Zhang[1,2], Arun Kumar[1], Jeffrey Whitaker[3], Jack Woollen[4,5]

[1] NOAA/CPC, College Park, MD [2] Innovim, Greenbelt, MD [3] NOAA Physical Sciences Div., Boulder, CO [4] NOAA/EMC, College Park, MD [5] I.M. Systems Group, Columbia, MD

Contact: Wesley.Ebisuzaki@noaa.gov

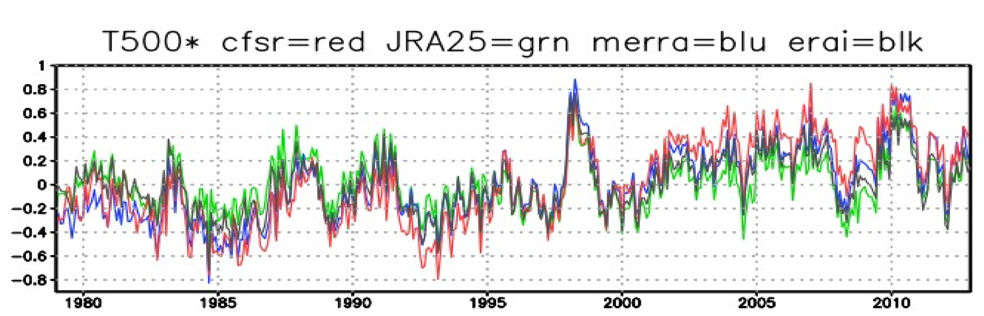
Introduction

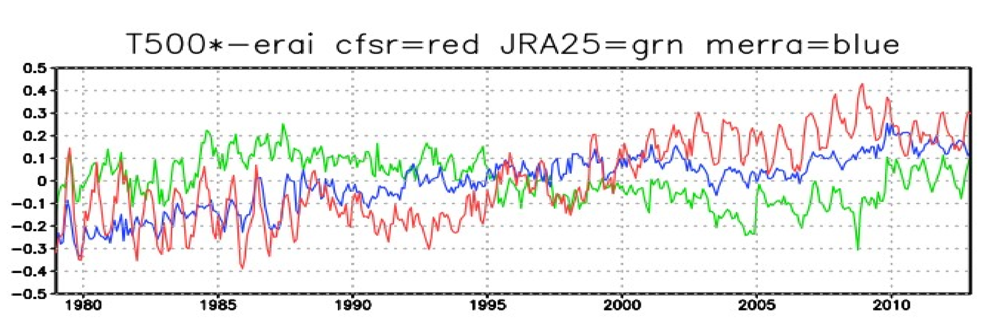
This poster refers to CORe. CORe is a global reanalysis that is planned to replace the NCEP/NCAR Reanalysis for climate monitoring at the Climate Prediction Center. CORe is based on the FV3/GFS-physics model using an 80-member ensemble Kalman filtering data assimilation. It assimilates conventional observations and Atmospheric Motion Vectors (AMVs). By not assimilating thermal radiances, we want to reduce the spurious trends introduced by the changing satellite systems. For more information about CORe, see Li Zhang's poster.

In this poster, we compare how the global reanalyses handled trends in 2012 versus 2022.

The situation in 2012: Available "modern" global reanalyses were

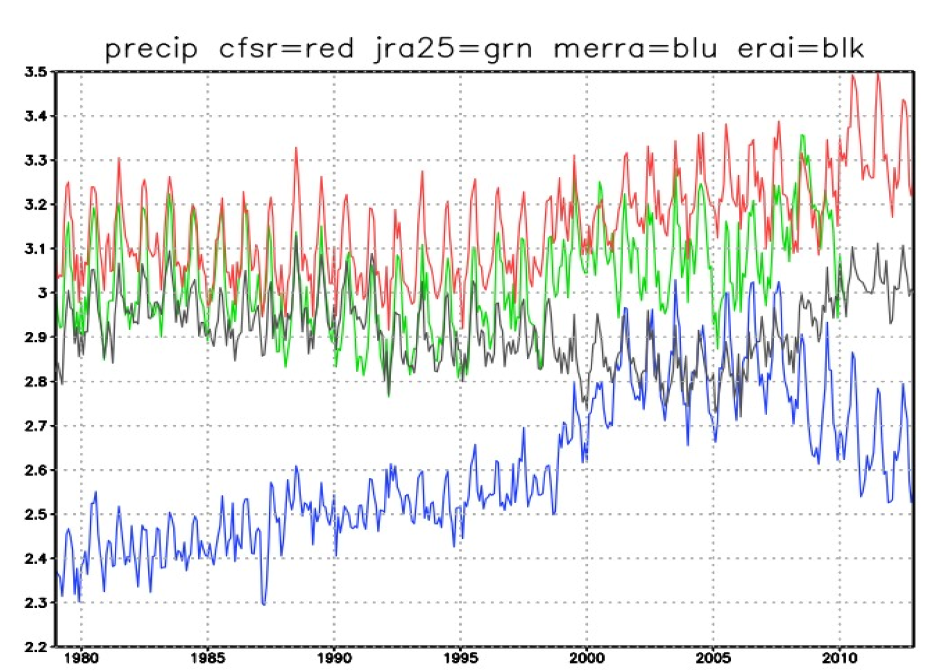
ECMWF:	ERA-interim	(ended)
JMA:	JRA-25	(ended)
NASA:	MERRA	(ended)
NCEP:	CFSR	(continuing)





The upper plot shows the global 500 hPa temperature anomaly (minus 1981-2010 climatology) for CFSR (red), ERA-interim (black), JRA-25 (green) and MERRA (blue). The lower plot shows the difference from the ERA-interim.

The differences between the reanalyses is 0.3C. Expected temperature trends are O(0.1C/decade), and with a time series of 33 years, you cannot resolve the temperature trends.



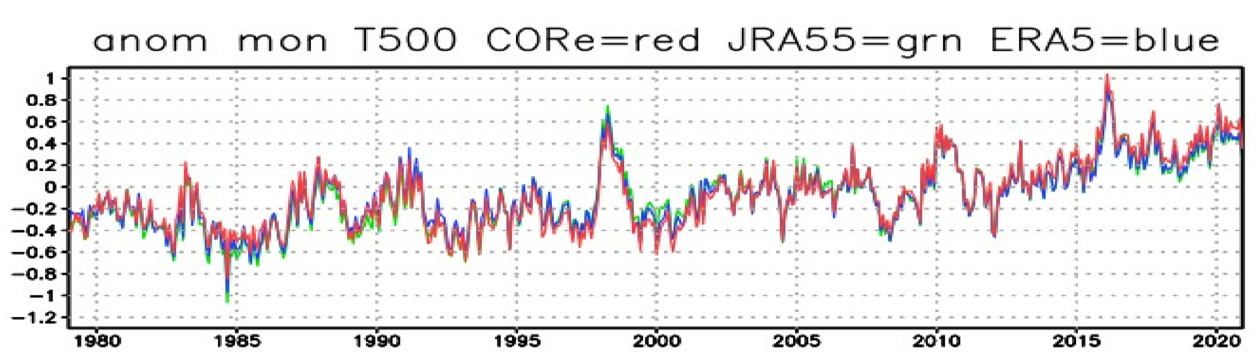
The previous plot shows the global precipitation anomaly with CFSR (red), ERA-interim (black), JRA-25 (green) and MERRA (blue). The trends between the different reanalyses are not consistent.

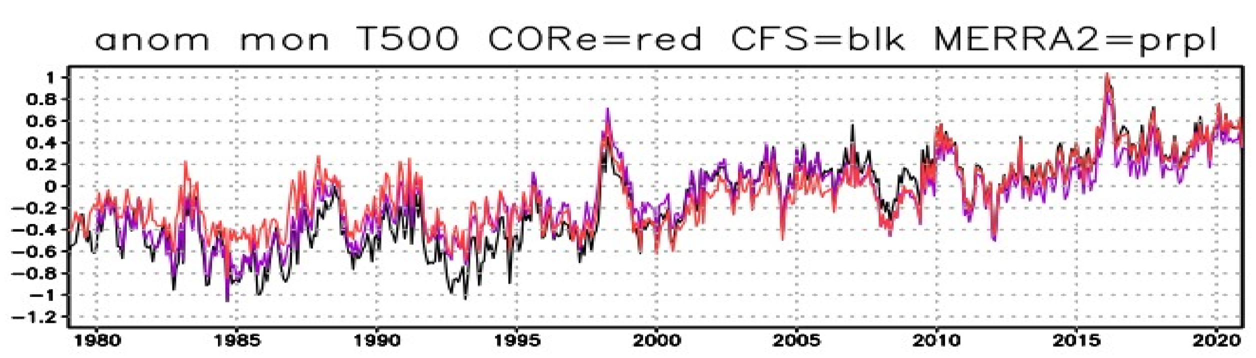
In 2012, the global reanalyses could not address the trends.

Situation in 2022: modern global reanalyses with long time series are

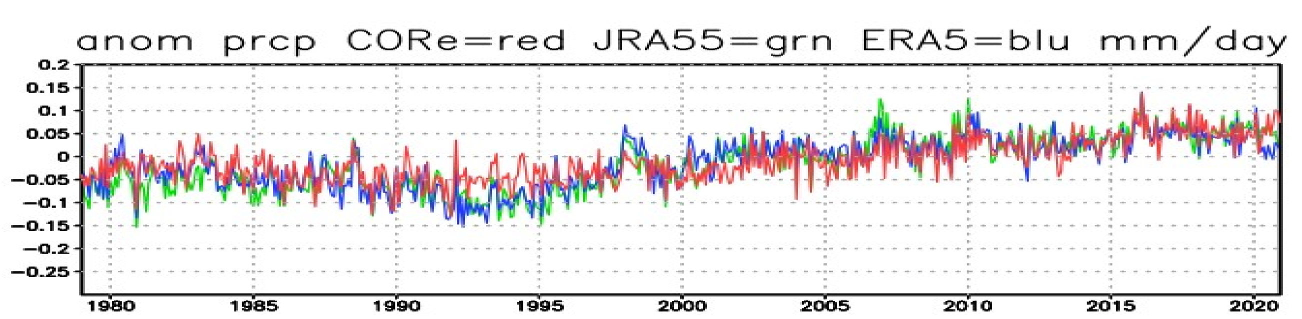
ECMWF:	ERA-5	starts in 1979 with preliminary 1950-1978
JMA:	JRA-55	starts in 1958
NASA:	MERRA-2	starts in 1979
NCEP:	CFSR	starts in 1979
NCEP:	CORe	starts in 1950, 2021+ in development

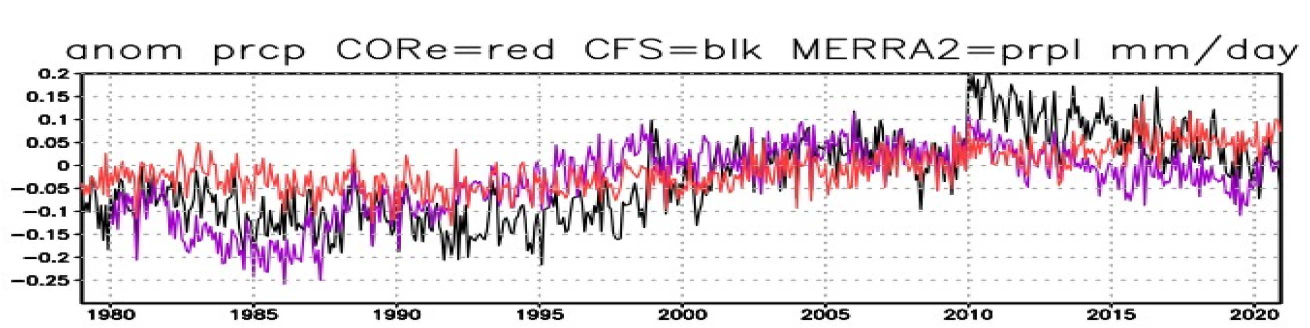
note: will show ERA-5 with the preliminary 1950-1978 analyses





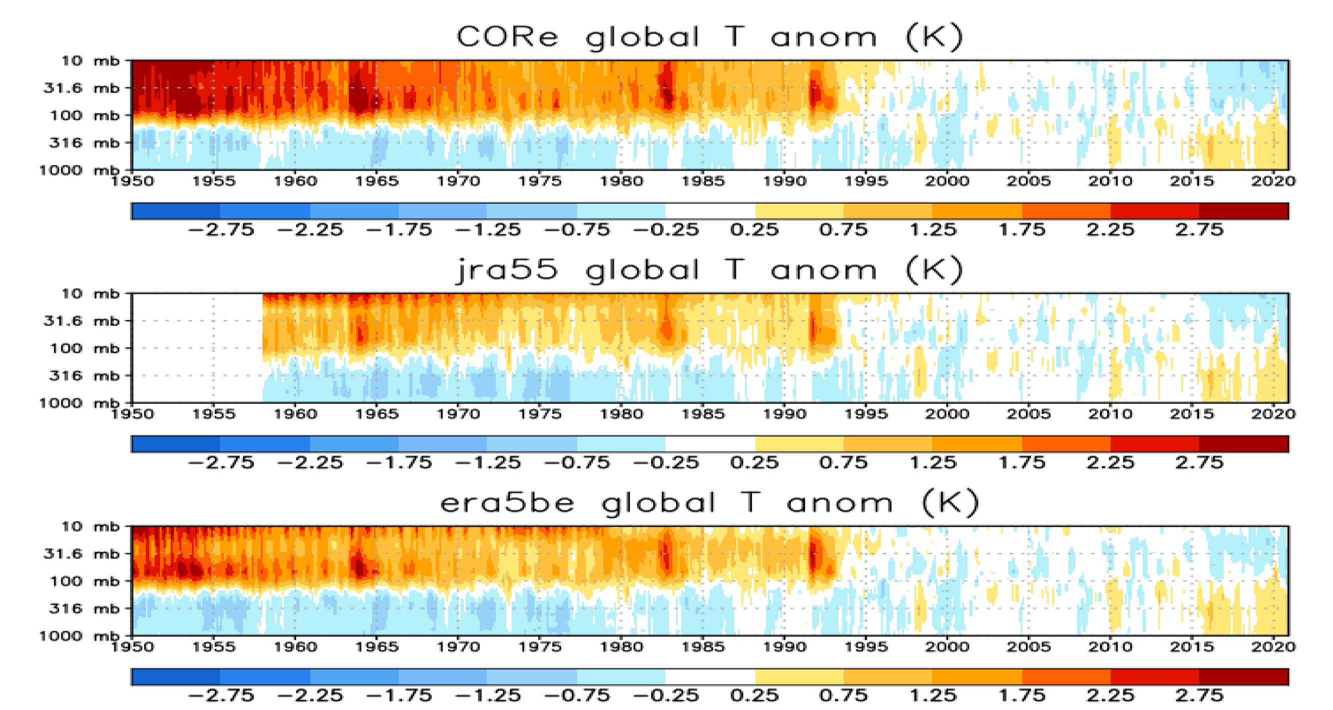
The above plots show the anomalous global 500 hPa temperature (1991-2020 climatology), CORe (red) CFSR (black), ERA-5 (blue), JRA-55 (green), and MERRA-2 (purple). CORe, ERA-5 and JRA-55 show good consistency between themselves. CFSR and MERRA-2 show more variations prior to 2010.



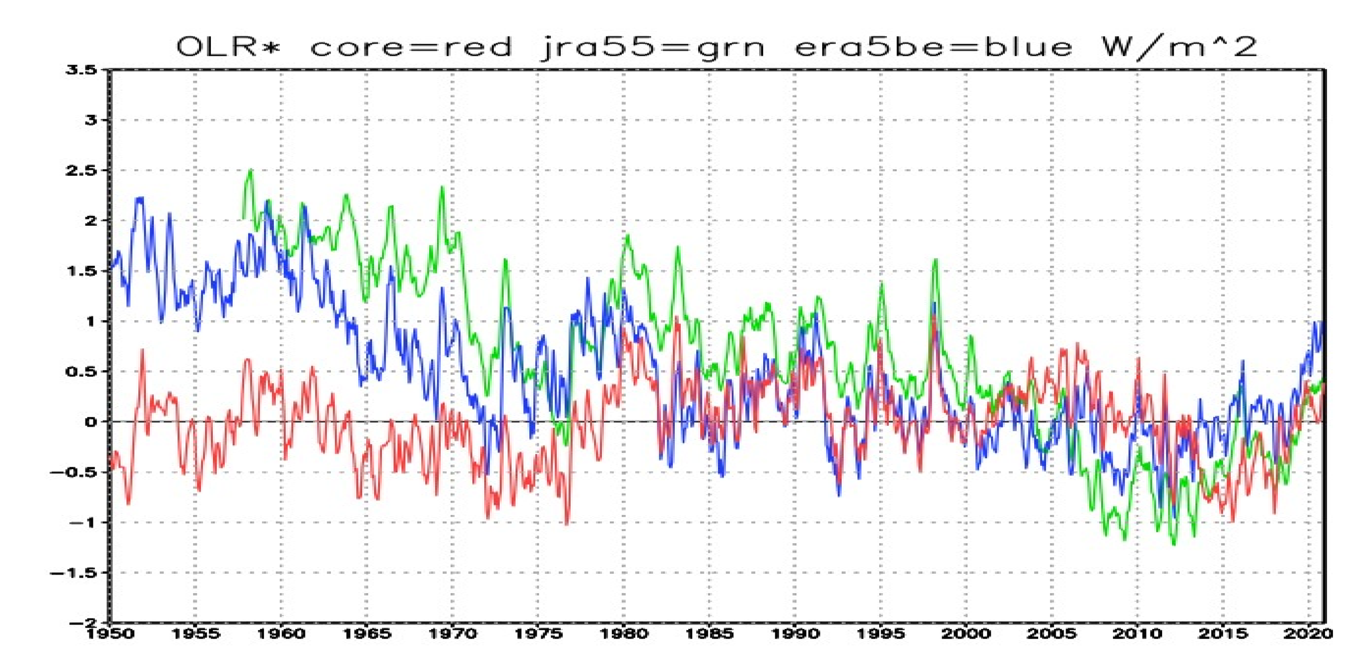


The previous plots show the anomalous global precipitation for CFSR (black), CORe (red), ERA-5 (blue), JRA-55 (green), and MERRA-2 (purple). The CORe, ERA-5 and JRA-55 show good consistency, and show a slight increase of precipitation with time. The CFSR and MERRA-2 show larger differences from the CORe/ERA-5/JRA-55 reanalyses.

CORe, ERA-5 and JRA-55 are produced with diverse systems: 3 different models, 2 types of data assimilation (ENKF, 4D-var, 4D-var), 3 satellite observation usage (only use AMVs, include cloudy, ignore cloudy) and updating of the background error covariances (dynamic, periodically updated, pre/post 1979). This suggests that these reanalyses are converging to a common trend.



The previous plots show the global temperature anomaly as a function of time and pressure. They are consistent in the 1979+ period and show larger differences in the earlier period which had fewer observations. However, they show much similarities.



The above plot shows the anomalous Outgoing Long-wave Radiation at the top of the atmosphere (OLR). Not all fields show a consistency between the reanalyses. So the situation in 2022 is that some of the modern global reanalyses are beginning to converge to a common large-scale averages but not for all fields. OLR is difficult because OLR is not usually assimilated and OLR depends on how how the model simulates clouds.

Summary:

In 2012, the global reanalyses were not able to address the trends. In 2022, the reanalyses are much improved. In particular CORe, ERA-5 and JRA-55 had similar large-scale averages for many fields. These reanalyses were diverse in model, treatment of satellite data and data-assimilation method. So in 2022, reanalyses have improved enough to start considering the trends.