A Conventional Only atmospheric Reanalysis (CORe)

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Introduction

Atmospheric reanalyses can be optimized to produce the most accurate reanalysis by assimilating all observations including satellite observations. This type of reanalysis often shows spurious “climate shifts” in various time series with the introduction of new satellite systems (ex., Zhang et al 2012). The 20th Century Reanalysis took another approach, and it made the time series more homogeneous by only assimilating surface pressure observations. Such a reanalysis is less accurate because it assimilates much fewer observations. The Climate Prediction Center (CPC) wanted a NCEP/NCAR Reanalysis (R1) replacement that would be between these extremes, The replacement reanalysis had to have accuracy of R1, eliminate the gross artifacts from the introduction of various satellites and span from the 1950's to the present. Can a conventional observation reanalysis satisfy these requirements?

This is part of the hierarchy of NOAA reanalyses: (0) AMIP - SST, (1) 20th Century V3 - surface pressure + SST, (2) CORe - conventional obs + SST, (3) CFSv3 - all obs + ocean

Details of CORe (Conventional Observations Reanalysis)

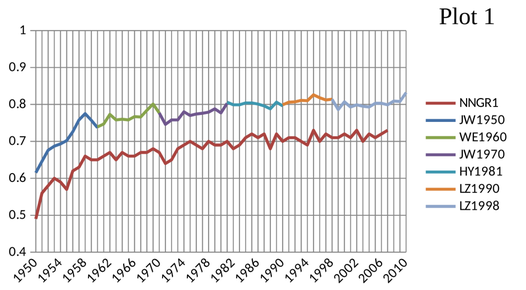
Ensemble-Kalman-Filter atmospheric data assimilation system.
Conventional observations, cloud track winds*
T254 L64 Semi-Lagrangian model (recent NCEP GFS)
80-member ensemble
1950 to 2010 run in 6 streams with 1 year overlap
*cloud-track winds are not sensitive to biases in sensors

Evaluation of CORe

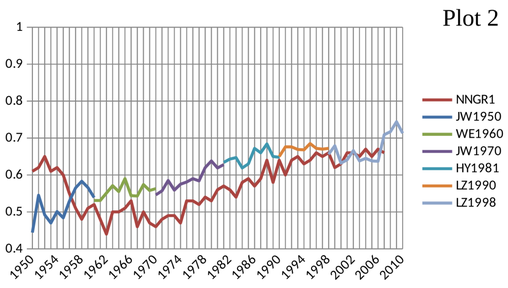
Plot 1 shows the 5-day forecast skill (correlation) for the NH 500 hPa geopotential height (Z500). R1 (red) forecasts are not as skillful as CORe (multi-color). Plot 2 shows a similar plot for the SH. The first decade is unusual because R1 shows more skill than the following decade. We speculate it's artificial skill from a lack of SH observations.

Forecast skill is influenced by the model. CORe is higher resolution (T254 vs T62,64 vs 28 levels) and has much better physics. So the improved fcst skill may be from better model rather than an improved analysis.

Plot 1



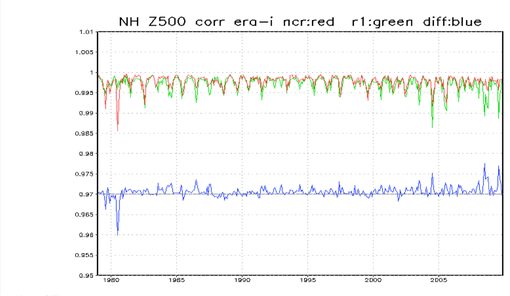
Plot 2



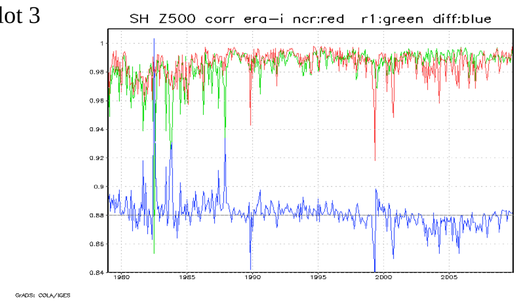
In order to evaluate the skill of the analyses, we will use ERA-interim as a proxy for truth and evaluate the monthly means. Plot 3 shows the anomaly correlation (AC) for the 30N-60N monthly Z500. The AC of CORe and ERA-interim is red. The AC of R1 And ERA-interim is green and the difference in AC is shown by the blue minus the black lines. Plot 3 shows that CORe is closer to ERA-interim than R1.

Plot 4 is similar to Plot 3 except for the SH (60S-30S). Both R1 and CORe have high ACs but not as high as in the NH. More often than not, CORe is closer to ERA-interim than R1 is to ERA-interim. The 2000-2007 period is an exception and may be the result of human error and not assimilating surface pressure (2000+) in CORe.

Plot 3



Plot 4

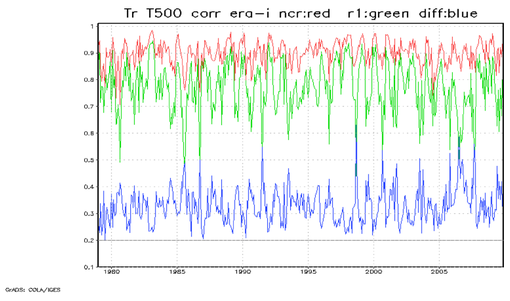


Evaluation of CORe in the Tropics

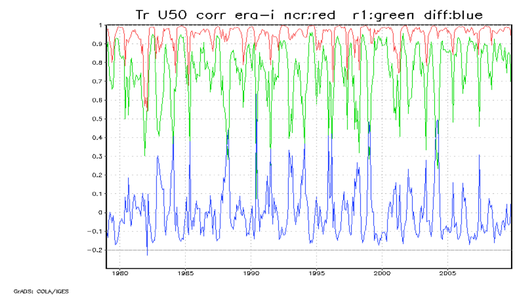
Plot 5 shows the AC of the 500 hPa temperature in 20S-20N band. The improvement in CORe vs R1 is about 0.1 (blue line – black line). CORe's improved skill may be from a better model leading to a better analysis.

Plot 6 shows the AC of the 50 hPa zonal wind in the 20S-20N band. CORe did better than R1.

Plot 5



Plot 6



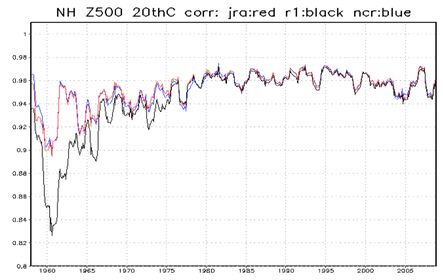
Evaluation in the pre-satellite period

The previous plots used ERA-interim as a reference and showed that CORe was usually better than R1 in the satellite period. For the full time series (1950-2010), we will use the 20th Century reanalysis (20CR) as a reference. 20CR is not as accurate as the analyses that use more observations but its time series should be more homogeneous. So a lower AC with the 20CR in the pre-satellite period indicates a poorer analysis relative to its satellite period analysis.

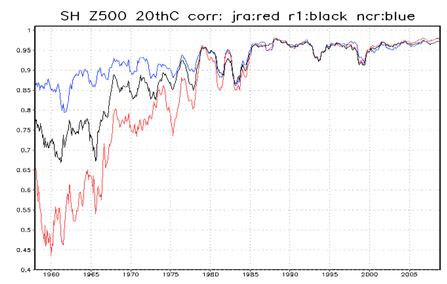
Plot 7 shows the AC of NH 20CR Z500 with CORe (blue), R1 (black) and JRA55 (red) in the NH. The CORe and JRA55 AC are very similar and only show a small drop in the 1970-1978 period. This suggests that both the CORe and JRA55 are doing well in this period. This is consistent with the skill of the JRA55C being similar to CORe with respect to ERA-interim.

Plot 8 is like Plot 7 except for the SH. The AC values are smaller in the SH than the NH because of the fewer observations and lower quality analyses. The CORe's AC showed the least amount of reduction in the non-satellite period which suggests that CORe showed the least degradation. However, some of the consistency between 20CR and CORe may be from using variants of the GFS model.

Plot 7



Plot 9



A (mostly) conventional observation based reanalysis is attractive because it eliminates the “climate shifts” caused by the introduction of satellites and new satellites. CORe demonstrates that such an analysis can have similar or better skill than R1 which CPC uses for climate monitoring. In our internal evaluation of CORe, our main concerns were the overly large precipitation and radiative fluxes in the tropics (not shown).

CPC is working to make CORe or an improved CORe operational. This system will be a replacement for the aging NCEP/NCAR Reanalysis system. We need community input about saving and distributing fields from the 80 ensemble members.