

Research Towards the Next Generation of NOAA Climate Reanalyses

A joint effort between NCEP, ESRL & NCDC
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Outline

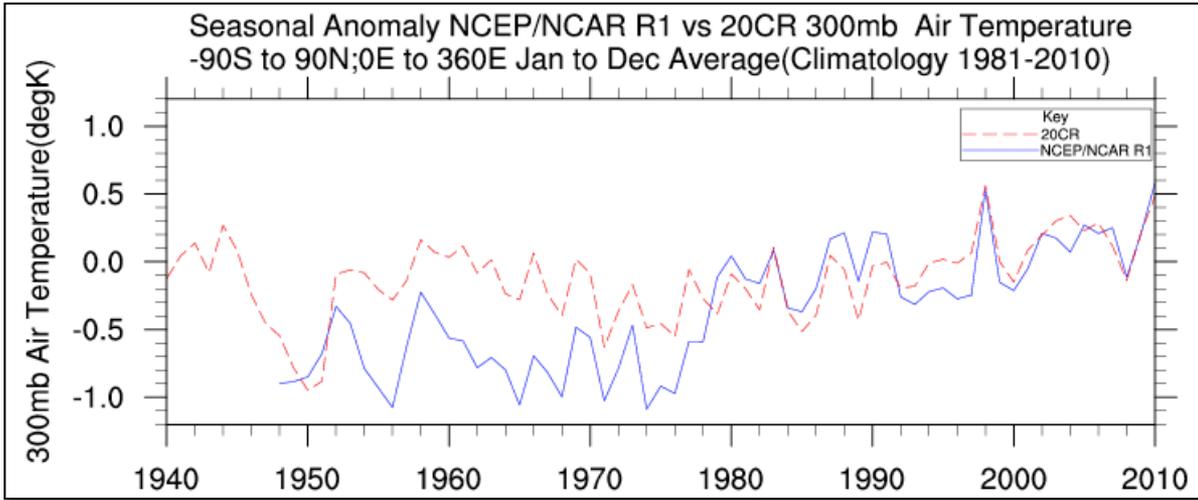
- Shortcomings of the current generation of NOAA climate reanalyses
- Proposed research and assimilation infrastructure
- Connecting with a unified NOAA reanalyses approach

- What is analysis?
 - An objective method for analysis using data assimilation to estimate the state of various components of the Earth System by forming weighted average of *observations* and *guess* generated by short-term (~ 6 hours) forecast based from a *model*
- What is climate reanalysis?
 - Regenerating the analyses over several decades using quality-controlled observations and a *fixed* data assimilation system to make a climate record. Climate reanalysis
 - can utilize delayed observations (that may have been missing in real-time)
 - can also use of symmetric time-windows for ingesting observations

- NCEP/NCAR (R1): 1948-present; *initiated ~ 1995*
- NCEP/DoE (R2): *1979-present; initiated ~ 1998*
- North American Regional Reanalysis (NARR): 1979-present; *initiated ~ 2004*

- 20th Century Reanalysis (20CR): 1871-2011; *initiated ~ 2009*
- Climate Forecast System Reanalysis (CFSR): 1979-present; *initiated ~ 2007*

- 20CR and CFSR, although both NOAA efforts, used different models and data assimilation systems
- CFSR has various discontinuities in the climate record. Some are due to
 - running the system in six different streams
 - ingest of latest observational platforms leading to changing observing system
- CFSR is not well suited for climate monitoring and a replacement for NCEP/NCAR R1

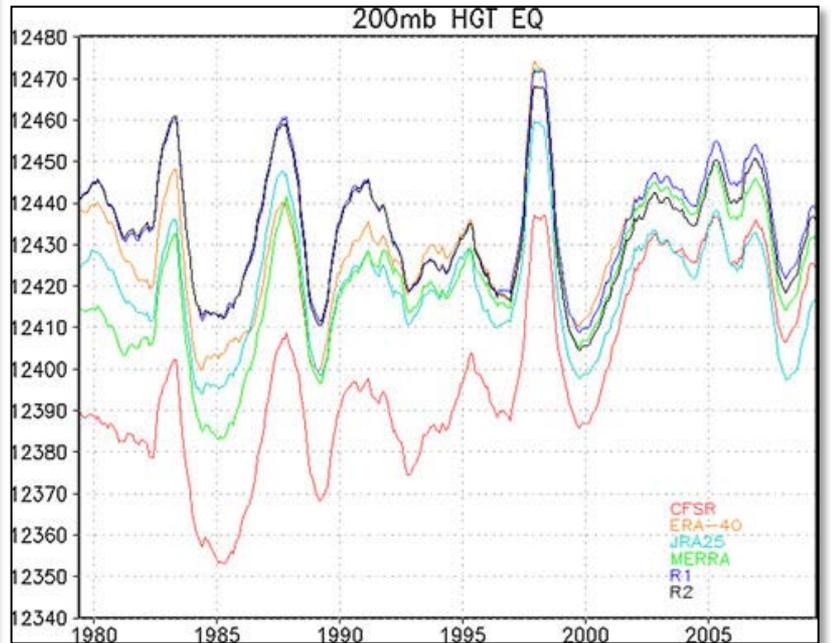
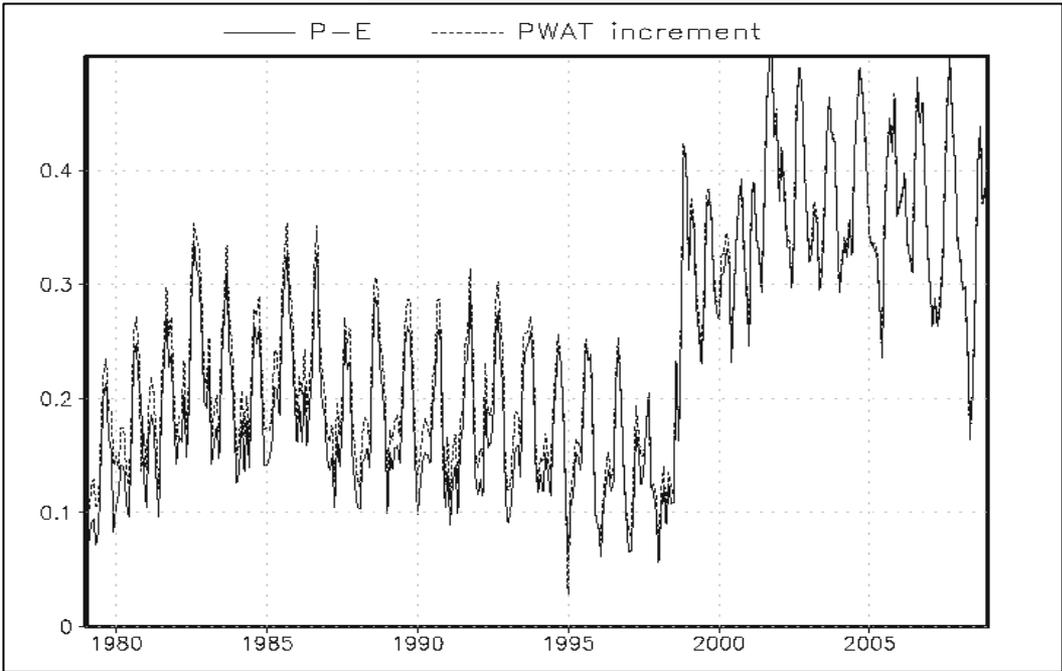


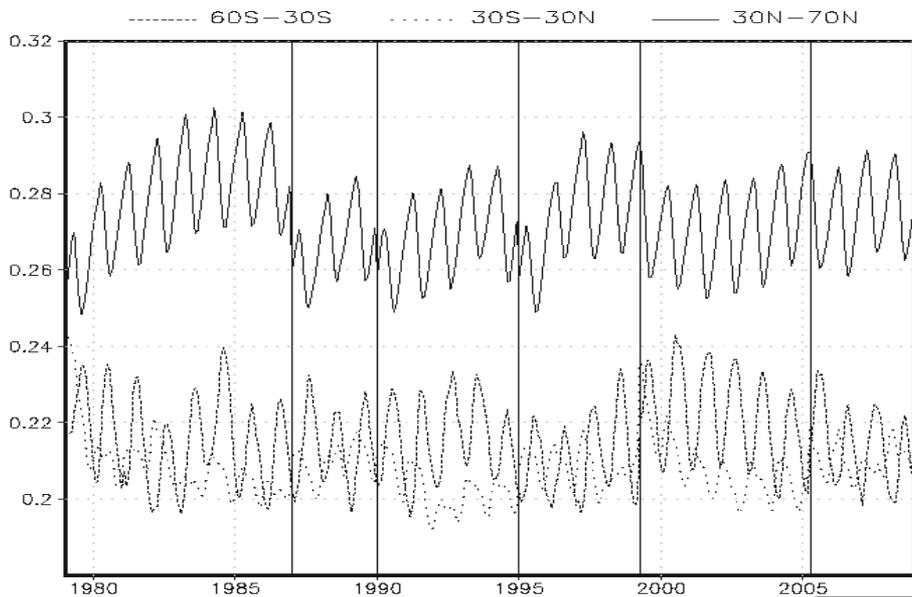
R1 vs. 20CR

Hydrological Cycle

CFSR - Issues with trends

Tropical 200mb Z

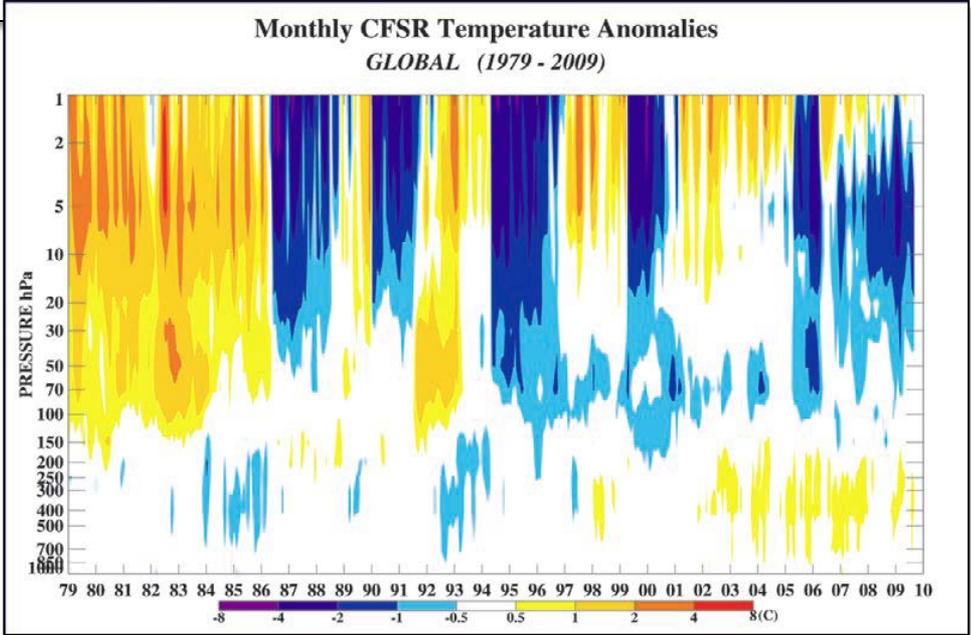




Soil Moisture

CFSR - Issues because of multiple streams

Stratospheric Temperature



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- Research towards the next generation of climate reanalysis for the atmosphere
 - Focus on developing methods to identify spurious climate trends due to changes in observational data (e.g., changes in observational platforms; data density etc.), and
 - Develop methods to reduce the influence of changes in observational data on climate trends

- Will follow a hierarchical approach with increase in the complexity for the reanalysis system
- Will utilize a common data assimilation infrastructure – Hybrid Ensemble Kalman Filter (EnKF)

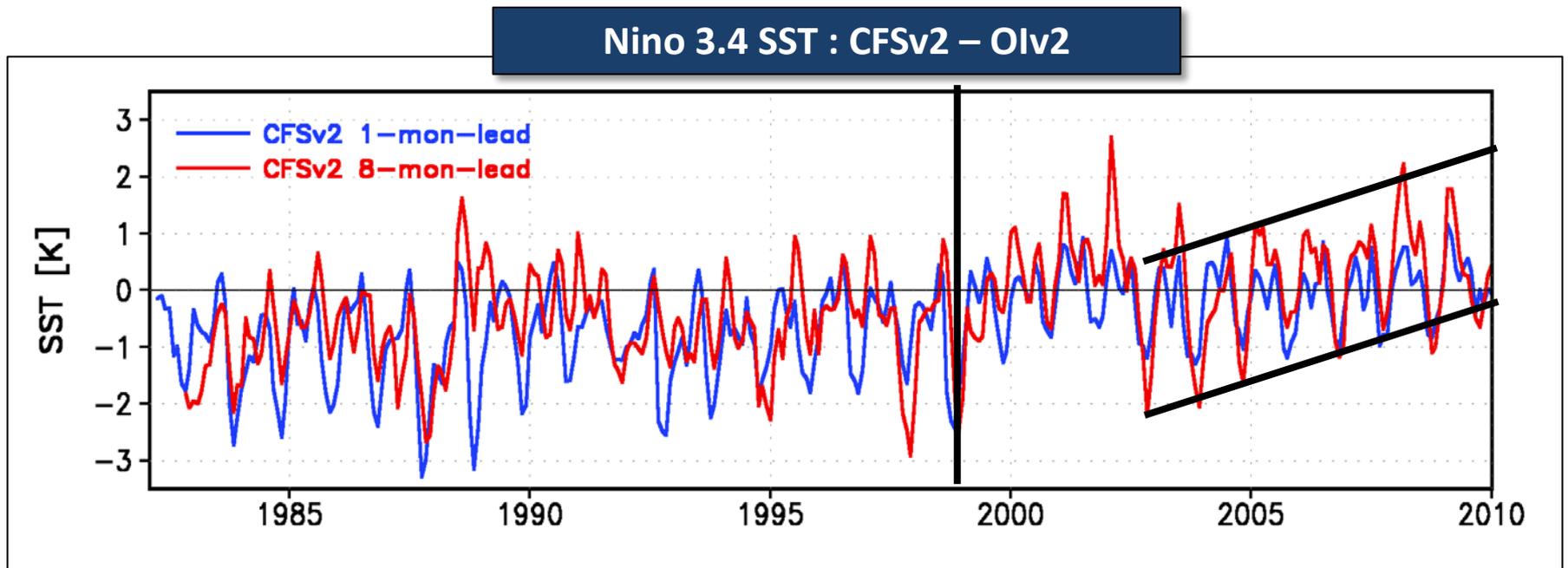
- Hierarchical (tiered) data assimilation approach
 - Boundary forced (equivalent to AMIP); 1850-present
 - Surface pressure; 1850-present
 - Surface and conventional data; 1946-present
 - Satellite data; 1973-present
- Reanalysis with higher level of complexity will be informed by the previous tier reanalysis

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- Uses of climate reanalysis
 - Climate monitoring
 - Providing initial conditions for hindcasts (reforecasts)
- Tension between analysis for the purpose for climate monitoring and for forecast initialization
- Hindcasts, and bias correction methods, are also susceptible to climate trends if the influence of initial conditions persists during the forecasts, or if the real-time analysis system differs from one for the historical analysis

A Distinct Change in Forecast Bias for SST in Equatorial Pacific Before and After 1999



- Hindcasts, therefore, also impose additional constraints on the quality, and strategies, for historical reanalysis
- With judicious design of a hierarchical reanalysis system and an integration with offline analysis of other components of the Earth system – ocean; land; cryosphere – it may be possible to come up with a climate reanalysis infrastructure that can address needs of various communities