Huug van den Dool and Suru Saha:

CFSR, The New Coupled NCEP Reanalysis 1979-2010

(Use of re-analyses and re-forecasts for the calibration of long-range predictions)

- CFSR
- CFSRR, both seasonal and 45 days

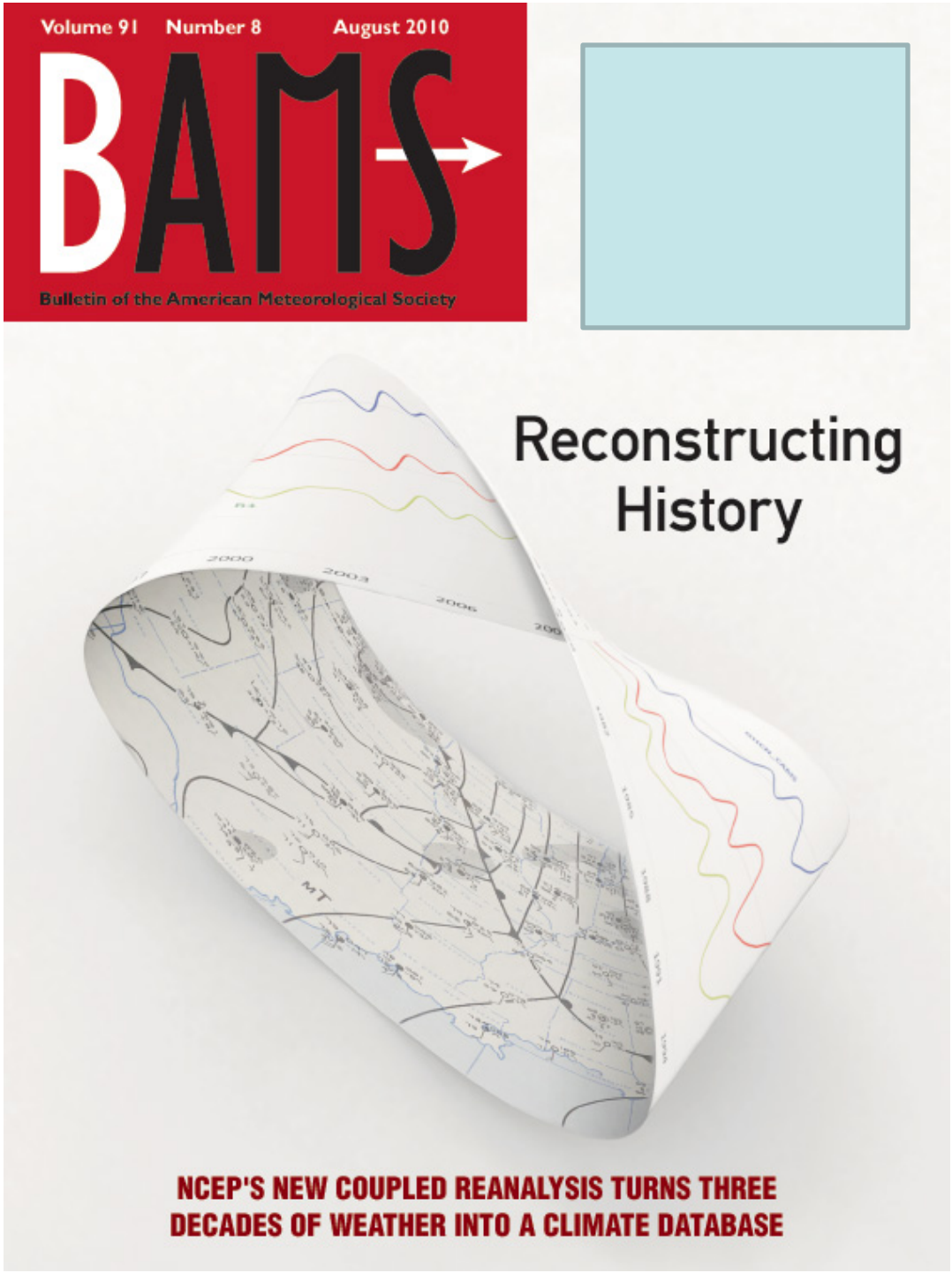
Outline

- CFSR overview (short)
- A few analysis results
- A few forecast results
- Surface pressure (a bridge to 20th century Reanalysis)
- Storms of historical significance

Acknowledge other Reanalyses

- ERA-15, ERA-40, ERA-Interim
- NCEP R1, R2, NARR
- 20th Century
- JRA-25, JRA-5x
- MERRA

- Older NASA and COLA



The NCEP Climate Forecast System Reanalysis

Suranjana Saha, Shrinivas Moorthi, Hua-Lu Pan, Xingren Wu, Jiande Wang, Sudhir Nadiga, Patrick Tripp, Robert Kistler, John Woollen, David Behringer, Haixia Liu, Diane Stokes, Robert Grumbine, George Gayno, Jun Wang, Yu-Tai Hou, Hui-ya Chuang, Hann-Ming H. Juang, Joe Sela, Mark Iredell, Russ Treadon, Daryl Kleist, Paul Van Delst, Dennis Keyser, John Derber, Michael Ek, Jesse Meng, Helin Wei, Rongqian Yang, Stephen Lord, **Huug van den Dool**, Arun Kumar, Wanqiu Wang, Craig Long, Muthuvel Chelliah, Yan Xue, Boyin Huang, Jae-Kyung Schemm, Wesley Ebisuzaki, Roger Lin, Pingping Xie, Mingyue Chen, Shuntai Zhou, Wayne Higgins, Cheng-Zhi Zou, Quanhua Liu, Yong Chen, Yong Han, Lidia Cucurull, Richard W. Reynolds, Glenn Rutledge, Mitch Goldberg

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For a new Climate Forecast System (CFS) implementation

Two essential components:

A new Reanalysis of the atmosphere, ocean, seaice and land over the 31-year period (1979-2009) is required to provide consistent initial conditions for:

A complete Reforecast of the new CFS over the 28-year period (1982-2009), in order to provide stable calibration and skill estimates of the new system, for operational seasonal prediction at NCEP

For a new CFS implementation (contd)

1. Analysis Systems : Operational GDAS:
   Atmospheric (GADAS)-GSI
   Ocean-ice (GODAS) and
   Land (GLDAS)

2. Atmospheric Model : Operational GFS

   New Noah Land Model

3. Ocean Model : New MOM4 Ocean Model

   New Sea Ice Model

For a new CFS implementation (contd)

1. An atmosphere at high horizontal resolution (spectral T382, ~38 km) and high vertical resolution (64 sigma-pressure hybrid levels)
2. An interactive ocean with 40 levels in the vertical, to a depth of 4737 m, and horizontal resolution of 0.25 degree at the tropics, tapering to a global resolution of 0.5 degree northwards and southwards of 10N and 10S respectively
3. An interactive 3 layer sea-ice model
4. An interactive land model with 4 soil levels

There are three main differences with the earlier two NCEP Global Reanalysis efforts:

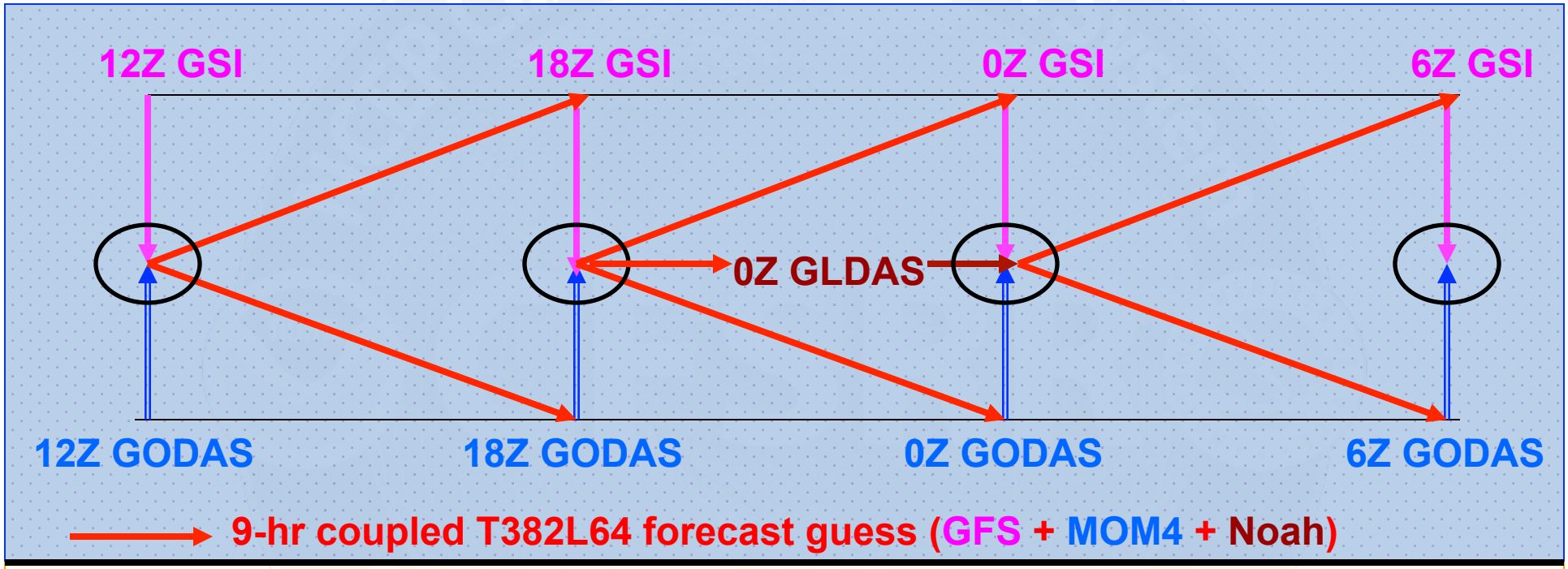
Much higher horizontal and vertical resolution (T382L64) of the atmosphere (earlier efforts were made with T62L28 resolution)

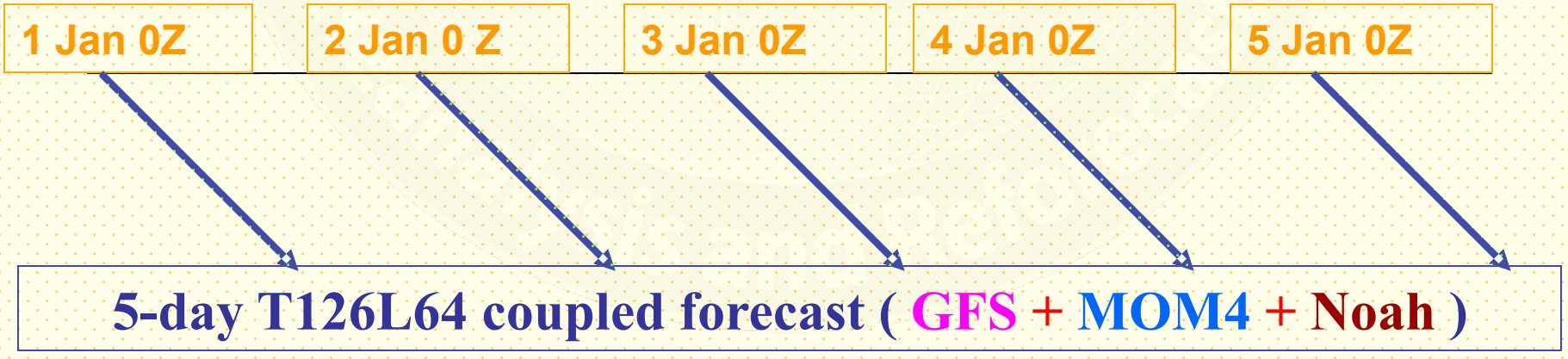
The guess forecast was generated from a coupled atmosphere – ocean – seaice - land system

Radiance measurements from the historical satellites were assimilated in this Reanalysis

To conduct a Reanalysis with the atmosphere, ocean, seaice and land coupled to each other was a novelty, and will hopefully address important issues, such as the correlations between sea surface temperatures and precipitation in the global tropics, etc. **CO2 !**

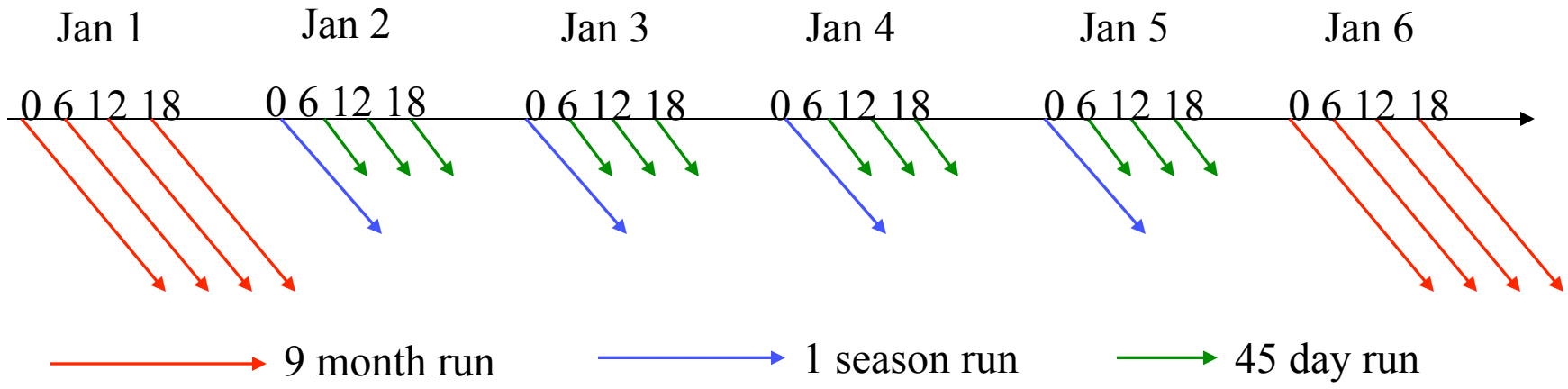
ONE DAY OF REANALYSIS





Hindcast Configuration for next CFS

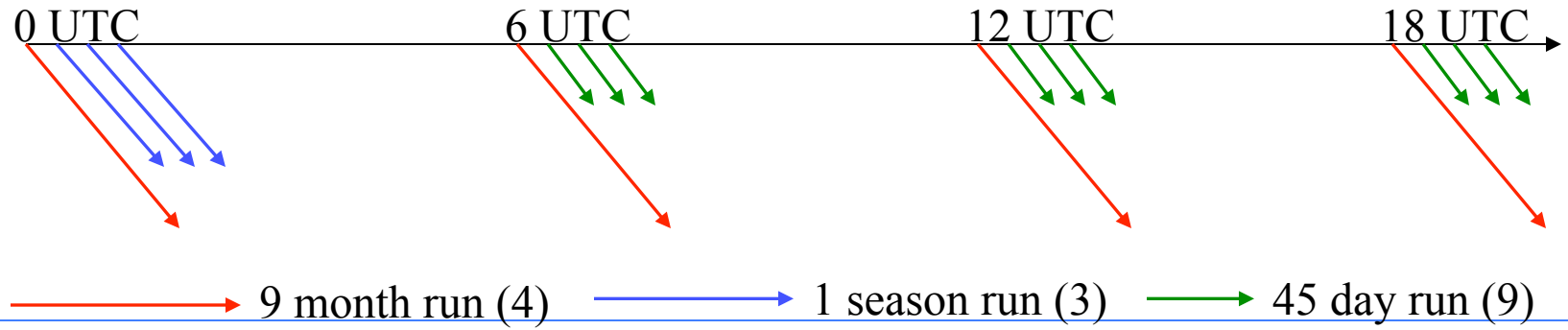
- 9-month hindcasts will be initiated from every 5th day and will be run from all 4 cycles of that day, beginning from Jan 1 of each year, over a 28 year period from 1982-2009 This is required to calibrate the operational CPC longer-term seasonal predictions (ENSO, etc)
- There will also be a single 1 season (123-day) hindcast run, initiated from every 0 UTC cycle between these five days, over the 12 year period from 1999-2010. This is required to calibrate the operational CPC first season predictions for hydrological forecasts (precip, evaporation, runoff, streamflow, etc)
- In addition, there will be three 45-day (1-month) hindcast runs from every 6, 12 and 18 UTC cycles, over the 12-year period from 1999-2010. This is required for the operational CPC week3-week6 predictions of tropical circulations (MJO, PNA, etc)
- **Total number of years of integration = 9447 years !!!!!**



Courtesy: Suru Saha

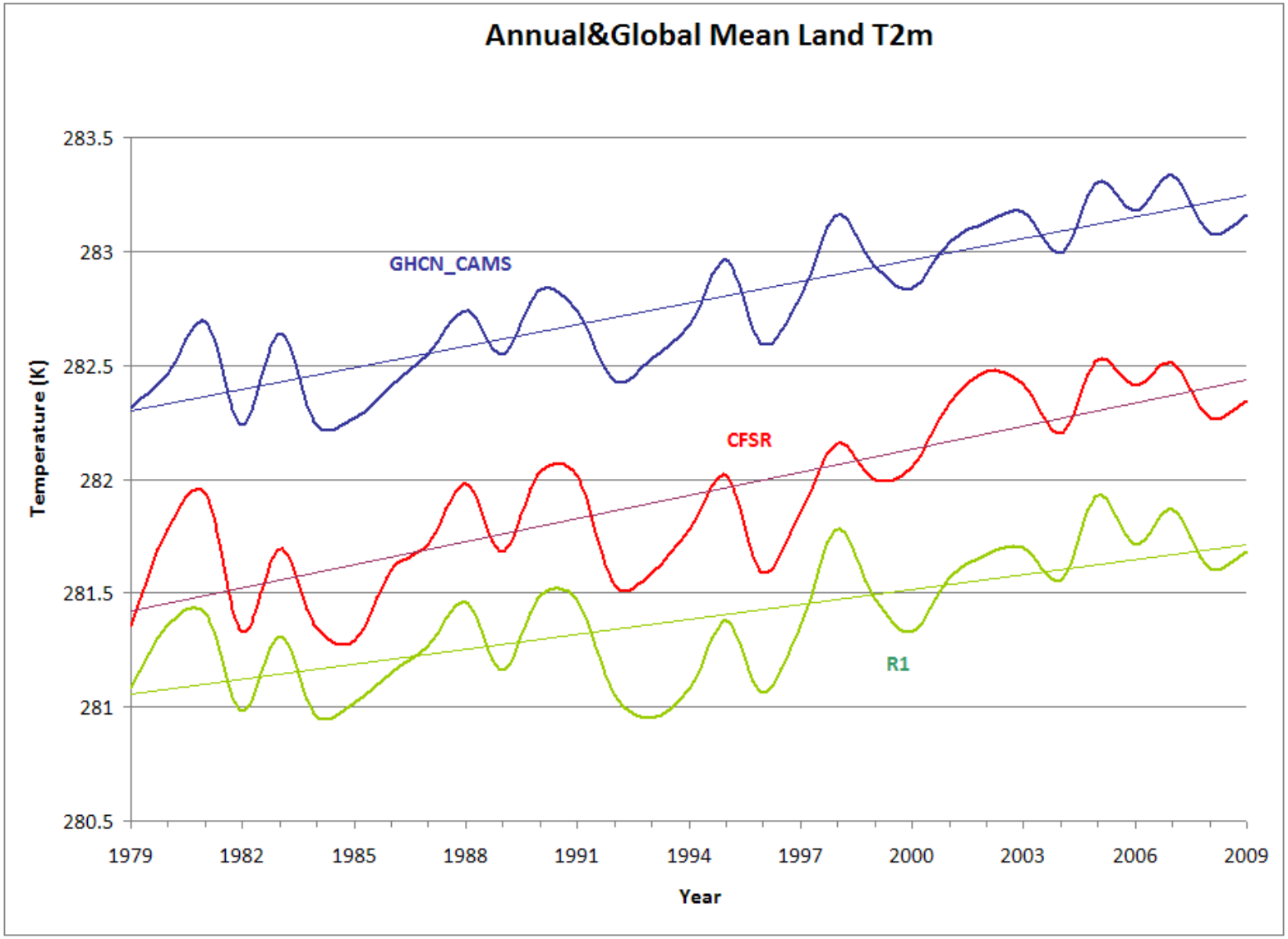
Operational Configuration for next CFS

- There will be 4 control runs per day from the 0, 6, 12 and 18 UTC cycles of the CFS real-time data assimilation system, out to 9 months.
- In addition to the control run of 9 months at the 0 UTC cycle, there will be 3 additional runs, out to one season. These 3 runs per cycle will be initialized as in current operations.
- In addition to the control run of 9 months at the 6, 12 and 18 UTC cycles, there will be 3 additional runs, out to 45 days. These 3 runs per cycle will be initialized as in current operations.
- There will be a total of 16 CFS runs every day, of which 4 runs will go out to 9 months, 3 runs will go out to 1 season and 9 runs will go out to 45 days.



Courtesy: Suru Saha

A few Analysis Results

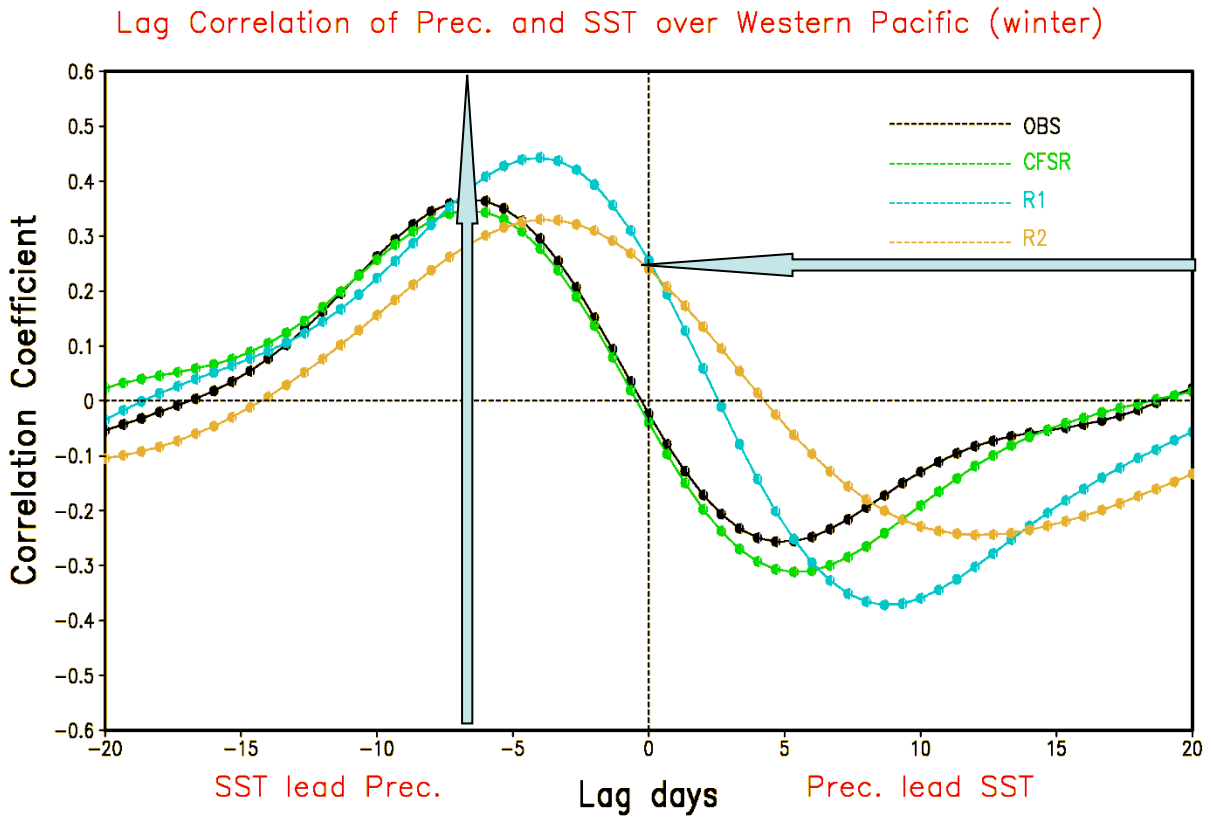


The linear trends are 0.66, 1.02 and 0.94K per 31 years for R1, CFSR and GHCN_CAMS respectively. (Keep in mind that straight lines may not be perfectly portraying climate change trends).

Courtesy: Huug van den Dool

SST-Precipitation Relationship in CFSR

Precipitation-SST lag correlation in tropical Western Pacific



Response of Prec. To SST increase : warming too quick in R1 and R2

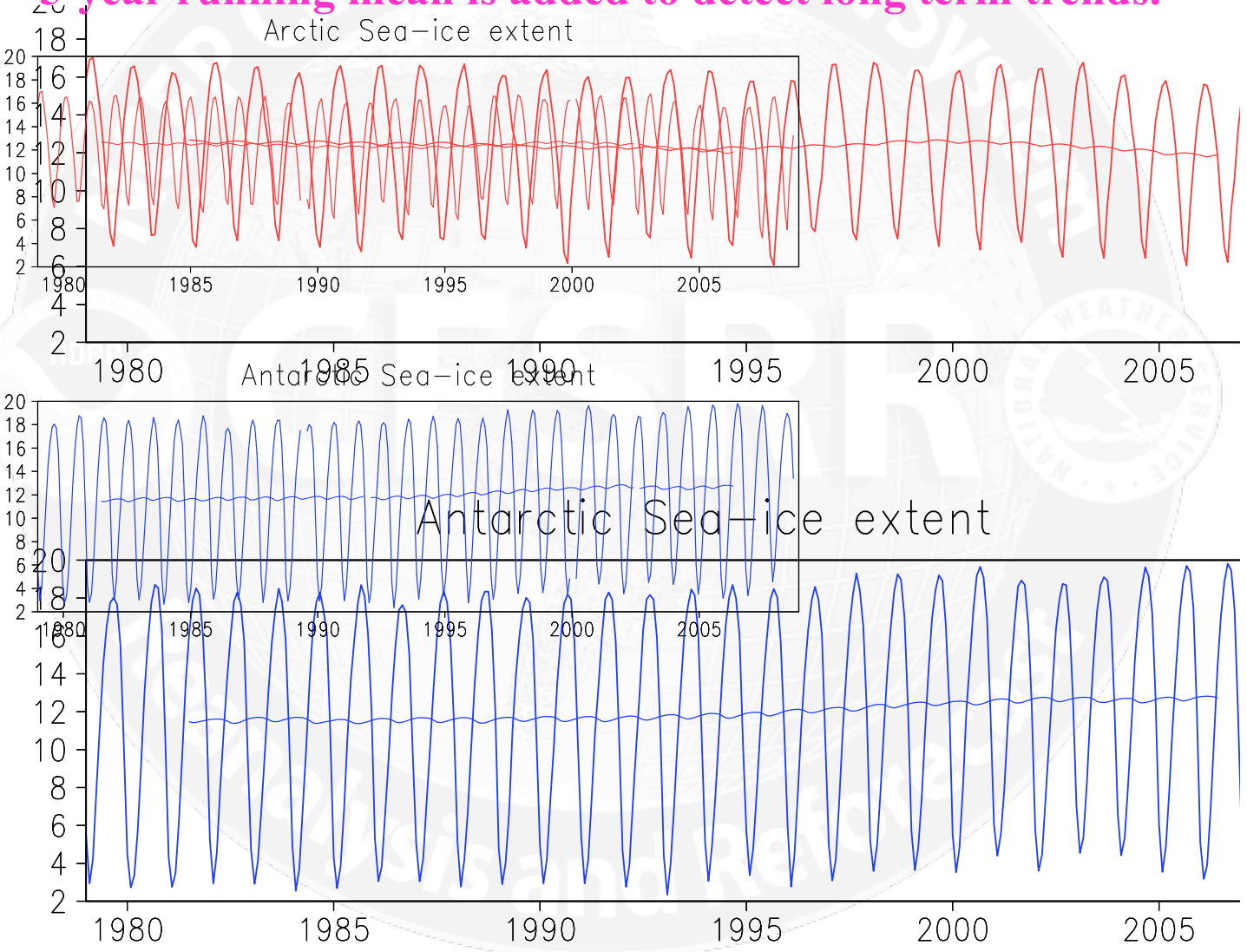
simultaneous positive correlation in R1 and R2

Courtesy: Jiande Wang

Monthly mean Sea ice extent (10^6 km^2)

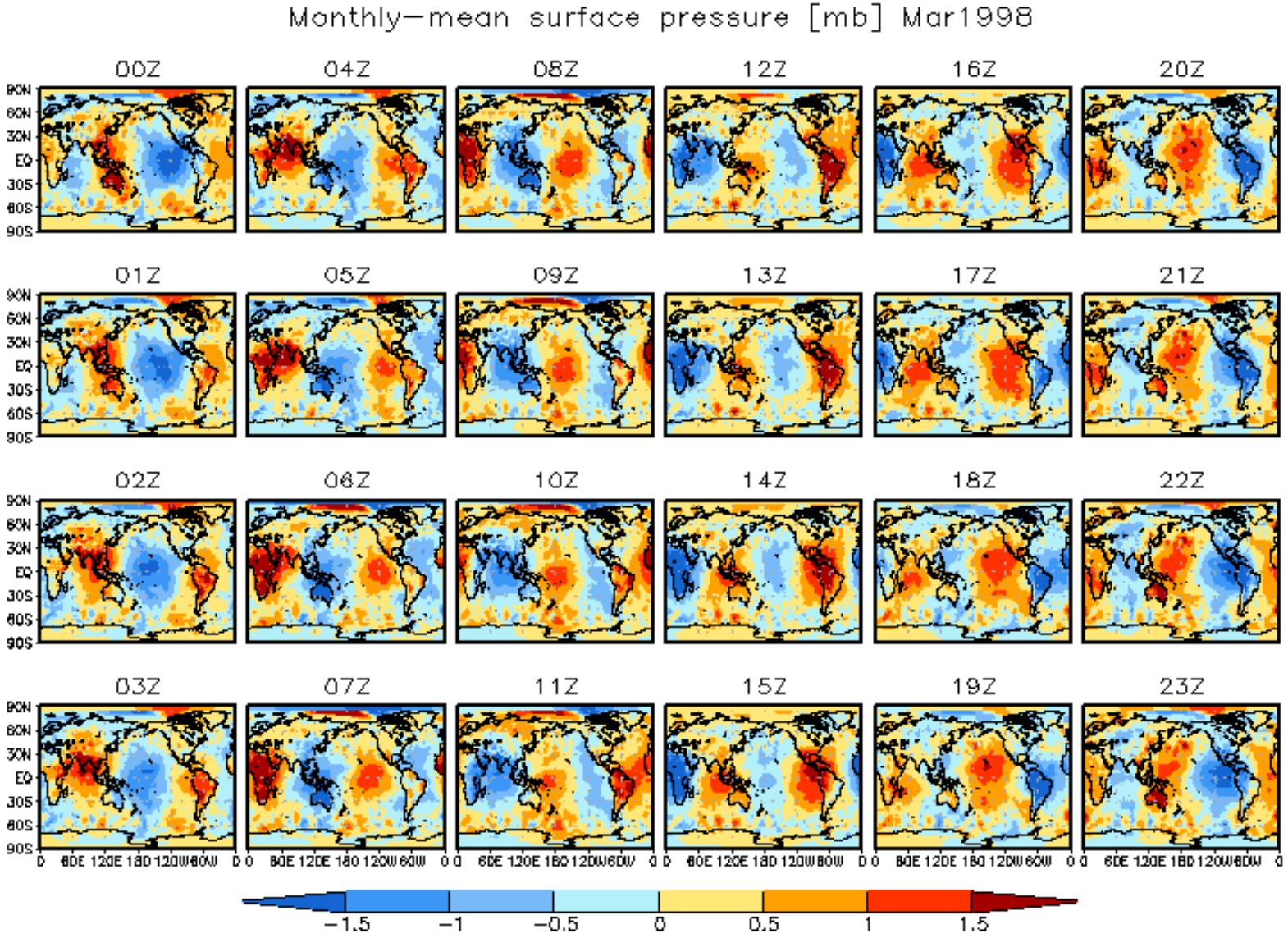
for the Arctic (top) and Antarctic (bottom) from CFSR (6-hr forecasts).

5-year running mean is added to detect long term trends.



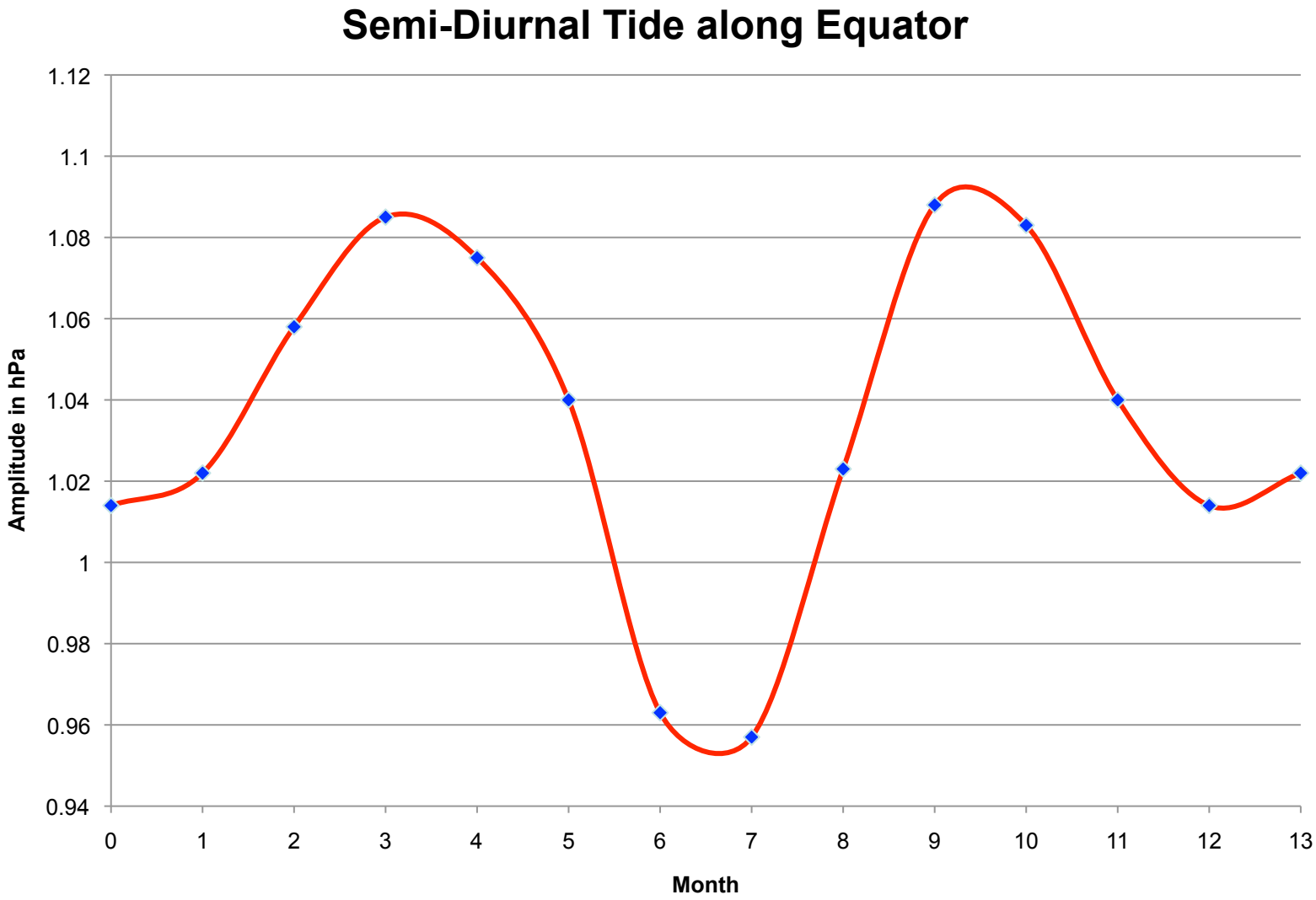
Courtesy: Xingren Wu

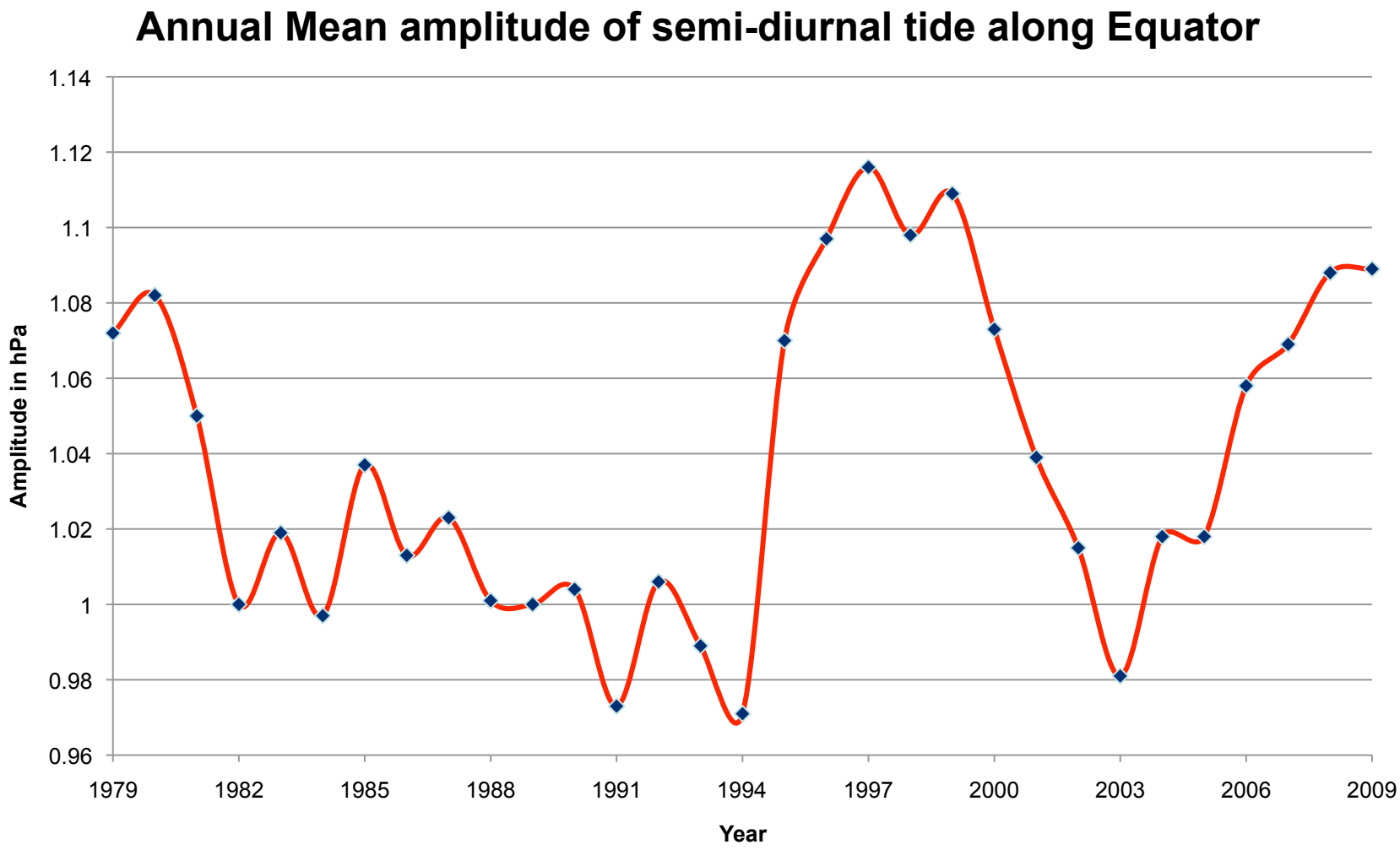
Monthly mean hourly surface pressure with the daily mean subtracted for the month of March 1998



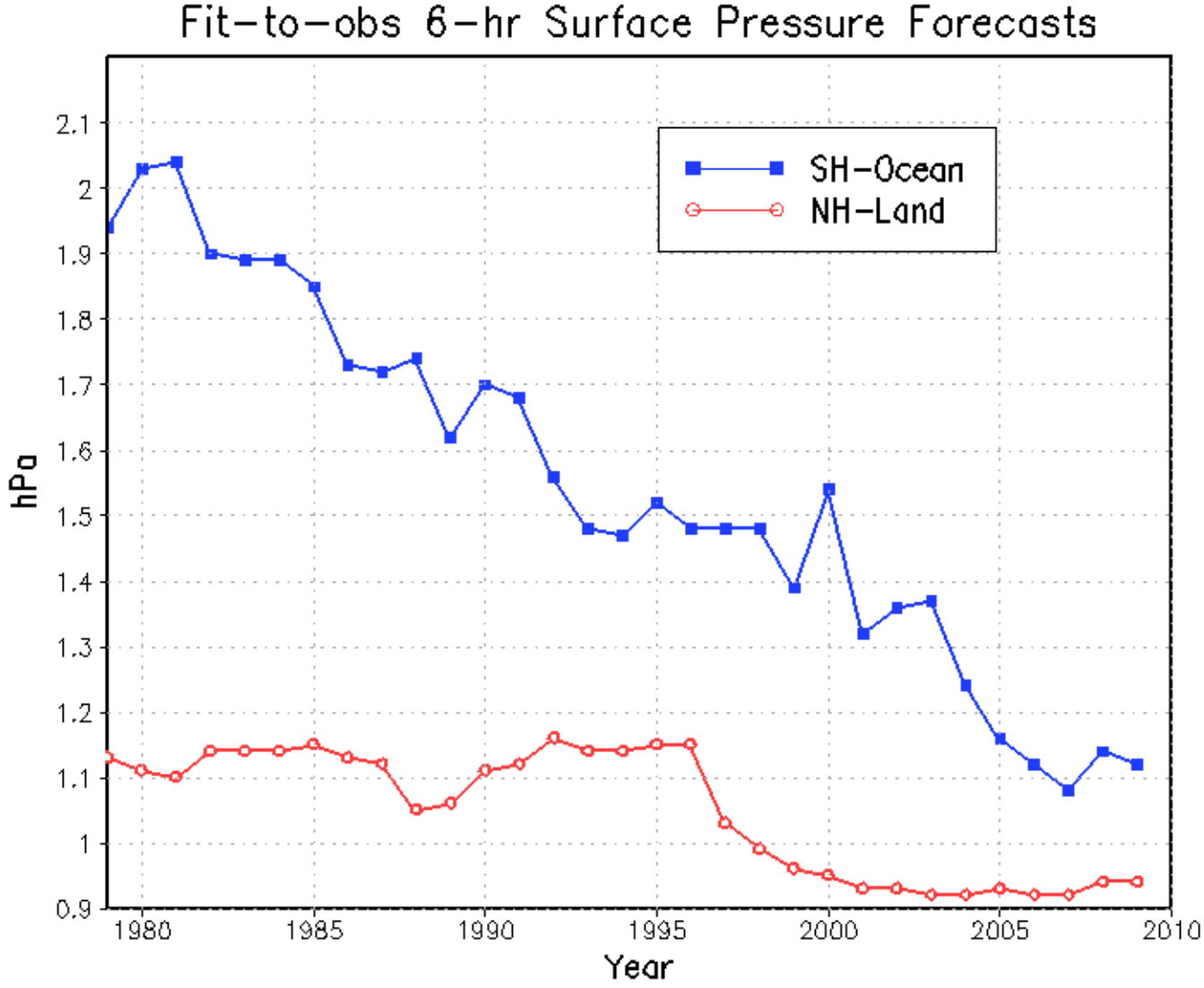
Amplitude much better than in R1 (6 hourly)

Courtesy: Huug van den Dool

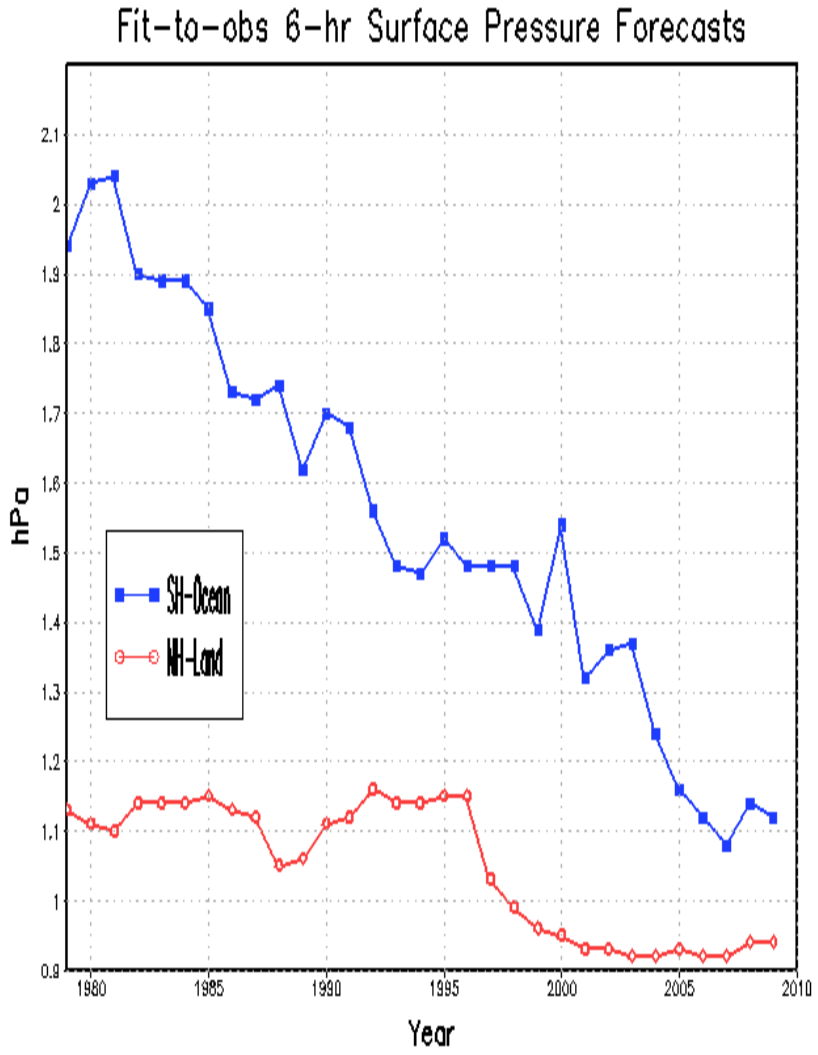

Semi-Diurnal Tide along Equator
Amplitude in hPa
1.12
1.1
1.08
1.06
1.04
1.02
1
0.98
0.96
0.94
0
1
2
3
4
5
6
7
8
9
10
11
12
13
Month

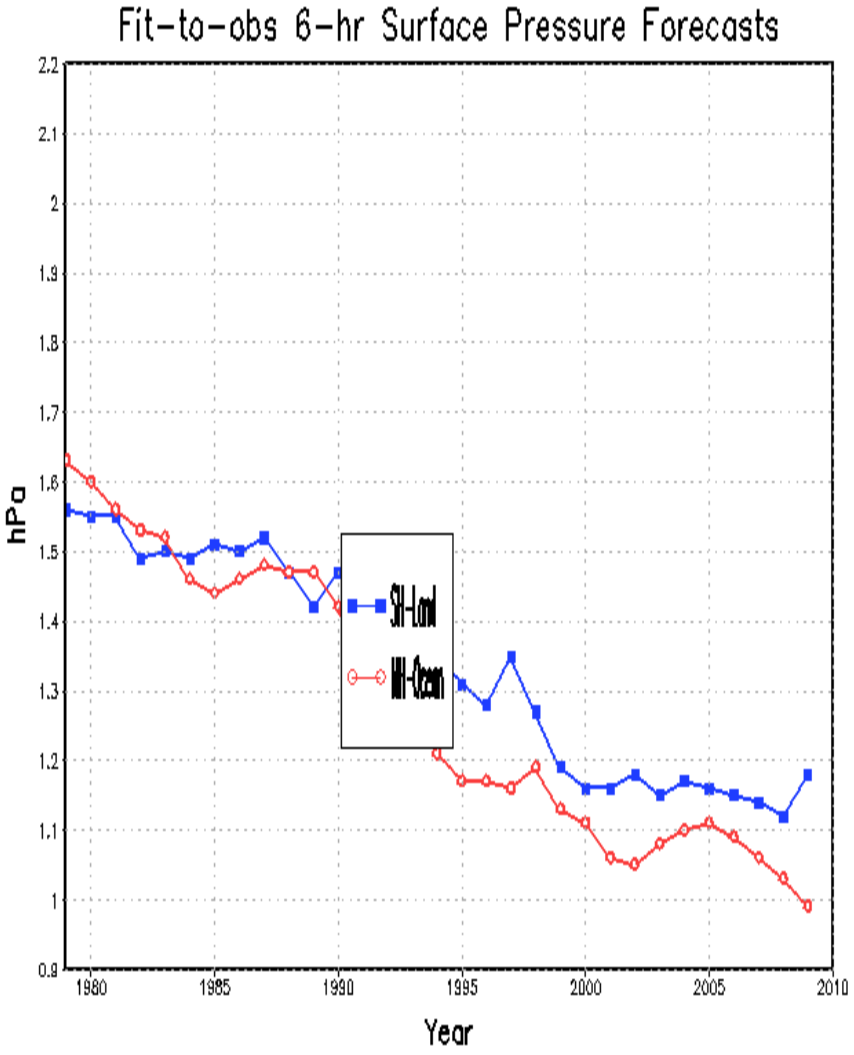

Annual Mean amplitude of semi-diurnal tide along Equator
Amplitude in hPa
1.14
1.12
1.1
1.08
1.06
1.04
1.02
1
0.98
0.96
1979
1982
1985
1988
1991
1994
1997
2000
2003
2006
2009
Year

The fit of 6 hour forecasts of instantaneous surface pressure against irregularly distributed observations (yearly averages)



Courtesy: Huug van den Dool

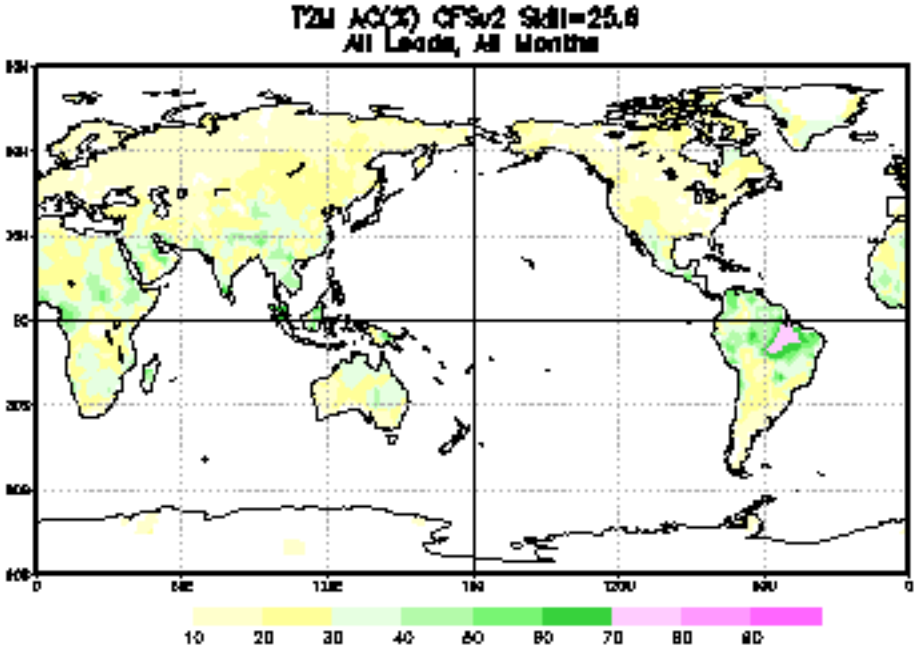


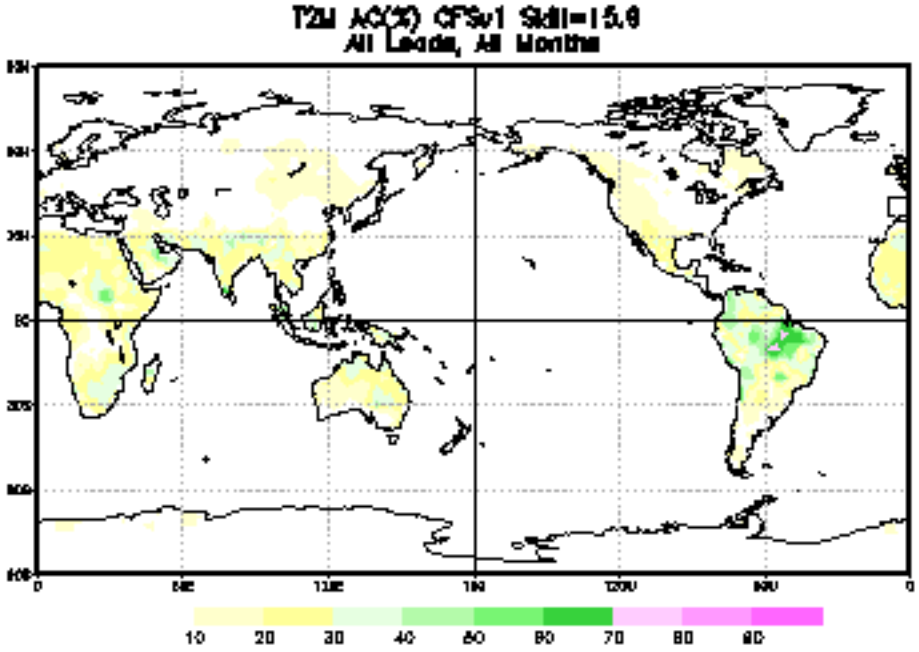


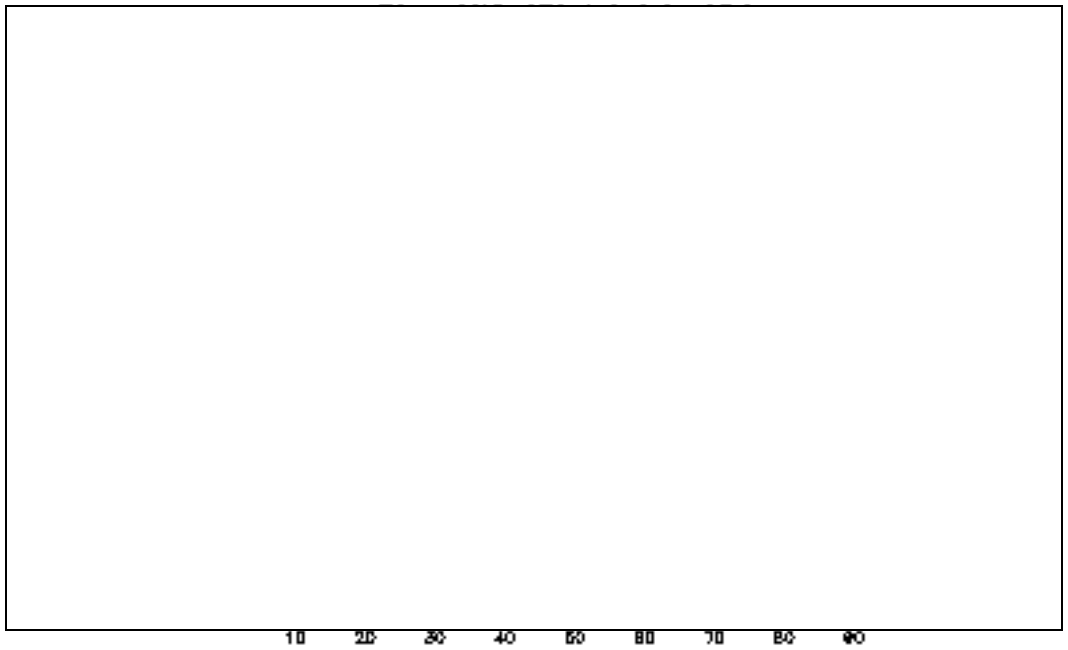
CFSR, assumed obs error:

Land 1.0 mb,
Ocean 1.6 mb

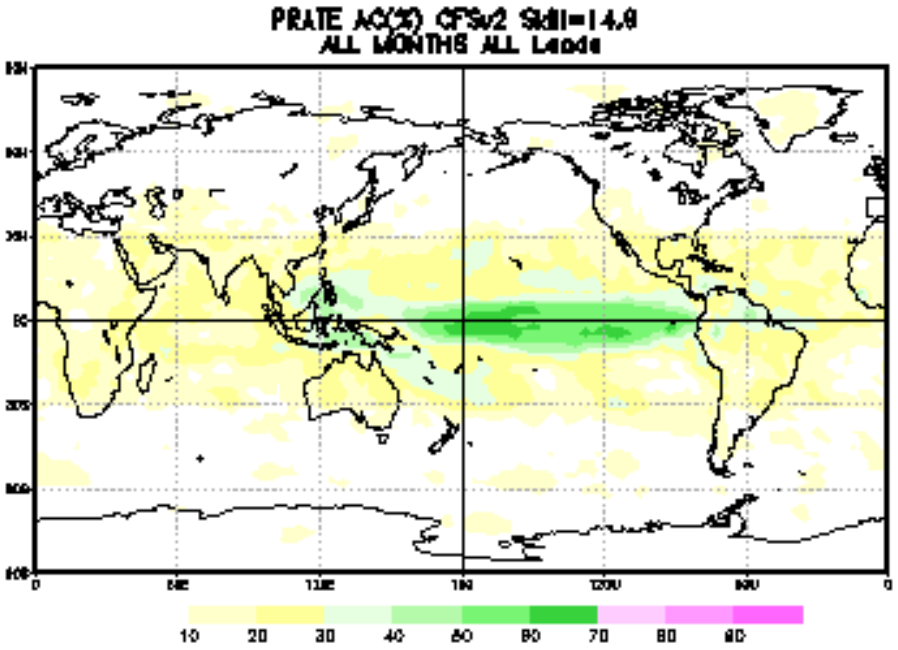
Comparison of Seasonal Prediction CFSv1 (ops) and CFSv2 (next upgrade)

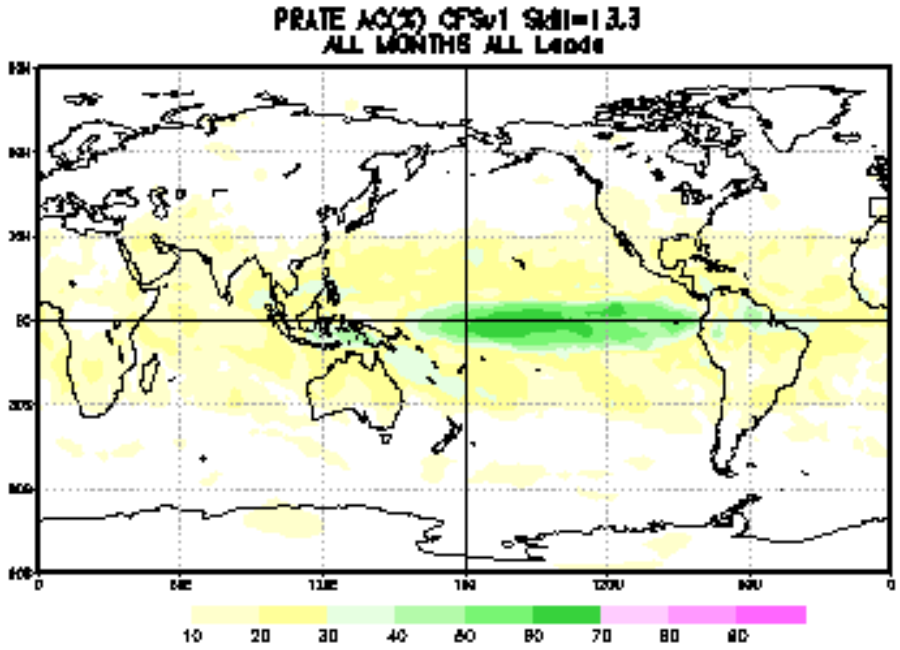


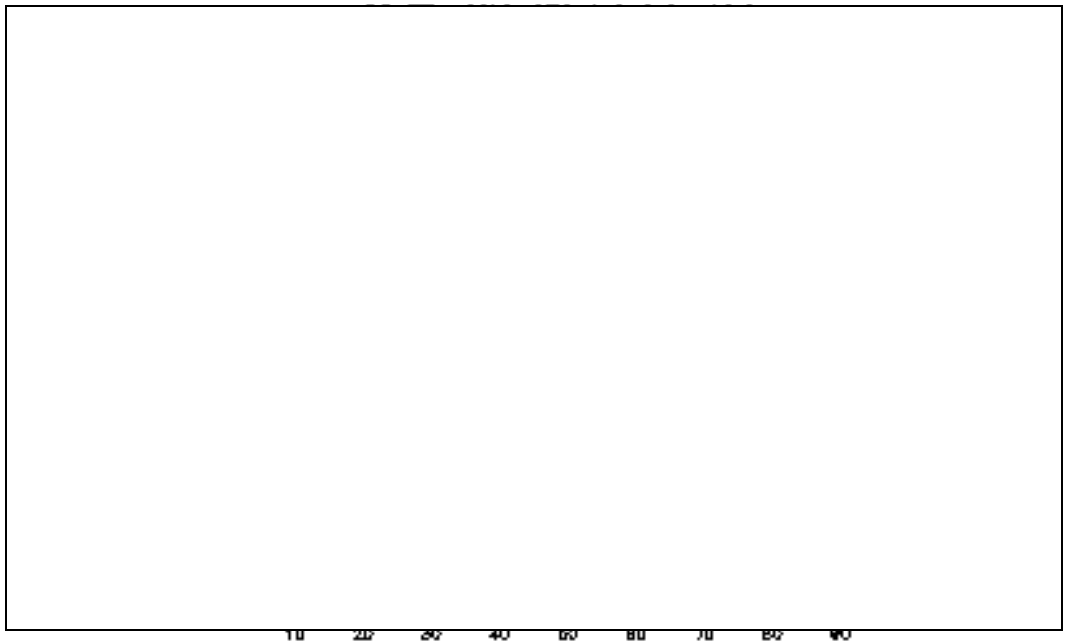




More skill globally for CFSv2







More skill in the western Pacific for CFSv2

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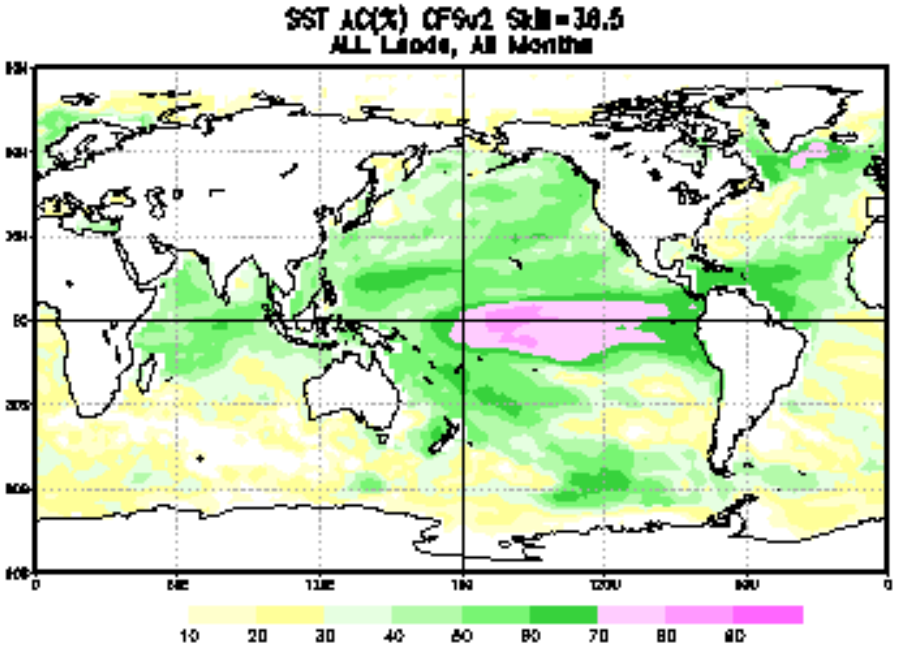

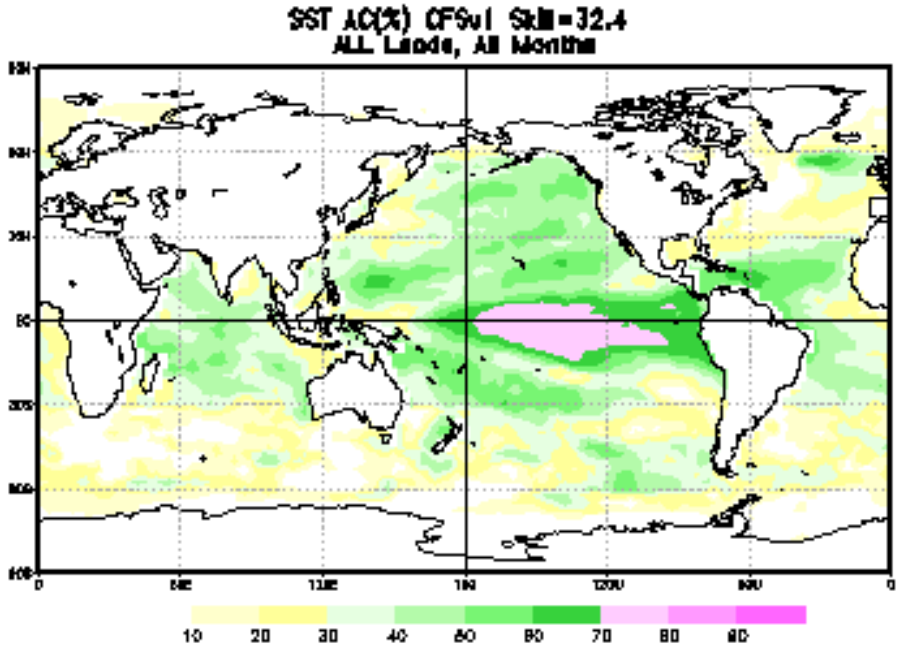

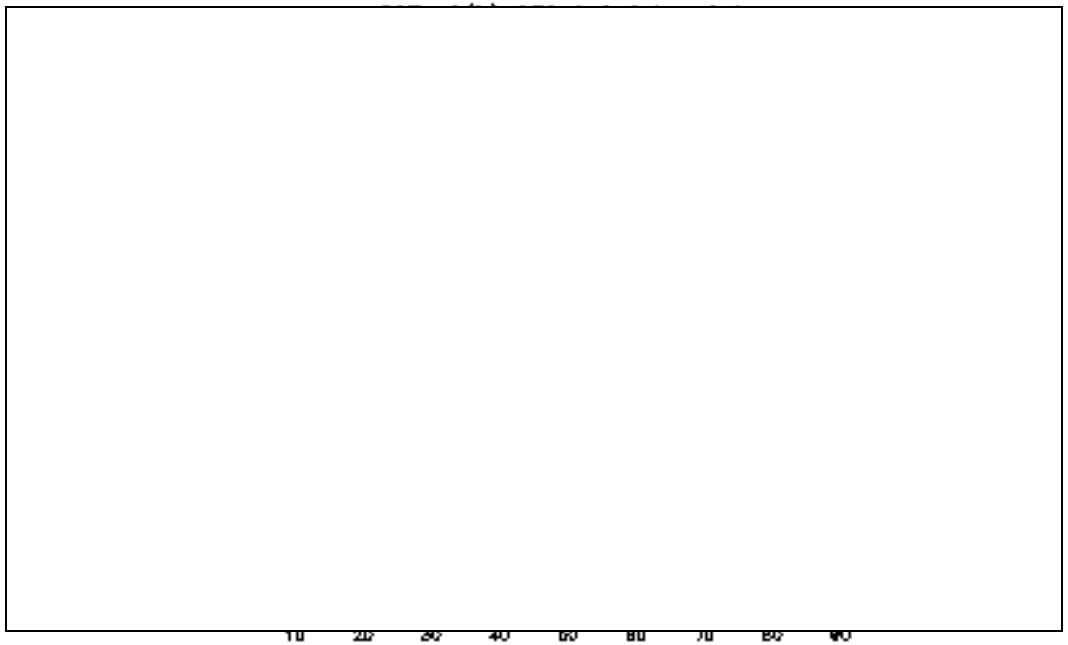

More skill west of the dateline and over the Atlantic for CFSv2

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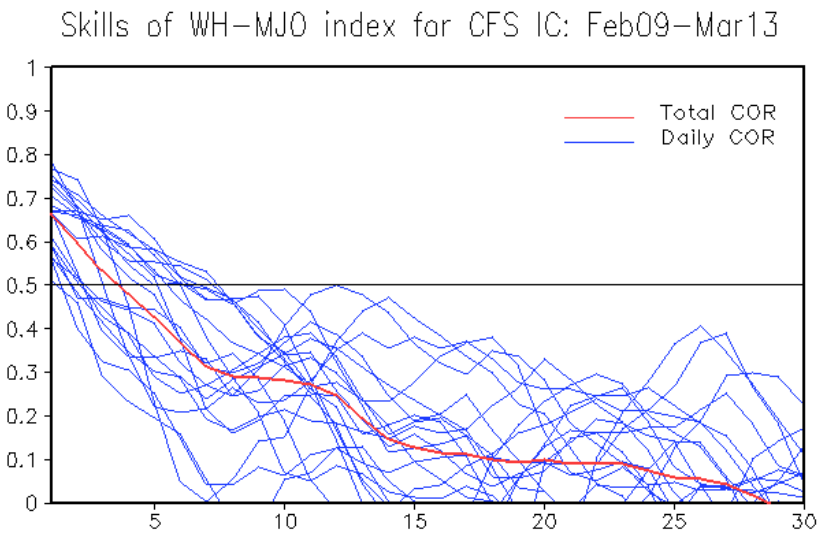
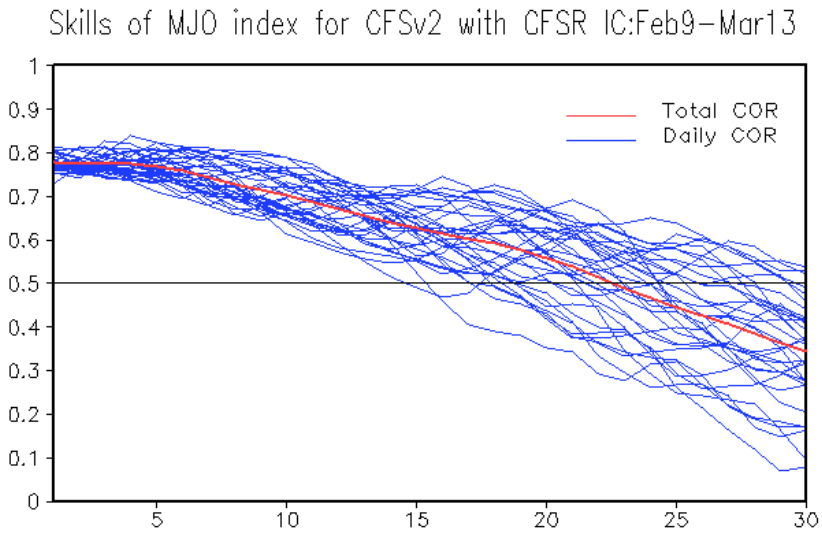
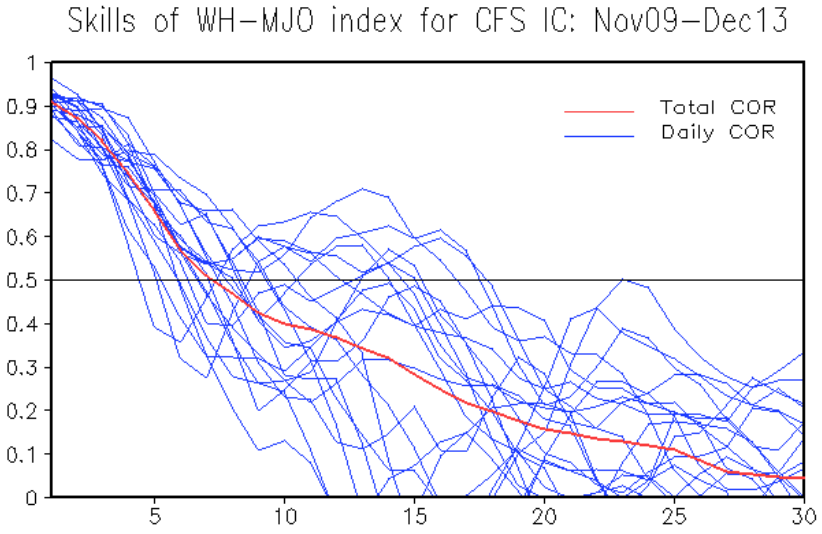
Switch gears to 45 day forecasts from CFSR

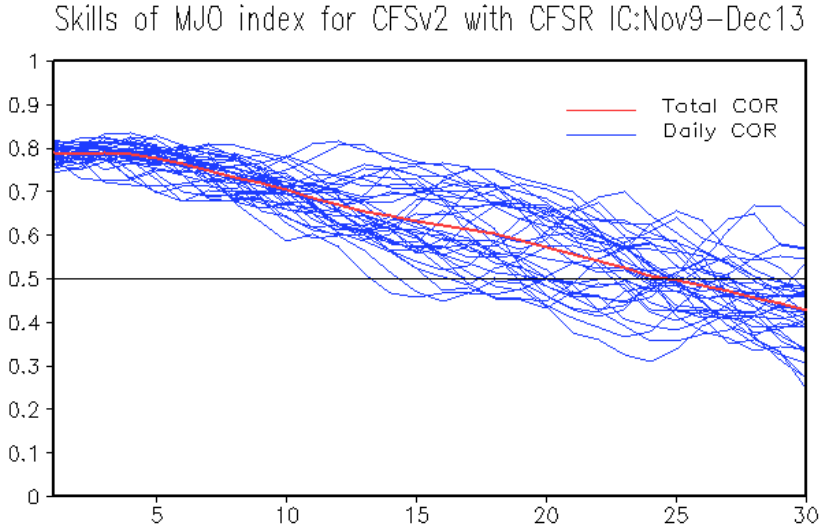
OLD v1



New v2



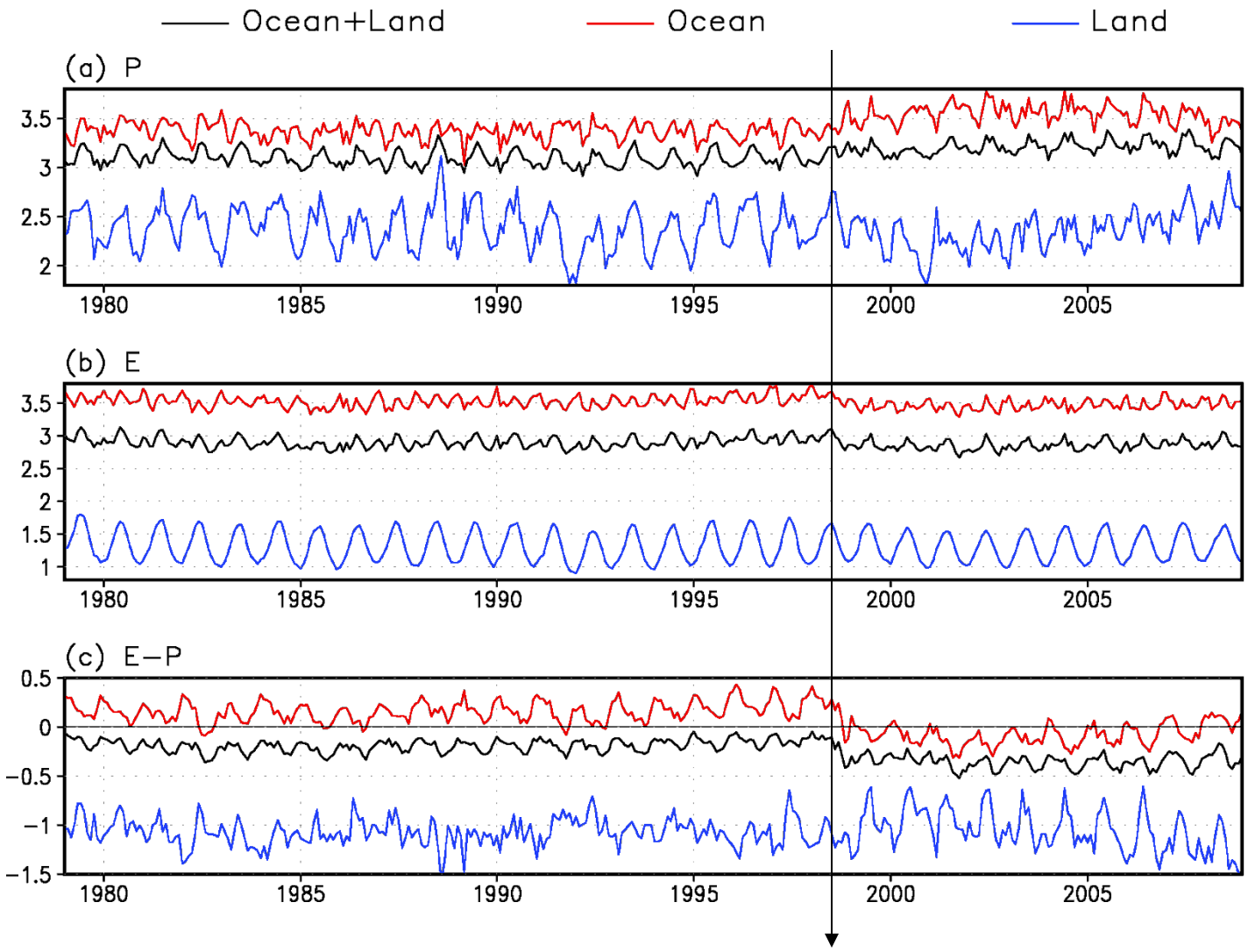




Period 1982 - 2008

Courtesy: Qin Zhang

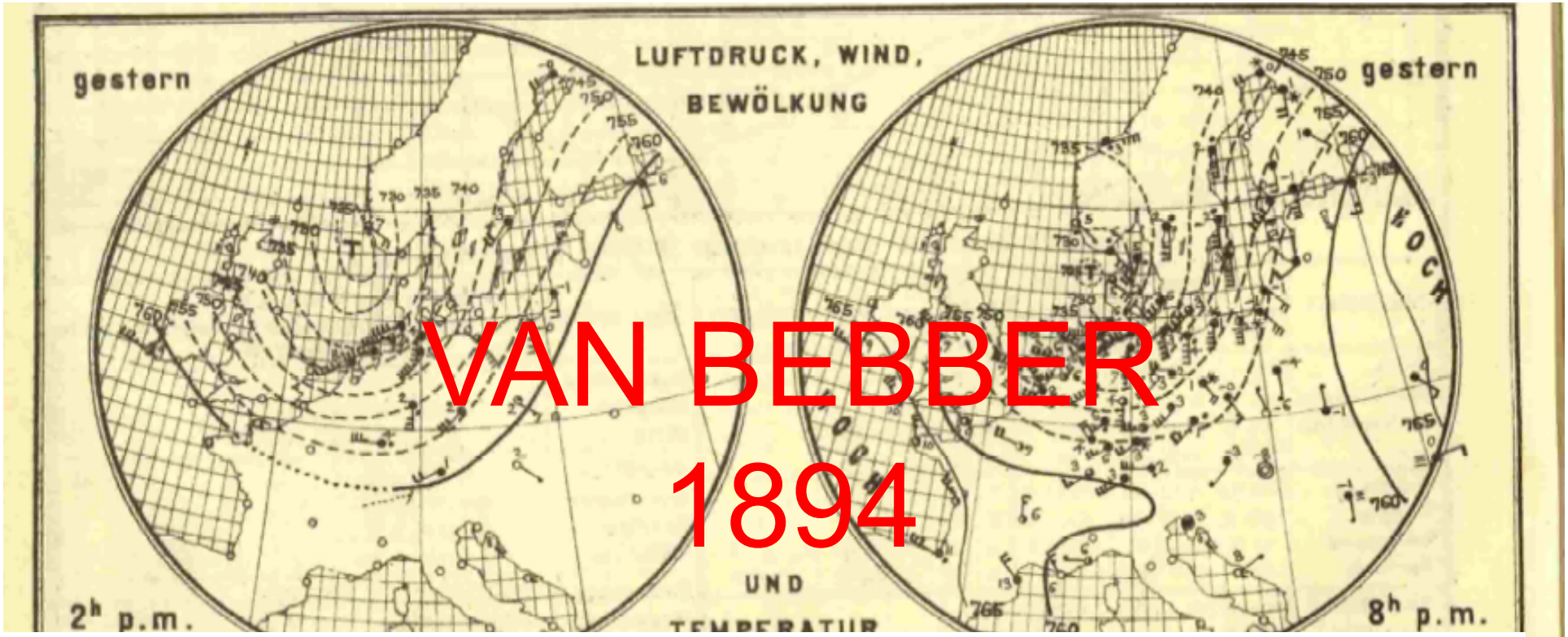
Is everything perfect with CFSR?? NO!



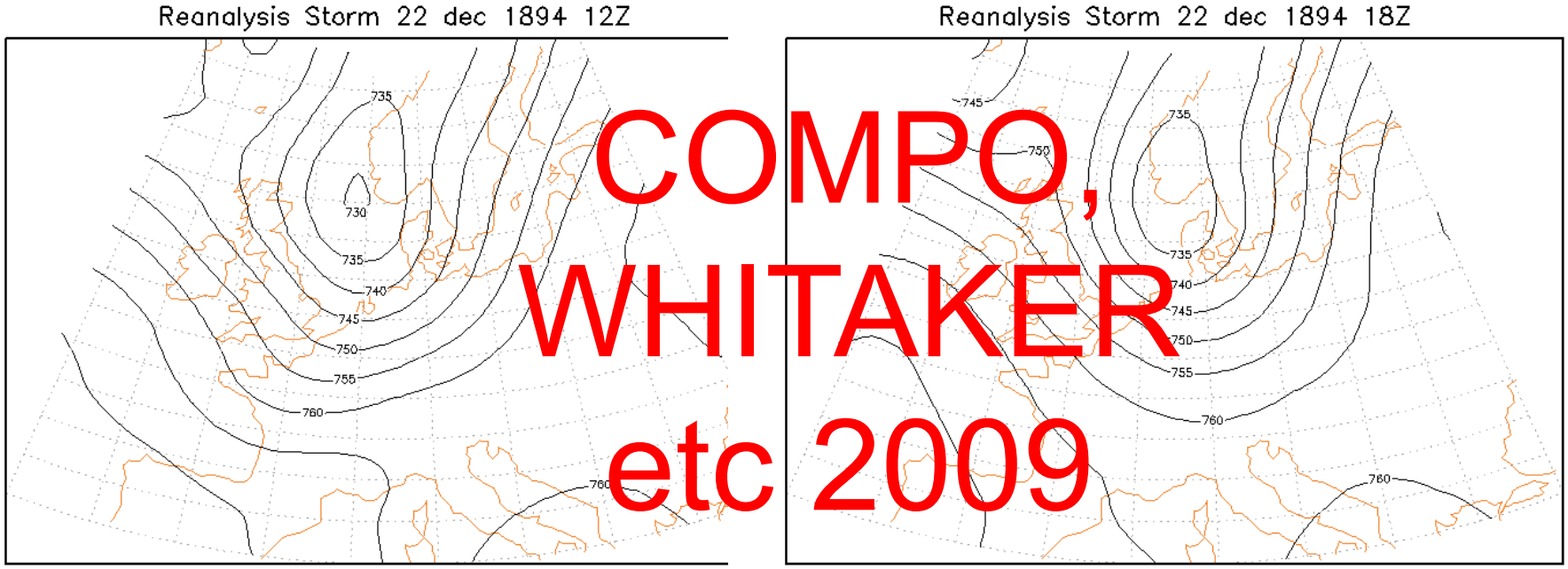
Oct 1998 (AMSU)

Additional comments

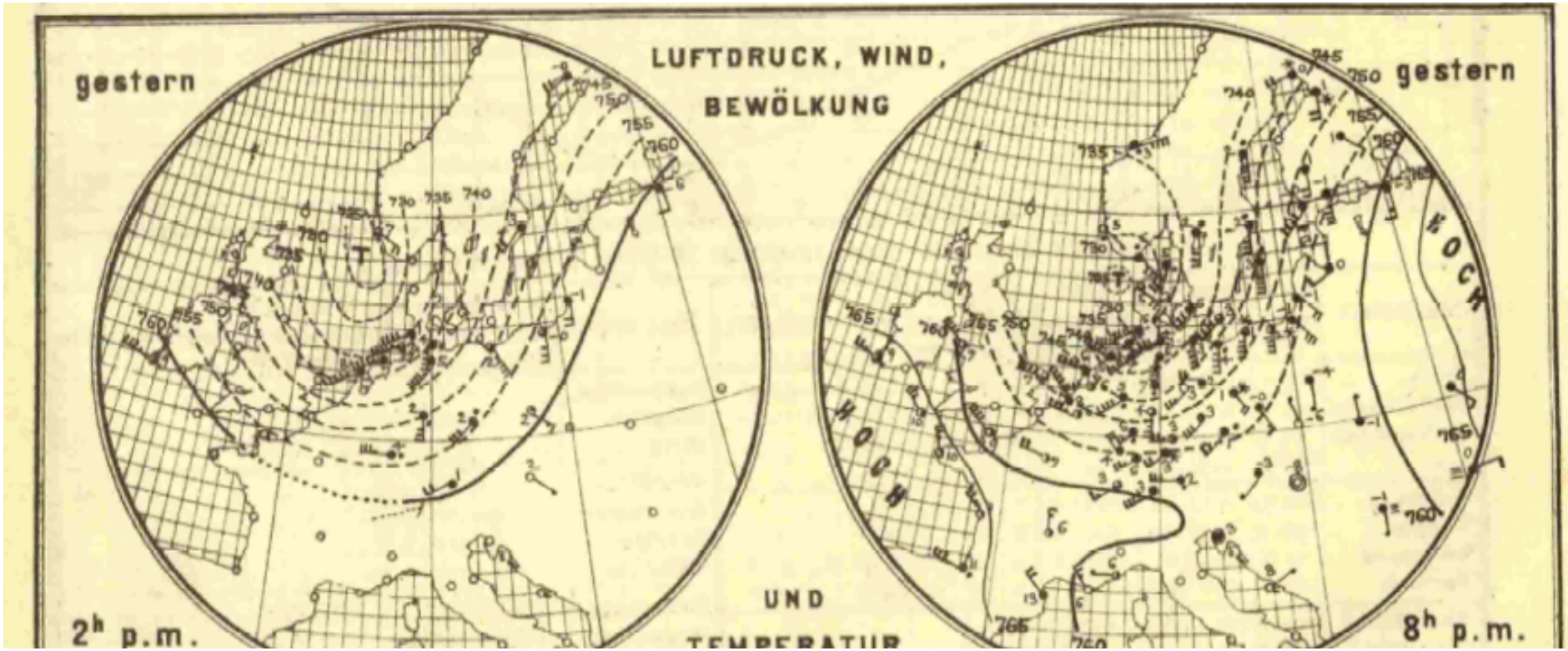
- The 7-year cycle
- CFSR-Light
- Backward extension to 1948, the radiosonde era
- Study of historical storms (1871, 1894, 1897)



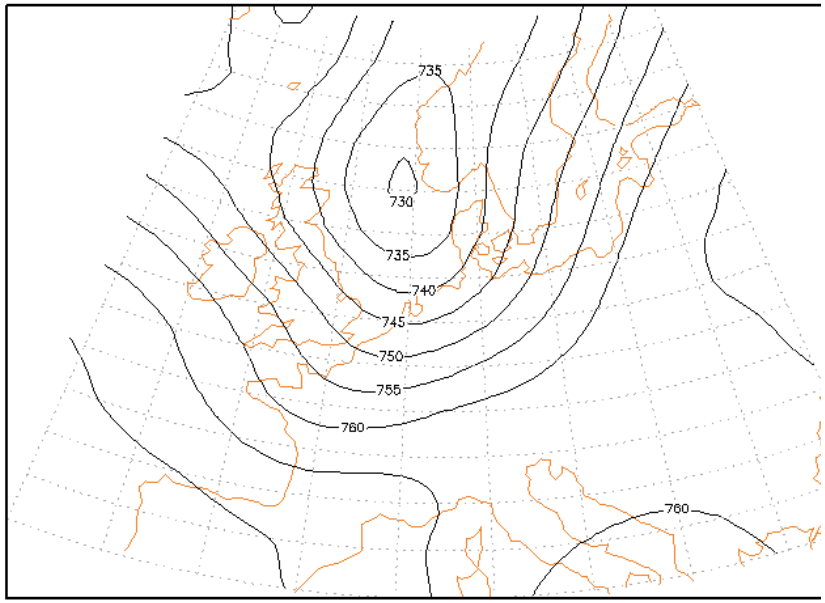
VAN BEBBER
1894



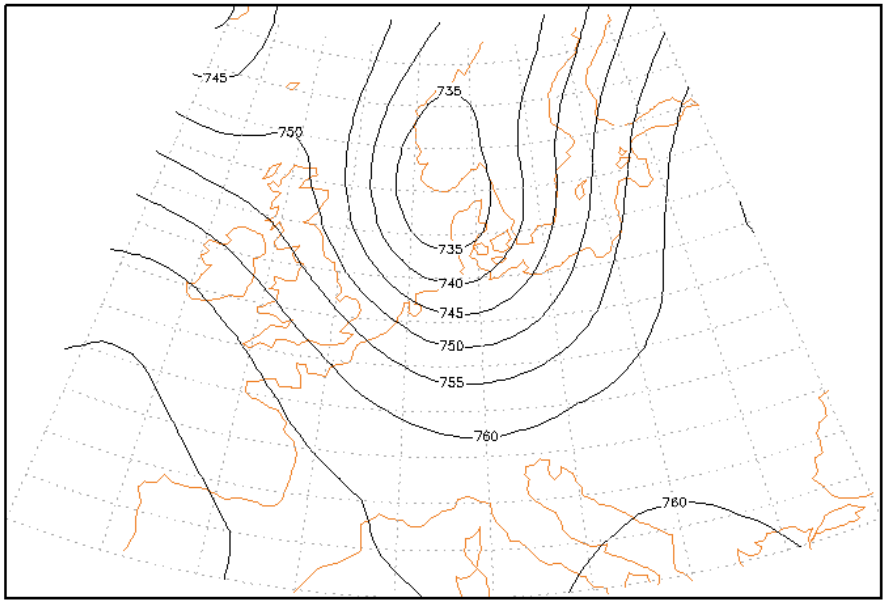
COMPO,
WHITAKER
etc 2009



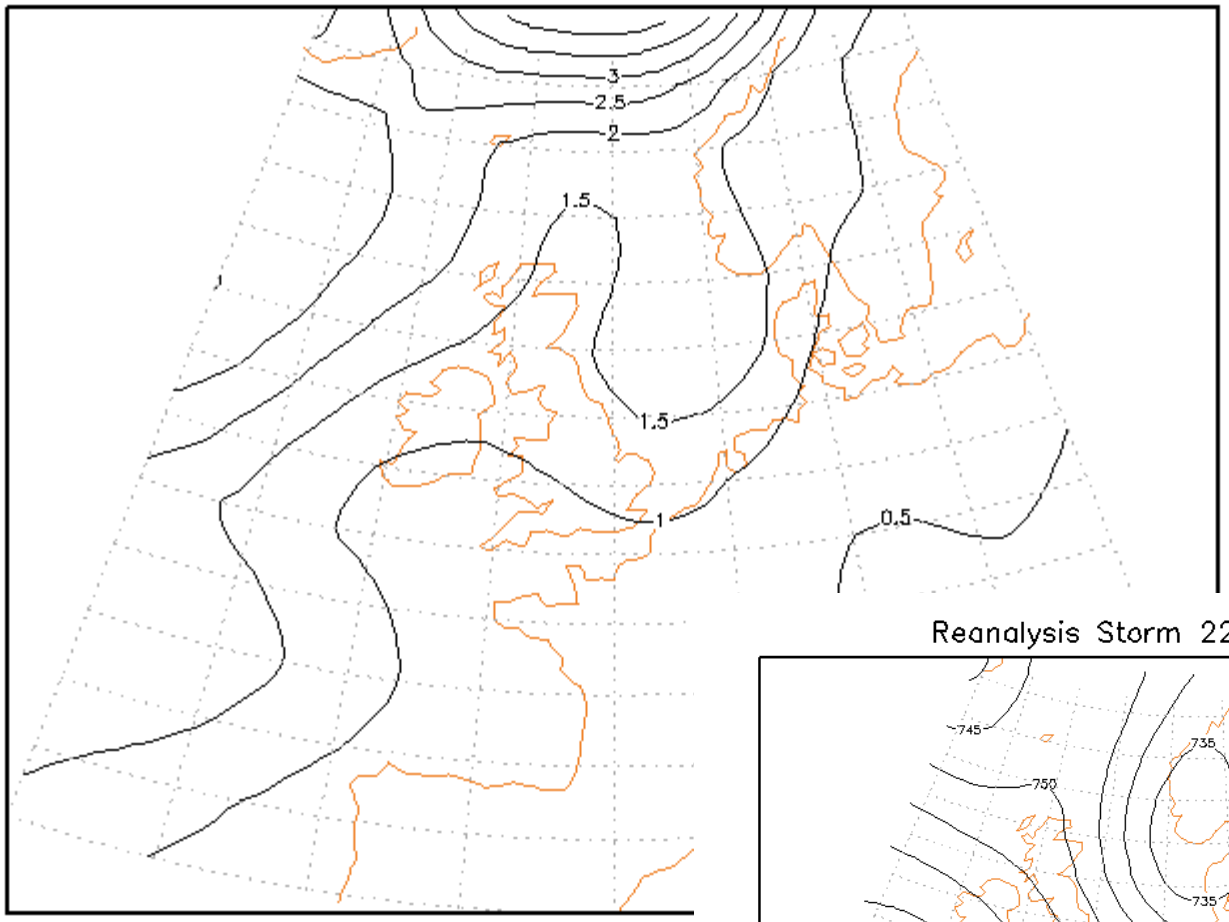
Reanalysis Storm 22 dec 1894 12Z



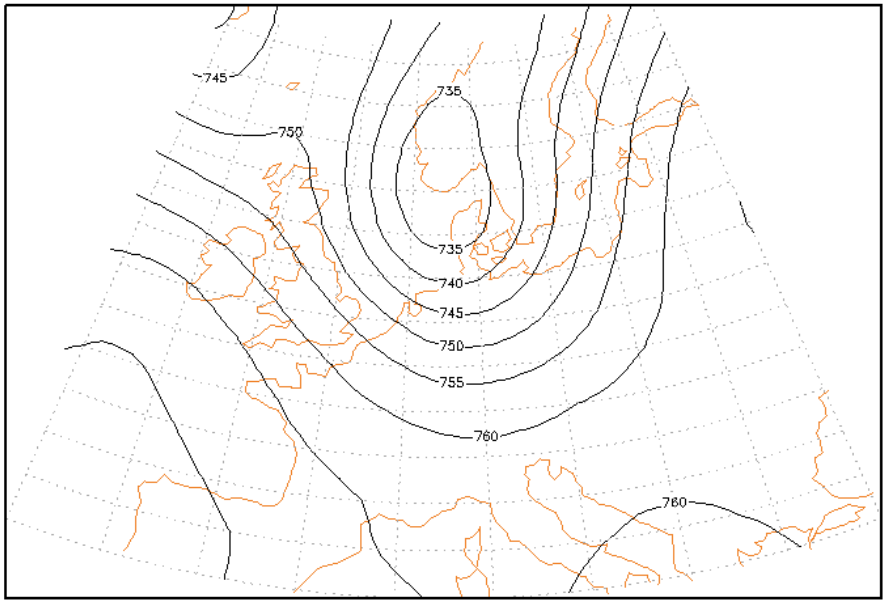
Reanalysis Storm 22 dec 1894 18Z



Spread Reanalysis Storm 22 dec 1894 18Z



Reanalysis Storm 22 dec 1894 18Z



THANK YOU

CFSR Website : http://cfs.ncep.noaa.gov/cfsr

Email : cfs@noaa.gov

An upgrade to the coupled atmosphere-ocean-seaice-land NCEP Climate Forecast System (CFS) is being planned for Jan 2011.

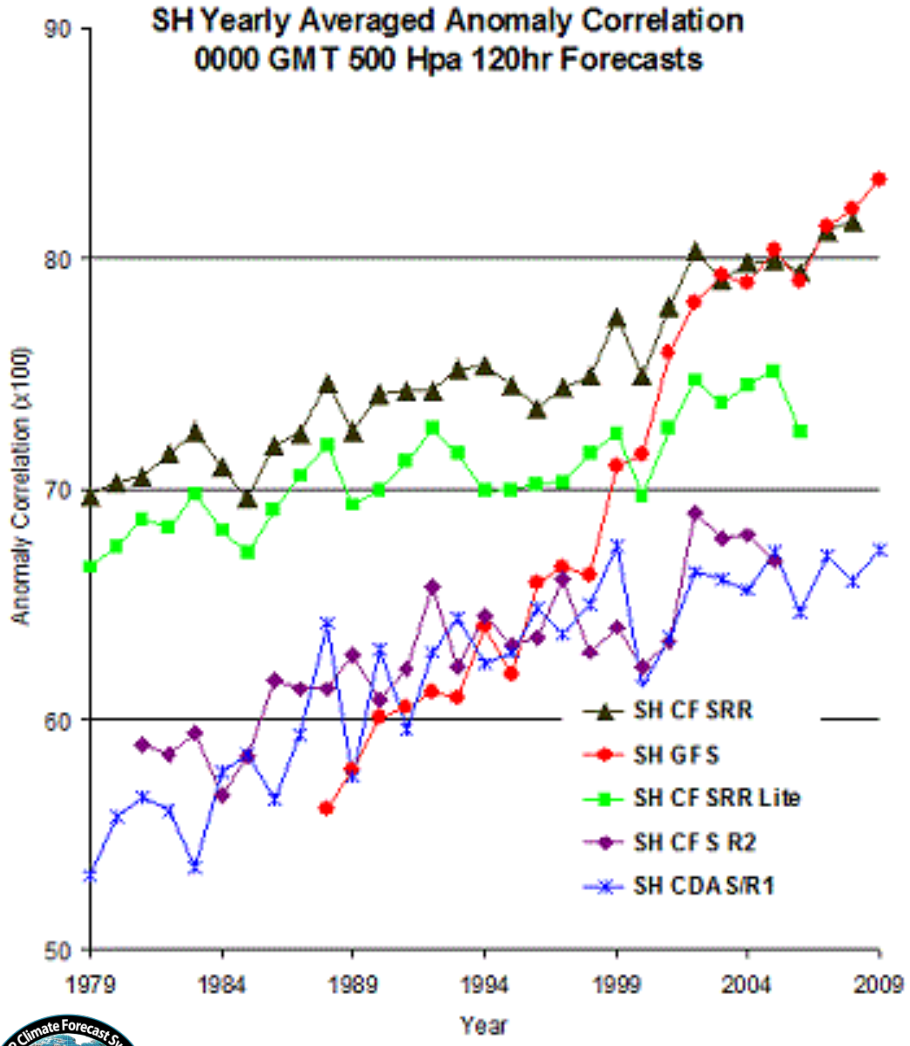
This upgrade involves changes to all components of the CFS, namely:

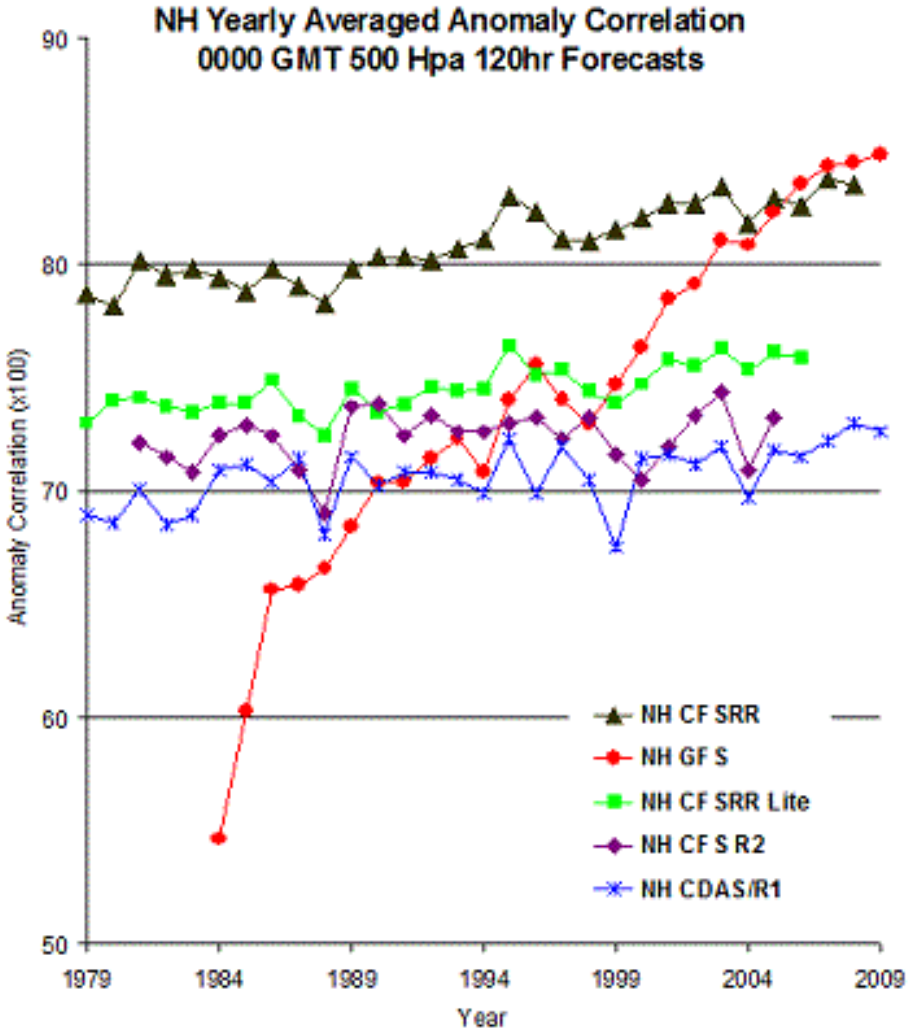
improvements to the data assimilation of the atmosphere with the new NCEP Gridded Statistical Interpolation Scheme (GSI) and major improvements to the physics and dynamics of operational NCEP Global Forecast System (GFS)

improvements to the data assimilation of the ocean and seaice with the NCEP Global Ocean Data Assimilation System, (GODAS) and a new GFDL MOM4 Ocean Model

improvements to the data assimilation of the land with the NCEP Global Land Data Assimilation System, (GLDAS) and a new NCEP Noah Land model

5-day T126L64 forecast anomaly correlations





Courtesy: Bob Kistler