



Design of the 30-year NCEP CFSRR

T382L64 Global Reanalysis and T126L64 Seasonal Reforecast Project (1979-2009)

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Purpose of the CFSRR

- 1. This reanalysis is intended to provide the best initial conditions for the CFS reforecast**
- 2. This reanalysis will also be used to address calibration and statistical applications for weather and monthly forecasts**
- 3. This reanalysis will be used by the scientific community to improve our understanding of the earth system**
- 4. This reanalysis can be used as the first version of the IESA for NOAA**



For a new Climate Forecast System (CFS) implementation

Two essential components:

A new Reanalysis of the atmosphere, ocean, sea ice 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 |
| 3. Ocean Model : | New MOM4 Ocean |
| 4. Land Model : | Operational Noah Land Model |
| 5. Sea Ice Model: | New Sea Ice Model |



An upgrade to the coupled atmosphere-ocean-seaice-land NCEP Climate Forecast System (CFS) is being planned for Jan 2010.

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 ice 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**



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 high 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 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 will be generated from a coupled atmosphere – ocean – seaice - land system**
- **Radiance measurements from the historical satellites will be assimilated in this Reanalysis**

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



4 Simultaneous Streams

- **Jan 1979 – Oct 1989** **11 years**
- **Apr 1989 – Oct 1998** **10 years**
- **Apr 1998 – Oct 2004** **7 years**
- **Apr 2004 – Dec 2009** **6 years**

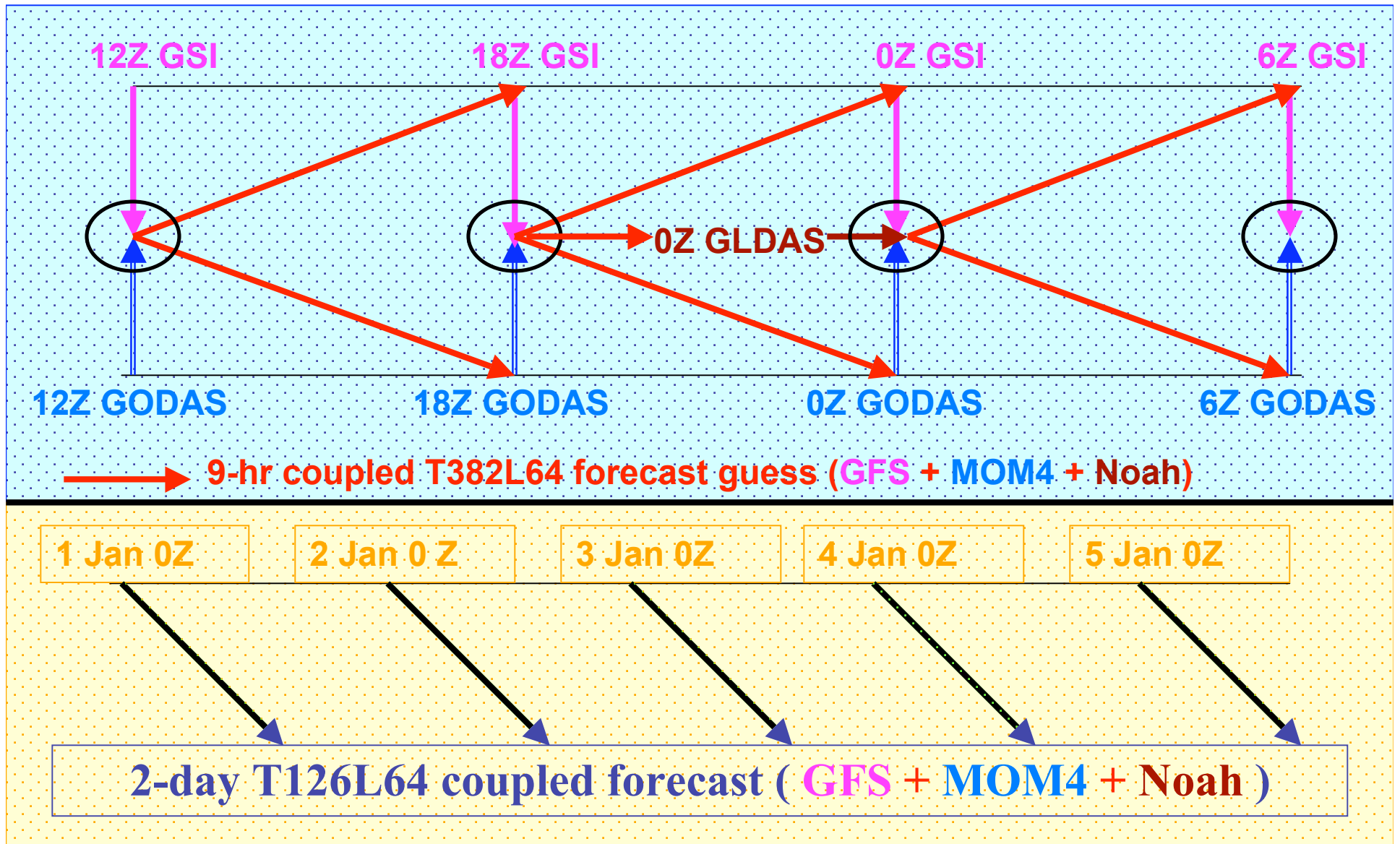
6 month overlap for ocean and land spin ups

**Reanalysis to cover 31 years (1979-2009) + 21
overlap months**

Reforecasts to cover 28 years (Jan 1982 – Dec 2009)



ONE DAY OF REANALYSIS





PROPOSED TIME LINE FOR COMPLETION OF CFSRR

- **January to December 2008:** Begin Production and Evaluation of the CFS Reanalysis for the full period from 1979 to 2008 (30 years)
- **January to December 2008:** Begin running CFS Retrospective Forecasts for 2 initial months: October and April, and evaluate the monthly forecasts as well as the seasonal winter (Lead-1 DJF) and summer (Lead-1 JJA) forecasts.
- **January to October 2009:** Continue running the CFS Reforecasts (for the rest of the 10 calendar months)
- **November 2009:** Begin computing calibration statistics for CFS daily, monthly and seasonal forecasts.

January 2010: Operational implementation of the next CFS monthly and seasonal forecast suite.



Data to be archived and made available to users by NCDC

CFS Hi Res IC (6-hourly) T382L64 Atmosphere + .5 degree Ocean

CFS Lo Res IC (6-hourly) T126L64 Atmosphere + 1 degree Ocean

Full Ingest Data (6-hourly) All input data for the re-analysis

Pgbh 0.5 x 05 (Hourly) 37 standard pressure level atmosphere products

Flxf T382 Gaussian (Hourly) surface and radiative fluxes on model grid

Ocnh 0.5 x 0.5 (Hourly) 40 standard depth level ocean products

Diabf 1.0 x 1.0 (Hourly) 37 standard pressure level diabatic heating rates

Ipvh 0.5 x 0.5 (Hourly) 16 standard isentropic level atmosphere products



28-year CFS re-forecast archive by NCDC (1982-2009)

6-hourly Pgb and Flx * 37 standard pressure level atmosphere products

6-hourly Ocn * 40 standard depth level ocean products

6-hourly Ipv * 16 standard isentropic level atmosphere products

- * 1.0 x 1.0 for first 6 months of forecast ; 2.5 x 2.5 for next 6 months of forecast**



Status of the CFS Reanalysis

- Tests performed:
 - 20 data impact studies (using T62L64 atmospheric-only data assimilation system)
 - SSU, SBUV, GPSRO, SST, cloud track winds (JMA and ERS)
 - 6 satellite radiance bias correction spin up runs (using T382L64 coupled data assimilation system). 9 more to go
 - 3 six-month overlap periods for 3 of the 4 streams (using T382L64 coupled data assimilation system)
For first stream, we went back to December 1978 to allow for one-month spinup
- Ready to start production



Issues

- Archival and Distribution
 - Working with NCDC to transfer the data to NCDC for distribution
- Monitor and Quality Control
 - Working closely with CPC team to monitor the reanalysis as the data are created to find and correct errors as we go
- Reforecast preparation
 - Plan to run two months (April and October) reforecast for evaluation



Issues

- Reanalysis 1948-2008 to replace R1
 - CPC and EMC are in the planning stage to complete a 1948-2008 (post WWII) reanalysis with uniform data
 - Current plan is to use the CFSRR system leveraging existing resources
 - What is the meaning of a 'uniform data' reanalysis?
 - Satellite data used in the current CFS reanalysis:
 - Radiance, SBUV ozone retrieval, scatterometer winds, cloud track winds, SST analysis, snow analysis, sea-ice analysis, tropical storm locations, daily global precipitation, sea surface height, vegetation fraction, albedo
 - In order to do a clean uniform conventional data reanalysis, we need to figure out how to do SST, snow and ice analysis without satellite information
 - Decisions to include cloud track and scatterometer winds are important for southern hemisphere analysis
 - Stratosphere analysis is probably troublesome without SBUV and radiance data
 - Community input to reach a consensus on this issue is important before starting the project



issues

- Integrated Earth System Analysis
 - Aerosol is in the plan for the operational data assimilation system and will be available at the next CFSRR
 - CO₂ changes are already built in the current CFS Reanalysis
 - 20-century type of CMIP runs indicates that the CFS in the CFSRR system is capable of responding to the CO₂ changes
- How can we accelerate the future CFSRR?
 - Data assimilation – combine satellite radiance usage with the earth system modeling to address atmosphere, ocean, land, ice, and biosphere
 - Improving both weather and climate signals in the fully coupled models
 - Resource needed to do both