Update on the Climate Forecast System (CFS) Development Activities at NCEP

Jae-Kyung E. Schemm
Climate Prediction Center
NCEP/NWS/NOAA

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An upgrade to
NCEP Climate Forecast System (CFS) planned for Jan 2010.

This upgrade involves changes to all components of the CFS:

- **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 the 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 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 29-year period (1981-2009), in order to provide stable calibration and skill estimates of the new system, for operational seasonal prediction at NCEP

This new CFS RR is a collaborative effort among NCEP/EMC, CPC and the NOAA Climate Test Bed.

For a new CFS implementation (contd)

1. Analysis Systems :	Operational DAS: Atmospheric (GSI) Ocean (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 Reanalysis:

1. **An atmosphere at high horizontal resolution (spectral T382, ~35 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 km, 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 from 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**

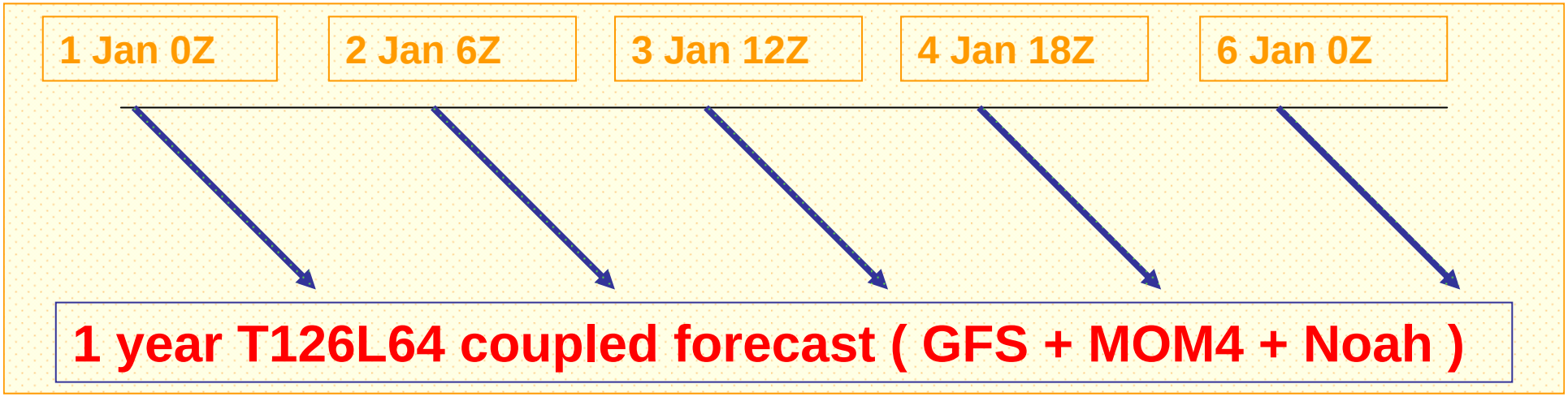
UPGRADES TO THE ATMOSHERIC MODEL

- **Hybrid vertical coordinate (sigma-pressure)**
- **NOAH Land Model : 4 soil levels. Improved treatment of snow and frozen soil**
- **Sea Ice Model : Prediction of ice concentration and ice fraction**
- **Sub grid scale mountain blocking**
- **Reduced vertical diffusion**
- **RRTM long wave radiation**
- **ESMF (3.0)**

SOME TEST UPGRADES TO THE ATMOSHERIC MODEL

- **Enthalpy**
- **MODIS Albedo**
- **AER RRTM Shortwave Radiation**
- **Ferrier-Moorthi Microphysics**
- **New Boundary Layer Parameterization**
- **New Shallow Convection**
- **New Aerosol Treatment**
- **New Convection Scheme (RAS)**
- **New convective gravity wave drag formulation**
- **Inclusion of historical CO2, solar cycle and volcanic aerosols**

CFS REFORECASTS



Coupled one-year forecast from initial conditions 30 hours apart will be made for 2 initial months (April and October) with the T126L64 GFS with half-hourly coupling to the ocean (MOM4 at 1/4º equatorial, 1/2º global). Total number of forecasts = 28 x 2 x 30 = 1680

For each cycle, there will be approximately 7 members per month, with a total of 210 members over a 30-year period. This ensures stable calibration for forecasts originating from each cycle, for a given initial month

Horizontal resolution experiment with the NCEP CFS

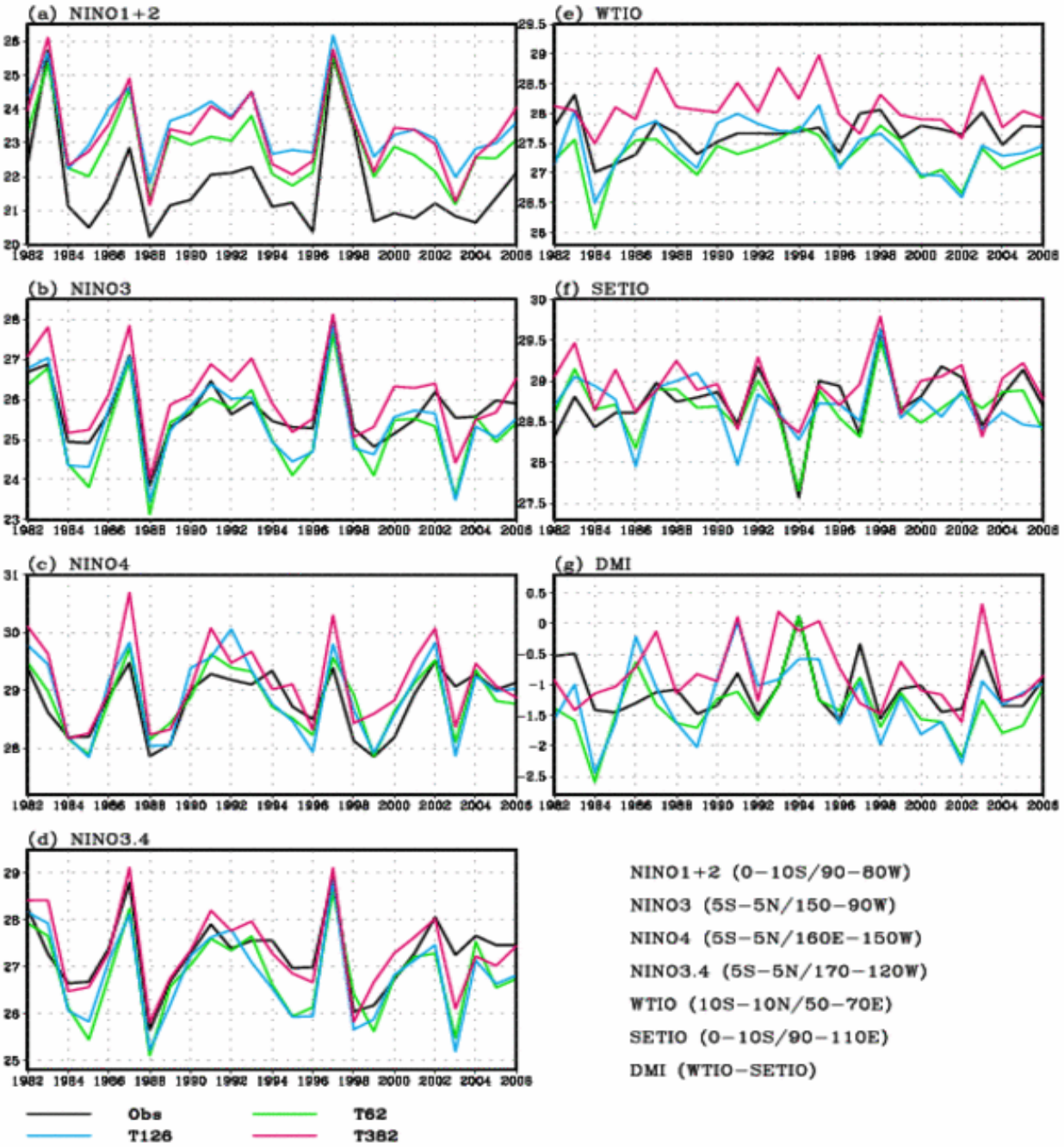
1. AGCM - Current operational NCEP GFS with the RRTM radiation package and Noah LSM.

2. OGCM - GFDL MOM3

3. All runs initialized with NCEP/DOE R2 and NCEP GODAS, at 0Z, May 15, 1981-2006.

4. AGCM spatial resolutions in T62L64, T126L64 and T382L64.

JJA SST Indices



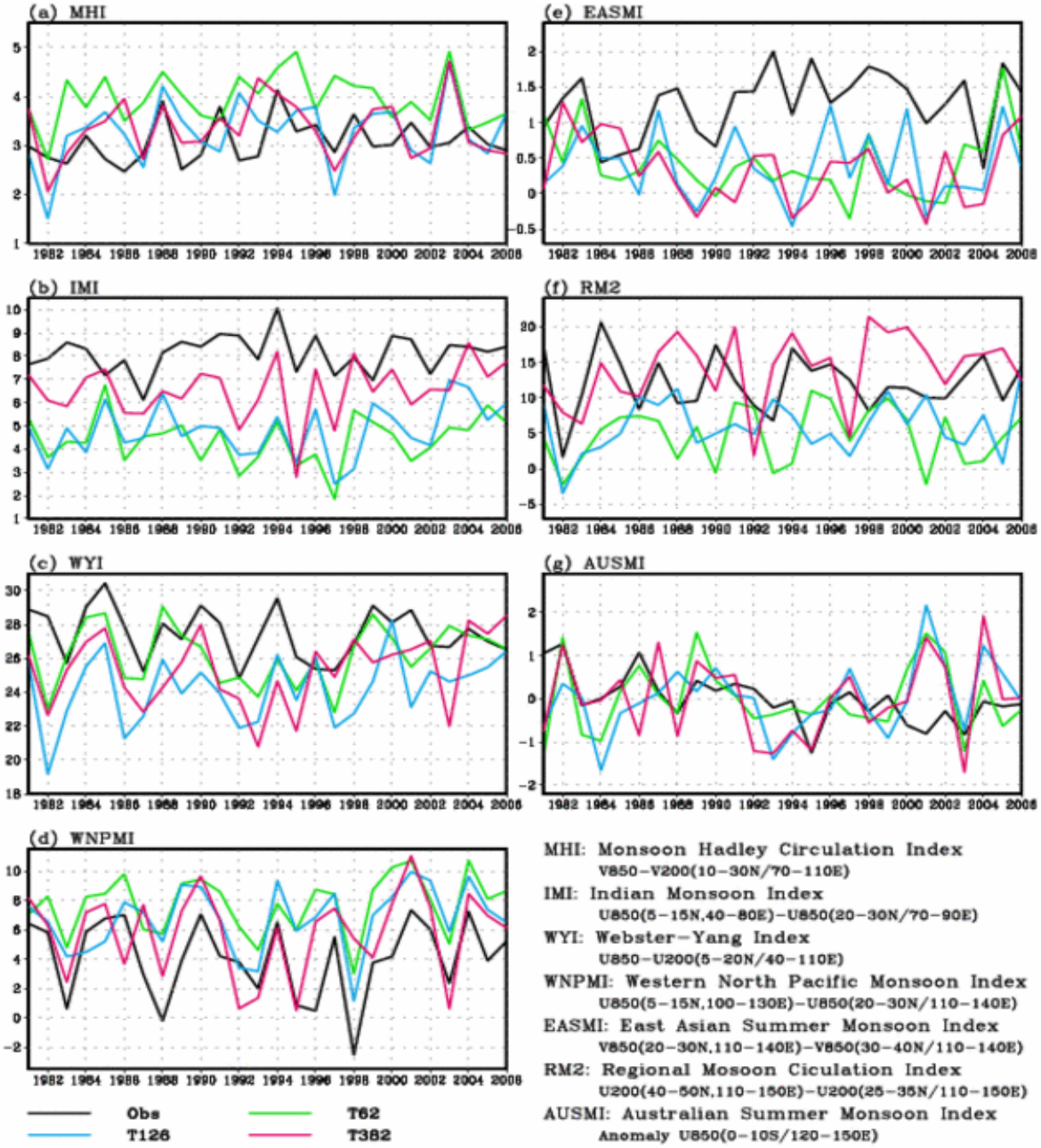
NINO1+2 (0–10S/90–80W)
NINO3 (5S–5N/150–90W)
NINO4 (5S–5N/160E–150W)
NINO3.4 (5S–5N/170–120W)
WTIO (10S–10N/50–70E)
SETIO (0–10S/90–110E)
DMI (WTIO–SETIO)

Correlation Coefficients of JJA SST Indices

Corr. Coeff. (1982-2006)	T62	T126	T382
NINO1+2	0.90	0.89	0.86
NINO3	0.88	0.88	0.88
NINO4	0.78	0.78	0.78
NINO3.4	0.83	0.83	0.88
WTIO	0.54	0.48	0.33
SETIO	0.82	0.54	0.68
DMI	0.62	0.44	0.36

90% 95% 99%

JJA Monsoon Indices



MHI: Monsoon Hadley Circulation Index
V850-V200(10-30N/70-110E)

IMI: Indian Monsoon Index
U850(5-15N,40-80E)-U850(20-30N/70-90E)

WYI: Webster-Yang Index
U850-U200(5-20N/40-110E)

WNPMI: Western North Pacific Monsoon Index
U850(5-15N,100-130E)-U850(20-30N/110-140E)

EASMI: East Asian Summer Monsoon Index
V850(20-30N,110-140E)-V850(30-40N/110-140E)

RM2: Regional Mosoon Ciculation Index
U200(40-50N,110-150E)-U200(25-35N/110-150E)

AUSMI: Australian Summer Monsoon Index
Anomaly U850(0-10S/120-150E)

Correlation Coefficients of JJA Monsoon Indices

Corr. Coeff. (1981-2006)	T62	T126	T382
MHI	0.19	0.15	0.23
IMI	0.03	0.24	**0.39**
WYI	**0.45**	**0.35**	0.30
WNPMI	**0.76**	**0.68**	**0.58**
EASMI	0.24	**0.34**	0.11
RM2	0.15	0.20	0.15
AUSMI	0.17	-0.08	0.22

90% 95% 99%

Schedule planned for the 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.