

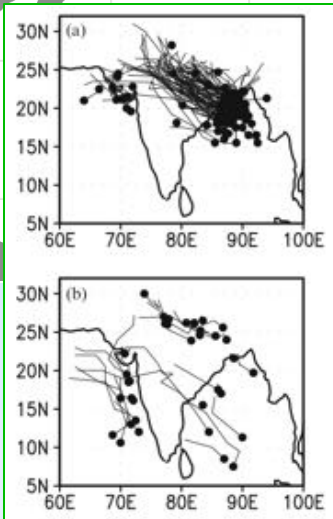
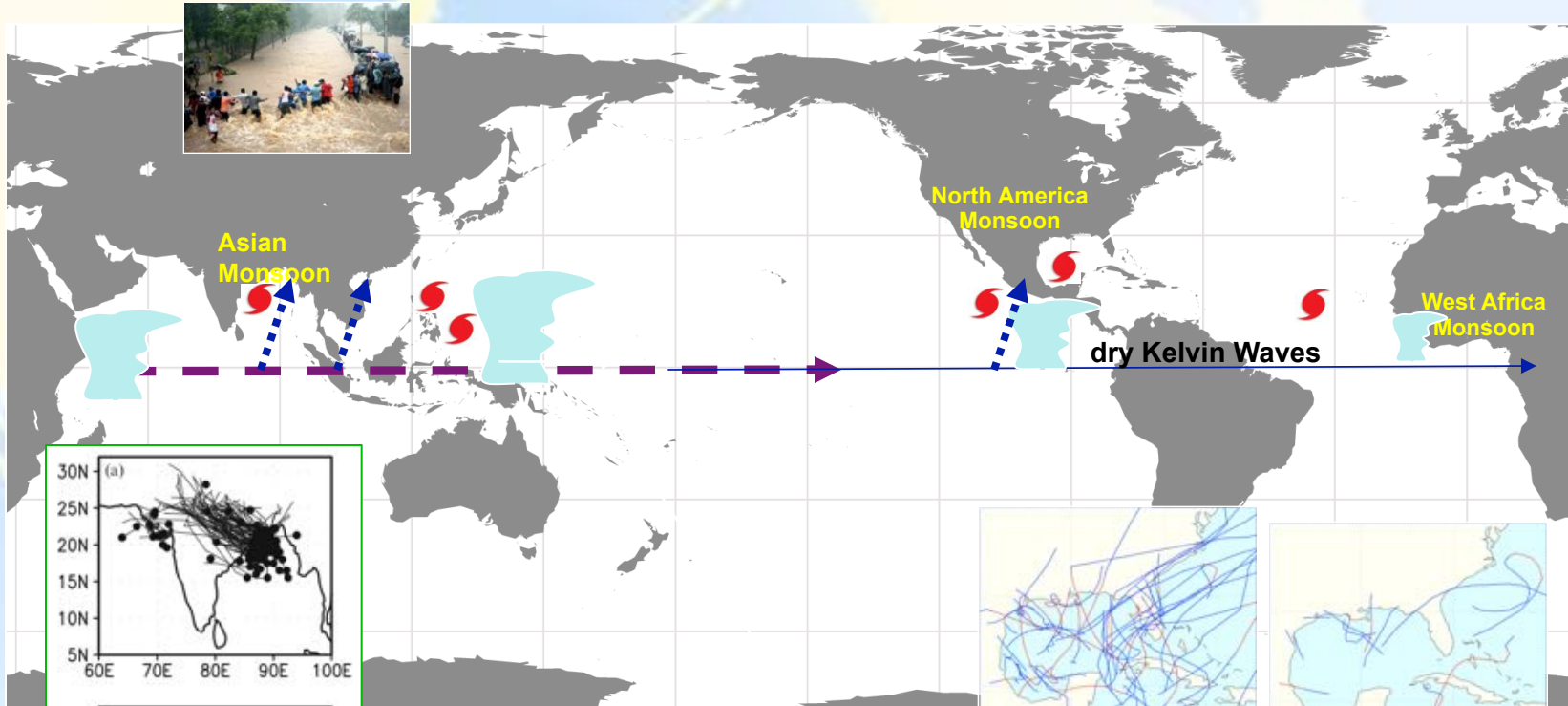
Intraseasonal Predictability of Northern Hemisphere Summer Monsoon and Tropical Cyclogenesis

Joshua Xiouhua Fu

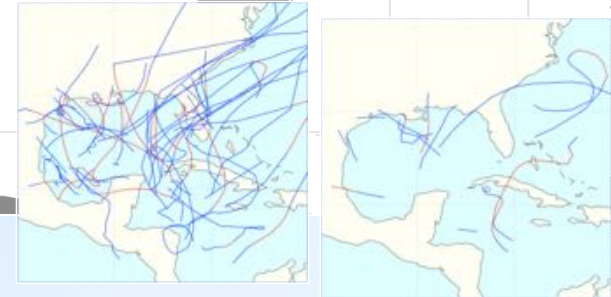
International Pacific Research Center
SOEST, University of Hawaii at Manoa

Collaborators: B. Wang, W. Q. Wang, J. Y. Lee, P. C. Hsu

Global Impacts of Madden-Julian Oscillation/ISO



Goswami et al (2003)



Maloney and Hartmann (2000)

Courtesy Xian-an Jiang

Outline

**(I), Intraseasonal Forecasting of 2008
Summer Monsoon in Four Models
(UH, CFSv1/v2, ECMWF)**

**(II), Intraseasonal Forecasting of
Tropical Cyclogenesis of
Nargis (2008)**

UH Hybrid coupled GCM (UH)

- **Atmospheric component:**

ECHAM-4 T30 (T106) L19 AGCM
(Roeckner et al. 1996)

- **Ocean component:**

Wang-Li-Fu intermediate upper ocean model (0.5°x0.5°)
(Wang et al. 1995; Fu and Wang 2001)




- Wang, Li, and Chang (1995): upper-ocean thermodynamics
- McCreary and Yu (1992): upper-ocean dynamics
- Jin (1997) : mean and ENSO (intermediate fully coupled model)
- Zebiak and Cane (1987): ENSO (intermediate anomaly coupled model)

- **Fully coupling without heat flux correction**

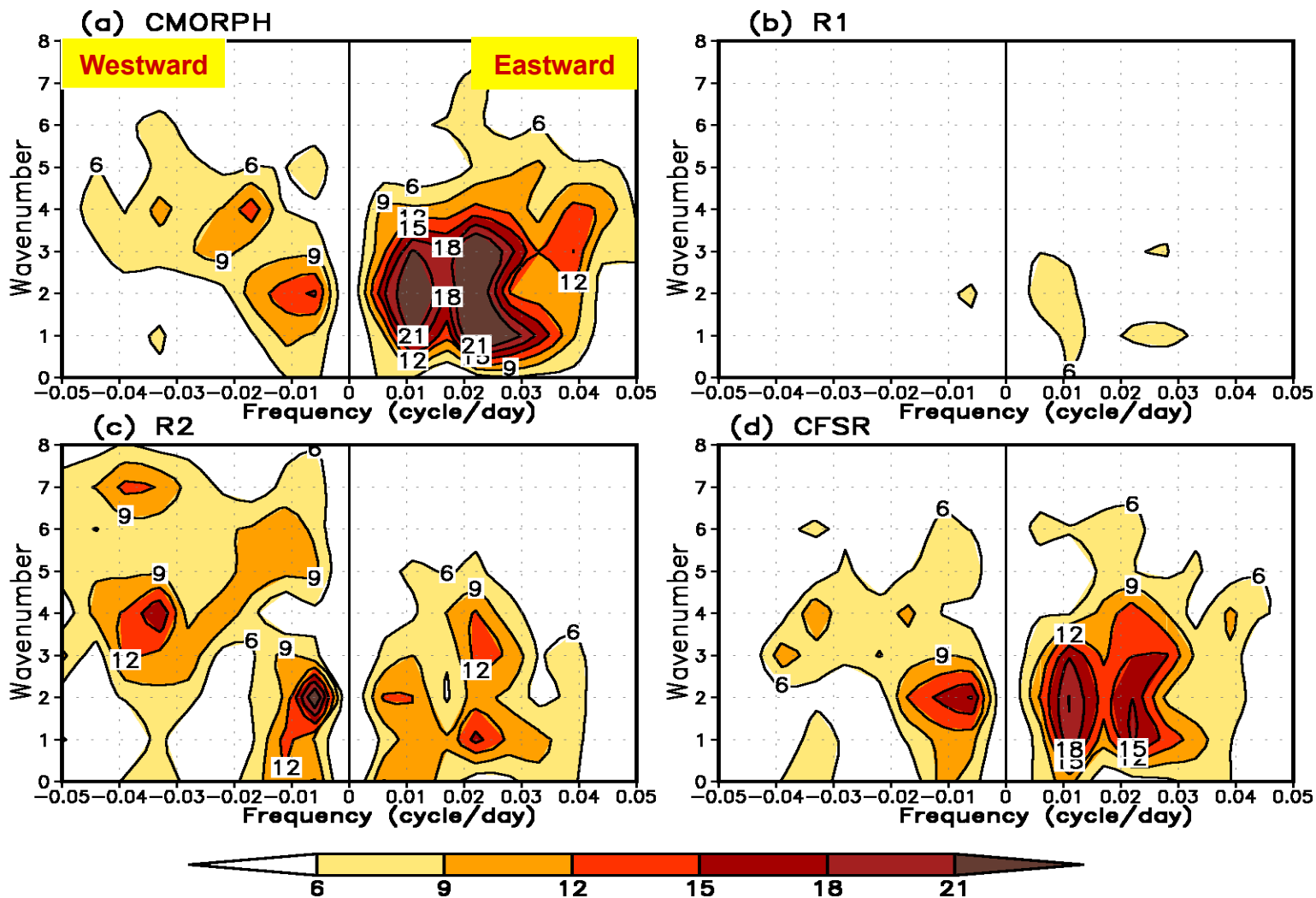
- **Coupling region: Tropical Oceans (30°S-30°N)**

- **Coupling interval: Once per day**

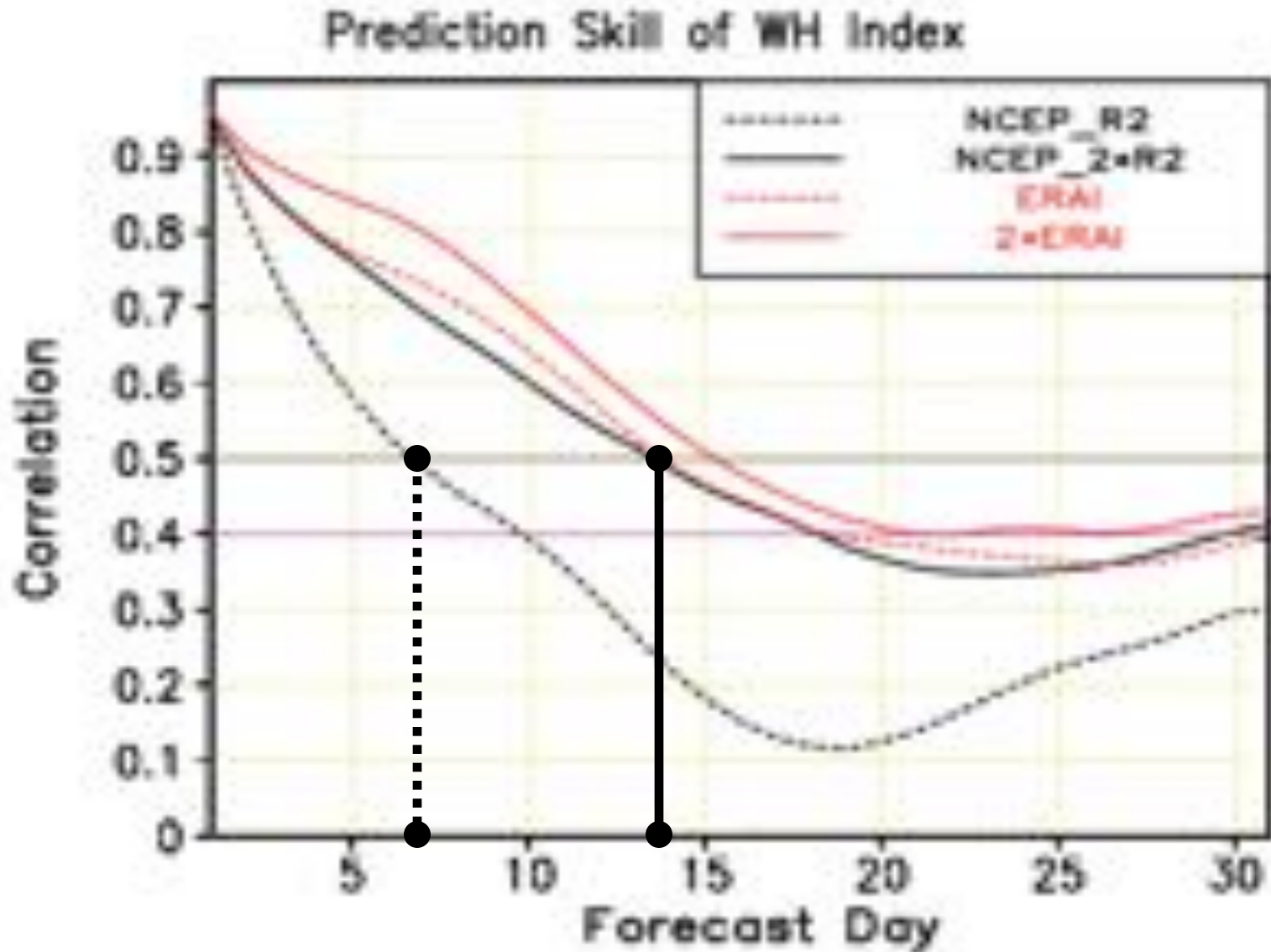
Three Key Components of MJO/ISO Prediction

Global Model	Boundary Conditions	Initial Conditions
Fu et al. 2008: (Shallow convection) Fu and Wang 2009: (Stratiform rainfall)	Fu et al. 2003, 2007 (Air-sea coupling)	Fu et al. 2009, 2011 (Signal-recovered NCEP R1/R2)
 <ul style="list-style-type: none"> • Higher resolution • Better Physics 	 <ul style="list-style-type: none"> • Higher-resolution • SST diurnal cycle 	 <ul style="list-style-type: none"> • NCEP/FNL/CFSR

MJO Intensity in Different Reanalysis Datasets



MJO Prediction Skill Measured with WH-index



Fu et al. (2011)

**(I), 2008 Monsoon Forecasting
in Four Dynamical Models
(CFSv1/v2, UH, ECMWF)**

(YOTC/AMY target year)

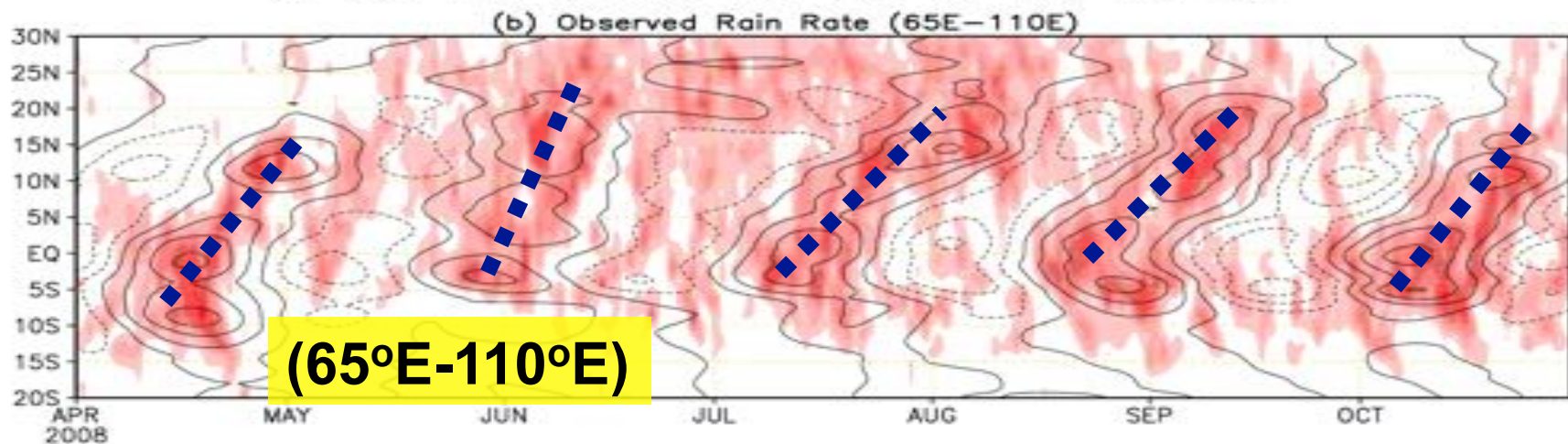
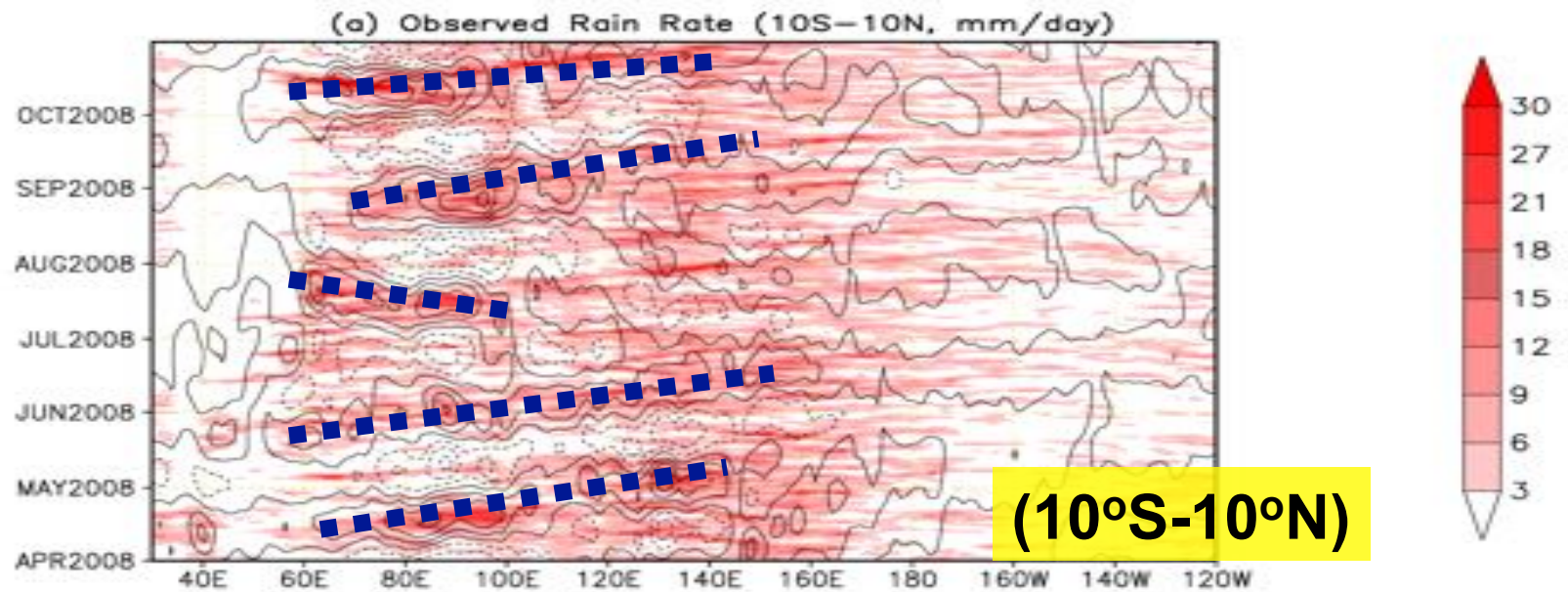
CFSv1: NCEP R2

CFSv2: CFSR

UH: FNL (~CFSR)

ECMWF: ERA-Interim

Observed Rainfall Evolution in 2008 Summer

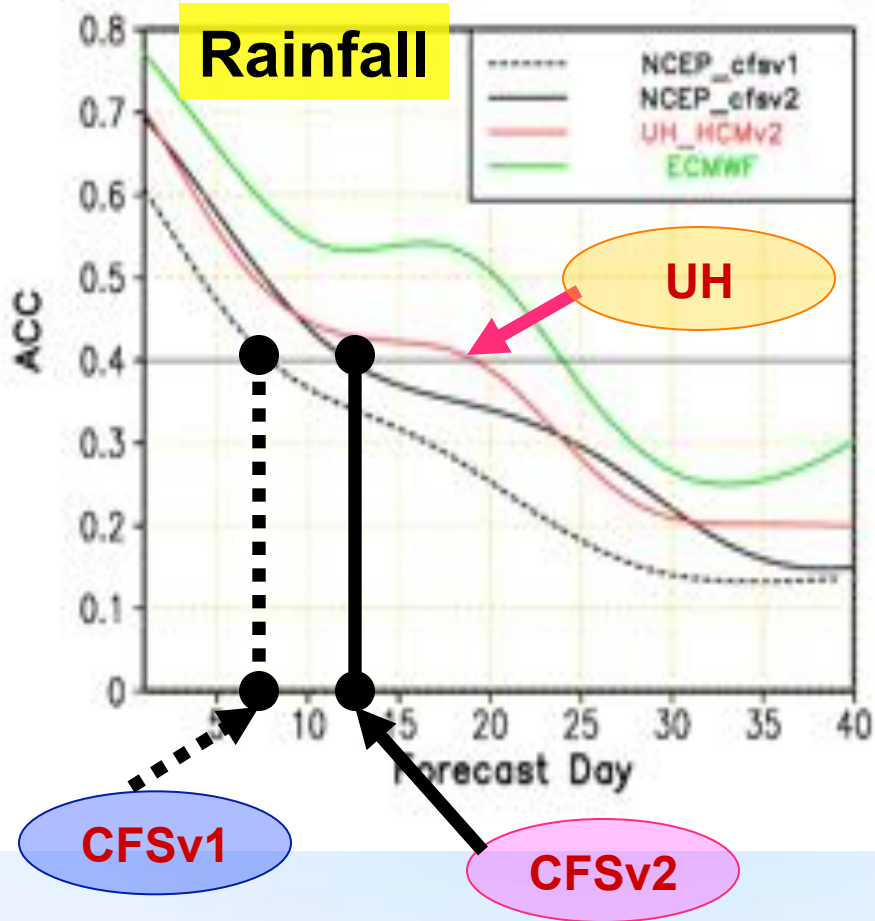


Experimental Monsoon Prediction with UH

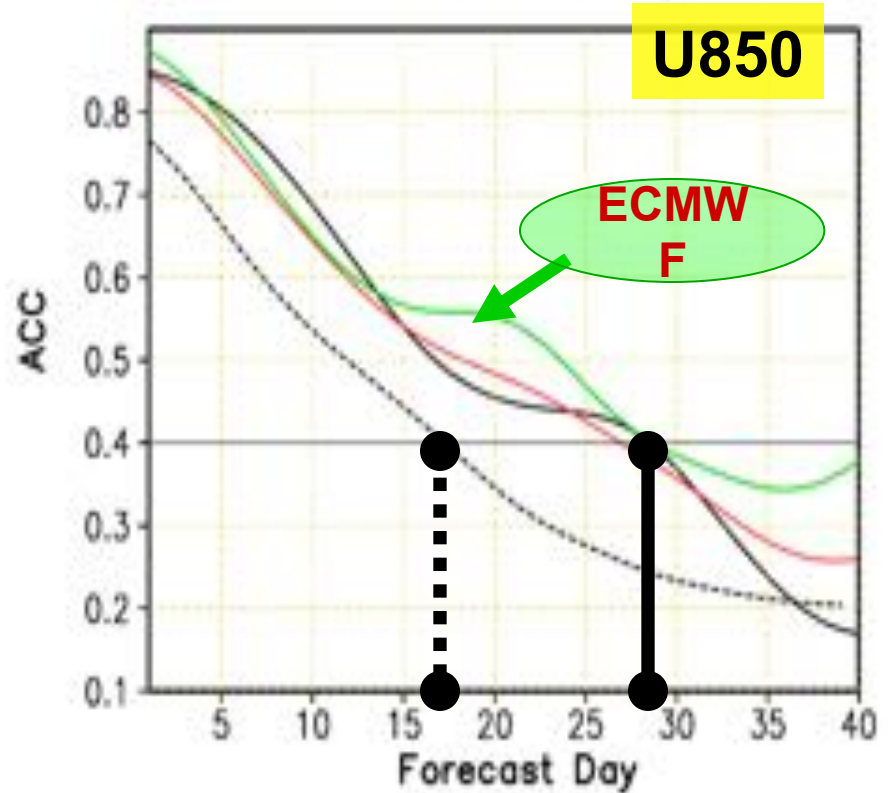
- **Target Period: May-October 2008**
- **Forecast Interval: Every 10 days, totally 16 forecasts**
- **10 Ensembles: Perturbations are 10% of daily differences**
- **Integration Length: 45 days**
- **Initial Conditions: NCEP FNL**
- **Skill Measure: Anomaly Correlation Coefficient over global tropics.**

Averaged Prediction Skills of 2008 Summer Monsoon over Global Tropics (30°S-30°N)

(a) ACC of Rainfall over Global Tropics

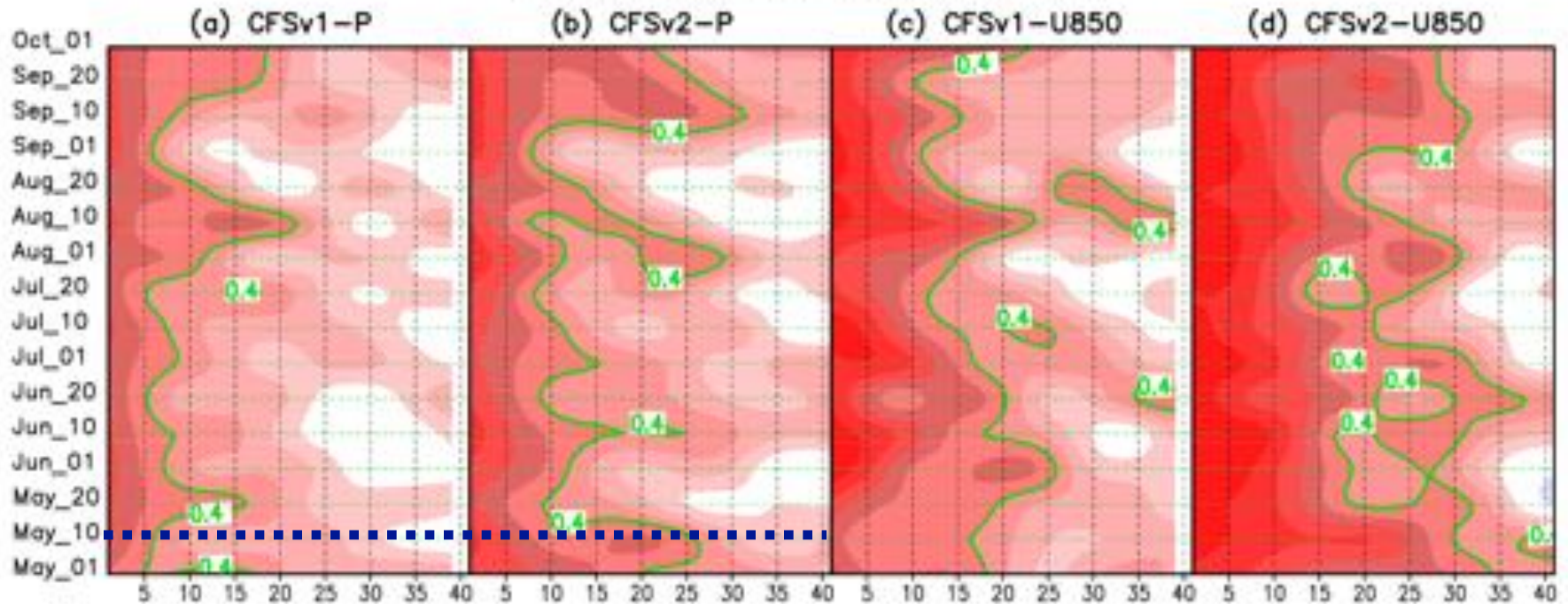


(b) ACC of U850 over Global Tropics



Monsoon Prediction Skills for CFSv1 and v2 over **Global Tropics (30°S-30°N)**

ACC of 30–90–day Filtered Forecasts in 2008 Summer
Over Global Tropics (30S–30N, 0–360)



Initial
Dates

CFSv1
Prep

CFSv2
Prep

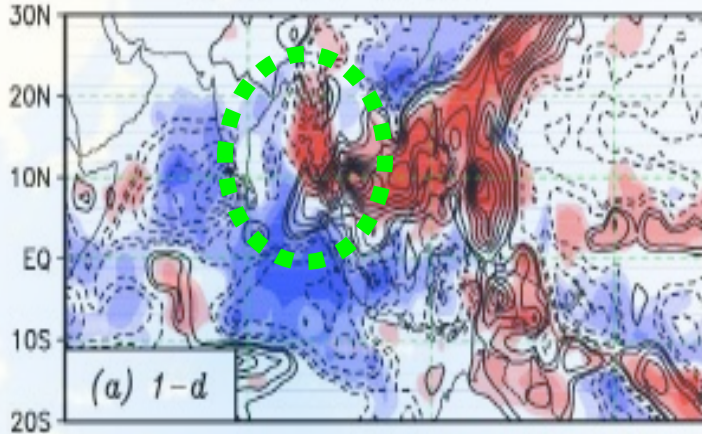
CFSv1
U850

CFSv2
U850

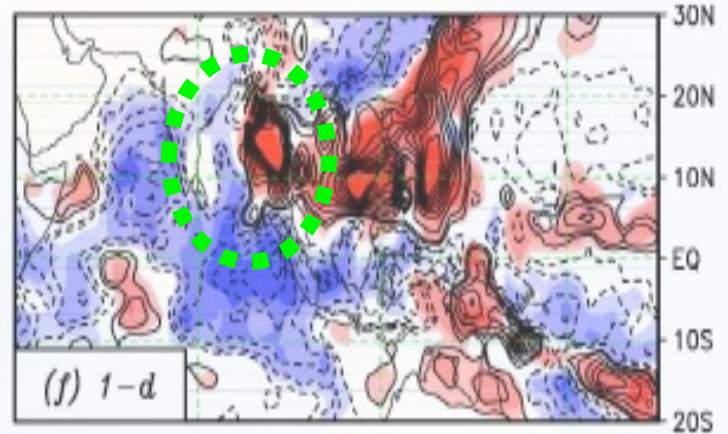
Forecasts of CFSv1 and CFSv2 Initialized on May 10th, 2008

1st day

OBS vs. CFSv1



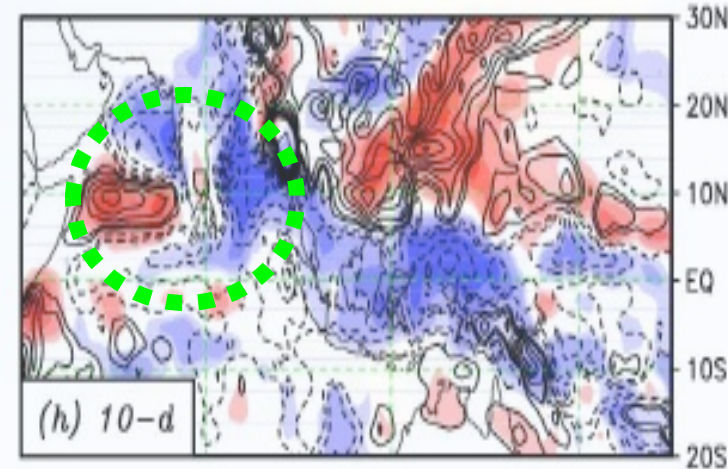
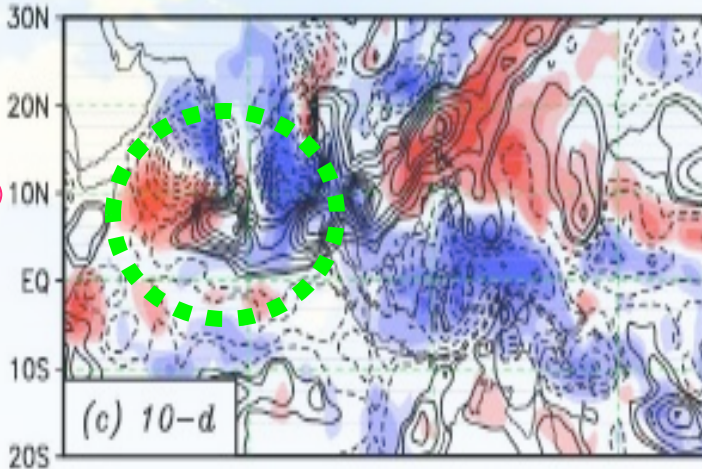
OBS vs. CFSv2



10th day

(a) 1-d

(f) 1-d



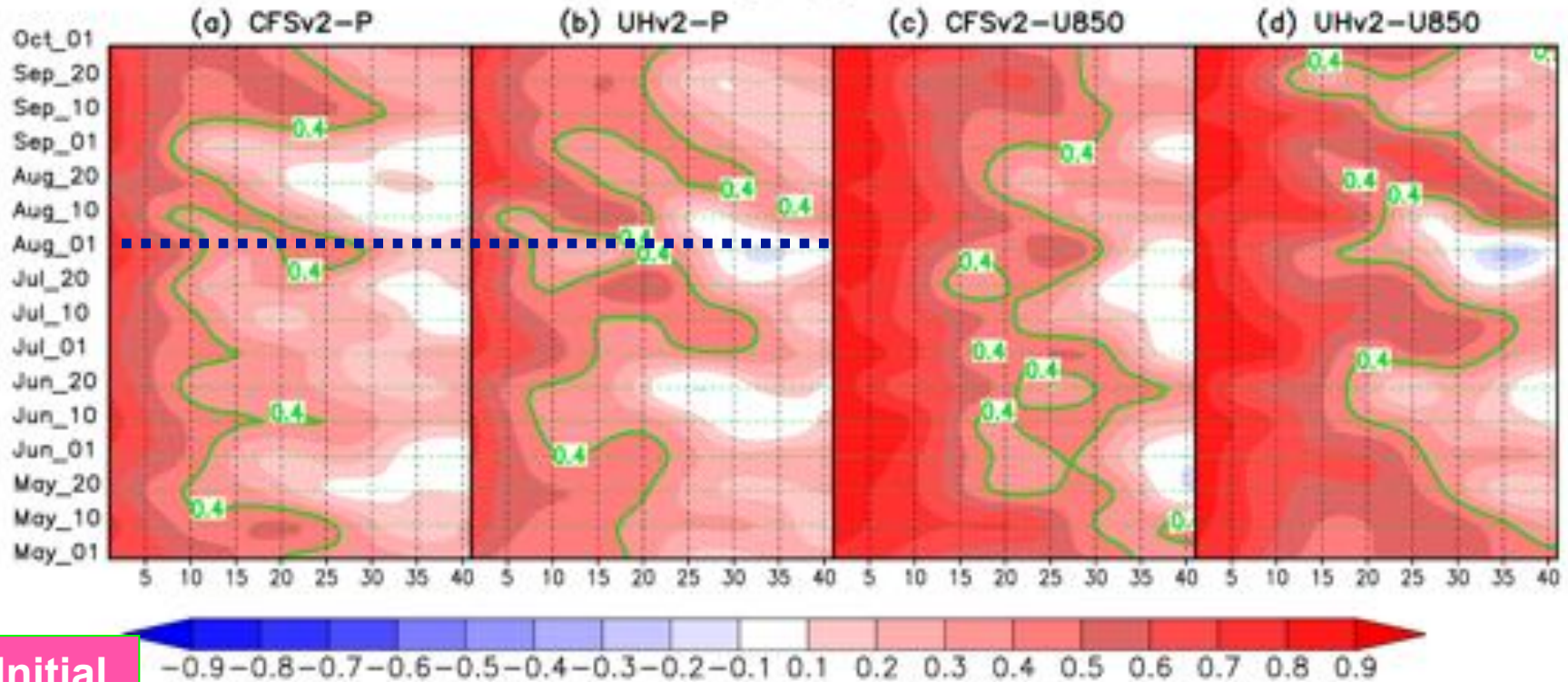
(c) 10-d

(h) 10-d

OBS (shading); Forecasts (contours)

Monsoon Prediction Skills for CFSv2 and UH over Global Tropics (30°S-30°N)

ACC of 30–90–day Filtered Forecasts in 2008 Summer Over Global Tropics (30S–30N, 0–360)



Initial Dates

CFSv2
Prep

UH
Prep

CFSv2
U850

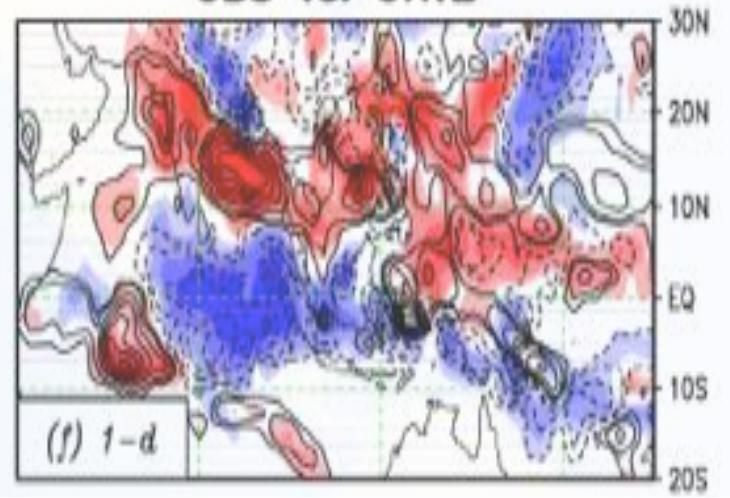
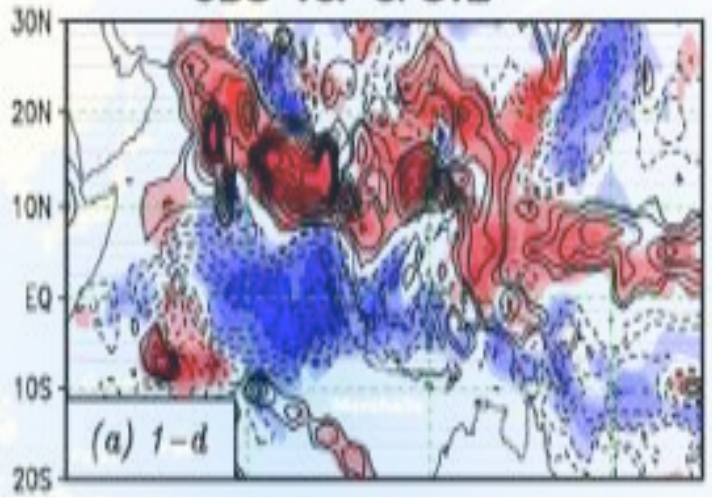
UH
U850

Forecasts of CFSv2 and UH Initialized on August 1st, 2008

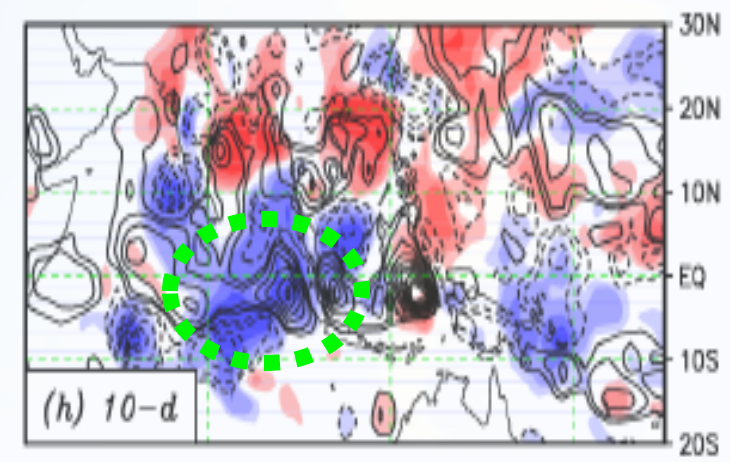
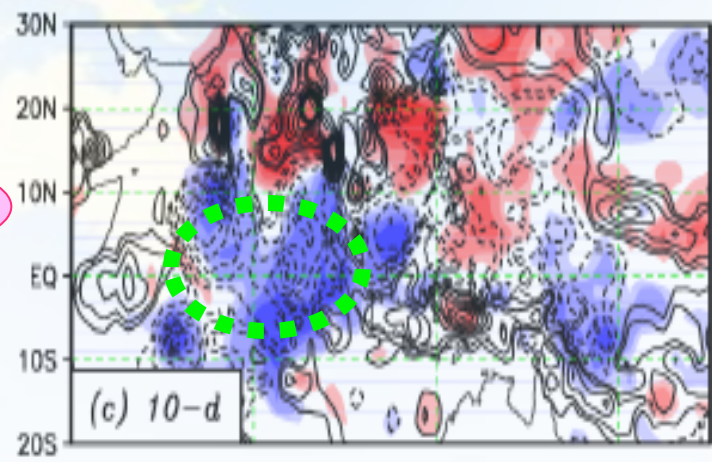
OBS vs. CFSv2

OBS vs. UHv2

1st day



10th day



OBS (shading); Forecasts (contours)

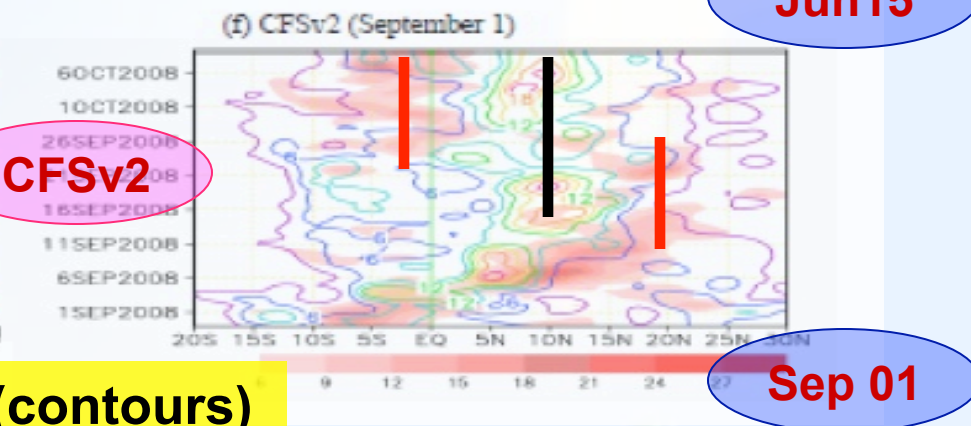
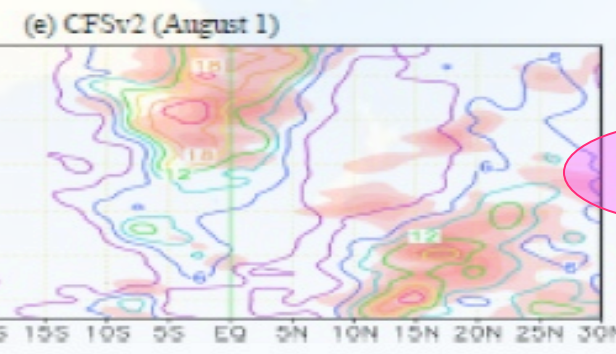
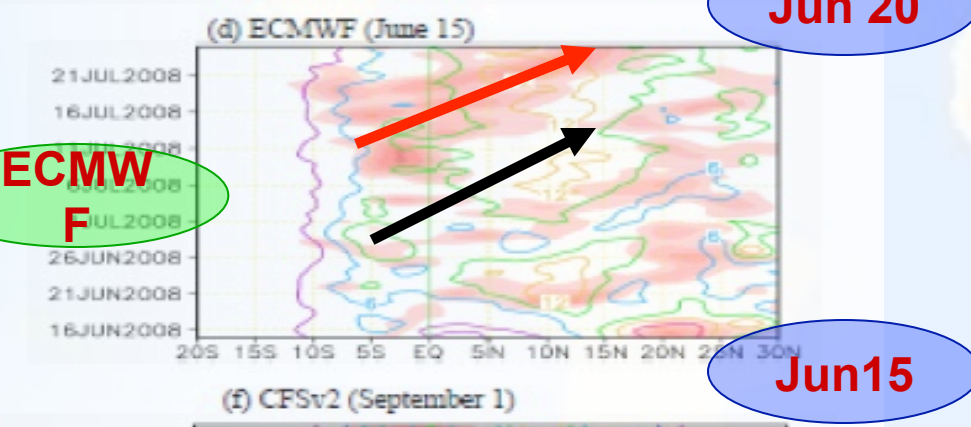
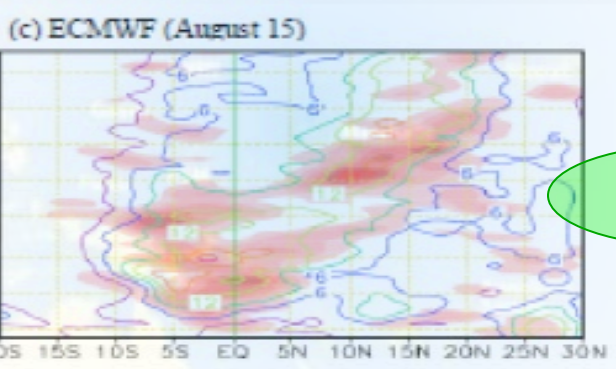
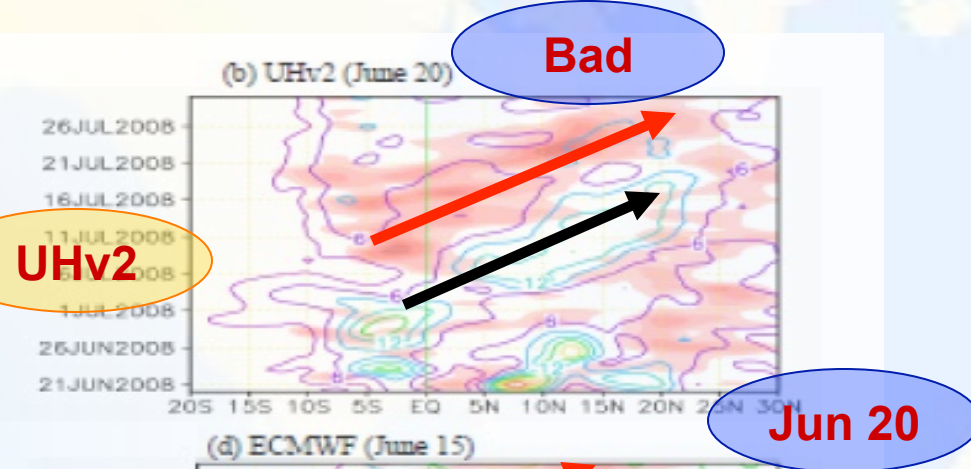
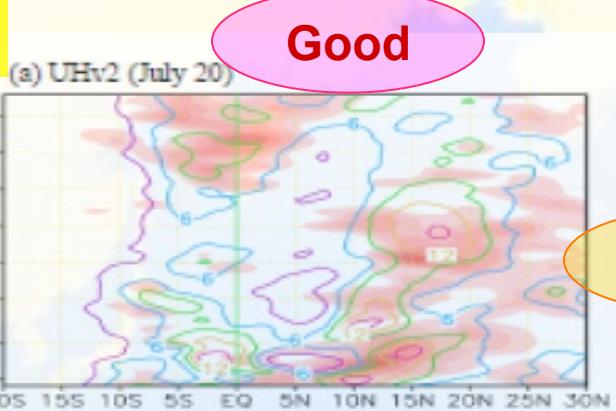
Good and Bad Forecasts in UH, ECMWF, and CFSv2

(65°E-110°E)

July 20

Aug 15

Aug 01



OBS (shading); Forecasts (contours)

(II), Tropical Cyclone Nargis (2008)

(April 25-May 3)

Model: UH (T106)

Initial Condition: FNL Analysis

Initial Date: April 10, 2008

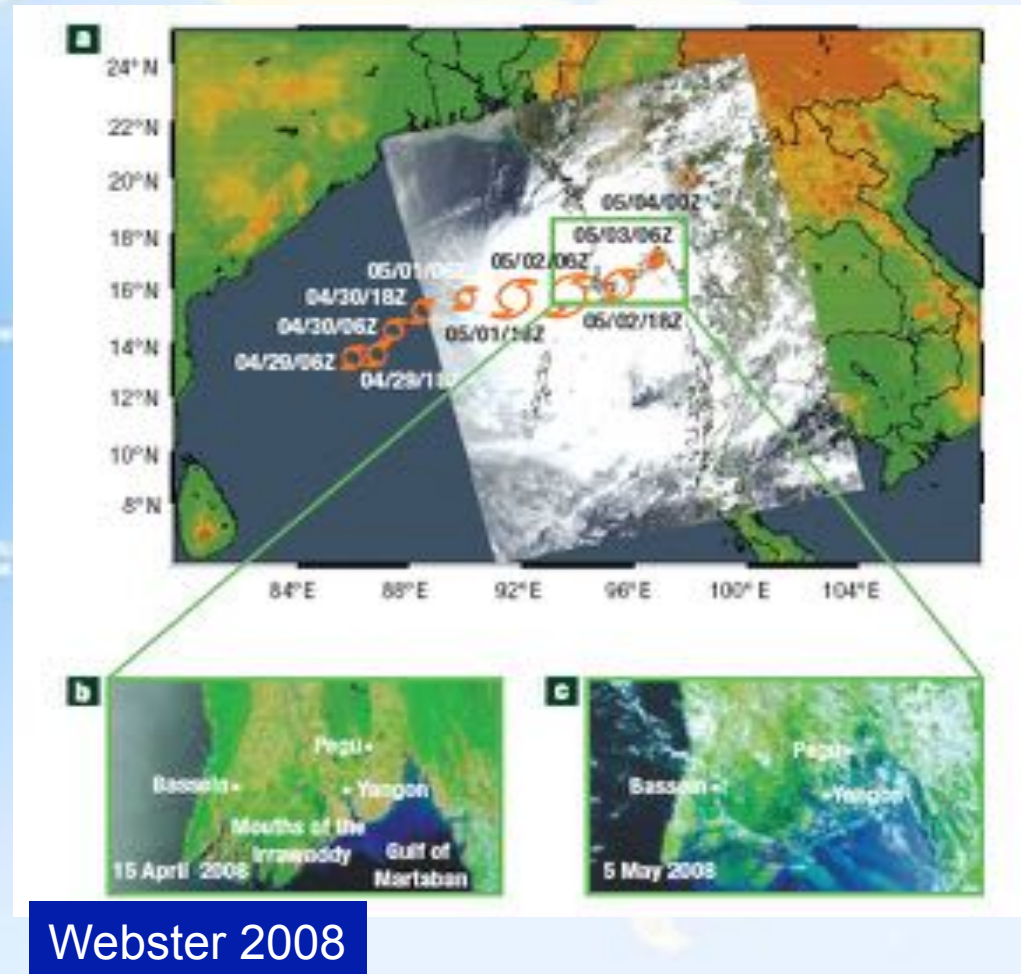
Fu and Hsu 2011, GRL

Extended-range Forecasting of Tropical Cyclogenesis of “Nargis” (2008)

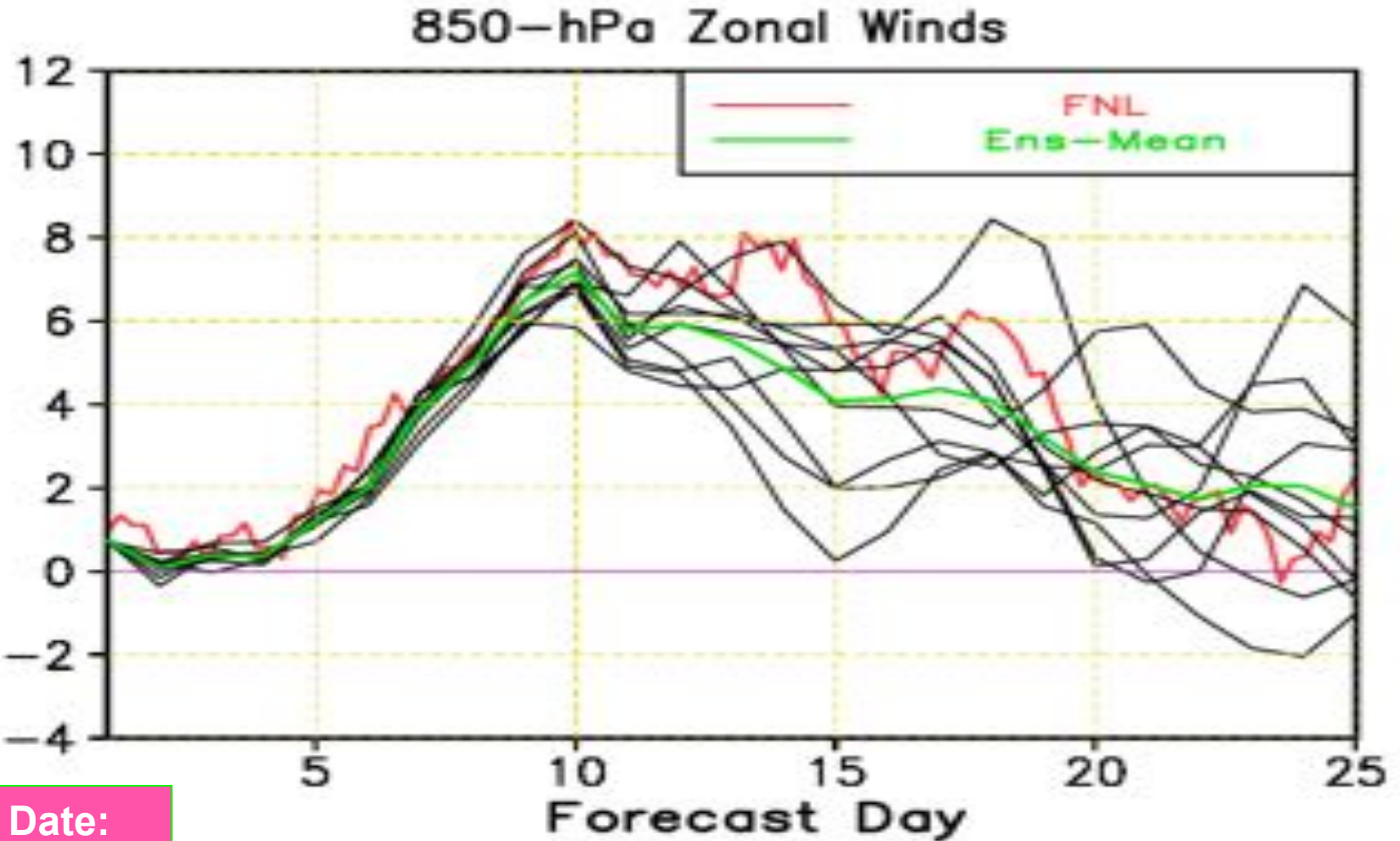
JTWC issued TC formation alert on April 25, 2008

IMD issued TC warning on April 27, 2008

The “Nargis” claimed over 130,000 lives and caused \$10 billion dollars in damage, was ranked the 7th deadliest cyclone of all time.



Forecasted Westerly Wind Bursts Associated with the Development of a MJO Event

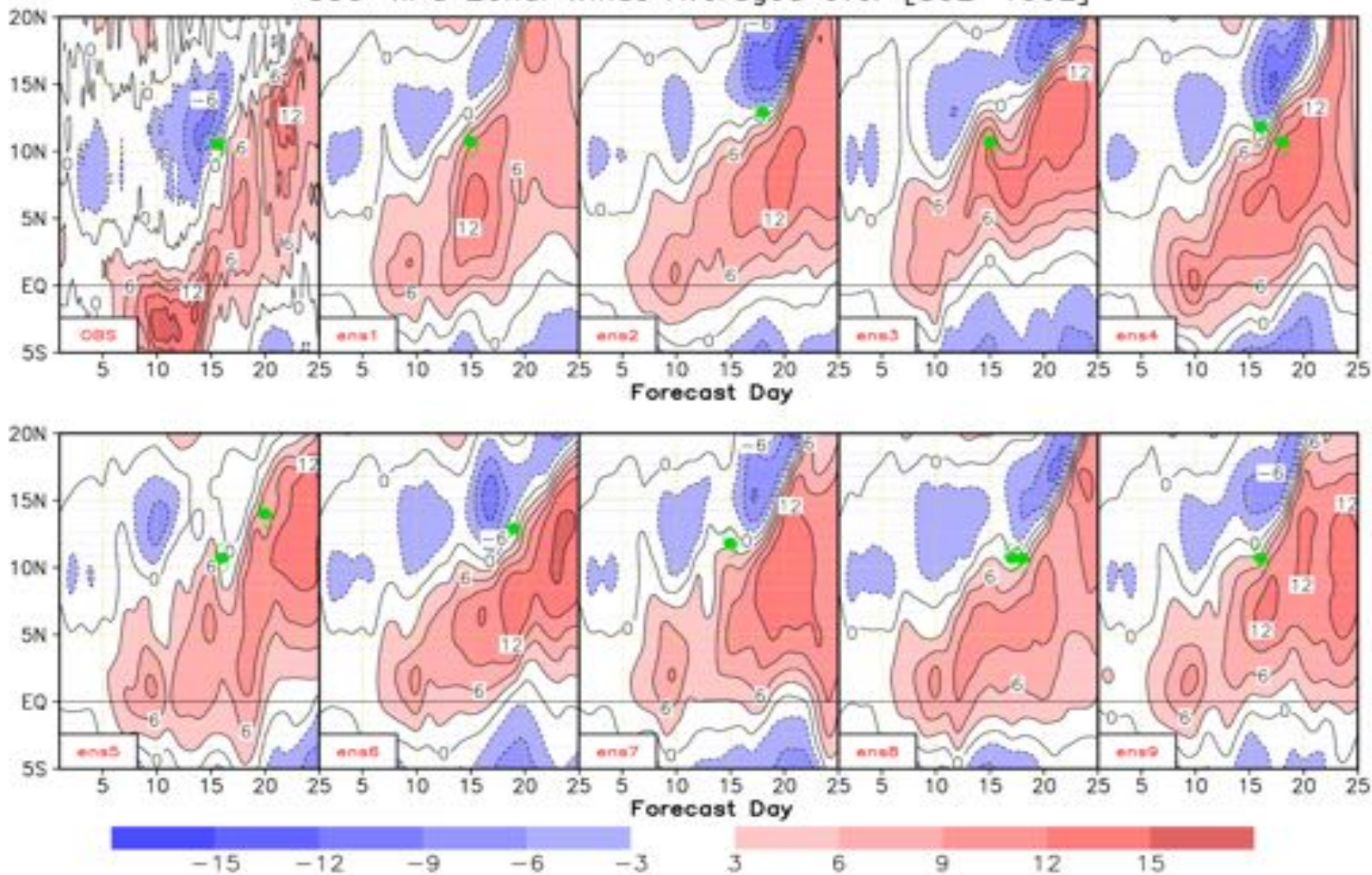


Initial Date:
April 10, 2008

Over Equatorial IO (5°S - 5°N , 70°E - 100°E)

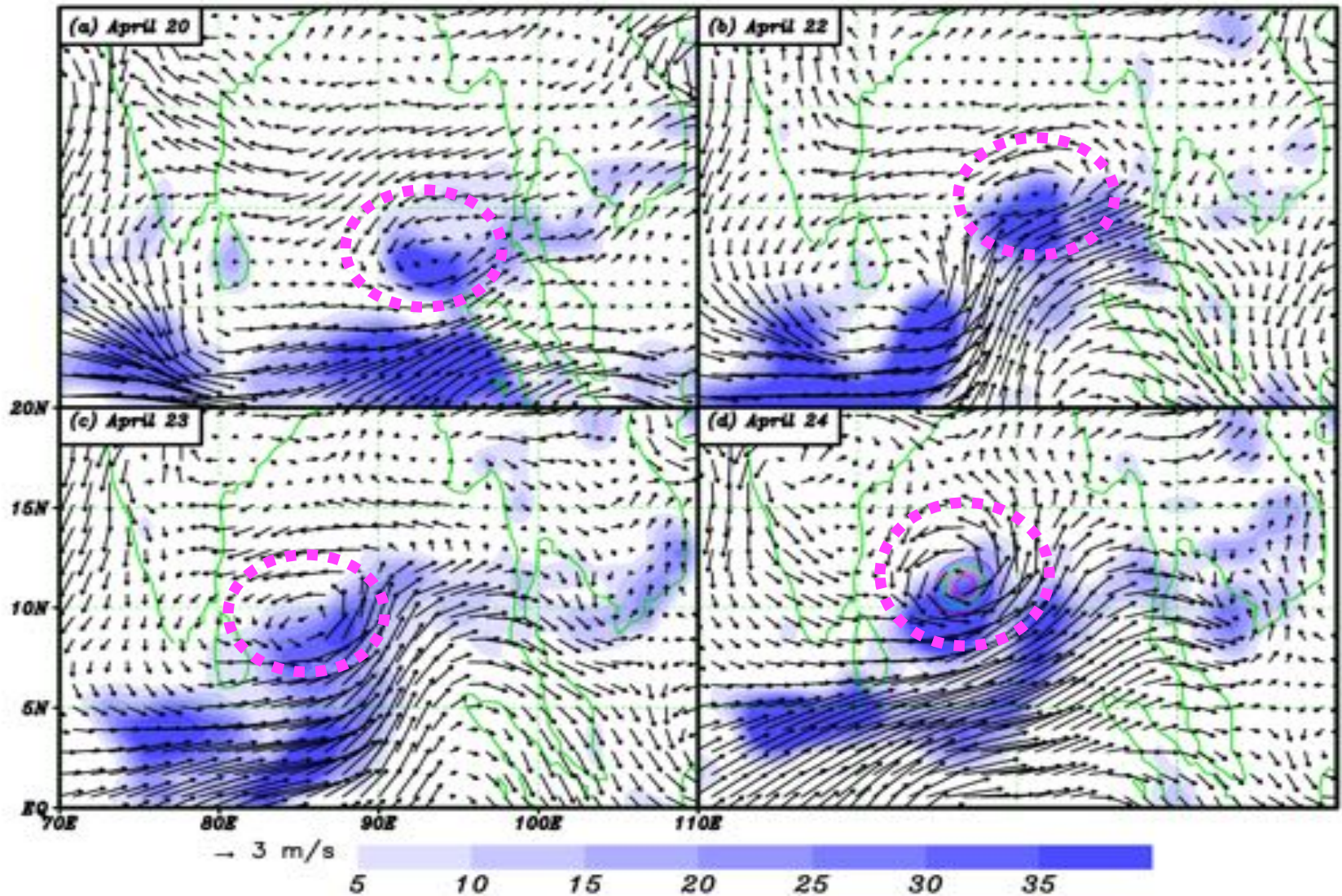
Northward-propagating ISO and TC Nargis (2008)

850-hPa Zonal Winds Averaged over [80E-100E]

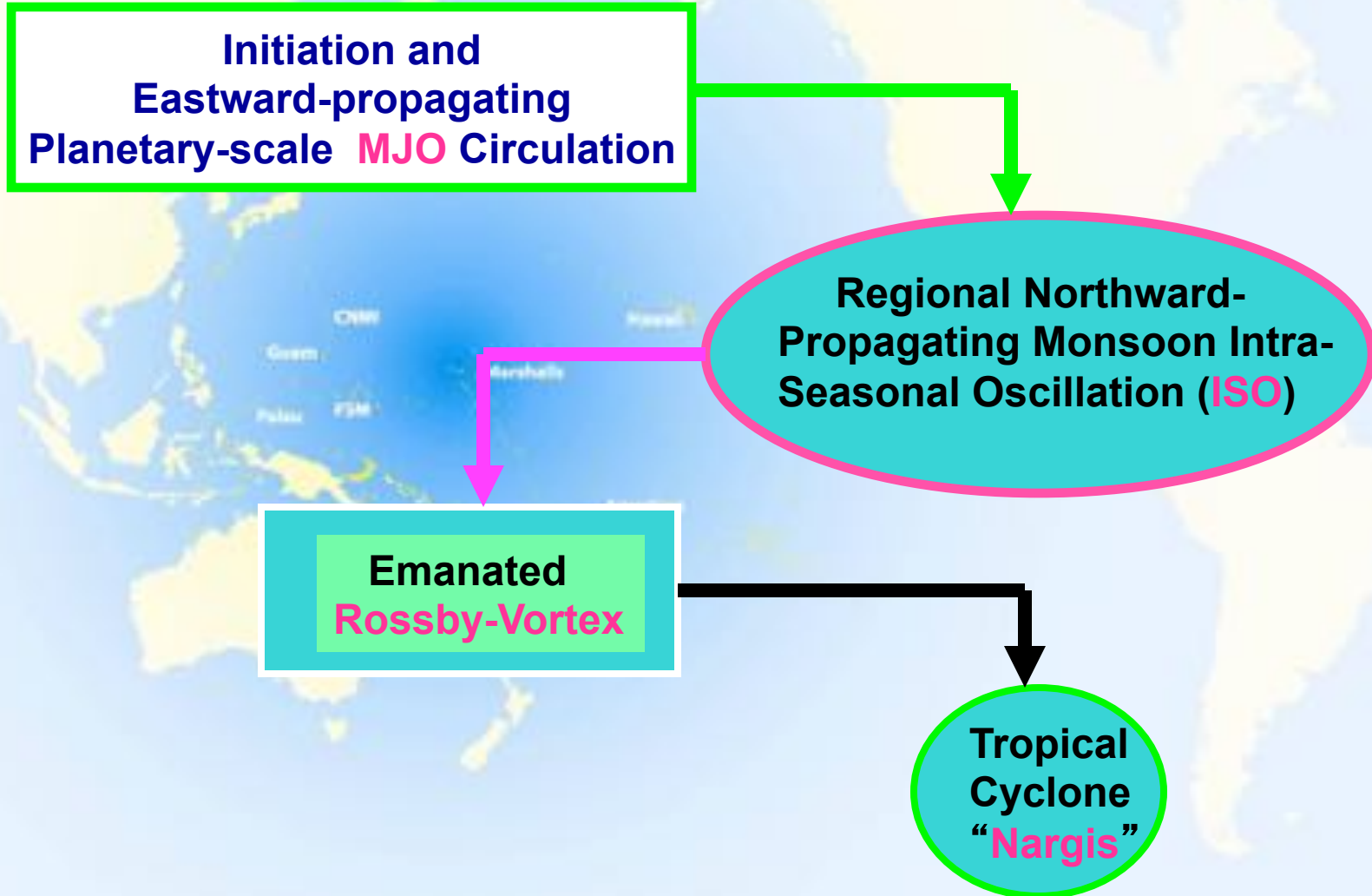


Forecasted Genesis Process of TC Nargis (2008)

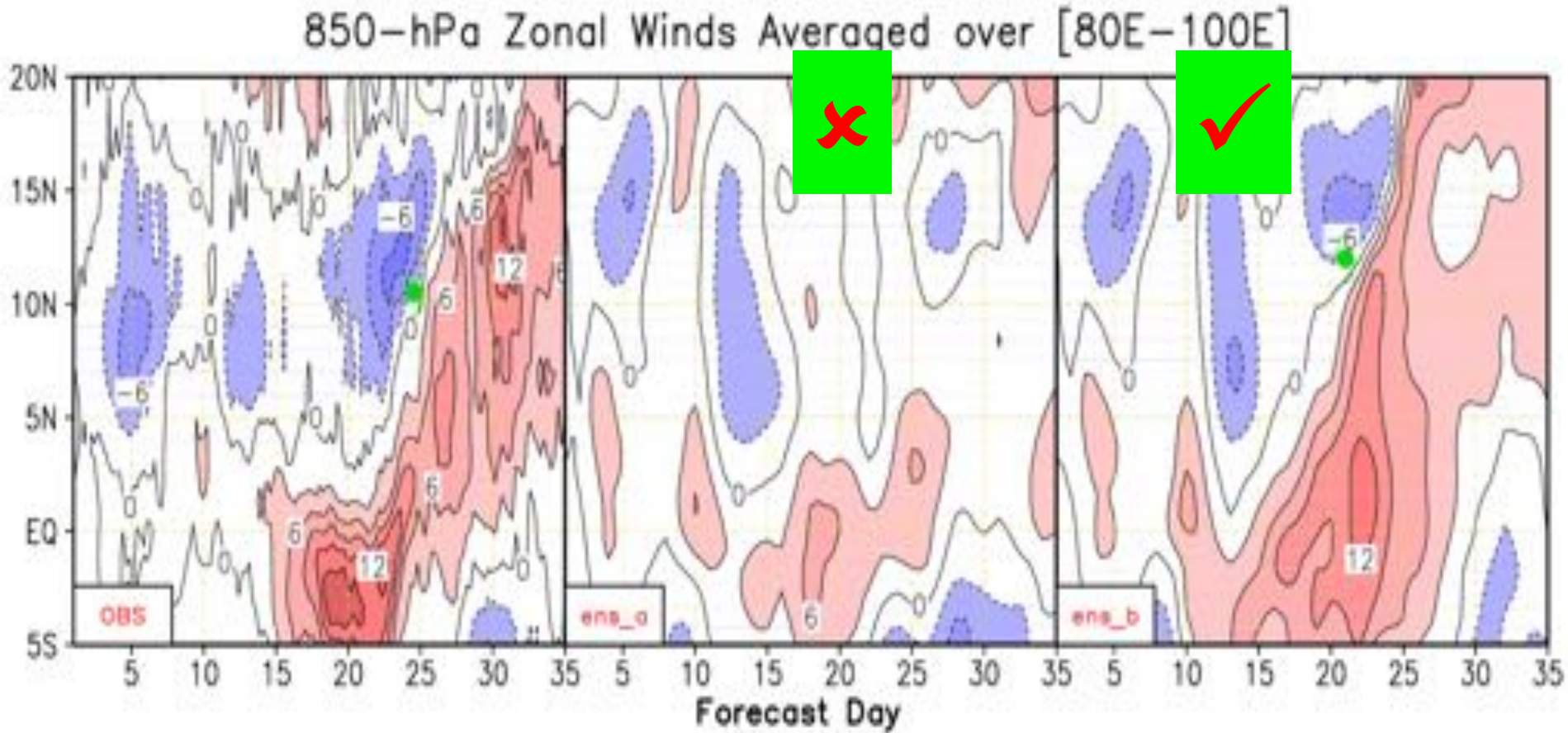
Forecasted Genesis of Tropical Cyclone Nargis



Multi-Scale Interactions Captured in This Forecast



Prospect: One-month lead Forecast



Initial Date:
April 01, 2008

Summary

- The representation of MJO in **CFSR** is much better than that in **R1 and R2**. Doubling MJO/ISO intensity in **R2** increases MJO predictability from **one week to two weeks**.
- The prediction skill of 2008 summer monsoon is much higher in **CFSv2** than that in **CFSv1**. UH model has similar skill as the **CFSv2** and ECMWF.
- If MJO and associated northward-propagating ISO are well predicted, tropical **cyclogenesis of Nargis (2008)** can be forecasted with a lead time of at least **two weeks**.

Thank you!

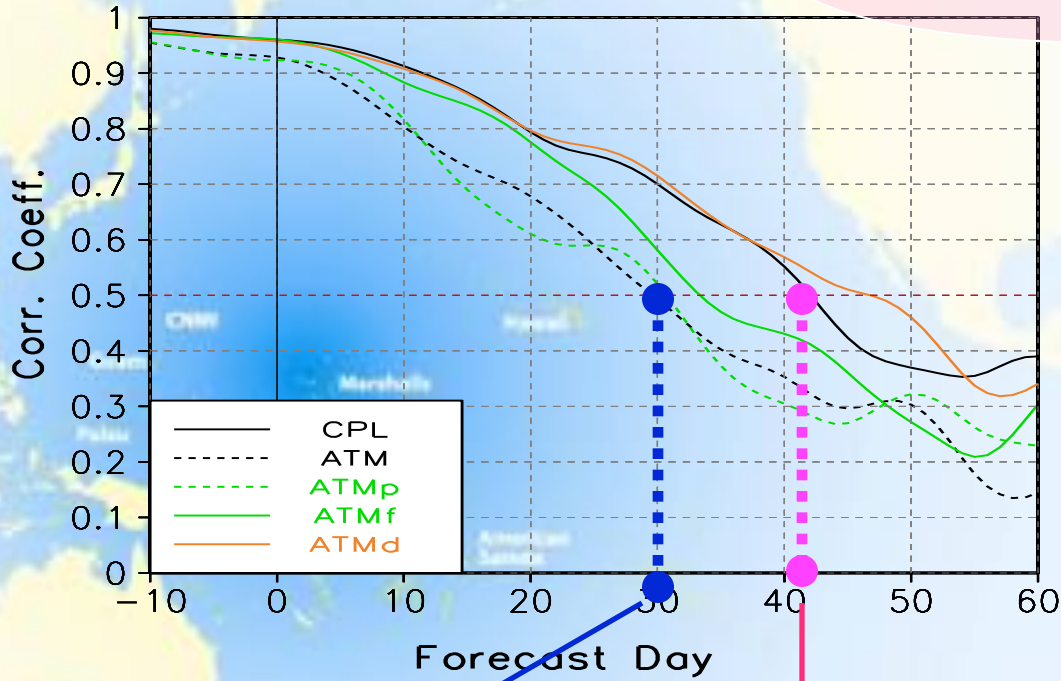
07-02-2004

36th_CDPW, Fort Worth, Oct. 3-6, 2011

Potential

ISO Predictability Measured by ACC

Anomalous Correlation Coefficient over [10N–30N, 65E–120E]



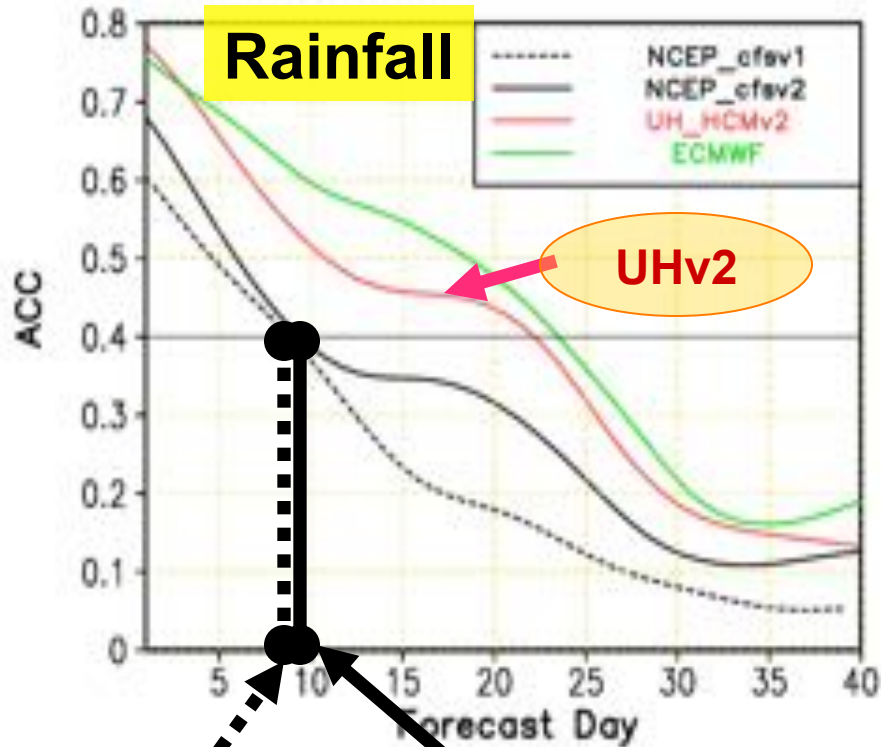
ACC

**Atmosphere-only:
30 days**

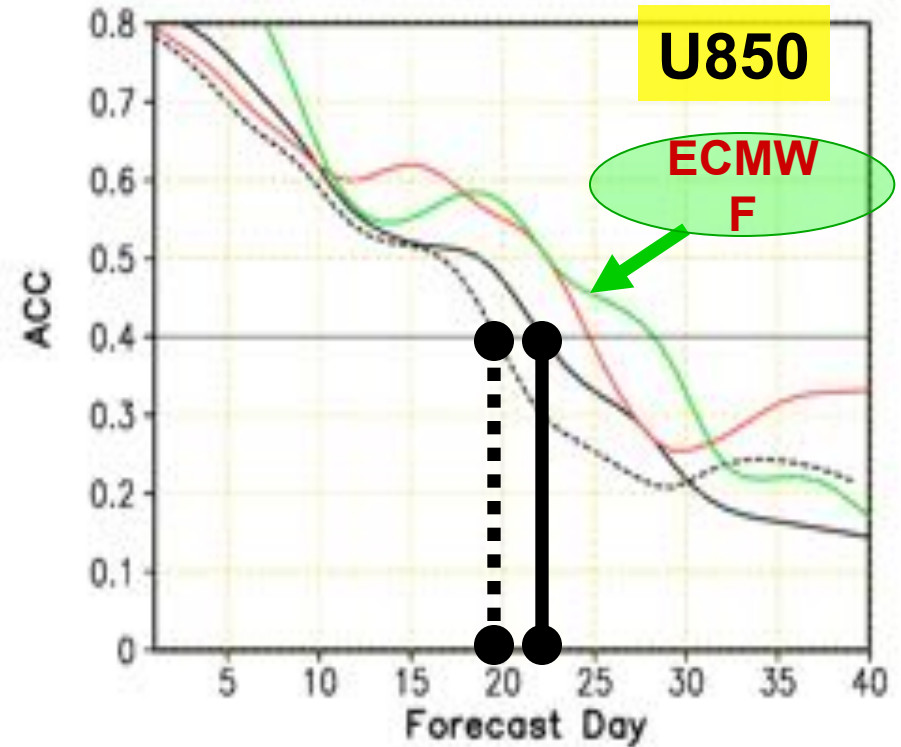
Coupled: 42 days

Averaged ISO Prediction Skills in 2008 Summer over Southeast Asia (10N-30N, 60E-120E)

(a) ACC of Rainfall over Southeast Asia



(b) ACC of U850 over Southeast Asia

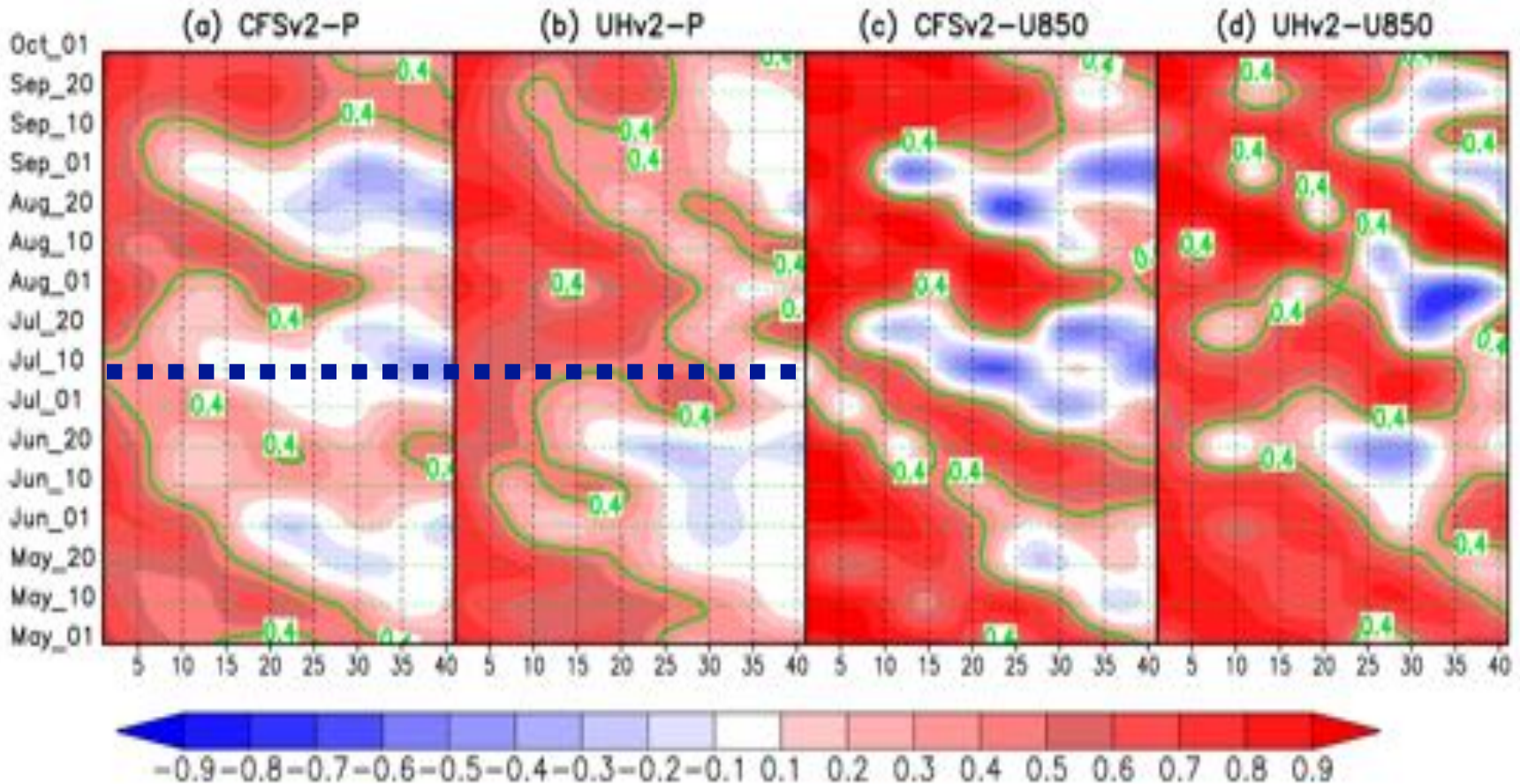


CFSv1

CFSv2

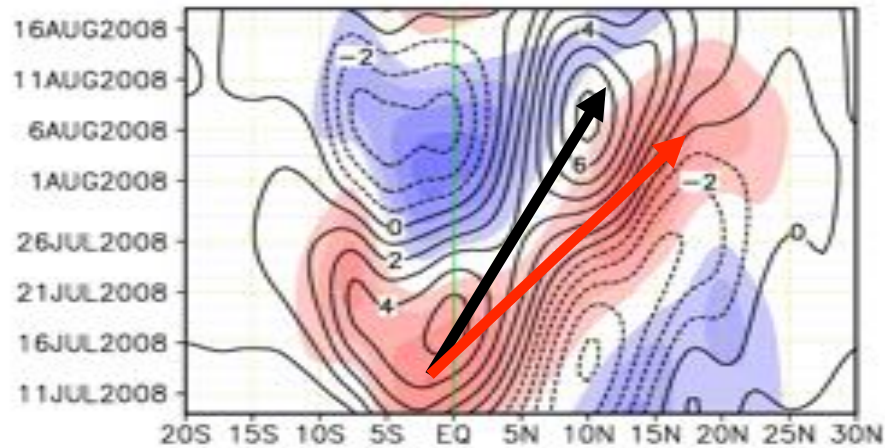
ISO Prediction Skills for CFSv2 and UHv2 over Southeast Asia (10N-30N, 60E-120E)

ACC of 30–90–day Filtered Forecasts in 2008 Summer
Over Southeast Asia (10N–30N, 60E–120E)

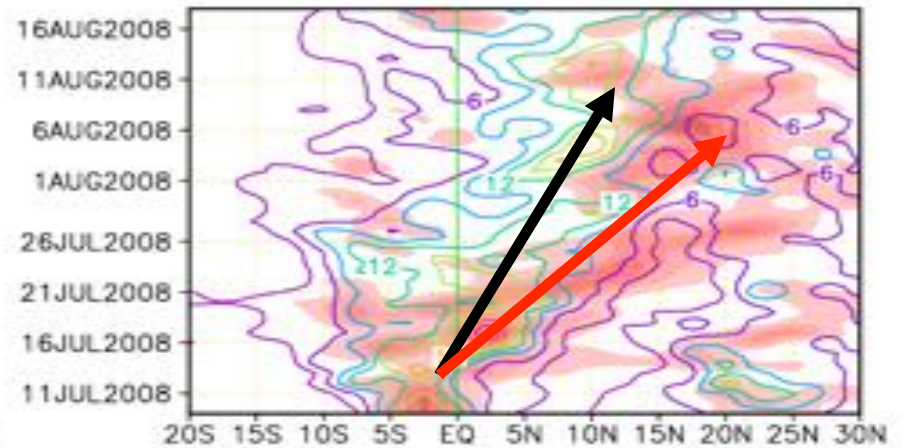


Northward-Propagating ISO in CFSv2 and UHv2

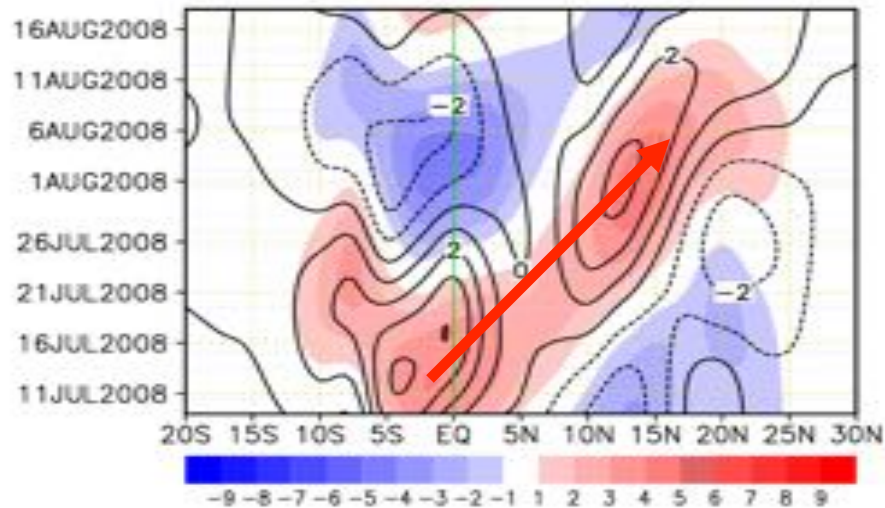
(a) OBS vs. CFSv2



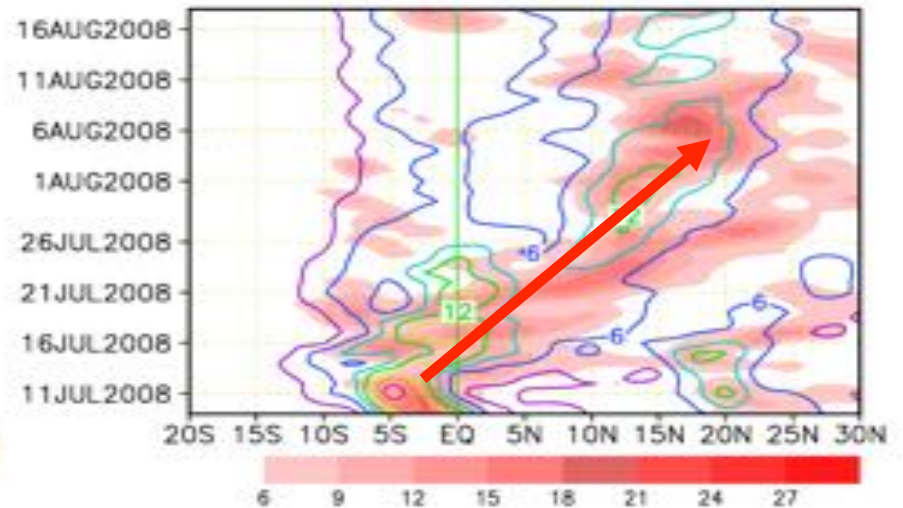
(b) OBS vs. CFSv2



(c) OBS vs. UHv2

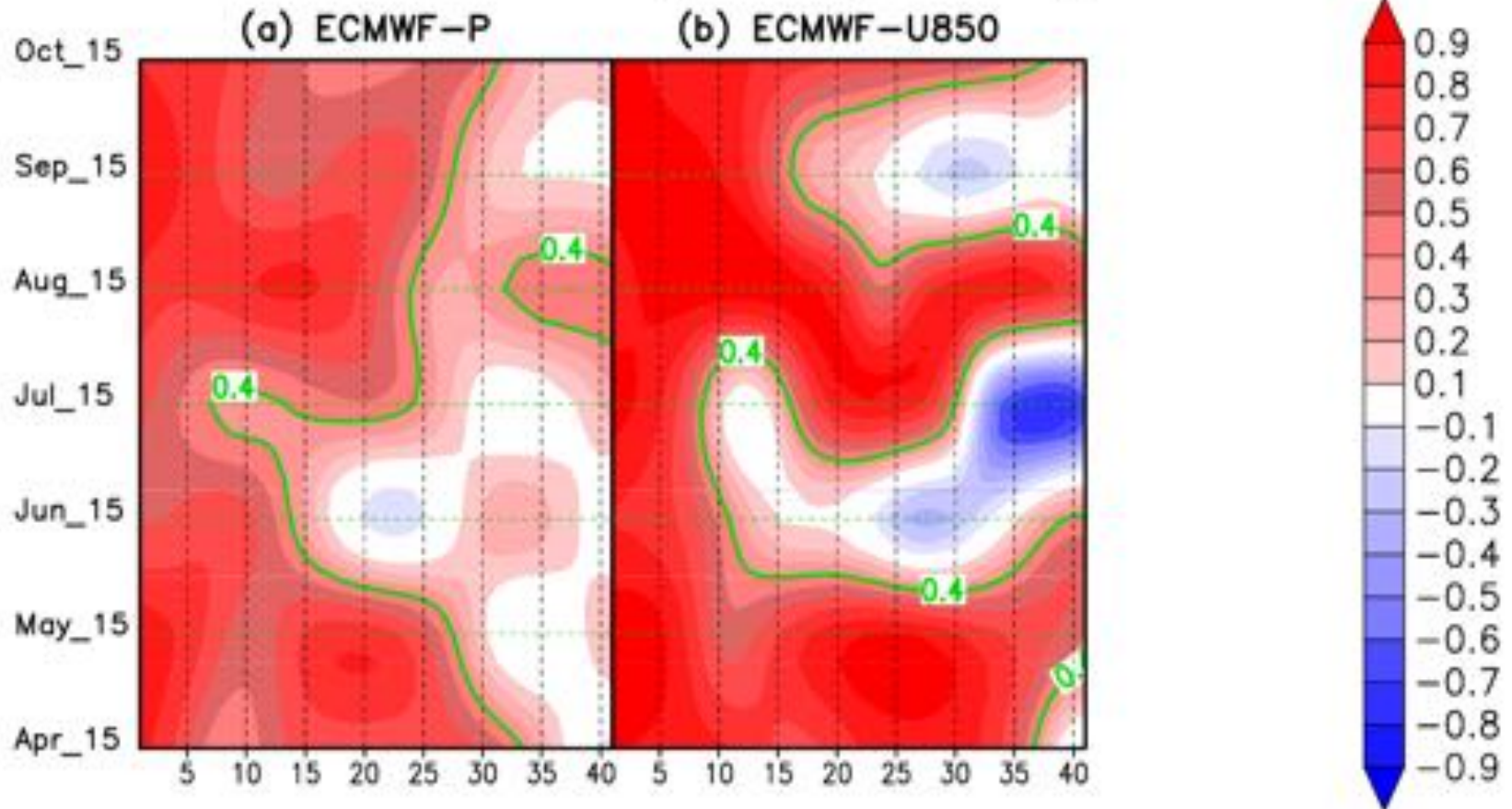


(d) OBS vs. UHv2



ISO Prediction Skills for ECMWF

**ACC of 30–90–day Filtered Forecasts in 2008 Summer
Over Southeast Asia (10N–30N, 60E–120E)**



Observed and Forecasted TC Nargis (2008)

