Experimental Intraseasonal Forecasting of 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

APCS, Honolulu, Oct. 17-20, 2011
Global Impacts of Madden-Julian Oscillation / ISO

Asian Monsoon
North America Monsoon
West Africa Monsoon
dry Kelvin Waves

Maloney and Hartmann (2000)

Courtesy Xian-an Jiang


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Outline

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

(II), Intraseasonal Forecasting of Tropical Cyclogenesisis of Nargis (2008)
UH Hybrid coupled GCM (UH)

- **Atmospheric component:**
  ECHAM-4 T106L19 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

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<th>Global Model</th>
<th>Boundary Conditions</th>
<th>Initial Conditions</th>
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<td>Fu et al. 2008: (Shallow convection)</td>
<td>Fu et al. 2003, 2007 (Air-sea coupling)</td>
<td>Fu et al. 2009, 2011 (Signal-recovered NCEP R1/R2)</td>
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<td>Fu and Wang 2009: (Stratiform rainfall)</td>
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- Higher resolution
- Better Physics

- Higher-resolution
- SST diurnal cycle

- NCEP/FNL/CFSR
MJO Intensity in Different Reanalysis Datasets

Wang, JD, WQ Wang, XH Fu, KH Seo, 2011

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MJO Prediction Skill Measured with WH-index

Fu et al. (2011)

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(I), 2008 Monsoon Forecasting in Four GCMs (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

(a) Observed Rain Rate (10oS-10oN, mm/day)

(b) Observed Rain Rate (65oE-110oE)
Experimental Monsoon Prediction with UH Model

- 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

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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

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

(a) ACC of Rainfall over Southeast Asia

Rainfall

(b) ACC of U850 over Southeast Asia

U850

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(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
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.

Webster 2008

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

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

Initial Date: April 10, 2008

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Northward-propagating ISO and TC Nargis (2008)
Multi-Scale Interactions Captured in This Forecast

Initiation and Eastward-propagating Planetary-scale MJO Circulation

Regional Northward-Propagating Monsoon Intra-Seasonal Oscillation (ISO)

Emanated Rossby-Vortex

Tropical Cyclone "Nargis"

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Prospect: One-month lead Forecast

Initial Date: April 01, 2008

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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.

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Thank you!
ISO Predictability Measured by ACC

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

Atmosphere-only: 30 days

Coupled: 42 days

Fu et al. (2007)
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
Observed and Forecasted TC Nargis (2008)
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