Intra-Seasonal Forecasting of Asian Summer Monsoon, MJO, and Tropical Cyclones

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Introduction and Objective

Tropical Intra-Seasonal Oscillation (TISO) is the major climate variability in the tropics with a period of 30-60 days, which offers an opportunity for intraseasonal forecasting of the affected global weather statistics from two weeks to two months. The TISO manifests as Boreal-Summer Intraseasonal Oscillation (BSISO) in boreal summer and Madden-Julian Oscillation (MJO) in boreal winter. They modulate the active and break spells of Asian Summer Monsoon and Tropical Cyclones (TC) activity over global TC basins. This poster highlights our recent efforts and progresses made in intraseasonal forecasting of Asian Summer Monsoon, MJO, and Tropical Cyclones.

Intra-Seasonal Forecasting of Asian Summer Monsoon

Air-sea Coupling Improves Northward-propagating BSISO

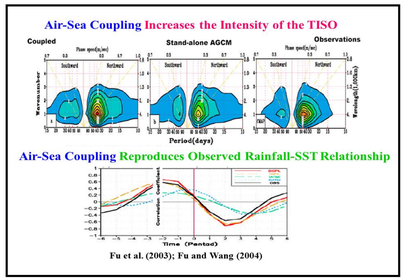


Figure 1. (Upper) Wavenumber-frequency spectra of northward-propagating BSISO-related rainfall from the coupled, stand-alone AGCM simulations and observations; and (Lower) Rainfall-SST phase relationships from the coupled, stand-alone AGCM simulations and observations.

Air-sea Coupling Improves Potential Predictability of the BSISO

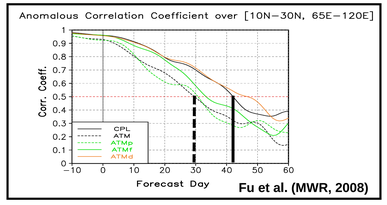
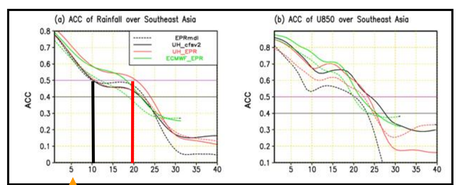


Figure 2. Potential predictability of 30-60-day filtered rainfall anomalies over Southeast Asia under different SST settings: Air-sea coupled run (CPL); AGCM forced by 'smoothed' SST (ATM); AGCM forced by persistent SST (ATM_p); AGCM coupled with a slab mixed-layer (ATM_f); AGCM forced by daily SST from the 'CPL' run (ATM_d).

Dynamical- Statistical Ensemble Improves the Forecasting Skill of BSISO



Better Initial Conditions Improve the Forecasting Skill of BSISO

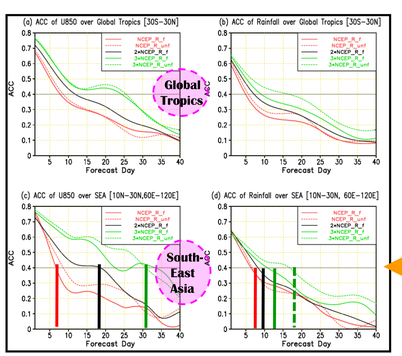


Figure 3 (Upper). The ACC of forecasted rainfall (a) and 850-hPa zonal winds (b) over Southeast Asia by an empirical model (EPRmdl), UH_CFSv2 ensemble, UH_EPR ensemble, ECMWF_EPR ensemble. Dashed red (green) lines represents UH (ECMWF) alone.

Figure 4 (Left). The ACC of forecasted 850-hPa zonal winds and rainfall over global tropics and Southeast Asia with different initial conditions. *Improved initial conditions lead to consistently better forecasting skills*.

Intra-Seasonal Forecasting of MJO During DYNAMO Period

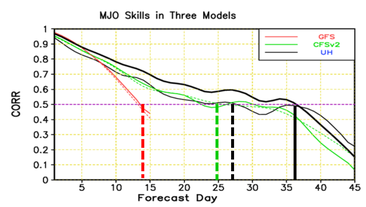


Figure 5. Prediction skills of MJO during DYNAMO period (Sep01, 2011 to Mar31, 2012) by the GFS, CFSv2, and UH models. Solid (dashed) lines represent weekly (daily) sampling. The thick black solid line represents UH-CFSv2 ensemble.

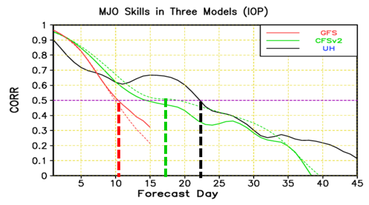


Figure 6. Prediction skills of MJO during DYNAMO IOP period (Sep01, 2011 to Jan15, 2012) by the GFS, CFSv2, and UH models. Solid (dashed) lines represent weekly (daily) sampling.

Air-sea Coupling Improves MJO Forecasting Skills

Forecasting experiments with UH model under different SST settings

Names of Experiments	SST Settings
CPL	Atmosphere-ocean coupled forecasts.
Fcst_SST (or fsst)	Atmosphere-only forecasts driven by daily SST derived from the 'cpl' forecasts.
Pers_SST (or psst)	Atmosphere-only forecasts driven by persistent SST.
TMI_SST (or osst)	Atmosphere-only forecasts driven by observed daily TMI SST.

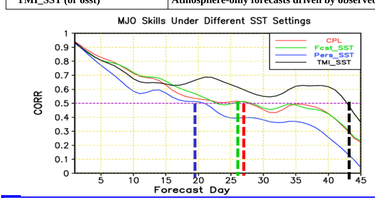


Figure 7. Prediction skills of MJO during DYNAMO period (Sep01, 2011 to Mar31, 2012) under different SST settings. *Atmosphere-only run forced by daily SST from the coupled forecast is able to reach a similar skill level as the coupled forecast.*

Air-sea Coupling is important for the initiation and propagation of MJO

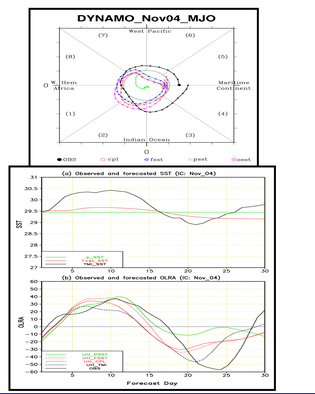


Figure 8. (Upper) Observed and forecasted Wheeler-Hendon phase diagrams under different SST settings initialized on November 4, 2011. (Lower) Total SST (a) from the observations, "cpl" run and "persistent" run and anomalous OLR (b) under different SST settings.

Intra-Seasonal Forecasting of Tropical Cyclones

TC Climatology in the OBS and UH Model

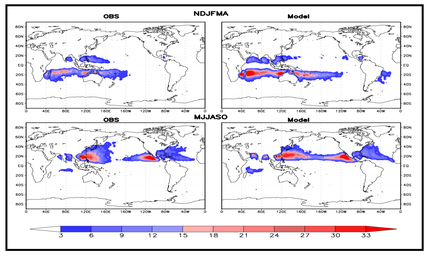
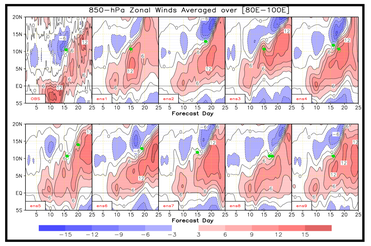


Figure 9. The climatology of TC occurrence in boreal winter (two upper panels) and in boreal summer (two lower panels) from the observations and UH model long-term simulations. Model TC is detected as in Fu and Hsu (GRL, 2011)

Extended-range Forecasting of TC "Nargis" (2008)



Fu and Hsu (GRL, 2011)

Figure 10. Latitude-time cross-sections of 850-hPa zonal winds averaged over (80°E-100°E) along with the genesis dates and latitudes of tropical Cyclone "Nargis" from the observations (top left plot) and ensemble forecasts (remaining plots).

Experimental Real-time Forecasting of TC-Bopha

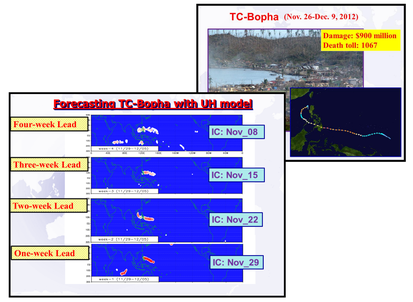


Figure 11. Observed track of TC "Bopha" and real-time forecasts of TC-Bopha's occurrence with different lead times. Experimental weekly forecast is available online at : http://iprc.soest.hawaii.edu/users/xfu/TC_fcst/TC.html.

Summary

- **Interactive air-sea coupling plays an important role to the realistic simulation of the northward-propagating BSISO: Its intensity and rainfall-SST phase relationship, thus extending its potential predictability. Initial conditions and multi-model (including dynamical-statistical) ensembles are also key techniques to improve intraseasonal forecasting of Asian Summer Monsoon.**
- **The MJO forecasting skill of UH and CFSv2 multi-model ensemble reaches about 36 days during 6-month DYNAMO period. Air-sea coupling extends MJO skill by about one week. *The atmosphere-only (e.g., GFS)forecasts driven by daily SST from coupled forecasts reach a similar skill level as the coupled forecasts.***
- **Improved forecasting of the BSISO and MJO ensures useful intraseasonal forecasting of Tropical Cyclones activity. Weekly experimental real-time forecasting is carried out for next four weeks at University of Hawaii. The product is available online at: http://iprc.soest.hawaii.edu/users/xfu/TC_fcst/TC.html.**