Intraseasonal Forecasting of the MJO During DYNAMO/CINDY Period

Joshua Xiouhua Fu

- The MJO Observed by DYNAMO/CINDY Campaign
- Assessment of Operational Forecasts in This Period
- Inter-comparison of GFS, CFSv2, and UH Models
- Summary and Future Study

Collaborators at NCEP/CPC: WQ Wang, S. Weaver; and at UH/IPRC: B. Wang, JY Lee, PC Hsu, O. Shieh, H. Taniguchi

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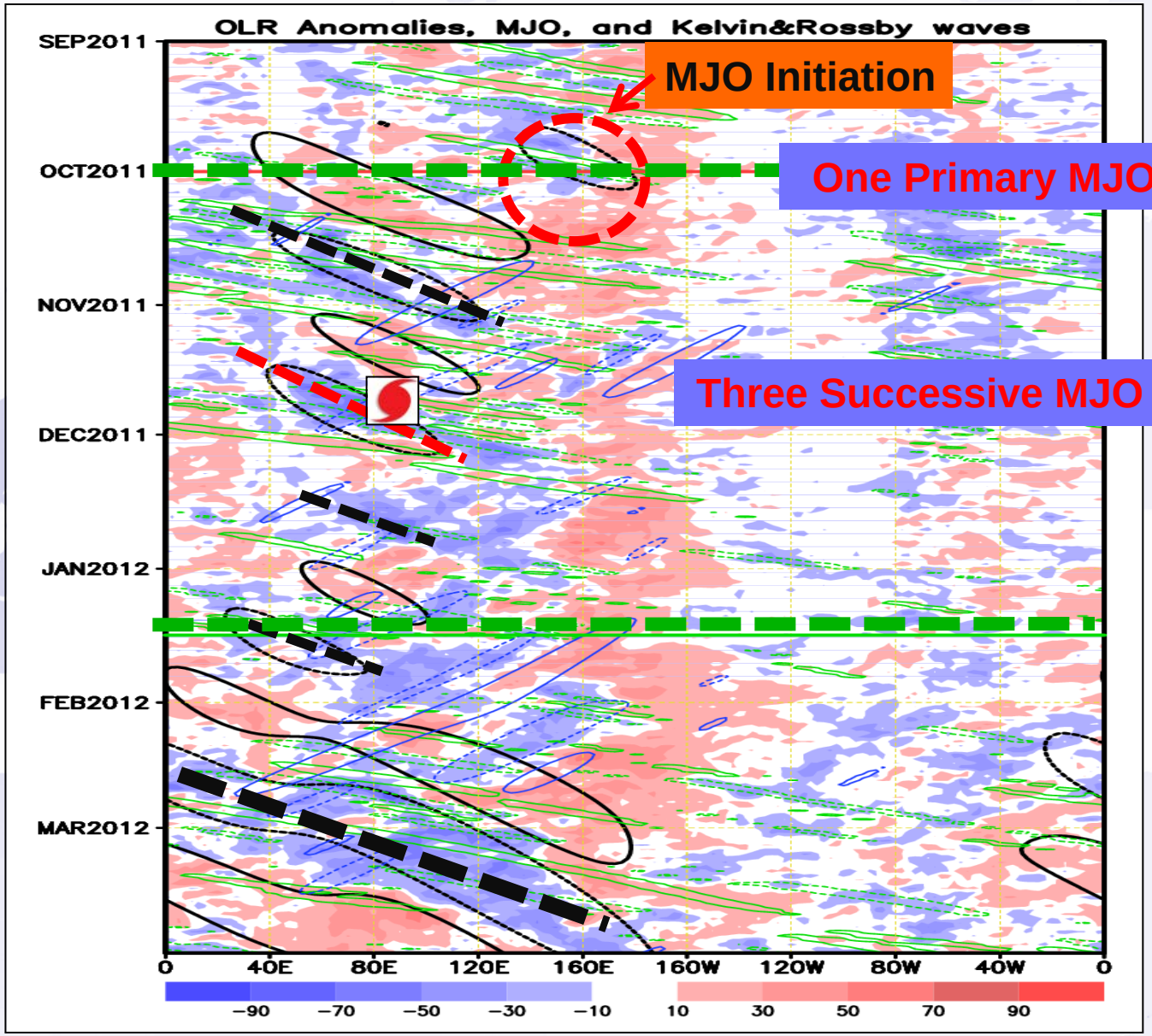
OLR Anomalies, MJO, and K/R Waves during DYNAMO



MJO-I

MJO-II

MJO-III

MJO-IV

MJO-V

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Preliminary Assessment of Operational MJO Forecasting Capability during DYNAMO/CINDY Period

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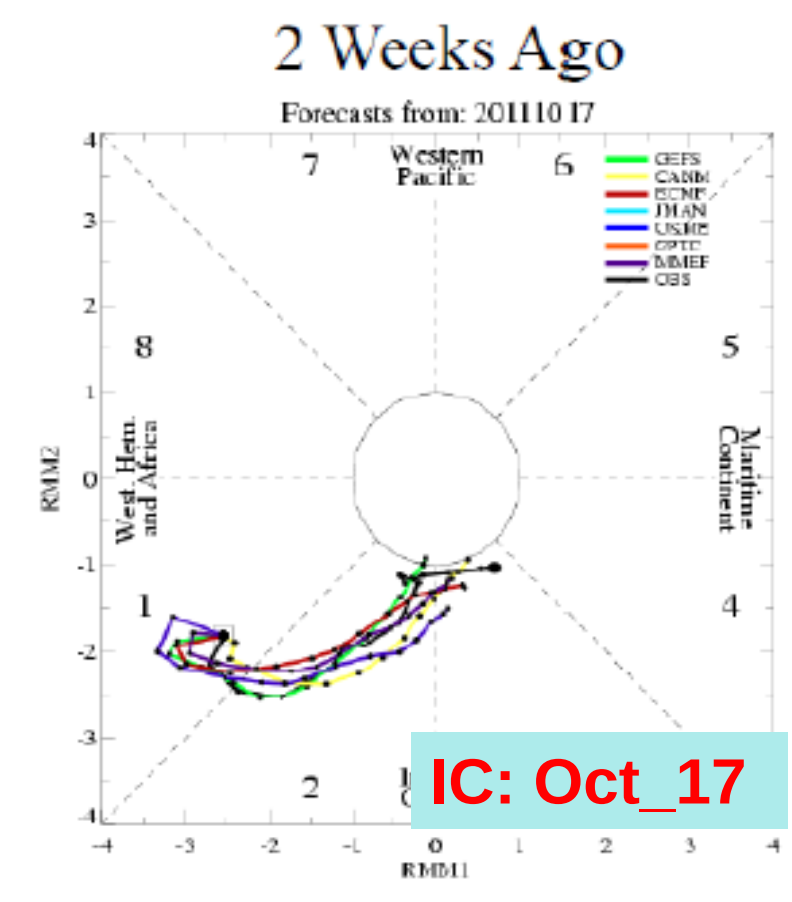
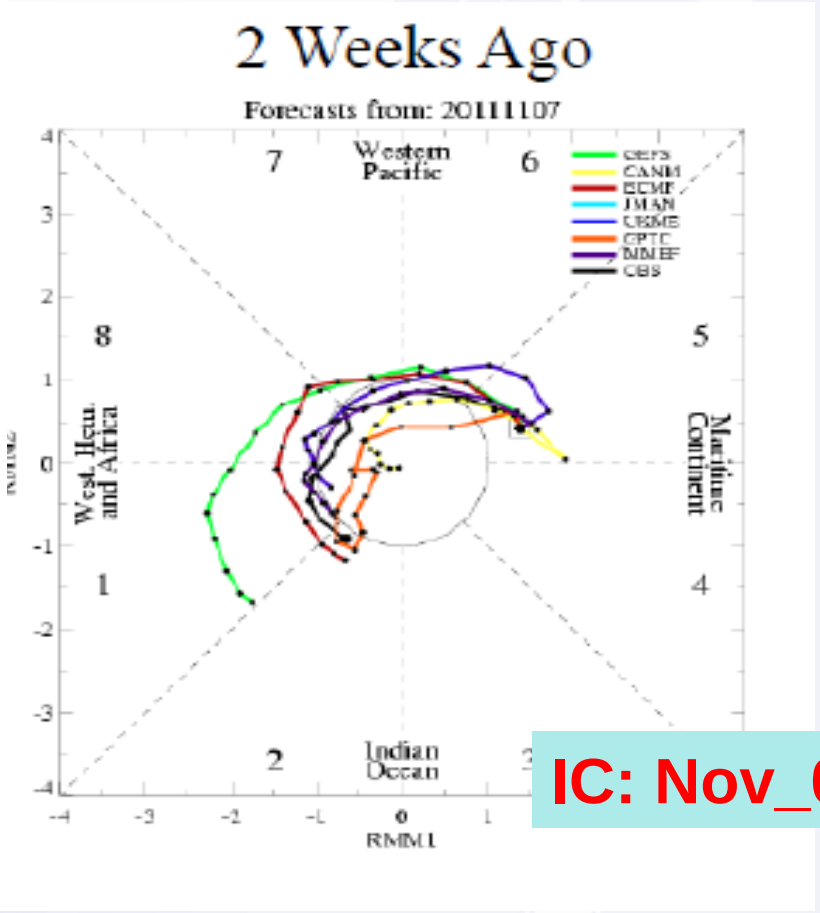
“Good”

“Good”



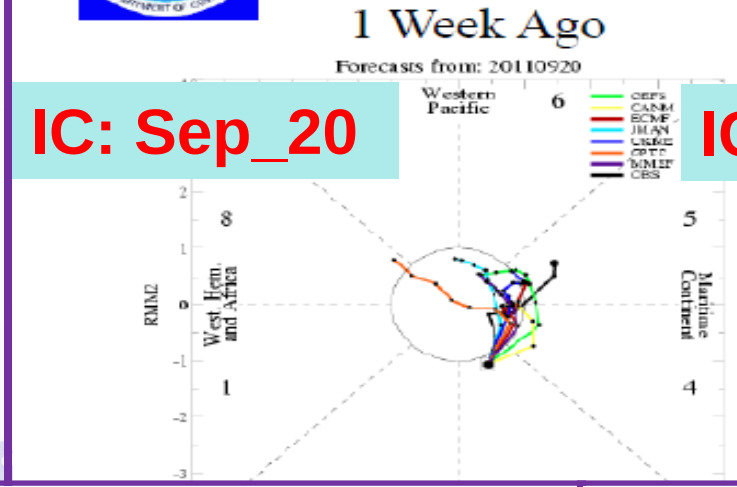
IC: Oct_17



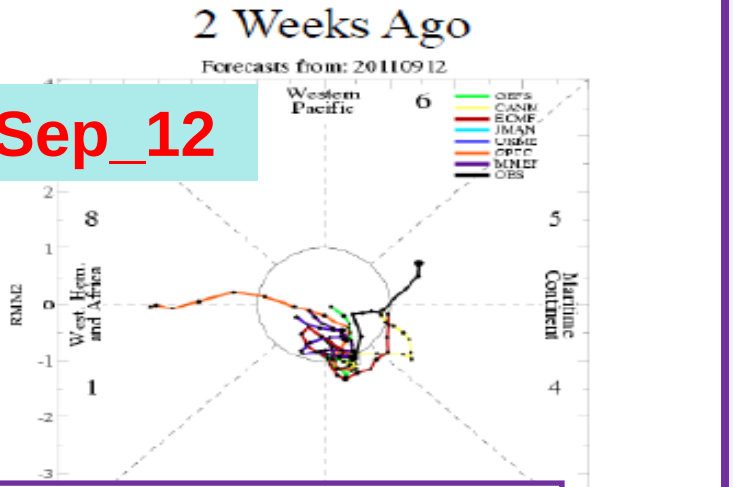
IC: Nov_07

Courtesy of NCEP MJO Discussion Summary led by Jon Gottschalck et al.

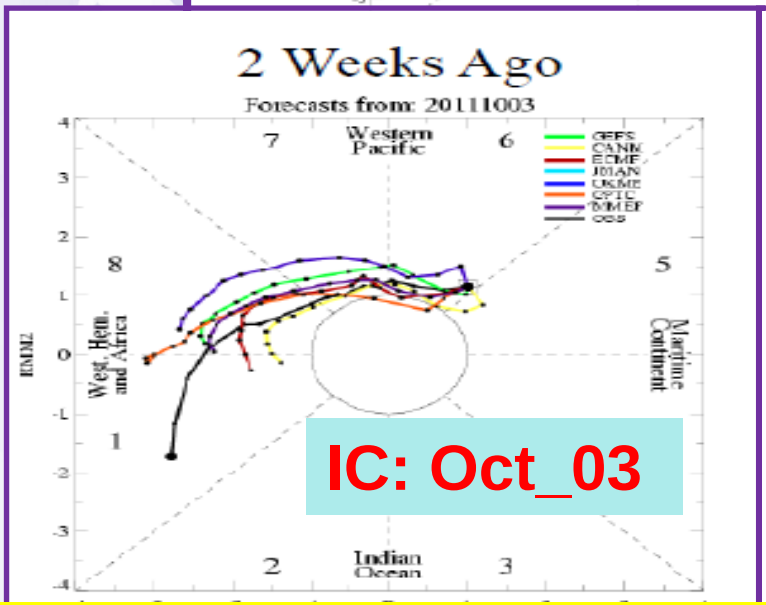
Failed to Predict "the Initiation of a Primary MJO Event"



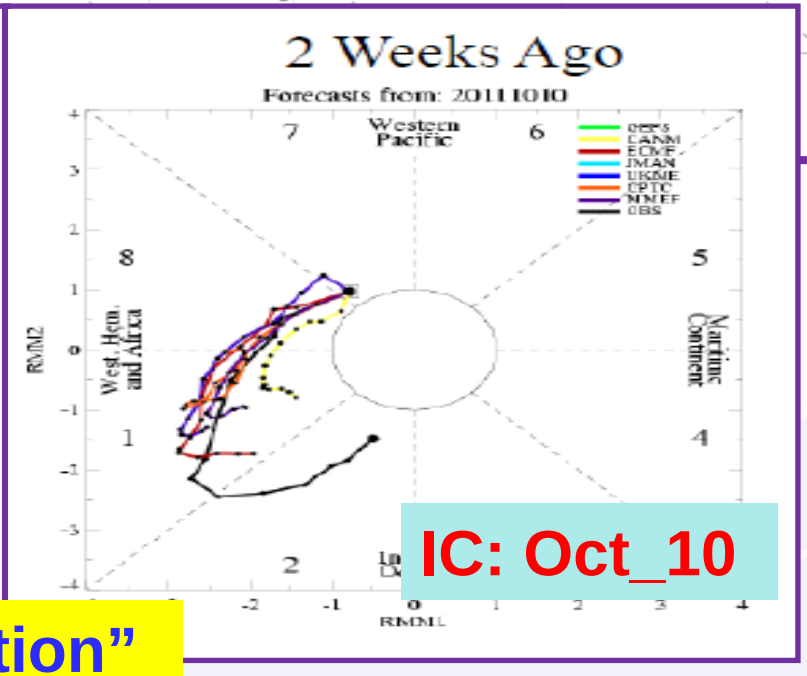
IC: Sep_20



IC: Sep_12



IC: Oct_03



IC: Oct_10

"Slow Eastward Propagation"

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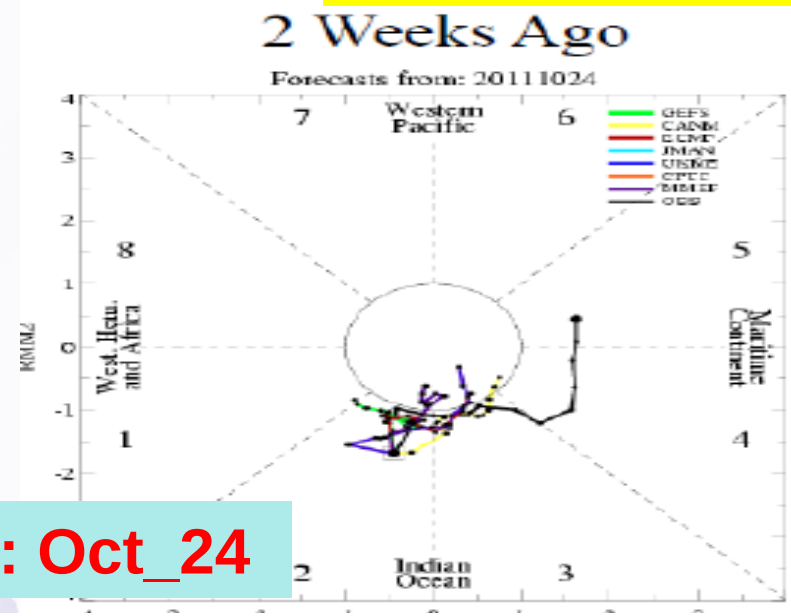
“Maritime Continent Barrier”



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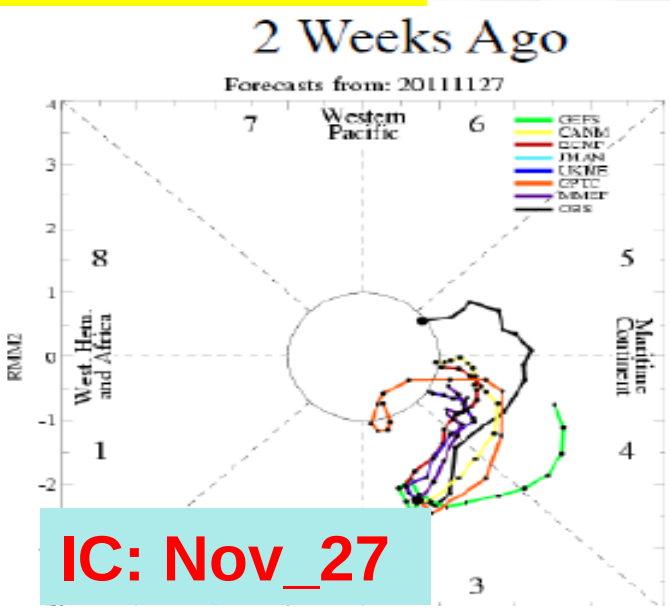
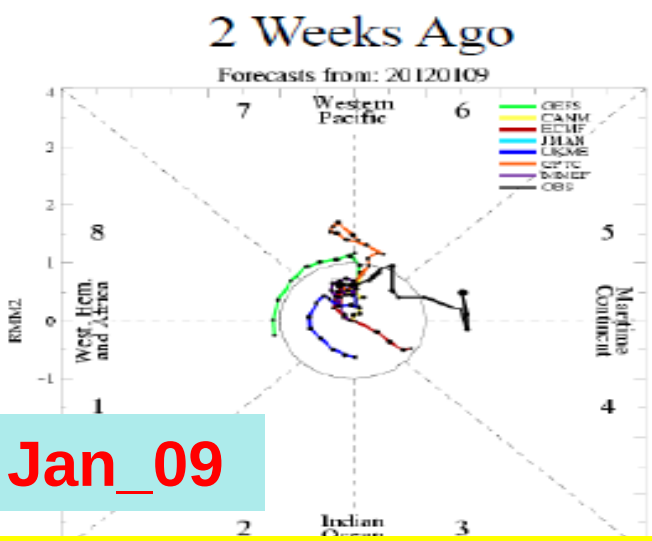
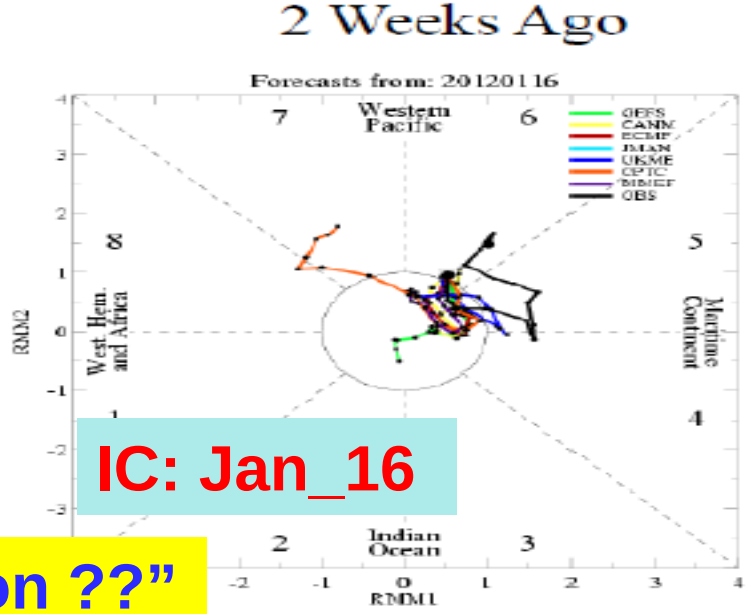


IC: Nov_27



IC: Jan_09



IC: Jan_16

“Rossby-wave MJO Initiation ??”

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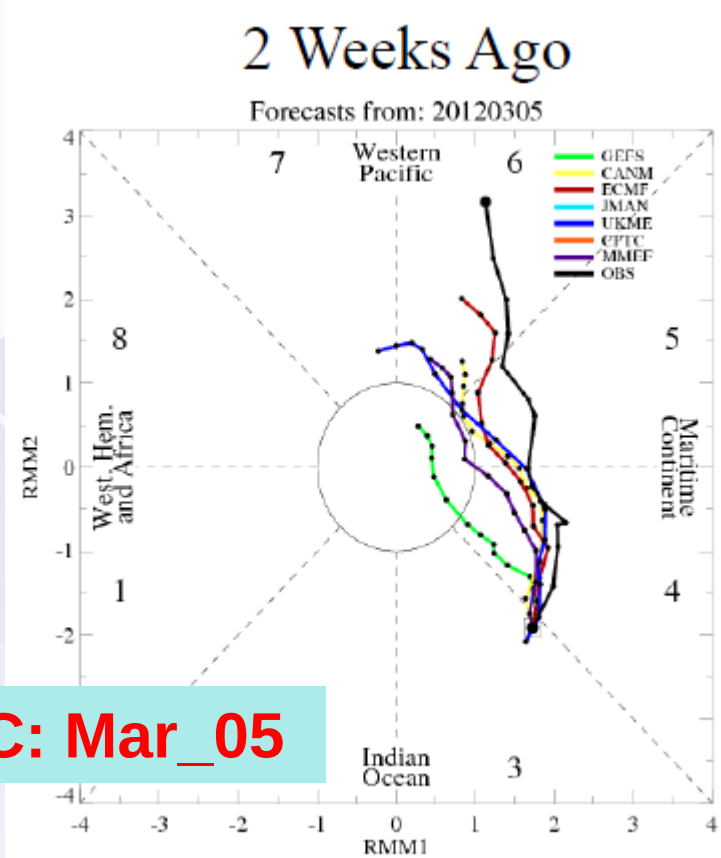
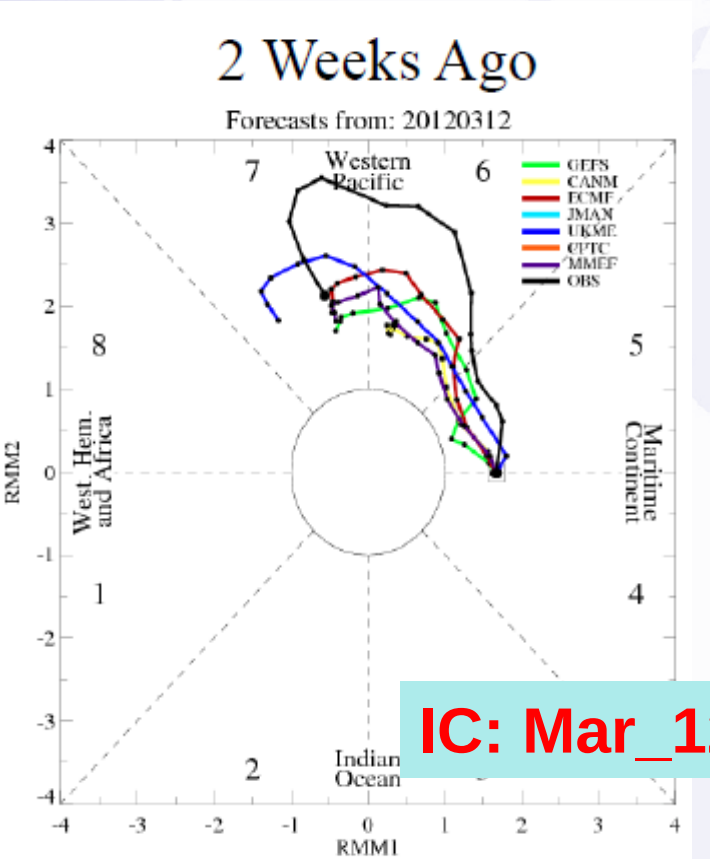
“Good but weaker intensity”





IC: Mar_05

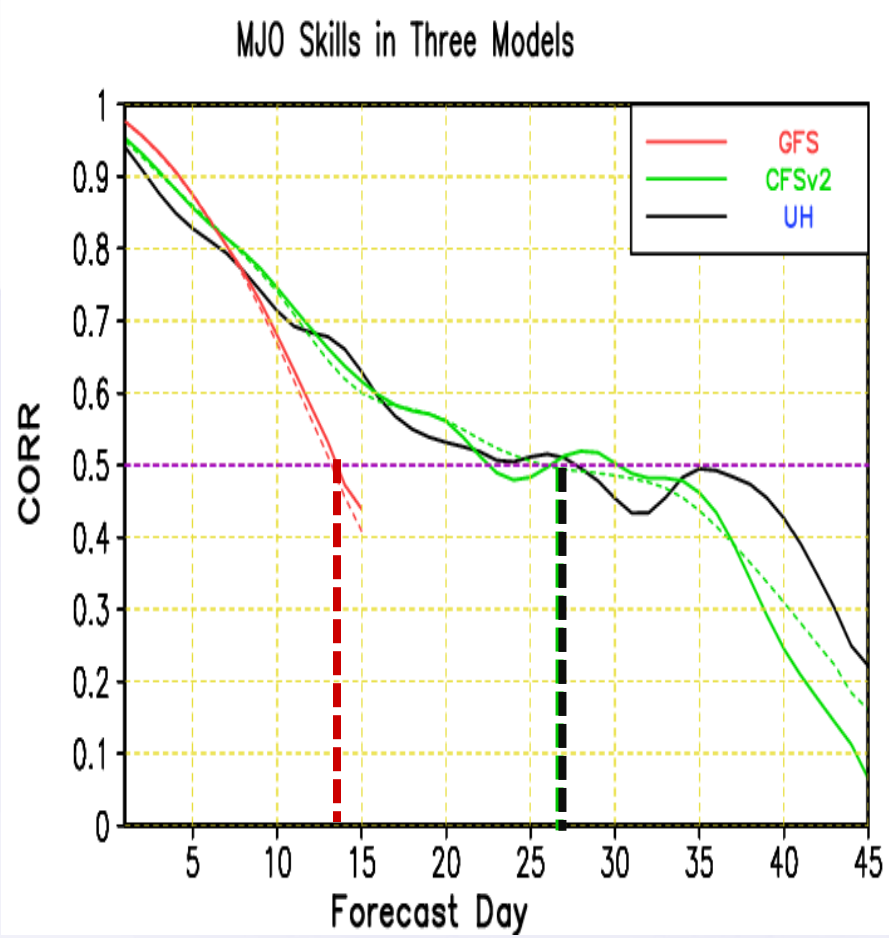
IC: Mar_12

Inter-comparison of GFS, CFSv2, and UH Models

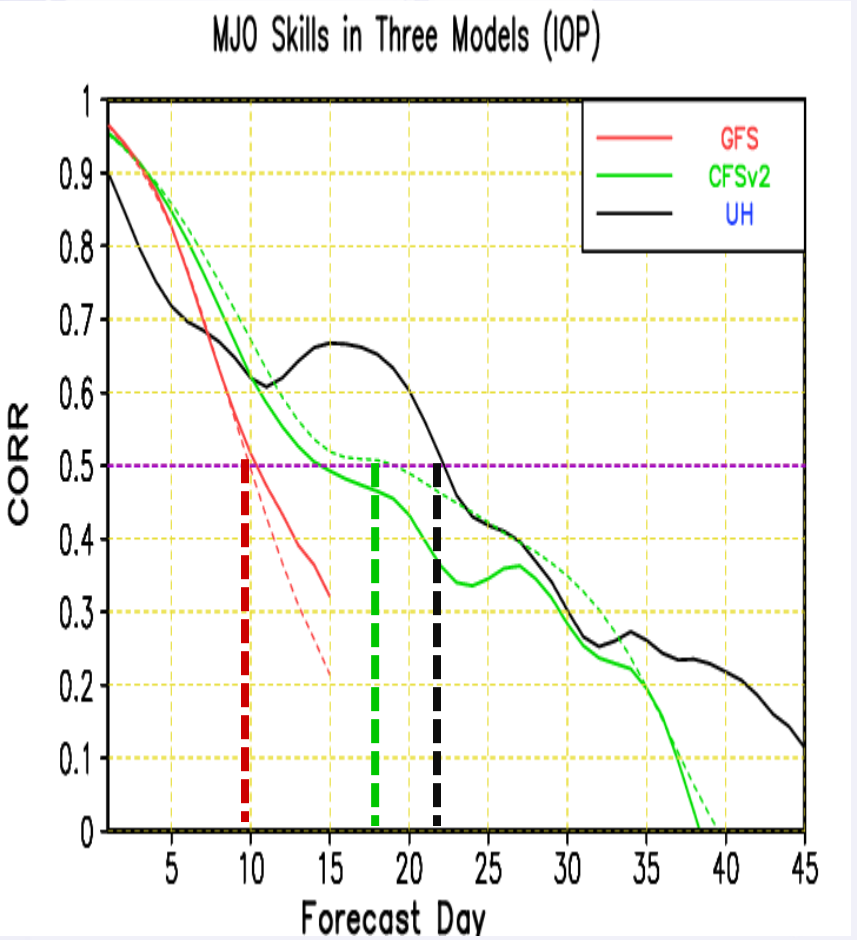
- **DYNAMO/CINDY Period:** Sep-2011 to Mar-2012
- **Forecast Interval:** Daily (GFS, CFSv2), Weekly (UH)
- **Ensemble Mean:** 4/4x4 ensembles daily (GFS/CFSv2), 10 ensembles (UH)
- **Integration Length:** 15/45 days
- **Initial Conditions:** NCEP GDAS/CFSR/FNL
- **MJO Skill Measure:** Wheeler-Hendon RMM Index

MJO Skills of Three GCMs During DYNAMO/CINDY

(Sep 2011- Mar 2012)



(IOP: Sep 2011- Jan 2012)



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Impacts of Air-sea Coupling and Stratiform Rainfall Fraction on MJO Forecast

➢ **Air-sea Coupling:** **Coherent structure, Propagation, Intensity, Predictability, and Prediction Skill.**

Krishnamurti et al. (1988); Flatau et al. (1997); Wang and Xie (1998); Waliser et al. (1999); Fu and Wang (2004); Woolnough et al. (2007); Fu et al. (2007); Pegion and Kirtman (2008); Fu et al. (2008) et al.

Sensitivity Experiments:

CPL: Coupled control run

Fcst_SST: Atmosphere-only run forced with forecasted daily SST

Pers_SST: Atmosphere-only run forced with persistent SST

TMI_SST: Atmosphere-only run forced with observed daily SST

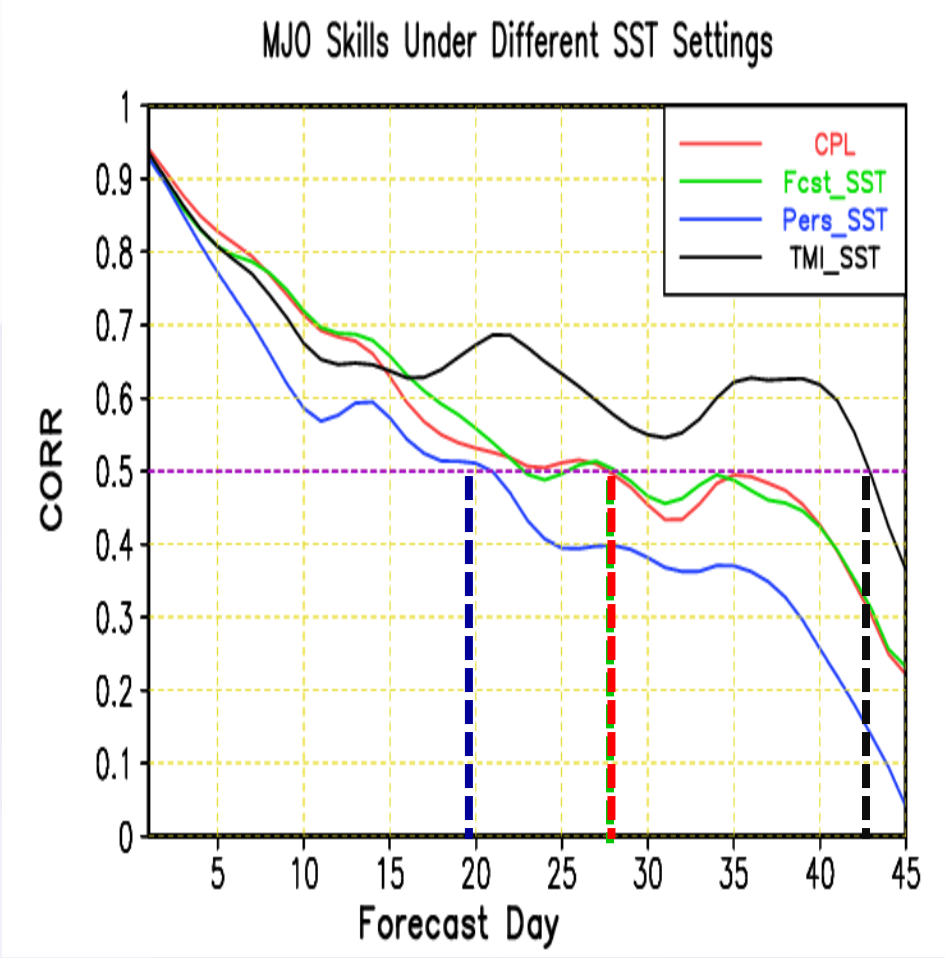
➢ **Fraction of Stratiform Rainfall:** **Intensity et al.**

Tompkins et al. (2003); Fu and Wang (2009); Seo and Wang (2010); Benedict et al. (2012)

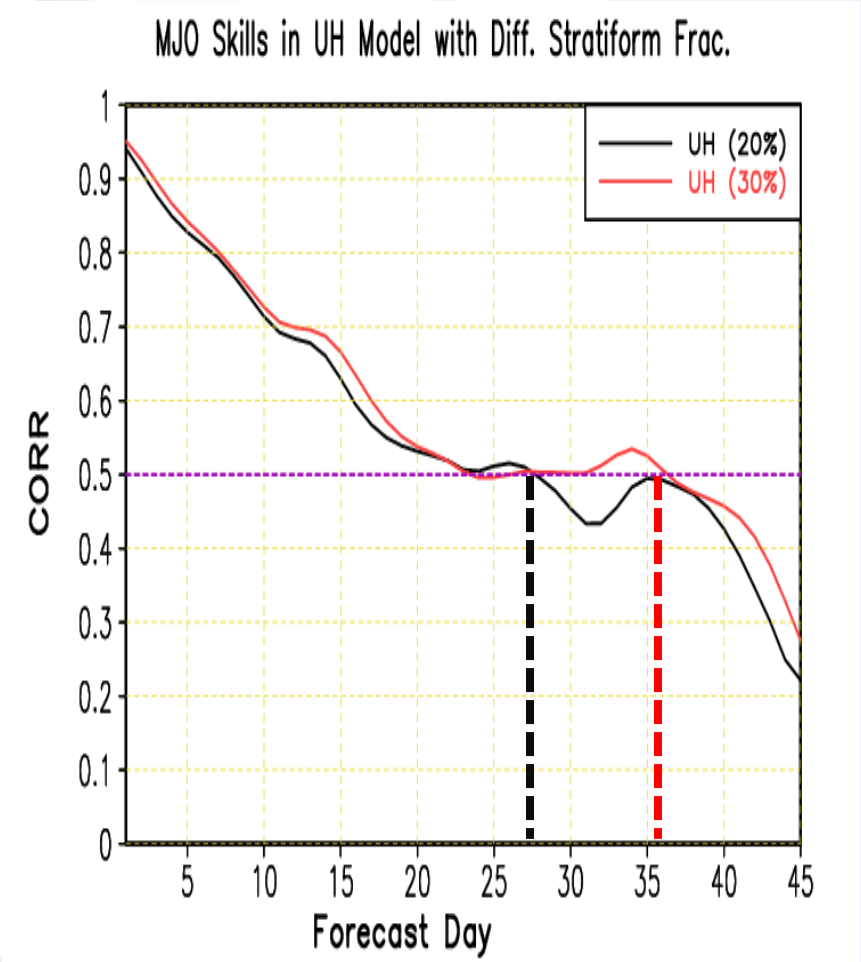
Sensitivity Experiments: Modifying detrainment rate

Sensitivity Experiments During DYNAMO/CINDY

Diff. SST Settings



Diff. Stratiform Fraction



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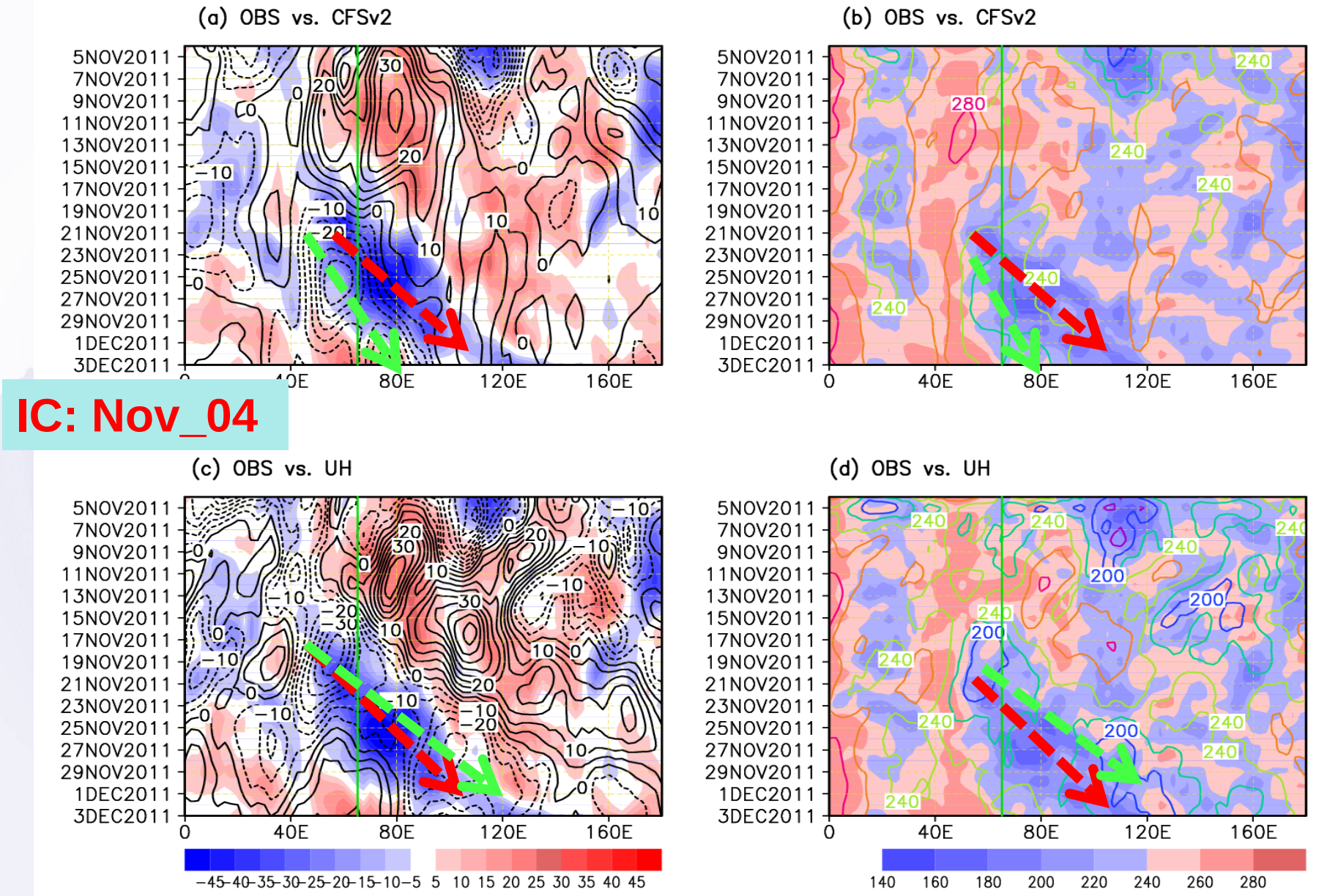
Nov-MJO Initiation Forecasted by CFSv2 and UH



IC: Nov_04

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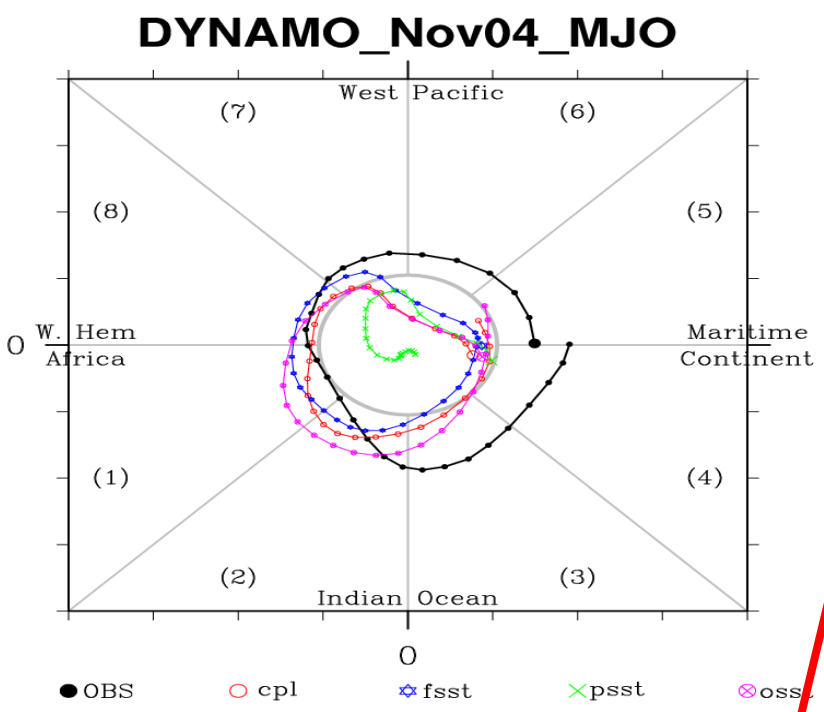
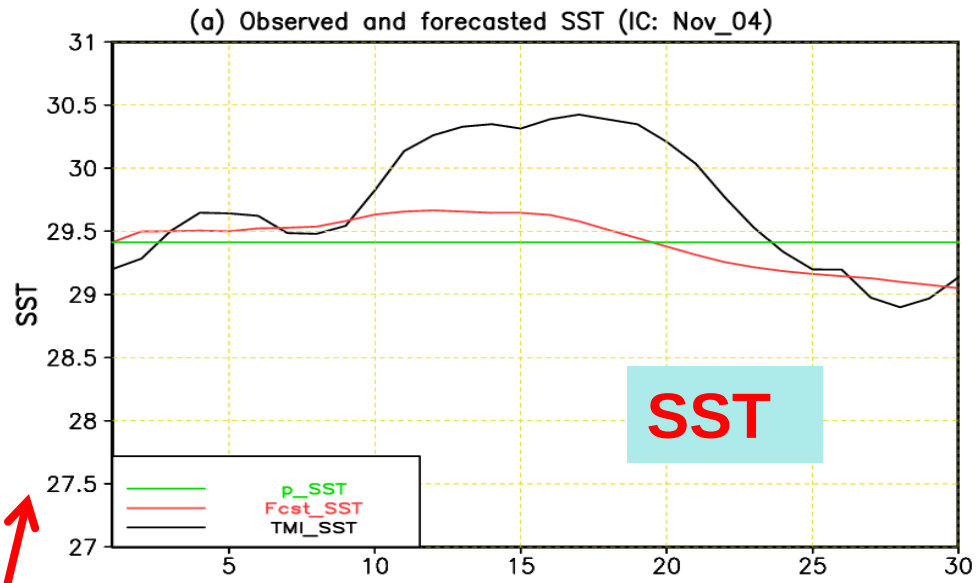
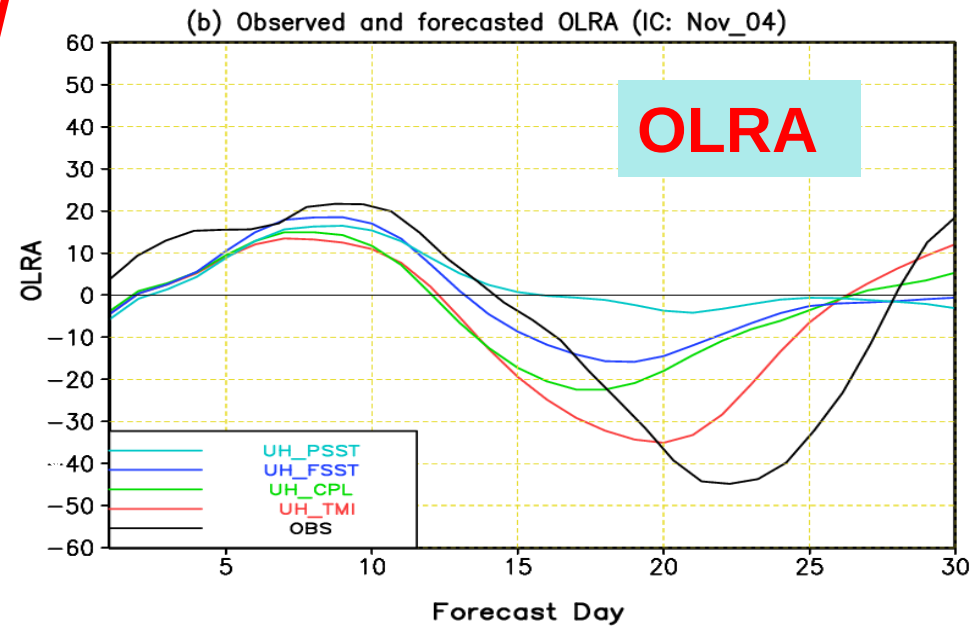
Air-sea Coupling is Important for MJO Initiation

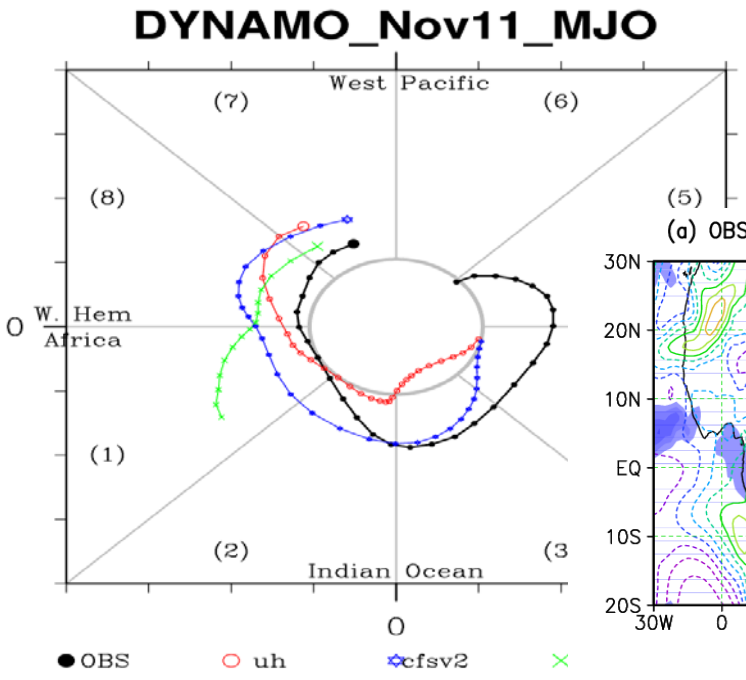




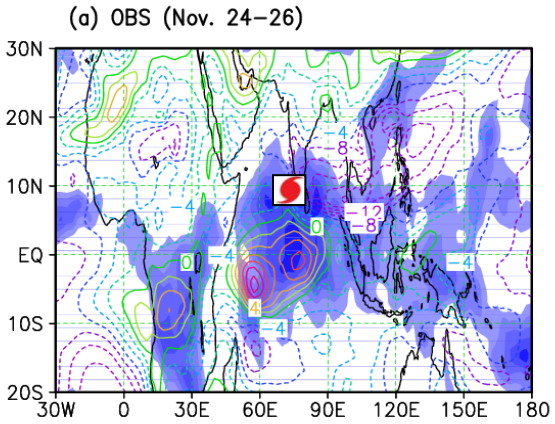


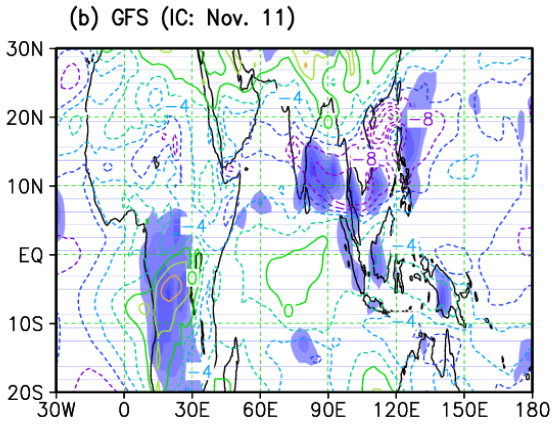
Observed and forecasted SST and OLR anomaly over tropical Indian Ocean with initial date on Nov. 04.

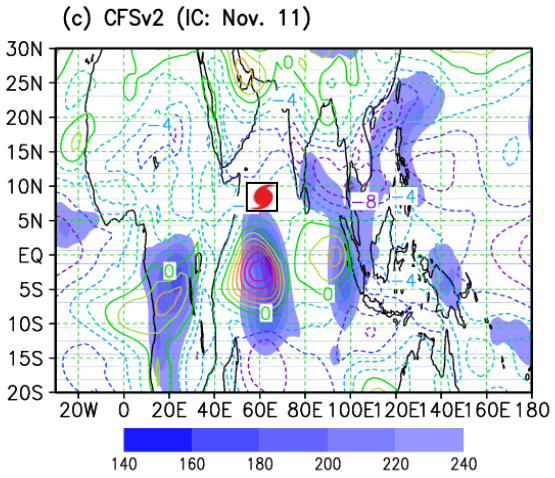
Forecasts of GFS, CFSv2 and UH with IC on Nov. 11

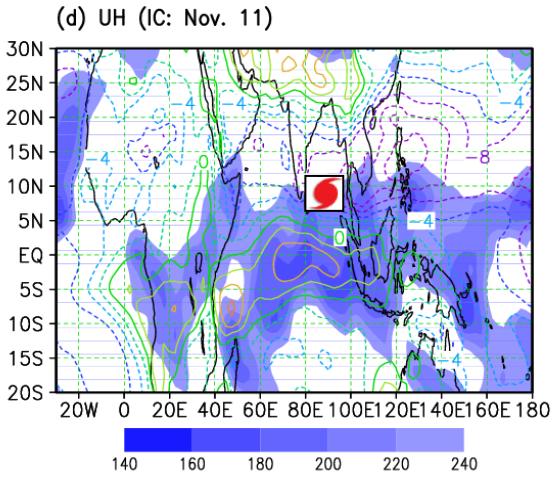


Observed and forecasted U850 and OLR averaged for day-13-15



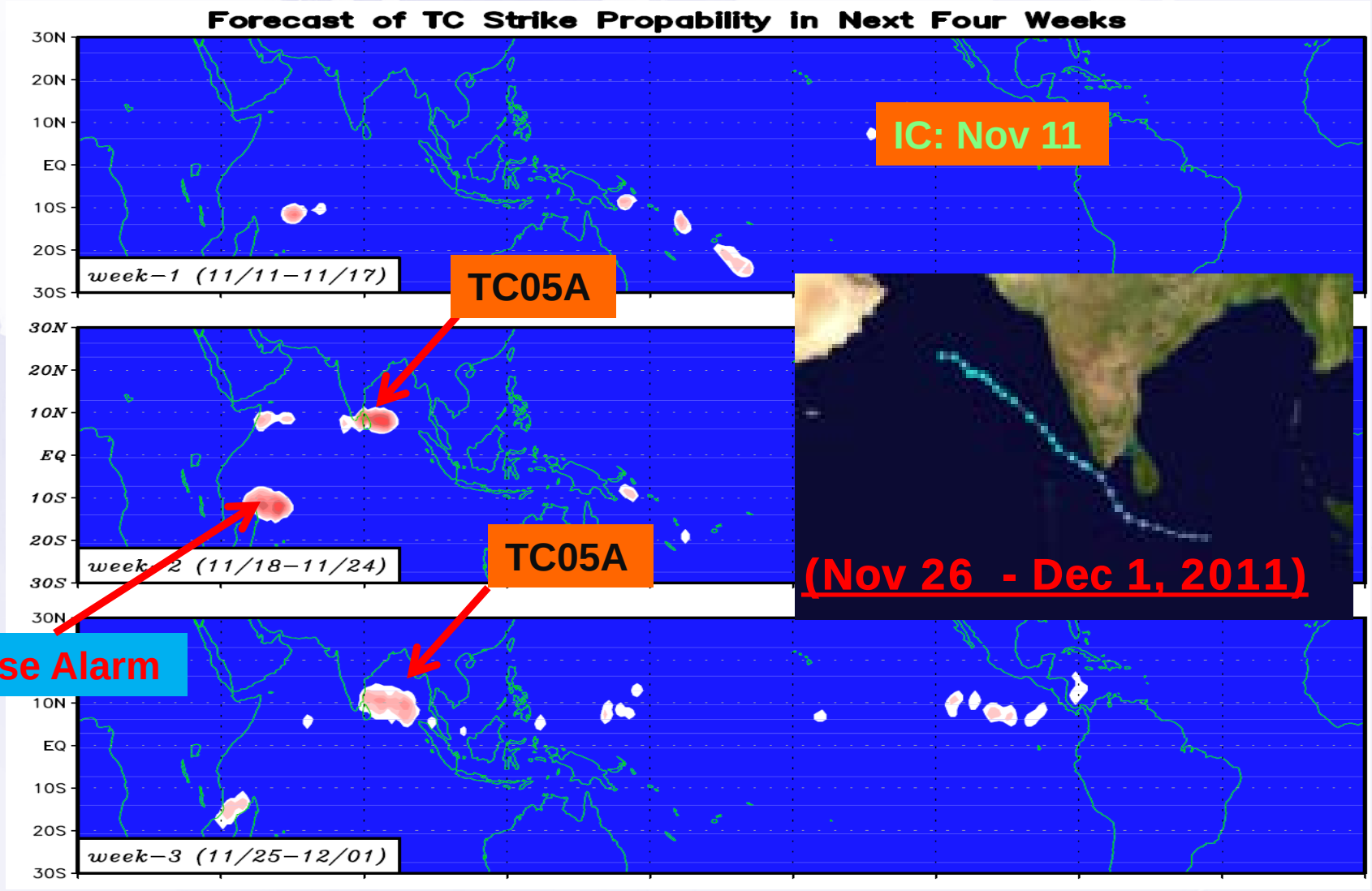






U850 (contours)
OLR (shading)

UH Three-week-lead Forecast of TC Occurrence Probability



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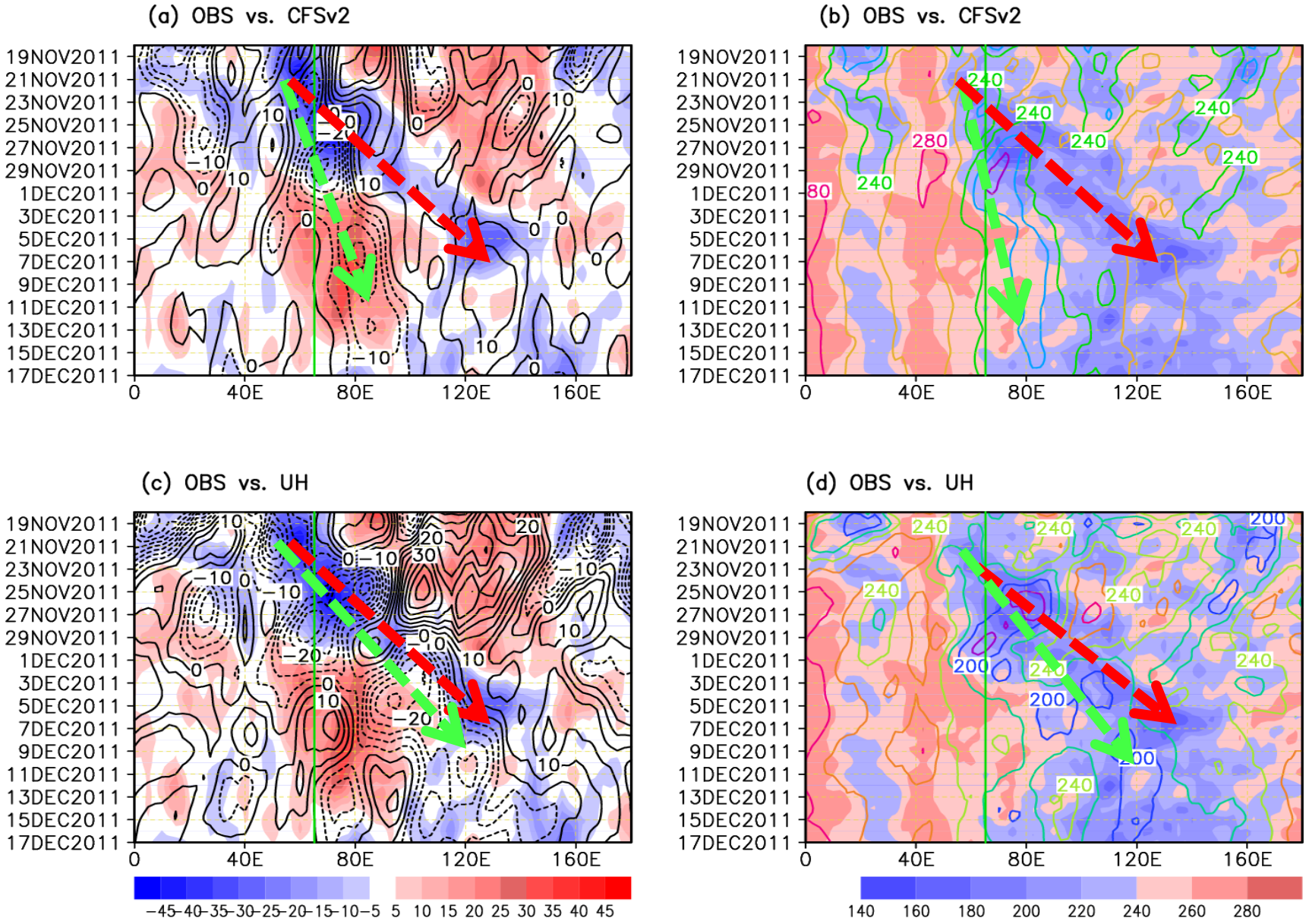
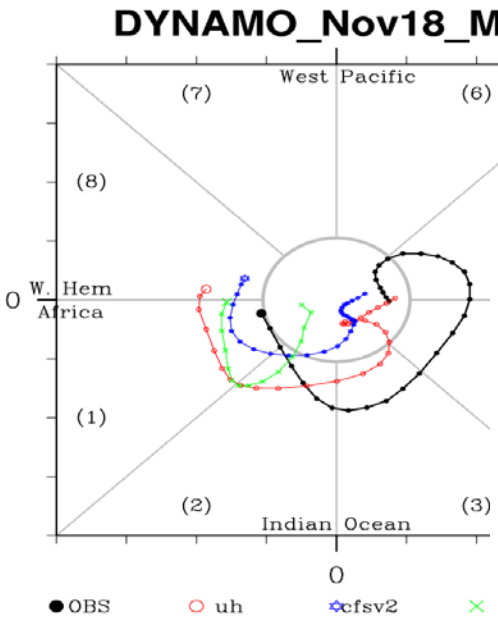
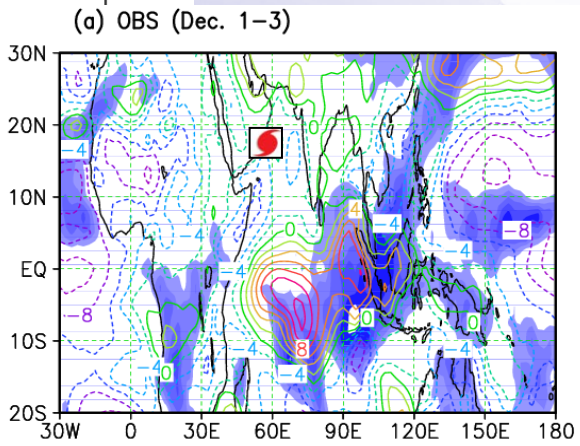
Forecasts of CFSv2 and UH with IC on Nov. 18

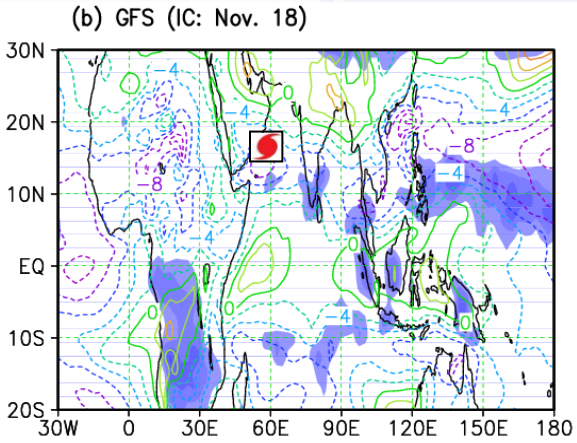


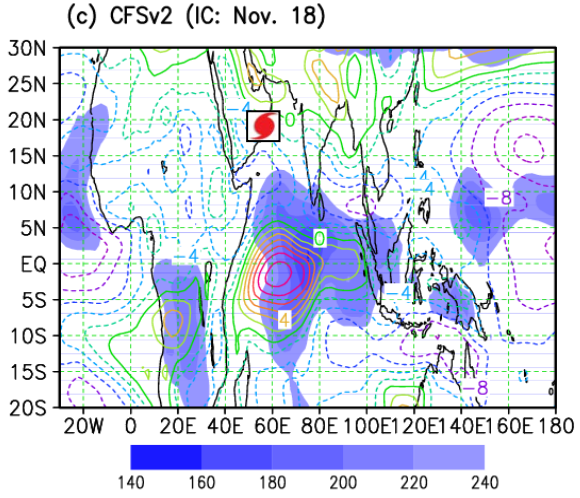
Forecasts of GFS, CFSv2 and UH with IC on Nov. 18

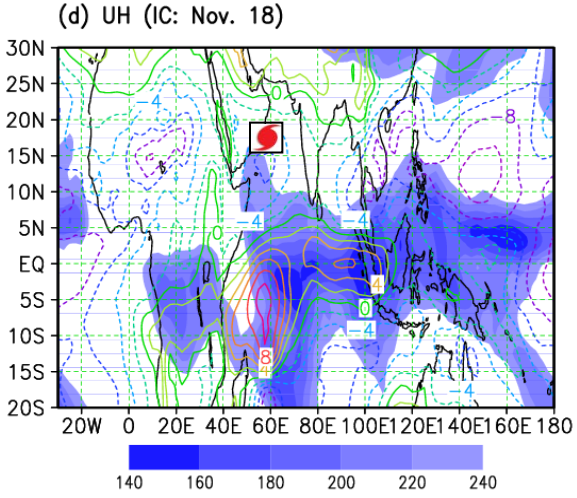


Observed and forecasted U850 and OLR averaged for day-13-15









U850 (contours)
OLR (shading)

Summary:

1. Successive MJO is more predictable than primary MJO. Major problems of operational models are: Slow eastward propagation, Maritime Continent barrier, and weak intensity.

2. MJO forecast skills are about 14 days in GFS and 25 days in CFSv2 and UH models for entire DYNAMO period. CFSv2 model has lower skill during IOP due to slow eastward propagation.

3. Intraseasonal SST anomaly (or air-sea coupling) and enhanced stratiform rainfall significantly improve MJO forecast skill.

Future Study:

i) validation of air-sea coupling; ii) cause of slow propagation in CFSv2; iii) MJO-TC interaction.

Thank You Very Much!

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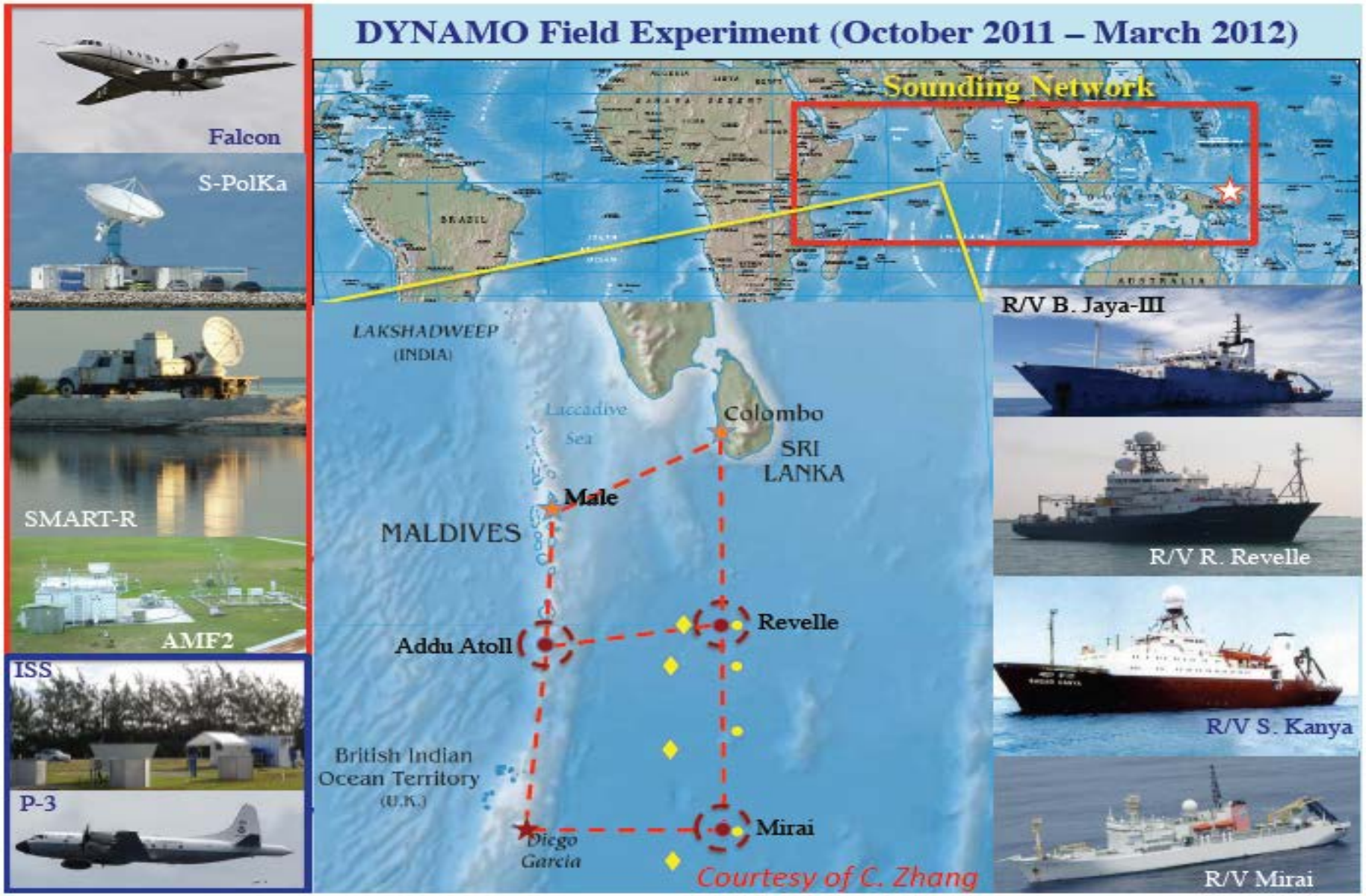
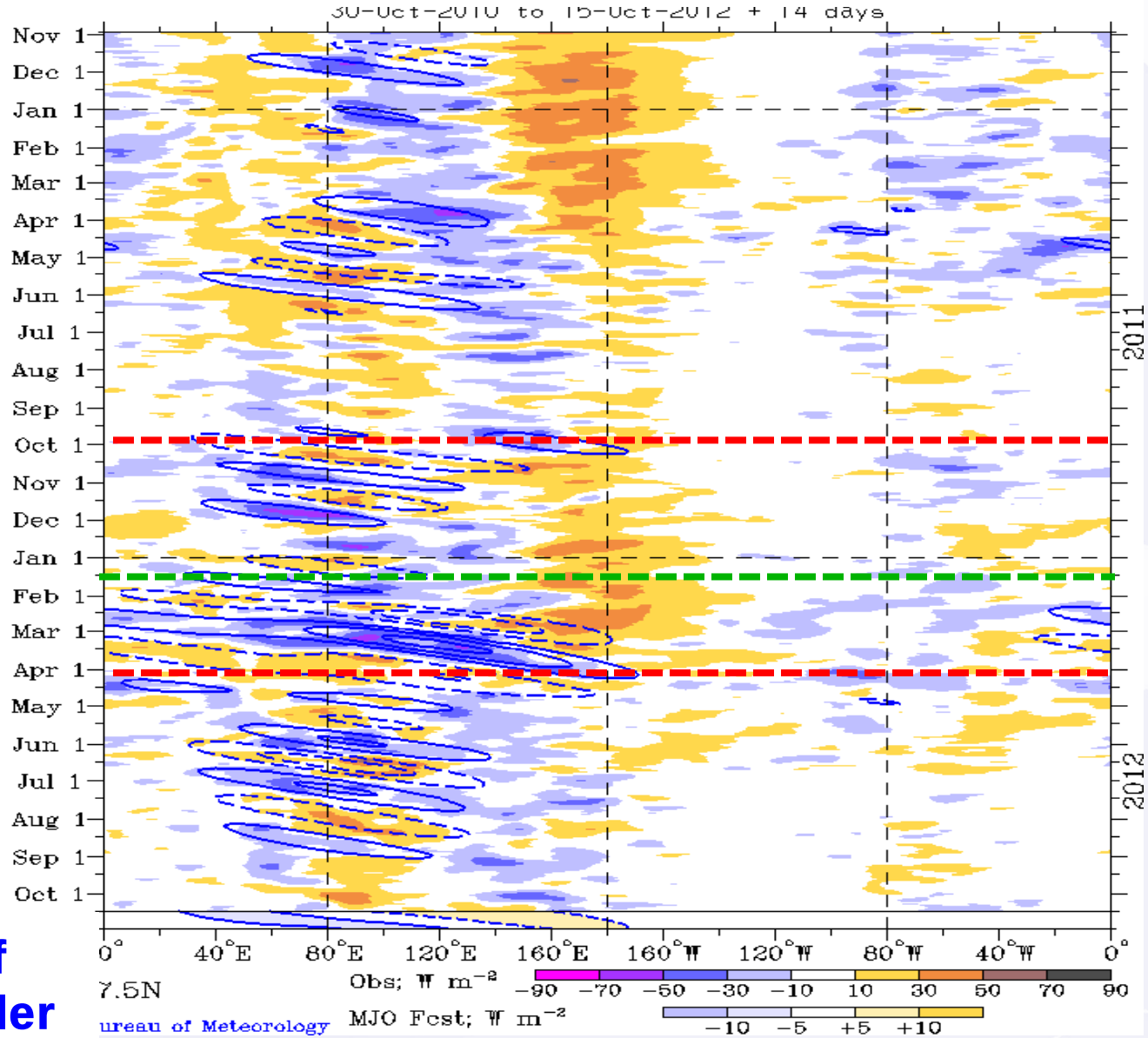
DYNAMO/CINDY Field Campaign (Oct 2011-Mar 2012)



OLR Anomalies and MJO in 2011-2012



DYNAMO IOP

Courtesy of Matt Wheeler

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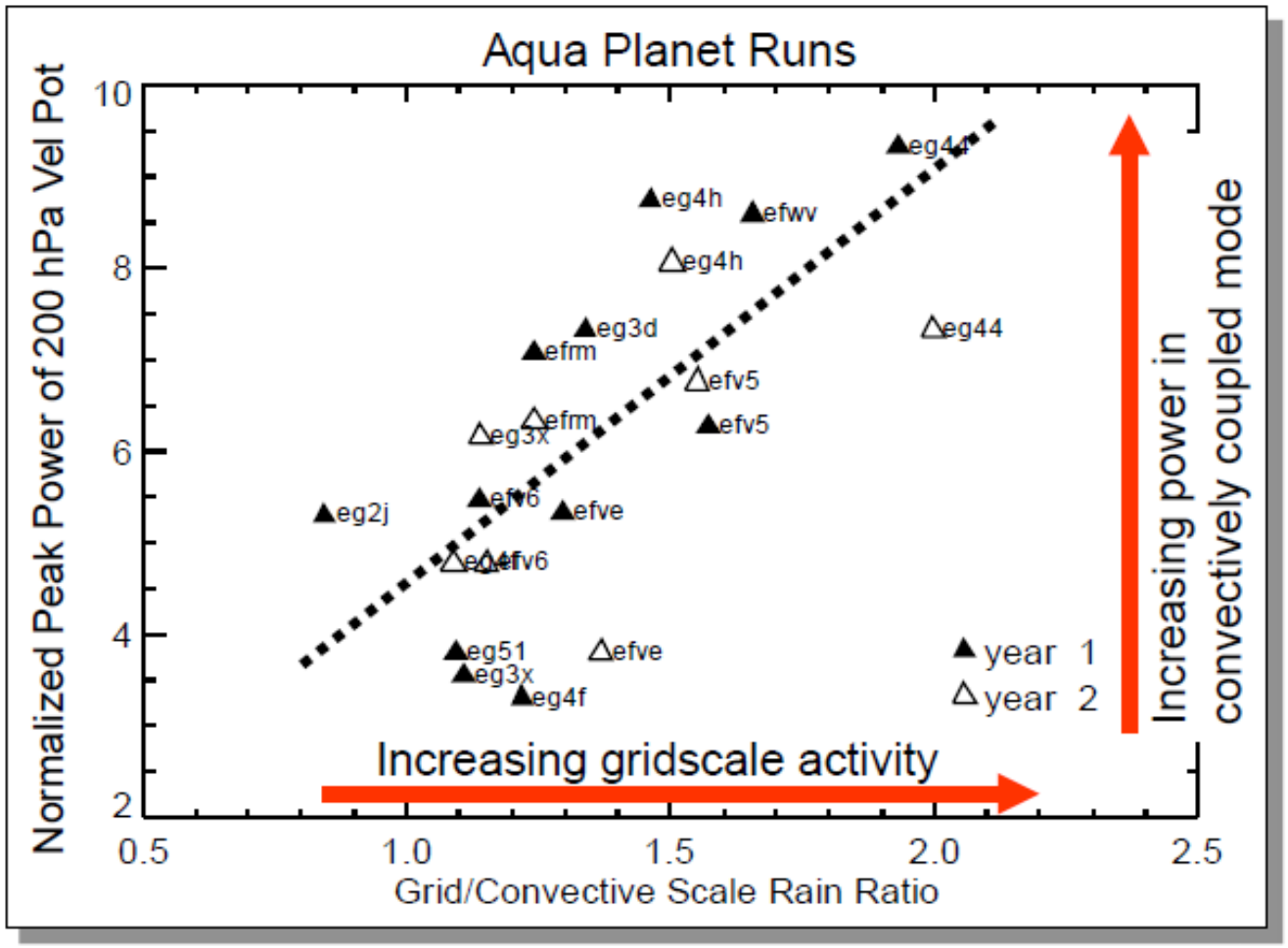
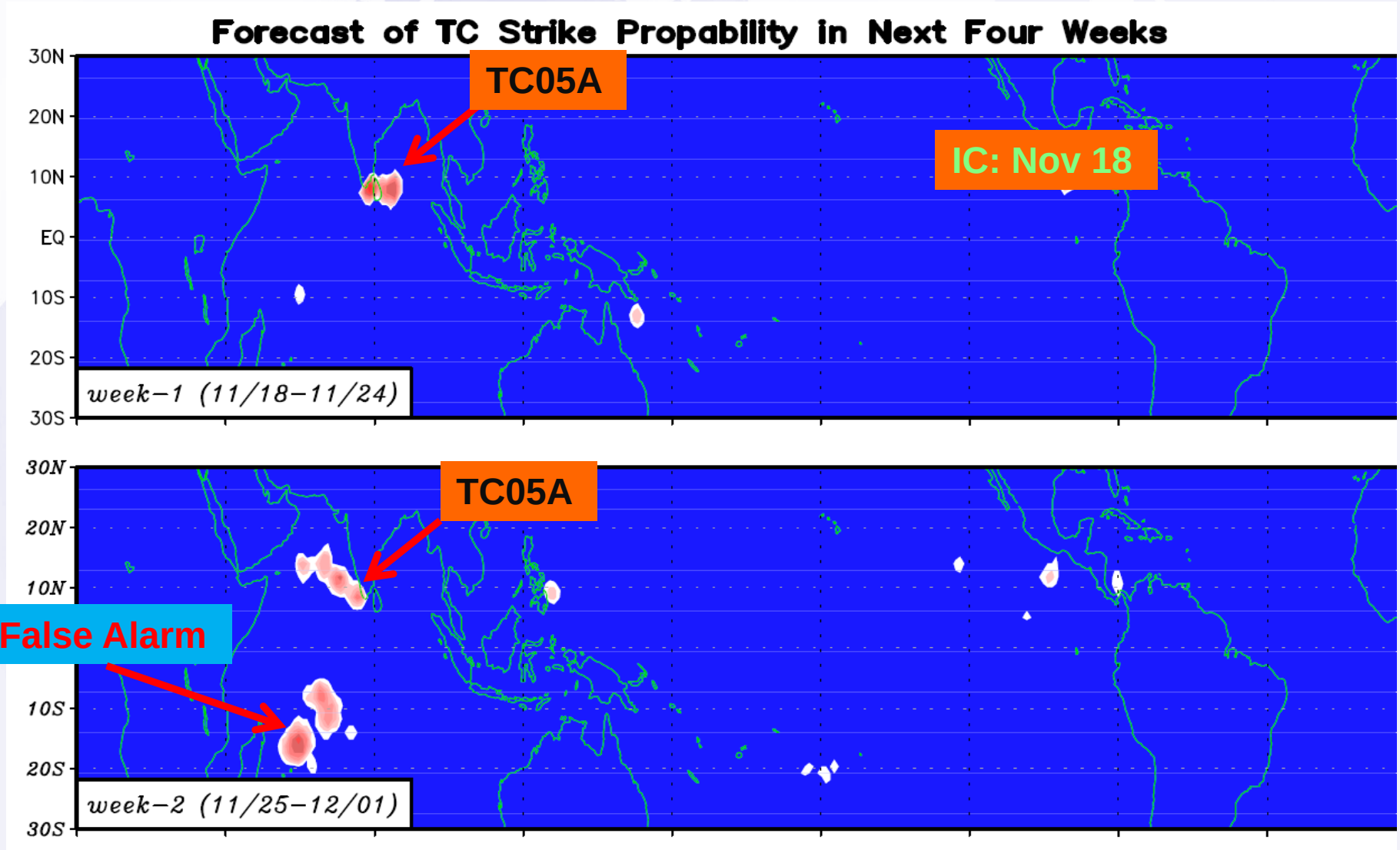
Increasing Large-scale activity increases peak power (K=1,2,3 15 days<p<120 days)



Tompkins et al. (2003)

UH Two-week-lead Forecasts of TC Occurrence Probability



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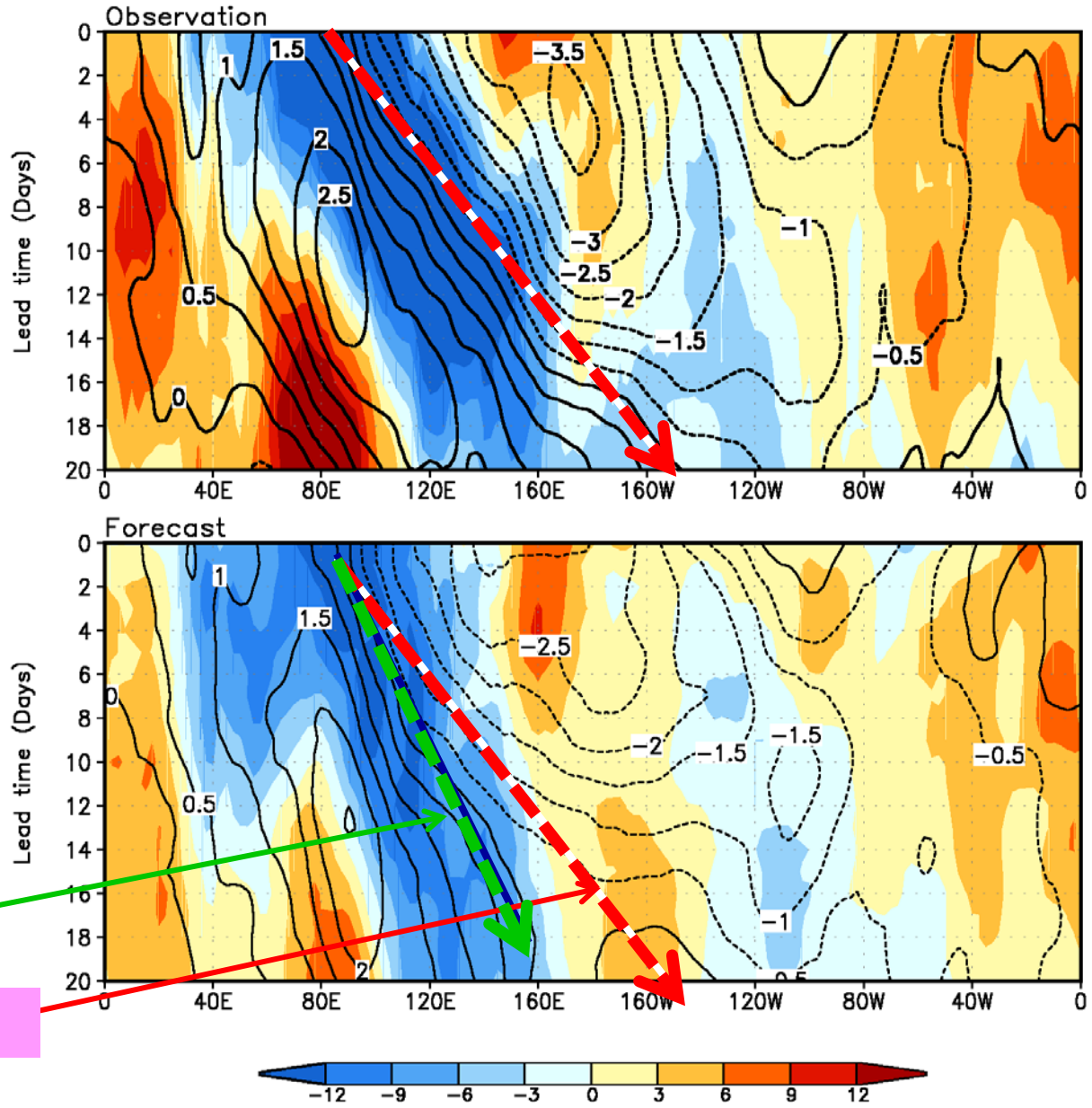
Composite for initial MJO phase 3 in CFSv2 (1999-2010)

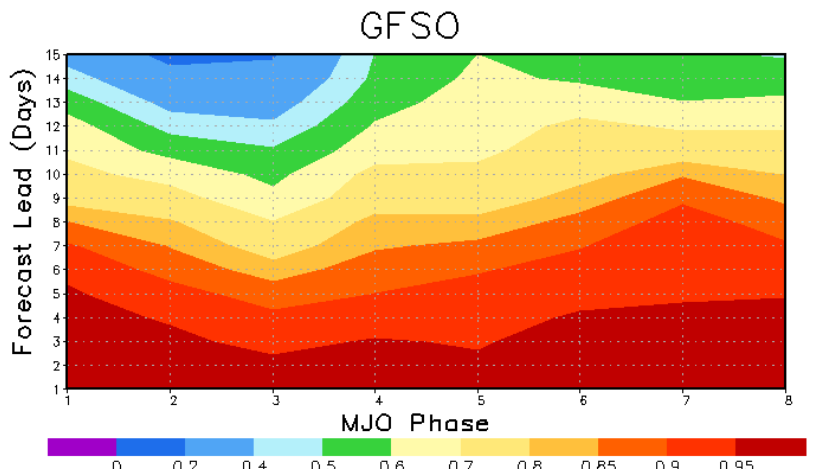


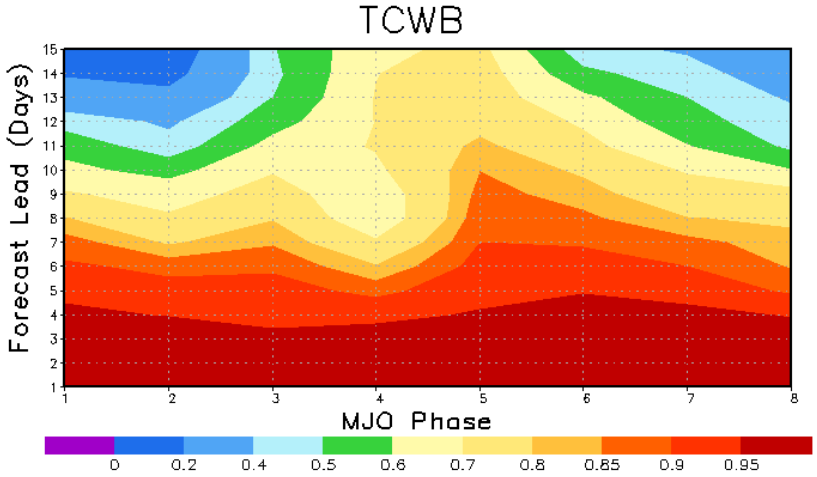
Contours: u850
Shadings: OLR

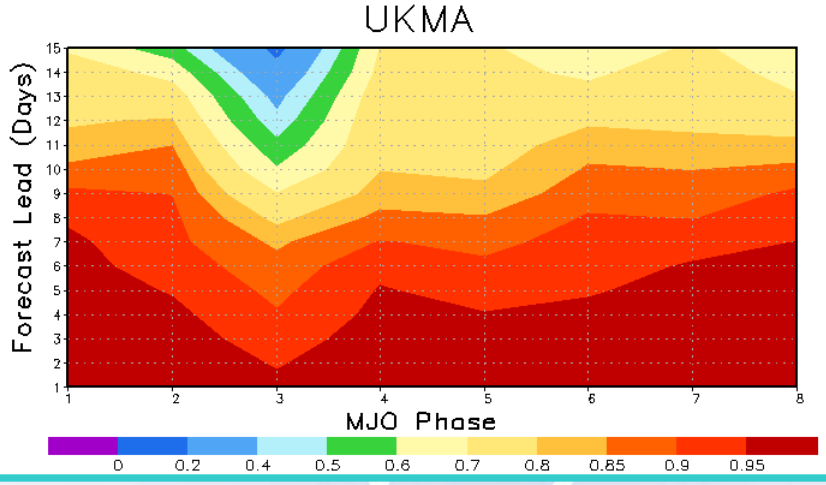
Forecast

Observation

Correlation for MJO phase Sep 2011-Mar 2012



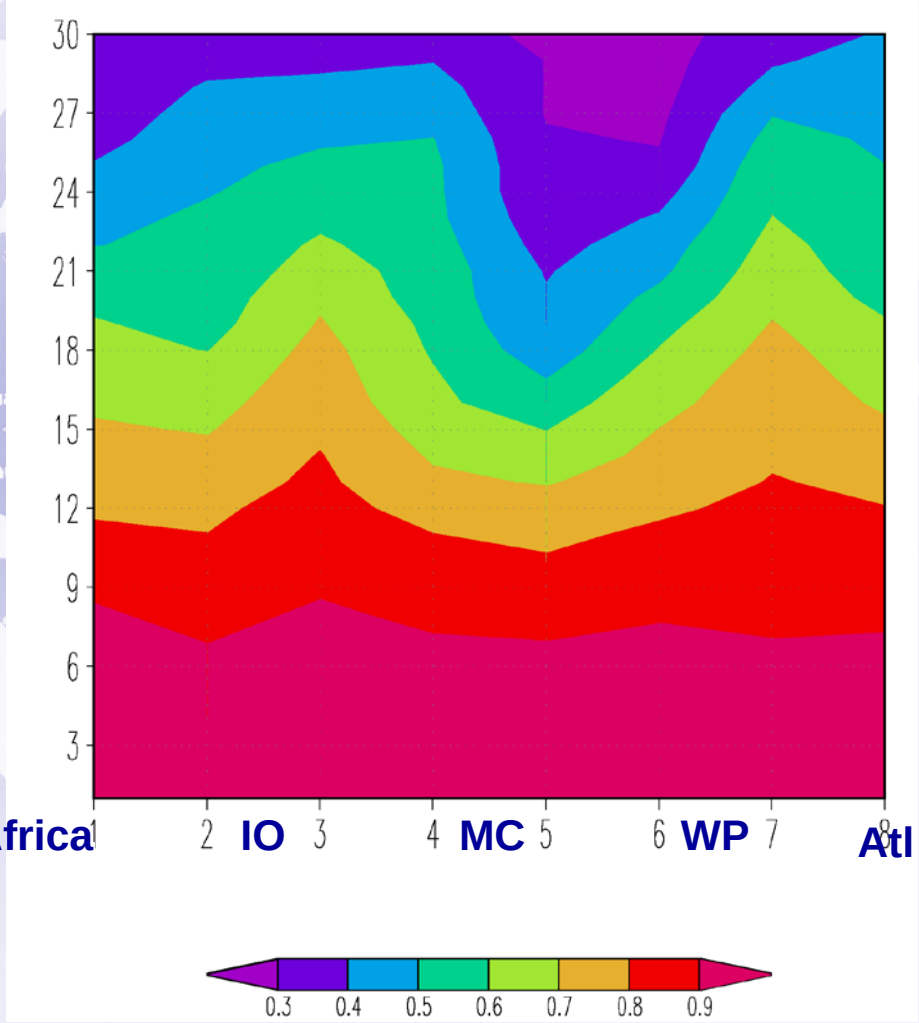




Courtesy of Jon Gottschalck at NCEP/CPC

- Keyed to initial MJO forecast phase
- Operational higher resolution forecast models
- Models have a tendency for lower skill in Phases 1/2/3 and 8

MJO skill as a function of target phase
(MJO days during 1999-2010)



MJO Skill of CFSv2 with 12-yr (1999-2010) Hindcasts