Intraseasonal Forecasting of the MJO During DYNAMO/CINDY Period

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- 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

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AGU, San Francisco, Dec. 03, 2012
OLR Anomalies, MJO, and K/R Waves during DYNAMO

MJO Initiation

One Primary MJO Event

Three Successive MJO Events

MJO-I

MJO-II

MJO-III

MJO-IV

MJO-V

AGU, San Francisco, Dec. 03, 2012
Preliminary Assessment of Operational MJO Forecasting Capability during DYNAMO/CINDY Period
“Good”

2 Weeks Ago

Forecasts from: 20111107

IC: Oct_17

“Good”

2 Weeks Ago

Forecasts from: 20111107

IC: Nov_07

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

AGU, San Francisco, Dec. 03, 2012
Failed to Predict “the Initiation of a Primary MJO Event”

"Slow Eastward Propagation"

AGU, San Francisco, Dec. 03, 2012
“Maritime Continent Barrier”

IC: Oct_24
IC: Nov_27

IC: Jan_09
IC: Jan_16

“Rossby-wave MJO Initiation ??”
“Good but weaker intensity”
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

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MJO Skills of Three GCMs During DYNAMO/CINDY


MJO Skills in Three Models

- GFS
- CFSv2
- UH

MJO Skills in Three Models (IOP)

- GFS
- CFSv2
- UH

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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

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Sensitivity Experiments During DYNAMO/CINDY

**Diff. SST Settings**

MJO Skills Under Different SST Settings

- CPL
- Fcst_SST
- Pers_SST
- TMI_SST

**Diff. Stratiform Fraction**

MJO Skills in UH Model with Diff. Stratiform Frac.

- UH (20%)
- UH (30%)

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Nov-MJO Initiation Forecasted by CFSv2 and UH

(a) OBS vs. CFSv2

(b) OBS vs. CFSv2

(c) OBS vs. UH

(d) OBS vs. UH

IC: Nov_04
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.

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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

Forecast of TC Strike Probability in Next Four Weeks

- IC: Nov 11
- TC05A
- (Nov 26 - Dec 1, 2011)
- False Alarm

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Forecasts of CFSv2 and UH with IC on Nov. 18

(a) OBS vs. CFSv2

(b) OBS vs. CFSv2

(c) OBS vs. UH

(d) OBS vs. UH

AGU, San Francisco, Dec. 03, 2012
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.
DYNAMO/CINDY Field Campaign
(Oct 2011-Mar 2012)
OLR Anomalies and MJO in 2011-2012

DYNAMO IOP

Courtesy of Matt Wheeler

AGU, San Francisco, Dec. 03, 2012
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

Forecast of TC Strike Probability in Next Four Weeks

TC05A

IC: Nov 18

False Alarm

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

Contours: u850
Shadings: OLR
Correlation for MJO phase Sep 2011-Mar 2012

- 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

Courtesy of Jon Gottschalck at NCEP/CPC
MJO skill as a function of target phase (MJO days during 1999-2010)
MJO Skill of CFSv2 with 12-yr (1999-2010) Hindcasts

- OLR EOFs
- Combined EOFs

Useful Skill