MJO Prediction in the Climate Forecast System Version 2

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Motivation

• The MJO is a propagating tropical mode of climate variability that offers enhanced prospects for improving intraseasonal climate prediction.

• Realizing this potential is predicated on robust simulation and prediction of MJO variability.

• Societal Relevance & NOAA Interests
  – Active and break phases of Monsoon Systems.
  – Tropical Cyclone Genesis.
  – Nexus of Weather and Climate.

• 45 Day hindcasts initialized daily provide a unique dataset for examining aspects of MJO prediction.
DATA

• Variables
  • U850/U200
  • OLR
• Hindcasts
  • 01Jan 1999 – 31Dec 2010
  • 4 members/day out to 45 days.
• Observations:
  • U850/U200 from CFSR
  • OLR from NOAA/AVHRR
• Intraseasonal Anomalies: \[ F' = F - F_c - F_L \]

Where: \( F \) (total field) \( F_c \) (daily climo) \( F_L \) (previous 90-day anomaly)
MJO Definition

Combined EOFs (U850, U200, OLR) 
Ave(5S:15N), 20-100-day filtered

Combined EOF, All Season, 1980–2010

OLR EOFs (30S-30N)

OLR leading EOFs, All Season, 1980–2010

PC-1

PC-2

<table>
<thead>
<tr>
<th>OLR</th>
<th>U850</th>
<th>U200</th>
</tr>
</thead>
<tbody>
<tr>
<td>STD : 8.85 [Wm$^{-2}$]</td>
<td>STD : 3.69 [ms$^{-1}$]</td>
<td>STD : 1.34 [ms$^{-1}$]</td>
</tr>
</tbody>
</table>
MJO Lifecycle
WH MJO Phase Space

(RMM1, RMM2) phase space for 15-Mar-2012 to 23-Apr-2012

Labeled dots for each day.
Blue line is for Apr, green line is for Mar.

Wheeler and Hendon (2004)
CAWCR/Bureau of Meteorology
PREDICTION SKILL
Bivariate correlation and RMSE of PCs (All Days)

The Following analysis will be for combined EOFs

CFSv1 skill is about 10-15 days (Seo et al. 2009)
Bivariate correlation and RMSE of PCs as a function of initial phase (MJO Days)
Bivariate correlation and RMSE of PCs as a function of target phase (MJO Days)
Seasonal variation of MJO forecast skill

181-day running window

Lead Time [day]

Amplitude

Target Time

15th day Correlation
Evolution of Average Amplitude

(a) All cases

(b) Initially strong cases (> 1)
Composites forecast for each initial phase.

<table>
<thead>
<tr>
<th>Initial Phase</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Obs (CFSv2-obs)</strong></td>
<td>6.9 (-1.7)</td>
<td>6.7 (-1.2)</td>
<td>7.4 (-1.2)</td>
<td>7.6 (-0.5)</td>
<td>6.7 (-1.3)</td>
<td>7.2 (-2.0)</td>
<td>7.2 (-1.2)</td>
<td>6.4 (-1.3)</td>
</tr>
</tbody>
</table>

Phase speed (Degree/day)
Composite from initial phase 3

Contours: u850
Shadings: OLR
Composite from initial phase 4

Contours: u850

Shadings: OLR
Composite from initial phase 5

Contours: u850
Shadings: OLR
Three MJO events in OND 2011

Observed OLR (10S-10N average)
OLR anomalies from November 18\textsuperscript{th} to December 17\textsuperscript{th}

(a) OBS vs. CFSv2

- Too slow eastward propagation, especially in CFSv2
- Unable to propagate across the Maritime Continent in CFSv2

(b) OBS vs. UH

UH Model:
ECHAM 4 coupled to UH ocean model and CFSR for IC.

Shadings: Observed
Contours: Forecast
Bivariate correlation during DYNAMO

Fu et al. (2012)
Closing Remarks

- CFSv2 prediction skill is about 20 days, improved compared to CFSv1. Less skillful for convection than dynamic fields.
- Low skill for crossing MC, initialization, and reamplification.
- CFSv2 MJO amplitude is weaker than observed, especially during early forecast period, likely a result of weaker convection in the model.
- Propagation in CFSv2 is still too slow. There is room for further enhancement with improved model physics.
Lag Correlation (days): 20-100dy filtered anoms. U850 vs Prec. (10S-10N 70-100E)
Fig. 5. Variation of MJO forecast skill
# Climate Forecast System

<table>
<thead>
<tr>
<th></th>
<th>CFSv1</th>
<th>CFSv2</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Coupling</strong></td>
<td>Daily</td>
<td>½ Hourly</td>
</tr>
<tr>
<td><strong>Resolution</strong></td>
<td>T62</td>
<td>T126</td>
</tr>
<tr>
<td><strong>Ocean</strong></td>
<td>MOM3</td>
<td>MOM4</td>
</tr>
<tr>
<td><strong>Land</strong></td>
<td>OSU 2-L</td>
<td>NOAH 4-L</td>
</tr>
<tr>
<td><strong>IC atm</strong></td>
<td>R2</td>
<td>CFSR</td>
</tr>
<tr>
<td><strong>IC ocn</strong></td>
<td>GODAS</td>
<td>CFSR</td>
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