High-Impact Tropical Weather Prediction: Evaluation & Verification of Coupled Air-Sea Model Forecasts of the MJO Using Ocean Vector Winds

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(IONVST, Sapporo, Japan, 19 May 2016)
Goal:
    ➢ Better OBSERVE and PREDICT high-impact tropical weather systems (tropical cyclones, the Madden-Julian Oscillation)

Methods:
    ➢ Satellites and in situ observations from recent field campaigns (e.g., DYNAMO, ITOP, CARTHE) with a focus on near surface properties and air-sea fluxes
    ➢ Evaluation of the coupled model prediction of the MJO and TCs

In this talk:
  1. Develop an MJO data base for weather and climate applications
  2. ASCAT & OSCAT surface winds and DYNAMO observations
  3. Coupled atmosphere-ocean modeling of the MJO and model verification using scatterometer winds and OAFlux
Time-Longitude TRMM 3B42 rainrate & Realtime Multivariant MJO (RMM) Index

Yoneyama et al. (2013)
Large-scale Precipitation Tracking (LPT), Kerns and Chen (2016, JGR)

TPW and rainfall rate, 2011-11-22

TRMM - 12mm

TPW (mm)
### 42 MJO LPTs Oct-Feb 1999-2014 TRMM (continued using GPM data)

Kerns and Chen (2016, JGR)

<table>
<thead>
<tr>
<th>Case</th>
<th>IO or WP</th>
<th>Duration (days)</th>
<th>Speed (m s⁻¹)</th>
<th>Volumetric Rainfall (10⁶ mm•km⁻²)</th>
<th>RMM MJO</th>
<th>OMI MJO</th>
<th>Nino 3.4 (Celsius)</th>
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Unified Wave-Interface Coupled Model (UWIN-CM):

- **Weather Research and Forecasting (WRF) v3.7.1:**
  12-4-1.3 km nested grids, 44 vertical levels
  physics: YSU PBL, Donelan+Garrat sfc., WSM6 microphy
  Initial and boundary conditions from ECMWF analysis fields

- **University of Miami Wave Model (UMWM) v1.2:**
  4 km, 0.01 Hz

- **HYbrid Coordinate Ocean Model (HYCOM) v2.2.34:**
  1/25 degree (~4 km) horizontal resolution, 32 vertical levels;
  Initial and boundary conditions from global 1/12 deg. HYCOM
WRF (Uncoupled)
OAFlux (daily)
ECMWF forecasts

a) ECMWF 2-Day Forecasts

b) Model Errors:
   - Bias = -0.4 m/s
   - MAE = 1.2 m/s
   - RMS = 1.5 m/s

c) ECMWF 5-Day Forecasts

d) Model Errors:
   - Bias = -0.2 m/s
   - MAE = 1.5 m/s
   - RMS = 1.9 m/s

e) ECMWF 10-Day Forecasts

f) Model Errors:
   - Bias = 0.0 m/s
   - MAE = 2.1 m/s
   - RMS = 2.7 m/s

g) ECMWF 15-Day Forecasts

h) Model Errors:
   - Bias = -0.3 m/s
   - MAE = 3.2 m/s
   - RMS = 3.3 m/s

WSRD [m/s]

2 day
5 day
10 day
15 day
GFS forecasts

a) GFS 2-Day Forecasts

b) Model Errors:
   - Bias = -0.6 m/s
   - MAE = 1.9 m/s
   - RMS = 2.3 m/s

c) GFS 5-Day Forecasts

d) Model Errors:
   - Bias = -0.7 m/s
   - MAE = 1.9 m/s
   - RMS = 2.6 m/s

e) GFS 10-Day Forecasts

f) Model Errors:
   - Bias = -0.9 m/s
   - MAE = 2.5 m/s
   - RMS = 3.3 m/s

g) GFS 15-Day Forecasts

h) Model Errors:
   - Bias = -1.4 m/s
   - MAE = 3.1 m/s
   - RMS = 3.5 m/s
Summary and **Next Step**

- Large-scale Precipitation Tracking (LPT) using TRMM-GPM made it possible for building an MJO data set for weather and climate applications.

- ASCAT, OSCAT, and OAFlux data are compared with the in situ DYNAMO observations.

- Air-sea coupling significantly improves model biases.

- Building the MJO data base (e.g., wind, rain, SST, air-sea fluxes)

**Suggestions???

- Evaluating and improving air-sea coupling physics in UWIN-CM