DYNAMO

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DYNAMO Science Steering Committee

on behalf of

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Why subseasonal is important for interannual and beyond time scales….

Forecasting ENSO with the NASA model

(Vintzileos et al., 2005) Observed subseasonal activity modified the forecast from La Nina to neutral in just one month.
Outlook:

What is DYNAMO? – The science questions

Was DYNAMO successful?

The components of DYNAMO:

Radiosondes - Dropsondes

Radars – Buoys

Monitoring/Forecast support

DYNAMO post-field activities
Conceptual Model for MJO initiation:

*Pre-onset stage* (A): Convectively suppressed; recharging with deepening moist layer, aided by shallow clouds

*Onset stage* (B): Convectively active, with both shallow and deep (including stratiform) convective clouds; deep moist layer, maintained by low-level moisture supply

*Post-onset stage* (C): strong surface wind and entrainment cooling; deep convection declining due to low SST

**Hypotheses:** Three essential factors for MJO initiation

I. Interaction between convection and its environmental moisture

II. Distinct roles of different types of convective clouds at each MJO initiation stage

III. Upper ocean processes and air-sea interaction
CINDY/DYNAMO Field Campaign – 1/10/2011 to 31/3/2012
Outstanding Science Issues:

- **Cold pools**: their structures, evolution, air-sea interaction,
- **Dry-air intrusion**: its origins, structure, evolution, dynamics
- **Diurnal cycle**: its role in cloud evolution and air-sea coupling
- **Scale interaction** between convective, diurnal, 2-4 day, synoptic, MJO, and seasonal variations in convection and the circulation
- **Convective organization vs. stochasticity and convective momentum transport**: their representation in models
- **Ocean dynamics**: roles of equatorial waves, near inertial waves, the Wyrtki jets, the thermocline ridge
- **Large-scale atmospheric dynamics**: roles of vertical wind shear, upstream and extratropical influences, upper-level perturbations, moisture transport and convergence, and the ITCZ
- **Up-scaling of the field observations**: connections between case observations and statistics, and between local observations and basin scale
- **Sources of prediction skill** for initiation of the primary vs. successive MJO; **necessary vs. sufficient conditions** for MJO initiation
Was DYNAMO successful?
DYNAMO was a lucky campaign!

Review of DYNAMO through the RMM index

October to December 2011

January to March 2012

- Africa
- Western Pacific
- Maritime Continent
- Indian Ocean
Radiosondes - Dropsondes
Total number of soundings: $18,992^* + 4,401^{**} = 23,393$

* Priority Sounding Site (PSS) sondes: 17,544
  Non-PSS sondes: 1448

**Pibals

Total high-resolution soundings: 11,918 (incl. 469 drop sondes)
TRMM RAINFALL NORTHERN ARRAY

Agreement lends confidence to budget results

Low-level negative $Q_2$

Courtesy of R. Johnson
22 Nov 2011
(Dry air surge/onset of equatorial convection)

Courtesy of Shuyi Chen
Radars
K- and S-BAND, DUAL WAVELENGTH
Non precipitating clouds, vertical motion, liquid water content

C- and S-BAND POLARIMETRY
Microphysics and rain amount

C- and S-BAND REFLECTIVITY
Precipitation

C- and S-BAND DOPPLER
Air motions

S-BAND and MM WAVELENGTH
Anvil cloud structure

DUAL WAVELENGTH
Humidity

W-band: 3.3 mm
Ka-band: 8.6 mm
X-band: 3 cm
C-band: 5 cm
S-band: 10 cm

Courtesy of R. Houze
Convective Echo Tops Observed by S-PolKa at Addu Atoll
Moorings
DYNAMO moorings: From September 18th, 2011 to January 23rd, 2012
Array of inductive CTDs:
measuring T, S, surface mixed layer, barrier layer, and surface mixed layer heat content

Array of χ-pods:
measuring oceanic turbulence flux

300 and 1200 kHz ADCPs:
measuring 1/2-m bin velocity, and shear within and below surface mixed layer, resolving surface waves and internal waves
Monitoring and Forecast support
From NCEP to DYNAMO to NCEP
CPO funded CPC and ESSIC to provide monitoring and forecast support to DYNAMO

GDAS
CFS - R

GFS - High Res.
GEFS - Ensemble
CFS - Coupled

Global Telecommunication System

DYNAMO Tailored Products

Weekly CPC - GTH Outlook product (human forecaster)

Data Catalog
Earth Observing Laboratory (EOL), NCAR

DYNAMO

Gottschalck and Vintzileos
Forecast of Anomalous OLR (GFS) for the second DYNAMO MJO event

Week 1
GFS forecast anom. OLR for week 1 from: 20111117

Week 2
GFS forecast anom. OLR for week 2 from: 20111117

Verification

Observed 7-day mean OLR anom from day 20111118

Observed 7-day mean OLR anom from day 20111124

(Vintzileos and Gottschalck)
Summary of MJO forecast skill for the GFS (blue), GEFS (red), CFS (green) during DYNAMO for RMM1 (continuous) and RMM2 (dashed).

There is a very important increase in forecast skill when using the coupled ocean–atmosphere model (CFS) between the two DYNAMO periods.

(Vintzileos and Gottschalck)
Observed conditions during DYNAMO

From Gottschalck et al., 2013
DYNAMO Post-Field Activities

(1) Complete quality control and release of field observations for public use (98% completed)
(2) Test DYNAMO hypotheses and address other science issues;
(3) Generate DYNAMO legacy data products for the broad user community;
(4) Expedite transformation from field observations to model improvement and development.

Legacy data products:
(a) Merged air-sea data at Revelle and along P-3 tracks
(b) Uncertainty estimates for existing gridded flux products
(c) Combined cloud population statistics from all radars
(d) Integrated field observations for the DYNAMO MJO Cases
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Questions?
The CINDY/DYNAMO Field Campaign:

How May Its Data Help the GASS Project on MJO Vertical Heating Profiles?
Discussion Topics:

1. What are the primary observed fields that are needed for the GASS MJO model comparison project?

2. What are the primary derived field that are needed?

3. How should the design of the 2- and 20-day hindcasts be modified to optimize the benefit from the field observations?

4. How should cloud permitting models be added to the global model intercomparison project?