Report of the MJO Data and Analysis Workshop

Kona, HI, March 4 – 8, 2013

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and Session Chairs

1. Brief Description

One year after the completion of the CINDY/DYNAMO/AMIE/LASP field campaign in the Indian Ocean and surrounding regions, an MJO Data and Analysis Workshop was held in Kona, HI, March 4 – 8, 2013. The objectives of the workshop were to (i) review and summarize the status of data (collection, quality control, comparison, products) and modeling activities; (ii) exchange the latest scientific results and ideas; (iii) identify new science issues, set goals for the next phase of research, and make a roadmap of synthesizing research results. A full description of the workshop objectives is given in the attached workshop agenda.

There were 119 participants from 9 countries (including remote participants via teleconferencing). There were 107 posters presented and 7 plenary oral talks given to kick off the workshop. A total of 11 breakout sessions were conducted.

The workshop was sponsored by NSF, DOE, NOAA, ONR, JAMSTEC, WMO WWRP/ THORPEX. NSF and DOE provided travel support for student participants. The DYNAMO Project Office at NCAR EOL provided logistical support.

The workshop agenda, abstracts, and presentations are posted at the workshop website http://www.eol.ucar.edu/projects/dynamo/meetings/2013/mar/

2. Data and Products

The DYNAMO Data Archive currently includes 96% of the field data. Meanwhile, links between the DYNAMO, CINDY and AMIE data archives have been established to provide one-stop shopping for all project data.

All archived field data will be released on March 31 for public use[1]. They include (but are not limited to):

(a) Data collected by six types of radars from Addu/Gan, Manus, Revelle, Mirai, and the NOAA P-3;

[1] DOE ARM data were released at near real-time.

(b) About 26,000 sondes (including both upsondes and dropsondes) from 71 sites;
(c) Ocean surface flux data from Revelle and Mirai;
(d) Upper ocean biochemistry data from Revelle and Mirai;
(e) Profiles of temperature and salinity from Revelle and Mirai;
(f) Profiles of current and turbulence from Mirai;
(g) Surface meteorological data (including radiation) from Gan, Manus, Revelle, Sagar Kanya, and Baruna Jaya;
(h) Aerosol data from Revelle;
(i) Data from other platform (e.g., Seagliders, satellites)

Additional data products will be released between June and August 2013. They include

- Uniform radar rain rate estimates at Addu, Revelle, and Mirai;
- Combined radar latent and radiative heating profiles[2];
- Improved radar-based hydrometeor identification with possible changes to identifying particular microphysical categories at Addu/Gan;
- Q1, Q2, and forcing data for cloud resolving models from the two sounding arrays and at Gan;
- Updated COARE air-sea flux algorithm;
- Local MJO indices at Addu, Manus, and Darwin

3. Modeling

Simulations/hindcasts were performed with varying success by models of different configurations. These models include cloud system resolving models of local, limited and global domains, coarse resolution (with parameterized convection) models of regional and global domains, and atmospheric, oceanic, and coupled models.

Several efforts have been made to organize international projects of model comparisons and focused model case studies. One is an extension of the ongoing project of MJO Vertical Structure and Heating Profiles under the MJO Task Force (MJOTF) and Global Atmospheric System Studies (GASS). This extension adds the 2011 November MJO event during the field campaign as the third case to the existing two cases of the MJOTF-GASS project. Another was initiated by the DYNAMO Modeling Working Group, which includes several research and operational models. It also adds limited-domain and local cloud system resolving models to the project, which originally includes only global models. This latter effort also provides the benefit of examining all three 2011 MJO events during the DYNAMO campaign, provides additional flexibility for subsequent process-modeling studies, and increases involvement of the university community.

4. Current Research

[2] KAZR and S-Polka merged cloud reflectivity, microphysics, and radiative heating at Gan have been released as ARM PI products.

The current research addressing the scientific issues related to MJO initiation are reflected in the workshop abstracts, which are posted at http://www.eol.ucar.edu/projects/dynamo/meetings/2013/mar/abstracts/

The poster presentations covered all aspects of the field campaign and beyond in the areas of data quality control and comparisons, data products and analyses, modeling, and model/forecast evaluation. Many studies have been conducted to address the problems related to the three DYNAMO hypotheses (interaction between convection and environmental moisture, cloud population statistics, air-sea interaction and upper-ocean processes). In addition, several emerging science issues were discussed, which were not emphasized in the field campaign planning documents. They are:

(a) Cold pools; their structures, evolution, air-sea interaction, and roles in MJO and convective initiation;
(b) Dry-air intrusion; its origins, structure, evolution, dynamics, and effects on MJO convection;
(c) Scale interaction between convective, diurnal, 2-4 day, synoptic, MJO, and seasonal variations in convection and the circulation;
(d) Necessary and sufficient conditions for MJO initiation;
(e) Convective organization vs. stochasticity during MJO initiation;
(f) Ocean dynamics (e.g., equatorial waves, near inertial waves, the Wyrtki jets, the thermocline ridge, Langmuir circulation) and its role in MJO initiation;
(g) Large-scale atmospheric dynamics (e.g., vertical wind shear, upstream and extratropical influences, upper-level perturbations, moisture transport and convergence, the ITCZ) and its role in MJO initiation;
(h) MJO and non-MJO convective activities; "failed MJO" events.

5. Remaining Issues

5.1 Data and Products

The DYNAMO Data Archive is not yet complete. The DYNAMO Project Office and field PIs are working together to add more data to the archive. A few specific technical issues related to data quality control need to be addressed.

Additional efforts are needed to generate the following data products:

- Merged air-sea data and analysis at Revelle and Mirai (atmosphere, fluxes, ocean);
- Uncertainty estimates for existing gridded flux products (e.g., OAFLUX, TropFLux, SURFA, fluxes from reanalyses and model simulations) based on fluxes derived from field observations;

5.2 Science

In addition to the issues proposed in the DYNAMO hypotheses and new merging science issues listed in section 4 of this report, attention is needed to the following subject areas:

- An MJO initiation index
- High standard model evaluation for individual cases (e.g., forecast/simulation skill for rainfall)
- Integration of all field observations for the 2011 November MJO case
- Large-scale perspectives/context of the field observations (using data from satellite, RAMA, data assimilation, model simulations)
- Case vs. statistical studies

6. Way Forward

The first year of post-field data processing and analysis, modeling, and forecast evaluation has been very fruitful. In the coming years, post-field research will focused on the following activities:

(1) Complete data quality control, archive, and release. A few specific technical issues related to sounding, radar, flux, and ocean data need to be resolved; some ocean data from moorings have just been recovered and their quality control has just started. Updated data will be archived and released upon the completion of their quality control.

(2) Integrate data and products from different instruments and observing sites. The science that motivated the field campaign and new science emerged during and after the field campaign must be adequately addressed by integrally using data from all instruments deployed during the field campaign. Such data and products integration includes, but are not limited to,

- six types of radars at five locations (Addu/Gan, Revelle, Mirai, Manus, Darwin)

- air-sea flux estimates from two ships (Revelle, Mirai), multiple moorings, and aircraft

- observations of the atmosphere, ocean and their interface at two ships (Revelle, Mirai)

- radar and sounding observations at five sites (Addu/Gan, Revelle, Mirai, Manus, Darwin)

(3) Combine observation and modeling expertise to advance representations of cloud/precipitation in numerical models. The unprecedented field observations provide a unique database for development of cumulus parameterization schemes that emphasize the reproduction of cloud population evolution and convective organization/stochasticity. Close collaborations between experts in field observations, large-scale dynamics, and model development are needed to extract information of cloud population evolution and convective organization/stochasticity and their dependence on the large-scale environment, and to transform this information into improvement and development of cumulus parameterization schemes.

It was suggested an NCAR ASP summer colloquium in combination with a workshop be proposed for 2014 under the theme of observations-modeling integration. The main purpose of this colloquium is to bring together experts in field observations and model

development to discuss the optimal transformation of field data to model improvement, and to train the next generation of tropical atmospheric scientists to be proficient in both field observations and numerical model development, especially using radar observations to assist development and improvement of cumulus parameterization schemes.

7. Recommendations

Optimal outcomes from the field campaign can be guaranteed only by sustained funding support for post-field data analysis and synthesis, and observationally based model development. It is expected that the peak of publications using the field data would occur 2-5 years after the field campaign. It is crucial that sufficient support is made available for this period through competitive review processes of proposals by collaborative PI teams as well as individual PIs. The DYNAMO Science Steering Committee recommends the proposal submission and funding procedures be coordinated by the inter-agency group so that integrated scientific goals can be proposed and pursued to satisfy specific missions of multiple agencies.