Diurnal Cycle Interactions with Madden-Julian Oscillation Propagation

The Madden-Julian Oscillation (MJO), an Alaska-size collection of precipitating clouds that forms periodically over the Indian Ocean, marches slowly eastward until it hits an irregularly shaped barrier of marine islands called the Indo-Pacific Maritime Continent.

These islands, which include Sumatra, Borneo, New Guinea, and the Philippines, often interrupt the eastward march of those MJO cloud convection systems.

When the Maritime Continent gets in the way of the MJO, it creates a barrier effect so different every time that scientists have problems modeling and predicting it. That prediction barrier matters. The MJO is such a large-scale feature that it significantly influences global weather patterns, including atmospheric rivers, which provide much of the winter precipitation over the West Coast of the United States, as well as global tropical cyclone activities. Understanding the processes that govern the eastward march of the MJO across the Maritime Continent is one of the major challenges in tropical weather and earth system modeling and research.

DIMOP researchers chose to place instruments near Pontianak, Indonesia, in part because it is representative of the Indo-Pacific Maritime Continent, which impedes the free flow of the Madden-Julian Oscillation as it moves eastward.

A mid-afternoon storm approaches the proposed DIMOP site in Indonesia. The behavior of Madden-Julian Oscillation cloud convection systems as they pass over the Maritime Continent can be hard to predict.

The U.S. Department of Energy's Atmospheric Radiation Measurement (ARM) user facility will conduct the **Diurnal Cycle Interactions with Madden-Julian Oscillation Propagation (DIMOP)** field campaign from September 1, 2018, to August 31, 2019, in Indonesia. DIMOP will collect in situ data that may help unravel at least part of the problem of predicting the behavior of the MJO as it hits the Maritime Continent.

Science Objectives

The DIMOP team aims to determine why some MJO events are disrupted while others move on relatively unaffected. DIMOP will test the idea that the diurnal cycle of cloudiness associated with heat fluxes over island land masses controls the strength of the MJO and how it is disrupted. Specifically, it will vet the idea that the strength of the daily cycle and the disruption of the MJO depend on the net radiation flux reaching the surface of land masses, and how it is apportioned into sensible heat flux and surface evaporation.

Researchers will investigate their thesis by measuring the radiative and turbulent flux processes on a representative plot of land nearly on the equator, where land masses heat the fastest during daytime. Radiation surface flux estimates and sensible/latent heat and soil moisture will be collected during all phases of MJO episodes. These data will be paired with long-term satellite measurements to produce statistically robust estimates of the roles of the proposed diurnal cycle interaction processes.

Research Instrumentation

ARM plans to deploy a variety of ground-based instrumentation, including:

- a set of surface broadband radiometers to measure sky and ground radiation
- an eddy correlation flux measurement system, which measures surface turbulent fluxes
- a surface energy balance system, which provides upwelling and downwelling measurements of solar and infrared radiation, as well as soil measurements of temperature, moisture, and heat flow
- surface meteorology systems, which obtain 1-minute statistics on surface wind speed, wind direction, air temperature, relative humidity, barometric pressure, and rain rate
- a tipping bucket rain gauge
- a ceilometer to measure cloud-base height.

Collaborations

DIMOP instruments will be placed at a climatological site run by Indonesia's Meteorological, Climatological, and Geophysical Agency (BMKG) near the city of Pontianak, Borneo Island, Indonesia. Pontianak, a port city with 550,000 residents, is the world's largest municipality directly on the equator.

Thanks to BMKG, Pontianak also has built-in local science expertise. Free of charge, the agency will provide DIMOP with the site, technicians, power, and internet access for data transfer. In return, ARM staff will provide training on operation of the ARM instrumentation to the campaign's Indonesian collaborators. They will also have access to DIMOP data for collaborative and independent research.

A collection of ARM instruments, like the ones that participated in the Macquarie Island Cloud and Radiation Experiment (MICRE), will be deployed to Indonesia to support the Years of the Maritime Continent initiative through DIMOP.

DIMOP is part of the Years of the Maritime Continent (YMC), a collaborative international initiative unfolding from November 2017 through 2019. YMC, which includes field campaigns at sea and in the air, is aimed at understanding the barrier effect to close what scientists call the subseasonal-to-seasonal prediction skill gap. That is the gap between predicting weather (increments of a week or less) and predicting climate (increments of three months or more). The YMC initiative is aimed at closing that gap, which could help make possible forecasts with a lead time of two weeks to two months.

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https://www.arm.gov/research/campaigns/osc2018dimop

DOE/SC-ARM-18-023
July 2018

U.S. DEPARTMENT OF ENERGY | Office of Science

The ARM Research Facility is funded through the U.S. Department of Energy's Office of Science.
Additional information is available on the ARM website at www.arm.gov.