Welcome:

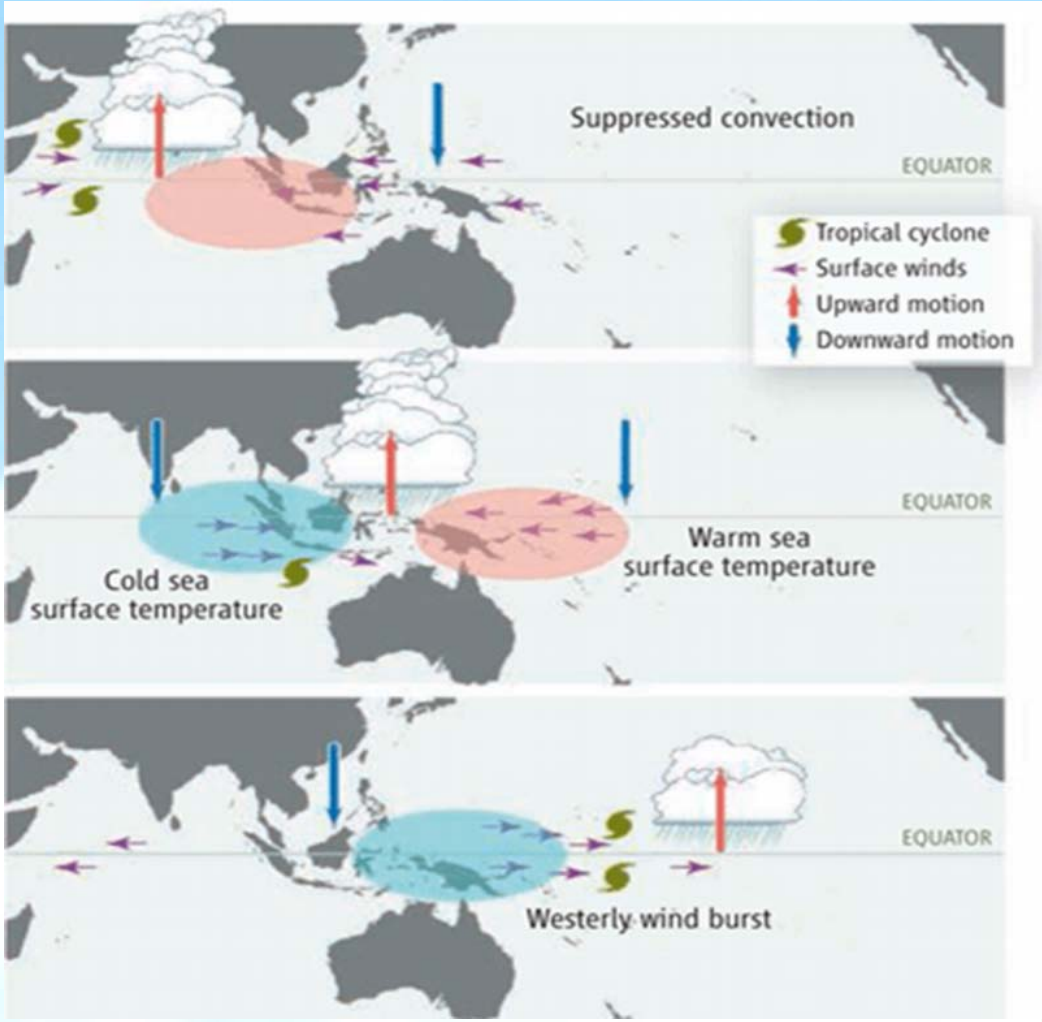
AMIE/AMF2/DYNAMO Breakout

Study of the Madden-Julian Oscillation (MJO)

Wednesday March 17, 1-3 pm

MJO: A Schematic

- Occurs during boreal winter
- Area of increased convection & rainfall
- First develops in the Indian Ocean
- moves eastward at about 5 m/s
- Through maritime continent and on into TWP
- Period of ~30-60 days



Panels separated by ~15 Days (Hartmann and Hendon, Science, 318, 1731)

Agenda

- Welcome (Chuck Long)
- The Maddening-Julian Oscillation in GCMs (Tony DelGenio)
- AMIE: MJO Studies for ASR Science (Chuck Long)
- AMIE/CINDY/DYNAMO: Observations of the Madden-Julian Oscillation for Cloud Modeling Studies (Bob Houze)
- Potential radar products for the Gan Super Site (Courtney Schumacher)
- Discussion

AMIE Overview: Study of the MJO for ASR Science

And synergy with CINDY2011/DYNAMO

AMIE

ACRF MJO Investigation Experiment

ARM Climate Research Facility

Madden-Julian Oscillation

Atmospheric Radiation Measurement Program

AMIE Science Steering Committee

AMIE Co-Experimenters (**ACEs**):

Tony DelGenio, Bill Gustafson, Bob Houze, Christian Jakob, Mike Jensen, Richard Johnson, Steve Klein, Ruby Leung, Xaihong Liu, Ed Luke, Peter May, Sally McFarlane, Pat Minnis, Courtney Schumacher, Andy Vogelmann, Yi Wang, Peter Webster, Xiaoqing Wu, Shaohong Xie, Chidong Zhang

4 deep in acronym land!

Chuck Long

AMIE Principle Experimenter (**APE**)

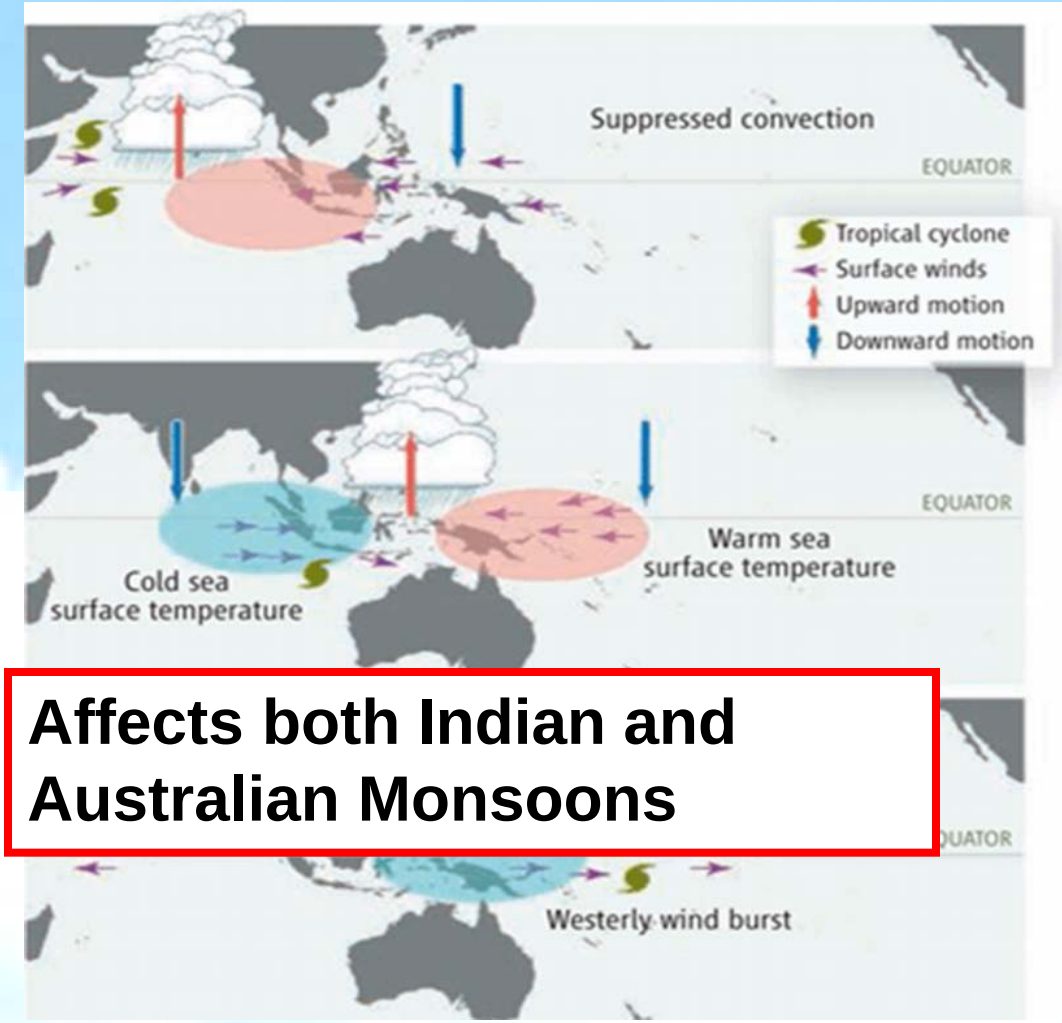
Background: Challenges presented by the MJO

- A poster child of numerical model deficiency
- Inability to consistently/knowingly reproduce the MJO/TIV* by global climate models
- Limited intraseasonal dynamical prediction skill (< 15 days) –particularly low prediction skill during the initiation of the MJO and during the passage of the MJO convection over the Maritime Continent
- Limited understanding of the mechanisms for the MJO/TIV, especially their convective initiation and evolution
- Lack of in situ observations to test hypotheses

* Tropical intraseasonal variability

MJO: A Schematic

- Occurs during boreal winter
- Area of increased convection & rainfall
- First develops in the Indian Ocean
- moves eastward at about 5 m/s
- Through maritime continent and on into TWP
- Period of ~30-60 days

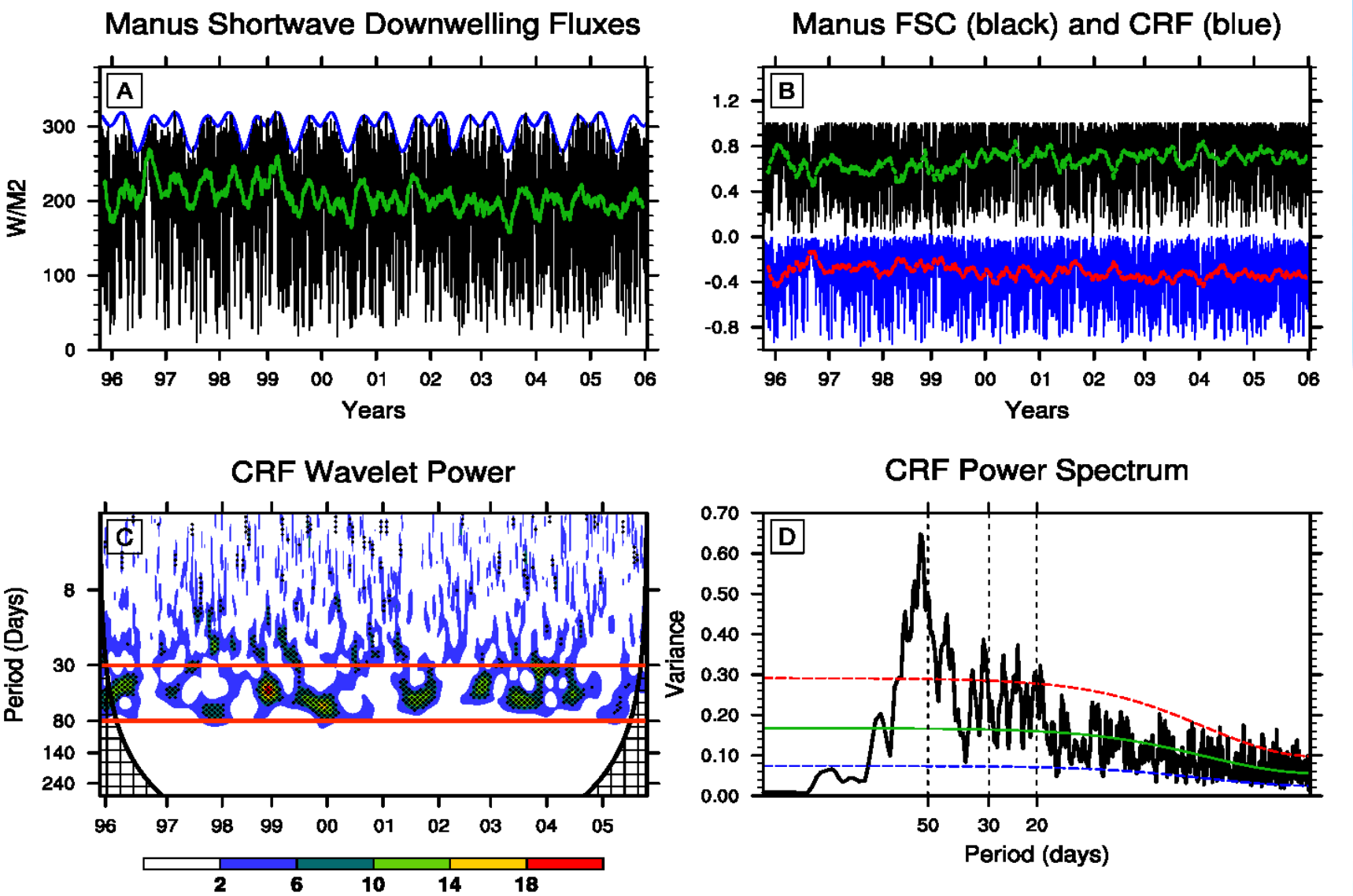


Affects both Indian and Australian Monsoons

Panels separated by ~15 Days (Hartmann and Hendon, Science, 318, 1731)

ARM TWP Sites

Manus MJO Signal

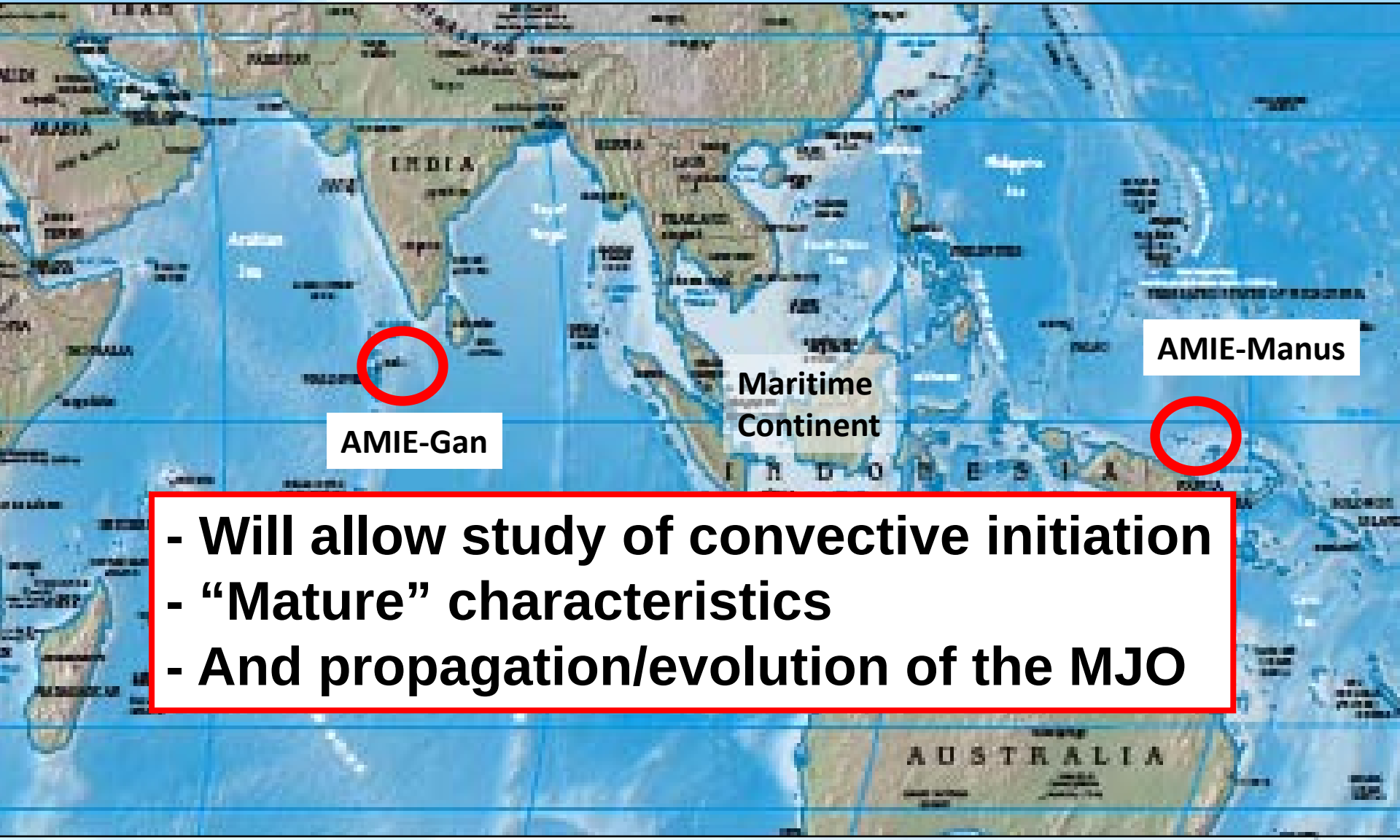


Wang Y, CN Long, JH Mather, and XD Liu. 2010. “Convective signals from surface measurements at ARM Tropical Western Pacific site: Manus.” Climate Dynamics, doi:10.1007/s00382-009-0736-z.

ARM/ASR Modeling Paradigm

- Single Column and Cloud Resolving models need context
- ARM has developed Variational Analysis data product for this
- Typically required surrounding the domain with sonde launches
- Not practical/possible for ARM TWP equatorial sites
- TWP-ICE showed the powerful constraint afforded by C-POL precipitation information

AMIE: A 2-prong Campaign



AMIE-Manus, AMIE-Gan

- Oct. 2011 – March 2012 (coincides with CINDY2011/DYNAMO)
- Take advantage of scanning C-band/ X, Ka band radars to be installed on Manus
- Deploy AMF2 and SMART-R on Gan Island
- Increased sonde launches
  - 8/day for entire period for Manus
  - Desire 8/day for Gan, minimum 4/day
- Use in conjunction with ECMWF reanalysis
- Produce Variational Analysis products for the entire 6-month period at each site

Hypotheses

MJO Characterization:

- **What are the primary cloud, precipitation, and thermodynamic property differences between the active and suppressed phases of the MJO, including variations linked to interactions with the diurnal cycle, topography, and surface flux variability?**
- **Can enhanced characterization of clouds, precipitation, and thermodynamic fields during the active and suppressed phases of an MJO cycle provide new understanding and insight for improving convection and cloud parameterizations and MJO simulations in GCMs?**
- **How well do the ARM Manus site measurements capture the local scale variability and characteristics of the larger Manus area?**

Hypotheses

MJO initiation:

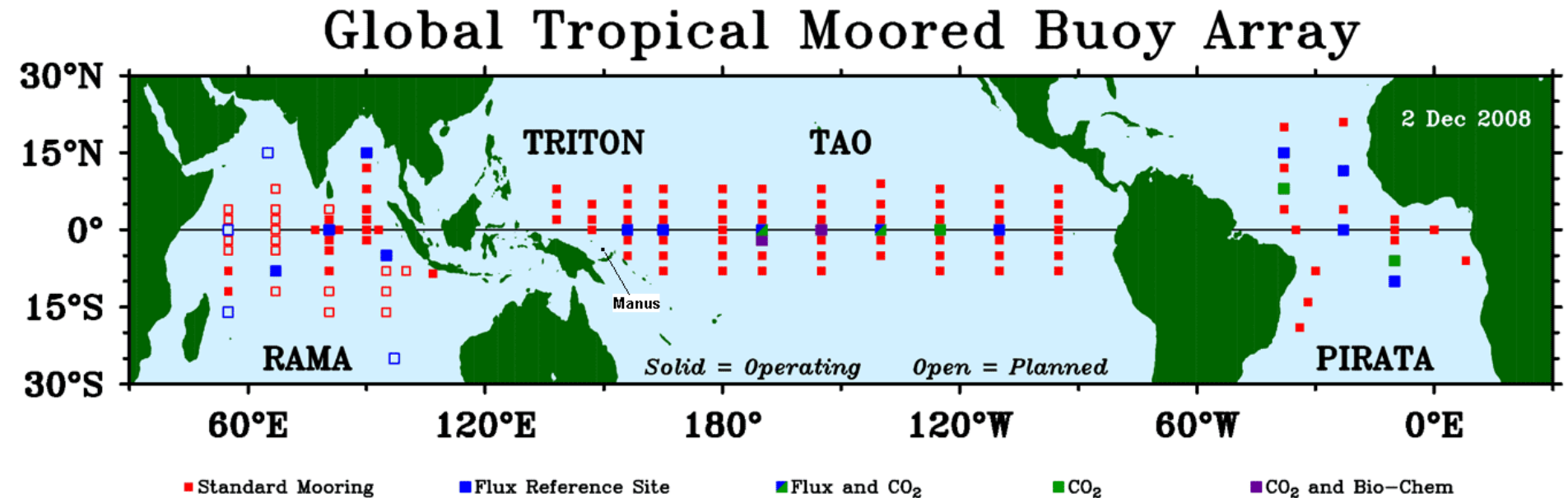
- **Energy recharge-discharge**
- **Previous circumnavigating MJO**
- **Extratropical influences**
- **Stochastic convective forcing**

MJO weakening over the Maritime Continents

- **Energy drainage by the diurnal cycle**
- **Lack of surface moisture flux over land**
- **Reduced moisture convergence due to topographic effects on winds**

Maritime Continent Flux

- **Surface latent/sensible heat flux Manus**
  - **Models show decrease in MJO as it propagates through maritime continent**
  - **One hypothesis is the difference in land/ocean surface/atmosphere energy exchange**
  - **TAO array (buoys) for ocean**
  - **Manus forest tower to represent land?**



Main observations/instruments of CINDY/DYNAMO/AMIE
90-120 days in the IO
6 months at Manus/Gan

- atmospheric soundings (IO and Manus) and Q1/Q2 estimates (IO)
- precipitation radar (IO and Manus)
- ARSCL (cloud radar, lidar, ceilometer) (IO - AMF2 and Manus)
- surface energy fluxes (IO and Manus)
- full radiation/met package (IO - AMF2 and Manus)
- aerosol (IO)
- upper ocean turbulence and mixing (IO)
- others

CINDY/DYNAMO/AMIE Synergy and Coordination

- A rare opportunity for monitoring convective initiation and evolution of the MJO from its birth in the Indian Ocean to its middle age crisis over the Maritime Continents and propagation beyond
- Provide observational constraints and initial conditions for model simulation/validation/development and hypothesis testing in two contrasting large-scale environments

The time is now!

- **A large coordinated international MJO measurement opportunity like this will likely not come along again for at least a decade or more.**

- **Let’s do this!**