Intra-seasonal air-sea coupling: Madden-Julian Oscillation (MJO) and Monsoon Intra-seasonal Oscillation (MISO)

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Focus: Indian Ocean region

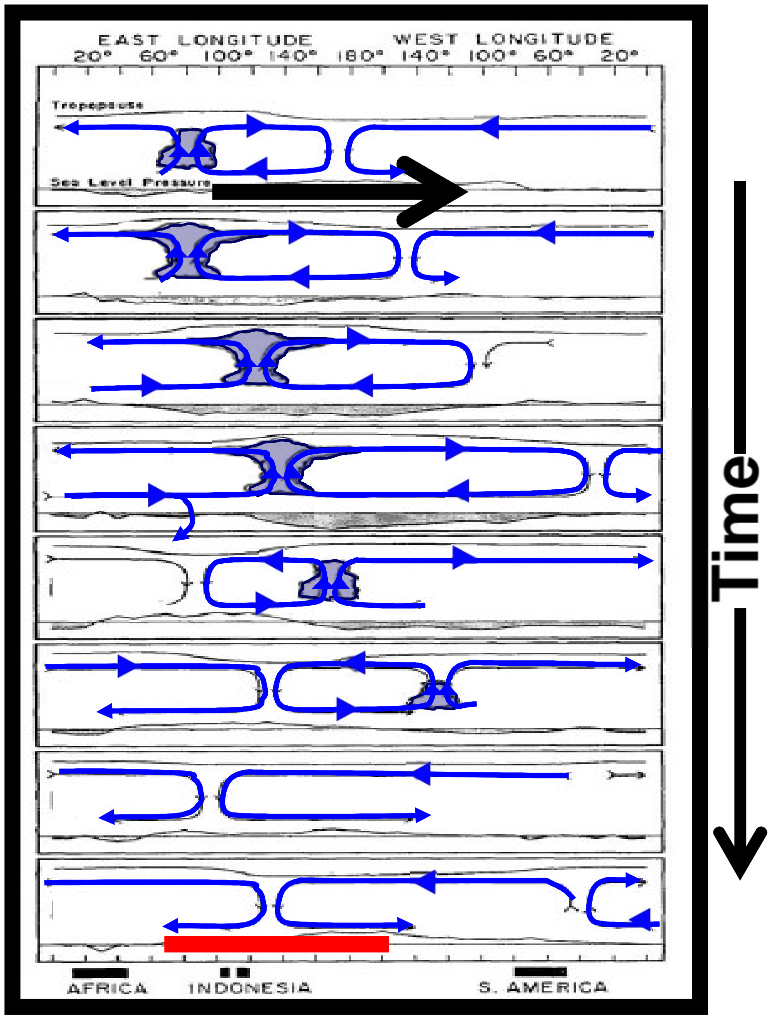
Recent review “Atmosphere-ocean coupled processes in the MJO”
DeMott et al. (2015)

for more details of science issues

Madden-Julian Oscillation (MJO): Observed Features

Eastward propagation along equator at 4-10 m/s (period of 30-60 days)

Atmospheric convection confined in the Indo-Pacific warm pool, while wind signals circumnavigate the globe



From Madden and Julian (1972)

Indian summer monsoon intraseasonal oscillation (MISO)

Cloudiness 70E-90E

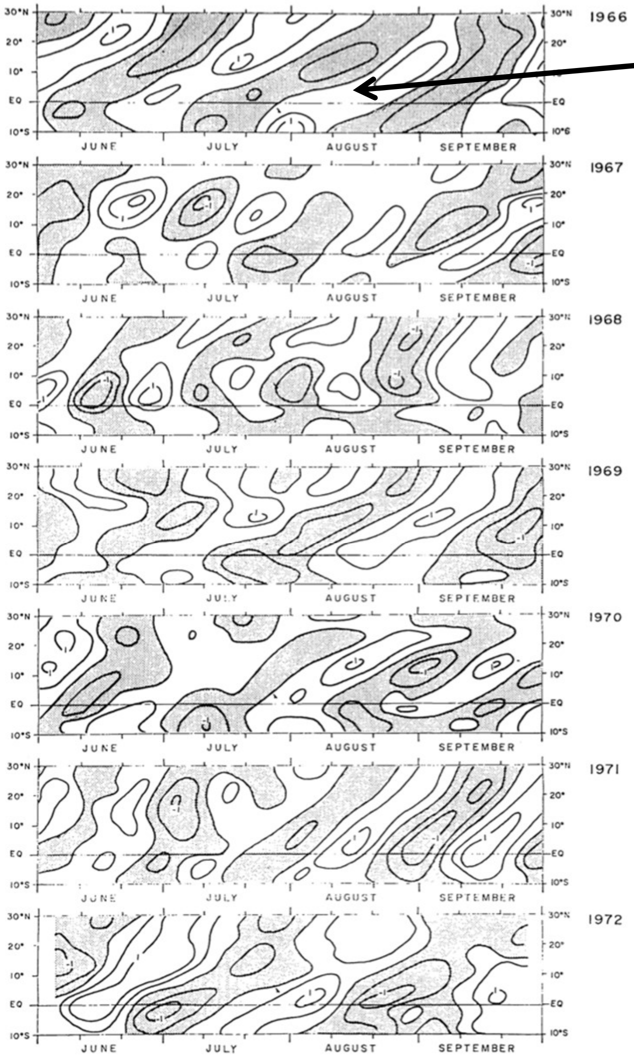


Fig. 3 Time-latitude cross sections of filtered cloudiness for 1966 through 1972. Unit of contour line is 0.5 and negative values are shaded.

Yasunari (1980)

Northward-propagation.

Major mode of intraseasonal variability in the tropical troposphere over the Asian monsoon region.

Impact on the Indian summer monsoon rainfall: active and break phases.

Recommendations

1. RAMA: Enhancement of vertical resolution in the upper 10 m

2. Continuation of surface buoy measurements at 18ºN, 90ºE in the northern Bay of Bengal

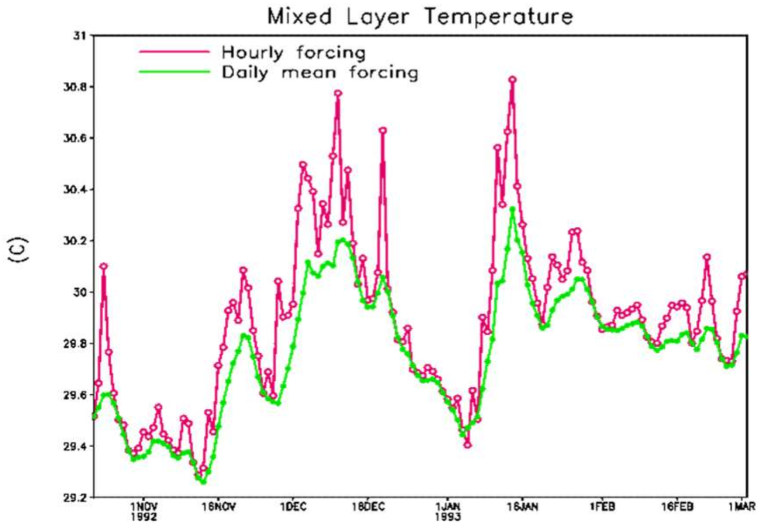
3. Adding a new site of surface buoy (RAMA) in the Timor Sea at 14ºS, 115ºE

4. ADCP measurements in SCTR (Seychelles-Chagos Thermocline Ridge)

5. Additional buoy measurements in Maritime Continent (Indonesian Seas)

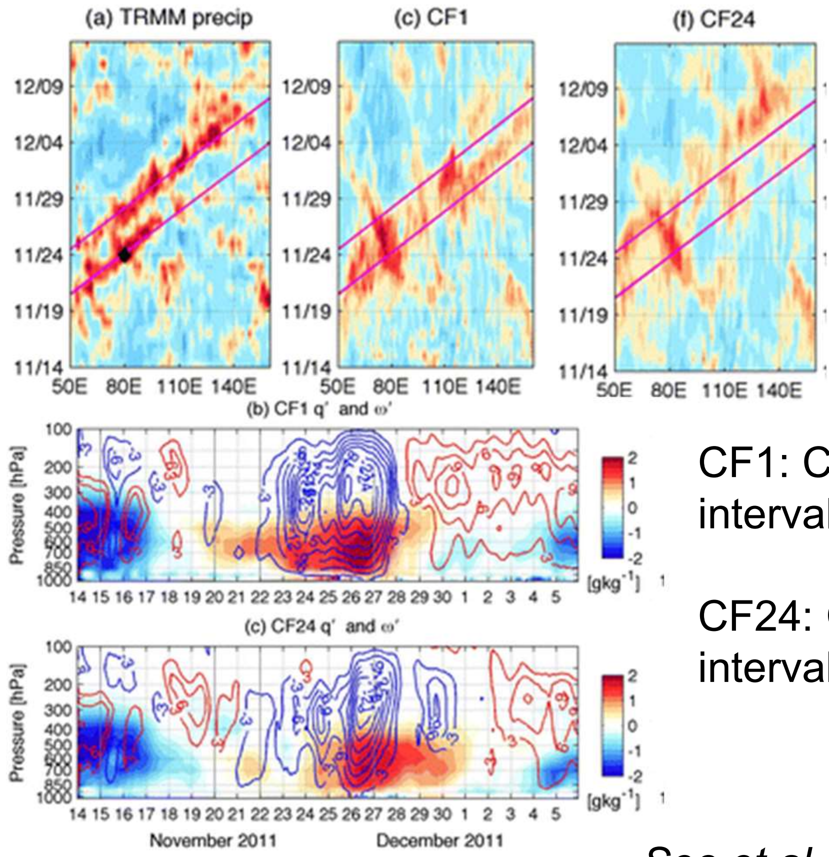
RAMA: Enhancement of vertical resolution in the upper 10 m

Previous studies suggest that diurnal cycle of shortwave radiation may impact MJO initiation and development



Shinoda and Hendon (1998), Shinoda (2005)

MJO event during CINDY/DYNAMO

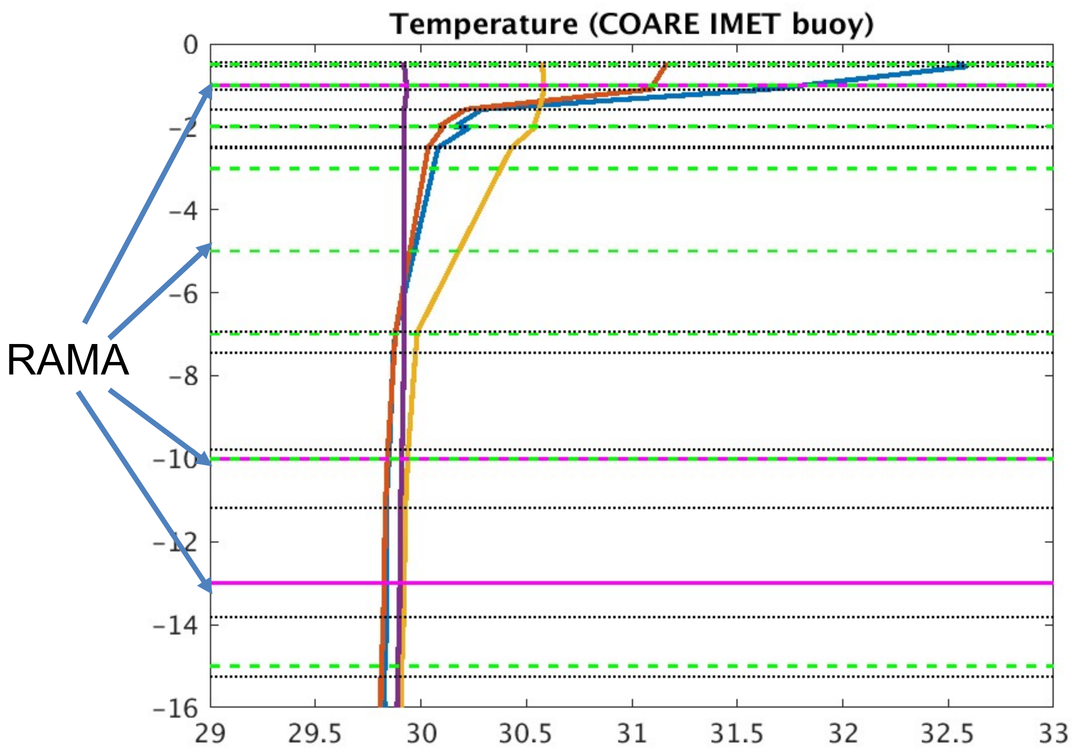


CF1: Coupling interval 1 hour

CF24: Coupling interval 24 hours

Seo et al. (2014)

TOGA COARE IMET buoy



Suggested depths: 0.5 m, 1 m, 2 m, 3m, 5m, 7 m, 10 m, 15 m

WHOI buoy in the northern Bay of Bengal

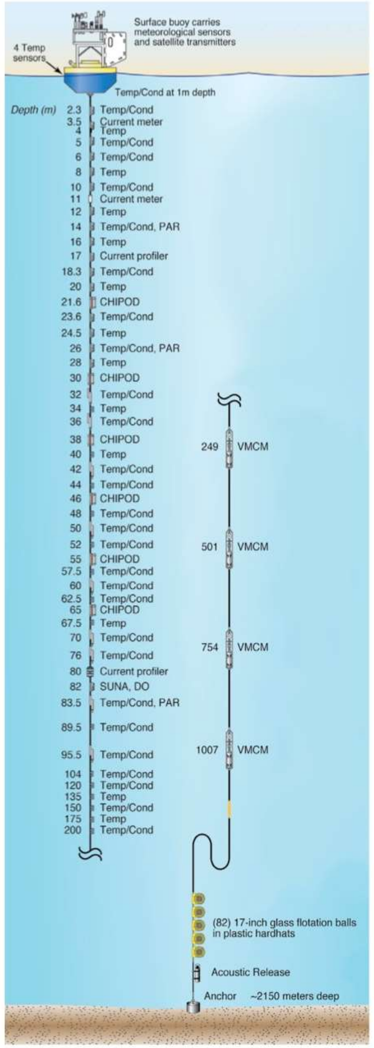


FIGURE 1. (a) Schematic drawing of the Woods Hole Oceanographic Institution (WHOI) surface mooring deployed at 18°N, 89.5°E. The placements are indicated for sensors that measure temperature (Temp), temperature and conductivity (Temp/Cond), turbulence (CHIPOD), velocity (current meter, current profiler, and Vector Measuring Current Meter, or VMCM), dissolved oxygen (DO), photosynthetically available radiation (PAR), and nutrients (SUNA).

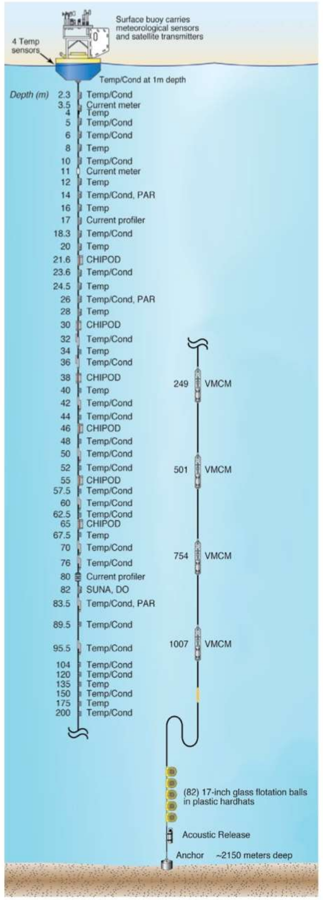
Weller et al. (2016)

Continuation of surface buoy measurements at 18ºN 90ºE in the northern Bay of Bengal

Recent studies suggest that strong salinity stratification in the Bay of Bengal may influence MISO development and propagation (e.g., Li et al. 2017).

WHOI buoy in the northern Bay of Bengal

Weller et al. (2016)



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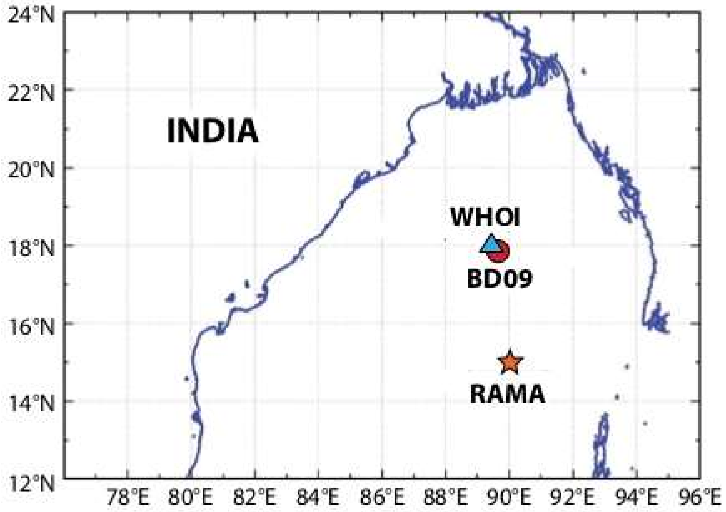
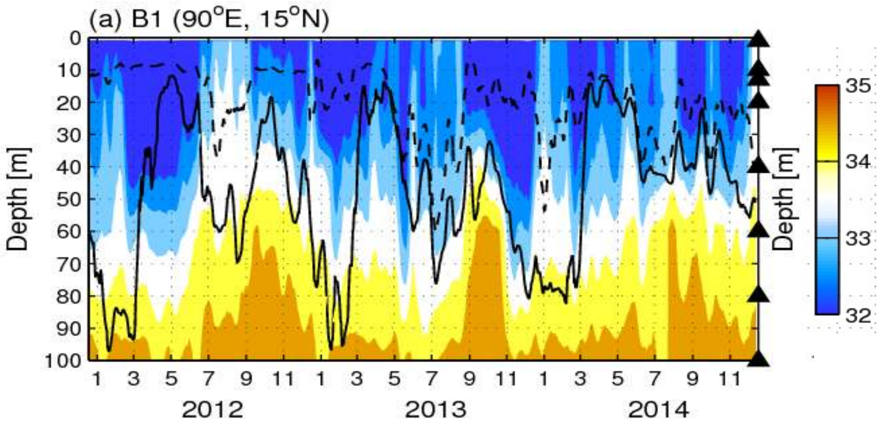
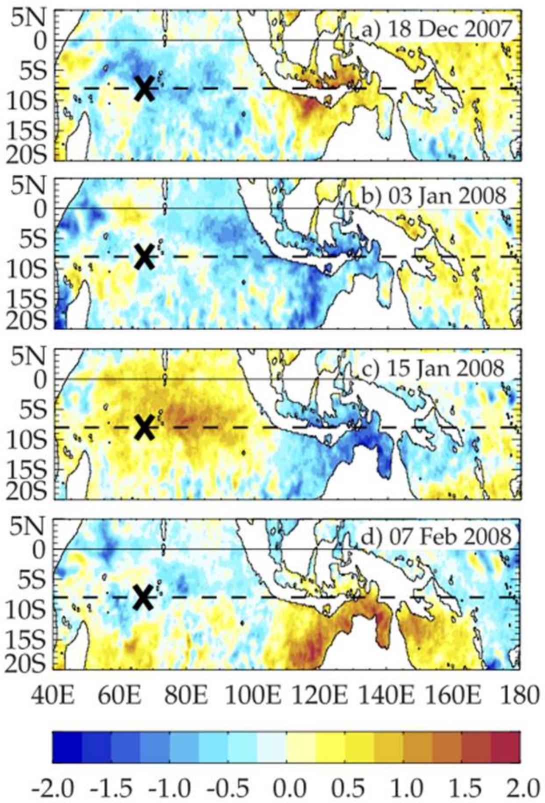




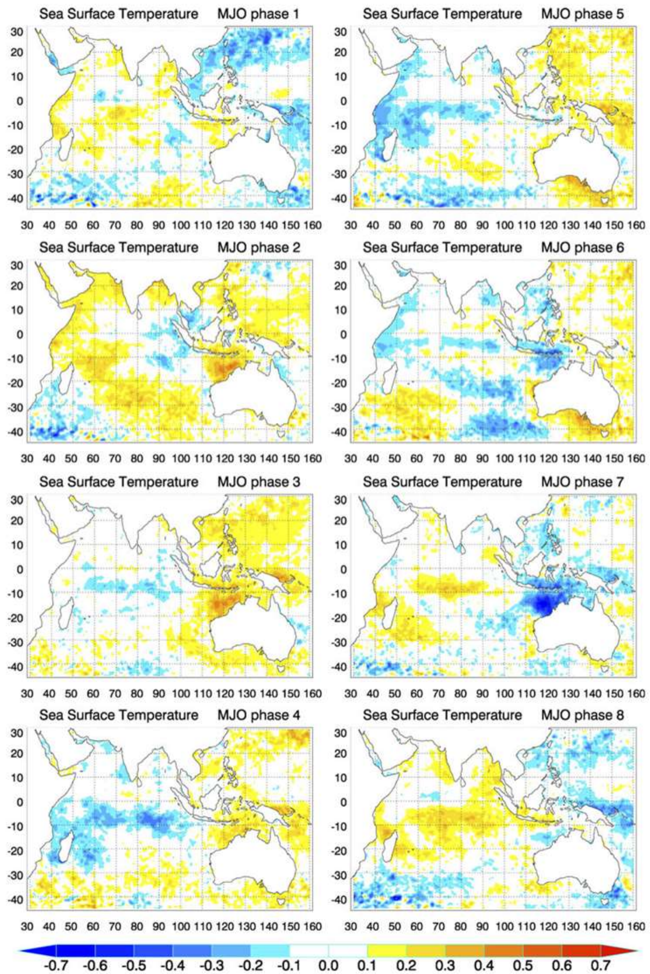
Li et al. (2017)

Adding a new site of surface buoy (RAMA) in the Timor Sea at 14ºS, 115ºE

Largest SST variability associated with the MJO (e.g., Duvel and Vialard 2007, Vialard et al. 2008, Vialard et al. 2013, Marshall and Hendon 2014)



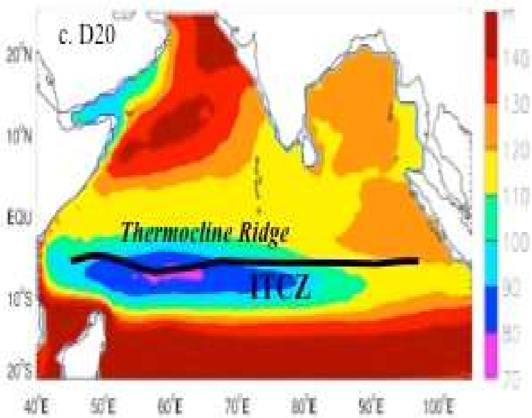
Vialard et al. (2008)



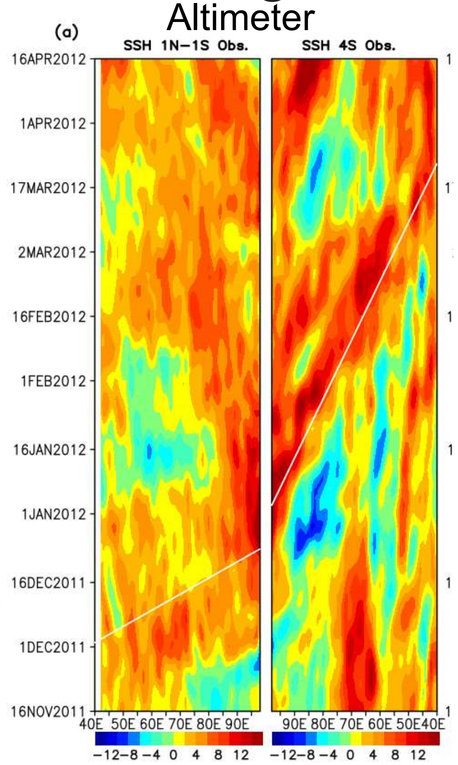
Marshall and Hendon (2014)

ADCP measurements in SCTR (Seychelles-Chagos Thermocline Ridge)

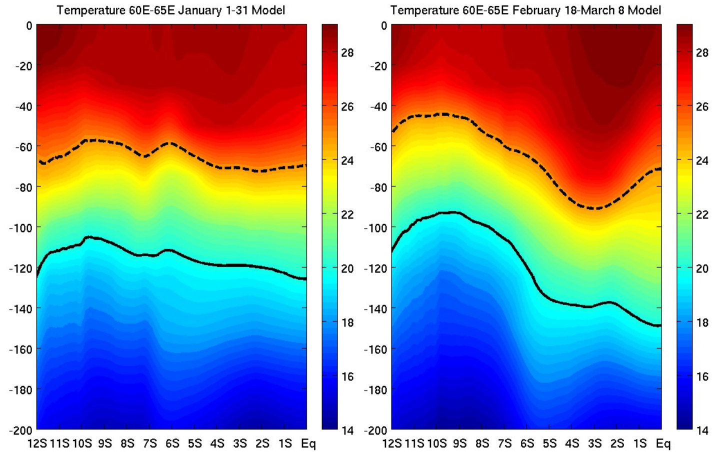
SSTs are sensitive to small changes of the thermocline depth and surface forcing.



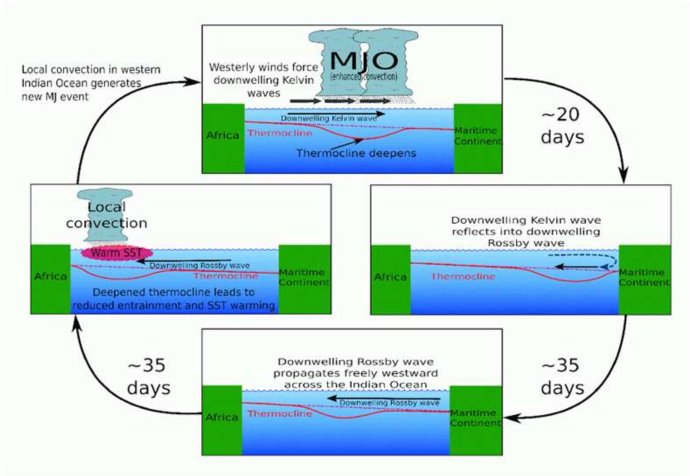
Altimeter



Model



Shinoda et al. (2017)



Webber et al. (2010)

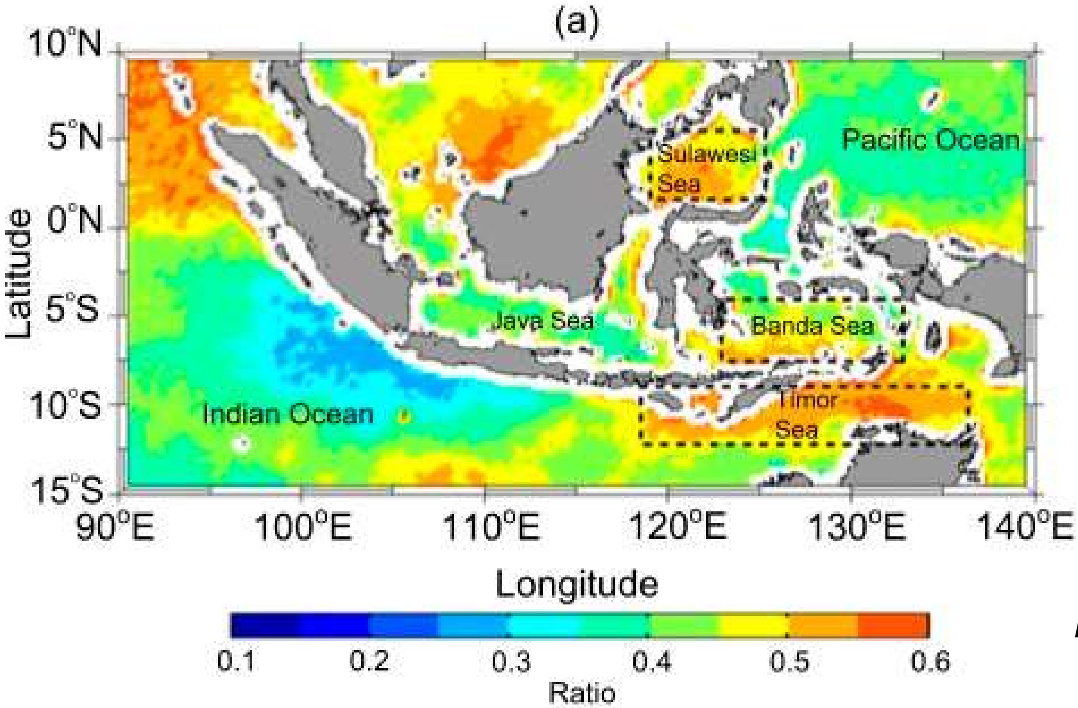
Addition of velocity (ADCP) measurements to the buoy at 4°S, 65°E would provide useful information for vertical mixing processes and thus the mixed layer heat budget.

Additional buoy measurements in Maritime Continent (Indonesian Seas)

MJO propagation barrier
The MJO propagating eastward from the Indian Ocean often weakens over the Maritime Continent (MC) region.

MC prediction barrier
The failure of the propagation through MC occurs more often in numerical model simulations.

A reduced surface moisture source due to the land coverage (Sobel et al. 2008), disruption of low-level winds by the island topography (Inness and Slingo 2006), and the pronounced diurnal cycle in precipitation over islands (Neale and Slingo 2003).



A southern part of Banda Sea - the largest intra-seasonal SST anomalies associated with the MJO are found within the Indonesian Seas

Napitu et al. (2015)

The ratio between the sum of SST variances on intraseasonal timescales (21 days<period<119 days) and the sum of SST variances with periods longer than 14 days.