Pacific Northwest
NATIONAL LABORATORY
Proudly Operated by Battelle Since 1965

Moisture Sinks: How Monsoons and ENSO interfere with the propagation of MJO across the Maritime Continent

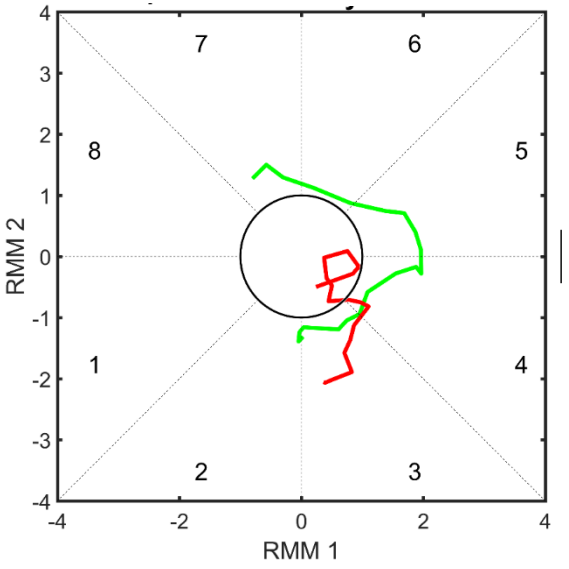
SAMSON HAGOS[1], CASEY BURLEYSON[1] , CHIDONG ZHANG[2]

U.S. DEPARTMENT OF ENERGY

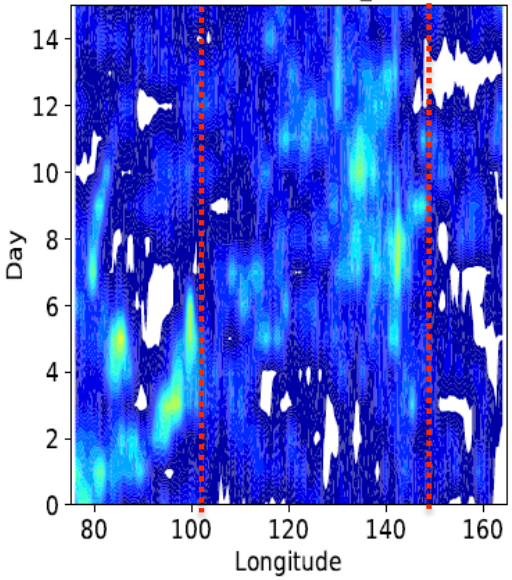
The problem

Examples of a weakened and a strengthened events

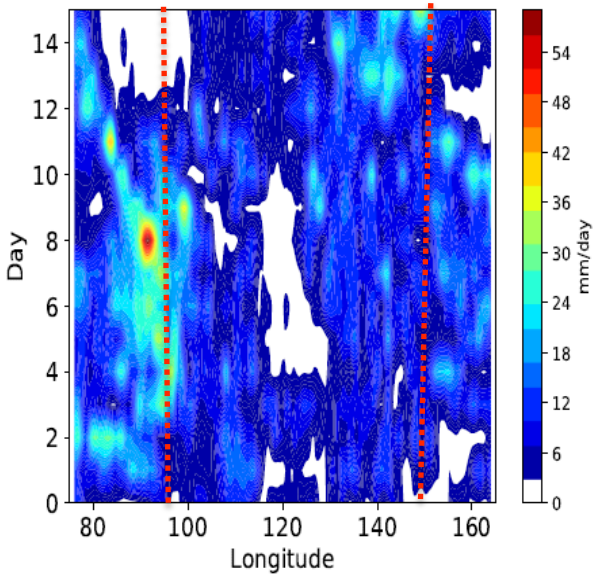
RMM cycles



Propagating



Weakened



Why are some MJO events weakened while others get stronger or propagate relatively unaffected as they cross the maritime continent?

Analysis of moisture sources and sinks

- Given moisture convergence field, one can identify sources and sinks moisture and moisture flux vectors.

$$-\nabla \cdot \frac{1}{g}\int_{ps}^{pt}(q\boldsymbol{v})dp \;;\; P-E$$

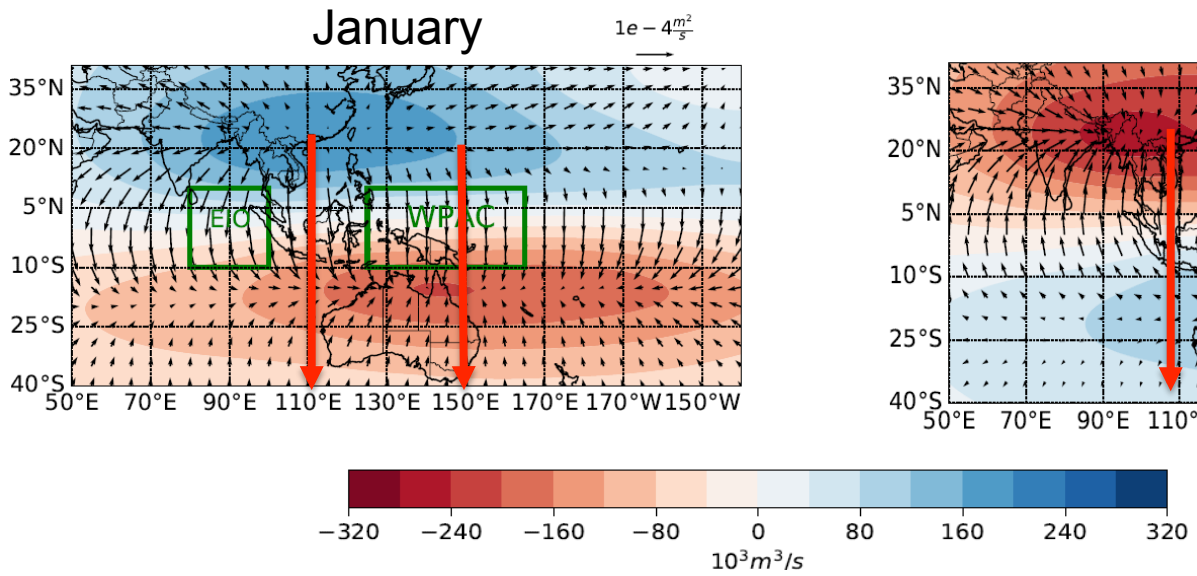
$$-\nabla^2\Phi \;\;;\;\; P-E$$

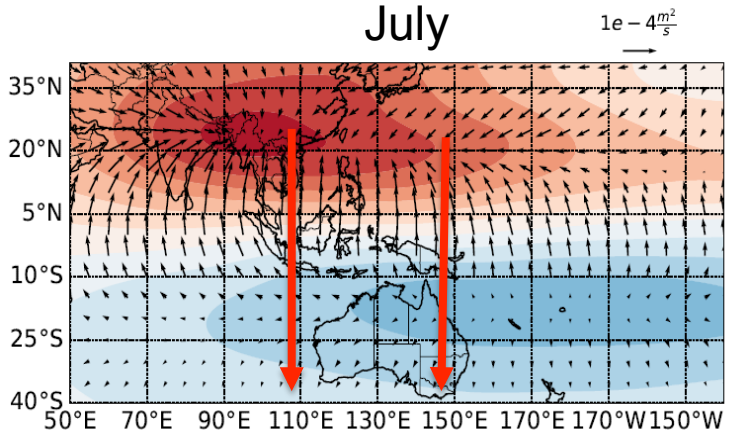
$$\boldsymbol{v}_q = \nabla \cdot \Phi$$

- We use 30 years of daily precipitation from Precipitation Estimation from Remotely Sensed Information using Artificial Neural Networks (PERSIANN Ashouri et al 2018) dataset.

$$-\nabla^2\Phi_p \;;\; P$$

Moisture transport during Asian and Australian monsoons

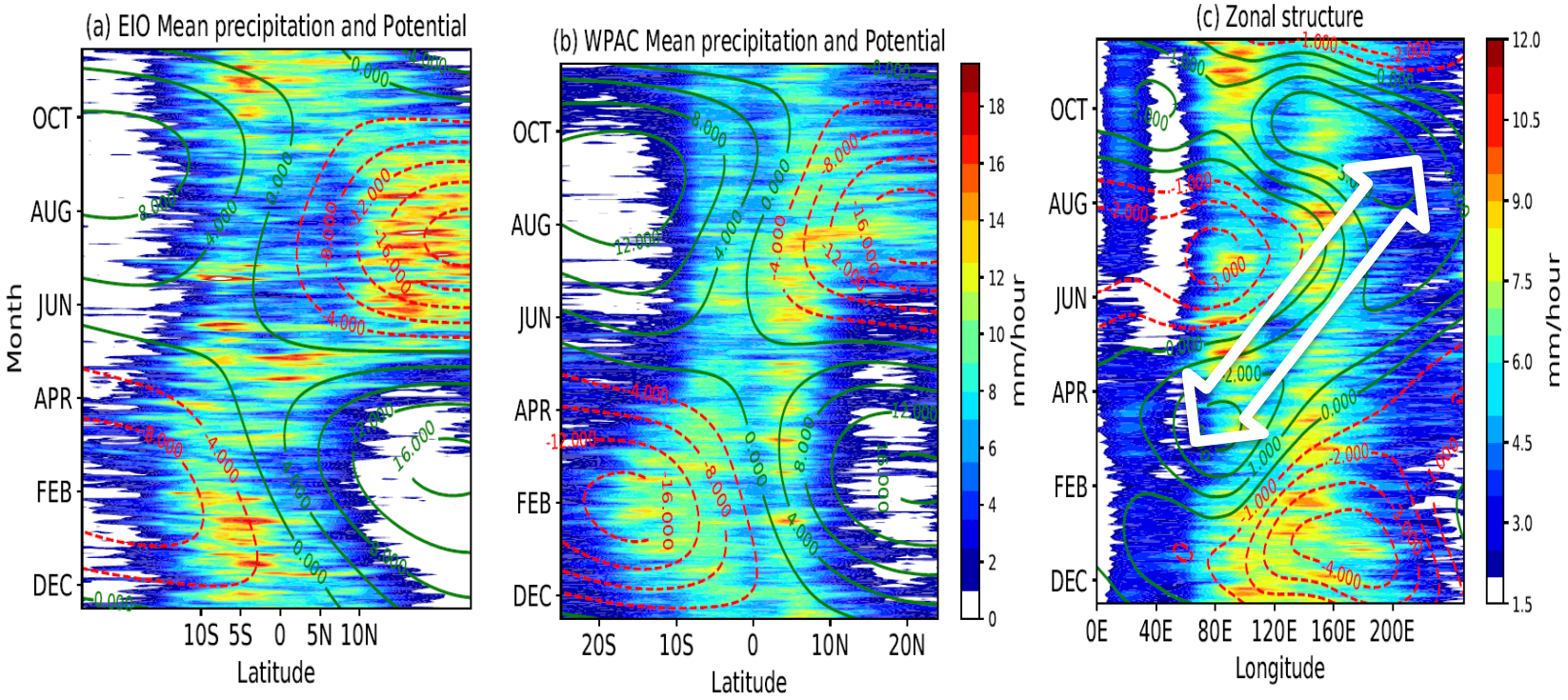




Moisture flux potential (shadings) and moisture flux vectors (arrows) calculated directly from 30 years of PERSIAN precipitation data

- The seasonal evolution of monsoons involves zonal movement of the moisture sinks and sources by about 40 degrees.

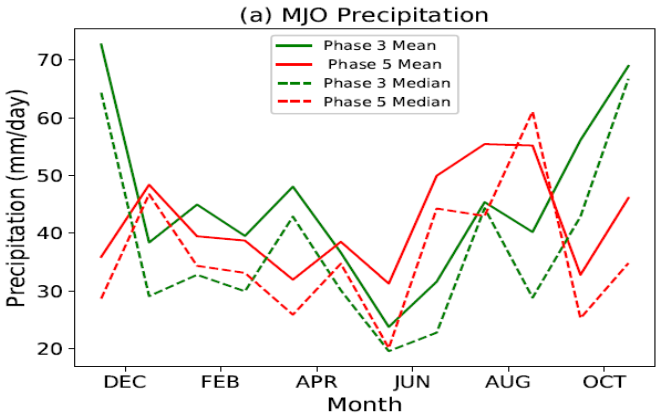
Seasonal cycle of moisture transport and MJO precipitation

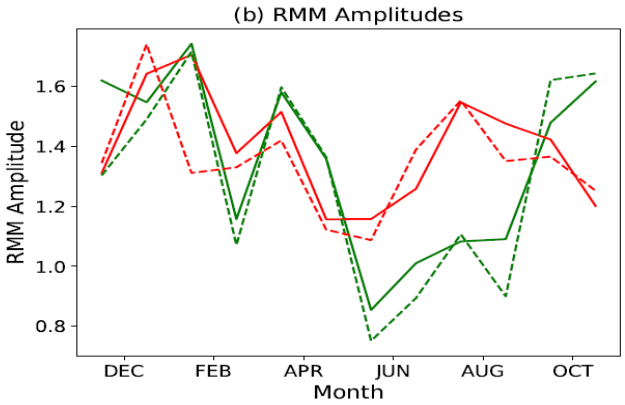


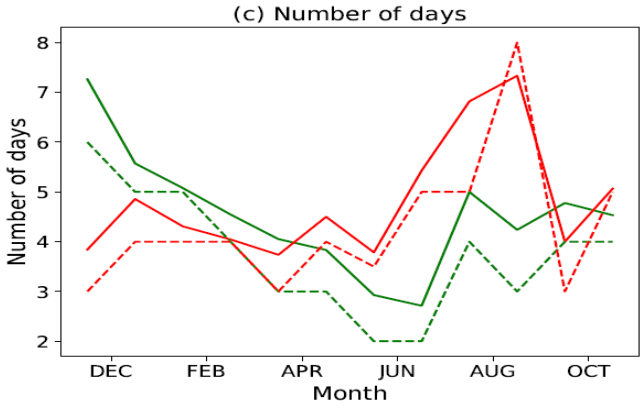
30 year mean moisture flux potential (contours) and precipitation (shadings). The precipitation is conditioned by RMM phases 3, 4 and 5. Both averaged between 10S and 10N.

- As the monsoons drive moisture poleward, subsidence(moisture divergence) at the equator migrates zonally across the maritime continent.

Seasonal cycle of MJO strength





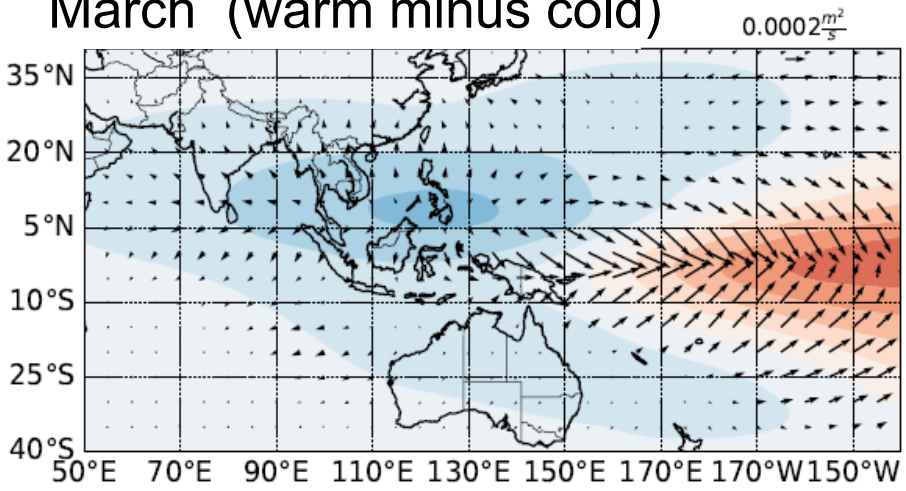


Mean and median seasonal cycles of precipitation, RMM amplitude and the number days where MJO events are in the given phase. Only events with amplitude 1.0 in phase 3,4, or 5 are included.

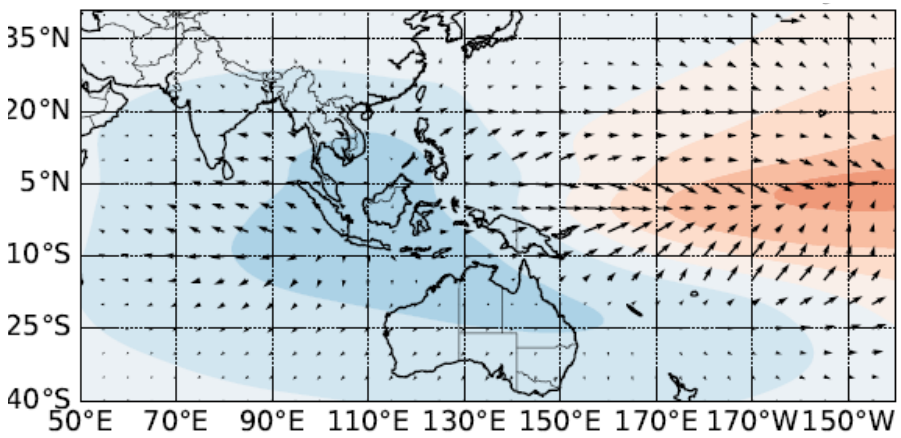
- In all these metrics, the RMM phases 3 and 5 are in phase between January and May and out of phase for the rest of the year.

Effect of ENSO

March (warm minus cold)



October (warm minus cold)

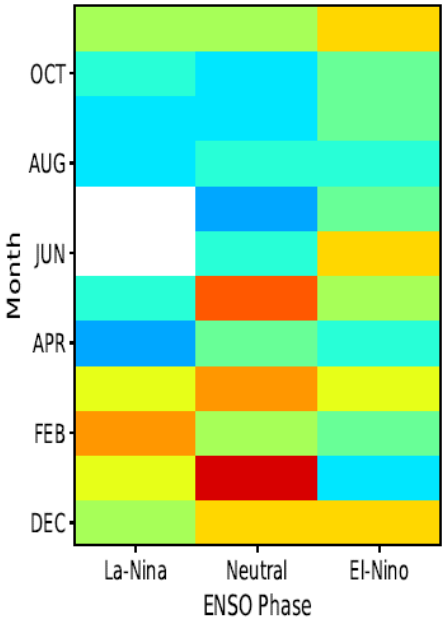


- Warm phase of ENSO drives away moisture from the MC regions for much of the year.

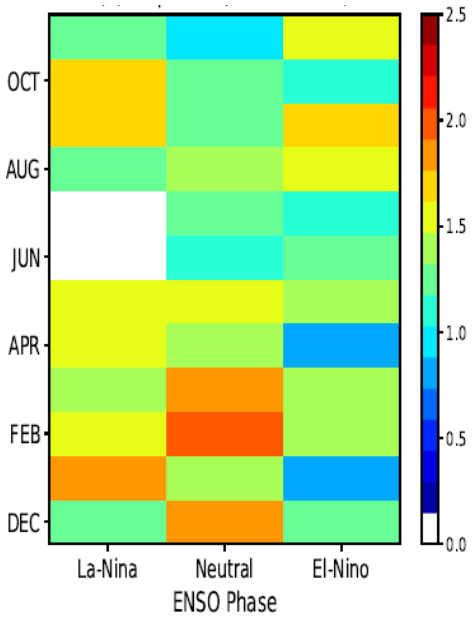
Combined effects of seasonality and ENSO on MJO strength

Pacific Northwest
NATIONAL LABORATORY
Proudly Operated by Battelle Since 1965

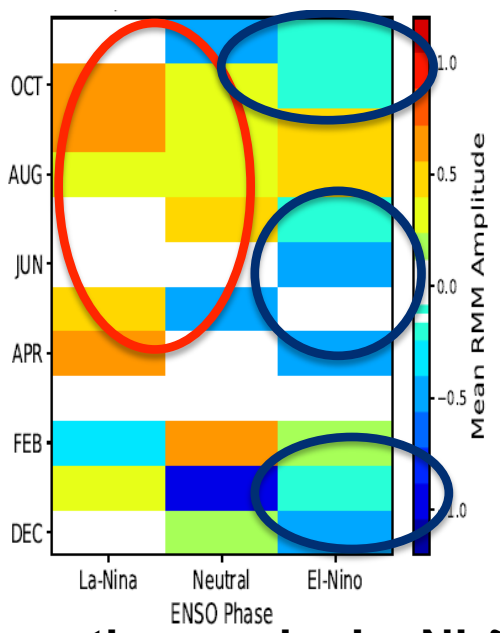
(a) Amplitude (RMM phase 3)



(b) Amplitude (RMM phase 5)



(c) Amplitude (RMM phase 5)



- **Spring and summer MJO events are likely to strengthen under La Ni·ña conditions** for they likely start out with weak phase 3 and enter a favorable environment.
- **Spring and winter MJO events are likely to weaken under El Niño conditions** because they are likely to start with strong phase 3 but enter an unfavorable environment.
- Responses to other conditions are more nuanced as the effects of seasonality and ENSO are comparable.

Summary

- Because of zonal movement of the subsidence associated with monsoons, the mean amplitudes of MJO over eastern Indian Ocean and Western Pacific are out of phase during summer to early winter and in phase during late winter to spring. In general, warm phase of ENSO favors weaker MJO over the western Pacific.
- The apparent strengthening or weakening of individual MJO events therefore takes place within the moisture budget constraints due to these seasonal and inter-annual factors.