The impact of diurnal cycle on the propagation of the Madden-Julian Oscillation across the Maritime Continent

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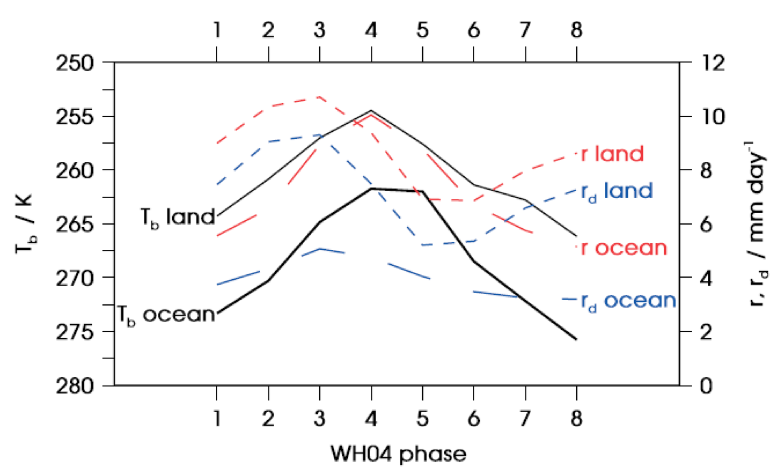
Introduction

▶Diurnal cycle vs MJO phases

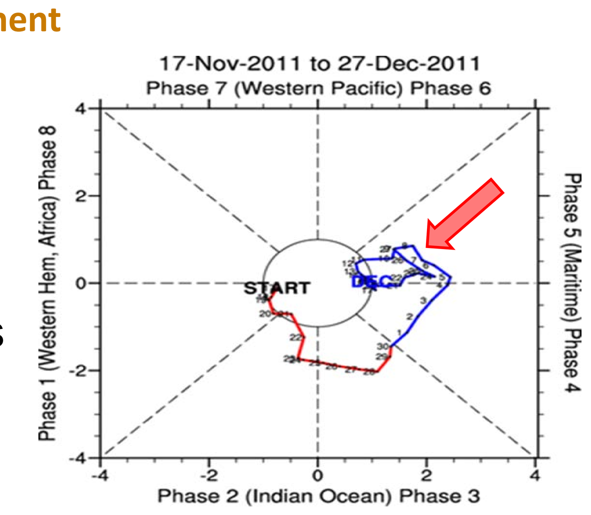
- Strongest as the MJO approaches the Maritime Continent as both surface fluxes and moist static energy are large.
- It weakens during active phases as cloudiness suppresses fluxes.
- It is at its weakest during the suppressed phases.



Magnitude of diurnal cycle of precipitation vs MJO phases. Diurnal cycle peaks just ahead of the arrival of MJO at MC. (From Peatman et al. 2014 QJRMS)

▶ The passage of MJO across the Maritime Continent

MJO convection often, but not always, weakens as it propagates across the MC. It could split into multiple standing convection centers over the islands. This results in a prediction barrier.



RMM cycle of the Nov 2011 MJO (From NOAA CPC)

▶**Objective:** To examine the impact of diurnal cycle on the propagation of MJO convection over the Maritime Continent using Cloud-permitting regional model simulations and analysis of long term observations by US DOE's ARM site at Manus and TRMM 3B42 data-set.

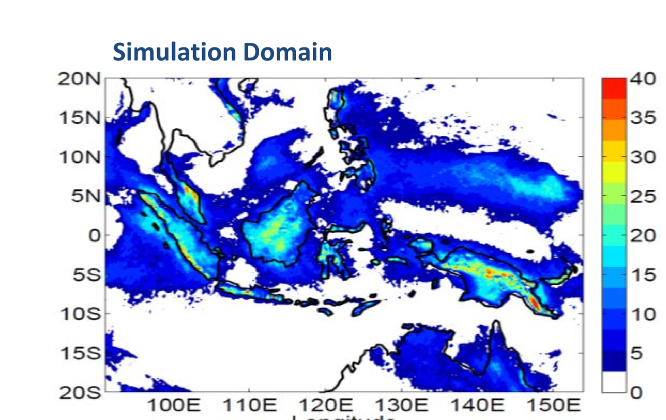
(a) Analysis of Model simulations Experimental Set-up

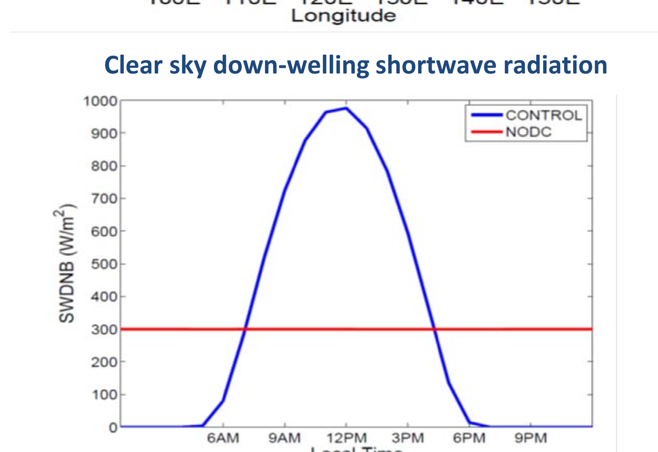
▶**CONTROL:** Realistic diurnal cycle and boundary conditions updated every 6 hours.

▶**NODC:** Perpetual morning with clear sky downward SW fluxes fixed at the daily mean value.

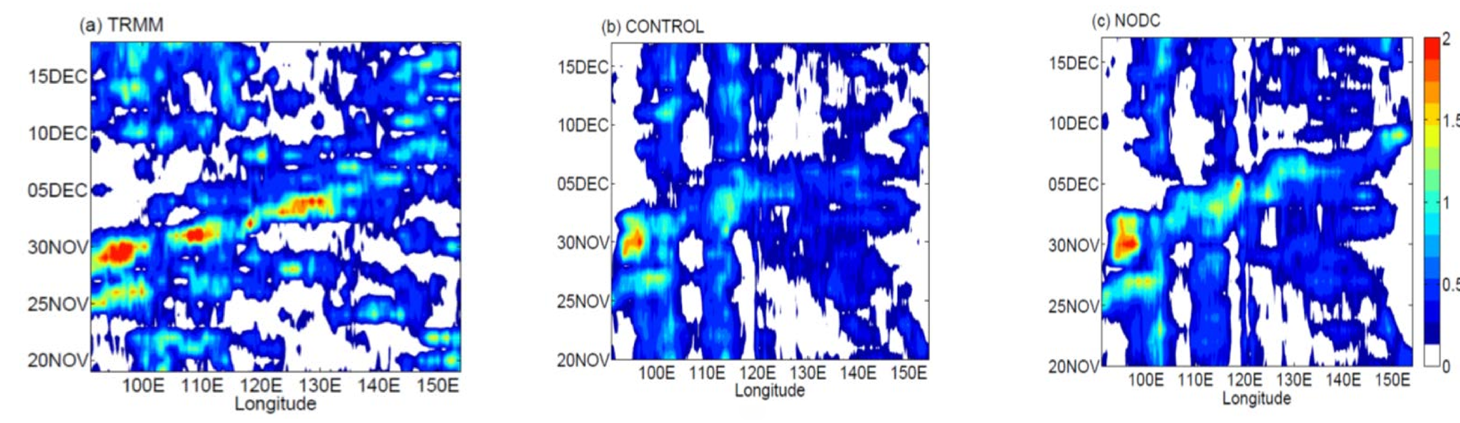
▶ Six ensemble members for each.

▶4 km grid spacing, no cumulus parameterization.



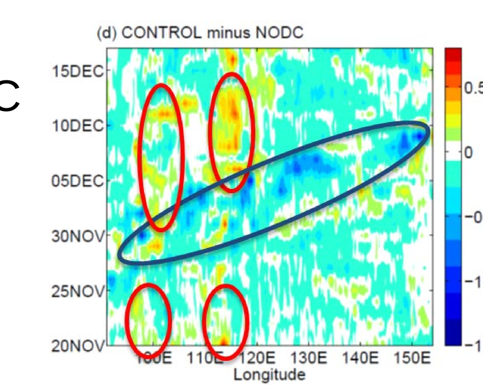


Diurnal cycle weakens MJO convection



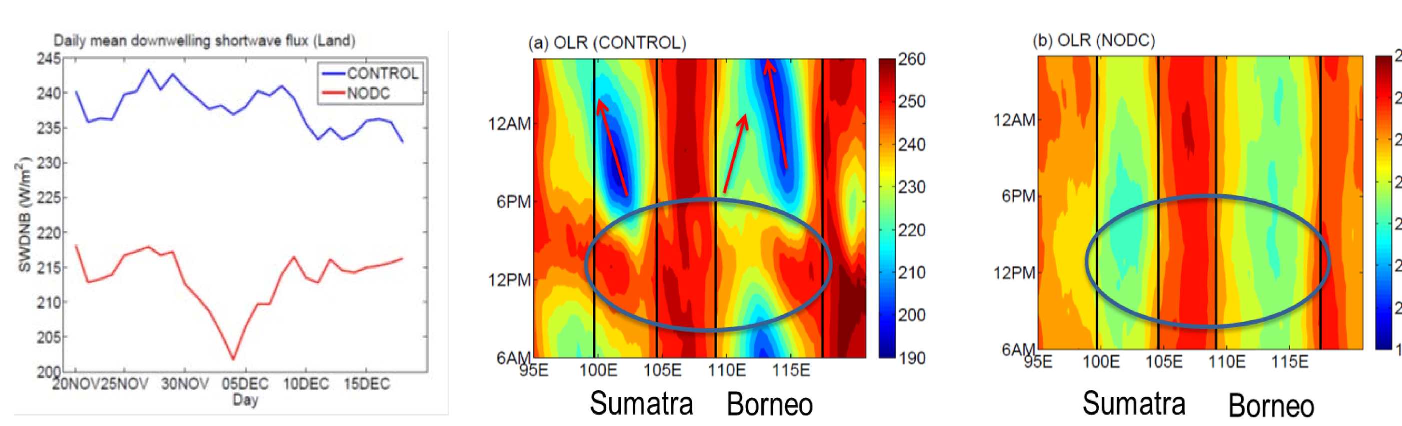
▶In the CONTROL simulation the precipitation signal is weakened in comparison to the NODC case.

▶Convection over the islands is larger before and after the passage of the propagating MJO signal.



Precipitation (mm/hr)

Why is the local convection over land enhanced in the CONTROL simulation?



▶ Daily downwelling shortwave radiation over land is larger in the CONTROL simulation!

▶ In the CONTROL simulation clouds propagate and the sky is clear near noon.

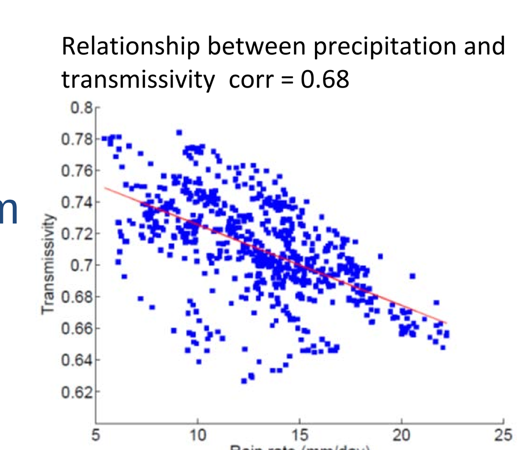
▶ In the NODC experiment, no propagation of clouds. It is cloudy all day.

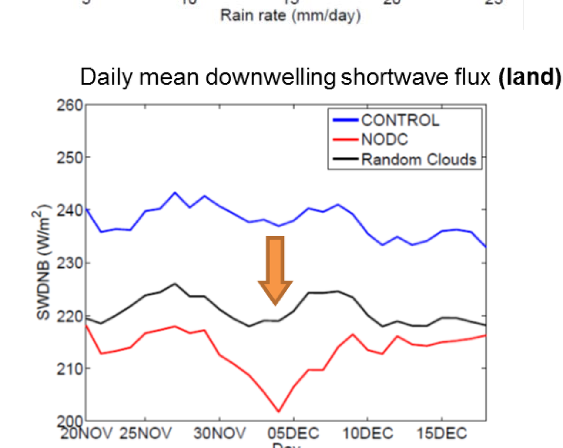
What if the clouds were randomly distributed throughout the day?

▶To answer the question

- Nighttime "transmissivity" is estimated from precipitation.
- The transmissivity is randomly sorted and multiplied by the clear sky shortwave radiation.

▶ 70% of the difference in down-welling shortwave flux between CONTROL and NODC is related to the diurnal cycle of cloudiness.



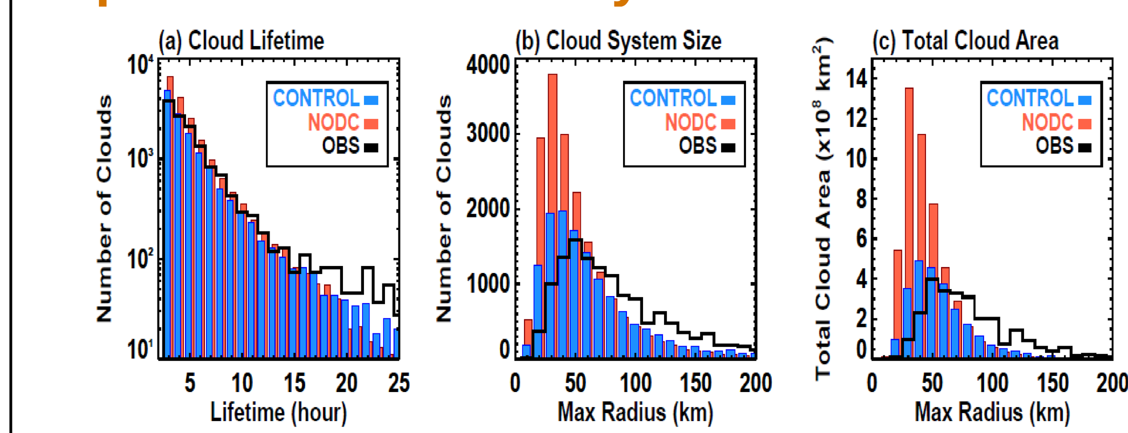


Summary

▶By introducing an additional 15-30 W m^{-2} in surface downwellling radiation over the Maritime Continent, the diurnal cycle of clouds favors the stalling and weakening of the MJO convection signal.

▶The findings of this study open door to understanding why some MJO episodes cross the MC while others do not. Specifically, how variabilities that modulate cloudiness over MC, such as seasonal cycle and ENSO may influence MJO propagation.

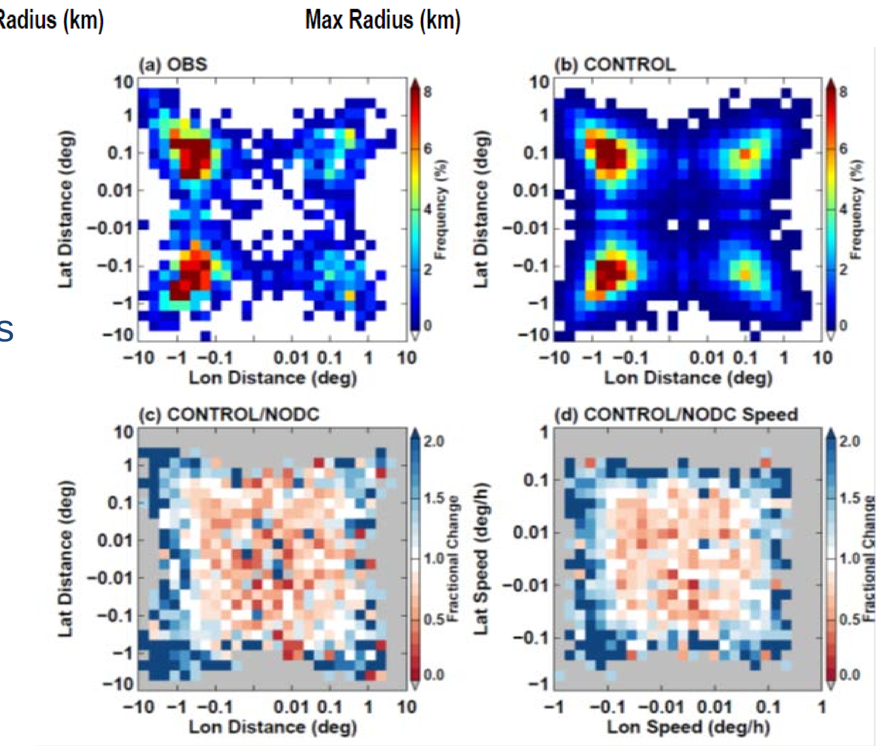
Impacts on cloud lifecycle



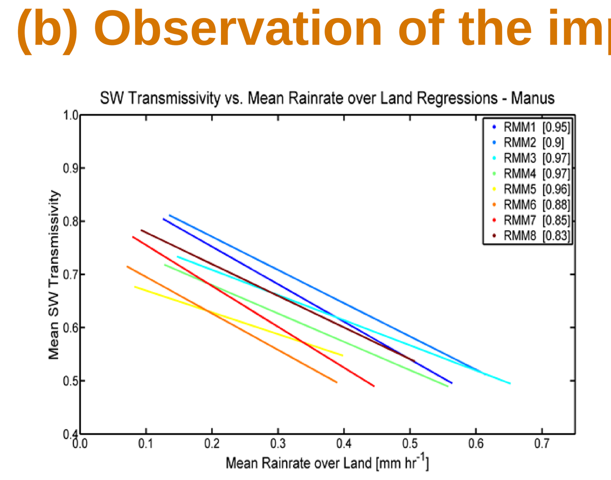
▶ With a diurnal cycle clouds:

- have relatively shorter lifetime, don't grow as large, and hence total cloud cover is smaller.
- propagate faster and farther.

▶ **The net result is that more SW radiation reaches the surface.**



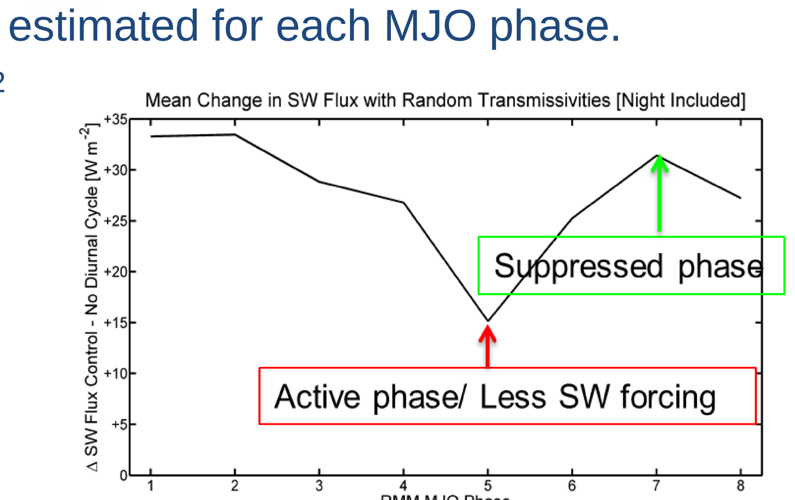
(b) Observation of the impact of diurnal cycle of cloudiness



- **ARM long term observations from Manus** are used to derive the relationship between precipitation and transmissivity over land using TRMM.
- Impact of diurnal cycle of cloudiness is estimated for each MJO phase.

▶Diurnal cycle of cloudiness introduces an extra 15-30 W m^{-2} of downwelling radiation at the surface.

▶It is out of phase with the MJO signal, and thus disrupts the smooth propagation of the MJO.



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