

Cloud evolution associated with the Madden-Julian Oscillation (MJO) life cycle

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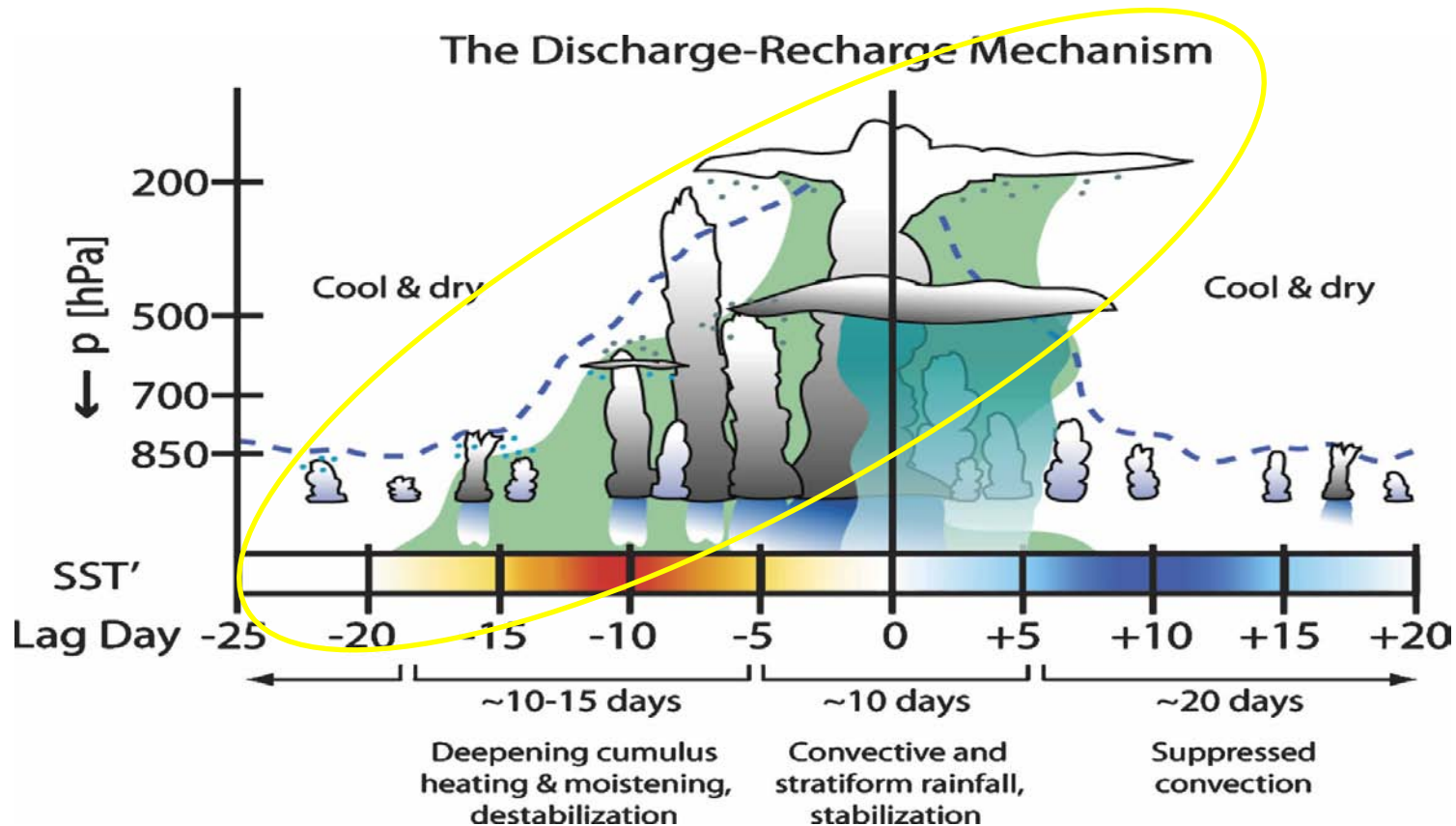
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Objective



❖ FIG. 13. Schematic diagram of the discharge–recharge mechanism associated with the MJO. (Benedict and Randall 2007)

❖ Period of the low frequency oscillation of convective heating is determined by the discharge time of convective stabilization together with the recharge time of moist static instability.

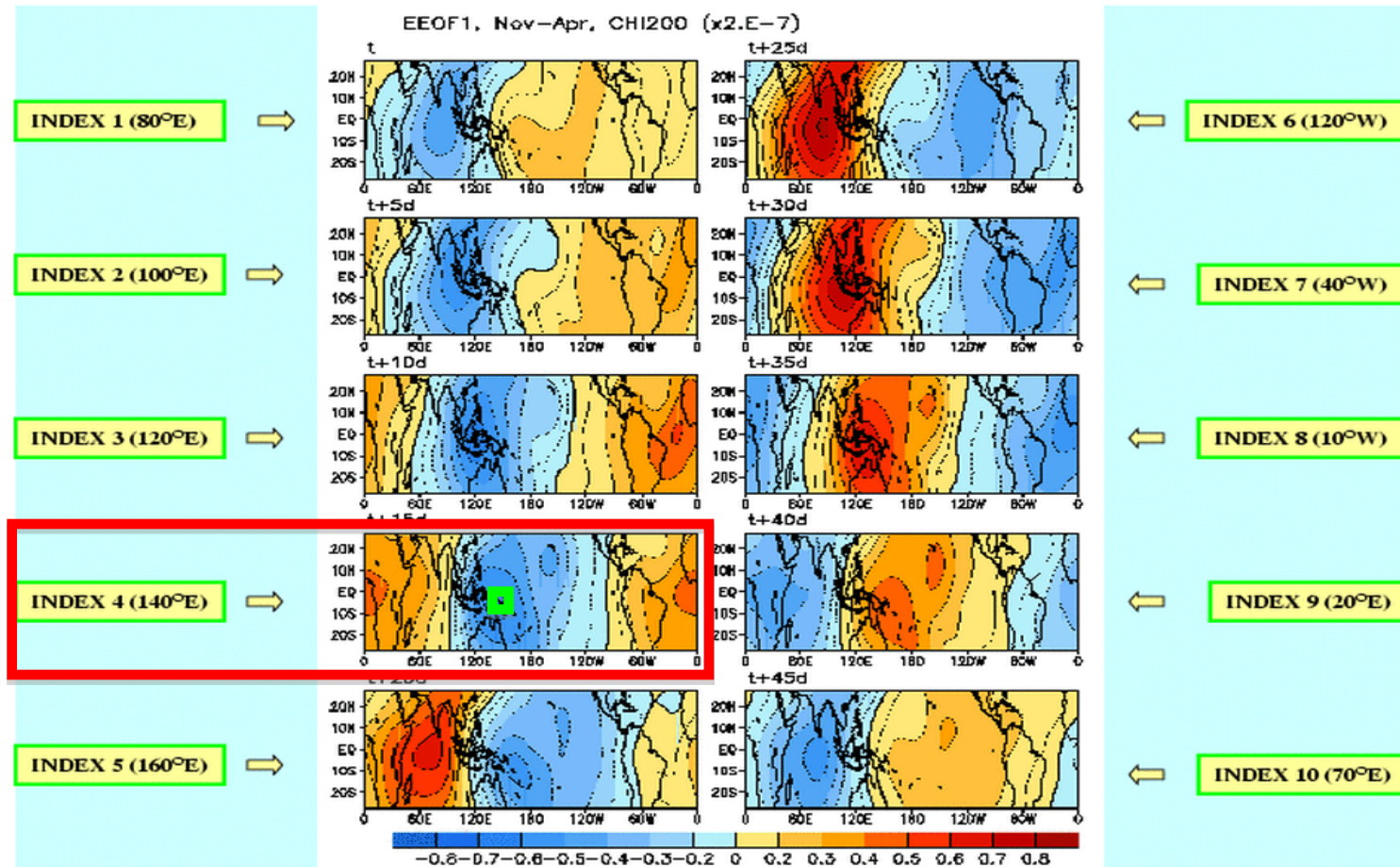


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NOAA MJO Index

ARM TWP Manus



❖ The blueish (reddish) color represents the enhanced (suppressed) convection, and the x-axis labels the centers of enhanced convection for the ten indices, which are determined from the ten time-lagged patterns of the first EEOF of CHI200.



http://www.cpc.noaa.gov/products/precip/CWlink/daily_mjo_index/mjo_index.html

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ARM TWP Manus datasets

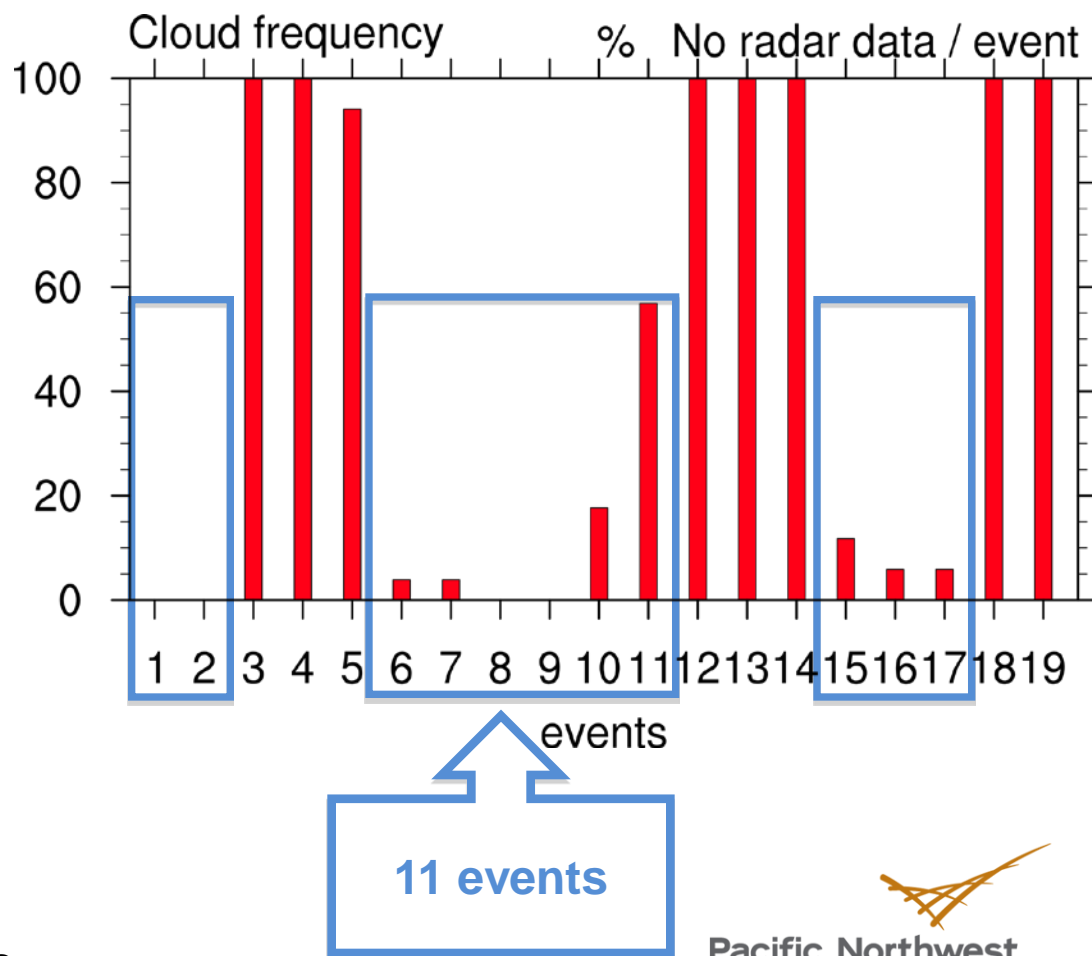
- ▶ Location of Manus (2.06S, 147.42E, 4.0 m MSL)

Variable	Measurement	Interval
Cloud frequency	Radar / lidar (MMCR / MPL)	2 minutes
Maximum precipitation	SMET (ORG-115 / 815)	2 minutes
Relative humidity, temperature, and zonal wind	SONDE (Balloon-borne sounding system)	2 times / day

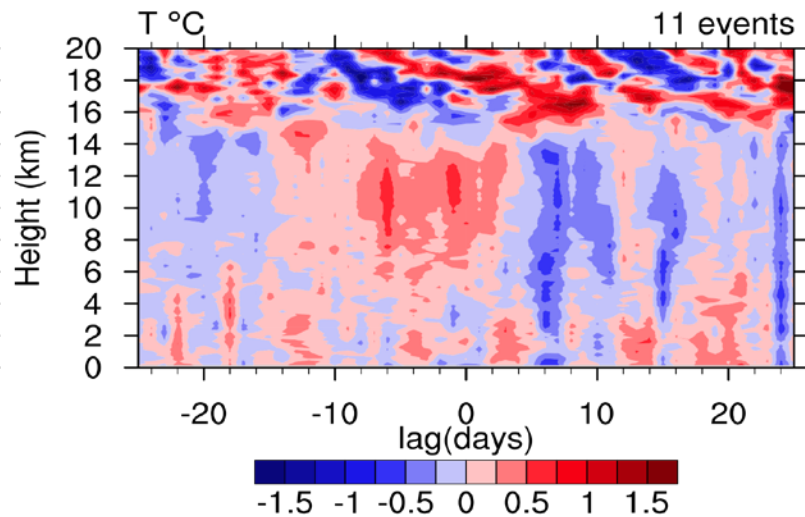
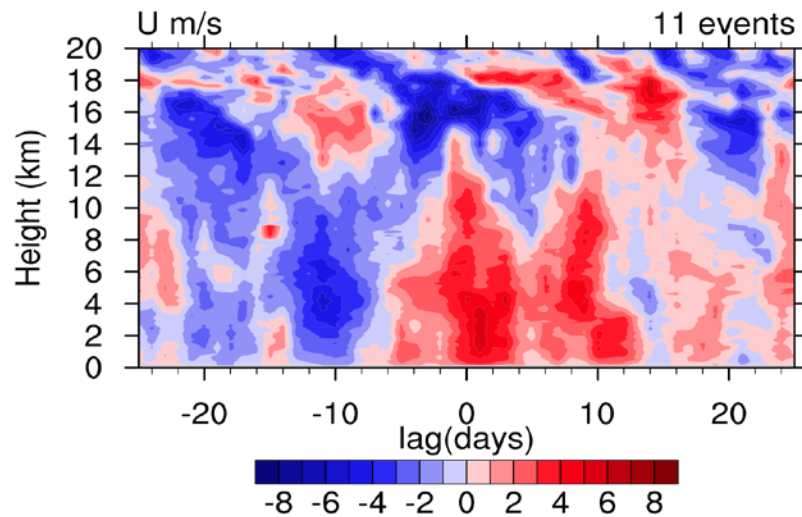
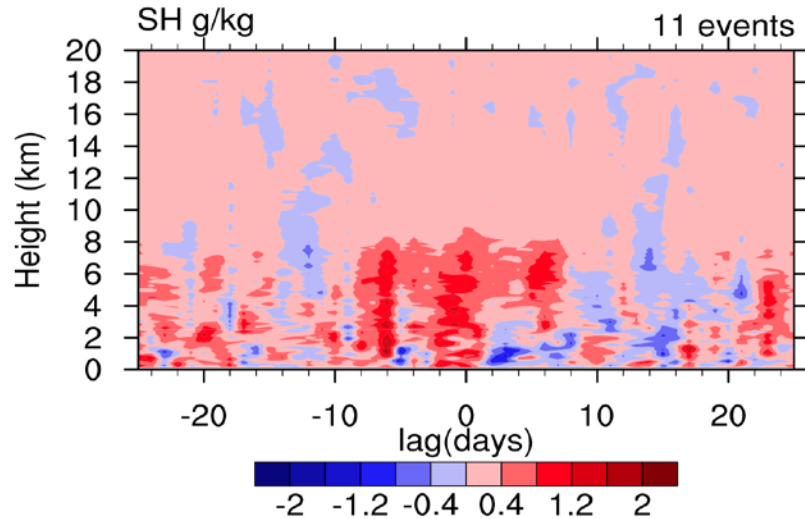
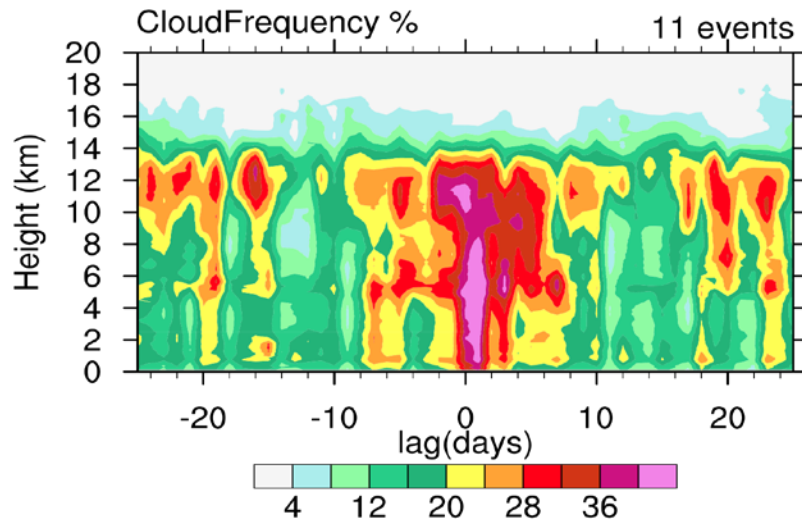
MJO events at Manus

Year	19 strong MJO peaks (November-April)
2002	0128 0217 1129 1229
2003	0309 1219
2004	0103 0207 0319
2005	0108 0202 0408 1109
2006	0123
2007	0103 0304 0329 1119 1224

- ❖ Events: Index < -1.0
- ❖ Each event: -25 days to 25 days

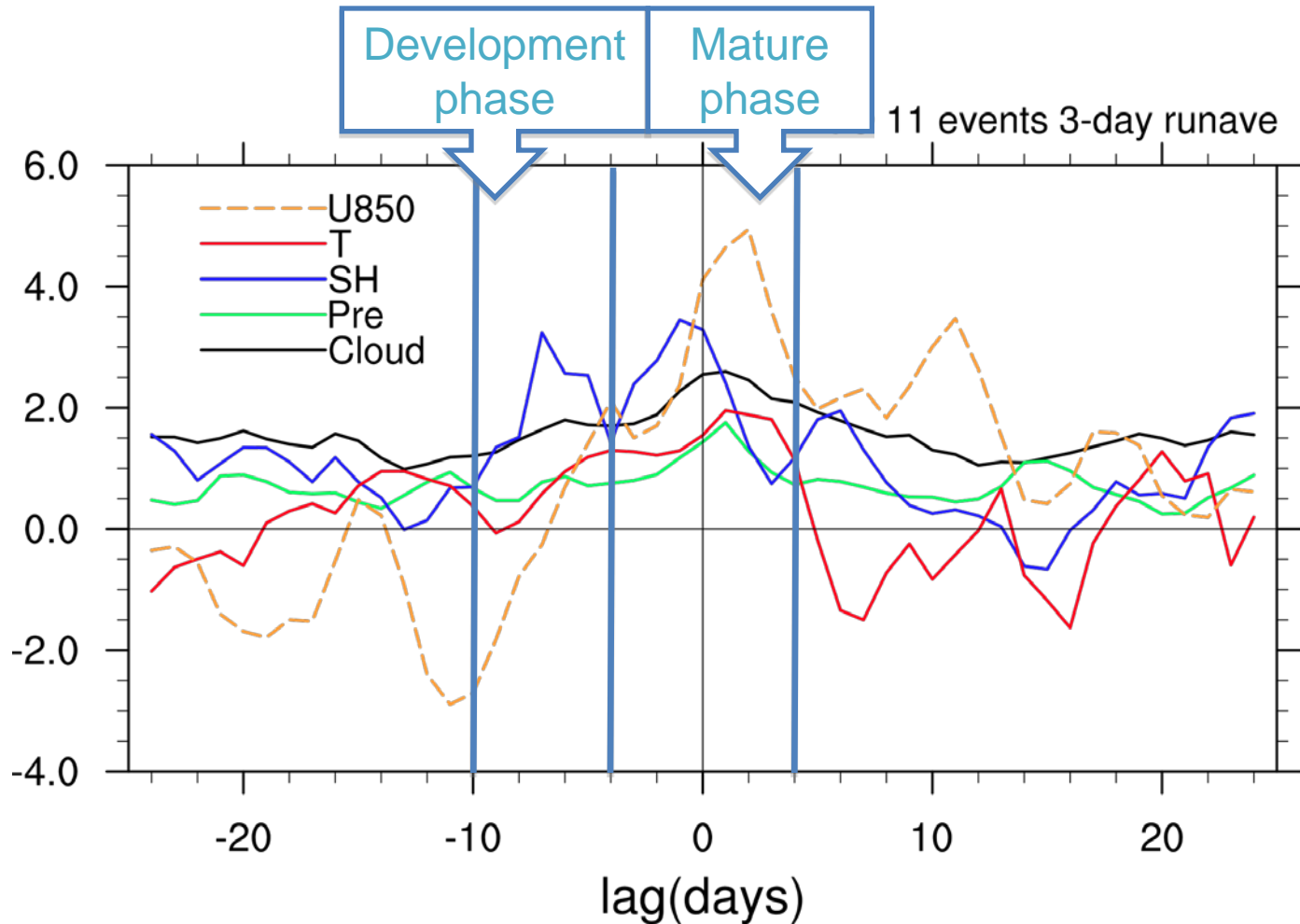


Composite MJO at Manus



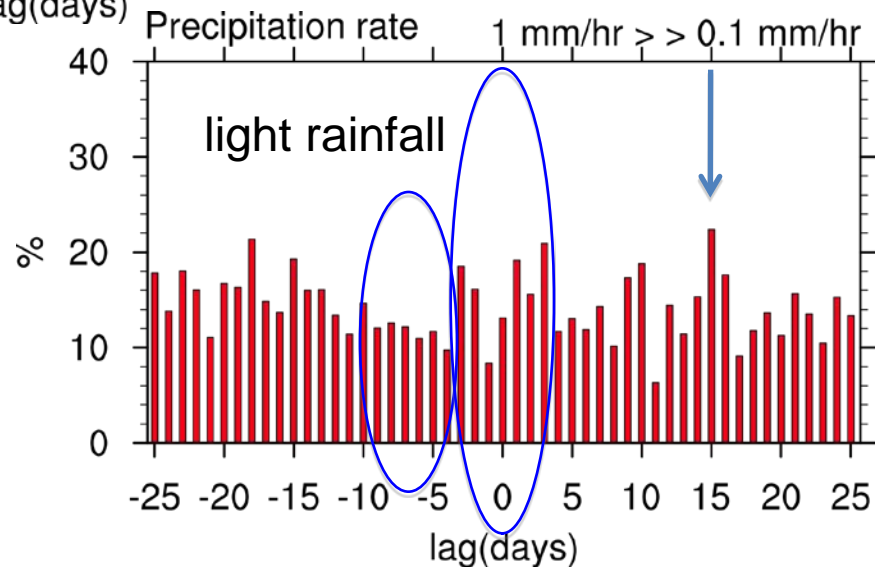
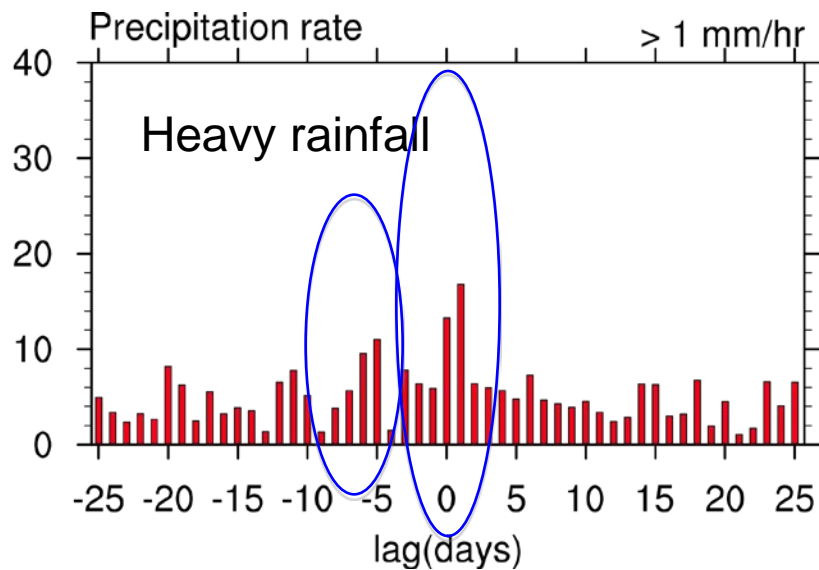
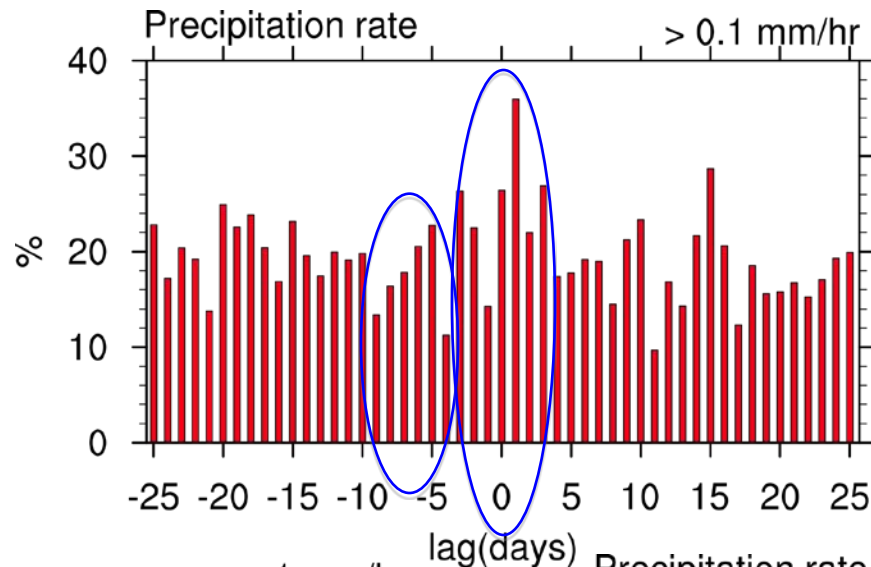
❖ Annual mean has been removed from last three figures: SH, U, and T

Composite MJO

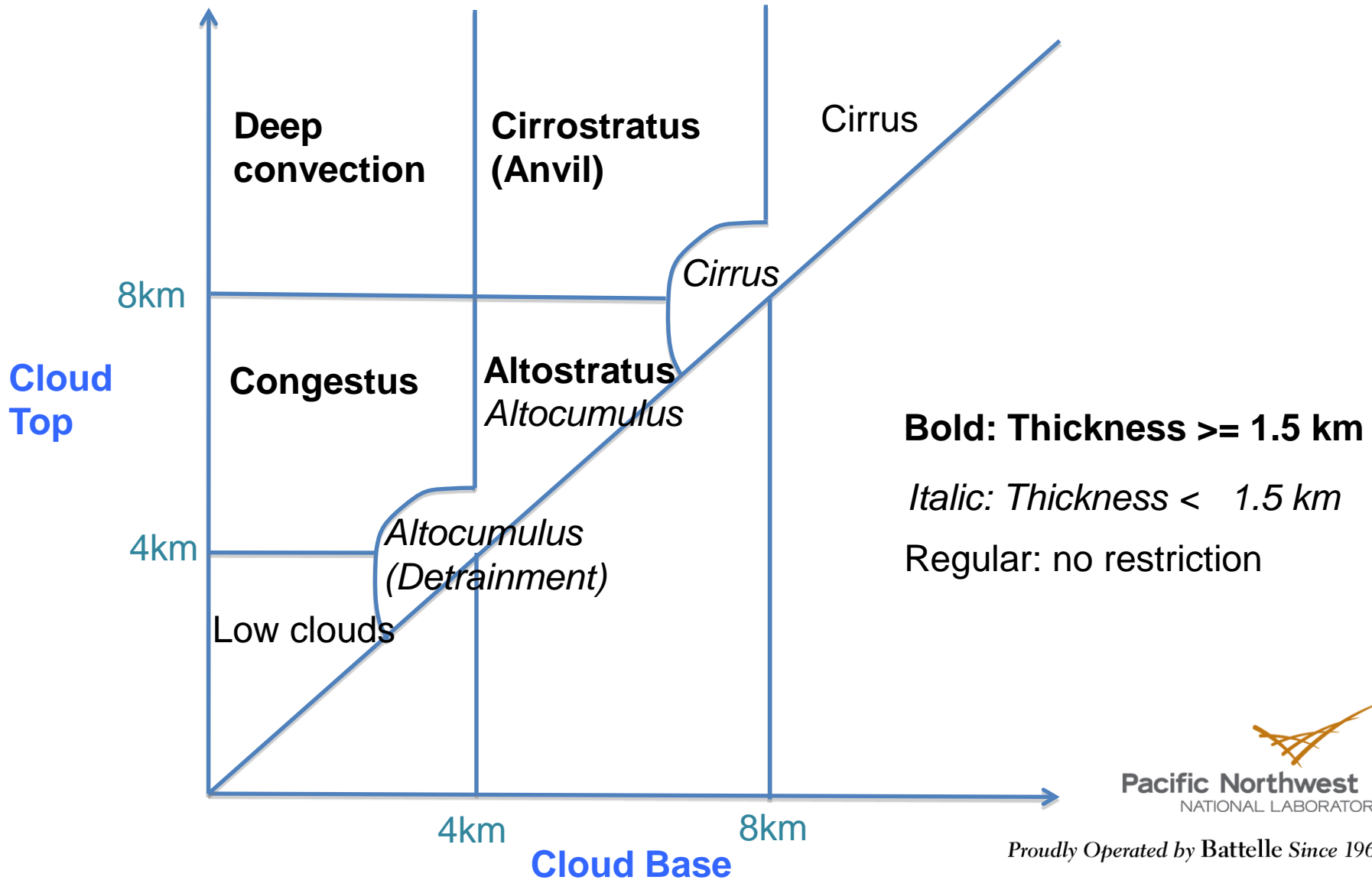


❖ The unit for U850 is m/s, T 0.1 °C, SH 0.1 g/kg, Pre mm/hr, and Cloud 10 %.

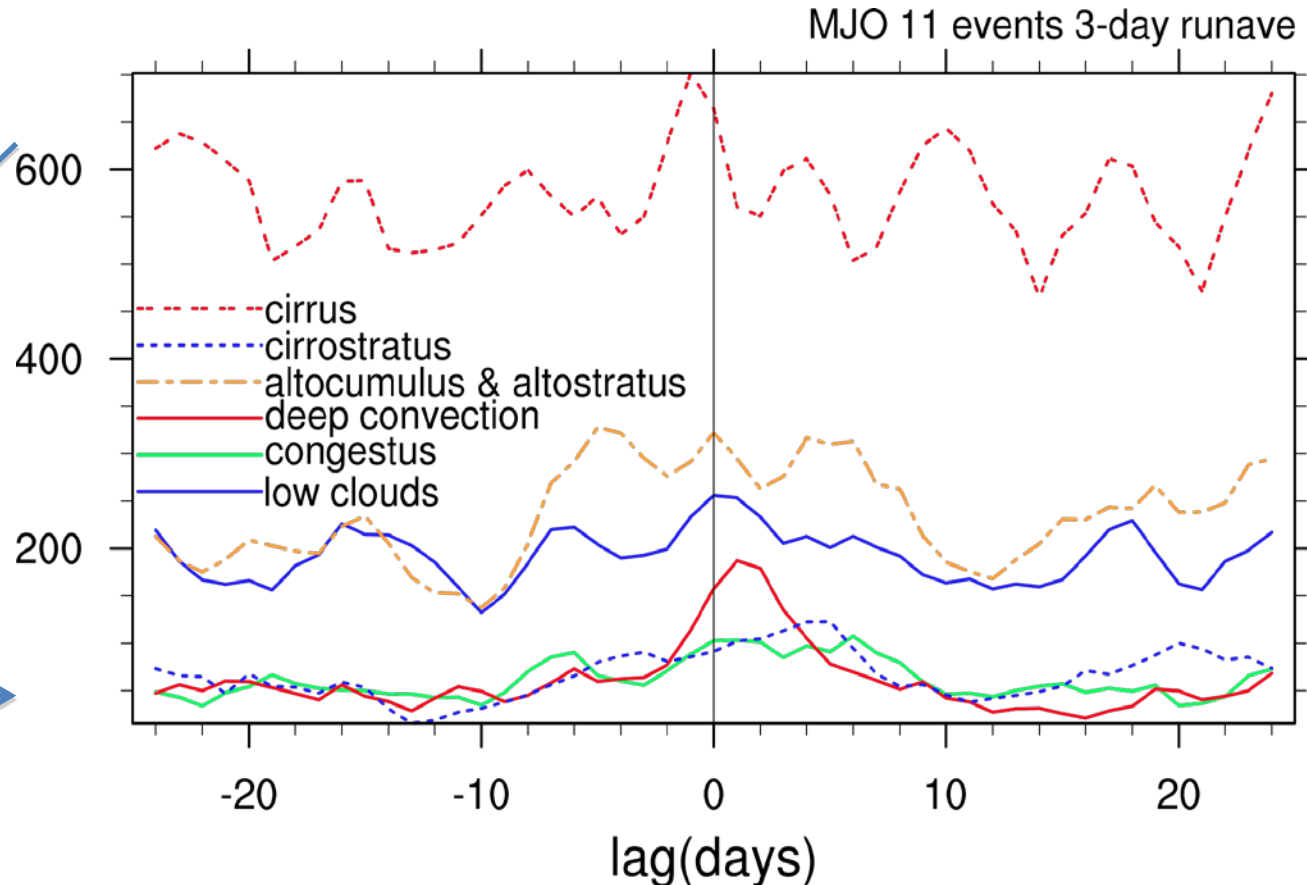
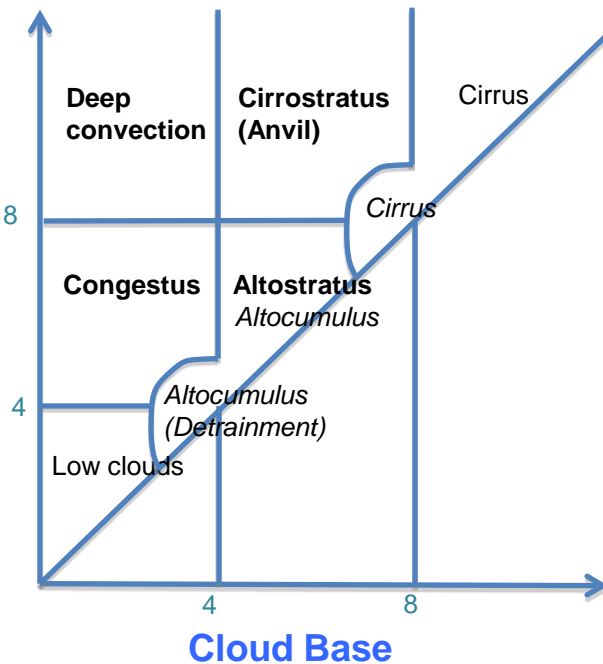
Composite precipitation rate frequency



Cloud Type

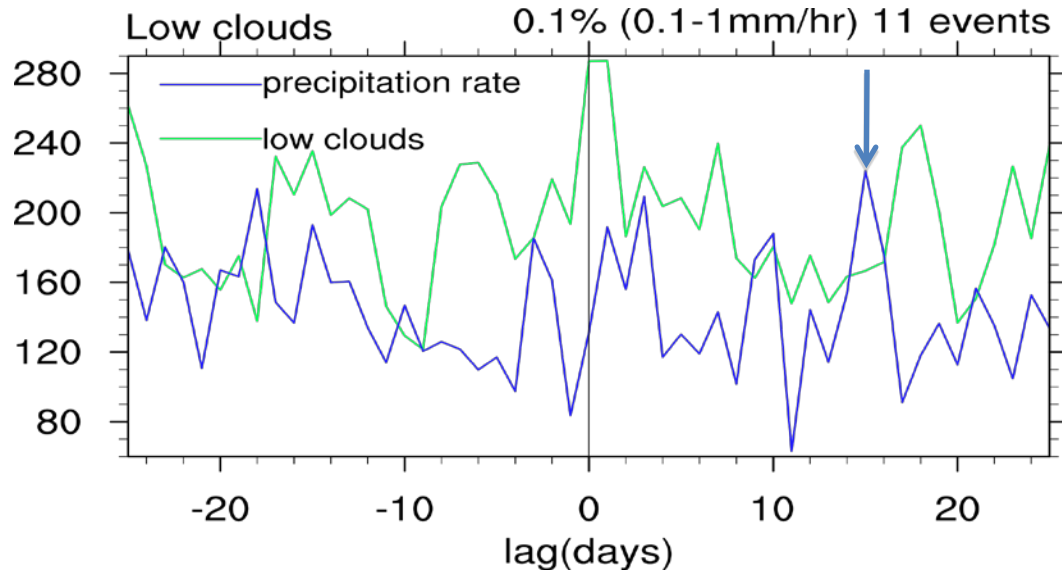


Composite cloud type

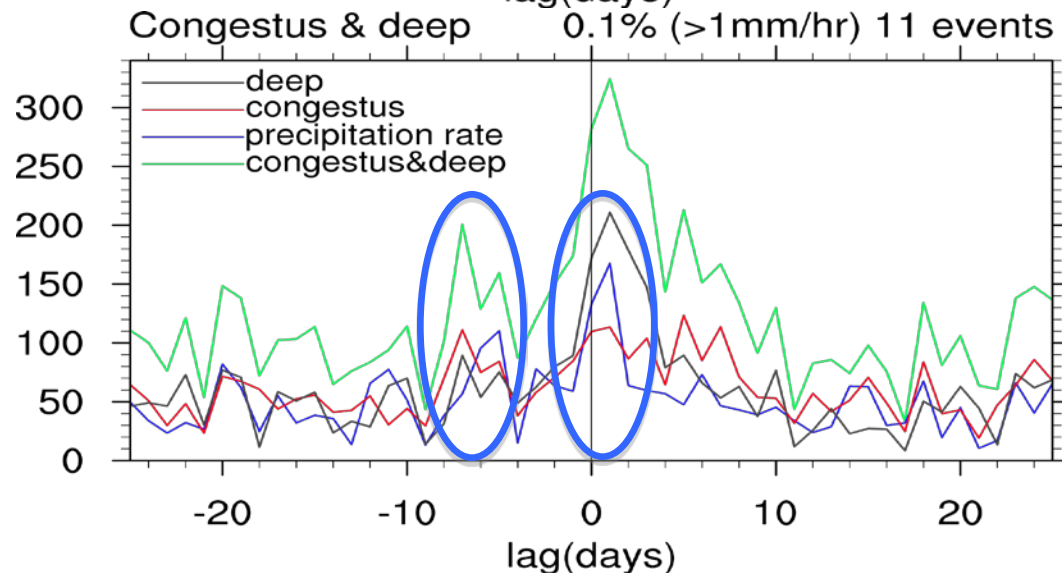


- ❖ Congestus peak followed by the peak of detrainment and altocumulus/stratus plays important role during the development phase.
- ❖ Deep convection peak followed by the anvil peak dominates the mature phase.

Cloud and precipitation rate frequency



❖ No tight relationship between light rainfall and low clouds.



❖ Both congestus and deep convection contribute to heavy rainfall.

Summary

- ▶ Clouds associated with MJO life cycle show a two-phase-structure: “development phase” and “mature phase”.
- ▶ Heavy rainfall also shows a double-peak-structure:
 - ❖ Congestus plays an important role during the first peak.
 - ❖ Deep convection dominates the second peak.
- ▶ Congestus followed by detrained altocumulus/stratus is the major contributor to the preconditioning moist anomaly in the mid-troposphere.



Thank you!



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