Raining Cloud Populations and their Evolution during MJO Convective Initiation In the West Indian Ocean

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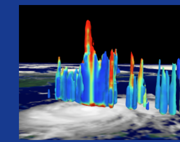
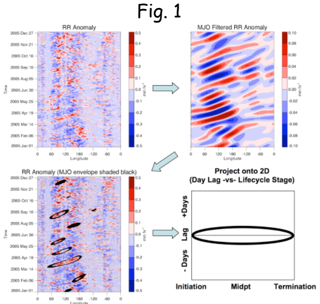


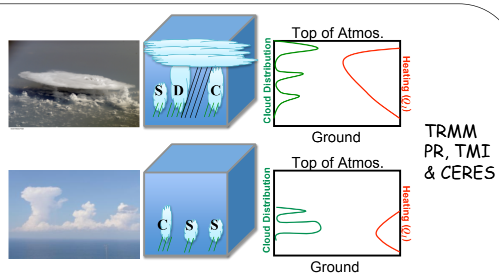
MJO Event and cloud population Identification

Fig. 1



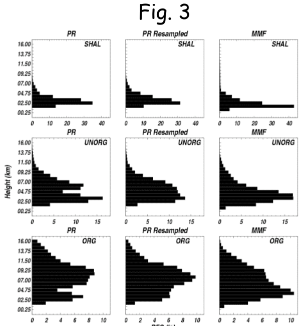
First, all MJO events (with longitudinal extent exceeding 20°) outlined in the bottom left panel are averaged and projected onto 2D panel displayed in bottom right. This portrayal allows for easy comparison of the evolution of cloud populations at initiation versus other MJO lifecycle stages.

Fig. 2



Secondly, clusters of differing mixtures of raining clouds [shallow clouds (denoted by S in Fig. 2), congestus clouds (C) and deep clouds (D)] are derived from both TRMM PR and the imbedded CRM in an MMF (CSU version coupled with a slab ocean model). These raining cloud clusters are composited onto the bottom right 2D panel in Fig. 1 so that the temporal evolution of cloud populations can be detailed as a function of MJO stage.

Fig. 3



Three simple clusters of cloud mixtures are found in obs and MMF (SHAL, UNORG & ORG). PR Resampled panels denote attempt to reconcile PDF differences that result from different vertical resolutions in MMF compared to TRMM PR. These clusters – defined according to constituent cloud populations – are composited for all stages of MJO.

Evolution of Raining Cloud Populations

Fig. 4

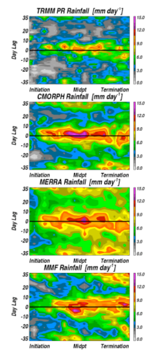
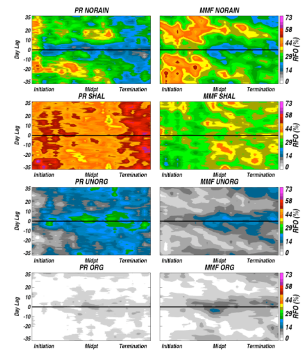


Fig. 5



Rainfall composite is shown in Fig. 4. Raining cloud populations are shown in Fig. 5. MJO mostly modulates non-raining scenes and deeper rainfall clusters. Shallow raining clouds (SHAL cluster) are always present. Instead of a transition from shallow to deeper convection, results suggest an "addition" of deeper clouds.

Role-Reversal of Moistening Processes

Fig. 6

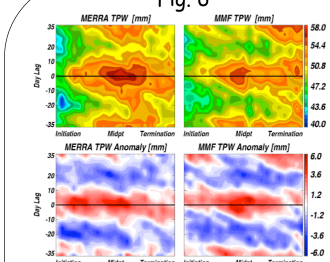


Fig. 7

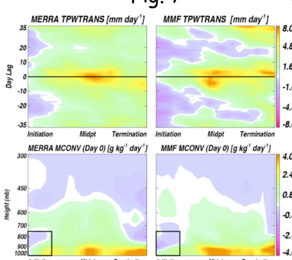
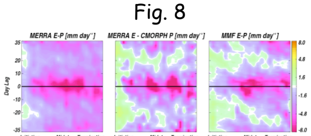


Fig. 8

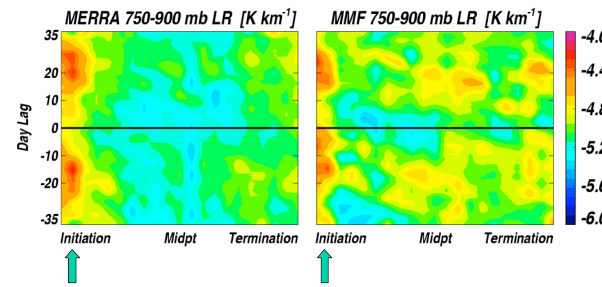


Reversal of moistening processes: during initiation, evaporation is most important (with some transition to shallow moisture convergence [TPWTRANS]); during later stages in composite MJO event, deep moisture convergence is most significant.

***MERRA Rainfall is biased high relative to observations. Analysis increment term for water vapor is positive during initiation, and approximately equal to MERRA P - CMORPH P

Lower-Troposphere Lapse Rates

Fig. 9



Consistently strong stable layer is found during initiation, unlike that which is found during other lifecycle stages. Both decreased TPW (assoc. with lower mid-trop RH) and increased CIN likely contribute to lack of deep systems during initiation.

Conclusions/Future Work

- For all stages of the composite MJO event, instead of a transition from shallow raining clouds to deeper ones, the evolution involves an addition of deeper convection and organized systems, while shallow regimes remain nearly constant in time. Because there is not a transition, does that mean the cooling and drying effect of deeper convection (i.e. stabilizing processes) are offset by shallow moistening and heating thus stretching the timescale over which deep convection can hang around?

- Initiation stage is mostly characterized by shallow raining cloud clusters and non-raining scenes. Deep convection is rare, finally becoming more common only 1-5 days before the eastward propagation of the event. Strong stable layer in lower troposphere is common during initiation – is this, along with lower TPW – the reason for the 10-20 day period of (only) shallow cloud clusters?

- Lack of deep convection for much of the initiation period allows for continual slow moistening by evaporation for most day lags of this MJO stage. If deep convection appeared more quickly, would timescale for moistening be shortened?