Shallow Clouds at Manus in Observations and GCM Simulations

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Scientific Problems:
1. It has been commonly hypothesized that shallow convective clouds moisten the lower troposphere and there by provide a favorable condition for deeper convection to develop, especially during the initiation or shallow-to-deep convective transition period of the MJO (Fig. 1). This hypothesis needs to be evaluated quantitatively.
2. In the past comparisons between cloud radar observations and GCM simulations of shallow convective clouds in tropical deep convective regions, such as Manus, no treatment of rain attenuation was applied. This would lead to overestimate of observed shallow clouds.

Objective of this study:
1. Quantify the fraction of shallow convective clouds and their moistening through the life cycle of the MJO at Manus.
2. Use rain attenuation corrected cloud radar observations to evaluate CAM5 simulations of shallow convective clouds at Manus.

Data:
• Observations from MMCR, soundings, and other instruments at the ARM site of Manus (April 03, 2001 - March 07, 2011) – for composite of shallow clouds and their moistening
• TRMM daily precipitation (0.25° x 0.25°, 1998-2009) – for identify MJO and non-MJO large-scale convective events
• 24 – 48 hrs output at Manus grids from CAM5 CAPT simulations (May 2008-April 2010) – For validation of simulated shallow clouds against ARM observations at Manus

Definition of Shallow Clouds:
Cloud-base height is within the boundary layer; cloud-top height is below the freezing level

Rain Attenuation Identification and Correction:
- Compare KAZR echo-top height with the merged Cloud-Precipitation Radar Dataset at Addu Atoll during AMIE/DYNAMO (Feng et al. 2014)
- Remove attenuated cloud radar echoes in Part I (Fig. 2a) and correct them in Part II (Fig. 2b).

Conclusion:
Shallow convective clouds, precipitating or non-precipitating, vary randomly through the life cycle of the MJO. They provide important background moistening effect on the lower troposphere, but they alone do not explain the observed increases in lower-tropospheric moisture leading to rainfall peaks of the MJO.

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