Characterizing the joint convective and radiative diurnal cycles in Amazonia for multiple successive general circulation and reanalysis models

J. Brant Dodson[1], Lindsey Rodio[2], Kyle F. Itterly[3], and Patrick C. Taylor[1]

[1]Climate Science Branch, NASA Langley Research Center, Hampton, Virginia, USA, [2]Florida Institute of Technology, Melbourne, Florida, USA, [3]Science Systems and Applications, Inc., Hampton, Virginia, USA

The diurnal cycle of convection (CDC) in a fundamental mode of atmospheric variability that remains difficult to simulate in general circulation models (GCMs), and retrospective analysis (reanalysis) products derived from GCMs. In continental tropical regions such as Amazonia, models tend to produce precipitation around local noon, several hours earlier the observed precipitation maximum. These errors potentially connect with other errors in the models, such as the top-of-atmospheric radiative flux diurnal cycle (RDC). These errors are investigated using a family of GCMs and reanalyses – the Goddard Earth Observing System Model, Version 5 (GEOS-5); the Modern Era-Retrospective Analysis for Research and Applications (MERRA), which uses GEOS-5 as the core GCM; and MERRA2, the successor of MERRA. In addition, the ERA-Interim reanalysis is used to provide an alternate view of the CDC and RDC for comparison.

The RDC and CDC are characterized for the Amazon basin for the wet and dry seasons. The common error of precipitation occurring too early in the day also exists for these models, but for GEOS-5 and MERRA, there is an additional unobserved secondary precipitation maximum occurring at local midnight (Fig. 1). This behavior varies across different sub-regions of the Amazon, and is less prominent near the northeast coastline (in northern Brazil) than to the south and west. These errors are connected with very large unrealistic mid-tropospheric vertical velocity at local midnight. In addition, the error in the timing of precipitation is not directly proportional to an error in the timing of the RDC. Instead, the longwave cloud forcing maximizes several hours later in the day than observed. This indicates a fundamental disconnect between the RDC and the CDC in the models. These errors are reduced in MERRA2, suggesting a route for improving the representation of the CDC in GCMs.

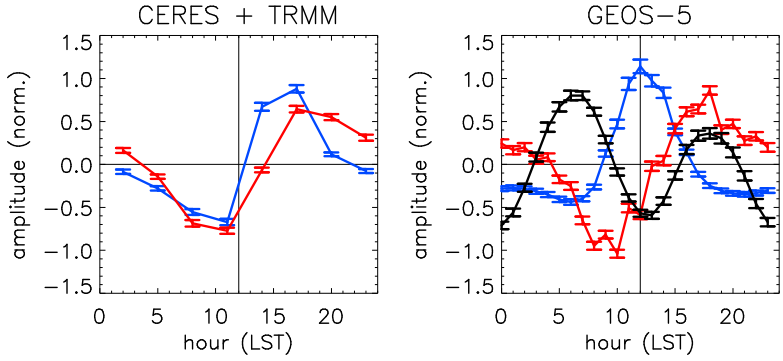

Figure 1. Comparison of satellite-observed (left) and GEOS-5 (right) RDC and CDC. Red line is longwave cloud forcing, blue line is precipitation rate, and black line (simulation-only) is 500 hPa vertical pressure velocity. Amplitudes are normalized by curve area. Local noon is indicated.