On the controls of deep convection and lightning in the Amazon

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Local observations and remote sensing have been extensively used to unravel cloud distribution and life cycle but yet their representativeness in cloud resolve models (CRMs) and global climate models (GCMs) are still very poor. In addition, the complex cloud-aerosol-precipitation interactions (CAPI), as well as thermodynamics, dynamics and large scale controls on convection have been the focus of many studies in the last two decades but still no final answer has been reached on the overall impacts of these interactions and controls on clouds, especially on deep convection. To understand the environmental and CAPI controls of deep convection, cloud electrification and lightning activity in the pristine region of Amazon basin, in this study we use long term satellite and field campaign measurements to depict the characteristics of deep convection and the relationships between lightning and convective fluxes in this region. Precipitation and lightning activity from the Tropical Rainfall Measuring Mission (TRMM) satellite are combined with estimates of aerosol concentrations and reanalysis data to delineate the overall controls on thunderstorms. A more detailed analysis is obtained studying these controls on the relationship between lightning activity and convective mass fluxes using radar wind profiler and 3D total lightning during GoAmazon 2014/15 field campaign. We find evidences that the large scale conditions control the distribution of the precipitation, with widespread and more frequent mass fluxes of moderate intensity during the wet season, resulting in less vigorous convection and lower lightning activity. Under higher convective available potential energy, lightning is enhanced in polluted and background aerosol conditions. The relationships found in this study can be used in model parameterizations and ensemble evaluations of both lightning activity and lightning NOx from seasonal forecasting to climate projections and in a broader sense to Earth Climate System Modeling.

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