On the trigger and time-scales of shallow-to-deep convection in Amazonia

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Deep atmospheric convection covers a range of spatial and temporal scale that are difficult to capture in numerical models. In tropical continental regions, in particular, this difficulty is exacerbated by the lack of observational data. Representing the shallow-to-deep (STD) convective transition is problematic and is often misrepresented in numerical models, hampering our ability to trust, for instance, important studies about climate change impacts on the hydrological cycle.

To further our understanding of the STD transition, we utilize 2-years of data from the GoAmazon 2014/5 experiment (Martin et al., 2017) to study the evolution of deep convective events over the T3 site, in central Amazonia (3° 12' 47.88" S, 60° 35' 55.32" W). Cloud top brightness Temperature (CTT) from GOES13 was used to identify 151 afternoon transition events following Adams et al. (2017). In an Eulerian approach, we built composites (centered at time of minimum CTT, t_0) to investigate the STD timescale and evaluate thermodynamic and environmental conditions.

Our analysis indicates that the typical STD transition begins at sunrise. The boundary layer height and the lifting condensation level (LCL) rise from 200m (t0-8h) to 600m (t0-4h) ??REALLY??, at the same time as the level of free convection (LFC) drops from 1800m to 600m, and CAPE increased from 200 J/kg to 1000 J/kg. During this period, the warm-cloud fraction (CTT > 0ºC) comprises 25% of cloud fraction, and deep-cloud contribution is negligible (<3%, CTT < -38ºC). After the atmospheric trigger (LFC = LCL), shallow clouds grow into congestus (t0-4h to t0-2h), with warm-cloud fraction decreasing to 15% and cold- fraction increasing to 15%. From sunrise (t0-8h), column water vapor increases from 5.5 to 5.8 cm. The next phase is the congestus phase organizing into deep convection, which happens from t0-2h to t0, at the expense of CAPE consumption. CTT drops from 280K to 220K. Evaporation of rain, which starts at t0-2h, moistens the PBL, increasing RH and lowering the LCL, which decouples from the LFC that begins to rise, as CAPE is reduced. Precipitation persists until t0+2h. Warm-cloud fraction reaches a minimum of 8% around t0+1h, when cold- fraction is maximum (60%).

Martin, S.T., et al., 2017: BAMS, 98, 981–997
Adams, D. K., et al., 2017: MWR, 145, 279-288