Precipitation Controls during the Amazonian Dry Season: Observations from the GOAmazon Field Campaign

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Motivation and Approach

The Amazon rain forest plays an important role in the global energy, hydrologic, and carbon cycles. The precipitation during the dry season (June to September) has a significant impact on the extent of the forest and the canopy. Most of the Global Climate Models (GCM) part of the IPCC's fifth assessment report (AR5) forecast the dry season to get longer and drier in the future (Cook et al. 2012; Joetzjer et al. 2013) with a considerable inter-model spread. In this work, we used the data collected during the 2014 and 2015 dry seasons as a part of the Green Ocean Amazon (GO Amazon) field campaign to study the controls of precipitation during the dry season. Precipitation was observed at the surface during 106 (43%) days, with daytime precipitation during 63 (26%) days. The nighttime precipitation was associated with transient storm systems, while the daytime precipitation resulted due to local land-atmosphere interactions. First we characterized the mean diurnal cycle of surface, clouds, precipitation, radiation, and thermodynamic properties for the entire dry season, and then contrasted them for precipitation and cumulus (non-precipitation) days.

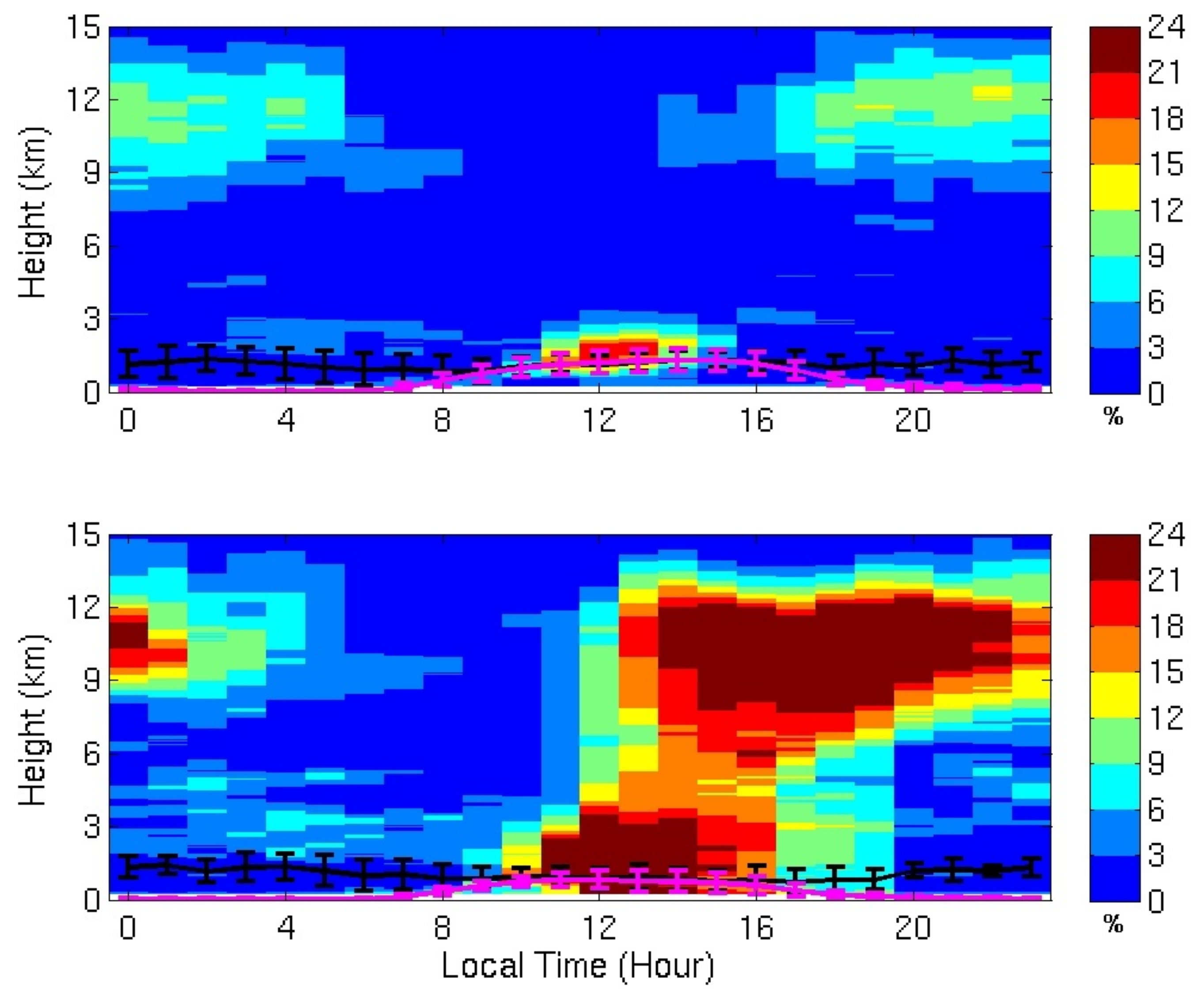

Figure 1: Time-height mapping of the diurnal cycle of hourly averaged ARSCL cloud fraction during the dry season for cumulus days (top) and precipitation days (bottom) along with the first cloud base height (black) and LCL (magenta). The nighttime cloud fraction of low-level clouds was higher during precipitation days than during cumulus days.

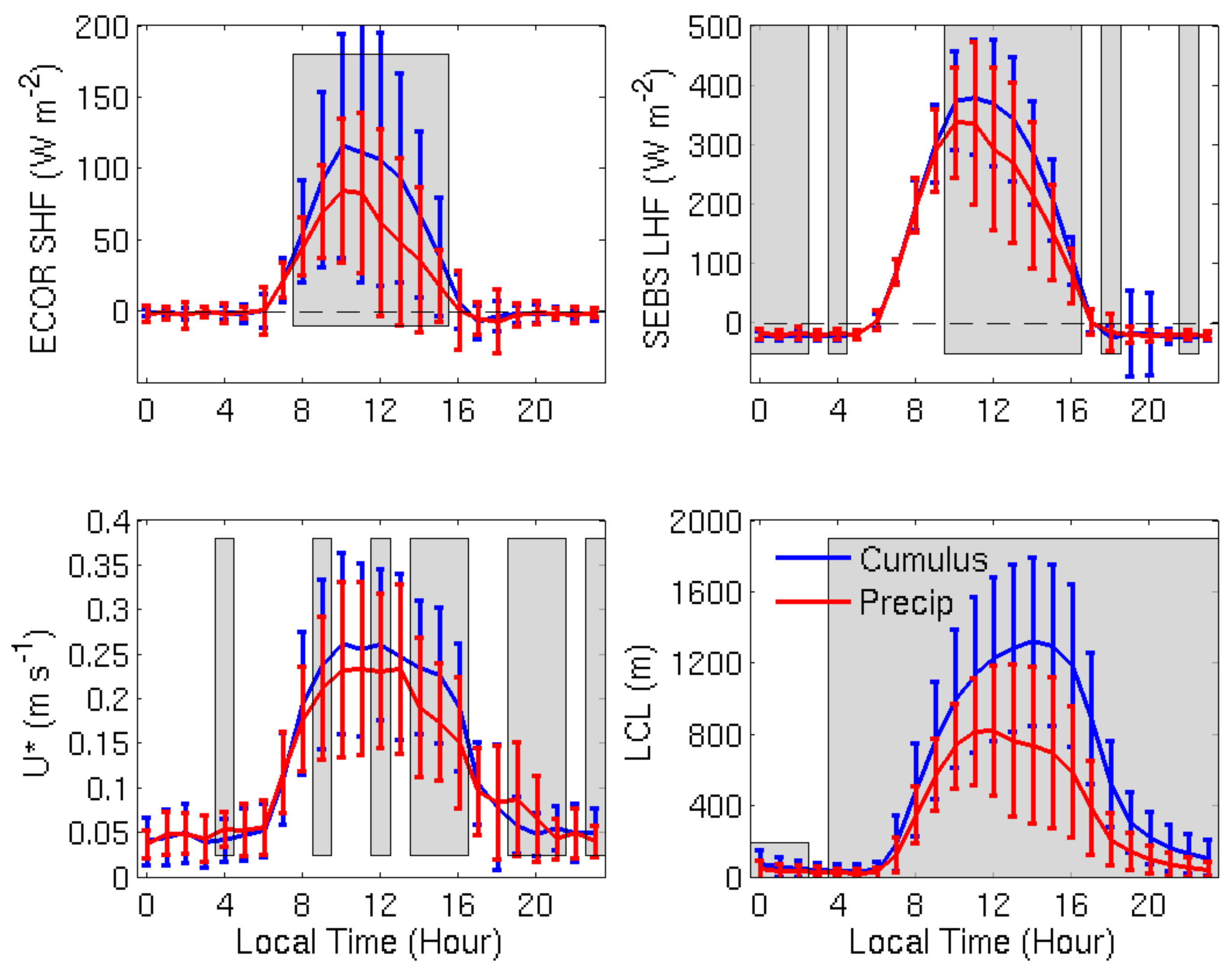

Figure 2: Mean diurnal cycle of surface sensible heat flux (SHF), latent heat flux (LHF), friction velocity (U*), and lifting condensation level (LCL) for precipitation days (red) and cumulus days (blue). The gray shading shows the times when the differences between the two cycles are statistically significant.

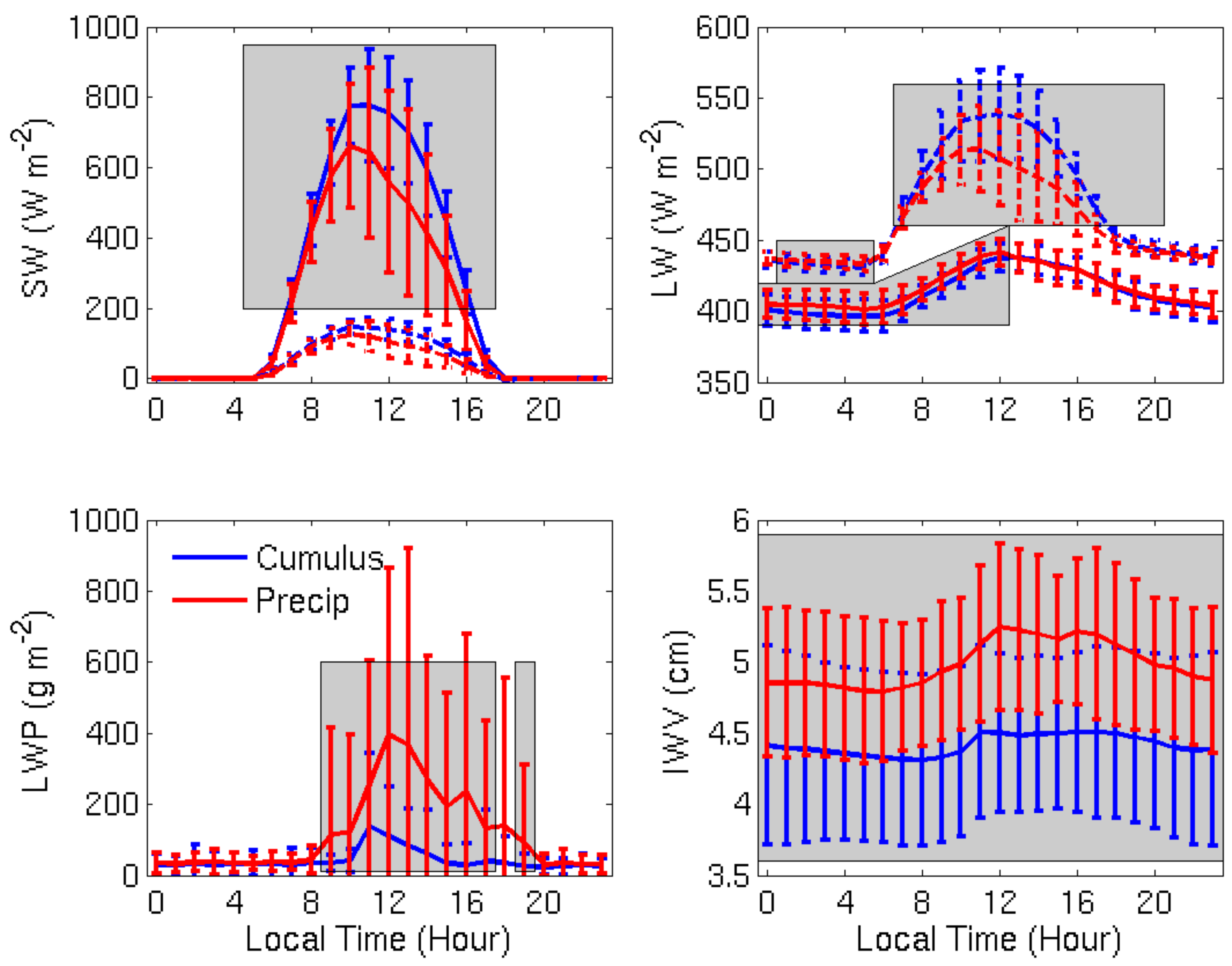

Figure 3: Mean diurnal cycle of surface shortwave radiation (SW), longwave radiation (LW), liquid water path (LWP), and integrated water vapor (IWV) for precipitation days (red) and cumulus days (blue). The gray shades show the times when the differences between the two cycles are statistically significant. The soundings reported water vapor from surface to 6 km on precipitation days was higher than that during cumulus days.

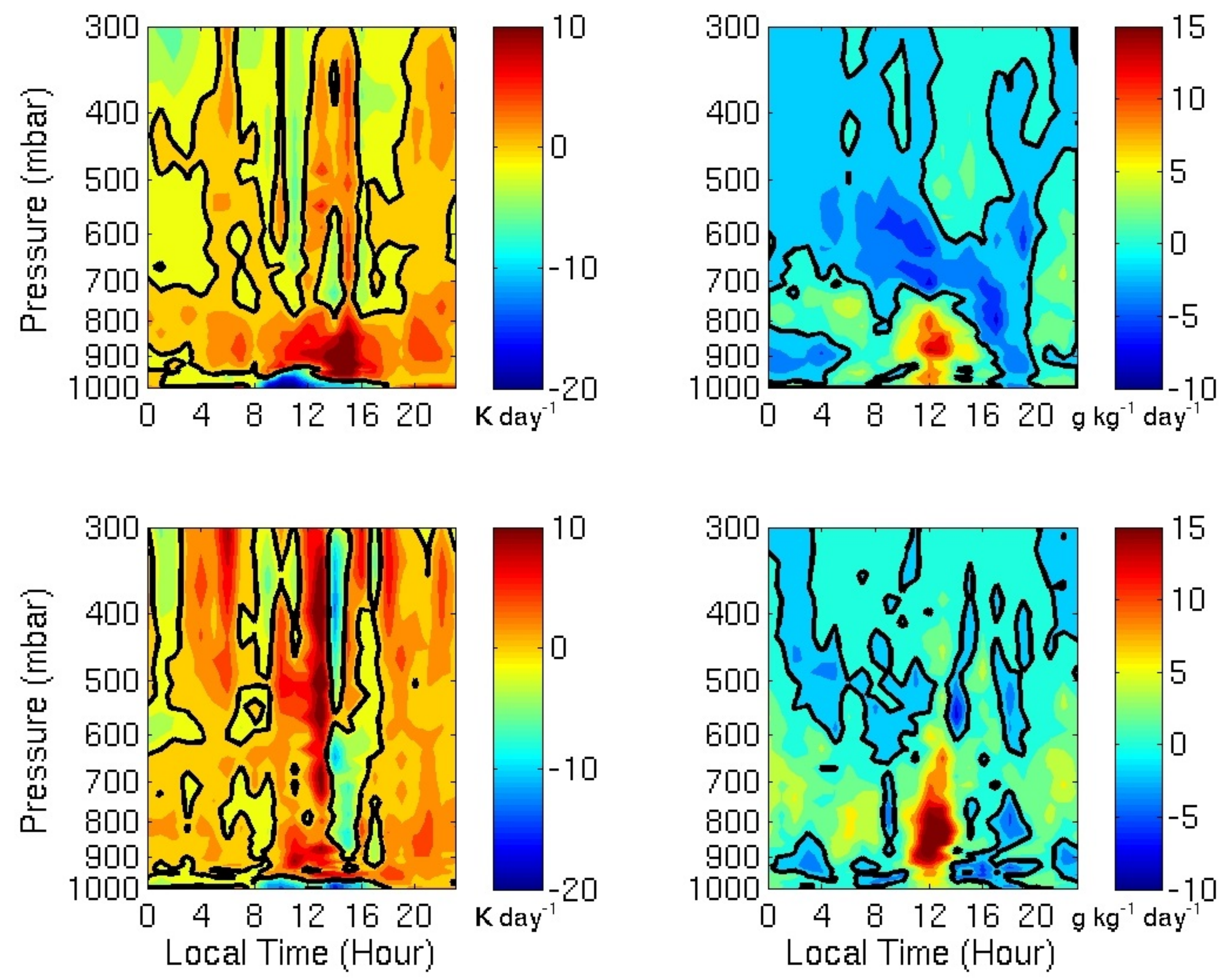

Figure 4: Mean diurnal cycle of the horizontal advection of temperature (left) and moisture (right) during cumulus days (top) and precipitation days (bottom). The black lines denote the zero-value contour. Dry advection above the boundary layer noticeable during the cumulus days was absent during precipitation days.

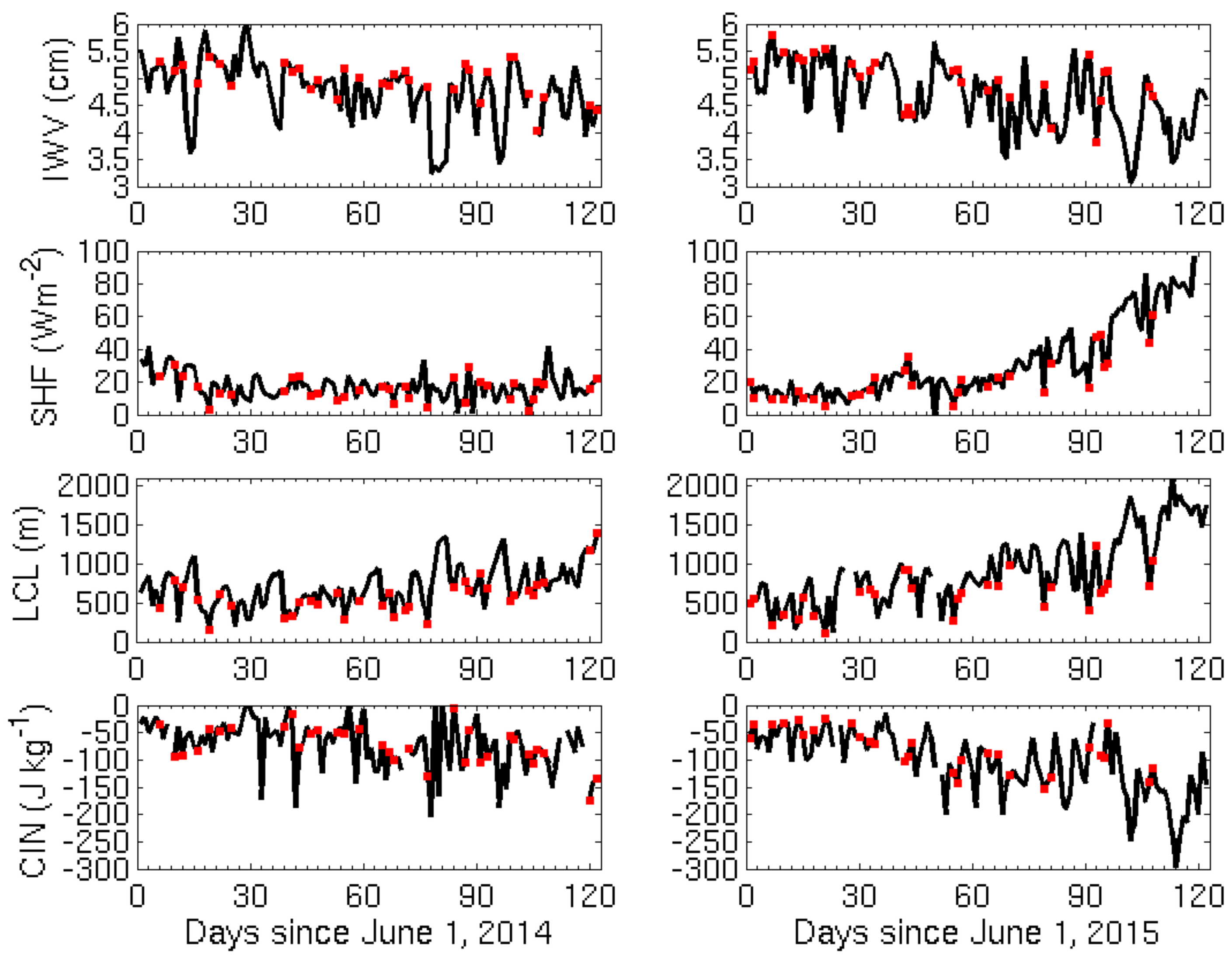

Figure 5: Daily averaged values of column integrated water vapor (IWV), sensible heat flux (SHF), lifting condensation level (LCL), and Convective Inhibition (CIN) for 2014 (left) and 2015 (right) dry season. The red dots represent days with daytime precipitation. *The progression of the variables through the dry season differed significantly between the two years.*

Key Results and Conclusions:

- In the dry season the winds within the boundary layer are southerly with near-zero temperature and moisture advection that change to westerly with cold advection below 900hPa during the daytime.
- During the precipitation days, due to lower surface air temperature and higher mixing ratio, the LCL is significantly lower compared to the non-precipitating days resulting in lower CIN.
- The moisture content below 6 km is significantly higher during the precipitation days than during cumulus days that also had dry advection above the boundary layer.
- Broadly synthesizing, mesoscale water vapor transport seems to be the principal control of daytime precipitation during the Amazonian dry season, with changes greater than 2 cm occurring over the span of few days.

References:

Cook, B., N. Zeng, and J.-H. Yoon, 2012: Will Amazonia dry out? Magnitude and causes of change from IPCC climate model projections. *Earth Interact.*, **16**, 1–27

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Joetzjer, E., H. Douville, C. Delire, P. Ciais, 2013: Present-day and future Amazonian precipitation in global climate models: CMIP5 versus CMIP3. *Climate Dynamics*, **41**, 2921-2936