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Assessing evapotranspiration drivers and patterns at multiple scale in the Amazon basin

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Evapotranspiration (ET) is a key variable to terrestrial climate system, transferring water from the surface to the atmosphere, regulating air temperature and carbon exchanges, thus, linking the water, carbon and water cycles. Despite its great importance, ET patterns in tropical biomes are not fully understood yet. Studies with eddy covariance (EC) ET measurements and remote sensing models demonstrated a huge importance over ET drivers and limiting factors. In this context, this study aimed to assess the ET process in the tropics, from local to basin scale, using EC measurements (from the LBA project) and remote sensing models (MOD16 and GLEAM). At local scale, measurements and estimates were evaluated against net radiation, precipitation and vegetation index (EVI), in order to assess how these drivers control ET patterns. Then, a Budyko approach was applied at basin scale to calculate how water and energy constrain ET in large basins, including Amazon, Solimões, Purus, Medeira, Tapajós, and Xingu rivers. Our results demonstrated disagreements between models to represent maximum and minimum ET rates at tropical forest vegetation (at K43, K67 and K83 sites), with ET measurements peaking during the dry season, in a pattern coincident with annual net radiation cycle. Moreover, deep rooting of well-established rainforests, available soil moisture and increased solar radiation allow ET processes to be maintained during the dry season. ET estimates from MOD16 algorithm agree with these patterns, however, estimates from GLEAM indicates maximum ET rates during the rainy season. At cropland/pasture vegetation (at K77 site), also located in central Amazon, EC measurements showed moderate negative agreement with net radiation (R^2 = -0.48) and positive with precipitation (R^2 = 0.53), with decreasing ET rates during the dry season. GLEAM showed ET rates reduction in dry months, but also showed a peak in during wet season, while increasing ET estimates are observed for MOD16, both presented similar behavior as in tropical forest sites. Furthermore, measurements in the southwest part (RJA and FNS sites) did not show clear seasonal patterns, and both MOD16 and GLEAM algorithms, agree with decreasing ET rates during the dry season, showing a significant relationship with precipitation and vegetation indices. Results based on the Budyko approach indicated agreement between the models, indicating a predominant energy-limited condition when evaluated whole basin (at Óbidos station), or basins located in the northern and western parts of Amazon (in Amazon, Purus, and Negro basins), which corroborates with other studies, where ET has limited energy availability. However, our results also

demonstrated disagreements in basins located in the southern and eastern parts (in Madeira, Tapajós and Xingu basins), where MOD16 showed some water-limited conditions, whilst it was not observed for GLEAM algorithm. Whether the models agree in terms of seasonality and water and energy limitations, they also disagree between them and ground measurements. This study highlighted the importance to understand limitations of multi-models and multi-scale ET processes for hydroclimatological studies in the tropics.