Response of a Bornean Rainforest to the Climatic Changes imposed by ENSO during 2009-2016

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Tropical rainforests belong to the most important biomes, as they are one of the largest terrestrial carbon sink and also a consequent source of latent energy. Furthermore, they will be among the first ecosystems to undergo climatic changes in the near future. Understanding how they will response to those changes is essential. El Niño-Southern Oscillation (ENSO) is an opportunity to study ecosystem response under real climatic change conditions.

Transpiration (Tr), net ecosystem exchange (NEE) and heat fluxes were measured with an eddy covariance system in a natural rainforest in Sarawak, Malaysia. Meteorological and soil moisture observations were also conducted. This region does not have phase-locked dry periods, and seasonal variations of both air temperature and solar radiation are small. However, it is directly impacted by ENSO events. During the study period, from November 2009 to December 2016, two events were selected : La Niña 2010-2011 and El Niño 2014-2016. Normal conditions were assumed as a third "neutral" period. Comparisons of measured flux and meteorological drivers between the three periods were carried out, and analysis of environmental controls, as canopy conductance (g_c) were made.

Precipitation and air temperature were significantly different between the three periods. While the water cycle (latent heat flux, Tr, g_c) responded immediately to the changes imposed by La Niña, the enhancement of the ecosystem respiration balanced the gross primary production gain, resulting into a NEE similar to neutral conditions. Conversely, the NEE during El Niño was significantly smaller than during neutral, when the water cycle seemed not impacted. However, further observations of this late rainforest response evolution showed that, during the first part of El Niño, Tr and g_c increased while CO_2 flux reduced. Then, during the second part, the trend reversed : CO_2 flux increased and Tr, as well as g_c, reduced. This may indicate a time lag between the meteorological drivers (precipitation and air temperature) changes imposed by El Niño and the ecosystem response (H_2O and CO_2 fluxes). The response delay may be caused by the rainforest tendency to poorly regulate its water use, being a particular moist environment. As for the response itself, it may be triggered by the depletion of the soil water content.

Those results imply that considering the length of El Niño and the ecosystem response trigger are important to understand and model bornean rainforest fluxes under future climatic scenario.

Keywords: Borneo, Rainforest, ENSO, NEE, Transpiration

