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Seasonal and interannual variations of carbon fluxes at the Amazon Tall Tower Observatory site in 2014-2019

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The vegetation and soils of the Amazon contain large amounts of carbon that may be vulnerable to loss given ongoing climate and land use change in the Amazon basin. Previous studies predicted that the Amazon rainforest would start to act as a net carbon source to the atmosphere by 2030-2040, and that it has switched from being a sink to source over the last decade. Using data from eddy covariance and vertical carbon dioxide profile measurement systems installed at the 80 m walk-up tower in the Amazon Tall Tower Observatory (ATTO) site, located in well-preserved central Amazon upland rainforest, we assessed net ecosystem exchange (NEE), gross primary productivity (GPP), and ecosystem respiration (R_{eco}) for the period 2014-2019. The NEE results indicate that the central Amazon upland rainforest was carbon neutral or a source during this 6-year period. Seasonal GPP variations were related to soil water availability and vapor pressure deficit. The strong 2015-2016 El Niño event decreased both GPP and R_{eco} due to the unusually long dry period, but also contributed to carbon flux dynamics in post El Niño periods. In the 2017-dry season, we measured higher dry-season GPP compared with the other years, which we hypothesize was triggered by photosynthesis activation in sub-canopy and understory trees. This is supported by the minimum green crown fraction at upper canopy trees, indicating more light availability in lower canopy trees, and the higher fraction of absorbed photosynthetically active radiation, both recorded during the dry-season of 2017. Our results show that the ground-based measurement setup at ATTO is well suited to investigate the local carbon fluxes on seasonal to interannual time scales.