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Enhanced NEE of CO_2 due to biogenic aerosol via diffuse radiation fertilization in the Amazon forest: long-term measurements at ATTO – Amazon Tall Tower Observatory

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Atmospheric processes and climate are closely linked to the Carbon cycle in the Amazon region as a consequence of the strong biosphere/atmosphere coupling. Aerosols particles may affect plant productivity through the increase in diffuse radiation fraction reaching the surface and, as a consequence, the Carbon cycle. This study examines the effects of atmospheric aerosols on net radiation and the consequences for NEE of CO_2 (Net Ecosystem Exchange) in the central Amazon. Some of the major exogenous factors affecting photosynthetic activity of plants are examined. CO_2 flux and NEE are analyzed as a function aerosol concentration at the ATTO tower sampling site, located in the Uatumã Reserve, approximately 150 km northeast from Manaus in a pristine forest of the central Amazon. Remotely sensed Aerosol Optical Depth (AOD) measurements at 550 nm from the MODIS sensor on the Aqua and Terra platforms (MODIS Atmospheric Products, MOD/MYD04L2-3K, Collection 6.1), previously validated with AERONET (Aerosol Robotic Network) sun photometers. CO_2 fluxes are measured with fast-response eddy covariance method. An algorithm of clear-sky irradiance was developed from a long observational time series (2012-2016) to calculate a variable denominated relative irradiance f, used to express the amount of extinction solar radiation due to the presence of aerosols and clouds in the region. Overall net absorption of carbon by forest (NEE of CO_2) varied not only with the concentrations of aerosols, but also with cloud cover, solar elevation angle (SZA) and other parameters. At ATTO, an average increase of 18% and 22% in the CO_2 flux and NEE was observed when the values of AOD ranged from 0.10 (background in the Amazon) to $\sim$ 0.50. For larger reduction in incident radiation the NEE was observed to be reduced to values close to zero. The increase of 18 and 22% of NEE was attributed to the increased diffuse fraction of solar radiation in relation to their direct fraction, especially attributable to biogenic aerosols. Important influences on the temperature and relative humidity induced by the interaction between radiation and high aerosol loading were also observed. In view of the transport of aerosols over long distances emitted by biomass burning, significant changes in the carbon flux may be occurring in large areas of Amazonia. The influence of aerosols on the CO_2 flux and NEE represents a very important effect for the Amazonian ecosystems and have an important influence on the global carbon budget.