Atmospheric Inversions and Satellite Data Reveal Recent Amazon Carbon Balance Variability Driven by Climate Anomalies

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Understanding the effects of heat and drought on tropical rainforests is critical for quantifying the effect of climate change on rainforest ecosystems. This knowledge in turn is important for understanding the likely magnitude of climate-carbon cycle feedbacks induced by global warming. We use aircraft vertical profiles of atmospheric carbon dioxide (CO_2) and carbon monoxide (CO) from 2010-2012 in an transport inversion to resolve monthly-scale evolution of sub-basin Net Ecosystem Exchange (NEE) in Amazônia. We find that inter-annual variation and annual carbon balances do not follow a year-to-year pattern but instead follow climate anomalies. Climate anomalies in the years observed appear to have driven high variability in NEE. In particular, wet season heat and dry season drought led to increased forest carbon loss in the central Amazon. We compare our results with satellite indicators for Gross Primary Productivity (GPP) in an attempt to parse the impacts of GPP and ecosystem respiration on the observed NEE signals.
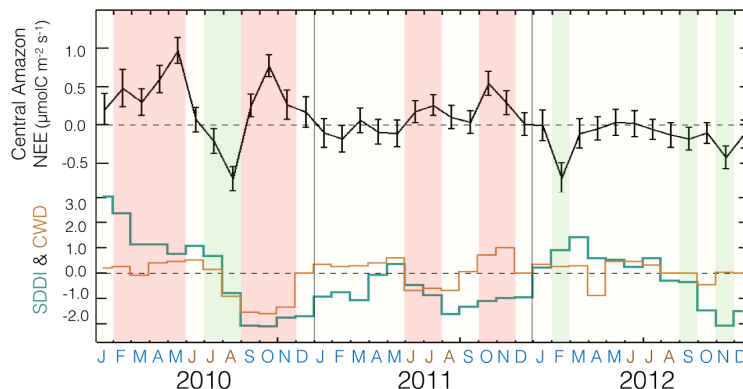
Figure 1. Monthly central Amazon net ecosystem exchange (top panel) with error bars showing 1-σ posterior uncertainty (SOM). In the second panel, a monthly standardized drought index that incorporates both temperature and precipitation (SDDI) (*SOM, Touma et al., in press*) (teal) and a monthly index of Cumulative Water Deficit (CWD) that resets to zero each December (*SOM*) (orange) are shown. The colors of the vertical bars correspond to monthly sink strength: red indicates a source to the atmosphere (within 75% confidence interval), yellow indicates neutral, and green indicates a sink for atmospheric CO_2 (within 75% confidence interval). Along the bottom of the timeseries, abbreviations for months are colored brown in the dry season (JJA) (*see SOM for definition*) and blue for the rest of the year. Sign conventions: (+) NEE indicates source to atmosphere and (-) values indicate sink, (+) SDDI and CWD indicate non-drought conditions and (-) indicate drought conditions.