Amazonian Atmospheric CO_2 Data Suggest Missing Moisture Sensitivity in Carbon-climate Models

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It is critical to assess whether the prognostic terrestrial biosphere models included in Earth System Models (ESMs) accurately represent carbon dynamics in the tropics, because of the distinct possibility of strong positive feedbacks between tropical carbon stocks and global climate. Atmospheric observations of carbon dioxide (CO_2) can help constrain surface-to-atmosphere fluxes of CO_2, but until recently this has been difficult in the tropics due to sparse high-quality observations. New, regular sampling of vertical profiles of air above the Brazilian Amazon in four locations from 2010 to 2015 was recently analyzed in three studies: a mass balance approach, a global inversion and a regional atmospheric inversion. All three studies found that during the 2010 drought, NBE was higher (i.e. the rate of carbon loss to the atmosphere was higher) than in the year(s) following, a result that agrees with forest-plot studies in the Amazon. The regional inversion study further found strong negative correlations between wet season precipitation anomalies and NBE in the month following, and strong positive correlations between wet season temperature anomalies and NBE in the same month, in the central and eastern regions of the Amazon. We compare regional inversion results with NBE from 8 dynamic global vegetation models (DGVMs) that are part of the TRENDY model project and find that the TRENDY models agree with basin-wide NBE differences between years. The TRENDY models also correctly identify a positive correlation between temperature anomalies and NBE in the wet season in the eastern and central Amazon. The TRENDY models do not appear, however, to capture the observed negative correlation between NBE and precipitation anomalies in the Amazon that is identified by the atmospheric inversion. The lack of sensitivity of the carbon balance of the TRENDY models to moisture represents a serious shortcoming in their model structure.

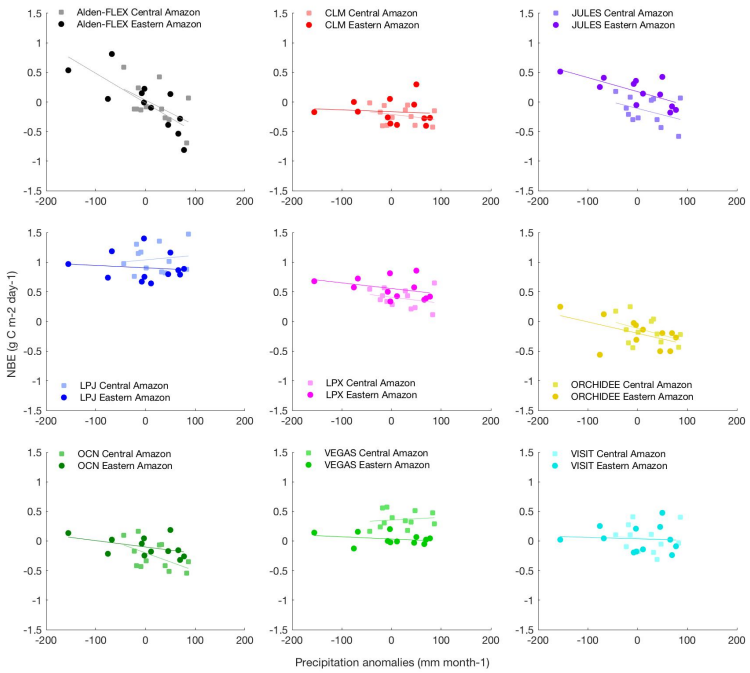

Figure 1. Wet season NBE from inversion results of Alden et al. (2016) (top left panel) and from 8 TRENDY models, plotted against precipitation anomalies. NBE is lagged 1 month behind precipitation. Linear fits shown for each. TRENDY model NBE is compared with precipitation anomalies from driver data (CRU-NCEP) and Alden-FLEX is compared with precipitation anomalies from GPCP.