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Comparing Amazon Basin CO_2 fluxes from an atmospheric inversion with TRENDY biosphere models

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Abstract:
Net exchange of carbon dioxide (CO_2) between the atmosphere and the terrestrial biosphere is sensitive to environmental conditions, including extreme heat and drought. Of particular importance for local and global carbon balance and climate are the expansive tracts of tropical rainforest located in the Amazon Basin. Because of the Basin's size and ecological heterogeneity, net biosphere CO_2 exchange with the atmosphere remains largely un-constrained. In particular, the response of net CO_2 exchange to changes in environmental conditions such as temperature and precipitation are not yet well known. However, proper representation of these relationships in biosphere models is a necessary constraint for accurately modeling future climate and climate-carbon cycle feedbacks. In an effort to compare biosphere response to climate across different biosphere models, the TRENDY model intercomparison project coordinated the simulation of CO_2 fluxes between the biosphere and atmosphere, in response to historical climate forcing, by 9 different Dynamic Global Vegetation Models. We examine the TRENDY model results in the Amazon Basin, and compare this “bottom-up” method with fluxes derived from a “top-down” approach to estimating net CO_2 fluxes, obtained through atmospheric inverse modeling using CO_2 measurements sampled by aircraft above the basin. We compare the “bottom-up” and “top-down” fluxes in 5 sub-regions of the Amazon basin on a monthly basis for 2010-2012. Our results show important periods of agreement between some models in the TRENDY suite and atmospheric inverse model results, notably the simulation of increased biosphere CO_2 loss during wet season heat in the Central Amazon. During the dry season, however, model ability to simulate observed response of net CO_2 exchange to drought was varied, with few models able to reproduce the "top-down" inversion flux signals. Our results highlight the value of atmospheric trace gas observations for helping to narrow the possibilities of future carbon-climate interactions, especially in historically under-observed regions like the Amazon.