Amazon Basin-wide Fluxes of CO_2 and CH_4 from Aircraft Vertical Profiles

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Potential feedbacks between land carbon pools and climate are one of the largest sources of uncertainty for predicting future global climate, but estimates of their sensitivity to climate anomalies in the tropics and determination of underlying mechanisms are either incomplete or strongly model-based. The Amazon Basin alone stores ~150-200 Pg (1015 g) of labile carbon, and has experienced an increasing trend in temperature and extreme floods and droughts over the last two decades. Here we report the first Amazon Basin-wide seasonal and annual carbon balances based on tropospheric greenhouse gas sampling, which is the product of a unique collaboration between scientists from NOAA, Brazil and the United Kingdom. Results presented here focus on an anomalously dry and a wet year, 2010 and 2011, providing the first Basin-wide assessment of sensitivity to such conditions. During 2010, the Amazon Basin lost 0.5±0.2 $PgCyr^{-1}$ while in 2011 it was approximately carbon neutral (0.06±0.1 $PgCyr^{-1}$). Carbon loss via fire was 0.5±0.1 $PgCyr^{-1}$ in 2010 and 0.3±0.1 $PgCyr^{-1}$ in 2011, as derived from Basin-wide carbon monoxide (CO) enhancements. Subtracting fire emissions from total carbon flux to derive Basin net biome exchange reveals that in 2010 the non-fire regions of the Basin were carbon neutral; in 2011, however, they were a net carbon sink of -0.3±0.1 PgC yr^{-1}, roughly consistent with a three-decade long intact-forest biomass sink of ~ -0.4±0.3 $PgCyr^{-1}$ estimated from forest censuses. In contrast to CO_2, fluxes of methane (CH_4) from the Amazon Basin are smaller in 2011 than in 2010. In both years, by far the largest fluxes were seen in the eastern part of the basin, a result that process-based models have been unable to reproduce. And also unlike CO_2, fire is a relatively small component of CH_4 fluxes with wetland emissions likely dominating.

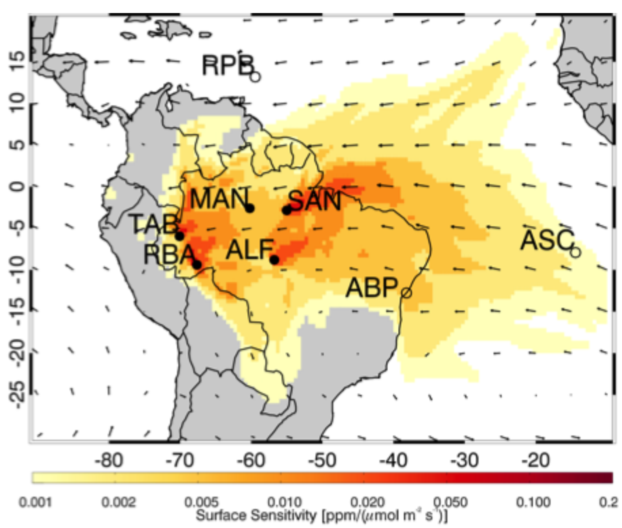

Figure 1. Map of IPEN (ALF, SAN, TAB, RBA) and NOAA (ABP, RPB, ASC) sites along with the soon to be implemented MAN site. Also shown are average surface influence functions for the four IPEN vertical profile sites during 2010 as calculated with the FLEXPART Lagrangian Particle Dispersion Model; annual average wind vectors below 600 mb also show the dominant influence of the trade winds in the lower troposphere.

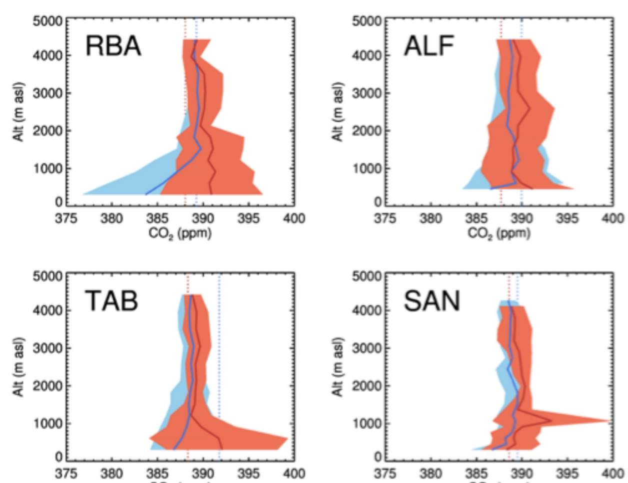

Figure 2. Examples of dry and wet season CO_2 light aircraft-based vertical profiles at the four IPEN sites from Fig 1. Red and blue lines are mean 2010 profiles for dry and wet seasons, respectively (n~10 per season), and background shading shows the one sigma standard deviation of variability at each altitude. Dashed vertical lines show the dry and wet season averages for the tropical Atlantic background CO_2 calculated as a weighted average of ASC and RPB.