Estimating emissions of Amazonian fire emissions using in situ and satellite measurements of atmospheric carbon monoxide

John
Miller
NOAA Global Monitoring Laboratory
Sourish Basu, University of Maryland
Luciana Gatti, INPE
Lucas Domingues, University of Sao Paulo
Guido van der Werf, Wageningen University
Merritt Deeter, retired
Jean-Francois Muller, Belgian Instute for Space Aeronomy
Poster

Fire is responsible for a significant fraction of carbon that leaves the forest and savanna biomes of the Amazon Basin. Most often, these fire carbon emissions are quantified using “bottom-up” inventory approaches that are partly constrained by satellite detection of fire hot spots, radiative power, or burned area, but also rely on highly uncertain parameters such as fuel loading and combustion completeness. As a complement to bottom-up emissions estimates, we will present independent, “top-down” estimates of carbon emissions from fires based on measurements of atmospheric carbon monoxide (CO). CO is emitted from fires, which allows its use, within an atmospheric inverse model, to determine total carbon emissions given knowledge of emission ratios for different vegetation types. In order to isolate the impact of Amazonian fires on atmospheric CO concentrations, a global CO modeling framework has been developed that describes all the sources and sinks of atmospheric CO. Most significantly for the Amazonian atmosphere, we have included a description of the production of CO resulting from oxidation of volatile organic compounds (VOC) constrained by satellite observations of formaldehyde. We have estimated fire emissions spanning 2010-2017 using satellite CO data from the MOPITT sensor aboard NASA’s Terra along with globally distributed measurements of in situ CO. We will also use highly accurate (but sparse in time and space) INPE aircraft vertical profiles above Amazonia to assess biases in fire emissions derived from inversions using satellite CO data streams.

Our inverse results, as validated by INPE vertical profile CO data, show good agreement with inter-annual variability of emissions from GFED 4.1s (which was not used as an inversion prior) over our study period. However, our top-down emissions suggest that GFED 4.1s tends to underestimate emissions in high fire years such as 2010 and 2016. In particular, the atmospheric CO-constrained fire emissions show substantial emissions in the late dry season and early wet season (October – December) after bottom-up emissions from GFED have largely ended. These seasonal differences between our inversions and GFED occur not just in high fire years but in most years we have studied. Significantly, these differences are too large to be explained on the basis of CO:total-C emission factors and very likely represent substantial differences in fire extent and/or intensity between the top-down and bottom-up approaches. This inference is supported by analysis of the spatial patterns of late-year GFED and CO-based fire emissions, which shows that the bottom-up/top-down discrepancy is dominantly located in the northeastern Amazon basin. Finally, we will assess the degree to which the initial version of newly produced GFED5 fire emissions might better represent fires in the late dry season in the northeast that don’t appear to be well-represented in GFED 4.1s.

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