Study of greenhouse gases emitted by biomass burnings with a decade of infrared observation of CO_2, CH_4 and CO by IASI

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ABSTRACT

Biomass burnings are one of the major sources of greenhouse gases in the atmosphere, impacting air quality, public health, climate, ecosystem dynamics, and land-atmosphere exchanges. In the tropics, South America represents about 10 % of the tropical emissions and present a large diversity of biomes and fire conditions. Over the last two decades, satellite observations have provided crucial information, notably via active fires detection, Fire Radiative Power (FRP) estimates and burned area (BA) measurements from imagers such as Moderate Resolution Imaging Spectroradiometer (MODIS) and Visible Infrared Imaging Radiometer Suite (VIIRS). Global inventories (e.g., GFED, GFAS, FEER, QFED, etc.) heavily rely on these satellite-derived indicators to estimate emissions from biomass burnings. However, emissions derived from these various models can significantly differ among them and large uncertainties persist regarding fire emissions, their variability, and their links with several drivers (e.g., type of combustion, vegetation, transport, etc.).

In this context, we propose a novel approach to estimate emissions from biomass burnings by directly using greenhouse gas concentrations in the atmosphere derived from spaceborne observations. Leveraging a decade of observations from the Infrared Atmospheric Sounding Radiometer (IASI) on-board the three Metop satellites, we have access to an unprecedented spatial coverage of global mid-tropospheric CO_2, CH_4 and CO concentrations twice a day (9:30 AM/PM LT). From this dataset, we developed the Daily Tropospheric Excess (DTE) method, which is based on the use of the diurnal cycle of biomass burnings combined with the vertical and horizontal transport of their emissions to link the observed diurnal variations of the mid-tropospheric CO_2, CH_4 and CO concentrations to burnings activities.

We will demonstrate the relevance of the DTE for analyzing CO_2, CH_4 and CO emissions from various type of burnings, biomes, and human activities across South America. This will be achieved by comparing DTE with existing indices of fire characteristics such as FRP from MODIS/SUOMI polar satellite observations (2 global scene per day) but also with geostationary data from GOES-R satellites (global scene every 10 minutes), alongside global emissions databases like GFED and GFAS. Globally, we will analyze interannual variability of fire emissions using IASI DTE and highlight how successive combustion phases affect emissions of each gas in various ways. We will show that their spatial distribution, seasonal intensity, and interannual variability are consistent with each other, even if some differences have been found and will be discussed.