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The relative role of Amazonian and non-Amazonian fires in building up the aerosol optical depth in South America

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In South America (SA) biomass burning is the major source of atmospheric aerosols. Fires occur all over the continent but are mainly concentrated in the Amazonia Forest and Cerrado regions during the dry season (July-November). The majority of aerosols studies over SA has been focused on the Amazonia region, this being the major continental source of aerosols during the dry season and an unique, global pristine region during the wet one (December-June). However, fires are systematically employed for land clearing and pasture maintenance all over SA so that other areas may have a potentially important impact over the continental aerosol load. This aspect has been poorly investigated until now.

The main aim of the study presented is to discern and quantify the relative contributions of Amazonia and other three SA source regions in building up the continental aerosol optical depth (AOD), a climate-relevant parameter that optically quantifies the aerosol load in the whole atmospheric column.

To pursue this aim, long-term (2005-2009) fires datasets from satellite (MODIS Terra) are combined with Lagrangian trajectory modeling to obtain a specific quantity, referred to as 'fire weighted residence time' (FWRT). For eight different target domains covering the whole continent, FWRT values were derived by coupling the MODIS fire counts and air masses transport modeling starting at the fire locations. The FWRT generally shows good correlation with satellite derived fine AOD (MODIS Terra) and is thus used as a proxy for biomass burning aerosols production and transport.

Results show that north of the Equator there is almost no contribution to the aerosol load from fires occurring in the near regions of Amazonia and Caatinga . This is because of the presence of the intertropical convergence zone (ITCZ) that decouples wind circulation north and south of the Equator. In the eastern part of Brazil aerosols produced by local fires from August-November are efficiently transported to the west of the continent by the typical easterly winds and the FWRT values does not match with the AOD pattern observed. This suggests that aerosol loads there are strongly impacted by transoceanic smoke transport from Africa, particularly in October. In central Brazil (including the southern border of the Amazonia forest and Cerrado regions), where the largest amount of fires in SA is produced, the FWRT is dominated by local fires all over the year. However there is a non trivial contribution of fires located in the east side of Brazil that can be as high as 50% during October. Fires originated south of 28°S have a minor contribution on central Brazil FWRT. In Paraguay and North Argentina, during the period August-November, the transport contribution from the Amazonia and Cerrado regions in building up the AOD reaches up to 40% which reduces to 25% in central Argentina. In the same regions, the contribution from fires in the eastern Brazil lowers down to 10% and 5%, respectively. Overall, atmospheric transport is important in the central and southern parts of SA during the period July-November where the presence of the South Atlantic Subtropical High forces low level easterly winds to turn southward, being channeled between the eastern slope of the Andes and the Brazilian Plateau.

Despite some limitations, the FWRT-based methodology developed is revealed a good quantitative way to assess the relative contribution of the different SA biomass burning regions to the continental aerosol loads.