Toward a global climatology of favorable conditions for pyrocumulonimbus events from 2002-2014

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Large smoke infused thunderstorms have been known to develop in the presence of strong forest fires and under the right background meteorological conditions. These are called pyrocumulonimbus events or "pyroCbs." PyroCbs are often accompanied by a trough, which aids pyroCb formation in two ways: the strong prefrontal winds intensify the fire, while the cold front that follows brings the moisture and instability that supports thunderstorm formation. Some of the more significant pyroCbs have overshooting tops which provide an efficient mechanism for aerosol transport into the lower stratosphere. These larger pyroCbs can transport enough aerosol to impact the composition of the lower stratosphere on a hemispheric scale, with climactic implications. However, the extent of these climate effects is not well known since many pyroCbs go unnoticed, especially in regions of both high fire activity and low population density.

The aim of this study is to provide a rubric for identifying pyroCbs that have gone unnoticed, so that the extent of their climate effects can be evaluated. First, data from case studies of confirmed and documented pyroCbs are used to establish thresholds to isolate potential pyroCb events using 13 years of satellite data, to select dates and locations where conditions are favorable for pyroCb formation. This is accomplished by using daily averaged 1°x1° level 3 satellite datasets from the MODerate resolution Imaging Spectroradiometer (MODIS), the Global Fire Emissions Database (GFEDv3), and Measurements of Pollution in the Troposphere (MOPITT). Total Totals index (TT), Lifted Index (LI), as well as Cloud Optical Thickness (COT) from MODIS are used, while CO emission values are taken from both the MOPITT and GFEDv3 datasets. From these parameters, thresholds are identified based on observed values from the confirmed pyroCbs. Five different regions are singled out as "pyroCb hotspots": areas in which unconfirmed pyroCb events are likely to have occurred. Level 1 data from the Optical Spectrograph and InfraRed Imaging System (OSIRIS) are then used to examine these areas during times of large fires in order to implicate overlooked pyroCbs and assess their stratospheric impact.