Compiling a Global Climatology of Pyrocumulonimbus Events to Assess their Climactic Impacts

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It has long been understood that big volcanic eruptions are an efficient mechanism for injecting large amounts of aerosols into the lower stratosphere. However, through similar processes and under the right background conditions, large forest fires can produce huge thunderstorms with overshooting tops that provide a similar mechanism for the transport of aerosol into the lower stratosphere. These storms are called pyrocumulonimbus events or “pyroCbs”. In the lower stratosphere, aerosols are efficiently disbursed by the strong stratospheric winds and are not subject to the scavenging that occurs in the troposphere. As a result, the aerosols that have been injected into the lower stratosphere affect a larger area for a longer period of time, which can carry global climactic implications because of their radiative warming and cooling effects. However, because many pyroCbs likely go unnoticed, the extent of these climactic effects are not very well known.

The timing of satellite pass-overs combined with the small temporal and spatial scale of the pyroCb events make pyroCbs difficult to observe. Typical pyroCbs are on a time scale of about 3 hours with diameters of around 10 km. The Moderate Resolution Imaging Spectroradiometer (MODIS) satellite takes 1 to 2 days to produce a complete view of the earth. Thus, it is likely that many pyroCbs go unnoticed, especially in regions of both high fire activity and low population density. The purpose of this study is to use known pyroCb events as guidelines to develop a method of identifying other potentially overlooked pyroCbs in the past, and to provide a rating system for use in classifying future pyroCbs and ultimately determine the climate impacts of these events. The study examines various large pyro-cumulonimbus events such as the Chisholm firestorm in 2001, the Canberra pyroCb in 2003, the Norman Wells pyroCb in 1998, and several others. The identification method will use a variety of satellite data sets to constrain variables such as relative humidity at the time of the fire, lightning polarity, amount of biomass burned in a given time, type of biomass burned, as well as cloud top heights, pressures and effective radius. The Global Fire Emissions Database (GFEDv3) is utilized to pinpoint areas where large fires have occurred in the past. We then use reanalysis data to help identify background meteorological conditions during the fires, and use the identification method to filter out the large fire events from which pyroCbs likely occurred.