



Wildfire-Driven Thunderstorms Cause a Volcano-Like Stratospheric Injection of Smoke

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Intense heating by wildfires can generate a deep, smoke-infused thunderstorm, known as pyrocumulonimbus (pyroCb), which can release a large quantity of smoke particles into the upper troposphere and lower stratosphere. To date, however, the impact of pyroCb on climate has never been systematically explored, and remains almost completely unquantified. Here we employ satellite observations to quantify the mass of smoke aerosol injected into the lower stratosphere from five near-simultaneous intense pyroCb observed in western North America on 12 August 2017. We find that the stratospheric aerosol mass injected by this extreme event was comparable to a moderate volcanic eruption, or a Volcanic Explosivity Index (VEI) event measured between 3 and 4. The stratospheric impact was an order of magnitude larger than the most significant single-event stratospheric intrusion of smoke aerosol recorded to date, producing a high-altitude smoke layer that encircled the Northern Hemisphere over several months. This extreme event likely exceeded the total stratospheric aerosol mass injected by all pyroCb activity (26 events) observed during the fire season of 2013 across western North America. These results demonstrate that that pyroCb activity, quantified as either large singular events or a fire season inventory, can significantly influence the lower-stratosphere in a manner similar to infrequent volcanic intrusions. The meteorology driving pyroCb occurrence, combined with increasingly active fire seasons, indicates that pyroCb are a significant and endemic summertime feature in several temperate regions worldwide. We anticipate that this study will establish a foundation for understanding the effects of pyroCb smoke on lower-stratospheric chemistry and dynamic circulation.