Geophysical Research Abstracts
Vol. 21, EGU2019-6199, 2019
EGU General Assembly 2019

Stratospheric aftermath of the August 2017 North American wildfires: a multi-platform perspective

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Extreme pyro-convection (PyroCb) events triggered by wildfires in northwest Canada and U.S. in August 2017 resulted in vast injection of combustion products and ice into the stratosphere. Various ground-based and satellite observations indicate that this PyroCb event had an unprecedentedly strong impact on stratospheric aerosol load, rivaling moderate volcanic eruptions like those of Sarychev peak and Nabro. This study synthesizes a wide array of ground-based and satellite observations to describe the spatiotemporal evolution of the smoke plumes in the stratosphere as well as its optical parameters, chemical composition and radiative effect. These are backscatter and depolarization measurements by ground-based lidar and CALIOP, extinction measurements at various wavelength by SAGE III and OMPS LP, water vapour and carbon monoxide observations by MLS along with GNSS radio occultation temperature profiling.

The observations put in evidence that after the multi-PyroCb event in British Columbia on 12 August, the smoke plumes have reached Europe in about a week, whilst ascending through radiative heating with a rate of up to 30 K/day. In about 3 weeks the thinner forefront plumes entrained by the jet have already circumnavigated the Earth, reappearing above Canada. Meanwhile, the thicker (major) plume travelling at higher levels was separated above middle Asia into eastbound (northern) and westbound (southern) patches in mid-September. By mid-November, the smoke aerosols have spread across the entire stratosphere North of the tropical belt. We show that both the magnitude and the duration of the BC wildfire-induced signal in stratospheric AOD series are comparable to a moderate volcanic eruption.

An important finding of this study is that the wildfire event has led to a measurable increase of stratospheric water vapour and carbon monoxide at hemispheric and monthly scales. By analyzing collocated measurements of smoke plumes by different satellite sensors we attempt to characterize the smoke aerosol optical properties, chemical composition and the magnitude of radiative heating.