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Transport of the 2017 Canadian wild fire plume to the tropics and global stratosphere via the Asian monsoon circulation

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We show that a fire plume originating at high northern latitudes during the Canadian wild fire event in July/August 2017 reached the tropics, and subsequently the stratosphere via the ascending branch of the Brewer-Dobson-Circulation (BDC). For this, we use a combination of aerosol extinction data from the Stratospheric Aerosol and Gas Experiment III (SAGEIII) and the Ozone Mapping Profiler Suite (OMPS), carbon dioxide measurements from the Infrared Atmospheric Sounding Interferometer (IASI), FLEXPART-TRACZILLA back-trajectories and information for the position and strength of the Asian Monsoon Anticyclone (AMA) transport barrier from the Chemical Lagrangian Model of the Stratosphere (CLaMS). The transport from high to low latitudes in the upper troposphere and lowermost stratosphere was mediated by the anticyclonic flow of the Asian monsoon circulation. The Canadian fire plume reached the Asian monsoon area in late August/early September, when the AMA was still in place. While there is no evidence of systematic mixing into the center of the AMA, we show that a substantial part of the Canadian fire plume is entrained into the circulation at the AMA edge, and is transported into the tropical UTLS, and possibly the Southern Hemisphere particularly following the North-South flow on the eastern side. In the tropics the fire plume is lifted by about 1.5 km per month.

Inside the AMA we find evidence of the Asian Tropopause Aerosol Layer (ATAL) in August, doubling background aerosol conditions with a top of the atmosphere shortwave radiative forcing of -0.05 W/m^2. This is estimated using the UVSPEC radiative transfer model and the LibRadtran package. The regional climate impact of the fire signal in the wider Asian monsoon area in September exceeds the impact of the ATAL by a factor of $\sim$3 (-0.13W/m^2). Once in the stratosphere, the climate impact of such kind of trans-continental transported plumes can be hemispheric and long-lasting, pointing at the importance of this long-range dynamical interconnection of pollution sources.