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Detection of aerosols in Antarctica from long-range transport of the 2009 Australian wildfires

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We analyze the long-range transport to high latitudes of a smoke particle filament originating from the southern tropics main plume after the Australian wildfires now colloquially known as 'Black Saturday' on February 7th 2009. Using a high-resolution transport/microphysical model, we show that the monitoring cloud/aerosol lidar instrument operating at the French Antarctic station Dumont d'Urville (DDU - 66°S - 140°E) recorded a signature of those aerosols. The 532 nm scattering ratio of this thin aerosol structure is comparable to typical moderate stratospheric volcanic plume, with values between 1.4 and 1.6 on the 1st and 3rd days of March above DDU station at around the 14 and 16 km altitude respectively.

In this study, a dedicated model is described and its ability to track down such fine optical signatures at the global scale is assessed and validated against the Antarctic lidar measurements. Using one month of tropical CALIOP/CALIPSO data as a minimal support to a relatively simple microphysical scheme, we report modeled presence of the aerosols above DDU station after advection of the aerosol size distribution. The space-borne lidar data provide constraints to the microphysical evolution during the simulation and ensure reliable long-range transport of the particles as well as accurate rendering of the plume small-scale features below the 1°x1° resolution threshold.

This case study of smoke particle signature identification above Antarctica provides strong evidence that biomass burning events, alongside volcanic eruptions, have to be considered as processes able to inject significant amounts of material up to stratospheric altitudes. Among the questions arising out of this study, we highlight the occurrence and imprint of such smoke particles on the Antarctic atmosphere over larger time scales. Any degree of underestimation of the global impact of such deep particle transport will lead to uncertainties in modeling the associated chemical or radiative effects, especially in polar regions where many specific microphysical processes take place. Mainly through sedimentation, particle trapping above Antarctica may also impact the ground albedo (which is some of the largest in the world). Correlated to the smoke presence, we also report an associated ozone increase observed with the DDU ozone lidar. This feature only rarely been observed for events where pyroconvection is originally involved.