



In-situ Measurements of the Tropopause Aerosol Layer at the Tibetan Plateau and the Influence of the Volcanic Eruptions

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A robust but thin aerosol layer in summer extending geographically from Eastern Mediterranean to Western China, the Asian Tropopause Aerosol Layer (ATAL) was observed and verified by the CALIPSO lidar measurements. However, its source and forming mechanism is still under debate. In August 2018 and 2019, two experimental campaigns over the Tibetan Plateau were carried out at Golmud (GLM, 36.48°N, 94.93°E) and Qaidam (QDM, 37.74°N, 95.34°E), during which a balloon-borne Portable Optical Particle Counter (POPS) was used to measure the features of aerosol particulates. The in-situ measurements show a robust ATAL around the tropopause, ranging from 14 to 18 km a.s.l., with a maximum aerosol number density of 35–40 cm⁻³ and a maximum aerosol mass concentration of 0.13 µg m⁻³ for particles with diameters between 0.12 and 3 µm, and majority of the particulates (98%) are smaller than 0.4 µm in diameter.

Backward-trajectory simulations are conducted with the Massive-Parallel Trajectory Calculations (MPTRAC) model to investigate the possible sources and transport pathways of the observed particulates. The backward-trajectory analysis revealed that the air parcels arrived at the altitude of the ATAL through two separate pathways: 1) the uplift below the 360 K isentropic surface, where air parcels were first elevated to the upper troposphere and then joined the ASM anticyclonic circulation, which will take about 5–10 days; and 2) the quasi-horizontal transport along the anticyclonic circulation, located approximately between the 360 and 440 K isentropic surfaces. The dispersion of the volcanic aerosol from the volcanic eruption of Raikoke in June 2019 has enhanced the aerosol layer in the Tibetan Plateau upper troposphere and lower stratosphere (UTLS), but the ATAL was not concealed by the volcanic plume because the boundary of the Asian summer monsoon (ASM) anticyclone acted as a transport barrier which stopped most of the volcanic aerosol entering the ASM region. Only at most 20% of the aerosol particulates observed in the Tibetan Plateau UTLS was contributed by the Raikoke volcanic eruption. Comparing with the Nabro eruption in 2011, the influence of volcanic eruption on the ATAL significantly depends on the relative geographical location of the volcanic eruption and the ASM anticyclone, as well as the volcanic plume height.