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The dominating aerosol distribution, properties and trends over the Pan-Third Pole from 10-year multi-sensor measurements

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The Pan-Third Pole (PTP), which extending westward from the Tibetan Plateau (TP) to Europe, is the core region of the "The Belt and Road" initiative. The TP has experienced a large-scale accelerated warming over the past few decades, which far exceeds the rate of global warming. This warming trend is considered to be the main cause for the retreat of glaciers and have profound impact on the regional and even global hydrologic cycle. Absorbing aerosols are known to exert a great melting potential on these glaciers through reducing snow and ice albedo and radiative forcing. Therefore, understanding the dominating aerosol types, properties and trends in the PTP region is of great significance for assessing the radiative forcing and climatic effects of this region.

In this study, the decadal (2007-2016) active (CALIOP/CALIPSO) and passive (MODIS/Aqua and OMI/Aura) satellite measurements are used to derive the climatology of columnar and vertical distribution, optical properties and changing trends of the dominating aerosols over the PTP region. Results indicate that the PTP region has very distinct climatic features from the west to the east as humid-arid-humid climate characteristics. The Taklimakan Desert (TD) and Iranian Plateau (IP) regions are dominated by dust aerosol, elevated smoke aerosol is the dominating type in Central Europe (CE) and Indo-China (IC) regions, while TP is the cleanest region of the whole PTP. The contribution of dust to total aerosol extinction was 96% and 86% in TD and IP regions respectively, but 54% and 30% of total aerosol extinction in CE and IC regions were contributed by elevated smoke. The mean aerosol extinction coefficient (MAEC) has obvious difference in different regions of the PTP, aerosol layers with the strongest extinction (>0.1 km-1) mainly occur below 4 km. The weakest extinction layers (>0.001 km-1) mainly distribute between 5-7 km and reach approximately 8 km in the TP region, which indicates pronounced vertical transport in this region. The decadal trends of column aerosol optical depth (AOD) over different regions of PTP related to the contributions of different dominating aerosol types. In IC region, significant upward trend (spring) and downward trend (autumn and winter) of AOD are mainly caused by elevated smoke. In CE region, The downward trends of AOD in spring and winter attribute to polluted dust and elevated smoke, respectively. Elevated smoke has significantly increased in summer over the TP region.