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On the nature and origin of the Asian Tropopause Aerosol Layer

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Satellite observations of insoluble gases such as CO have shown that convection associated with the Summer Asian Monsoon provides an effective transport pathway for boundary layer pollution to reach the upper troposphere. Since 2006, high-resolved backscatter profiles from the CALIPSO lidar have also demonstrated that the Asian Monsoon leads to the formation of a recurrent aerosol layer near the tropopause, called the Asian Tropopause Aerosol Layer (ATAL). A recent reanalysis of past SAGE II aerosol observations in the upper troposphere confirms the presence of this feature which was detected in the early 2000's but not prior to that time. Given observed increased levels of pollution in Asia during the past decade, the ATAL could result from the convective transport of primary aerosols and/or their gas-phase precursors emitted at the surface.

After isolating ATAL from signals associated with small volcanic plumes, which were relatively frequent in the Upper Troposphere and Lower Stratosphere (UTLS) region during the past 6 years, we show that the Asian Monsoon is the primary source of non-volcanic aerosols in the global upper troposphere. Perturbations of the fragile radiative balance near the tropopause can influence the transport of tropospheric air into the stratosphere, with important consequences for climate and ozone chemistry. It is thus highly important to improve our knowledge on the nature and origin of ATAL, as well as to assess its impact on the radiative, chemical and dynamical balance of the UTLS.

We have investigated the nature and origin of ATAL through a combined analysis of satellite observations, in situ measurements, and trajectory and aerosol transport models. Those results suggest that ATAL is primary composed of carbonaceous aerosol associated with tropospheric pollution and convection in South East Asia with a dominant influence of the Indian Sub-continent. Measurements of gas precursors, aerosol size distribution and composition within deep convective outflows as well as inside the Asian Anticyclone are crucial to better understand the origin and formation of ATAL as well as its interaction with the Monsoon. We hope to enhance collaborations between Asian, European and American researchers to promote an international field experiment that would help in a better understanding of ATAL and its impact in climate.