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Generation of the the Asian Tropopause Aerosol Layer by transport of convective air

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High resolution backward and forward trajectory calculations are used to study the transport of convective air in and around the Asian Monsoon Anticyclone (AMA). We focus on the 2017 summer season which is the first one during which MSG (Meteosat Second Generation) data and products are available over the Asian Monsoon region and during which the StratoClim campaign data are available. The transport is performed using ERA-Interim and ERA5 with both diabatic and kinematic vertical transport at 3-hourly and hourly time resolution.
This study corroborates previous findings by Tissier and Legras (ACP, 2016) and brings new important highlights on AMA air masses and the pathways from the boundary layer to the stratosphere during the Asian monsoon.
We show that the trajectories reconstruct a layer of concentrated convective parcels within the AMA at about 16 km which is also the altitude of the observed Asian Tropopause Aerosol Layer (Vernier et al., 2015). The main sources to the high altitude core of the anticyclone concentrate in preferred continental regions in Northern India, China and the Tibetan Plateau. The first two regions are highly polluted. The age of air with respect to convective injection is however minimal in the core of the AMA, and not maximal as instead expected, indicating that the observed pollutant concentration is not due to trapping but to the localization of sources and the favourable conditions of vertical transport in the TTL. We also emphasize that the main troposphere to stratosphere flux from Asian Monsoon convection is not processed within the anticyclone but circulate around and is mostly of maritime origin.
Both kinematic and diabatic trajectories generate a maximum amount of convective parcels at 16 km but there are also significant differences: for instance, in respect to the kinematic transport, the radiative diabatic transport rapidly washes out the levels below 14 km in the AMA. There are also differences between ERA-Interim and ERA5 diabatic transport due to differences in the cloud distribution in these two reanalysis. ERA5 has lower mean high cloud top but emphasizes the role of high penetrating convective towers.