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Characterization of transport from the Asian summer monsoon anticyclone into the UTLS via shedding of low-potential vorticity cutoffs

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Air mass transport within the summertime Asian monsoon circulation provides a major source of anthropogenic pollution for the upper troposphere and lower stratosphere (UTLS). In our study, we investigate the quasi-horizontal transport of airmasses from the Asian summer monsoon anticyclone (ASMA) into the extratropical lower stratosphere and their chemical evolution. For that reason, we developed a method to identify and track the air masses exported from the monsoon. This method is based on the anomalously low potential vorticity (PV) of these air masses (tropospheric low–PV cutoffs) compared to the lower-stratosphere, and uses trajectory calculations and chemical fields from the Chemical Lagrangian Model of the Stratosphere (CLaMS). The results show evidence for frequent summertime transport from the monsoon anticyclone to mid-latitudes over the North Pacific, even reaching high latitude regions of Siberia and Alaska. Particularly, the most promising region and time for measurements of transported anticyclonic air masses that cross the tropopause, is the North Pacific from July to August. Most of the low–PV cutoffs related to air masses exported from the ASMA have lifetimes shorter than one week (about 90%) and sizes smaller than 1 percent of the northern hemisphere (NH) area. The chemical composition of these air masses is characterised by carbon monoxide, ozone and water vapour mixing ratios at an intermediate range between values typical for the monsoon anticyclone and the lower-stratosphere. The chemical evolution during transport within these low–PV cutoffs shows a gradual change from characteristics of the monsoon anticyclone to characteristics of the lower stratospheric background during about one week, indicating continuous mixing with the background atmosphere.