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Transport pathways at the top of the Asian monsoon anticyclone into the UTLS with the focus on the StratoClim measurements

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The Asian summer monsoon is the most pronounced circulation pattern in boreal summer associated with deep convection and with an upper level anticyclonic flow that extends from the upper troposphere into the lower stratosphere (UTLS). It is believed that the Asian monsoon circulation provide an effective pathway for tropospheric trace gases such as ozone depleting substances and radiatively active species (including water vapour and aerosol precursors) into the lower stratosphere.The transport of ozone depleting substances and radiatively active species into the lower stratosphere has a significant impact on the chemical composition of the lower stratosphere and on surface climate, respectively. However, there is a longstanding debate about the transport mechanisms at the top of the Asian monsoon anticyclone and beyond into the tropical pipe and the horizontal transport into the northern extratropical lower stratosphere.

Simulations with the Chemical Lagrangian Model of the Stratosphere (CLaMS) will be presented using artificial tracers of air mass origin. With this technique the impact of young air masses on the composition of the Asian monsoon anticyclone and above in the lower stratosphere can be determined. The artificial tracers are continuously released since the pre-monsoon season in the model boundary layer.

Above the anticyclone, young air masses from continental Asia (India,China,..), southeast Asia and the tropical Pacific Ocean are found deep into the lower stratosphere. CLaMS trajectory calculations demonstrate that at these altitudes vertical upward transport of young air masses occurs at the edge of the anticyclone. Therefore, young air masses from outside the Asian monsoon anticyclone are also transported into the lower stratosphere (above the thermal tropopause) and contribute to the composition of air masses above the anticyclone. The CLaMS model results are compared with global HCFC-22 measurements of the MIPAS instrument onboard the ENVISAT satellite for previous monsoon seasons. Because HCFC-22 is emitted in locally restricted regions, in particular in eastern Asia and therefore in the Asian monsoon region, this trace gas is very well suited for studying transport processes in the region of the Asian monsoon anticyclone.

We will present comparisons between the CLaMS model simulations and airborne measurements of the Geophysica high-altitude aircraft during the StratoClim field campaign from Kathmandu (Nepal) in July/August 2017. The comparisons of CLaMS and campaign data confirm transport pathways found in the CLaMS model in particular, young air masses with an origin in India/China and the tropical Pacific at altitudes above the monsoon anticyclone (above 400K).