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Tropical tropopause layer (TTL) cirrus and humidity in the Asian monsoon anticyclone and the surrounding tropics

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A specific highlight of the Cirrus Guide II (Krämer et al., 2020, ACP) is the in-situ observation of tropical tropopause layer (TTL) cirrus and humidity in the Asian monsoon anticyclone during the Airborne StratoClim field campaign in 2017, in comparison to observations in the surrounding tropics from the campaigns POSIDON 2016, ATTREX 2014, SCOUT 2005, TROCCINOX 2005, etc. This is of importance, because water vapor is a greenhouse gas that has a significant impact on the surface climate of the Earth, especially in the tropics. The tropics are the main gate for water transport from the upper troposphere to the lower stratosphere, as gaseous component and also as ice particles. Our measurements show that the amount of water injected into the convectively very active Asian monsoon TTL is significantly larger (peak values of N_{ice} and IWC of 30 cm^{-3} and 1000 ppmv are detected around the cold point tropopause, CPT) than in the surrounding calmer tropical regions. Above the CPT, ice particles that are convectively injected might locally add a significant amount of water available for exchange with the stratosphere. We found IWCs of up to 8 ppmv above the Asian monsoon anticyclone in comparison to only 2 ppmv in the surrounding tropics. Also, the highest RH_{ice} inside of the clouds as well as in clear sky are observed around and above the Asian monsoon CPT. We attribute this to the high amount of H_2O (3–5 ppmv) in comparison to 1.5–3 ppmv in other tropical regions. Outside of the Asian monsoon, in the regions of weak convective activity, the supersaturations above the CPT are 10–20 %, while above the Asian monsoon anticyclone, supersaturations of up to about 50 % has been found. As saturation at the coldest point of an air mass was assumed to be the regulator of water vapor transport to the stratosphere, these supersaturations, especially above the Asian monsoon anticyclone CPT, suggest that the water exchange with the stratosphere is higher than expected.

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