Geophysical Research Abstracts
Vol. 21, EGU2019-13213-2, 2019
EGU General Assembly 2019

Dehydration and low ozone in the tropopause layer over the Asian monsoon caused by tropical cyclones: Lagrangian transport calculations using ERA-Interim and ERA5 reanalyses data

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Low ozone/water vapour structures near the tropopause layer over Kunming (South China) were observed using balloon-borne measurements performed during the SWOP (sounding water vapour, ozone, and particle) campaign in August 2009 and 2015. Here, we investigate low ozone/water vapour structures using FengYun-2D, FengYun-2G, Aura Microwave Limb Sounder (MLS) satellite measurements and backward trajectory calculations driven by both ERA-Interim and ERA5 reanalyses data. Trajectories with kinematic and diabatic vertical velocities are calculated using the Chemical Lagrangian Model of the Stratosphere (CLaMS) trajectory module.

All trajectory calculations display that air parcels with low ozone/water vapour structures originate from the western Pacific boundary layer. Deep convection associated with tropical cyclones over the western Pacific transport boundary air parcels with low ozone into the cold tropopause region. Subsequently, the air parcels are mixed into the strong easterlies on the southern side of the Asian summer monsoon anticyclone. These air parcels are dehydrated when passing the coldest temperature region ($<$190 K) over the western Pacific and become dry during quasi-horizontal advection. Final, low ozone/water vapour structures in the subtropics were detected over Kunming by balloon-borne measurements. However, trajectory calculations display different vertical transport via deep convection depending on used reanalyses data (ERA-Interim, ERA5) and vertical velocity (diabatic, kinematic). Both the kinematic and the diabatic trajectory calculations using ERA5 data show faster and stronger vertical transport than ERA-Interim primarily due to ERA5's better spatial and temporal resolution, likely resolving more convective events. The kinematic trajectory calculations from the ERA5 data show the fastest and strongest vertical transport around the deep convection caused by tropical cyclones compared to other trajectory calculations.