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Aerosols increase upper tropospheric humidity over the North Western Pacific

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Water vapour in the upper troposphere is highly important for the global radiative transfer. The source of upper tropospheric humidity is deep convection, and aerosol effects on them have got attention only recently. E.g., aerosol effects on deep convective clouds have been missing in general circulation models (Quaas et al., 2009). In deep convection, aerosol effect on cloud microphysics may lead to more ice precipitation and less warm rain (Khain et al., 2005), and thus more water vapour in upper troposphere (Bister & Kulmala, 2011).

China outflow region over the Pacific Ocean was chosen as a region for a more detailed study, with latitudes 25-45 N and three longitude slots: 120-149 E, 150-179 E and 150-179 W. In this study, we used satellite measurements of aerosol optical depth (AOD) and upper tropospheric humidity (UTH). AOD was obtained from the MODIS instrument onboard Terra satellite, that crosses the equator southward at 10:30 AM local solar time (Remer et al., 2005). UTH was obtained from a microwave humidity sounder (MHS) onboard MetOp-A satellite, with passing time at 9:30 PM local solar time. It measures relative humidity of a layer extending approximately from 500 to 200 hPa.

We binned the AOD and UTH data according to daily rainfall product 3B42 from Tropical Rainfall Measuring Mission (TRMM) satellite. Binning the data according to the amount of precipitation gives us a new way to account for the possible aerosol invigoration effect on convection and to alleviate the contamination and causality problems in aerosol indirect effect studies.

In this study, we show for the first time, based on satellite data, that there is a connection between upper tropospheric humidity and aerosols. Anthropogenic aerosols from China increase upper tropospheric humidity, which causes a significant positive local radiative forcing in libRadtran radiative transfer model (Mayer & Kylling, 2005).

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