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Effect of aerosol particles on relative humidity in the upper troposphere

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Aerosol effects on shallow moist convection have been studied extensively in recent decades. Less is known about the effects of aerosols on deep convection with associated clouds extending to the top of the troposphere. Any possible changes in humidity at these high altitudes can significantly change the radiative properties of the atmosphere (Shine and Sinha, 1991).

In deep convective clouds, aerosol particles can affect cloud microphysics by increasing ice precipitation at the expense of warm rain. Khain et al. (2005) showed with a spectral microphysics cloud model, that there are more ice particles in the upper troposphere in polluted air than in clean air. The lifetime of clouds in polluted air is also longer. Koren et al. (2005) stated that in polluted air convection causes larger ice anvils. The larger amount of ice in association with deep convection may increase relative humidity in the upper troposphere, as discussed recently by Bister and Kulmala (2011).

Recently developed microwave retrievals are capable of estimating upper tropospheric humidity even in areas with anvil clouds (Buehler et al., 2008). Upper tropospheric humidity data from a microwave humidity sounder onboard Aqua satellite is studied, together with Moderate Resolution Imaging Spectroradiometer (MODIS) aerosol optical depth, also from Aqua. According to the first results, it seems possible, that aerosol optical depth and upper tropospheric humidity have a connection. However, to restrict the effect of meteorology, the data will need to be binned according to vertical wind, obtained from ECMWF reanalysis data. A stringent test of cloud filtering will also need to be performed to rule out possible cloud contamination of aerosol and humidity data. It has also been proposed, that aerosols can invigorate convection (e.g. Khain et al., 2005). That effect can also increase upper tropospheric humidity locally. This effect will be considered by studying the data according to cloud top height, obtained from MODIS retrievals.

The aim of the study is to improve the understanding of aerosol effect on deep convection and evaluation of aerosol indirect effects on climate. Any changes in humidity at high altitudes affect longwave radiation strongly. By increasing relative humidity in the upper troposphere, anthropogenic aerosols may have a, so far overlooked, significant warming effect on the climate.

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