Geophysical Research Abstracts,
Vol. 10, EGU2008-A-04272, 2008
SRef-ID: 1607-7962/gra/EGU2008-A-04272
EGU General Assembly 2008

Upper tropospheric humidity and cirrus thickness: a statistical analysis using one year of collocated AIRS-CALIOP data

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Supersaturation of water vapor with respect to ice (RHice) in the upper troposphere has been given special attention only recently, and its importance in climate has raised increasing concerns. Ice clouds (cirrus) need a large degree of supersaturation to form, depending on thermodynamical and chemical conditions. Despite this need of high ice supersaturation, in situ measurements have shown RHice distributions inside cirrus clouds in midlatitudes are peaked at a value of RHice $\approx 100\%$. This infers that as soon as ice clouds are formed ice supersaturation is no longer the dominant feature. RHice profiles and cirrus properties determined from spaceborne instruments suffer a lack of vertical and spatial resolutions to show such behaviour. RHice distributions are usually obtained for pressure layers larger than the typical size of the clouds and show a dry bias in comparison with in situ RHi distributions inside cirrus.

We investigate the relationship between RHice near the tropopause and cirrus vertical and optical thicknesses using recent satellite observations from the Atmospheric Infrared Sounder (AIRS) and the Cloud-Aerosol Lidar with Orthogonal Polarization (CALIOP) in tropics and midlatitudes. AIRS provides temperature and humidity profiles at a horizontal resolution of 45 km $\times$ 45 km and relative humidity is derived in 50 to 100 hPa-thick pressure layers. CALIOP provides number of cloud layers and their respective vertical extension.

To highlight the importance of cirrus optical thickness in this relationship, apparent optical depths are derived for the highest cloud layers from CALIOP backscatter profiles. For an estimation of cirrus optical depth, the contribution of multiple scattering

has to be determined. Therefore the apparent optical depth from CALIOP is compared to the cirrus optical depth from AIRS. Finally, we investigate how the cirrus optical depth influences the relationship between RHice and cirrus vertical extent.