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# Untangling the role of upper tropospheric clouds in the modulation of the Earth's climate

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Upper tropospheric clouds, representing about 40% of the Earth's total cloud cover, play a crucial role in the climate system by modulating the Earth's energy budget and heat transport. These clouds, most abundant in the tropics, form either as cirrus anvils from outflow of deep convection or as cirrus by in situ freezing and often build mesoscale systems. Their evolution with climate change and their feedback can only be reliably estimated if these cloud systems are adequately represented in climate models.
Satellite instruments give a global picture of these systems. Studies on tropical mesoscale convective systems so far concentrated mainly on the thick cirrus anvils, because visible-infrared imagery either miss or misidentify thin cirrus. The thinner cirrus, however, might be the part of the anvils with significant radiative impact which then might regulate convection itself.
The good spectral resolution of Infrared Sounders (e.g. HIRS, AIRS, CrIS, IASI) allows a reliable cirrus identification, down to an infrared optical depth of 0.1, both day and night. We present results from a 15 year-climatology from AIRS, being part of the A-Train, and 10-year climatology from IASI, developed at LMD.
Studying interannual variability, tropical cirrus increase relative to all clouds with increasing global mean surface temperature. Changes in relative amount of tropical high opaque and thin cirrus with respect to mean surface temperature show different geographical patterns, suggesting that their response to climate change might differ.
Recently, these cloud data have been further used to build mesoscale upper tropospheric cloud systems by applying a spatial composite technique on cloud pressure. Convective cores, cirrus anvil and thin cirrus within these systems are then distinguished by cloud emissivity. This made it possible to link horizontal anvil structure to convective intensity. It seems that stronger tropical storms include relatively more thin cirrus in / around their anvils. This will have an effect on the atmospheric heating and therefore on the large-scale circulation.
The horizontal emissivity structure of these systems is being complemented by the vertical structure, using the active instruments of the A-Train. We compare the heating rates of the different parts of the systems for different atmospheric conditions.
The observational behaviour is also being used to evaluate detrainment processes in the LMDZ climate model. We highlight its sensitivity to bulk ice crystal fall speed and ice crystal diameter.

References
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