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Cirrus clouds and upper tropospheric humidity

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The discovery of significant supersaturations with respect to ice (RHice >> 100 %) in tropical upper tropospheric cloud-free air and inside tropical cirrus clouds calls into question our understanding of the physics of ice cloud formation. These findings represent potentially important modifications in our characterization of upper tropospheric and stratospheric water and energy budgets, with implications for cloud formation, for fluxes of water and radiation, and for atmospheric chemistry. Various hypotheses recently put forward as explanations will be discussed in this talk. These include: (1) potential out-of-cloud effects, such as low mass accommodation of H2O on aerosol or underestimated vapor pressure of supercooled water; (2) potential in-cloud effects, such as mesoscale temperature fluctuations and subresolution patchiness, control by ice nuclei, blocking of ice growth by HNO3 deposition on ice, forming NAT, very low mass accommodation of H2O on ice, or higher vapor pressure of cubic ice; (3) the question of insufficient data quality. This presentation reviews the current state of understanding provided by field observations, laboratory measurements and modeling. It further discusses new field observations performed with novel balloon-borne instrumentation including the light-weight backscatter sonde COBALD and the best available hygrometers. These observations nourish the conception that even in thick cirrus decks substantial supersaturations (RHice ~ 130 %) can occur and require explanation.