Upper tropospheric and lower stratospheric measurements in the West African and the Asian Monsoons: Physics and chemistry of aerosols and clouds

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During the Asian and West African monsoons large meteorological structures develop which reach into the UTLS with impact on the aerosols and the precursor gases entering the stratosphere. Embedded in the Easterly flow in West Africa these are widespread fields of Mesoscale Convective Systems (MCS) which reach altitudes of 16 to 18 km. Further Northeast the Asian Monsoon Anticyclone (AMA) forms from mid-June until October in an altitude band from 12 to 20 km. The AMA extends from East Asia to the Middle East and, as a fairly closed rotating air mass it is reminiscent of the polar vortex, albeit with a strong convective uplift. Long range transport from as far as Eastern China provides materials which are carried aloft by the West African MCS and the deep convective AMA clouds. Sources (e.g., biomass burning) from the regional boundary layers also contribute here. The anvil outflows of the West African MCS and the AMA clouds release the uplifted (and partly processed) source gases and aerosols into the UTLS. Here New Particle Formation events (NPF) generate new aerosols from the inorganic and organic precursors by homogeneous nucleation. Such NPF occur in clear, cloud free air, as well as in the presence of ice particles in the margins of Cb and MCS anvils. CALIPSO measurements revealed a distinct aerosol layer (the Asian Tropopause Aerosol Layer; ATAL) between 15 and 16.5 km within the AMA, the physical and chemical characteristics of which still are unclear. However, in other tropical vertical profiles (e.g., Hawaii, Brazil, Burkina Faso, Australia) enhancements of submicron aerosol mixing ratios also have been observed -outside of “confinements” like the AMA- between 350 K and 380 K theta altitude levels. Only about 50 % of these particles evaporate when exposed to 250 °C heating. Since these phenomena occur at and above the tropopause in areas with slow upwelling motion, they may contribute to the global stratospheric aerosol. By contrast, recent hypotheses indicate, the aerosol particles nucleated in the UT (probably from organic condensable gases) above Amazonia are transported downward, possibly supplying CCN for cloud development in the middle troposphere. With emphasis on in-situ measurements this presentation provides an overview of the aerosol properties at the gateway to the stratosphere in the tropical UT/LS.