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Airborne in situ tracer observations inside the Asian Summer Monsoon anticyclone: first results and implications for trace gas transport

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The Asian Summer Monsoon is a major agent for rapid transport of polluted air from the surface into the stratosphere. We present the first high altitude in situ tracer observations deep inside the Asian Summer Monsoon anticyclone (ASMA) and the overlying stratosphere up to 20 km altitude. The measurements were obtained over Nepal and India in July and August 2017 during a deployment of the M55 Geophysica research aircraft from Kathmandu, Nepal, in the frame of the EU-funded project StratoClim (Stratospheric and upper tropospheric processes for better climate predications). On board the aircraft long-lived tracers (N_2O, CH_4, CO_2, H_2, F12, F11, H-1211, SF_6) were measured by the University of Wuppertal's High Altitude Gas AnalyzeR (HAGAR), CO by the Carbon Oxide Laser Diode (COLD), and O_3 by the Fast Ozone ANalyzer (FOZAN). The deployment comprised eight scientific flights, including survey flights aimed at improving our understanding of large-scale transport and flights above and around mesoscale convective systems aimed at investigating their impact on the composition of the ASMA and on stratosphere-troposphere exchange.

A first analysis of these measurements will be presented with regard to the principal transport processes controlling the chemical composition of the ASMA and tropical lower stratosphere. Vertical profiles and correlations between the various species, serving as stratospheric tracers, as boundary layer tracers, or age-of-air tracers, will be used to assess i) in-mixing of aged mid-latitude air inside the ASMA and the stratosphere above, ii) the impact of convection as a function of altitude, and iii) slow up-welling inside the ASMA. Comparisons will be made with data obtained with the Geophysica during the AMMA mission focused on the African Summer Monsoon, and the present observations will be put into a climatological context. The picture emerging from this analysis is that surface air delivered by convection up to at least 370 K potential temperature ascends coherently and in isolation inside the ASMA up to 400 K within about 3 months, but rapidly mixes with aged air above 410 K.