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Trace gas transport out of the Indian Summer Monsoon

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The trace gas transport out of the Indian summer monsoon was investigated during the aircraft campaign OMO (Oxidation Mechanism Observations) with the German research aircraft HALO (High Altitude and Long Range Research Aircraft) in July/August 2015. HALO was based at Paphos/Cyprus and also on Gan/Maledives. Flights took place over the Mediterranean Sea, the Arabian Peninsula and the Arabian Sea. In this work the focus is on the distribution of carbon monoxide (CO) and methane (CH4) in the upper troposphere. They were measured with the laser absorption spectrometer TRISTAR on board of HALO.
During the Indian summer monsoon strong convection takes place over India and the Bay of Bengal. In this area the population is high accompanied by many emission sources e.g. wetlands and cultivation of rice. Consequently the boundary layer is polluted containing high concentrations of trace gases like methane and carbon monoxide. Due to vertical transport these polluted air masses are lifted to the upper troposphere. Here they circulate with the so called Asian monsoon anticyclone.
In the upper troposphere polluted air masses lead to a change in the chemical composition thus influence the chemical processes. Furthermore the anticyclone spreads the polluted air masses over a larger area. Thus the outflow of the anticyclone in the upper troposphere leads to higher concentrations of trace gases over the Arabian Sea, the Arabian Peninsula and also over the eastern part of North Africa and the eastern part of the Mediterranean Sea.
During OMO higher concentrations of methane and carbon monoxide were detected at altitudes between 11km and 15km. The highest measured concentrations of carbon monoxide and methane were observed over Oman. The CO concentration in the outflow of the monsoon exceeds background levels by 10-15ppb. However the enhancement in the concentration is not obviously connected to the monsoon due to the natural variability in the troposphere. The enhancement in the methane concentration (30-40ppb) is more obviously connected to the monsoon because it is much higher than the natural variability. Consequently methane is a very good tracer for the monsoon influenced air masses.
Beside flights into the outflow of the Indian summer monsoon, there were also measurements of background concentrations in the upper troposphere in air not influenced by the monsoon. Profiles have shown that the high concentrations of trace gases are only observed in the upper troposphere. The high concentrations in the upper troposphere cannot be explained by vertical transport form local ground sources.