Geophysical Research Abstracts,
Vol. 11, EGU2009-8057, 2009
EGU General Assembly 2009

CARIBIC measurements of methane and other trace gases in the easterly outflow of the Indian summer monsoon

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Indian monsoon is one of the most important global meteorological phenomena in the tropics. In particular during Indian summer monsoon, deep convection occurring in Intertropical Convergence Zone located in the Indian subcontinent brings the polluted surface air to high altitude, perturbing clean free troposphere and/or the lowermost stratosphere. CARIBIC (Civil Aircraft for the Regular Investigation of the atmosphere Based on an Instrument Container, www.caribic-atmosphere.com) conducted atmospheric chemical composition measurements at 8-11 km using an automated instrumental package. Monthly regular flights between Germany and the Maldives or Sri Lanka from November 1997 until April 2001 provides an opportunity to investigate spatial and temporal variation of a variety of atmospheric chemical composition. In summer large enhancement of CH4 was observed in the easterly jet flowing from northern Indian subcontinent between 20°N and 30°N. At the same latitudes, other trace gases (CO, O3, NHMCs, CH3Cl) also show an increase, suggesting the influence of surface air masses driven by deep convection to the chemical composition at high altitude. Seasonal variation of CH4 reveals clear enhancement in summer which is opposite to background observations in the marine boundary layer. This reflects the impact of Indian summer monsoon to the chemical composition of free troposphere. Aided by temporal and spatial variation of other trace gases measured in CARIBIC, we will discuss the source regions of this CH4 plume and estimate the amount of trace gases delivered to the flight altitudes during Indian summer monsoon.