Civil Aircraft for the Regular Investigation of the Atmosphere Based on an Instrument Container (CARIBIC) Observations of CO_2 Uptake During the Indian Summer Monsoon

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During the Indian summer monsoon major changes in large scale atmospheric circulation take place. The Inter-Tropical Convergence Zone (ITCZ) travels $3*10^3$ km north, up to the Himalayas, and surface winds (especially the Somali jet) bring moisture-laden air deep into the sub-continent and neighboring regions. While low pressure systems are abundant, and deep convection is ubiquitous, an extensive upper tropospheric high pressure system develops that to some degree traps air that bears characteristics of surface trace gas emissions, and, in the case of CO_2, uptake. The chemical regime across the anticyclone however does bear the characteristics of a strong north-south division as given by the presence of the ITCZ. Rainfall is abundant and intensive providing ideal conditions for strong CO_2 uptake by vegetation. The CARIBIC Observatory has been used to investigate the trace gas chemical composition of parts of the upper tropospheric anticyclone from 1998 to 2001 and in 2008. Systematic increases in SF_6 due to increased convection, and increase in CH_4 for the same reason, but also because of increased production, can be clearly discerned. Similarly, but somewhat later in the monsoon period, CO_2 decreases are recorded. Because quantitative information about the fluxes of CO_2 for India and more generally South Asia is scarce, we have tried to use our data to improve this situation. The flux of CO_2 can be derived when we assume the flux of SF_6 to be known. Using this crude tool, the uptake of CO_2 was estimated. Later, using additional data from the CONTRAIL Project giving vertical profiles over Delhi and surface measurements (NOAA) and modeling a more refined estimate of CO_2 fluxes could be arrived at.

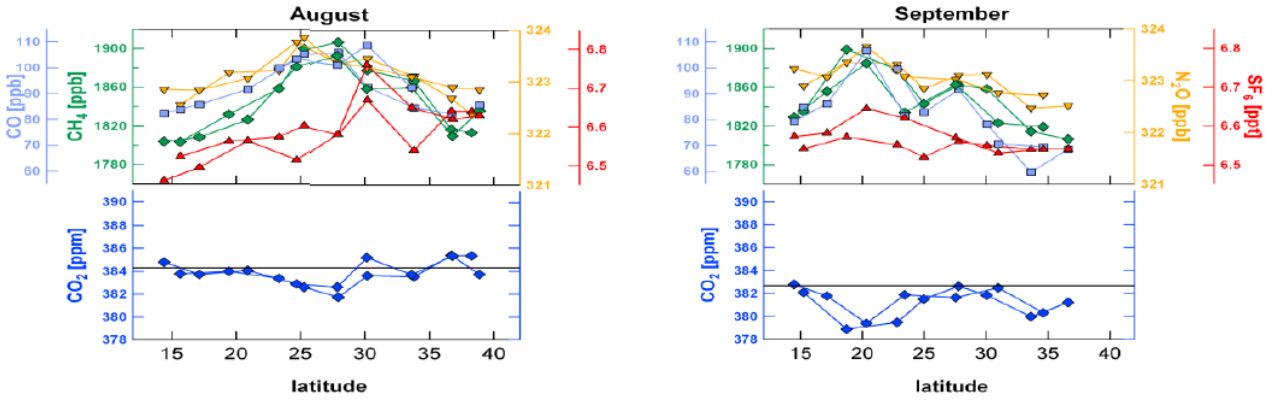

Figure 1. Trace gas mixing ratios measured at about 11 km pressure altitude over India and the Middle East in August and September 2008 by CARIBIC. The influence of surface air is clear from the increase in CO (light blue), CH_4 (green), N_2O (yellow), and SF_6 (red). The bottom panel shows the accompanying decrease in CO_2.