

Convective sources and transport patterns into the stratosphere during the 2017 StratoClim campaign

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The StratoClim stratospheric aircraft campaign, that took place on summer 2017 in Nepal, provided a wide dataset of observations of particle properties and trace gases inside the Asian Monsoon Anticyclone. Simultaneously with the aircraft measurement campaign, balloon soundings have been conducted on the Indian subcontinent and close-by areas. In the framework of the project, with the purpose of modelling the injection of pollutants and natural compounds in the stratosphere, we performed a series of diffusive back-trajectories runs along the balloons and flights tracks, and in correspondence of the field of view of the remote sensing instruments onboard of the plane. The diagnose of the convective sources and mixing in the air parcel samples have been then derived by integrating the trajectories output with high-resolution observations of cloud top from the MSG1 and Himawari geostationary satellites.

Back-trajectories have been calculated using meteorological fields from ECMWF (operational model, ERA-Interim and ERA5) at 3h resolution, using both kinematic and diabatic motion. In general, the comparison among the different trajectories runs shows a better agreement with observed data, and consistent source patterns between diabatic and kinematic simulations, in the ERA5-based runs respect to the ERA-Interim ones. A large variety of transport conditions was observed during the 8 flights of the campaign, with a larger influence by convective injections from continental sources in China and India. Only a small contribution comes from maritime regions, in particular the South Pacific and the Bay of Bengal that, contrarily to the expectation, has not been particularly active during the period of the campaign. Thin filamentary structures of polluted air, characterized by peaks in CO (measured by COLD) and other anthropic tracers, are observed, mostly associated with young convective air (age less than few days) with a large predominance of Chinese origin. Observed air from continental India, on the contrary, are often linked to lower concentration of trace gases and to air masses recirculating within the anticyclone, with average ages between 10 and 20 days. Finally, while we mostly observe sharp differences between tropospheric air and stratospheric air, at least on one day of the campaign a deep mixing layer, extending over several kilometres, has been detected between upper troposphere and lower stratosphere by both trajectories and observations.

Key words: StratoClim, stratosphere, deep convection, trajectories, Asian Monsoon.