Geophysical Research Abstracts
Vol. 20, EGU2018-10535, 2018
EGU General Assembly 2018

Convective sources of air parcels in the Asian Monsoon Anticyclone during the Stratoclim campaign

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We have analysed the convective origin of air parcels sampled by the Geophysica and balloon flights during the summer 2017 StratoClim campaign from Nepal using diffusive back-trajectories and high-resolution charts of top cloud altitudes from MSG1 and Himawari geostationary satellites. The back-trajectories have been calculated using winds and diabatic radiative heating rates from ECMWF (operational model, ERA-Interim and ERA5) at 3h and 1h resolution, using both kinematic and diabatic motion.
We diagnose at for each second of the flight the distribution of convective sources that mix in the sample air parcel. Most of the 8 flights occurred inside the Asian Monsoon Anticyclone. We find a large variety of conditions during the 8 flights of the campaign with a large prevalence of continental sources in China and India and a small contribution fro maritime region, especially the Bay of Bengal, that did not provide air masses penetrating the anticyclone. Recent convective air, which age can be of few days or less, is associated with peaks of CO (measured by COLD) and other anthropic tracers. More often air masses age can be larger, of about 10 to 20 days, due to the recirculation of air that loops within the anticyclone.
As a consequence, there are a several instances where, according to the back-trajectories, air masses from the same sources have been sampled two times by flights a few days apart, offering the way to study their evolution. The trajectories detect a number of thin filamentary structures that often corresponds to spikes in tracers. The transition is usually sharp between tropospheric air and stratospheric air although at least on one occasion a deep mixing layer of several kilometres has been detected by trajectories and observations. The comparison among trajectories, calculated with operational, ERA-Interim and ERA5 data, shows a consistent pattern with some significant redistribution among the sources. The diabatic trajectories tend to show a more diffuse distribution of sources than the kinematic velocities that concentrate sources on a limited number of high penetrating convective events. We discuss in details these differences and use the observed data of the campaign to assess the quality of the trajectory calculations.