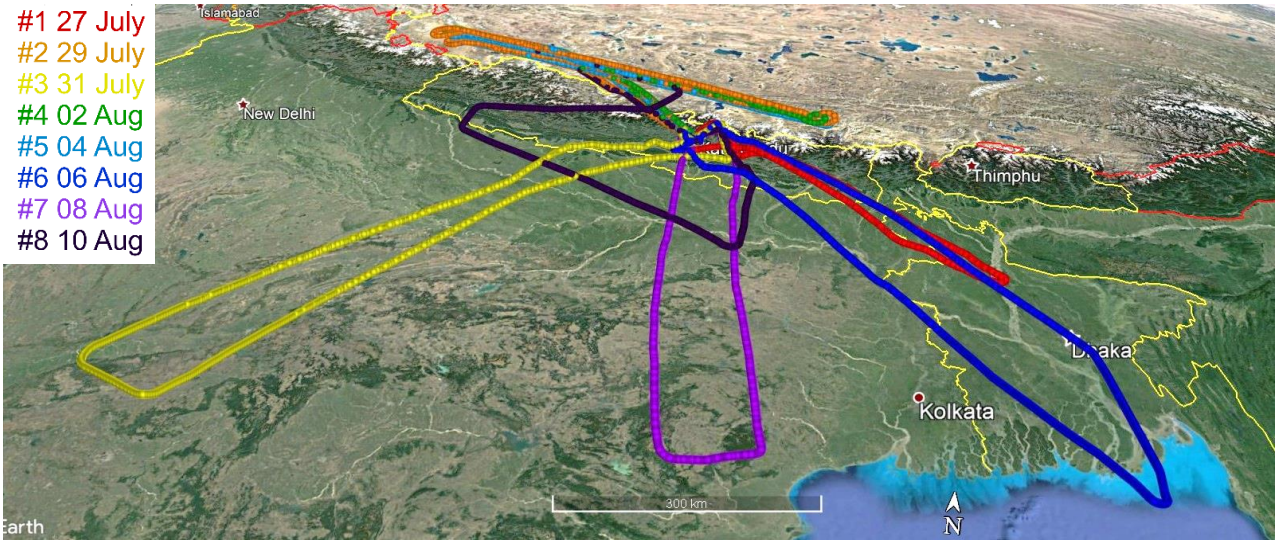

Figure S1. Geophysica aircraft flight tracks during StratoClim campaign in Kathmandu. © Google Earth 2020.

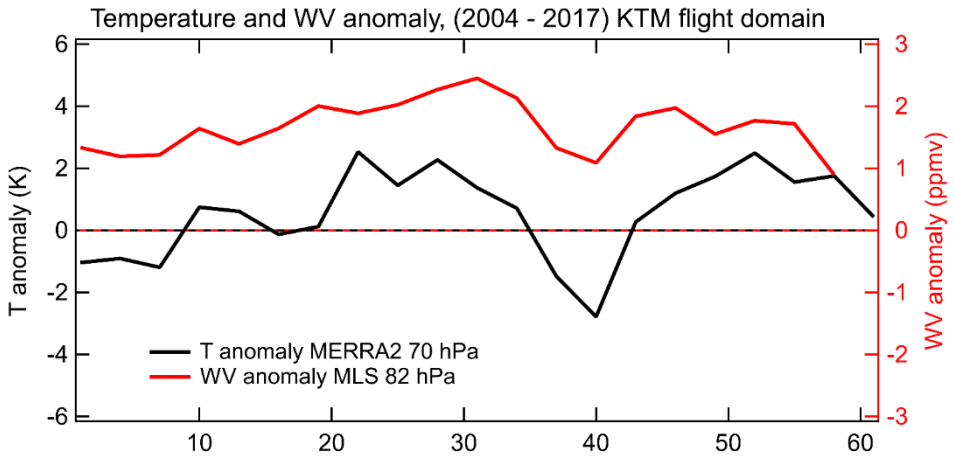

Figure S2. Deseasonalized anomaly time series of water vapour (MLS, 82 mBar level) and temperature (MERRA2, 70 hPa level) during July-August 2017 within the StratoClim flight domain. The anomalies are based on 2004 – 2017 climatology. The horizontal axis signifies days since 1 July 2020.

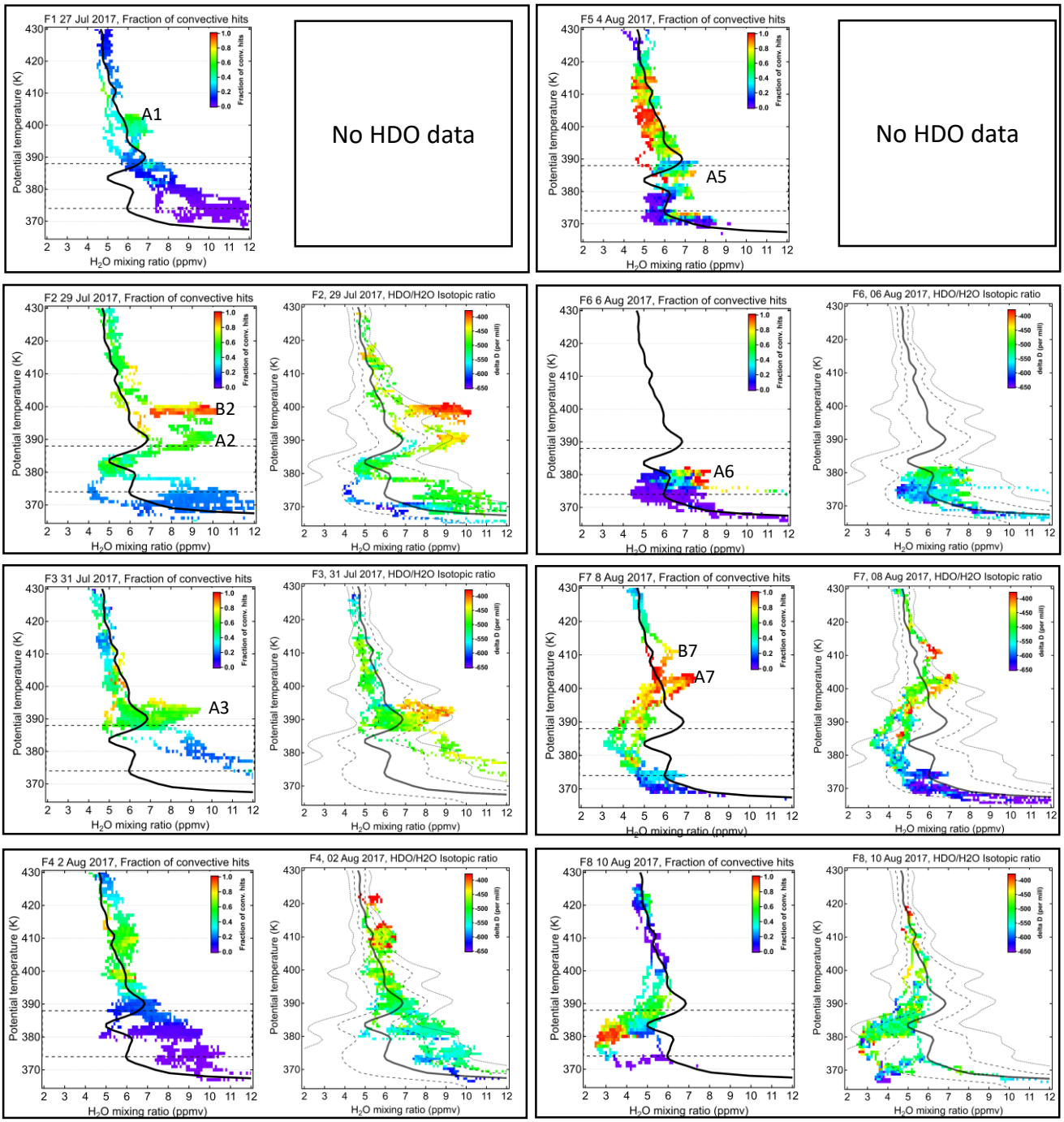

Figure S3. Binned ensemble of FLASH H2O measurements for each flight. The pixels are color-coded by convective hits fraction (left-hand panels in each block) and ChiWIS HDO/H2O isotopic ratio (right-hand panels). The black solid and dashed/dotted curves depict campaign-median H2O profile and one/two standard deviation(s) respectively. The hydrated features (layers of enhanced water vapour, exceeding 1 standard deviation) are marked as A*x* or B*x*, where *x* is the flight number. Note that all the hydrated features are characterized by isotopic enhancement, suggesting their convective overshooting origin. Their relation to convective events upwind is confirmed by the higher convective hits density specific to these parcels.

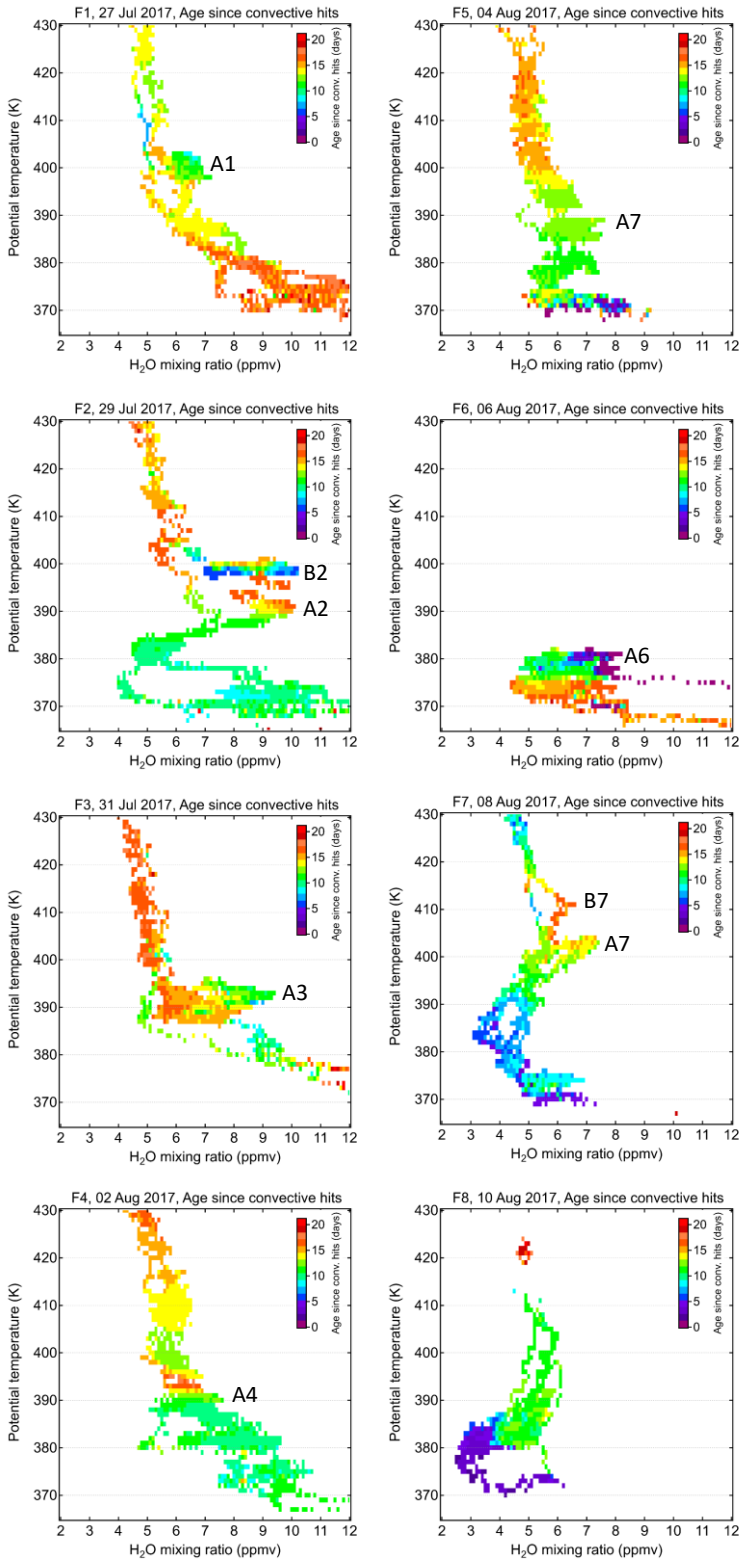

Figure S4. Binned ensemble of FLASH H2O measurements for each flight. The pixels are color-coded by the mean age since convective hits. The hydrated features (layers of enhanced water vapour, exceeding 1 standard deviation) are marked as A*x* or B*x*, where *x* is the flight number.

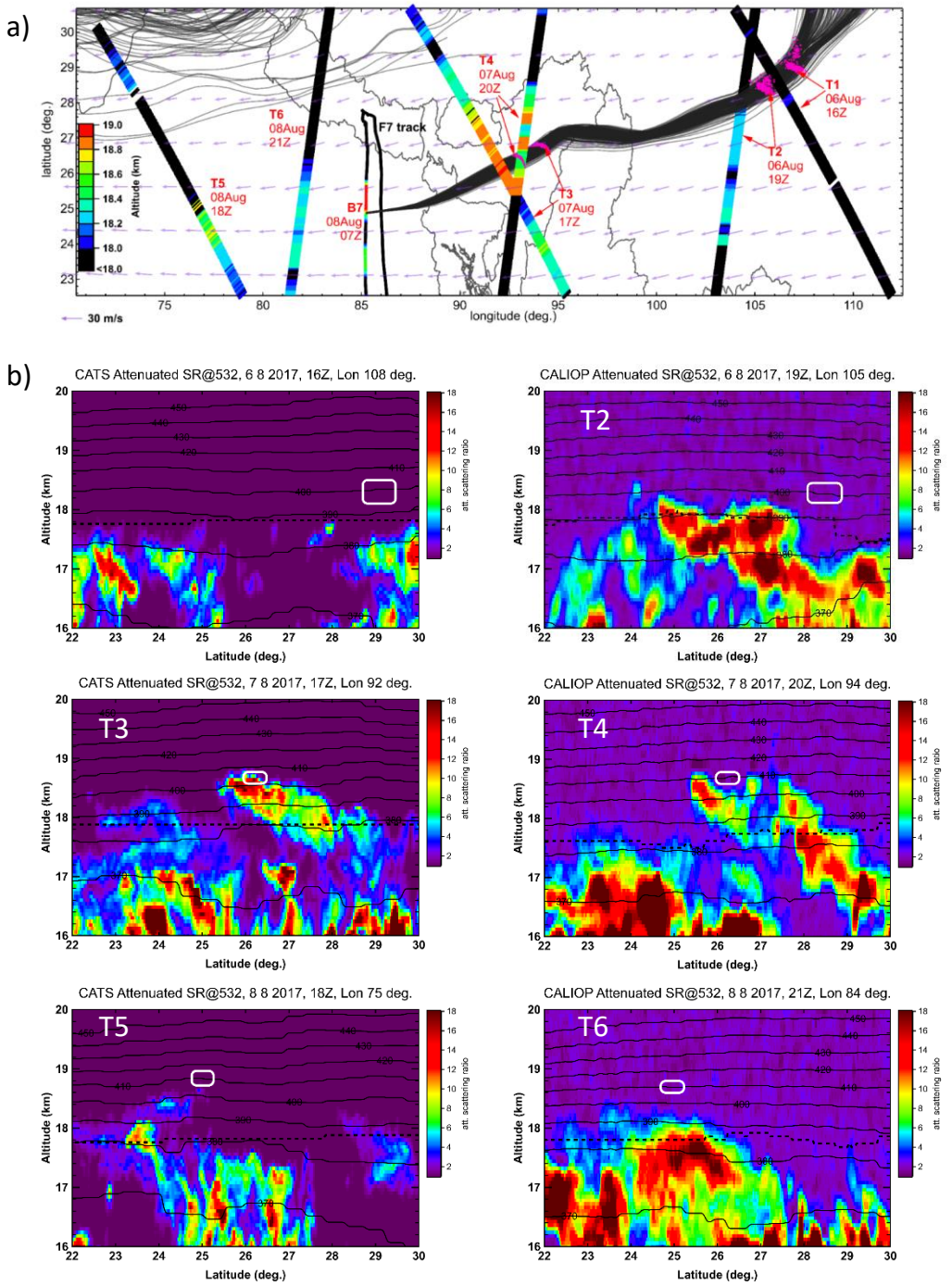

Figure S5. Evolution of cloud occurrence along the backtrajectories released from B7 (H2O enhancement at 410 K in F7). (a) Backtrajectories (black curves) and ground tracks of CALIPSO and CATS satellite lidars color coded by the cloud top altitude. The magenta circles mark the locations of the tracked parcels at the time of the nearest satellite transacts. The red labels indicate the transacts number (T1 – T6) and its UTC. The arrows are wind vectors (ERA5) interpolated at 410 K level. The track of F7 flight is shown as solid curve with altitude color-coding. (b) Attenuated scattering ratio curtains for T1 – T6 transacts The white oval shows the latitude-altitude location of the B7 parcels at the time of the corresponding transact.

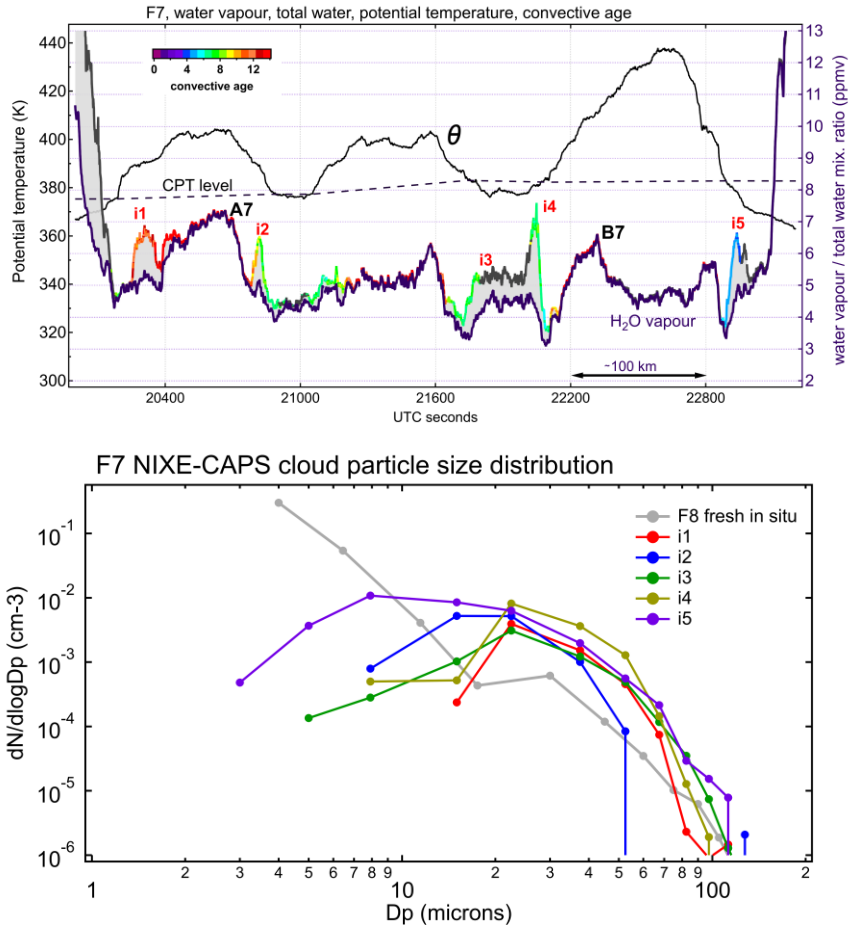

Figure S6. (top) F7 time series of potential temperature Θ (left-hand axis) and water vapour/total water (right-hand axis). The IWC is shown as grey shading stacked on the water vapour curve, with the upper limit being the total water (right-hand axis). The total water is color-coded by mean convective age of the parcels, which provides an indication of the time since convective encounter but does not necessarily mean that the observed ice was produced by overshoots. The cloud occurrences are annotated i*x*. (bottom) Particle size distribution (PSD) for the different clouds around CPT detected in F7 compared with the PSD of a fresh homogeneously-nucleated in situ cirrus sampled in F8. A fresh cirrus is dominated by ice crystals with sizes below 10 um. The age of the clouds in F7 is not known, however we note that the cloudy parcels with more recent convective encounters (i5) contain more small particles, whereas in the parcels with longest age since convection (i1), the smaller particles are absent and the PSD shows the dominance of 20 um crystals.