Upper tropospheric water vapour and its interaction with cirrus clouds as seen from IAGOS long-term routine in-situ observations

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IAGOS (In-service Aircraft for a Global Observing System) performs long-term routine in-situ observations of atmospheric chemical composition (ozone, CO, NO_x, NO_y, CO_2, CH_4), water vapour, aerosols, clouds and temperature on a global scale by operating compact instruments on board of passenger aircraft. The unique characteristics of the IAGOS data set originate from the global-scale sampling on air traffic routes with similar instrumentation such that the observations are truly comparable and well suited for atmospheric research on a statistical basis. Here, we present the analysis of 15 months of simultaneous observations of relative humidity with respect to ice (RH_ice) and ice crystal number concentration in cirrus (N_ice) from July 2014 to October 2015. The joint data set of 360 hours of RH_ice – N_ice observations in the global upper troposphere and tropopause region is analysed with respect to the in-cloud distribution of RH_ice and related cirrus properties. The majority of the observed cirrus is thin with N_ice < 0.1 cm^-3. The respective fractions of all cloud observations range from 90% over the mid-latitude North Atlantic Ocean and the Eurasian continent to 67% over the subtropical and tropical Pacific Ocean. The in-cloud RH_ice distributions do not depend on the geographical region of sampling. Types of cirrus origin (in situ origin, liquid origin) are inferred for different N_ice regimes and geographical regions. Most important, we found that in-cloud RH_ice shows a strong correlation to N_ice with slightly supersaturated dynamic equilibrium RH_ice associated to higher N_ice values in stronger updrafts.