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3D climatology of ice supersaturated regions over the North Atlantic

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Water vapor is an essential component for regulating the Earth's radiation budget. To realistically determine the global radiation budget, an accurate description of the water vapor distribution in the upper troposphere and lower stratosphere (UTLS) is therefore indispensable. For example, small changes in water vapor concentration can lead to significant changes in local radiative forcing, especially in the dry lower stratosphere. The change in this region can be even stronger if condensed water in the form of ice clouds is present instead of solely water vapor.

The formation and evolution of ice clouds is crucially determined by the saturation ratio over ice (Si). Ice crystals can only form (and grow) at supersaturated conditions (i.e. Si>1), i.e. in so-called ice supersaturated regions (ISSRs), which also constitute potential regions for the formation and existence of persistent aircraft contrails. Knowing and precisely forecasting the occurrence of ISSRs can help reducing the contribution of aviation to man-made climate change, as contrails usually have a warming effect on the climate.

Ice supersaturation is often observed in the UTLS. However, despite their importance, the large-scale three-dimensional structure of ISSRs is widely unknown. Therefore, we present a three-dimensional climatology of ice supersaturation in the UTLS over the North Atlantic for the years 2010 to 2019. This climatology is based on the recent ERA5 reanalysis data set of the European Center for Medium Weather Forecast (ECMWF), which explicitly allows ice supersaturation in cloud-free conditions. To quantify the quality of the ERA5 data set with respect to ice supersaturation, we use the long-term in-situ measurements of the European Research Infrastructure 'In-service Aircraft for a Global Observing System' (IAGOS; www.iagos.org) (Petzold et al., 2015).