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UTLS Water Vapor Climatologies derived from combined In-Situ Passenger and Research Aircraft Measurements

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Water vapor in the upper troposphere and lower stratosphere (UTLS) plays an important role in the climate system. In order to investigate processes affecting water vapor in the UTLS, accurate in-situ measurements are of particular importance in this region. In this work, in-situ airborne measurements from passenger as well as from research aircrafts are utilized. Different measurement campaigns are aggregated in a combined data set named JULIA (JÜLich In-situ Airborne Data Base). JULIA uses measurements from advanced airborne instrumentation (e.g. water vapor, cloud particle radius and concentration) that were taken during more than 500 flights or balloon launches in the period 1996-2021 on different locations around the globe. Measurements from passenger aircrafts are provided by the IAGOS-MOZAIC (1994-2014) and IAGOS-CORE (2011-today) data sets (later I-M/C), with a total of more than 60.000 flights.

In this study, statistics of the UTLS water vapor distribution are investigated by combining the advantage of a large number of measurements (I-M/C) with the more advanced campaign measurements (JULIA). Therefore, a comparison of JULIA and I-M/C is performed in a climatological manner. In order to reduce the natural dynamical variability in both data sets, the water vapor distribution is analyzed vertically relative to the thermal tropopause and horizontally in equivalent latitude coordinates. In the UT, JULIA and I-M/C water vapor measurements were found to be in good accordance. In the LS however, I-M/C overestimates the very low stratospheric water vapor concentrations, with a wet bias of approximately 10 ppmv for values of less than 7 ppmv. Despite this bias, I-M/C observations better resolve the seasonality of water vapor in the UTLS than JULIA. A correction of low water vapor amounts is applied and the resulting data provide more accurate water vapor values combined with the better resolution of I-M/C. This combined data set is used to present seasonal climatologies of the vertical resolved water vapor variability in the UTLS. This residual water vapor variability can be linked to transport processes around the tropopause, which are not resolved by meteorological reanalyses.

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