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In situ measurements of elevated dichloromethane from Asia in the UTLS over the Atlantic Ocean during the HALO WISE mission in autumn 2017

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At northern hemispheric (NH) summer, when the subtropical jet is weakest, quasi-isentropic transport of young air from the troposphere and the tropical tropopause layer into the lowermost stratosphere (LMS) is increased. Quantifying the different transport pathways and time scales into the NH LMS over the Atlantic Ocean and Europe was one of the main topics of the WISE (Wave-driven ISentropic Exchange) campaign taking place in Shannon (Ireland) in September and October 2017. Extensive sampling of this region was achieved by the German research aircraft HALO (High Altitude and LOng range) during 16 flights reaching up to 410K potential temperature. Among others, two instruments on board HALO provided in situ tracer observations: the University of Wuppertal's HAGAR-V (High Altitude Gas AnalyzeR - 5 channel version) measuring a suite of 14 short- and long-lived tracers including CH_2Cl_2 (Dichloromethane, DCM) and $CHCl_3$ (Chloroform), and the University of Mainz's UMAQS (University of Mainz Airborne QCL Spectrometer) measuring CO and N_2O with a high temporal resolution.

The DCM-N_2O correlation observed in the UTLS (Upper Troposphere Lower Stratosphere) during WISE shows a significant split into two branches towards higher N_2O mixing ratios implicating two different transport pathways into the NH LMS. The "lower branch", mainly observed at $<$370K potential temperature, shows large fractions of very young air exhibited by strong signs of DCM's prominent seasonal cycle, indicating fast transport from background troposphere. The "upper branch", mainly measured at $\sim$380K potential temperature, shows highly elevated DCM mixing ratios, indicating a significant contribution of air originating from industrial source regions. Artificial tracers of air mass origin calculated by the CLaMS (Chemical Lagrangian Model of the Stratosphere) model show that a fraction of around 40% of each air parcel measured in the "upper branch" originated at the surface in the Asian summer monsoon region of India and China including Southeast Asia within the last 6 months, thus indicating an efficient and relatively fast transport path from the Asian summer monsoon anticyclone into the UTLS over Western Europe. This provides direct evidence for the first time that the large and rapidly increasing industrial production of the ozone depleting short-lived DCM in Asia impacts the lowermost stratosphere over Western Europe. Backward trajectories will be presented for more details of the two transport pathways visible in the DCM-N_2O correlation of the WISE campaign.