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HDO variability in the upper troposphere and lower stratosphere

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Water is the most important trace species in the atmosphere. It plays a crucial role in the UT/LS region both for the radiative budget of the stratosphere and its chemistry. SImporant information is still missing about the details of the mechanisms that transport water from the UT to the LS. Also the pathways of water in the TTL are not fully understood. The lack of continous and reliable global observational data of suitable tracers is one reason that lead to this situation. Physical processes like phase changes leave a fingerprint in the isotopic composition of water. Thus, the examination of naturally occuring isotopes has the potential to reveal the processes water has undergone along its atmospheric transport. In recent years high precision satellite based remote sensing isotope data has become available and matured to enhance available in situ data. Together with modelling approaches these data constitute a new tool for the examination of atmospheric processes on a global scale. We have used vertical profiles of HDO inferred from spectral IR measurements, recorded by the Michelson Interferometer for Passive Atmospheric Sounding (MIPAS) between September 2002 and March 2004, to study transport processes of water in the tropical UT/LS. A clear annual cycle in the isotopic composition is identified at the tropopause which is in phase with that of H_2O. This signal propagates upward into the stratosphere similar to the well-known water tape recorder. Quantitative evaluation of the relative HDO and H_2O variations reveals that the seasonality is close to, but not exactly equal to the one expected from Rayleigh fractionation. This means that temperature is a key factor in determining the seasonal H_2O cycle of water at the tropopause, but other processes, most likely convection, act not only to isotopically stringly enrich water entering the stratosphere, but also have a seasonality that modulates the temporal HDO-H2O correlation. In the stratosphere, we find that CH_4 oxidation leads to a signal that is almost indistinguishable from the seasonal cycle at the tropopause level, which means that this leads to a HDO-H2O Correlation that is very similar to that of the temporal variations of water entering the stratosphere, rendering separation of the two sources of water in the stratosphere a difficult task.