Temporal and Spatial Variability of the Stable Isotopic Composition of Atmospheric Molecular Hydrogen

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Molecular hydrogen (H_2) from different sources shows clearly distinct values in isotopic composition. This can be used to improve our understanding of the global atmospheric molecular hydrogen cycle, but few H_2 isotope data have been published so far. Within the EUROpean network for atmospheric HYDRogen Observations and Studies project (EUROHYDROS), weekly to monthly air samples from six locations in a global sampling network have been analysed for H_2 mixing ratio ($m(H_2)$) and the stable isotopic composition of H_2, (δD). The time series thus obtained now cover one to five years for all stations. This is the largest set of ground station observations of δD so far. Annual average δD values are higher at the Southern Hemisphere (SH) than at the Northern Hemisphere (NH) stations; the maximum is observed at Neumayer (Antarctica), and the minimum at the non-arctic NH stations. The maximum seasonal differences in δD range from ≈18 ‰ at Neumayer to ≈45 ‰ at Schauinsland (Southern Germany). In general, seasonal variability is largest at the NH stations. The timing of minima and maxima differs per station as well. In Alert (Arctic Canada), the variations in δD and $m(H_2)$ can be approximated as simple harmonic functions with a ≈5-month relative phase shift. This out-of-phase seasonal behaviour of δD and $m(H_2)$ can also be detected, but delayed and with a ≈6-month relative phase shift, at Mace Head and Cape Verde. However, no seasonal δD cycle could be observed at Schauinsland, which likely reflects the larger influence of local sources and sinks at this continental station.

At the two SH stations, no seasonal cycle could be detected in the δD data. If it is assumed that the sink processes are the main drivers of the observed seasonality in $m(H_2)$ and δD on the NH, the relative seasonal variations can be used to estimate the relative sink strength of the two major sinks, deposition to soils and atmospheric oxidation by the hydroxyl (OH) radical. For the NH coastal and marine stations this analysis suggests that the relative contribution of soil uptake to the total annual H_2 removal increases with latitude.

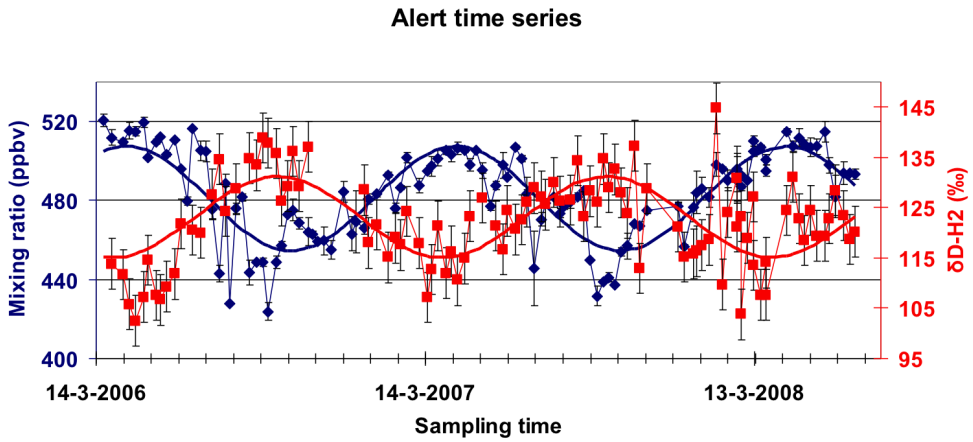

Figure 1. Time series of $m(H_2)$ (blue diamond, measured by UHEI-IUP, LSCE and MPI-BGC) and δD (red squares) measured by IMAU on air samples from Alert. Solid lines represent a harmonic best fit to the data. Error bars indicate one standard deviation