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# The stable isotopic composition of atmospheric molecular hydrogen at the Cabauw tall tower in the Netherlands

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Molecular hydrogen ($H_2$) is a promising energy carrier that might replace fossil fuels in vehicles. It has great potential for making transportation more sustainable, but there may be environmental side effects that, to some degree, offset the benefits. Concerns have been raised that large-scale leakage of $H_2$ into the atmosphere could affect the atmosphere's oxidative capacity and stratospheric ozone chemistry. To assess these risks, a better understanding of the global, regional and global atmospheric $H_2$ cycle is needed. Since the $H_2$ source and sink processes have large effects on $\delta D(H_2)$, due to the large relative mass difference between 'ordinary' hydrogen and deuterium, studying the stable isotopic composition of $H_2$ ($\delta D(H_2)$) is a promising way to achieve this. Over the last decade, studies of the isotope effects in $H_2$ source and sink processes have appeared, $\delta D(H_2)$ has been incorporated into global chemical transport models and many more environmental observations of $\delta D(H_2)$ have been published. The latter, however, were mostly obtained from samples that were collected at ground level at remote locations, which is not sufficient to fully characterize the $H_2$ cycle or to assess the possible environmental effects of $H_2$ leakage in very polluted regions.
For this project, samples are collected at the Cabauw tall tower owned by KNMI. The Cabauw tower is 213 m tall and located in a central part of the Netherlands. It is equipped with a tubing system with air inlets at 20, 60, 120, and 200 meter altitude. This tubing system was used to make continuous measurements of carbon monoxide (CO) and $H_2$ mixing ratios, but also to collect flasks samples at different heights for the analysis of $\delta D(H_2)$. More than 200 samples were collected over a period of more than three years. The results show that the local $H_2$ cycle at Cabauw is under heavy anthropogenic influence compared to Mace Head, a station that receives mostly clean marine background air at the Irish West Coast. On average, $m(H_2)$ is larger and $\delta D(H_2)$ lower at Cabauw, a result of anthropogenic emissions of deuterium-depleted $H_2$. Because of the same anthropogenic emissions, the samples collected from the lower levels of the tower tend to have larger $m(H_2)$ and lower $\delta D(H_2)$ than the samples collected from the higher levels. This also indicates that the local uptake of $H_2$ by soils is relatively weak.