*\_*D(H2) at the Cabauw tall tower in the Netherlands

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**Fig 1:** Land cover map of

the region around the station

(*Popa et al.*, 2011)

**Fig 2:** Time series of *\_*(H2) and *\_*(CO) at 3 heights (*Popa et al.*, 2011)

Continuous *\_*(H2) data

Air from the di\_erent sampling heights

is analyzed every half hour for *\_*(CO) and

*\_*(H2) with an RGA-3 reduction gas analyzer.

This has resulted in the \_rst (quasi-)

continuous measurement series of *\_*(H2)

vertical pro\_les in the boundary layer

(*Popa et al.*, 2011) at a polluted location.

High *\_*(H2) peaks are observed, especially

in winter (Fig. 2). These are superposed

on a seasonally varying background.

Flask data time series

As the di\_erent sources and sinks of atmospheric H2 have very distinct

isotopic signatures, measurements of *\_*D(H2) can be a useful

addition for constraining source and sink terms. For more than

three years, air samples from the di\_erent heights of the Cabauw

tower have been analyzed for *\_*(H2) and *\_*D(H2) at the IMAU.

The results are shown in Fig. 3, together with data from Mace

Head, a background station on the Irish west coast. The Mace

Head *\_*(H2) data form the lower bound of the Cabauw *\_*(H2) data

(Fig. 3(a)). Especially in winter, very large excursions occur to large

*\_*(H2) values at Cabauw. It can be seen in Fig. 3(b) that these *\_*(H2)

peaks are associated with very low *\_*D(H2) values. These features

indicate that Cabauw is heavily in\_uenced by H2 produced in fossil

fuel combustion, which is depleted in deuterium.

**Fig 3:** *\_*(H2) **(a)**and *\_*D(H2)**(b)** timeseries of the \_ask samples from Cabauw and Mace

Head (*Batenburg et al.*, 2011). Grey solid lines are harmonic \_ts to the Mace Head data.

Pollution *\_*D(H2) signature

To investigate the isotopic source signature

of the source mix at Cabauw, we use a \_Keeling”

plot (*\_*D(H2) vs 1/*\_*(H2), Fig. 4). The yintercept

of this plot indicates the source signature.

The source signature from this plot (-336 ‰)

is more depleted than what is often assumed

for H2 from fossil fuel combustion (-200 to

-270 ‰). *Vollmer et al.* (2010) found that catalytic

converters and certain (congested) driving

conditions can lower the source signature

down to -370 ‰. This fits to the Dutch crowded

roads and modern vehicle fleet.

**Fig 4:** `Keeling plot’ (*\_*D(H2) vs. inverse *\_*(H2)) of all

Cabauw \_ask data, with bivariate \_t. Grey bar indicates

y-axis intercept.

Flask *\_*(H2) and *\_*D(H2) pro\_les

Cabauw is the only location where vertical pro\_les of *\_*D(H2) in the

boundary layer have been obtained. These pro\_les (Fig. 5) provide additional

insight into local source and sink processes.

Soil uptake of H2 preferentially removes the \_light\_ H2. Therefore,

lower *\_*(H2) values and higher *\_*D(H2) values are expected close to the

ground at locations with strong soil uptake. This is clearly not the case

at Cabauw, probably because of the soil type (peat/clay) and high

ground water table, which suppresses the uptake.

*\_*(H2) values are not signi\_cantly di\_erent for the di\_erent levels.

Median *\_*D(H2) levels are, however, signi\_cantly lower at 20 and 60 m

than at 120 and 200 m. This may point to a di\_erence in the source

signature of the fossil fuel combustion source between the influence

regions of the different levels, possibly due to differences in traffic

conditions or vehicle fleets between Northwest European countries.

**Fig 5:** *\_*(H2)**(a)** and *\_*D(H2)**(b)** on days where more than two sampling heights were sampeled. The height pro\_les are overplotted with a boxplot of the same

data. In the boxplots, red lines indicate medians, box edges indicate lower and upper quartiles and whiskers indicate lower and upper 95th percentiles

Conclusions

*\_*D(H2) observations at this

anthropogenically in\_uenced

site complement previous observations

at background locations.

They provide information

on the H2 cycle in

densely populated regions

and can help in assessing climate

and air quality impacts

of future H2 emissions.

As an added advantage, the

measurements at di\_erent

sampling heights can help in

distinguishing local from regional

in\_uences.

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