

## **Temporal and spatial variability of the stable isotopic composition of atmospheric molecular hydrogen: observations at six EUROHYDROS stations**

The paper described seasonal variations of the hydrogen mixing ratios and its stable isotope ratios based on the long term observations at six stations, which cover the globe from the Arctic to the Antarctic. Using these characteristic seasonal variations at each station, the authors discussed the regional strengths of the sink and source of atmospheric hydrogen, and finally drew the conclusion that the H<sub>2</sub> uptake by soil increases with latitude in the northern hemisphere. Although huge number of air samples was analyzed to determine stable isotope ratios of H<sub>2</sub>, interpretation of the results is weak and leaves a large room to finish up. In particular, it is hard to imagine strong photochemical destruction in winter at Cape Verde and large accumulation of H<sub>2</sub> in summer, seasonal cycle of which is different from the other northern hemispheric stations. It needs clear and logical explanation about seasonal variation at Cape Verde. In view of context, this links the conclusion that soil sink strength increases with latitude in the northern hemisphere, which is based on seasonal variations of  $\delta D$  and H<sub>2</sub> at Alert, Mace Head, and Cape Verde. What if the seasonal variation at Cape Verde comes from other than sink processes? For instance, transport, inter-hemispheric mixing, seasonal variation of sources, etc. Although some drawbacks are disclosed in the paper, I recommend publication with revision of the following comments.

### **Specific comments:**

Page 10089, Line 5: Include Xiao et al. (2007) J. Geophys. Res., 112, D07303.

Page 10090, Line 1: Include Rhee et al. (2006b).

Page 10090, Line 4: I recommend omitting the bracket in " $\delta(D)$ " in the equation and in the text following the convention of isotopic nomenclature.

Page 10090, Line 8: Cite literature for the value of  $R_{VSMOW}$ .

Page 10090, Line 23: Include Mar et al. (2007) J. Geophys. Res., 112, D19302.

Page 10091, Line 14: It needs more information on how to treat inside of the glass flasks before dispatching for sampling, how to collect air sample, whether or not use a scrubber or a pump, etc. Have you checked any potential artifacts such as leaking or H<sub>2</sub> production inside the flask?

Page 10093, Line 22: How did you determine the factor 1.064 and how did you apply it for correction of the original data?

Page 10095 Line 4: Equation (2) considers only seasonality. Have you included an inter-annual trend function to fit the measurements?

Page 10095, Line 21: Not all sources are "deuterium-depleted". Photochemically produced H<sub>2</sub> contains more deuterium than the ambient air (see Table 1). The authors should consider this in interpreting seasonal variations of  $\delta D$  and H<sub>2</sub> in the text.

Page 10098, Line 10: How often have the air samples been taken in Mace Head? What would be optimal time interval of sampling to pick up the full variability of  $H_2$  and  $\delta D$ ?

Page 10098, Line 24: Conrad and Seiler (1980) reported that  $H_2$  emission from  $N_2$  fixation in soil is strong between April and June. However, time series of  $\delta D$  at Shauinsland station does not seem to show this seasonal variation although the authors speculated it. It needs explanation why the authors speculate.

Page 10099, Line 12: Why do the maximum of  $H_2$  and minimum of  $\delta D$  occur in summer rather than in spring, which is different from what is typically observed in the northern hemisphere? The maximum of  $\delta D$  was observed in winter not late summer or early autumn. Why is it so at Cape Verde? As shown in Fig. 7, the authors argued strong photochemical destruction of  $H_2$  at Cape Verde (~70% of  $H_2$  sink). However, it is hard to imagine that strong chemical destruction in winter rather than in summer, which needs clear explanation.

Page 10100, Line 1: Some literature pointed out that biomass burning in the southern hemisphere dominates seasonal variation of trace gases. For instance, Noville et al. (1999) argued that seasonal variation of the southern hemispheric  $H_2$  is driven by biomass burning. Gross et al. (1999) observed clear seasonal variation of CO at Amsterdam Island which was attributed to the emission of biomass burning. However, time series of  $\delta D$  here does not reveal the effect of biomass burning emission of  $H_2$ . Why is it so?

Page 10100, Line 19: In summer, photochemical destruction of  $H_2$  can also occur as the authors ascribed it to the large amplitude of  $\delta D$  at Cape Verde. If so,  $\delta D$  should be high in austral summer which is not the case at Neumayer station. Why is it so?

Page 10100, Line 23: Does the horizontal transport of air mass from the low latitude take place all the year? Or does it happen in summer only?

Page 10101, Line 2: Describe what stand for DJF, MAM, JJA, and SON.

Page 10101, Line 26: Replace "Atlantic" with "Pacific".

Page 10106, Line 14: Does "anthropogenic combustion source" mean fossil fuel combustion only, or fossil fuel combustion and biomass burning together? The  $\delta D$  minimum was observed at Cape Verde in summer season which the authors attributed to the emission of anthropogenic source. This argument needs to show supporting evidence.

Page 10115, Fig. 2: Scale of y-axis needs to be blown up. It is very hard to distinguish symbols. How big is the error bar in Figure 2? It looks smaller than that in Figure 4 of Pieterse et al. (2011) in spite of the same data.

Page 10118, Fig. 5: Add standard deviation of the intercept.

Page 10119, Fig. 6: It is very hard to match the month and symbol. It needs to make plot clearly.