

Review on:

Isotopic fractionation during soil uptake of atmospheric hydrogen

The paper described the isotopic fractionation occurring during the soil uptake of atmospheric  $H_2$ . This is an important issue to understand the processes of  $H_2$  deposition on soil surface and to determine global budget of atmospheric  $H_2$  using isotopic processes and signatures. Although the authors investigated the impact of two major factors controlling soil uptake, temperature and moisture content in soil, their arguments are weak. The values of kinetic isotope effect (KIE) the author determined are not different from those of previous studies. In particular, the mean value of KIE is exactly the same as what found by Gerst and Quay (2000) in summer season. Perhaps this may indicate insignificant role of soil moisture in KIE, which is also displayed in Figure 2. The paper only confirmed the previous results of KIE. Another aspect to be concerned is the source of  $H_2$  produced in soil. The authors determined asymptotic value of  $H_2$  ( $H_{2e}$ ) and HD ( $HD_e$ ), which contains isotopic signature of the  $H_2$  produced in soil, but did not mention and not discuss them how they are related with experimental conditions. Of course, the paper focuses on destruction of  $H_2$  in soil. However, as the asymptotic values are used in determination of deposition velocity and KIE, it would be useful for the reader to describe the asymptotic values of  $H_2$  and HD obtained during the experiments and how they are related to soil conditions. In addition, I recommend taking into account the following comments for revision:

1. Experimental section needs to be described in detail. Experiments were carried out only 3 days and a series of experiments were done only for 2 days. Each experiment was run for 20 minutes. However, Exp # 5 ran only for 15 minutes, and Exp #3 started right after finishing Exp #2 with different moisture content in soil. Based on the experimental section, it is difficult to follow the experimental procedure. It would be useful if the authors make a table with providing experimental condition and the concentration and isotopic values of  $H_2$  in time series for each experiment.
2. Deposition velocity was determined using Eq. (2) with 3 points of measurement. Since initial value is fixed, 2 points were applied to determine the unknown of  $H_{2e}$  (asymptote) and  $k_{H_2}$ . Since this approach considers production of  $H_2$  in soil, it is suggested to show  $H_{2e}$  in Table 1 together with deposition velocity for understanding the process taking place in the experiment.
3. KIE was determined by Eq. (5) which is based on Eq. (2) and (4). To help understanding the role of the source of  $H_2$  during the experiments, it is recommended to show  $HD_e$  (or  $\delta D$  value). This can be further used to determine the isotopic ratio of source signature.
4. Although the authors argue that KIE is related to moisture content in soil, Figure 2b show scatter of data points only. It would be better to separate data into "summer" and "winter" season and to plot a regression line showing correlation. The same can be applied for Figure 4. Unfortunately it is difficult to follow the discussion on page 8009 which need to rewrite clearly.

Minor point

p.8005, L.25, It would be better to cite original paper, Hagemann et al. (1970)

P.8006, L.21, Describe how to determine the effective chamber height.

p.8008, L. 11 & L. 24, I think  $\alpha = k_{HD}/k_{H_2}$  as described in p.8003, L.20. I wonder what is the difference in the definition of KIE and  $\alpha$  in the text.

P.8009, L. 7, Eq. (3) should be replaced with (2). Thus, ..., combining Eqs. (2) and (4):

P.8009, L. 8, Eq. (5) has a typo on the left-hand side.  $H_{2i}$  should be replaced with  $HD_i$ . Thus,  $\ln((HD - HD_e)/(HD_i - HD_e))$

Table 1. Please add the uncertainties in deposition velocity and KIE.

Figure 1b. This plot may confuse the reader. It should be plotted  $\delta D$  vs. time since  $[HD]$  changed very small and depends much on  $[H_2]$  according to the definition of  $\delta$  (and this is why definition of  $\delta$  is used in general). In addition, this figure does not give an impression of enrichment of deuterium in  $H_2$  during soil uptake, but rather depletion.

Figure 2. Plot with different symbols for each month (or season).

Figure 3. Use different symbols. The title in x- and y-axis should be consistent with Eq. (5).

Figure 4. Use different symbols.