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Interactive comment on "The overwhelming role of soils in the global atmospheric hydrogen cycle" *by* T. S. Rhee et al.

Anonymous Referee #1

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General Comments:

In this study, the concentration and isotopic composition of the free atmosphere H2, were measured from samples collected by aircraft flight tracks which covered the latitudes 30S to 50N. This is the first study which achieved such coverage of free atmosphere H2 isotopes ratio (a hard quantity to measure), and thus as the authors rightly claimed, could benefit our understanding of the current sources and sinks of atmospheric H2. This understanding is important, not just because of pure scientific reasons, but also because of future plans of moving into a "Hydrogen Economy", and its unknown impact on the hydrogen cycle. Thus, the paper addresses relevant scientific questions which lie within the scope of ACP and presents novel data. The

paper reaches an important conclusion regarding the role of soils in the H2 cycle, that while is not completely new, seems to be qualitatively supported. However, other more quantitative conclusions are based on many assumptions, which are not all explicitly discussed, and thus seem to me to have a much weaker ground. I recommend that these parts of the manuscript based on such hidden assumption should be revised before the paper could be accepted. In general the paper is very well written and easy to follow, and the figures are helpful, but I do recommend some small improvements below.

Specific Comment:

In section 4.2 the authors aim to estimate the soil uptake rate in the North-Hemisphere (NH) from their measurements. To do so they use a model which assumed constant sources of H2 both in terms of sources isotopic composition (which they justify in a later section - however a reference to this section is needed in section 4.2), and in terms of sources strength (flux). The second assumption (constant source strength) is not explicitly stated. However one would expect seasonal variations in all the main sources (fossil fuel burning, biomass burning, and photochemical production). Thus, in order to validate their calculation, the sensitivity of the calculated soil sink to changes in the sources strength must be evaluated, and its contribution to the observed seasonal cycle at the NH must be taken into account. Section 4.4 deals with the Southern Hemisphere (SH) seasonal cycle, which was found to be smaller in magnitude than the NH one. The seasonal cycle in the SH is assumed by the authors to be controlled mainly by “injection” of NH air during the SH winter. Changes in other sources strength (such as biomass burning and photochemical production which are discussed later) are ignored. The exact contribution of NH air to the SH should be better be studied using a 3D atmospheric transport model, which is of course outside the scope of this study. However, in any case, there is no justification to treat this NH contribution as “injection”, and it is clear from simple mass balance principles, that mixing of NH air into the SH must be accompanied by mixing of SH air into the NH. This must have an

ACPD

5, S3791–S3793, 2005

effect on the NH seasonal cycle, which was ignored in section 4.2.

In summary, the isotopic mass balance for both the NH and SH must take into account all possible contributions, and not to ignore some of them arbitrary. Contributions which are hard to estimate could be preliminary checked for possible importance, and the reader must be warned when such are omitted from a certain calculation.

Another lingering question regards the limited temporal resolution of this study. The seasonal cycle is inferred from three times of sampling. While the sinusoidal fit seems to be justified based on the NOAA/CMDL data, the question of the contribution of such aircraft measurements over surface sampling seems to remain open. Discussing the results in light of this question is highly desirable in my view.

Minor comments:

In figure 2, the month (and not the “fraction of year”) should be indicated on the horizontal axis. Section 4.6 is somewhat hard to follow. The effect of climate change on the soil sink should be mentioned earlier than in the conclusions.

Interactive comment on Atmos. Chem. Phys. Discuss., 5, 11215, 2005.