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***Interactive comment on* “The impact of soil uptake on the global distribution of molecular hydrogen: chemical transport model simulation” by H. Yashiro et al.**

Anonymous Referee #2

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This paper presents a novel and very interesting study of model simulations of the global atmospheric hydrogen budget. It uses a Chemical Atmospheric General Circulation Model that is coupled to a land process model which explicitly calculates hydrogen deposition on soils, based on soil moisture/porosity, temperature and plant cover. Modeled data are compared to globally distributed tropospheric observations performed by the NOAA ESRL group from 1997 – 2005, where generally very good agreement is achieved, not only concerning the mean climatology of the global H₂ distribution and seasonal variations, but also concerning its inter-annual variability. This indicates that the assumptions on (climate-dependent) H₂ sources and, to a less extent on the mechanisms of the soil sink, are realistic. The main weakness of the study is that the global

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soil sink has not been determined really independently but was tuned via a parameter, i.e. the depth of the inactive soil layer which acts as a diffusion barrier for H₂ uptake by soils. With such a tuning parameter it seems always possible to close the global budget of H₂ sources and sinks (but possibly not to correctly reproduce the seasonal cycle or mean north-south gradient of H₂). This needs to be made clear already in the abstract of the paper.

The manuscript is principally suitable for publication in ACP. However, a few other changes besides the point mentioned above are still necessary. In particular, the manuscript would very much improve if a native English speaker would edit the text.

My further suggestions for changes and corrections are as follows:

Abstract line 4: Explain the term “AGCM”

Page 4062,

Line 6: It may be confusing for the reader who is not totally familiar with the problem, that here it is said that the uptake takes place in a “thin soil layer near the surface” while in the abstract it is stated that there is a “biologically inactive layer near the surface”. A bit more explanation would help here.

Line 10: reference: Do you mean “Schmitt et al., 2009” (also at a few places further down in the text)

Line 12: should read “Hauglustaine”

Page 4065:

Lines 15 ff: Why should the distribution of ocean and land H₂ emissions be similar to that of CO if the associated processes are totally different?

Lines 25 ff: If most of the H₂ uptake happens in the first 5 cm of the soil (with an inactive layer of 0.7 cm) why is the vertical resolution of the soil model with a layer thickness of 5cm, 20cm, 75cm etc. sufficient to model H₂ uptake?

Page 4066, line 3: explain “MIROC”

Page 4067:

Line 11: unit of C should be kg m⁻³ to be in agreement with Eq. 2

Lines 15ff: The sentence “Furthermore, R_c is described as . . .” is unclear. It would help if the authors explicitly present the respective equation.

Lines 23 ff: Why should the permeability of snow be always low?

Lines 25 ff: It is not clear to me how the deposition on snow is calculated. Do the authors mean “ratio” instead of “rate”? Why is this related to the “depth” of snow?

Page 4068:

Line 9: Please correct flux unit.

It would be helpful to write “D_s” (the diffusion coefficient in the soil) as “D_s” (D_index_s) in the Equations (and text) not to confuse the reader as it may also mean “D multiplied by s”.

Line 15: Correct air ratio unit.

Page 4069, line 17: Why “reduction”? Do the authors mean “estimate”?

Page 4070

Equation (13): the term α_{sat} seems a bit misleading here. I guess what is meant is the total porosity (which may be completely filled with water in which case the soil is saturated).

Equation (17): α_{SW} needs to be defined

Page 4071, lines 10ff: “In addition . . .” It is unclear what was made here.

Page 4073, lines 25ff: “However, the model did not capture . . .Japan Island” This sentence is unclear to me.

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Page 4074 ff: For comparison with observations, the proper way would be to select the atmospheric model estimates only for those dates and times when the flasks have been collected at the stations. Correspondingly, only these model data should be compared with measurements in Figure 3. I understand that these selected data were used to calculate the bias numbers reported in Table 1?

Page 4082, lines 22ff: “In this study the correction ...” This sentence and correction are unclear to me.

In Figures 1, 6 and 7 the axis are practically unreadable, please increase the numbers.

Interactive comment on Atmos. Chem. Phys. Discuss., 11, 4059, 2011.

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