

Interactive comment on “A novel source of atmospheric H₂: abiotic degradation of organic material” by H. Lee et al.

Anonymous Referee #1

Received and published: 21 August 2012

General comments:

This paper presents experimental observations of H₂ production from a range of organic material representing plant litter types from arid and semi-arid ecosystems. H₂ production increases with temperature and is further stimulated photolytically. Production was observed in aerobic and at reduced, but significant, levels in anaerobic conditions. Thermal and photodegradation of H₂ may be an important process in arid systems, and possibly in other ecosystems, which may act to counterbalance the significant soil sink for atmospheric H₂, thus confounding our understanding of a straightforward H₂ soil sink. This study is an important contribution to our understanding of the atmospheric H₂ budget and will stimulate future endeavors to quantify the process in other ecosystems and globally.

The paper should include more caveats surrounding the assumptions and methods (namely use of H₂-free air and abiotic assumption) used in the experimental work. With those issues addressed, the paper is fit for publishing and is a welcome contribution to the field.

Specific comments:

Abstract: The abstract wording is a bit awkward.

Abstract: The following statement in the abstract is not necessarily supported by this work: "Our results suggest that abiotic release of H₂ during organic matter is ubiquitous in terrestrial ecosystems". Please revise to reflect that the biomass and temperatures tested suggest the process is ubiquitous in arid ecosystems (such as cited in lines 17-19), and may also occur in other ecosystems/climatic zones.

Page 1 Line 8 - Delete "a" in "through a microbially-mediated".

Page 1 Line 13 - Replace "in" with "at the" in "Among the known source-sink dynamics in soil-atmosphere interface"

Page 2 Line 21 - Do you have an example of typical H₂:CO mole fraction ratios from your samples that you could report to provide evidence for this mechanism?

Page 5 Lines 20-23 - It does seem that the probability for microbial activity is low, but one might assume these plants and associated microbes are desiccation resistant, and microbial activity can most likely persist after two days of drying. It is not reasonable to expect microbial activity to be assayed given the scope and methods of this study. I would just convey that the likelihood of microbial activity is minimized, but not cannot be excluded as a possibility. It is not clear that the radiation supplied (UVB near natural solar conditions) would halt microbial activity, as Johnson, 2003 only reports that levels considerably greater than ambient are be damaging.

Page 6 Lines 2-3 - What is the basis for this statement? "since it is unlikely that any microbial activity could respond with such rapidity in reaching near steady state (mole

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fractions)" Temperature-dependent enzymatic processes can respond quite rapidly (see Figure 2 in Smith-Downey, N. V., Randerson, J. T., & Eiler, J. M. (2006). Temperature and moisture dependence of soil H₂ uptake measured in the laboratory. *Geophysical Research Letters*, 33(14), 1–5. doi:10.1029/2006GL026749). Also adjust Page 12 Lines 16-17 accordingly.

Page 9 Line 1 - The use of zero air or N₂ tanks is worrying in this study because H₂ mole fractions are about an order of magnitude lower than ambient levels (e.g., your Fig 1). Apparent H₂ production could be due (partially or entirely) to outgassing of H₂ from the substrate, which as a diffusive process, could be enhanced by temperature. Did you conduct any of these experiments in natural or synthetic air with H₂ mole fractions around 500 ppb? I feel this is an important test to validate these experimental results.

Page 9 Line 7 - Instead of "on an aerial basis" use "area" or "per unit area".

Page 10 Line 3 - Do you have an estimated detection limit for your calculated H₂ production rates? If so, please state in methods and report rates accordingly. Should be repeated on Page 14 line 14.

Page 10 Line 15 - units - also in Table 1. Also page 12 line 21.

Page 10 Line - Activation energy instead of reactive energy

Page 11 Line 16 - delete "the" in "The H₂ production"

Page 13 Line 4 - Please make sure you are clear about whether you are discussing thermal or photolytic degradation when comparing to Derendrop 2011c here.

Page 13 Line 10 - Please specify whether you are just referring to the two pathways of degradation you have proposed (thermal or photo), or whether additional pathways are suggested.

Page 14 Line 10 - list Derendrop species again.

Page 14 Line 16-19 - Sentence is awkward.

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Page 15 Line 19-20 - Under represented is not correct terminology here. Not represented?

Discussion: Please mention again that microbial activity cannot be completely excluded. H₂ production may occur anaerobically via fermenting bacteria and aerobically by fungi.

Table 1 - units for E_a in table and caption. Space in thermaldegradation.

Table 2 - define SE

Figure 1 - define ppb and use mole fraction instead of concentration. No need for MM:SS units/label in graph, the time should start from zero when experiment began. Is date relevant?

Supporting Information - Define SE.

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