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Interactive Comment

Interactive comment on "Ecosystem fluxes of hydrogen: a comparison of flux-gradient methods" *by* L. K. Meredith et al.

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Response to Anonymous Referee #1

The authors thank anonymous referee #1 for the positive evaluation of our manuscript. We are grateful for the thoughtful comments, which we have addressed according to our responses below.

Comment: As the trace gas similarity method systematically underestimates CO2 fluxes and overestimates H2O fluxes due to significant sinks and sources within the canopy. Have the authors considered developing a method to correct for the systematic bias?

Response: This is a good observation and suggestion. At first, we favored simply stating the scaling factor between the inferred K from the trace gas similarity method for CO_2 and H_2O (P2901: $K_{H2O} = 0.68*K_{CO2}$ (R^2 = 0.51)) without applying the correction. This was for the purposes of highlighting that 1) changes in source/sink distributions of tracers can contribute to mismatches in the trace gas similarity method and 2) not to use a specific scaling factor for our ecosystem and time period so that future studies would make independent flux measurements to determine their own corrections relevant for the study location and time. We agree with Referee #1 that including a correction method is a valuable example and can further illustrate how well the trace gas similarity method can work. Therefore, we have used the scaling factor to provide "corrected" trace gas similarity results, which show better agreement with independent flux calculations. In addition, we have emphasized points 1 and 2 above by adding language to the text: P2906 "Finally, we encourage the use of independent flux measurements to correct for any systematic biases in the flux-gradient methods (i.e., from different source/sink distributions), which should be determined for the particular ecosystem and time period of interest."

Comment: Page 2885 line 7-11: what is the sampling flow rate? The flow rate will allow the reader to get an idea about the exchange time in the 2L and 25 L mixing volumes.

Response: We thank the reviewers for catching this oversight on our part regarding listing the sampling flow rate. The sampling flow rate was 250 mL min-1 through the 2L volumes. The 25L volumes were flushed at 3 L min before sampling, and then were sampled by the four sample lines with a combined 2 L min-1 flow rate. The sampling flow rate has been added to the text on Page 2885 and this detail regarding the 25 L volume on Page 2890: "The volume was pre-flushed at 3 L min-1 (τV = 8.3 min) and then sampled by all sample streams at 2 L min-1 total flow (τV =12.5 min)."

Comment: Page 2889 line 20: "measurement error" may better describe the session 2.4.3 than "Bias" does, because the session discusses the potential error due to measurement issues.

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Response: Thank you, this suggestion will help clarify this section for our readers. We want to distinguish between instrument precision, sampling error (due to the discontinuous nature of sampling), and measurement accuracy (the necessity to reduce inherent differences, or biases, in gradient measurements). Therefore, we have renamed Section 2.4.1 Instrument precision and Section 2.4.3 Measurement accuracy. We have also added this to page 2889: "High measurement accuracy was required to measure small differences in concentration between two sampling inlets. Any inherent nonzero differences in the measurement, here referred to as measurement bias, would cause errors in the gradient measurement and had to be accounted for."

Comment: P2892 line 16: what is the relevant eddy length scale?

Response: Thank you for pointing this out. We have added more information to the statement for to be more specific: "but should not exceed relevant eddy length scales, which can range from the mechanical eddy size forced by obstruction of the wind by the trees (~5 m) to the lower planetary boundary layer buoyant eddy size (~100 m). At Harvard Forest, the dominant flux-carrying eddy frequency is between 0.01 and 0.2 Hz, which corresponds to eddy scales of 10 to 200 m for mean winds around 2 m s-1 (Goulden et al., 1996)"

Comment: P2898 line 16: slightly different u* values are used in the cited literatures, e.g. 0.05 m s-1 vs. 0.07 m s-1. This is not an issue, but it might be useful to check and see whether some differences between gradient method and eddy covariance measurements for CO2 are due to the choice of this threshold.

Response: When coming up with our filtering criteria, we did explore the influence of u* threshold values on the fit between gradient methods and the eddy covariance methods. With regards to 2 m K-parameterization method, a lower u* threshold of 0.05 m s-1 basically increases the amount of data in the flux calculations by including fluxes calculated during periods with lower turbulence than the 0.07 m s-1 threshold. The risk here is that data will be included from times when there is not enough turbulence

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for flux-gradient methods to apply, K-theory in this case. Indeed, the fit of CO_2 fluxes calculated with the more stringent u* threshold (0.07 m s-1) have slightly better correlations with CO_2 eddy fluxes in the summer (e.g., r=0.24 for 0.07 m s-1 u* threshold and r=0.2 for 0.05 m s-1 u* threshold) but more bias (e.g., bias=0.7 umol m-2 s-1 for 0.05 m s-1 u* threshold and bias=-0.5 umol m-2 s-1 for 0.07 m s-1 u* threshold) than the 0.05 m s-1 threshold. No significant difference is seen between the eddy flux and flux-gradient agreement over the entire measurement period between the two thresholds. We do find that using a u* threshold of 0.07 m s-1 improves the fit between the flux-gradient and CO_2 soil respiration chambers (e.g., r=0.68 and bias=0.1 for 0.07 m s-1 u* threshold and r=0.53 and bias = -0.2 for 0.05 m s-1 u* threshold) at night all year. Therefore, we decided to go with the more conservative threshold (0.07 m s-1) that gave us better overall agreement between flux-gradient methods and independent methods, but we do not think that 0.05 m s-1 would necessarily be a wrong choice in many situations.

Comment: P2906 line 28 as data from a very limited period is shown in the paper; it is not sufficient to conclude that "consistent uptake of H_2 by the biosphere". Do the authors have more data to support this statement? Does the data filter procedure affect the conclusion?

Response: We thank Referee #1 for this astute observation. We do have more data to support net uptake of H_2 by the biosphere at Harvard Forest, but in some periods there were unexpected emissions from the biosphere as well. Therefore, we have changed the statement to reflect this and to point to our paper on the entire study period for more information: "We observed net uptake of H_2 by the biosphere both above and below the canopy during the example periods, which point to the particular sensitivity of H_2 to soil uptake, and uptake was stronger in summer than winter, as is presented over the entire study period in Meredith, 2012 and is the subject of a manuscript in preparation." Similar to our discussion of the u* threshold choice, we have evaluated our filtering procedure intensively. We find that applying reasonable filters gives us the

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most consistent and clear results. However, our results are not particularly sensitive to the choice of values within those reasonable bounds, in that the same patterns emerge for a range of filtering criteria possibilities.

Interactive comment on Atmos. Meas. Tech. Discuss., 7, 2879, 2014.