Interactive comment on "Hydrologic control of the oxygen isotope ratio of ecosystem respiration in a semi-arid woodland" by J. H. Shim et al.

We have agreed with all suggestions from the reviewers and include their comments and our responses below.

Thank you for considering our revised manuscript for publication in Biogeosciences.

Sincerely,

Jee Shim, and co-authors

William Riley, Nate McDowell, Alexander Knohl, Todd Dawson, William Pockman, Heath Powers, Clif Meyer

Anonymous Referee #1

Received and published: 1 March 2013

This is a substantial research effort that reports variations in the oxygen isotope composition of ecosystem respiration in relation to climate in a semi-arid temperate woodland. These ecosystem scale observations provide a very important link between leaf level studies and global studies of the $\delta^{18}O$ of atmospheric CO_2. The authors found that the progression of drought following rain events lead to increasing enrichment of the $\delta^{18}O$ signal of ecosystem respiration, and they relate this to an increasing importance of leaf respiration relative to soil respiration as the upper soil layers dry down. The pattern makes sense, and the observations are novel and informative. I have a few minor recommendations for improving the manuscript.

page 2, line 6: The abbreviation ET with T in subscript looks very similar to the abbreviation often used for evapotranspiration, ET with the T not in subscript. I wonder if there would be a more distinguishing abbreviation that could be used to make clear when transpiration is being referred to rather than evapotranspiration.

Response: We appreciate the importance of clear acronyms, as raised by the referee. After much debate, we feel the current acronyms are the most clear. Our approach has been to use the standard acronyms in

the physiology and biogeochemistry world of evaporation (E) with subscripts referring to the specific flux/tissue the evaporation originates from, e.g. transpiration (E_T) or soil evaporation (Es). As the reviewer pointed out, evapotranspiration is often labeled ET, with both letters in caps rather than the T in subscripts. If this is critical to the editor, we are willing to change the acronyms.

page 3, line 25: Not clear what the phrase "even more" is referring to here? I think it means that at night leaf water enrichment can be more than the craig-gordon enrichment due to the lag in relaxation of the daytime leaf water enrichment toward the night time value. Perhaps this could be clarified.

We agree and clarified as follows; At night, leaf water can become more enriched than that predicted by the Craig-Gordon model, due to the lag in relaxation of the daytime leaf water enrichment toward the night time value (Cernusak et al., 2002; Farquhar and Cernusak, 2005).

page 14, line 14: In the calculations of P-Ep, when is the calculation reset? Is this for each rain event?

We clarified this in the methods, but have added text to this section to ensure clarity for the reviewers. The added text is "As a reminder, P-E_P was calculated on a daily time step (Fig. 1b), and in Fig. 8b the daily value was averaged over the period extending from one rain event to the day before the next rain event, never extending more than 11 days.

page 18, line 6: Sentence does not make sense.

We corrected as 'ISOLSM precipitations were less dynamic than observations, particularly depletions during pulse events.' Thank you.

Fig 8b: Does this figure indicate that the size of the rain event influences the size of the maximum change in dr following the rain event? I have a difficult time to interpret what the x-axis means in this figure.

To clarify we have added the following text. "Fig. 8b highlights that increasing precipitation and decreasing potential evapotranspiration both lead to larger enrichment of δ_R after rain events."

Fig A2: This is interesting in that it seems to indicate that the post-pulse increase in dr is more related to VPD change than to soil water content change. VPD could drive both leaf water enrichment and transpiration, but this changes my interpretation about what is controlling the dR signal. It makes it appear as though Et is related to dr enrichment more through covariation with VPD, rather than driving dR per se. I suppose this could be addressed in a more controlled experiment, with manipulations to decouple Et and VPD, although I can see this would not necessarily be easy.

This is a great point. We have added text to the discussion to highlight that manipulative studies that alter VPD and E_T separately are needed to test models of $\delta^{18}O$ exchange.

Anonymous Referee #3

This paper presents long-term variations of oxygen isotope composition in relation to hydrologic condition in a semi-arid woodland. This manuscript fits well in the scope of this journal as aspects of explaining variations in the oxygen isotope composition of ecosystem respiration in a semi-arid woodland.

Moreover, this study provides on information for long-term monitoring of the connection of oxygen isotope ratios between atmospheric CO_2 and wood leafs (Juniperus monosperma). These observations are useful to understand variations of carbon and oxygen circulation to climate change. I believe that this manuscript is comparatively well-written and discussion is well-conducted. Here are some minor revisions and comments:

Specific comments: page 3 line 3: Check a reference "Riley et al. 2003, 2005"

Response: The two articles are appropriately cited in the sentence and listed in references page, but they were not arranged in chronological order. We have rearranged them from early to recent years. Thank you.

page 27 line 3, Reference: Sharp, 2005 should be move to the position after Seibt et al., 2006 in p28.

Thank you, we corrected it as you suggested.

3. page 29 line 1, Reference: Whang and Yakir, 1995 should be move to the position after Walker et al. 1988 in p28.

We moved it. Thank you.

4. Discussion and Conclusions: If these results give some information linked carbon cycle, I would suggest that the authors add an implication of that.

We addressed in the Discussion regarding the implication of this study on how these results link to carbon cycle and why they are unique and powerful detectors of changing climate as follows:

"In contrast, $\delta^{13}C_R$ is derived from the relatively slower transport of carbon from foliage to the mean location of respiration (foliage, stems, roots, and heterotrophic biomass), including additional lags due to autotrophic and heterotrophic storage (Bowling et al., 2008). These storage effects make deciphering the information derived from $\delta^{13}C_R$ measurements more difficult because $\delta^{13}C_R$ is frequently un-coupled from climate, at least in this semi-arid woodland (Shim et al., 2011). Thus, the relative value of δ_R is enhanced not only by its unique representation of terrestrial hydrology, but also because its dependence on climate and physiology is more easily detected.