Anonymous Referee #2 Received and published: 29 March 2016
In this manuscript, the authors used data from eddy covariance measurement and treering observations to derive an empirical relationship that links fractional change in water use efficiency (WUE) to changing atmospheric CO2 and atmospheric humidity deficit. The authors then reconstruct fractional change in WUE during historical period, and compare the results with those from CMIP5 simulations. It is found that reconstructed global fractional increase in WUE is much larger than that simulated by CMIP5 models. The method used in this study is scientifically sound, the analysis is comprehensive, and the results are important for understanding land surface response to increasing atmospheric CO2 and climate. I recommend publication after the following issues are addressed.

Thank you very much

Specific comments:
Line 121: In what years are those data taken from eddy-covariance observations?
This is between 1995 and 2006 and we added this in the manuscript

Line 138: In what years are those data taken from tree-ring observations?
Data are selected since 1900

Line 146: "WUE is estimated using equation 2". equation 2 should be equation 4.
Thank you
Line 157: "We rewrite equation 3". equation 3 should be equation 5.
Thank you we have changed this
Lines 187-190: It would be helpful to the readers to specify some possible missing constraints in the optimization theories.
We have changed this and added also for example the work by de Boer, who found that vegetation can adapt their density against CO2 levels and therefore can change the CO2

Line 248: It would be great if the authors can also discuss the difference in historical WUE change between observational based reconstructions and CMIP5 results at regional scales.
We do this in the next section.

In the following section, the authors discussed substantial regional difference in WUE after all. It would be useful to know at what regions, there exist large discrepancy in WUE change between reconstructions and models, and among CMIP5 model members
Good suggestion, we will zoom in to the regions were we also have tree-ring information. These lat/lon locations will be compared to the CMIP5 model members.