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Interactive comment on "Impact of nitrogen fertilization on carbon and water fluxes in a chronosequence of three Douglas-fir stands in the Pacific Northwest" *by* X. Dou et al.

Anonymous Referee #1

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Dou et al. present results from a 12-year eddy-covariance study across a forest chronosequence in British Columbia. They used the first 9 years as a control before adding N fertilization. The last 4 years of the study were used to estimate the GPP, respiration, NEP, and ET response to N fertilization. Traditional nitrogen experiments that use concurrent control and fertilization treatments are very challenging when using the EC technique, primary due to the footprint size and costs. Since the study lacked a traditional control treatment, the authors used the 7 years before the N fertilization to develop an empirical model, based on environmental variables, that was used to predict what GPP, respiration, NEP, and ET would have been without the N fertilization. Therefore, the core of the study lies in ability to predict the control treatment.

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Interactive Discussion
Discussion Paper

This study does not represent the first analysis of how N fertilization alters carbon fluxes using the same data. Chen et al. 2011 estimated the N fertilization impact on carbon cycling for the first year after N fertilization in the oldest site using a model-data fusion technique. Jassal et al. 2010 reported the N fertilization impact on carbon cycling for the first 2 years after N fertilization in same three sites as this study but used an alternative empirical model. The main goal of this manuscript was to estimate the N fertilization effect for 4 years after N fertilization on both carbon and water fluxes and to compare methods for estimating the control carbon and water fluxes during the period of N fertilization.

Successfully predicting the control treatment during the post-fertilized years requires generating a model that fits observed pre-treatment data. This is addressed using two different approaches and using a 7-year training period. They clearly demonstrate that the ANN method achieved a better fit than the multiple linear regression in generating a model that fit the observed pre-treatment EC data. Successfully predicting the control treatment during post-fertilization years also requires using a model that can provide good predictions outside the training period. To demonstrate the ability to prediction outside the training period, 2-years of data between the training period and the N fertilization treatment was used to evaluate the model. Successful prediction outside the training period also requires: 1) No major change in environmental conditions between pre- and post-fertilization periods or generating a model that can handle the variation in environmental conditions. The authors show that the environmental conditions were similar before and after the N fertilization so the models did not need to handle unique environmental conditions. 2) No major change in forest structure and function that was not associated with N fertilization. They addressed this challenge by focusing on short-term (4 yrs) responses where successional changes may not be as pronounced. If there were changes in forest structure that increased GPP independently of N fertilization then it would be most pronounced in the youngest stand where the GPP increase attributed to N fertilization was largest. I recommend adding discussion about how stand-development through succession could lead to error in the

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attribution of the impact of N fertilization on EC fluxes.

Overall, the EC fluxes measurements before and after N fertilization at three different ages is a unique study-design and the results are interesting to the broader discussion about carbon-nitrogen interactions in forest ecosystems. The manuscript clearly offers additional analysis beyond Chen et al. 2011 and Jassel et al. 2010 and represents a worthy contribution to the scientific literature. The estimation of N fertilization on ET also adds to the discussion on climate-N interactions.

Below are recommendations for improving the manuscript:

1) Add more discussion of the uncertainties in the EC estimates of GPP and R. GPP and R are derived from models that had uncertainty. However, the manuscript currently appears to treat GPP and R as without uncertainty. The fact that the GPP and R responses to N fertilization were less than 10% could be within the uncertainty in the measurement. Since there is less uncertainty in the NEP (NEE) measurements than the modeled GPP and R, the presentation of the results could start with the NEE response and then break NEE into GPP and R responses. 2) I would avoid discussing temporal trends in the 4 years post-fertilization data because the time period is short. For example Page 2018 lines 5-9 talk about stand productivity to N fertilization being temporary despite only 4-years of data. 3) It is not clear how the N-use efficiency is calculated on Page 2020. This number is tricky to calculate because there was only 1 addition of nitrogen. The calculation should be the sum of NEP response divided by the N addition amount. This recognizes that the N fertilization has a multi-year effect. Also, how is the range calculated? Overall, more description of the calculation is needed since readers will be interested in the reported N-use efficiency because it helps compare these results to other studies. 4) The discussion section needs to reintroduce the differences among this study, the Chen et al. 2011 study, and the Jassel et al. 2010 study. For example, the time period analyzed, the forest stands used, and the methods used are different among the studies. The discussion could also benefit from more insight into why the results from studies differed from one another. How

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different are the methods? Which one should we believe or should the three studies be combined to get the best estimate of the N fertilization response? 5) Figure 3 isn't clear and needs improvement. What is the connection among the points? Why are some black and some white? The caption needs to be greatly expanded so that the reader can interpret the figure. 6) In figure 9, the 'This Study (MLR)' and 'Chen et al. 2011' symbols are exactly the same. Please use two different symbols to make the figure clearer.

Interactive comment on Biogeosciences Discuss., 11, 2001, 2014.