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Interactive comment on "Can current moisture responses predict soil CO_2 efflux under altered precipitation regimes? A synthesis of manipulation experiments" *by* S. Vicca et al.

Anonymous Referee #3

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MANUSCRIPT ref. bg-2013-482 TITLE: Can current moisture responses predict soil respiration under altered precipitation regimes? A synthesis of manipulation experiments. Authorship: S. Vicca S et al.

Initial Manuscript Evaluation Report The reviewed manuscript represents a fully comprehensive assessment about the suitability of extrapolating current relationships between soil respiration and environmental predictors (soil temperature and water content) in order to forecast soil respiration responses under scenarios of climate change. To test this idea, the authors make use of information from 38 precipitation manipulation field-experiments that cover a range of environments world-wide for which there are available data (some important climate-types, however, are poorly represented –

tropical- or are lacking –boreal-). For each of these experiments, four different models are parameterized using respiration, temperature and moisture data from soils in control plots. Then, temperature and moisture data from the corresponding manipulated plots are used as inputs, in the best control models, in order to predict soil respiration under an altered rainfall pattern. These predictions are afterward compared with actual soil respiration data from the manipulated plots. For the cases predictions didn't match observations, further analyses were performed to get insights on possible underlying mechanisms that would explain why the control model failed to predict soil respiration under altered precipitation; for this, different sources of variation among studies (climate, soil-type, frequency of observations. . .),as well as the time-course of the accuracy of predictions, are considered. The obtained results are highly relevant since they point out to the constraints on applying current relationships to predict soil respiration fluxes under altered precipitation regimes. In particular, the conclusions about the need to improve experimental designs (higher frequency of soil respiration measurements,more accurate assessment of soil water availability, and the consideration of both immediacy and legacy effects of climate extremes) will likely have a strong impact on future studies, and modeling approaches, to assess ecosystem responses to altered precipitation regimes. In summary, I consider the manuscript is of very high scientific significance. It certainly represents the first complete and spatially extensive test analyzing an important and open question related to the estimation of a key component of the carbon cycle under future climate conditions: to what extent, phenomenological models linking soil respiration to soil temperature and water content variability will remain unaltered beyond the current climatic window within which such relationships were constrained. On the other hand, the study focuses on the best currently available experimental system for testing such a question: an ample, world-wide collection of field-experiments involving manipulation of precipitation and mid- to long-term monitoring of soil respiration responses. And the test has been performed elegantly through a well-planned approach in which different modeling and statistical data analyses are applied, in a sequential scheme, to calibrate control models, to validate predictions, and to assess raised questions from the cases where predictions didn't pass the validation tests. Finally, the manuscript is concise and well structured, and the results are highlighted and discussed in an appropriate and balanced way, emphasizing the resulting perspectives and recommendations for future studies, and the identification of knowledge and approach gaps (e.g., the need that models account for the Birch effect, given the additional experimental evidences on the relative contributions of the heterotrophic and autotrophic components of soil respiration). —- As a minor change, I suggest the authors should clarify the (apparent?) contradiction between results that are differently highlighted in the Abstract or in the Conclusions sections. The Abstract stresses that "there are no serious problems associated with extrapolating current moisture responses to future climate conditions". This conclusion is based on the fact that the hypothesis was accepted in most (> 80%) of the cases studied (those for which models parameterized with data from the control plots -soil temperature and water content as predictor variables- did adequately predict soil respiration measured in manipulated plots). However, the Conclusions section underlines the striking correspondence between the cases for which the hypothesis was rejected and the cases with the highest frequency of soil respiration measurements. Consequently, the Conclusions highlight that "Our analysis demonstrated the limits to applying current soil moisture responses for predicting soil respiration under altered precipitation regimes". Is it that an inadequate parameterization of the models in the cases the hypothesis was accepted (because frequency of available data was too low) led to the wrong conclusion that extrapolation of current moisture responses to future climate conditions is suitable? Please, clarify this.

Interactive comment on Biogeosciences Discuss., 11, 853, 2014.