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Biogeosciences Discussions

Interactive comment on "Sensitivity of North Patagonian temperate rainforests to changes in rainfall regimes: a process-based, dynamic forest model" *by* A. G. Gutiérrez et al.

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We appreciate comments provided by referee 2, that can certainly clarify our MS. Also we believe that the MS can be shortened following suggestions of the referee. We discuss below main concerns raised by the referee

Main comments

1) Model validation

In our opinion, we have been careful in not calling our analyses a validation of the model. We believe model results are comparable to available forest hydrologic mea-

surements using less-detailed and static models under current climate.

Soil moisture.- The main conceptual problem to conduct the quantitative validation asked by the referee is the different spatial scales of the model and empirical data. The empirical data presented in the MS are the best available, representing a highly intensive data collection but for a small spatial scale (400 m2) and few points in this space. They are only available for one complete year (2008). The model results represent processes at a spatial scale >1 ha. To avoid stochasticity, multiple patches of 400 m2 (N= 2500 for every simulation run) are averaged in the model results. These issues play against a quantitative comparison, thus we only used field data for a qualitative assessment of the soil moisture pattern throughout a year (Fig. 5) and discussed in the text.

The referee suggests an analysis to derive soil physics parameters from a simple comparison with theta and psi. Following this advice, we estimated the parameters of a theta-psi curve using methods outline in Seki (2007). We obtained rˆ2 ranging between 0.49 to 0.53 depending on the equation used. theta_s, usually consider as soil porosity, ranged between 0.81 and 0.84, i.e. slightly overestimates the porosity calculated for the studied soils (0.76 according to Janssen et al. 2004). Using the only available "real theta-psi curve" for this soil type (Janssen et al., 2004) we obtained a rˆ2 = 0.46. According to these results, the model follows the pattern expected from soil matric potential data (psi). In general model predictions tended to overestimate soil moisture obtained from psi. In other words, estimations of soil moisture predicted by the model under drought are conservative. However, it should be kept in mind if these comparisons are conceptually correct as discussed above.

We concluded that the model is a suitable tool for predictive analysis, but also recognize the implications of some key assumptions (e.g. section 4.3) needing further research. In addition, we have done a comprehensive literature research to include independent empirical information to assess model performance. To the best of our knowledge, there is no study documenting a dynamic calculation as the one presented

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in this MS. Finally, parameters selected for this study were taken from the literature (based on empirical research) or calibrated using our own field data as indicated in Table 1. Therefore, our set of hydrologic parameters can be considered as empirically based (i.e. realistic). Part of this discussion on a quantitative validation of the model can be included in a new version of the MS.

Forest structure comparison.- All the information on the structure of the old-growth stand (OG) have been described in detail in earlier publications (Gutiérrez et al., 2004;Gutiérrez et al., 2009). In addition, OG structure is shown in Figure 3. Comparison of Formind performance to reproduce field data from OG are discussed in detail in Gutierrez and Huth (2012) including Ad validation based on tree-ring records. In a new version of this MS we can expand the description of OG.

Weather records and weather generator validation. - Please see reply to referee 1 on the same topic. Unfortunately long-term, daily weather records (temperature, rainfall and radiation) are not available in the study area. Weather station at Estacion Biologica Senda Darwin is the best and most representative of the climate at the study site. In a new version of the MS we will include the data asked by the referee in table 2.

2) Water-use efficiency

Please see reply to referee 1 on the same topic. The comment of the referee on P6303 L12- seems to be a misunderstanding. We did not argue a direct control of Transpiration (T) by soil moisture in the model. The decrease in T due to soil moisture scarcity emerges from the linked mechanism of water needed for growing and tree dynamic competition for light. These lines refer to the technical problem of limiting T when soil moisture reaches the permanent wilting point (PWP). Calculations of T and Ad are not conducted when PWP is reached. These technical sentences can be deleted in a new version of the MS to avoid confusion.

The comment on P6312: [4.3 Model limitations and research needs: It looks that you emphasized “constant WUE method” is useful] seems more a referee’s personal im-

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pression rather than our emphasis in this section. Our intention was to encourage further research on WUE of the studied forest type and tree species. The state-of-the-art knowledge in temperate rainforests of SSA does not allow us considering WUE as a time-dependent variable. However, having more empirical information will inform modellers to include this in new model applications when empirical data is available. The model can be easily changed in this regard as we stated in line 6312 L18-20.

3) Equations and detailed description of Formind core model.

See also Biomass production calculations in Reply to Referee 1 for a short explanation on Ad calculation. In order to keep the paper short and focused we decided not to include information reported in earlier publications. For example equations of the core Formind model are comprehensively detailed in Rüger et al. (2007, see its supplementary material). Additional improvements to run the model in temperate rainforests of SSA are found in Gutierrez and Huth (2012, see its supplementary material). A diagram of the model can be found in Gutierrez 2010 (P: 148). If requested by the editor we can include a supplementary material for online publication with equations relevant to this manuscript (e.g. Ad calculation).

Other comments

"P6305L15-: How depths were the measurements? How did you derive s from those potential data? This derived s is needed for the model validation." Response: Sensors were located in the organic soil ca. 15 cm depth (this will be included in the new version). Because of the reasons discussed above, we did not derive s from soil matric potential data set.

P6299, equation (2) is wrong. This should be changed to theta=s*n. Response: To be fixed in a new MS version.

P6300: Could be values of alpha and f obtained by observations? Response: These parameters were calibrated using water fluxes observations taken at YS as explained

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in Fig. 2, Table 2, and in the text (L27, 6305).

L9-: Did not you compare the model results with field measurements at OG? Response: Water fluxes were only taken at YS for simplicity of field working conditions and visual impact in the forest. This study was conducted in a natural reserve, and OG represents one of the few remnants of primary forests remaining in the landscape.

P6301L8: What is "the soil hydraulic conductivity of the given soil at field capacity"? Unclear. Response: ksoil refers to the saturated hydraulic conductivity, a commonly used soil hydrological parameter (Maidment, 1993).

P6303L3: "the mean amount of daily rainfall" is incorrect. Response: This is correct, but wording could be misunderstood. We will rewrite this sentence in the new Ms version.

P6307L23-: Please give a detailed description about relationships between eta and 1/lambda when you change eta or 1/lambda for the simulation. Response: Changes were done linearly every 10%, i.e. six levels of each of the two rainfall parameters including the current climatic scenario. It will be included in the text.

P6308L15: Under what conditions was the "model performance"? Give detailed information. Response: The heading of this section (3.1.) will be changed to "Model results under current climate" to clarify this point.

Fig.6 and 7: Here, changes in rainfall regimes apparently mean drought. You should make it clear in the manuscript. Fundamentally, simulation plan, for what you conducted these computation, and concrete findings from these computations are unclear. Response: In a new Ms version we will expand our discussion on this topic. We avoided the use of the concept "drought" because we were working under virtual climatic scenarios. This can be fixed in a new MS.

All other minor and technical comments will be considered, corrected and clarified.

References

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