Biogeosciences Discuss., 9, C3208–C3214, 2012
www.biogeosciences-discuss.net/9/C3208/2012/

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.

A. G. Gutiérrez et al.

alvaro.gutierrez@env.ethz.ch

Received and published: 14 August 2012

We appreciate the helpful comments provided by the referee. Below we reply concerns raised by the referee.

Main Comments

1) Expanding explanations of obtained results, particularly about different response patterns between the young-secondary stand (YS) and the old-growth stand (OG).

We kept short our discussion with the intention of focusing on the role of soil moisture limitations on biomass production. In our opinion the only two (modelled) mechanisms

behind this result are 1) the different biomass production among stands (indicated in 6311 L22) due to a higher Ad (canopy photosynthetic rate) of larger trees found in OG, and 2) our assumption of the same water-use efficiency of stands. Accordingly, the amount of water needed to produce the potential biomass is much higher in OG than YS, and cannot be covered by the water supply under strong drought conditions. As consequence (see also 6309, L22-), OG had a stronger decrease in evapotranspiration compared to YS (also seen in Fig. 6) pointing to grow limitation due to soil water scarcity. Associated dynamic mechanisms are an increased mortality of (large) trees and consequently a decrease in above-ground biomass (AGB). LAI tended to be similar among stands (ca. 4.5), explaining similarities in net precipitation among stands (80%, Table 4). We used the same parameter set (Table 1, 2) in both stands. In a new version of the manuscript we can expand the discussion of these results, and provide a diagram of the mechanisms explained above.

2) Estimation of transpiration using the water-use efficiency (WUE) concept

The estimation of WUE is detailed in 6306 L6-. We used WUE as a constant (parameter), i.e. it doesn't vary with stand development (time) nor among seasons. The WUE value used in all our simulations is indicated in Table 1. The referee is right on the influence of the WUE (a constant parameter in our model) on model results, but we recognized this influence in the MS discussion (6312 L15-25). In Figure 1 we exemplify the impact of this parameter on ET as requested by the referee. Changes of $\pm$50% changes in our selected WUE value (9 gCO_2/kgH_2O) can produce variations of ca. $\pm$7% ET under current climate. As we stated in 6312 L15-25 , the model can be easily changed to consider WUE as time dependent variable in the model. However, to the best of our knowledge empirical information is lacking that can support or provide a metric for changes in WUE through stand development. In a new version of the manuscript we can include this figure as a result of model simulations and expand our discussion on WUE accordingly in the text.

Other comments:

Biomass production calculations

Equations describing calculations of the photosynthetic rate (Ad) for every tree follow Thornley and Johnson (1990) and are detailed in Rüger et al. (2007). In short, the rate of single-leaf photosynthesis is modelled as a saturating function of the incident light on the leaf, and integrated over the total LAI of the tree to account by self-shading of the tree canopy. The resulting instantaneous rate of photosynthesis is multiplied by the crown area of the tree (obtained from allometric equations) and a conversion coefficient from absorbed CO2 to organic dry mass.

Soil moisture influence on biomass production

In our model, the reduction factor due to water scarcity (eq. 12) is only applied to biomass production possible to achieve under light competition. The rate of biomass production influences tree respiration rate through maintenance and growth respiration, which are calculated afterwards in the model. Calculations are performed for every simulated tree and pooled together to calculate the stand-level value. We can clarify this and the previous issue in section 2.3.4 in a new version of the MS.

Time steps of the model

Formind core model runs in annual time steps, but the hydrological calculations are done in daily timescales (L1, 6299). This is noted in the MS equations by the subscript d. In a new version, we will clarify this issue naming the hydrological calculations as "The hydrologic submodel".

Lateral water flow

During the rainy season in this region soils tend to be saturated (e.g. Fig.5a Julian day 100 – 250). In sites located on flat conditions (as the ones studied in this research), accumulated water on the soil during this period laterally move but cannot infiltrate the soil. In our opinion considering this lateral water flow as run-off is realistic.

Weather generator results

The figures 2 and 3 support the performance of the weather generator (both available in Gutiérrez (2010), Pages: 152-153). These figures can be provided as supplementary online information if requested by the editor in a new MS version.

Minor comments:

In a new version of the MS, we will change the title as suggested by the referee and avoid the use of sensitivity along the text. The paper on model parameterization and testing (Gutierrez and Huth, 2012) is now published in Perspectives in Plant Ecology Evolution and Systematics 14, 243-256. Figure 5a, b are only shown as reference that model results resemble the pattern of soil moisture during a year. We show data for year 2008 because is the only year with complete measurement records. Measurements were taken between June 2007 and March 2009 (indicated in L23, 6304).

All other minor and technical comments will be considered in a new version of the MS.

References

Gutiérrez, A. G.: Long-term dynamics and the response of temperate rainforests of Chiloé Island (Chile) to climate change, Lehrstuhl für Waldwachstumskunde, Technische Universität München, Freising, Germany, 170 pp., 2010. url: http://d-nb.info/100941819X/34

Rüger, N., Gutiérrez, A. G., Kissling, W. D., Armesto, J. J., and Huth, A.: Ecological impacts of different harvesting scenarios for temperate evergreen rain forest in southern Chile - A simulation experiment, Forest Ecol Manag, 252, 52-66, 10.1016/j.foreco.2007.06.020, 2007.

Thornley, H. M. J., and Johnson, I. R.: Plant and Crop Modelling – A mathematical approach to plant and crop physiology, Clarendon Press, Oxford, UK., 1990.

Interactive comment on Biogeosciences Discuss., 9, 6293, 2012.

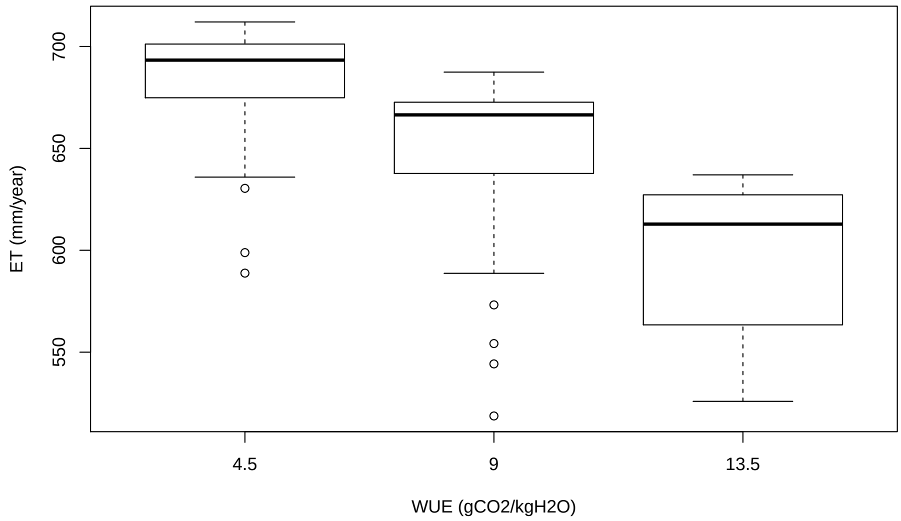

Fig. 1. Changes in evapotranspiration (ET) of the old-growth stand under current climate when using different water-use efficiency values (WUE). Simulations run under the same conditions detailed in

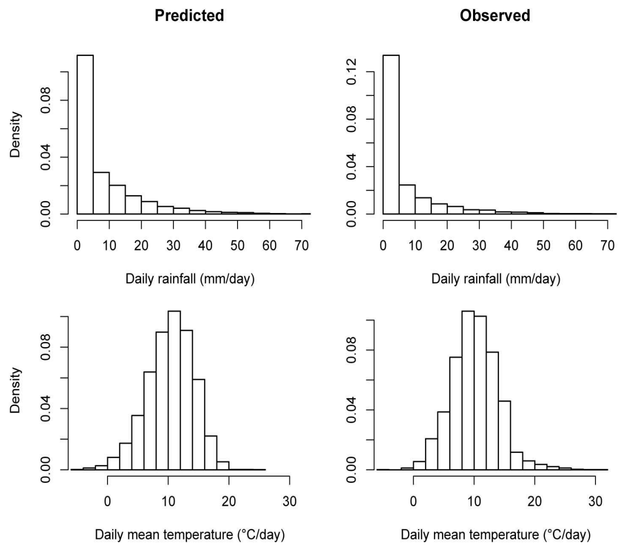

Fig. 2. Density functions of daily rainfall and daily mean temperature predicted by the weather generator compared to observed weather records from EBSD meteorological station

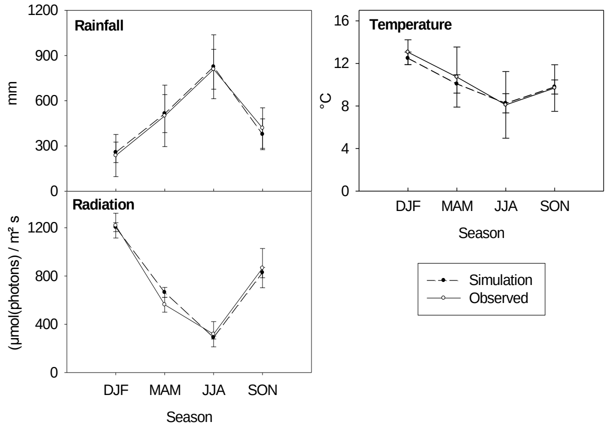

Fig. 3. Comparison between simulated and observed climatic patterns during the year. Simulations were run for 100 years using parameters in Table 2. Daily data were averaged by seasons