Review for Regional modeling of vegetation and long term runoff for Mesoamerica by P. Imbach, L. Molina, B. Locatelli, O. Roupsard, P. Ciais, L. Corrales, and G. Mahé

Response to reviewer #1:
The integral reviews are included in this response. Answers to the questions made by the reviewer are marked in italic text. Changes to the manuscript, revised and new paragraphs are indicated by a bold font.

Review: "The paper definitely raises a lot of scientific interests, though it tried to discuss many aspect of land surface modelling that could be split in more than one manuscript. It addresses well the issue of regional mapping of run-off, evaporation and Leaf Area Index. It established a comprehensive ancillary and forcing datasets which are crucial for land surface modelling. Then the model was assessed against different parameters sensitivities and precipitation forcing uncertainties. The final results were shown to be satisfactory at the regional level. Taking into account the following few comments I would highly recommend publication of the paper: • Precipitations is validated against outputs of run-off , it would be useful to check precipitation products against independents observations (not those used in the interpolation process). This might give more insight on the model/forcing errors."

Response 1: Independent observations are not available at the regional scale (data availability, holding institution, quality and accessibility are different for each country) neither are the points used for the interpolation of the precipitation maps needed to assure their independence. A final paragraph was added to the end of Section "2.3.1 Precipitation" P808 L14, stating: **"A regional dataset of precipitation observations independent of those used to generate the precipitation maps was not available, therefore a validation of the datasets used in this study was not possible."**

Review: "• According to the precipitation regime (and vegetation), the studied area is divided in two regions, the study could be done separately for each of those regions. (though the author has done few analysis on that directions, I think it should be more explicit)."

Response 2: We divided the region by an annual precipitation threshold (2000 mm) that provided two advantages: - each class roughly had half the data points, - it divided the region in seasonal (dry) and year-round rain (humid) areas that followed the vegetation classes described in the text. For clarification, the first sentence of the second paragraph of section "3.1 Performance of calibrated model assessed by statistical tests" P814 L23 was changed for: **"After splitting the dataset by rainfall category in two classes, above and below 2000 mm of annual rainfall, roughly splitting data points in half and in summer and year-round rainfall areas (see vegetation types in the section on region description); we found that model performance was lower in dry areas (71 catchments with a R^2 of 0.22, slope of 0.32 and intercept of 143.7 mm) than in wetter areas (67 catchments with a R^2 of 0.60, slope of 0.67 and intercept of 525 mm)."**

Review: "• A more critical opinion on the acceptable level of run-off results uncertainty (42%) according to the needed use (climate change/water resources management)."

Response 3: According to Beven (1993), measuring model uncertainty can be used to assess different model structures (given that they use the same method) or the value of including additional data into the model. The parameter uncertainty presented here should be also compared to uncertainties in projected runoff under climate change scenarios (paper in preparation) in order to assess the uncertainty of predicted impacts. We added a sentence at the end of the final paragraph of section "3.4 Residuals distribution and uncertainty analysis" in P817 L11: **"Our uncertainty assessment could be used in future studies of the region on a comparison of the suitability of different model structures and the benefits, in terms of reduced uncertainty, of adding data (Beven, 1993). Furthermore, it could help quantify the uncertainty of predicted impacts of climate change in the runoff of Mesoamerica."**

The References section was also updated, P821 L21, with: "**Beven, K.: Prophecy, reality and uncertainty in distributed hydrological modelling, Advances in Water Resources, 16, 41-51, 1993."**

Review: "Besides that, the manuscript is overall well written; and for the sake of completeness an overview of the MAPSS model equations is needed (could be annexed)."

Response 4: The model is described in full detail by Neilson (1995) with all equations in Appendix 1. We did not include the equations because we believed that the presentation of a simplified model version would raise more questions than it would bring information. Nevertheless we deepened model explanation and revised the whole Section 2.2, P806 L6 – P807 L4, to look as follows:

"MAPSS simulates potential vegetation cover and leaf area given light and water constraints. The water balance of one year is calculated in monthly time steps based on the vegetation leaf area and stomatal conductance for canopy transpiration and soil hydrology (Neilson, 1995). The modeled year represents a multi-year average climate parameters (see periods for each variable in Table 1). Canopy interception and evaporation of precipitation are a function of the number of rain events and leaf area index (LAI) and are linearly related to monthly precipitation. Summer and winter frequency of events is estimated depending on a potential evapotranspiration threshold in order to distinguish frontal and convective storms. Water reaching the soil layer is divided into fast runoff and infiltration. The latter is regulated by saturated and unsaturated percolation processes according to Darcy's Law (Hillel, 1982). As much as three times per month, water balance is compared to soil capacity and excess of water leads to infiltration and percolation. The soil is divided in three layers with grasses having access to water from the top layer, woody vegetation (including trees and shrubs) from the top and intermediate layers, and the deepest layer is used for base-flow and has no roots. Before percolation, transpiration by grasses and woody plants occurs.
The ratio of actual to potential evapotranspiration (PET) increases exponentially with LAI. PET is calculated using climate and an aerodynamic turbulent transfer model (Marks, 1990). Stomatal conductance decreases with decreasing soil water potential and with increasing PET. Actual transpiration is calculated for each life form, constrained by PET

and based on canopy conductance. Canopy conductance is the product of the life form stomatal conductance and canopy leaf area (based on LAI). Stomatal conductance depends on soil water content and PET.
The calculation of LAI involves competition for both water and light between woody and herbaceous vegetation. Water is used by each life form proportional to their LAI values. Woody and grasses competition is based on an inverse linear relationship, in which LAI of trees increases and that of grasses decreases up to a threshold where grasses are eliminated and the canopy is closed. The final equilibrium LAI is calculated iteratively for grasses and woody vegetation, so that life forms consumes most of the available water in a single month of the growing period and never drops below the wilting point.
MAPSS assumes the annual soil and aquifers water storage term (Δs) in Eq. (1) is close to zero, which is mostly true on an annual basis or in catchments characterized by a high superficial runoff to infiltration ratio:

$$R = P - E - I - \Delta s \quad (1)$$

Where, R is runoff, P is precipitation, E is evapotranspiration, I is interception and Δs is the water storage in soils and aquifers.

Vegetation physiognomy is hierarchically classified with rules based on life forms LAI (grasses, shrubs and trees), leaf form (broadleaf or microphyllous) and phenology (evergreen or deciduous) of woody vegetation and thermal zones (tundra, taiga, boreal, temperate, subtropical and tropical).

A detailed model description, in which we based this section, including model equations and default parameters, is given by Neilson (1995).”

Review: “I am not sure if it is a pdf conversion problem but the titles/sub-titles, the “i” is always written as “l””

Response 5: It might be a conversion problem (we do not see this problem in our versions) but we will check this issue when resubmitting.

We added a new paragraph to the acknowledgments section after P820 L25 with the following: **“The authors would like to thank Ron Neilson, Ray Drapek and John Wells from the USDA Forest Service, Pacific Northwest Research Station in Corvallis, Oregon, USA. They provided essential support for this work, by providing the model code and advice in its implementation and usage.”**