Interactive comment on "Climate and topographic controls on pasture production in a semiarid Mediterranean watershed with scattered tree cover" *by* J. Lozano-Parra et al.

We want to thank the anonymous referee for his comments that undoubtedly will help to improve the manuscript. In this reply we hope to clarify the reviewer's questions. We also indicate where we will make changes in the revised manuscript based on the anonymous referee's suggestions.

Anonymous referee #2

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In general, the manuscript is well-written, and addresses relevant scientific questions with the scoped of HESS. It presents a physics-based, spatially-distributed ecohydrologic model, and gives some interesting results or conclusion. While, there are some parts need to be made clear or rewritten. I suggest that the manuscript can be accepted after major revision.

1. The title is not suitable for the manuscript. The ecohydrologic model is the core of the manuscript, and the 300 yr long climate dataset is one of the highlights for the paper. But, model and 300 yr climate dataset can not been seen in the title.

   Reply:
   As was discussed in the previous reviews, we will make explicit in the title that this is a modelling study, and it will be revised to be along the lines of: 'Climate and topographic controls on *simulated* pasture production in a semiarid Mediterranean watershed with scattered tree cover'. The title may be further edited before the submission of the final paper. We think that there is no need to specify in the title the length of the simulation since it is just a methodological detail.

2. Lines 14-15 page 15172, the author said: Annual potential evapotranspiration is twice the annual rainfall amount. But, Lines 15-18 page 15184, the author said: Annual mean value of evapotranspiration for the whole catchment was 390mm while annual mean precipitation was 508 mm. It is incongruous obviously. Are the model results wrong?

   Reply:
   In lines 14-15 page 15172, we refer to annual potential evapotranspiration, while in lines 15-18 page 15184, we talk about annual actual evapotranspiration. The annual water balance is correct and typical of the region. Mean annual evapotranspiration representing more than 75% of water outputs of the catchment. The remaining amount between of 120 mm becomes runoff. The range of measured runoff values in the catchment oscillate between 10 and 190 mm depending on annual precipitation.

3. Lines 15-18 page 15174, the overall soil moisture of each site was considered to be the depth-averaged soil moisture of the sensors. However, the soil water content (SWC) at 5 cm depth can change very fast, and SWC at 30 cm depth may not. I am not sure it is suitable to average the soil moistures at different depth.

Reply:
It is appropriate to average soil moisture measurements from sensors located at different depths. If the sensors are evenly spaced the arithmetic mean approximates the average water content of the profile; when the sensors are not evenly spaced a weighted average is used. An aggregate estimate of the soil moisture in the soil profile was necessary for comparison purposes since the model simulates the depth-averaged soil moisture content of the soil profile, not the soil moisture at specific depths.

4. Lines 15-18 page 15174, the overall soil temperature of each site was considered to be the depth-averaged soil temperature of the sensors either. But, in lines 5-6 page 15174, the soil temperature was measured at 5 cm depth only. How to get the depth-averaged soil temperature?

Reply:
Unlike soil moisture, the ecohydrologic model is designed to simulate two soil thermal layers and we use the measurement of the topmost soil sensor as the reference for calibration. We do not average temperature over the soil profile. This is corrected in the revised version of the manuscript.

5. Lines 20-21 page 15174, the natural pasture production were measured from Sept 2008 to August 2011. While, in lines 1-3 page 15175, the plant height were measured from 1 March 201 to 31 August 2012. It is confused that why the measurements have not been taken during the same periods.

Reply:
The initial measurements were primarily aimed at determining pasture yield in order to estimate the aerial biomass production in every site by cutting twice a year. However, we observed that by using only this method we would not be able to simulate the phenological cycle, therefore we carried out complementary measurements. For this reason 16 measurement of plant height were taken biweekly during two hydrological years and added to the database, which reported a continuous record of the herbaceous biomass variation and supplemented the database.
Also, quality indicators of pasture production indicated that the yield was properly simulated. We think that capturing the phenological dynamic of natural grasses was also very important. In this regard, we consider that the database of pasture production allows to simulate both pasture yield and phenological cycle, such as represented in Fig. 5 and Fig. 6-B, where we can see that the phenological cycle of the herbaceous plants in the study site was captured by the simulated data, as well as transpiration associated to the seasonal phenology.

6. Line 21 page 15177, what's the resolution of the digital elevation model (DEM)? It is suitable for the model? It should be made clear.

Reply:

The entire modeling domain was discretized with a 30m x 30m grid based on the extensive experience of the research group simulating this catchment. The main objective of the paper was to determine the climate and topographic factors that control pasture production at the catchment scale. A lower grid size would start to introduce small and micro topographic effects into the ecohydrological processes, and therefore the focus of the paper would change toward smaller scale. A smaller grid size would also introduce a level of precision in the topographic description that is not congruent with the information available for other catchment properties. On the other hand, a coarser grid would introduce too much topographic smoothing that may not properly capture the spatial ecohydrological processes dependent on the physiographic characteristics of the landscape.

7. Lines 4-6 page 15178, the author said "Maps of soil properties such as soil depth, porosity, and other hydrologic properties (Fig. 2) where derived from the geomorphologic characteristics of the basin as described in (Maneta et al., 2008)". Since the data of Fig.2 from the reference of Maneta et al(2008), it should be clarified in Fig.2.

   Reply:
   We incorporate the suggested change in the text in the revised version of the manuscript.

8. Lines 7-8 page 15178, the author said, "Tree density and tree canopy cover maps were obtained from aerial photograph interpretation and through image classification methods (Fig. 2) (Maneta, 2006)". Were the maps from the reference of Maneta(2006), or the methods from the reference? If the maps were from the reference (published in 2006), the maps data may be out of date for the case study.

   Reply:
   The methods and data are from the reference. The experimental catchment is a savannah-like environment dominated by *Quercus ilex*. Unless there is logging, fires, or any other major impact, the density and structure of the tree layer in this type of land use does not change significantly in the decadal time frame.

9. In the section of "3.4 Generation of atmospheric forcing", the generation of a 300 yr-long climate dataset was chosen and used. But the reviewer is confused that the 13 yr of data from the meteorological station (2000–2012) are enough to generate the 300 yr-long data. Furthermore, during the 300 yr-long periods, what will happen to pasture growth, and how to consider about the dynamic change of pasture growth?

   Reply:
   The stochastic weather generator uses the statistical properties of a dataset of meteorological observations to generate a synthetic and typically longer dataset that maintains the statistics of the observations. The 13 yr of observations from our meteorological station include a wide range of variations, from very dry to very wet years, together with "normal" climate situations. Therefore, we consider that it is a good opportunity to create a synthetic weather series from observations of the original site. Similarly, the pasture growth model described in the manuscript and embedded in the

referenced ecohydrologic model is calibrated under the observed meteorological conditions so reproduce the pasture growth observations. Once calibrated the models was used to simulate the dynamics of pasture during the 300 years of synthetic weather data.

10. Line 2 pages 15179, 51 yr data from a station located at 24 km from the study site were used. Do we need to consider about the spatial variation of climate data? When using climate data from other place, are there some model uncertainty because of this?

    Reply:
    The 51 years were used only for daily wind, which was found to be uncorrelated to any of the other weather variables and therefore was simulated independently by cycling a measured series of 51 years.
    We used the official meteorological station located at 24 km to fill some small gaps in our database, and we found that this station has a strong correlation with weather variables of the experimental catchment due to proximity and a fairly similar and gentle topography, so that strong spatial variations of climate data were not observed. The small existing variations between our meteorological station and the station 24 km out were statistically corrected using linear regression. This last point, not explicitly indicated in the original manuscript, is included in revised version

11. In the section of "3.5 Model calibration", 4 years data were used to calibrate the model, and then predict 300 yr-long change. The reviewer is not sure about this.

    Reply:
    The 4 years of observed data were utilized to calibrated the model, then we used the 300 yr-long to simulate how pasture responds to climate variations according to landscape variables, such as tree density or topography. The calibration stage was done with our best available information and the calibration was robust given that it was done with at a high temporal resolution (calibration period totaling 1460 days). Since the weather in the subsequent 300 yr-long simulation has the same statistical character than the weather during the calibration period (no extrapolations far outside the conditions of the calibration period), we are confident that the results represent the feasible range of pasture production within the basin.

12. Line 15 page 15190, the water consumption by trees was referred to. While, nutrient consumption of trees is important also. It should be discussed in the section of 4.2.4.

    Reply:
    We discussed this topic in section 4.2.3 by saying that tree canopy cover was found to be negatively related with pasture production, reflecting the importance of variables as rainfall and light interception, and water consumption by trees. However we argued that this interpretation may not be exhaustive since the production of pasture under tree canopies is a complex issue. For instance, trees may promote pasture production by enhancing soil fertility and structure. We acknowledge that these factors were not explicitly simulated in this study.

13. Fig.5 page 15210, it can be seen from the Fig.5 that the observed data were limited or not enough maybe.

    Reply:
    This was one of the reasons why measurements of plant height were taken biweekly during two hydrologic years. The additional data densified the database, increasing the temporal resolution of observations, and captured the phenological cycle of pasture. Quality indicators of the model performance indicated that the measured values of pasture production were consistent with simulated values, and that the phenological cycle was correctly captured, such as shown in Fig. 5 and Fig. 6-B. Further increases in the temporal resolution of the pasture growth dataset would have decreasing returns in terms of improving model performance.