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Hydrology and Earth System Sciences Discussions

Interactive comment on "Ecohydrology in Mediterranean areas: a numerical model to describe growing seasons out of phase with precipitations" *by* D. Pumo et al.

D. Pumo et al.

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Dear Editor and Referees, We are very grateful for your prompt and constructive comments to our manuscript. Certainly your expert suggestions will improve the fluency and technical contents of our work. Following the suggestions of the Editor, we hope to have provided a response to every comment and observation of all the Referees. Particularly, we have reviewed the entire manuscript, reorganizing its structure, improving the English, and making better the conclusions. Below you can find enclosed the replies to all the Referee comments; these have been divided according to the treated topic (from A to G) and grouped in two parts: Major and Minor Revision. Finally we wish to thanks the Editor for the suggestion of a paper of great interest for our field

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of research.

MAJOR REVISION

A- Referee Comments:

Referee 1:

A.1.1 - The paper (see Section 2.1, 2.3 and 2.4) could be shortened in some parts by simple citing original papers. A.1.2 - Page 2778, lines 9-11, the sentences is not well connected to the previous part of the section.

Referee 2:

A.2.1 - The description and explanation of some literature concepts (analytical solution, water stress expression) should be omitted and referenced through quotation of the specific original papers. A.2.2 - It is not clear what is the use of Eq.2, Eq.3 and Eq.4 in the economy of the presentation

Referee 3:

A.3.1 - The concepts about the interceptions and the soil balance equation (section 2) should be contracted being already explained in recent research. Eq.5, Eq.6 and Fig.1 are unnecessary. The page 2776 may be contracted reporting only the innovative information. A.3.2 - A few lines with references can be introduced instead of the section 2.2 A.3.3 - At page 2779 the parameters of the rainfall model have been previously described. At page 2780 the resume of all the input model is not necessary (previously described). A 3.4 - Section 2.4 may be reduced.

A- Response and Actions Taken by authors:

The Authors agree with the referees' suggestion about the necessity to shorten the paper for what concerning the description and explanation of some literature concepts mainly present in the Sect. 2.

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In this sense, the following changes have been made: - The entire Sect. 2.1 has been revisited and contracted; the Eq. (1) and the Eqs. from (3) to (6) have been removed. For what concerning one of the above mentioned comments of the Referee 3 (A.3.1), we consider the Fig.1 very important to give an immediate interpretation of the assumed schematization for water losses from the soil in both the analytical and numerical modellistic approaches. Actually, we have substituted the figure from Laio et al. (2001b) with one of the losses schemes really adopted by us in order to emphasize the differences between the water losses during the dormant and the growing season. - Following the suggestion of Referee 3 (A.3.2), the Sect. 2.2 has been eliminated, shortening the expressed concepts through opportune references and moving these at the end of Sect.2.1. Page 2778, lines 9-11, the sentences has been removed (A.1.2). - The Sect. 2.3 (now Sect. 2.2) have been deeply modified providing further information about the influence of the temporal discretization in the numerical approach and adding the Fig. 2. - The Sect. 2.4 (now Sect. 2.3) has been considerably shortened through citation of the specific original papers (Eqs. from 17 to 21 have been removed).

All the above mentioned and corrections modifications have been accompanied by opportune substitutive comments and references in the paper.

B - Referee Comments:

Referee 1:

B.1.1 - It is not clear how the model considers a river basin as a collection of elementary cells (page 2780 and in the application). B.1.2 - There is no connection of the model application to the catchment scale or the catchment features. B.1.3 - The paper does not provide any data that could validate the model conceptualizations or the model results in the studied area. B.1.4 - The model is applied keeping a stationary vegetation cover. To what extent a stationary vegetation cover could be assumed in Mediterranean environment?

Referee 2:

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B.2.1 - In the application, none of the water balance or hydrological result refers to the hydrological behavior of the catchment. B.2.2 - It is not clear why the catchment study was limited to one sole vegetation cover type. B.2.3 - The peculiarity of simplified soil moisture simulation models makes any validation of results quite problematic. B.2.4 - In the application no reference to the basin scale is found in the results. B.2.5 - The catchment application is doubtful to the effective results of the paper.

Referee 3:

B.3.1 - The model should be applied also for the different vegetation cover type.

B - Response and Actions Taken by authors:

In this paper, the main target of the application (Eleuterio case study) is to show (and to submit to expert colleagues opinion) a new methodology, a different approach to the ecohydrology model in Mediterranean areas and to investigate on the influence of different annual discretizations. The choice of Eleuterio basin is only due to the need to use real data typical of a Mediterranean area. The proposed model must be applied within an area homogeneous with regard to climate, soil and vegetation and it is not a distributed model that works at cell-scale and is not yet a model able to work at catchment scale. Improperly and probably in a misleading manner, we have spoken about a division of the basin in more cells. The intent was to show how is possible to obtain catchment-scale results starting from a single homogeneous cell and a subsequent aggregation procedure of results. Anyway, in the previous version, we did not deepen this last aspect. This initial intent has been later dropped and in a wrong way we did not remove any references to the catchment scale.

In truth the application of the model it has been made considering the basin divided into different homogeneous areas of different size (anyway the size is unimportant for our aim). The division has been considered just to identify the possible combinations soil-vegetation present within the watershed. Moreover the model has not been applied to all the possible homogeneous areas but only to the areas covered by trees, because

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the main intent of this paper is to investigate on the possibility to overcome the problems connected to the transient effect due to a not neglectable soil moisture initial condition in Mediterranean areas. From this point of view, the most important vegetation cover is certainly the woody vegetation because it is the most subjected to the transient effect; particularly, increasing the active soil depth, the amount of water that can be stored into the soil during the dormancy season increases and furthermore because of the slower soil moisture dynamics relative to the deeper soil layer, more time is required to reach a possible stationary condition during the growing season. For this reason we have decided to limit the application to an unique vegetation type (the most present and critical within the basin), investigating also on the importance of different soil types. In an our not yet published work, we have found that for grass and shrub vegetation cover in the Euleterio river basin the transient soil moisture dynamics are much quicker, having a duration of few days (less than 10-15 days). All these aspects have not well expressed in the paper and for this reason we have reviewed the entire manuscript (removing any references about the cell discretization of the basin and the catchment scale) and added some brief but important comments in the Introduction, in Sect. 3 and in the Concluding Remarks.

Particular attention has been paid to the observation of the Referee 1 about the stationary vegetation cover (B.1.4). Actually the application of the proposed ecohydrological model should be limited to the areas covered by vegetation with features practically constant in time and homogeneous in space. Also for this reason we have chosen the Eleuterio river basin, that being characterized by a low interannual variability of precipitation and being a natural reserve in a ecological state of maturity, presents a low variability in time from pedological and vegetational point of view. Nevertheless the variability in time and in space of the vegetation within the basin could be taken into account when the model is applied to the entire basin, introducing some procedure able to simulate also the process of spatial colonization by different vegetations (probably linked to the plant water stress state). This is out the purpose of this paper and represents a very interesting idea for future implementations of the model and for the

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study of vegetational dynamics in Mediterranean areas.

With regard to the validation of results (B.1.3 and B.2.3), it is usually very difficult considering the results relative to a partial area of the basin (that covered by trees); it could be instead practicable from an hydrologic point of view, considering the results regarding the whole basin and it is the goal of an our work presently in progress. Certainly the complete validation of the results for the ecohydrological models is somewhat of really arduous even for the most consolidate analytical models in semi-arid environment and this new proposed model applied in a different climate situation is not an exception.

C - Referee Comments:

Referee 1:

C.1.1 - What is the actual sensitivity of the numerical solution to the computational time step? C.1.2 - Page 2781, lines 12-14, what does it mean to "scale-down" at the same "time-scale" the "saturated hydraulic conductivity"

Referee 3:

C.3.1 - Major attentions have to be dedicated to the comparison between numerical and analytical model.

C - Response and Actions Taken by authors:

A further important argument has been added and discussed in the section describing the numerical solution of the soil water balance (now Sect. 2.2) with the intent to explain the choice of the time-step. This represents an important contribution in the comparison between numerical and analytical model. Particularly, the influence of the temporal discretization on the numerical approach has been discussed, emphasizing as the choice of an opportune time-step is fundamental for a correct evaluation of the soil moisture dynamics. We have added a new figure (Fig. 2) where the ability of the proposed numerical model in reproducing the analytic soil moisture pdf in steady conditions, proposed by Laio et al. (2001b), has been shown. The sentence "to scale-down

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at the same time-scale" (C.1.2) simply meant that all the input data and parameters have been reduced to the chosen temporal step. In the case of the saturated hydraulic conductivity, the values of ks have been converted from cm/d to cm/step (i.e. ks=2,5 cm/d correspond to a ks=0.417 cm/step when the step is equal to 4 hours). It was a wrong sentence relative to a superfluous explanation which we have partially removed from the paper.

D - Referee Comments:

Referee 1:

D.1.1 - How did the authors verify that the higher is the interannual discretization for rainfall and evapotranspiration parameters, more accurate is the resulting pdf? How is the accuracy measured?

Referee 3:

D.3.1 - The conclusion of the section 3.4 is obvious and it is not in phase with the concluding remarks at lines 21-22.

D - Response and Actions Taken by authors:

Certainly the accuracy mentioned in the concluding remarks at lines 21-22 (page 2794) has not been estimated, and it is not the result of a validation procedure. In Sicilian areas, the months of July and August are much drier and hotter than April, March and October, then, even if the historical data of soil moisture recorded in continuous during the growing season are not available, we could expect that the more accurate is the annual discretization considered for rainfall and evapotranspiration parameters, the more physically consistent is the annual soil moisture behavior and then the resulting pdf. Particularly, in this way it is possible to take into account the climatic variability during the growing season, typical in that area. We have revisited the conclusions, confiding to be more clear and precise and to facilitate the comprehension of all the concepts.

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E - Referee Comments:

Referee 2:

In the comparison (between Scheme A and B) of soil moisture time profile in Section 3.4 (Fig.6a and 6b) it seems that the reported differences could not be related only to the different parameterization of rainfall generatores.

E - Response and Actions Taken by authors:

The simulations have been carried out starting from two different rainfall series (each one 100 years) using two different parameterizations (SCHEME A and B). The two generated rainfall series present the same mean value, with regard to the total seasonal rainfall relative to the growing and the dormant seasons; but this aspect does not warrant also a correspondence year by year of the seasonal rainfall. The Fig. 6a and 6b showed the results relative to one of the 100 year simulated, randomly extracted from each synthetic series. The comparison year by year must be considered quantitative only with regard to different soil type within the same figure, while the comparison between the two figures (Fig. 6a and 6b) must be considered only from a qualitative point of view. Nevertheless, even if the differences between the two figures were also due to the different precipitation features, it was equally possible to identify some peculiarities of the typical behavior for each different scheme. Anyway we have reviewed this part pointing out the qualitative nature of the comparison between Fig.6a and Fig.6b (now Fig. 7a and 7b). Furthermore, in order to give a more meaningful comparison between the two figures, we have changed the years considered, choosing these not randomly, but extracting two years with the same values of total seasonal precipitation from the two synthetic series. A quantitative comparison between the results coming from the two different schemes (only for the growing season) has been reported in Table 6 (whose structure has been modified), where the results are comparable because the seasonal mean values of precipitations and evapotranspiration relative to each scheme are the same.

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MINOR REVISION

F - Referee Comments:

Referee 1:

F.1.1 - References under tables 1 and 2 are not correct or at least they do not match with the references cited in the text. F.1.2 - The parameters concerning the shrub and the grass could be omitted from table 1.

Referee 2:

F.2.1 - Referencing in some of the tables does not mach the guidelines for authors.

F - Response and Actions Taken by authors:

The references mentioned at pages 2787 and 2788 have been corrected (F.1.1 and F.2.1). Actually the parameters concerning the shrub and the grass in Table 1 are not functional for our purpose and then they have been removed from the table; the correspondent citation in the text at page 2787 has been opportunely modified (F.1.2).

G - Referee Comments:

Referee 3:

G.3.1 - The concepts expressed in the section 3.2 are similar to those explained by Caylor et al. (2005) G.3.2 - In Fig.5a the units of measurement of the vertical axis should be introduced. G.3.3 - In Fig.6 it is not clear the meaning of the x-axis description. G.3.4 - In Fig.7 in the box of each plot it is preferable to introduce colored lines for legend. G.3.5 - Page 2792, line 17 the figure should be 5b instead of 5a. G.3.6 - Page 2793 line 11 the equation should be 23 instead 17.

G - Response and Actions Taken by authors:

G.3.1 - We agree with the Referee 3, since we have followed the same procedure (as mentioned at page 2789 line 2). The substantial difference from Caylor et al. (2005)

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procedure is that we don't take into account any spatial distribution of climatic variables, and for this reason, in the previous version of the paper, we reported in a detailed manner all the part of Caylor et al. procedure that we have actually adopted. Nevertheless, in agreement with all the Referees about the necessity to shorten the literature concepts, the description and explanation of this procedure has been omitted and referenced through quotation of the specific original paper.

G.3.2 - We have added the units of measurement of the vertical axis (just mentioned in the legend) also in Fig.5a (now Fig.6a).

G.3.3 - The x-axis in Fig.6 (now Fig.7) represents the time measured in step, starting from the first step of the first day of the first year. Anyway, in order to give a better representation of the time axis, it has been modified in day of the year (DOY).

G.3.4 - Following the Referee's suggestion we have provided to introduce colored lines for legend in the box of each plot in Fig.7 (now Fig.8).

G.3.5 - The citation in the text (page 2792 line 17) has been corrected.

G.3.6 - The part of the text containing page 2793 line 11 has been modified, because we have removed Eq.23.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 4, 2769, 2007.