Hydrology and Earth System Sciences Discussions

Interactive comment on "Improvement, calibration and validation of a distributed hydrological model over France" *by* P. Quintana Seguí et al.

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The questions of the referee show that the article, as it was submitted, does not clarify important points that must be clarified. The authors of the article would like to thank the referee for these questions as they will led to important improvements in the article.

First, the referee wants to have more information on how the C_i parameters are calculated or calibrated and how they are related to k_{sat} and an explanation about the fact that a more complex model was calibrated instead of directly calibrate the existing model.

It is true that the article does not explain in detail how the C_i are calculated. Actually, it refers to Noilhan and Planton (1989) and Boone et al. (1999) which explain that the

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ISBA dimensionless force-restore parameters (C_i) are related to the soil texture properties and moisture (Noilhan and Lacarrère, 1995) using the parameter expressions and values from Clapp and Hornberger (1978), which is also cited in the article. It was chosen to avoid repeating what is already explained in detail in recent articles, like Decharme et al. (2006) and the main articles about ISBA.

C_1 is related to the exchanges with the atmosphere (Eq. 1), C_2 and C_4 are related to the diffusion within the soil (Eq 6 and 7) and C_3 is related to drainage (Eq. 4 and 5). All these parameters depend on the value of k_{sat}, among other variables (Mahfouf and Noilhan, 1996). C_3 is primarily affected by changes in the k_{sat}. The other coefficients, which correspond to the restore coefficients, are also affected, but in a lesser extent.

Sections 2.2 and 4 have been modified to clarify these points.

Concerning the improvement of the model and the calibration, Section 4 of the article identifies a precise problem: SIM does not produce the right drainage, which has consequences on riverflow.

The first step followed to explore a possible solution to this problem was to test the sensibility of the simulated discharge to the C_3 parameter by directly calibrating it on a small number of basins. This test is not explained in the article and it will be briefly commented in the modified version. The tests showed that the modification of this parameter was an interesting way to follow in order to find a solution to the problem, as the statistics of discharge improved. Nevertheless, the resulting hydrogram was not yet satisfactory. This tests have been mentioned in the new version of the manuscript.

At that time, Decharme et al. (2006), following the work of Chen and Kumar (2001) and Montaldo and Albertson (2001), showed that having a constant value of k_{sat} in the whole column of the soil, as it is implemented in ISBA, is not very realistic and that the introduction of an exponential profile greatly improves the quality of the simulations. When the exponential profile is introduced to the model, as is explained in detail by Decharme et al (2006), the C_i parameters must be modified, to make them compatible

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with the theoretical model. This modification creates a dependence between C_i and the two parameters of the profile. Because the modification of k_{sat} implies a modification of C_i, a calibration of f and d_c implies a calibration of C_i. As a consequence, the new exponential profile of k_{sat} improves the dynamics of water within the soil and allows us to calibrate the model consistently.

Finally, the referee asks, *what understanding is gained after the introduction of more complexity, except that higher parameterization is better able to fit the observed data*.

The study presented in the article shows that a model in which conductivity decreases with depth better describes the dynamics of water within the soil and, as a consequence, improves the simulated runoff, drainage and riverflow making the model more robust. Furthermore, the introduction of the new k_{sat} allows a proper calibration of the model. The article shows that the other fluxes of the model, that weren't intended to be modified, remained very stable after the calibration, which is compatible with the fact that the model ISBA is applied in many different contexts. According to us, this results are largely enough to justify the new layer added to the model.

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