

Towards a simple representation of chalk hydrology in land surface modelling

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The paper describes the addition of the bulk conductivity (BC) model into the JULES land-surface model. The authors have implemented this very simple model in attempts to improve the simulation of chalk hydrology. The BC model is calibrated and shown to improve the simulated mass and energy fluxes over the Kennet catchment. The authors conclude by commenting on the potential suitability of this simple model for large scale land-surface modelling.

It is clear that the authors have taken the time to properly implement the comments and suggestions from the first pass of reviews which have greatly improved the manuscript. The rewording of the title and abstract highlight the strength of the simplicity of the approach, and the calibration of the BC model parameters makes for a much cleaner and more convincing study.

I have found the paper clunky to read in places. Some restructuring could help improve the readability of the manuscript.

Personally I feel that the calibration step needs to be clearer. The calibration step is not mentioned in the Abstract or Introduction of the paper. The word evaluation is used in places where 'calibration' would be more relevant. The BC model is first calibrated using soil moisture data at a point scale. The calibrated model performance is assessed and compared to the performance of the default JULES parameterization. Finally it is evaluated against independent data at a catchment scale.

Minor Comments

Introduction: It is worth mentioning in the introduction what default JULES does, this becomes clearer later but a sentence here to the effect: 'JULES has nothing in place for chalk' would be useful.

Pg 4 line 65: '*...relatively large number of parameters*' could be worth stating how many to contrast with the three parameter model described in the paper.

Pg 3 line 69: '*At the point-scale the BC model is **evaluated** using observed soil moisture data.*' maybe use calibrated instead of evaluated.

Pg 4 line 87: the units for K_s are inconsistent with the units found in table 3.

Pg 5 line 105: it is not clear how Price et al.'s values of $3-5 \text{ mmd}^{-1}$ for K_s imply a range of $0.8-86 \text{ mmd}^{-1}$ for calibration.

Pg 5 lines 112-123: Please consider moving the calibration description into the methodology.

Pg 8 line 189 or Pg 10 line 223: Consider discussing the choice of using the default JULES parameters in the configuration. It is not too surprising that the calibrated parameterization of BC model would outperform an uncalibrated JULES model. The authors address this point in the first pass of reviews but I feel some of the text would benefit from being in the text. Especially since it highlights the BC model's application to a completely 'naive' model setup.

Fig 1b): The 'Bare soil', 'Needleleaf' and 'Broadleaf' colours are very similar and hard to distinguish.

Fig 4 (panels (b) to (c)): It would help to shade the bars of the unchanged values differently so that the changes in parameter values becomes more obvious. These panels also don't get discussed much in the main text.

Pg 12 line 271-276: The sensitivity of S_0 is particularly interesting and in turn the model doesn't seem sensitive to f_m . I feel the sensitivity of the parameters could be further discussed. Why is it advantageous to use the macro configuration with the two optimized parameters vs the three optimized parameters?

Table 3: there seems to be a lack of consistency between Figure 4 and Table 3. In the text (line 276) '*... we select the macro configuration with optimized K_s and S_0 ...*' which should mean f_m remains unchanged. However in Table 3, f_m 's optimized value differs for its unoptimized value. The value for f_m in this table might be from optimising over this parameter alone, but then the other parameters have optimized values which differ from their single optimisation value (e.g. K_s). What optimized values are shown in this table? Surely the values used in $macro_{opt}$ should be represented here.

A further comment on Fig.4 and Table 3: what are the units of K_s ? In figure they are of order $\times 10^{-4}$, in the table units (md^{-1}) and earlier in the text (mmd^{-1}).

Table 3: Add ranges over which the parameters were allowed to vary in calibration stage.

Pg 13 line 196: It is worth commenting that it is still an underestimate.

Pg 16 line 375: Two parameters vs the three referenced in the rest of the paper... is K_s no longer considered a parameter in the conclusion?

Fig 6: Consider adding vertical lines between the bins to highlight the fact the boxplots are of the same depth. This is not immediately clear and I've noticed that reviewer 3 also mentioned the slight confusion caused by this figure.