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Hydrology and Earth System Sciences Discussions

Interactive comment on "A distributed continuous simulation model to identify critical source areas of phosphorus at the catchment scale: model description" *by* B. K. Koo et al.

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Response to the Anonymous Referee 1

I. General comment:

In the paper, please note that CAMEL is described as not 'process-based' but 'process-oriented'. The authors admit the model includes some empirical or conceptual components to represent certain processes or structure of the model as described in the paper. Catchment models may fall into three categories - empirical, conceptual and physically-based (or process-based) models. Considering the structure of CAMEL and its representations of processes, we reckon that it is reasonable to put the model between conceptual and process-based models. This is why the authors describe the model as 'process-oriented' rather than 'process-based' or 'conceptual'. The authors accept the uncertainty involved in the model is very high, but we also note that this is typical of a spatially-distributed model. However, the uncertainty issue is not currently dealt with in the paper, so it will be briefly discussed in the discussion section.

II. Specific comments:

1. Page 1360, line 17

The phrase ‘computationally efficient’ might not have been very clear, but the authors do not mean to describe the model is ‘numerically efficient’. We mean that the model sparingly employs iterative numerical approaches and therefore it requires relatively low computing power, which has been already mentioned in the discussion section (p. 1387, line 12). The authors will try to rephrase it to deliver the meaning more clearly.

2. Page 1362, line 18

The authors do not know of any HRU models in which HRUs are connected with each other and water flows between HRUs are calculated explicitly. We will appreciate if you could give us a few examples of such models. In CAMEL, every grid cell has a stream channel in the middle of the cell. Here, please note that the ‘channel’ can be very small and no water may flow in most days of the year or may not flow at all in a limited period. For description of surface water flows between grid cells, the authors believe that it is more realistic to assume channel flows (concentration of water flows) than any other types of flows (e.g. sheet flows).

3. Page 1369, line 14

Detailed information of field drains on a certain area is rarely available and, thus, in practice, effective values may need to be used instead.

4. Section 3.5

For a given point within a catchment, the upstream area is divided into isochrone areas of flow travel time to the given point. Isochrone areas are defined as certain cells from which water drains to the given point within a time-step (Isochrone 1), within two time-steps (Isochrone 2), and so on. Then the amount of water draining from each of the isochrone areas (unit hydrograph ordinates) are superposed to give total discharge at the given point. Applying this approach to the entire catchment, discharge variables are estimated at every grid cell. For determining isochrone areas, this approach assumes a constant flow velocity at a given point. Given the channel slope, dimensions and roughness, a constant flow velocity means a constant water depth. Based on the observed discharge data, the user provides a constant water depth as a fraction of the channel width (rather than channel depth). Here, the reason for using channel width as the reference dimension is just to avoid unreasonably high water depths for some cases of high ground cells where the channel bed elevation can be very much lower than the mean ground elevation.

5. Page 1375, line 24

The soil aggregation process is represented in the model using a simple exponential function. Based on results of test simulations, this function was found to be insensitive and therefore the exponent was arbitrarily hard-coded to be 1. The overland sediment storage represents the sediment particles that are disaggregated by rain drop impacts and remain loose. Thus, as soil aggregation process proceeds during the dry periods, the size of overland sediment storage decreases over time.

6. Page 1376, line 4; Page 1386, line 12

The sediment routing scheme implemented in CAMEL would not be considered to be comprehensive if it were to estimate sediment concentrations at the catchment outlet only or if it did not take into account isochrones. It is a cascade routing scheme to calculate sediment budgets at every single cells considering isochrones. The description of the scheme may sound simple, but its implementation in the model is not. To calculate the sediment flux from multiple upstream cells to a downstream cell efficiently (without unnecessary scanning over the memory or duplicate calculations), a comprehensive combination of algorithms and array management skills was developed and implemented. As this routing scheme is one of the biggest component in the model which requires a large fraction of the total computing power, the development of a comprehensive routing scheme had a significant impact on the overall model performance.

7. Page 1378, line 20

If required, the authors can describe the working equations of the fourth-order Runge-Kutta approach for Equations 25 - 28. However, there are 25 working equations in total (5 equations for each of the 5 P pools) which are too many to put in the paper. As the approach is well known and it would be unnecessary to repeat similar equations for 5 times, we feel it is unnecessary to put the working equations in the paper. It is a kind of one-step approach, so the time-step used in the model is a day.

8. Page 1386, line 4 and line 17

The authors accept the comments and will rephrase the corresponding words appropriately.

III. Technical corrections, etc.

1. Page 1361, line 30. OK.

2. Page 1364. OK.

3. Page 1366, line 17. OK.

4. Page 1367, line 16. The unit of Keff is m h-1 (note that unit conversion factor 1000 is included in the equation).

5. Page 1369, line 18. Yes, Equation 10 is used to estimate daily field drainage from a grid cell.

6. Page 1376, line 23. OK.

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7. Page 1377, line 9. The organic matter decomposition rate may vary according to the ratio of fresh organic matter to the decomposed organic matter (i.e. humus). However, in the model, this variation is ignored and the decomposition rate remains constant. But the decomposition rate is affected by temperature.

8. Page 1386, line 8. This sentence is a description of the P transport processes not in reality but in the model.

Interactive comment on Hydrology and Earth System Sciences Discussions, 2, 1359, 2005.