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Hydrology and Earth System Sciences Discussions

Interactive comment on "Confirmation of *ACRU* model results for applications in land use and climate change studies" *by* M. L. Warburton et al.

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General Comment

The ACRU model provides a powerful tool to evaluate the impact of land use and climate change on catchment agro-hydrology, as demonstrated for the three catchments in this paper. Continuous development and refinement of ACRU over a long period of time has enhanced the capabilities and versatility of the model. This has been particularly evident through the development of soils, land use and climate datasets that support the application of the model in a Southern Africa context. While the model has received international interest it is, as expected, primarily applicable to the regional context in which it has been developed and evaluated and where the developers have

experience and local knowledge. The model is promoted as a physically based, non-calibration model. An important test would be to confirm the models accuracy, based on readily available information, in other international agro-hydrological regimes that can be represented by the modelling approach.

Specific Comment

The adequacy of a model for predicting hydrological response will depend on the decisions to be made by the user. The paper demonstrates the usefulness of ACRU when considering land use and climate change. A good representation of the magnitude and variability of daily stream flows is shown. This would give confidence in the use of the model for sizing a reservoir or assessing impacts of forestation on water yield. Other hydrological decisions such as impact on overland flow generation and related water quality parameters may not be as well represented by the model or the goodness of fit statistics used to evaluate model performance. For example the magnitude of surface runoff relative to base flow will be impacted by infiltration processes. These are represented in the model by a soil moisture deficit, which in turn will be related to soil characteristics, land use and soil moisture status. Further the relative proportion of generated stormflow exiting a catchment will impact peak flow rates in river channels. The streamflow response variables do not appear to have a strong physical basis.

The goodness of fit statistics used in the paper may not adequately measure the ability of the ACRU model to represent such surface runoff dominated processes and the timing of flows leaving a sub-catchment.

The model has been run using long term climate datasets for the selected catchments. Hydrological processes will change over wet and dry periods in response to the changing dominance of rainfall and evaporation components of the water balance. It would be informative to split the analysis period into subsets representing wet and dry cycles in order to gain a better understanding of how well the model represents various components of the water budget and simulates gauged flows during such cycles.

The ACRU model is promoted as a physically based model that requires no calibration. Given the complexity of the hydrological cycle and the catchments that need to be modelled, the use of calibration techniques to improve the model accuracy, based on an incomplete understanding of all processes should not be dismissed. This does not negate the benefits of a physically based model since meaningful changes to calibrate input parameters can be made.

There needs to be a trade off between the size and hydrological complexity of a catchment and the level to which it is disaggregated into zones or sub catchments of relative uniformity. It would be useful to use a model such as ACRU to undertake a sensitivity analysis on the appropriate levels of disaggregation and trade off between data collection, computational complexity and improved accuracy with increase in number of sub catchments.

Given the detail with which ACRU models the land use components (eg canopy interception, evaporation, root characteristics, initial abstractions etc) it would be important to consider the dynamic changes of these variables under changing growth cycles of the crop or vegetation and changing climate regime (eg moving from a dry cycle to a wet cycle which would impact plant growth patterns).

Impervious areas, while not dominant in the catchments considered, will dominate the hydrological cycle in many catchments with growing urban and peri-urban settlement. Representation in ACRU of adjacent and disjunct impervious areas was not well documented in the paper.

Understanding the sensitivity of a model to changes in input variables has been an important part of the ACRU development team's efforts. The hydrological practitioner wishing to use ACRU would find a guide on sensitivity in parameter estimation very useful.

Technical Correction.

Page 4606 line 11. reference to Table 5 incorrect

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 7, 4591, 2010.