STREAMFLOW ASSIMILATION:  
A STUDY ON NESTED CATCHMENTS

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Introduction

Measurements of soil moisture are usually limited to local point measurements or remote sensing. While point measurements are restricted to local areas, remotely sensed soil moisture values can be masked by dense vegetation cover. A better understanding and knowledge of soil moisture will have a positive impact on fields such as weather forecasting, agriculture and drought control. Therefore, as both measuring techniques are limited in their applicability, other ways to quantify soil moisture in catchments have to be found.

In this research streamflow is assimilated into a land surface model to predict soil moisture initial states. Previous results (Rüdiger et al., 2004) have shown that this can be applied to estimate initial soil moisture states for a single catchment. It is shown that the same approach can be used for nested catchments.

Single Catchment

Fig. 4 and 5 compare the control experiment with the degraded and assimilated runs for two different experiments. In Fig. 4 forcing data and “true” output data were perfect, while the experiment in Fig. 5 had errors in the precipitation (increased by 20%) and radiation forcing data (decreased by 35%).

While the “true” observations could be adequately reproduced in the first experiment, the second produced a discrepancy in the data towards the end of the assimilation window.

Fig. 6 shows the results for the retrieval of the root zone and surface soil moisture states.

Multi Catchment

Due to the length of the assimilation window of one month a discrepancy between assimilated and “true” observations occurs, as the mass balance of the catchment is changed.

The runoff values were assimilated into all three study catchments simultaneously. The results in the following figures show that the combined still produces adequate output.

The assimilation was concentrated on the retrieval of catchment deficit and root zone excess, as surface excess is a minor soil moisture store found to be poorly determined by streamflow assimilation.

Method

This twin experiment assimilates Catchment Land Surface Model (CLSM; Kasler et al., 2000) total runoff predictions for the Goulburn River catchments into a simulation with degraded initial soil moisture states. A Bayesian nonlinear regression suite (NLFIT; Kuczera, 1988) is used for the assimilation. This is a brute force variational type approach that perturbs the initial soil moisture states until the multi-objective function is minimised.

Table 1: Comparison of initial soil moisture states for catchment 2 (multi-catchment study).

<table>
<thead>
<tr>
<th>True</th>
<th>Degraded</th>
<th>Assimilated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Catch Def.</td>
<td>221.6</td>
<td>51.6</td>
</tr>
<tr>
<td>Root Zone</td>
<td>-5.67</td>
<td>-3.67</td>
</tr>
</tbody>
</table>

Conclusions

The application of single and multistage catchment streamflow data assimilation has been shown for small catchments. It can be seen that the proposed technique has promising potential for the retrieval of soil moisture profile estimates. In the study catchment deficit was the dominant variable. Changes in the surface excess did not influence the objective function sufficiently and were therefore ignored in subsequent assimilation runs. A sensitivity study may give more insight on the importance of the three variables in a catchment wide context.

Future Work

Future work will include the application to data collected during an intensive field campaign in the Goulburn River catchment (Rüdiger et al., 2008) and a study of the optimum temporal positioning (sequential or sliding) and length of the assimilation window.

References