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.

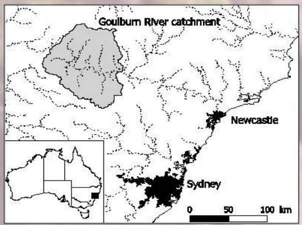

Fig. 1 Location of Goulburn River Catchment

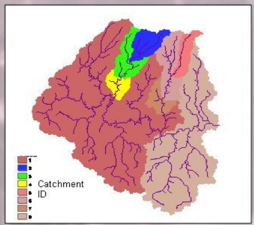

Fig. 2 Subcatchments within the Goulburn River catchment

Method

This twin experiment assimilates Catchment Land Surface Model (CLSM; Koster 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, 1983) 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.

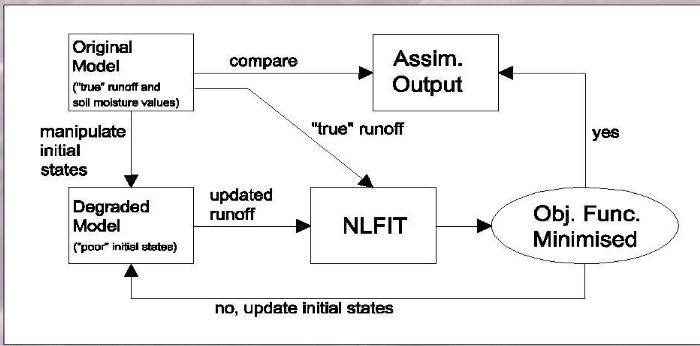

Fig. 3 Schematic of the assimilation process

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 33%).

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.

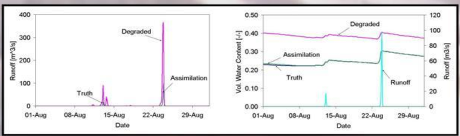

Fig. 4 Results from assimilation run with "true" forcing data (left: runoff, right: soil moisture profile).

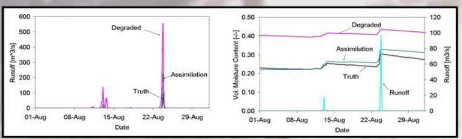

Fig. 5 Results from assimilation run with "degraded" forcing data (left: runoff, right: soil moisture profile).

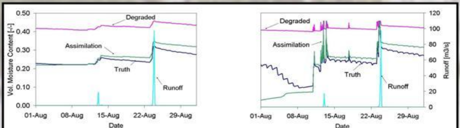

Fig. 6 Results from assimilation run with "degraded" forcing data (left: root zone, right: surface)

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.

Multi Catchment

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.

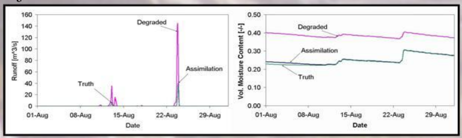

Fig. 7 Results from assimilation run with "true" forcing data for catchment 2

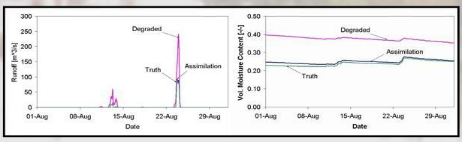

Fig. 8 Results from assimilation run with "true" forcing data for catchment 3

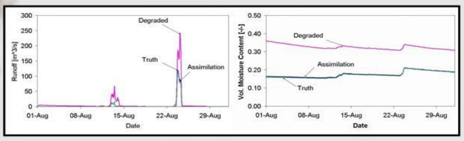

Fig. 9 Results from assimilation run with "true" forcing data for catchment 4

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

	True	Degraded	Assimilated
Catch. Def.	221.6	51.6	209.1
Root Zone	-5.67	-3.67	-6.00

Conclusions

The application of single and multicatchment 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., 2003) and a study of the optimum temporal positioning (sequential or sliding) and length of the assimilation window.

References

Koster, R.D., et al., A catchment-based approach to modelling land surface processes in a general circulation model, J. Geoph. Res. 105 (D20), 24809-24822, 2000.

Kuczera, G., Improved parameter inference in catchment models, 1. Evaluating parameter uncertainty, Water Resour. Res., 19(5), 1151-1162, 1983.

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