DEVELOPMENT OF COUPLED LAND SURFACE MODEL WITH GROUNDWATER REPRESENTATION FOR THE YONESHIRO RIVER BASIN

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1. Introduction

Land surface models (LSM) or Soil Vegetation Atmospheric Transfer Schemes (SVAT) are models of the land surface that are used as lower boundary conditions for atmospheric models. They calculate the sensible heat, latent heat and momentum transfer between the earth's surface and the atmosphere.

Because the water cycle affects these transfer processes, they include hydrological sub-models. However, land surface models emphasize the transfer processes between the land and the atmosphere, and they are only one dimensional models (1D in the vertical direction). As a consequence, they have a relatively simple representation of surface runoff and groundwater, and of lateral flows between different grid cells.

Streamflow is measured at many locations throughout the world, and it provides a way to assess the overall performance of land surface models. For example, it can be used to evaluate the model's ability to partition of rainfall into runoff, infiltration and, evapotranspiration. In contrast, fluxes from the land surface are difficult to measure and they are available only in a few locations. Therefore, comparison to river discharge observations is one of the most common ways to evaluate the performance of land surface models.

Although streamflow provides a convenient way to evaluate the LSM performance, it should be noted that river discharge is generated by different mechanisms. In general, streamflow can be divided into *quickflow*, flow generated shortly during and after a storm, and *baseflow*, flow sustained throughout the year. Generally, quickflow and base flow are simulated by different model components, and they should be calibrated individually (Srinivasan and Arnold, 1994). Comparison to *quickflow* will evaluate the rainfall partitioning mechanism, and comparison to baseflow will evaluate, vadose zone movement, plant transpiration, and groundwater movement parts of the model.

Different surface runoff transport processes with different time scales contribute to the river discharge during a storm. The runoff transport processes are not usually represented in LSM. Moreover, LSM are generally run at resolutions larger than 1 km, and within this cell size, different runoff transport processes coexist. Therefore, it is necessary to consider the subgrid variability of surface runoff to predict the correct time evolution of river discharge hydrographs, and to assess the performance of LSM.

In this study, SiBUC (Tanaka, 2004), a LSM, is combined with spatially averaged surface runoff equations (Tayfur and Kavvas, 1994) to analyze its rainfall partitioning performance. This model is referenced as SIBUC-ASR: SiBUC with spatially average surface runoff. First, the observed river discharge will be divided into baseflow and quickflow. Then, SiBUC-ASR output will be compared to streamflow observations.

2. Study area

The study area is the Yonaizawa river sub watershed (700 km^2) in the Yoneshiro river basin. The Yonaizawa streamflow station (40^{o}7'15" N, 140^{o}25'60" E) was taken as the outlet of the watershed.

Keywords: Land surface model, SiBUC, Surface runoff, Aereally averaged overland flow equations
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3. Methodology

SiBUC, a LSM, is combined with spatially average surface runoff equations (Tayfur, 1994) to analyze the performance of its surface runoff generating mechanism (SiBUC-ASR). First, the observed river discharge will be divided into baseflow and quickflow. Then, the SiBUC-ASR output of will be used as the input of a river discharge model. Finally, the output of the river discharge model will be compared to streamflow observations.

3.1 Base flow and quick flow separation of observed river discharge

To separate the quickflow from the baseflow, the method proposed by Rodriguez (1989) is used.

$$\frac{\mathrm{d}Q^B}{\mathrm{dt}} = -\mathrm{k}Q^B + bQ^q$$

$$\frac{\mathrm{b}}{\mathrm{k}} = \frac{Water\ in\ quick\ flow}{Water\ in\ base\ flow}$$

- Q^b: Base flow
- Q^q: Quick flow
- *b, k*: Parameters assumed constant for a given time period

This method works essentially as a low pass filter, so it attenuates short period variations. The parameters required for this method are obtained by analyzing time series of streamflow during both wet and dry periods.

3.2 River discharge model

Before evaluating SiBUC performance, it is necessary to elaborate and calibrate a river discharge model. A one dimensional flow routing model based on the diffusion wave approximation is used. To estimate the inflow to rivers, the spatially averaged runoff equations are used. Effective rainfall is estimated by subtracting infiltration and canopy interception to the rainfall. Infiltration is estimated by the Green-Ampt method.

The outputs of this model are calibrated and evaluated by comparison to streamflow observations at the Yonaizawa station.

3.3 SiBUC and spatially averaged surface runoff equations: SiBUC-ASR

SiBUC output for surface runoff will be used as the effective rainfall required by spatially averaged surface runoff equations. Then, the runoff will be used as the input to the previously calibrated river discharge model.

Finally, the discharge modelled by SiBUC-ASR and the observed river discharge and quickflow at the Yonaizawa station will be compared to assess the performance of SiBUC.

4. CONCLUSION

Infiltration is an important inflow to the root zone water. In the future, a model to estimate the vadose zone water movement, including horizontal transport, and a groundwater model (saturated zone) will be added to improve the prediction of the baseflow hydrograph.

5. ACKNOWLEDGMENTS

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