Scale Effects In The Dependence Of Water Balance Fluxes Partitioning On Soil Moisture

Vania Toninelli
Ph.D. student, Department of Hydraulic, Environmental and Surveying Engineering, Politecnico di Milano, Milano, ITALY

Guido Daniel Salvucci,
Associate Professor At The Departments Of Earth Sciences And Geography, Boston University, Boston, Massachusetts USA

Abstract. The issue of scale in land surface water and energy balance processes has been a dominant research theme for decades [Sposito, 1998]. It is an issue that cannot be avoided in either modeling (i.e. simulation) or in monitoring (i.e. estimation) frameworks. In climate and hydrological modeling it arises from the disparate scales of processes resolved in the atmosphere and land surface. In field estimation it arises from the difficulty to compare point-scale measures (not everywhere and uniformly available) to larger size grids in the modelling discretisation. In both cases, the presence of subgrid heterogeneity of parameters and forcings, as well as lateral flows and nonlinearities in the state dependence of fluxes, renders so-called bottom-up modeling framework both necessary and, most likely, impossible. Moreover, this well-known problem of scale mismatch limits the conclusiveness of validations (generally based on point data) and thus the reliability of model estimates.

In this study the focus has been on observed relations among scale fluxes and states, and ways of comparing these relations to existing models (most of which have a point-scale legacy). In particular, the attention has been focused on the water balance partitioning, and how it is influenced by scale effects, using:

1) a new method for estimating the sensitivity of surface fluxes (drainage plus runoff plus evapotranspiration) to soil moisture using conditionally averaged precipitation. The method [Salvucci, G. D, 2000] is scale-invariant and so applicable using point or area-averaged precipitation and moisture;

2) a reasonable closure approximation for partitioning the loss term into runoff and evapotranspiration from an independent estimate of potential evaporation.

This method has been tested by repeated simulations with a finite element water movement model in three-dimensional variably saturated media [SWMS_3D, Simbnek J. et al., 1995] for various climate, soil, and vegetation parameters and at hourly, daily and monthly time scales. The results are discussed.

A major task of this work has been to field validate (and/or modify) the proposed closure assumption by comparing the results with estimates from the Global Runoff Data Center [Vorosmarty et al, 1998].

REFERENCES

Salvucci, G. D., Estimating the moisture dependence of root-zone water loss using conditionally averaged precipitation, Water Resour. Res., 37(5), 1357-1365, 2000.

Simunek, J., K. Huang, and M. Th. Van Genuchten, The SWMS_3D Code for Simulating Water Flow and Solute Transport in Three-Dimensional Variably- Saturated Media, Version 1.0. Research Report No. 139, U.S. Salinity Laboratory, USDA, ARS, Riverside, California, 1995.

Sposito, G., Scale Dependence and Scale Invariance in Hydrology, (Ed.), Cambridge University Press, New York, 1998.

Vorosmarty, C.J., B.M. Fekete, and B.A. Tucker, Global River Discharge Database (RivDIS) V. 1.1. Available online [http://www-eosdis.ornl.gov] and on CD-ROM from the ORNL Distributed Active Archive Center, Oak Ridge National Laboratory, Oak Ridge, TN, USA, 1998.