Geophysical Research Abstracts, Vol. 8, 03957, 2006
SRef-ID: 1607-7962/gra/EGU06-A-03957

A simplified parameterization of soil water budget for large scale environmental modeling

A. Pistocchi, F. Bouraoui, D.Pennington

European Commission, DG Joint Research Centre, Institute for Environment and Sustainability, Rural, Water and Ecosystem Resources Unit, Ispra (VA), Italy (alberto.pistocchi@jrc.it / Fax: +39-0332-785601)

Predicting soil moisture is key to many environmental modeling applications. In the last years, large scale modeling (continental to global) has received more and more attention as a tool to investigate phenomena of increasing social importance in meteorology, climatology, and the fate and transport of chemicals, which cannot be tackled effectively at more limited spatial scales. Usually, in this type of applications soil moisture is evaluated using either remote sensing techniques (e.g. using radar imagery), or simulation models which involve parameterization of the soil properties, and the choice of a physical scheme of the soil hydrological processes. In this context, we propose a simplified method to characterize the soil water budget at a monthly time step. We use a physically based one-dimensional kinematic model of the topsoil (assumed to be uniformly 30 cm thick) to predict direct runoff (i.e. runoff directly generated from the topsoil, net of the return flows from deeper soils), infiltration to deeper soil, topsoil moisture, and evapotranspiration at daily time step using a set of precipitation and computed potential evapotranspiration time series available for Europe, and the soil properties of the HyPRES database that represents a comprehensive characterization of European soils. This model provides an insight into the variability of monthly total runoff response and actual evapotranspiration, and into average soil moisture. The model results were analyzed to infer rules to estimate runoff, actual evapotranspiration and soil moisture as a function of precipitation, potential evapotranspiration and infiltration , yielding results at monthly step consistent with the daily calculations. Monthly runoff volume is modeled using a phenomenological relation with precipitation volume, which accounts for soil texture and land use and is similar to the well-known SCS Curve Number model. The model parameters, however,

result different from those of the original method, intended for daily time steps. Actual evapotranspiration is computed directly from potential evapotranspiration and an index of climate humidity, in accordance with the Bouchet's hypothesis which states evapotranspiration can be predicted only from climate parameters. Infiltration is the difference between precipitation, runoff and evapotranspiration, and is used to compute directly soil moisture under a kinematic assumption. A power law is fitted to monthly infiltration-soil moisture data, which shows consistency with commonly used models such as the ones of Van Genuchten-Mualem and Brooks-Corey.

It is thus possible to compute in closed-form, with no need for iterative procedures, the terms of the water budget normally accounted for in methods such as the well-known Thornthwaite's bookkeeping procedure, or evapo-climatonomy models. However, the intermittent nature of rainfall, runoff and infiltration is accounted for. In addition, the predictions reflect the non-linearity of moisture-soil hydraulic conductivity and rainfall-runoff relations. This allows computing maps of the different terms of the water budget equation at monthly time steps, which can be used with both climatological averages and actual time series. We provide an example application for continental Europe using a climatological year and the soil geographic database of Eurasia, and we discuss the use of the results applied to modeling the fate and transport of chemicals, where the chemical mass stored in the soil after a given emission is controlled by removal through runoff and infiltration, partitioning and degradation in the soil depending on soil water content.