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Predicting root zone soil moisture using surface data

S. Manfreda (1), L. Brocca (2), T. Moramarco (2), F. Melone (2), J. Sheffield (3), and M. Fiorentino (1)

(1) Department of Environmental Engineering and Physics, University of Basilicata, Potenza, Italy (salvatore.manfreda@unibas.it), (2) Research Institute for Geo-Hydrological Protection (IRPI), CNR, Perugia, Italy, (3) Department of Civil and Environmental Engineering, Princeton University, Princeton, USA

In recent years, much effort has been given to monitoring of soil moisture from satellite remote sensing. These tools represent an extraordinary source of information for hydrological applications, but they only provide information on near-surface soil moisture. In the present work, we developed a new formulation for the estimation of the soil moisture in the root zone based on the measured value of soil moisture at the surface. The method derives from a simplified form of the soil water balance equation and for this reason all parameters adopted are physically consistent. The formulation provides a closed form of the relationship between the root zone soil moisture and the surface soil moisture with a limited number of parameters, such as: the ratio between the depth of the surface layer and the deeper layer, the water loss coefficient, and the field capacity. The method has been tested using modeled soil moisture obtained from the North American Land Data Assimilation System (NLDAS). The NLDAS is a multi-institution partnership aimed at developing a retrospective data set, using available atmospheric and land surface meteorological observations to compute the land surface hydrological budget. The NLDAS database was extremely useful for the scope of the present research since it provides simulated data over an extended area with different climatic and physical condition and moreover it provides soil moisture data averaged over different depths. In particular, we used values in the top 10 cm and 100 cm layers. One year of simulation was used to test the ability of the developed method to describe soil moisture fluctuation in the 100cm layer over the entire NLDAS domain. The method was adopted by calibrating one of its three parameters and defining the remaining two based on physical characteristics of the site (using the potential evapotranspiration and ratio between the first and the second soil layer depth). In general, the method performed better than traditional low pass filters and its performance increased especially in dry areas. The skill of the method is therefore encouraging and there is potential to use the method to derive root zone soil moisture from satellite retrievals.