A coupled SVAT-3D unsaturated flow model for the assessment of soil-vegetation-atmosphere exchanges

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A fully-coupled model for evaluating soil-vegetation-atmosphere mass and energy exchanges is presented, using a discrete approach based on an extension of the original Cellular Automata (CA) computational paradigm. The model is composed of two interacting modules, a soil-vegetation-atmosphere transfer scheme (SVAT) and a three-dimensional model for unsaturated flow. It requires as input common meteorological data (precipitation, air temperature and humidity, wind speed, atmospheric pressure, downward shortwave radiation and albedo) together with parameters characterizing the hydraulic soil properties, and provides in output the estimate of the main energy balance components (net radiation, soil heat flux, latent and sensible heat flux), evapotranspiration, surface temperature, three-dimensional distribution of soil water content, runoff excess, as well as some additional parameters like drag coefficients and the atmospheric stability parameters. The model has been tested by means of ground ET measurements, carried out through eddy covariance systems in summer periods of the years 2005 and 2006 on two different areas in southern Italy, characterized by different physiographic and vegetative conditions (sparse vegetation and semi-arid climate in the former site, alfalfa field and sub-humid climate in the latter). In both sites the model showed good estimates of the numerous variables considered, proving to be a reliable tool for the estimate of energy and mass fluxes, as well as the space-time distribution of soil moisture. From a computational point of view, the CA structure on which the model is developed permits to achieve high efficiency values running it on a parallel architecture, allowing the proposed model to be used on wide areas with a very high detail.