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A study on the combined effects of evapotranspiration and redistribution

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The objective of our work is to study the predictive ability of soil moisture models including different mechanisms, namely: evapotranspiration (ET), leakage and redistribution at different depths, for different land covers. To this aim, we evaluated these processes over the whole year at a midlatitude site, with a wide spectrum of soil moisture values. The site has two different land covers: permanent meadow and vineyard. For each land cover, we considered 7 years soil moisture data. Data were taken vertically from the surface down to the following depths: 0.3, 0.6, 1.0 and 2.0 m. For each depth, 16 probes measured the soil water content. The soil of the site is sandy, with a slope of about 1%, and thus no overland flow. There is no irrigation at the site.

From a first analysis of the data, we observed that the rate with which soil moisture decreases is always higher during the growing season than during the dormant season. Therefore, during these months evapotranspiration represents the main water loss process. When vegetation is dormant we also observed the effect of leakage.

We developed 4 simplified models for potential evapotranspiration PET. We used a sinusoidal function with fixed amplitude (1) and the Hargreaves-Samani formula (2), and then each of them multiplied for Kc crop coefficient function (3, 4). This Kc function is a trapezoidal function with 5 parameters: (1) Kc initial value, when vegetation is dormant; (2) a, the day of the start of the growing season; (3) b, the day of the start of the mid- season; (3) c, the day of the end of the mid-season and start of the late season; (4) d, the day of the end of the late season. The start of the growing season and the initial Kc value in general vary among the years, while the maximum of Kc is always reached during summer and the end of the late season corresponds to the beginning of autumn. Therefore, we fixed b, c and d and we calibrated initial Kc and a from the data.

We also developed 4 models of actual evapotranspiration AET, using a threshold value, below which plant transpiration is reduced by stomatal closure, and , the residual soil water content, namely the lowest possible value.

Finally, we coupled AET and leakage with redistribution. Leakage is obtained as a function of the power of the Brooks Corey conductivity relation and the soil hydraulic conductivity at saturation, while we used an analytical solution to simulate redistribution. In conclusion, we considered 5 parameters: Kc initial, the day of the start of the growing season, the field saturation water content, the power of the Brooks Corey conductivity relation and the soil hydraulic conductivity at saturation.

As a result, we observed that coupling ET and leakage with redistribution leads to a quite accurate reproduction of the observed data. Therefore, the use of more physical parameters helps in evaluating soil water content dynamics over the entire year.