



## Modeling interactions between surface water and the unsaturated/saturated zone

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The research project SID&GRID, started April 2010 and financed by Regione Toscana (Italy) under the POR FSE 2007-2013 programme, will develop a watershed-scale model able to simulate surface and subsurface flow in a three-dimensional domain based on open source and public domain solutions (Rossetto et al., 2010).

The model will be structured by combining MODFLOW2005-LGR (Mehl and Hill, 2005) with a new version of MODFLOW2000-VSF (Thoms et al., 2006). While the first one allows for local refinement of the grid, the latter allows 3D simulation of the unsaturated zone using Richards equation. Considering a large scale model will then be possible to define sub-models (child models) linked to the parent one by rewriting the boundary conditions: this will allow the level of detail required to simulate 3D unsaturated flow at scale up to 25-50 km<sup>2</sup>. In larger areas, the unsaturated zone will be solved using the simplified 1D approach based on the kinematic wave approximation by means of the UZF package (Niswonger et al., 2006).

Within the framework of the above-mentioned codes, modules are being developed or modified to attain simulation of all the main processes of the hydrological cycle. Current research activities focus on defining groundwater recharge to the aquifers by simulating canopy interception, evapotranspiration, ponding, surface runoff, interflow, and surface-/ground-water interactions.

New subroutines are being developed to account for canopy interception: this will be divided in wet canopy evaporation and cumulate throughfall and stemflow rates. In each time step, these quantities will be computed to get net rainfall rates reaching the soil surface.

Cascading flow process is being upgraded, respect to UZF and VSF codes, by means of a new algorithm to compute the redistribution of the excess flow for each cell of the model in condition of soil saturation, considering cell slope and its exposure.

As far as surface-/ground-water interactions a new algorithm was developed to compute stream flow routing in open channel and, in turn, to estimate the leakage flow between stream beds and aquifers. The new module is based on the numerical solution of the 1D Saint-Venant equation, in which the leakage flow is considered as a source term for the equation itself. Such procedure (widely used in other codes, like PARFLOW-CLM, Maxwell and Miller, 2005) has been implemented in a new version of the MODFLOW SFR2 package (Niswonger and Prudic, 2005). The preliminary tests show a coherent behaviour of the solution.

To be updated about code development, please, follow our work at the website: <http://ut11.isti.cnr.it/SIDGRID/>

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