Model
Rich_Clim

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1 Objectives

The model simulates water flow. Climatic data are used to define the boundary conditions at the soil surface. The model does not consider a crop with its impacts on the energy balance and water uptake by the roots. The model does not consider a mulch at the soil surface with its consequence of water flow and energy balance. There is no prefential flow in this model. The water balance module is coupled with a runoff module. The model considers also as surface boundary conditions: imposed water potential, flux imposed, and flooding. At the lower boundary, the model can use the boundary conditions: imposed water potential, no flow condition, atmospheric pressure and free drainage condition.

This model can be easily modified either by adding modules to account for other mechanisms or by substitution of a module by another provided that its inputs are satisfied by the modules of the model and its outputs contains the variables eventually needed by the other modules. The **VSOIL-MODELS** helps and guides the user in this task.

2 Modules

- **Richards_KDW** To calculate the terms of the water balance, the water potential, the volumetric water content, the flux of water, the drainage or capillary rise and the evaporation at the soil surface.

- **runoff_PastisKDW** A runoff module allowing to calculate the heigh of water and the runoff when the soil infiltrability is lower than the flux of water applied. The module interacts with the water flow module.

- **climate_from_files** A module to read the climate variables: minimum and maximum daily temperature, rain intensity and global radiation. The module returns the instantaneous temperature and the rain intensity. Examples of files are provided with the module.

- **etp_from_files** A module to read the daily maximum evapotranspiration demands. The daily maximum evapotranspiration is distributed in the day according to day length and latitude and reproduces the increase and decrease according to the height of sun. The module returns the mean instantaneous maximum evapotranspiration for the time integration interval. An example of file is provided with the module.

- **bottom_pressure_from_files** The module returns a soil water pressure at the bottom of the profile. The module reads a file. Used in this model.

- **soil_structure_forced** The module returns some characteristics of the soil: bulk density, granulometry, etc. These values are constant all along the run. Some are used by other modules.

- **sprink_solutes_file** The module returns the intensity and the solutes species concentration of irrigations when they occur. An example of file is provided with the module. This file can be empty.

- **flooding_irrigation_from_file** The module returns the schedule of flooding irrigation with the height of water applied. The water flow module uses this information and manages its boundary conditions to infiltrate the amount applied.

- **spit_climate** The module calculates the evaporation demand applied to the soil and depending of the maximum evapotranspiration and of the presence of a vegetation. It carries out a simplified energy budget at the soil surface to calculate the soil surface temperature.

- **hydraulic_properties_pedo_func** The module offers the choice between several formulations of the hydraulic properties. Pedo-transfert functions (Hypress) are also available in this module. Pedotransfert functions uses outputs of the **soil_structure_forced** module.

  Other modules are present. These modules are either *neutral modules* when the mechanisms are not simulated or boundary conditions modules that must be present but are not always used by the transport module.

3 Test cases

- **Infil** Simulation of infiltration with a flux imposed. No evaporation. No flux condition at bottom. Soil hydraulic properties correspond to those of a sand.

- **evap_sand** Richards equation with evaporation at soil surface and zero flux at lower boundary. Evaporation up to the time the soil becomes limiting. Schifts from Neuman to Dirichlet BC at soil surface. Sand properties.

- **colmar_water** Simulation of water flow on a long period for the soil of an ORE. The model uses the climatic data to impose the rains and the evaporation demand.Soil water potential imposed at the lower boundary. Data comes from the PhD of A. Isch *Caractérisation de la dynamique hydrique et du transport de solutés en sol nu soumis à des apports répétés de Produits Résiduaires Organiques. Application au risque de lixiviation des nitrates.* Université de Strasbourg, 2016.

- **waterbalance_2** Richards equation with boundary conditions: flux at soil surface and free drainage at lower boundary. Contains several runoff events. Slope 1

- **waterbalance_3** Richards equation with boundary conditions: flux at soil surface and lower boundary at atmospheric pressure. Several seepage periods.
- **waterbalance_4** Richards equation with boundary conditions: flux at soil surface and zero flux at lower boundary.
- **waterbalance_5** Richards equation with boundary conditions: flux at soil surface and imposed water potential at lower boundary.
- **waterbalance_6** Richards equation with boundary conditions: irrigation by flooding at soil surface at two dates and imposed water potential at lower boundary.
- **waterbalance_7** Richards equation with boundary conditions: flux at soil surface and free drainage at lower boundary. Drying event with a sprinkling irrigation (120mm) with high intensity to mimic a heavy rain event. Produces a runoff event (slope 10%).