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Using the finite volume method for generalized approach of catchment models
Ina Plesca, Philipp Kraft, Hans-Georg Frede, Lutz Breuer

Classical mathematical models and methods have been constantly applied to solve different hydrological problems, especially for water flux processes description. The Catchment Modeling Framework (CMF) is an open source, modular and expandable platform which has been created to simulate the water balance from plot to landscape scale. CMF consists of several modules, each applied for specific flux-processes depending on different parameters or dimensions. The CMF expandability allows applying hydrological model structures that fit best the current context.

The main CMF software components are written in C++. A Python interface is used to interconnect these. The mathematical model behind CMF is governed by the mass and momentum conservation law in order to describe the temporal and spatial variation of the water system depending on several climatic, soil and land use parameters. The approximation method to solve the wide system of equations resulting from water transport processes is based on the finite volume approach discussed by Qu and Duffy (2007, Water Resour Res, DOI: 10.1029/2006WR005752).

In this work we present the equation system resulted from a 3D-model-example created using CMF and applied over the small Schwingbach catchment in Hesse, Germany. In addition, the system of equations representing the water surface and subsurface fluxes in the catchment and the numerical CVODE solver (Hindmarsh et al. 2005, ACM Transactions on Mathematical Software, doi10.1145/1089014.1089020) for this system will be described. A special attention will be given to the stiff ODE methods contained in the CVODE solver and tested on the ODE systems that originate from time dependent PDE systems. Runoff results obtained by the model simulation in the Schwingbach catchment as well as results of the model calibration and validation will be presented.