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CNMM: a catchment nutrients management model for managing water quality and greenhouse gas emissions

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Mitigating agricultural diffuse pollution and greenhouse gas emissions is a complicated task due to tempo-spatial lags between the field practices and the watershed responses. Spatially-distributed modeling is essential to the implementation of cost-effective and best management practices (BMPs) to optimize land uses and nutrient applications as well as to project the impact of climate change on the watershed service functions.
CNMM (the Catchment Nutrients Management Model) is a 3D spatially-distributed, grid-based and process-oriented biophysical model comprehensively developed to simulate energy balance, hydrology, plant/crop growth, biogeochemistry of life elements (e.g., C, N and P), waste treatment, waterway vegetation/purification, stream water quality and land management in agricultural watersheds as affected by land utilization strategies such as BMPs and by climate change. The CNMM is driven by a number of spatially-distributed data such as weather, topography (including DEM and shading), stream network, stream water, soil, vegetation and land management (including waste treatments), and runs at an hourly time step. It represents a catchment as a matrix of square uniformly-sized cells, where each cell is defined as a homogeneous hydrological response unit with all the hydrologically-significant parameters the same but varied at soil depths in fine intervals. Therefore, spatial variability is represented by allowing parameters to vary horizontally and vertically in space. A four-direction flux routing algorithm is applied to route water and nutrients across soils of cells governed by the gradients of either water head or elevation. A linear channel reservoir scheme is deployed to route water and nutrients in stream networks. The model is capable of computing CO_2, CH4, NH3, NO, N2O and N2 emissions from soils and stream waters.
The CNMM can serve as an idea modelling tool to investigate the overwhelming critical zone research at various catchment scales.