AN ASYNCHRONOUS SOLVER FOR DIFFERENTIAL EQUATIONS ARISING FROM RIVER BASIN MODELS

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We describe an efficient parallel implementation to solve a large system of ordinary differential equations arising from a hillslope-link river basin model. The motivation for this implementation is flood forecasting. The model construction results in a large number of streams and associated hillslopes each with a corresponding system of differential equations to solve for water fluxes/storages. The model takes into account several factors, including transport of water along the channels of the river network, dynamic hillslope runoff generation from the ponded surface, and soil water storage dynamics. The coupling of differential equations is given by the tree structure of the river network, which is constructed from 30m Digital Elevation Model topography data for large basins (> 16,000 square kilometers). Other observations including high-resolution radar-rainfall, remote sensing based land-use and land-cover and soil properties are used to force/parametrize the model and solve for streamflow in every channel of the river network. Predicted streamflow hydrographs are compared with streamflow observations where available. Our implementation uses asynchronous integration to integrate numerically the system of differential equations. Further, an asynchronous communication scheme is used to exchange data amongst different processes, which is the basis for the parallelization of the numerical integrator. The authors discuss run-times for sample basins. As an example, the authors show that the implementation can integrate a system of 300,000 equations representing water movement on a 16,000 square kilometer basin for a period of 20 days of continuous forcing in 5 minutes, bringing the idea of real-time flood forecasting using distributed hydrological models closer to reality.