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Development of an extended spatially distributed routing scheme and its impact on process oriented hydrological modelling results

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Abstract Fully spatially distributed hydrological modelling requires a topological linkage of single modelling entities (e.g. hydrological response units – HRU) in order to reproduce relevant attenuation and translation processes within the stream, but also during the transport of water in the form of lateral surface or subsurface flow. Most often such linkage is considered by a one-dimensional (1-D) approach which links one modelling entity to only one receiver that follows the flow direction. The comparison with actual lateral water movement in catchments show that such a 1-D routing scheme is often too simple, which can lead to an overestimation of the runoff concentration along the 1-D flow paths. On the other hand, an underestimation of runoff in flow cascades that do not reside next to the main 1D flow paths can occur as the affected HRUs do not receive realistic inflow from their source entities above. As a catchment-wide consequence the 1-D routing scheme can result in a significant over- or underestimation of the contributing area for specific parts of a catchment, which can have important implications for the spatial distribution of accompanying processes such as spatial variation of soil moisture, soil erosion or solute transport. To address the problems outlined above, a new approach has been developed that allows a multi-dimensional linkage of model entities in such a way that each entity can have various receivers to which the water is passed. This extended routing scheme was implemented in the hydrological modelling system J2000 (Krause, 2001) and was used for the simulation of the hydrological processes of a number of meso-scaled catchments in Thuringia, Germany. The paper presents the most important details of the extended routing scheme, the simulation results along with the comparison of those obtained with the 1-D linkage and highlights the impacts on the hydrological process dynamics as well as on the HRU-based mass transport and balancing.

Key words hydrological modelling; routing scheme; multi-dimensional linkage; HRU; model entities