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Shrink and Stretch – using a celerity-velocity based model to explore the influence of spatial scale on catchment storage, flow and transport

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Predicting both the hydrological response and the transport of water in a catchment is a tricky business. This is in part because the fundamental relationships between water storage, flow and transport within a catchment are non-linear and this non-linearity is scale-dependent. This scale dependency is due to the differences between water transit time (velocity) and hydrologic response (celerity) - increasing spatial scale causes the lags between pressure-wave celerities and transport velocities to become more apparent.
The influence of catchment scale is explored here by 'shrinking' and 'stretching' a catchment within a virtual experiment carried out with the Multiple Interacting Particles model (MIPs). This model explicitly represents both water flow and transport in one coherent solution and has been shown to reproduce both flow and transport data within a hypothesis testing framework. MIPs is used here as a window on the influence of scale in hydrology, allowing us to observe how scale influences: hydrological flows; storage-discharge hysteresis and links to antecedent storage; and water transit and storage residence times.