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Integrated surface and groundwater modelling in the Thames Basin, UK using the Open Modelling Interface

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The River Thames catchment is situated in the south-east of England. It covers approximately 16,000 km2 and is the most heavily populated river basin in the UK. It is also one of the driest and has experienced severe drought events in the recent past. With the onset of climate change and human exploitation of our environment, there are now serious concerns over the sustainability of water resources in this basin with 6 million m3 consumed every day for public water supply alone.

Groundwater in the Thames basin is extremely important, providing 40% of water for public supply. The principal aquifer is the Chalk, a dual permeability limestone, which has been extensively studied to understand its hydraulic properties. The fractured Jurassic limestone in the upper catchment also forms an important aquifer, supporting baseflow downstream during periods of drought. These aquifers are unconnected other than through the River Thames and its tributaries, which provide two-thirds of London’s drinking water. Therefore, to manage these water resources sustainably and to make robust projections into the future, surface and groundwater processes must be considered in combination. This necessitates the simulation of the feedbacks and complex interactions between different parts of the water cycle, and the development of integrated environmental models.

The Open Modelling Interface (OpenMI) standard provides a method through which environmental models of varying complexity and structure can be linked, allowing them to run simultaneously and exchange data at each timestep. This architecture has allowed us to represent the surface and subsurface flow processes within the Thames basin at an appropriate level of complexity based on our understanding of particular hydrological processes and features. We have developed a hydrological model in OpenMI which integrates a process-driven, gridded finite difference groundwater model of the Chalk with a more simplistic, semi-distributed conceptual model of the Jurassic limestone. A distributed river routing model of the Thames has also been integrated to connect the surface and subsurface hydrological processes. This application demonstrates the potential benefits and issues associated with implementing this approach.