Hydro-JULES

Project 6 - Reservoir Storage and Release in the UK for Water Resources.
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Water resource modelling is an area of increasing importance as a combination of climate change and population growth places increased pressure on limited freshwater resources. Surface water reservoirs are a key source of water for human use in the UK and can significantly impact flow rates downstream (for example, the flow regime of the river Tyne is heavily influenced by the Kielder reservoir). It is therefore vital that reservoirs are represented in water resource models, so that an important water source is included when assessing supply-demand balance, and to improve the accuracy of river flow simulations.

In recent work, a representation of reservoirs was added to the JULES land surface model, along with other water resource management functionality. This representation uses generic reservoir routing equations (akin to those used in the H08 model) and is applicable at a coarse scale for global or regional modelling;however, these equations are not suitable for finer resolution modelling. In this project, we hope to determine a generic reservoir routing scheme that can model reservoir storage and release within a gridded water resource model at a 1km resolution. The objectives of this project are:

• Review existing reservoir routing schemes applicable to fine-scale spatial modelling.
• Where possible, test these routines using observed/modelled inflow, outflow, and storage data for UK reservoirs.
• Make a recommendation on the most suitable reservoir routing scheme to be incorporated into the JULES model and/or UniFHy framework.

Depending on time, there is scope for the student to extend this work according to their interest (e.g. expanding geographical extent, exploring machine learning options, etc.).

A successful candidate will have:
• Experience in a scientific programming language such as Python, R, Fortran.
• Some experience in data handling and visualisation.
• Good numerical and oral/written communication skills.
The candidate will gain an understanding of water resource modelling, timeseries performance metrics, and key research skills such as reviewing literature, using data, and communicating science. The internship will take place over a
period of six weeks, summer 2024.

Suggested reading:
- Daryl Hughes, Stephen Birkinshaw, and Geoff Parkin. A method to include reservoir operations in catchment hydrological models using SHETRAN. Environmental Modelling & Software, 138:104980, apr 2021.
- Jungho Kim, Laura Read, Lynn E. Johnson, David Gochis, Rob Cifelli, and Heechan Han. An experiment on reservoir representation schemes to improve hydrologic prediction: coupling the national water model with the HECResSim. Hydrological Sciences Journal, 65(10):1652–1666, jul 2020.
- Gang Zhao, Huilin Gao, Bibi S. Naz, Shih-Chieh Kao, and Nathalie Voisin. Integrating a reservoir regulation scheme into a spatially distributed hydrological model. Advances in water resources, 98:16–31, dec 2016