Modelling water resource management over the UK.

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Water resource modelling is an area of growing significance, as a combination of climate change and population growth places increased pressure on limited freshwater resources. Key aspects of modelled water resource management (WRM) include: water withdrawals from ground and surface water sources to meet water demand (domestic, industrial, and agricultural); return flows; water transfers; and managed reservoirs. Including these processes in a hydrological or land-surface model has several benefits: it allows water resource assessments to be undertaken; the impact of anthropogenic influences on the hydrology can be explored; and simulated stream flows in heavily influenced catchments become more realistic.

Many large-scale gridded models have WRM modules, including WaterGAP [1], VIC [2], H08 [3], LPJmL [4], PCR-GLOBWB [5], WBMplus [6], GWAVA [7], CWATM [8], and, recently, JULES. These models are often run at a coarse spatial resolution, for example, our team has implemented JULES-WRM at 0.5° resolution over Brazil. The next challenge is to further develop the models and datasets necessary for water resource modelling at a finer spatial scale [9, 10, 11, 12, 13], so that more detailed information on water demand and availability can be provided to water users and policy makers.

Within Hydro-JULES, we are building on the current WRM functionality within the JULES model, refining the WRM module to address the coarse-scale assumptions and making use of new datasets to ultimately model water resources in the UK at a 1 km × 1 km resolution.

In this project, initial model outputs (utilising new datasets and existing model functionality) will be explored. The objectives of this project are:

- To compare simulated stream flows with observed data from the National River Flow Archive (NRFA) [14] (for model runs with and without WRM) to determine the impact of anthropogenic influences on stream flow over England.
- To compare simulated water withdrawal for irrigation (as calculated within the JULES model) to estimates from the new abstraction dataset (citation), to estimate the validity of the JULES irrigation scheme in England.
- To identify potential limitations with the current WRM module which will inform the development of a high-resolution WRM module.

Depending on time, there is scope to extend the project according to the interests of the student, e.g. to compare additional model outputs to observed data (soil moisture, groundwater level, etc.) to understand the impacts of anthropogenic influences on the wider hydrological system; or to explore the effects of different parameter choices within the WRM module.

A successful candidate will have:

- Experience in using a scientific programming language for data handling and visualisation (e.g. Python or R).
- Some experience in statistical methods for assessing goodness-of-fit.
- Knowledge of the hydrological system, ideally including anthropogenic influences.
- Good numerical and oral/written communication skills.

The candidate will gain an understanding of water resource modelling; experience analysing spatial and time-varying data; and develop key research skills including communicating science. The internship will take place over a period of six weeks, summer 2025.

References

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[6] D Wisser et al. *Geophys. Res. Lett.*, 35(24), 2008.

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[13] E. F. Wood et al. *Water Resour Res*, 47(5), 2011.

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