Making digital rivers flow: integrating hydrologically-relevant calibration in Earth System Modelling

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Climate change, population growth and human intervention within river channels and catchments make it more challenging than ever to provide reliable information on the current and future state of water in the world's rivers. Yet society urgently needs timely, dependable information for early warning of floods and droughts, which still today surprise and devastate entire communities.

Weather forecasting centres around the world are now using a global Earth System modelling approach to represent the interactions between the land, the ocean and the atmosphere so that they can get the best forecasts of the upcoming weather. This approach also has the potential to be used to forecast river flow and thus floods and droughts. However, rivers are still not fully represented in these Earth System models which means predictions of river flow, and forecasts of floods and droughts cannot currently be directly made and require downstream hydrological modelling without consideration of land-atmosphere feedbacks or any benefit from data assimilation correction of initialisation errors.

The European Centre for Medium-range Weather Forecasts (ECMWF) is a world leading weather forecasting centre with one of the largest supercomputer facilities and meteorological data archives in the world. The ECMWF vision is to use the Earth system approach to take global hydrological prediction to the next level aiming at the development of fully coupled hydrological prediction within Earth system models within the next decade.

ECLand is the land component of ECMWF's operational weather forecasting model and this project will use global land-atmosphere coupled simulation experiments in order to assess how integrating river discharge routing processes into ECLand impacts the representation of surface fluxes, testing out different land-atmosphere coupling configurations. The PhD project offers the first opportunity to explore the impact of riverflow-resolving calibration on land-atmosphere processes based on a modelling framework as close as possible as that used in producing real weather forecasts.

In particular, the research will aim to tackle three research questions: which of the land parameters governing soil, vegetation, hydrology and snow processes in ECLand are most sensitive to river discharge calibration? What impact does land parameter tuning have on land/ surface variable representation? And which hydrological calibration strategy is most likely to achieve a neutral impact on weather simulations?

The student will be embedded within the ECLand forecasting and research teams at ECMWF and this project will deliver research findings that could change the future of global weather and hydrological forecasting.

Training opportunities:
This PhD includes a placement and visiting scientist status at the European Centre for Medium range Weather Forecasts

Student profile:
This project would suit a candidate with a strong undergraduate degree (i.e. at least upper second class, merit, or equivalent) in a computational, mathematical, physical, meteorology or geographical science. Given this project's strong focus on modelling experiments and data analysis, it would suit a candidate who is also highly enthusiastic about computer science. Pre-existing familiarity with open-source programming languages (e.g. Python) would be a significant bonus, but training will be provided if necessary

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