Hydro-JULES

Project 5 - Exploring the use of satellite observations to improve wetland inundation modelling.

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Extreme rainfall is driving rapid expansion of wetlands in East Africa and with it an increase in methane fluxes. The largest and most complex of these systems is the Sudd which is situated in South Sudan and supplied with water from the Nile River. Land surface models that include a representation of overbank inundation can simulate wetland systems and associated methane emissions, yet they tend to underestimate the seasonal and interannual inundation variability. One key limitation in the models is that flooded extent is limited to areas close to the main river channel whereas the true extents of the largest wetlands extend beyond the main river through bifurcating river channels. Although current models are capable of simulating bifurcations, implementation and parameterisation of bifurcations is not straightforward as the model parameters to be calibrated are not directly observable. At the same time, we now have a wealth of information from earth observation datasets such as satellite borne observations of inundation extent and river altimetry that could be used to constrain our models. Traditional hydrological model calibration seeks to optimise model parameters using point timeseries information e.g., river discharge, however the aim here is to explore novel operators comparing gridded timeseries of inundation to investigate model behaviour and identify optimal parameter sets.

This project will work towards using data assimilation to optimise the model parameters controlling bifurcations in wetland systems using observed inundation extents. We will provide existing simulations of an inundation model (CaMa-Flood) in the Upper Nile, that can be used as a test case to explore new operators and derive new parameter sets.

The objectives of the project are to:

1. Review current state of the art methods for comparing satellite observations to modelled inundation. Which operators are most useful for capturing the wetland dynamics of interest?
2. Apply selected operator(s) to existing model output and explore model sensitivity to these. What does this tell us about model behaviour?
3. Generate parameter ensembles for a predefined set of bifurcation nodes and run CaMa-Flood to explore parameter uncertainty within the ensemble.
4. If time allows, use a DA technique to select the best parameter set and evaluate the new model.

Lots of help will be provided to generate any additional model simulations but a successful candidate should have:

- experience using Python in a Linux environment
- some experience manipulating and visualising gridded data
- an awareness of basic statistical concepts relating to distributions
- good oral/written communication skills and be willing to learn!

The candidate will gain an understanding of different earth observation datasets, advanced model optimisation methods and python programming.

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