Modelling hydrological state in the UK

Michael Eastman, Catherine Sefton, Simon Parry, Cecilia Svensson, Juhyun Park

The aim

An improved understanding of the occurrence, distribution and characteristics of temporary rivers in the UK to underpin more robust evidence for the protection of vulnerable, dynamic habitats

The approach

Statistical modelling of temporary rivers at catchment and national scale to enable the simulation of hydrological dynamics

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Catchment Scale

Models are trained on environmental data from the Chiltern Hills in England and observations of hydrological state (flowing, ponding, dry) along the rivers.

River flow

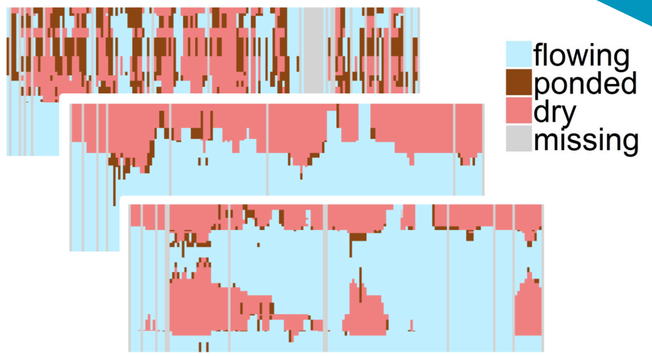
Spatial variability

Temporal variability

Groundwater

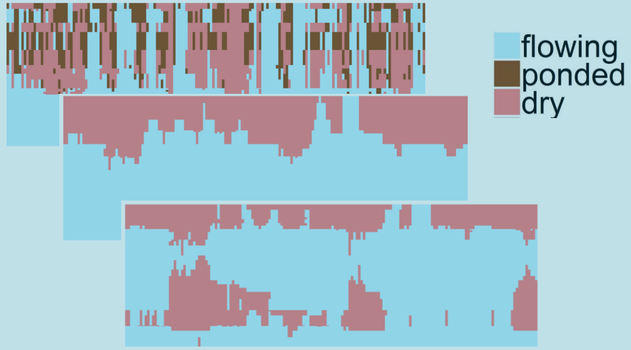
Meteorology

Hydrological state



Statistical Model

Hydrological state



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Eastman et al. (in prep)

Sefton et al., 2019. Fund Appl Limnol 193(1), 21–38.

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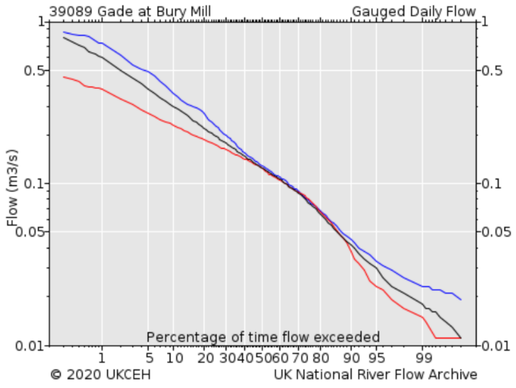
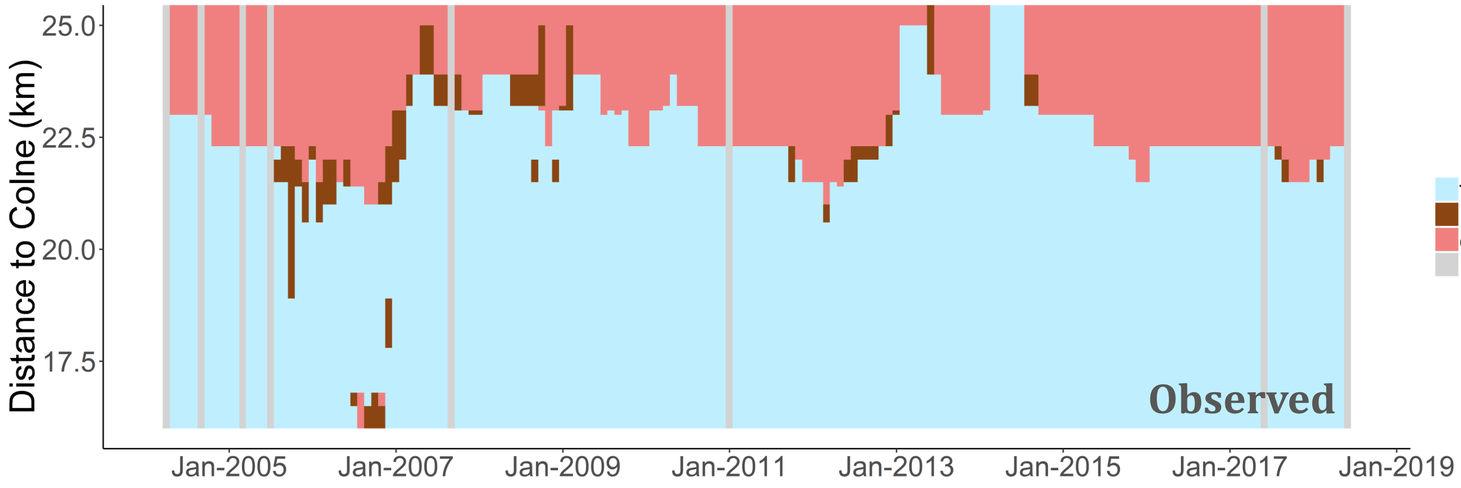
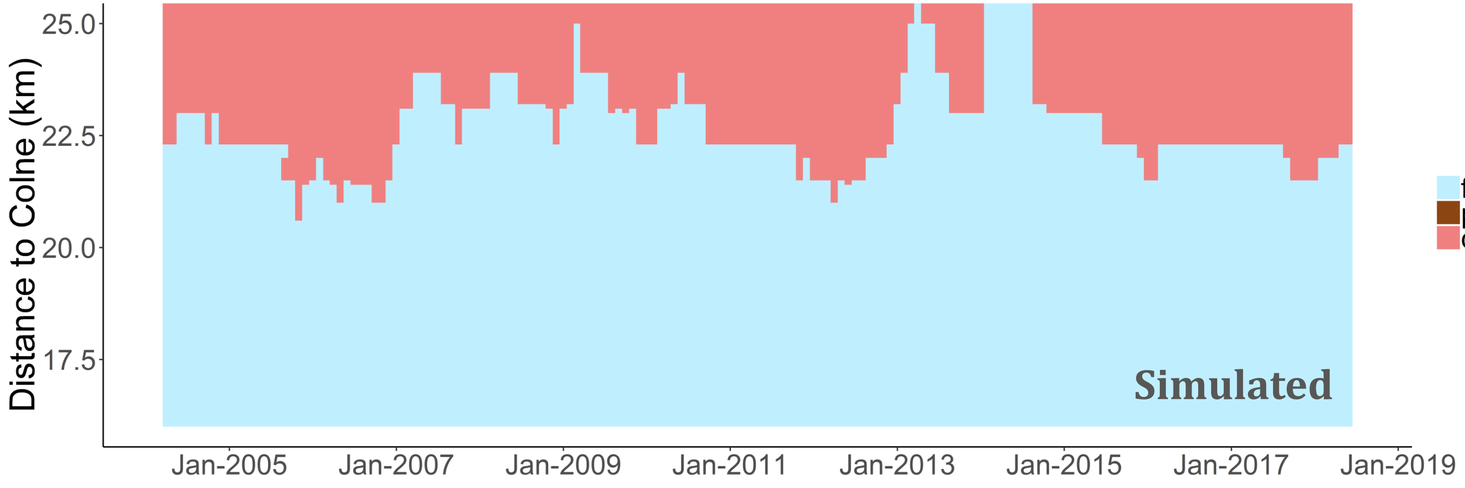
River Gade

Chalk with some clay (BFI = 0.93), influenced by abstraction







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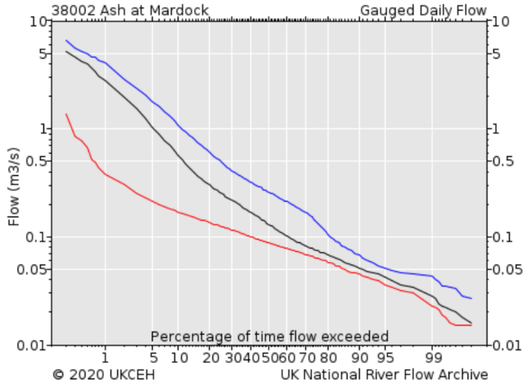
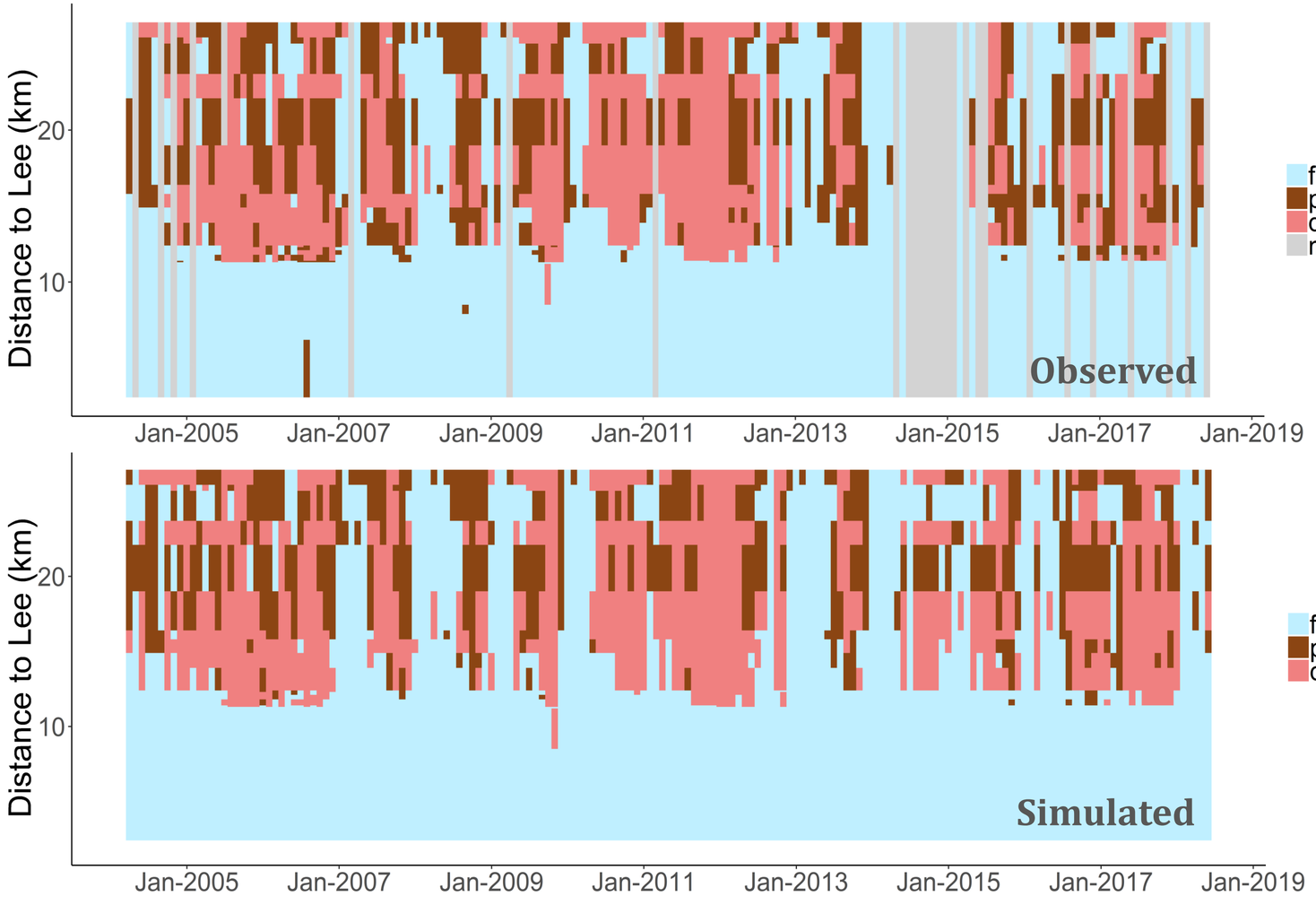
River Ash

Chalk with extensive superficial deposits (BFI = 0.53), influenced by abstraction





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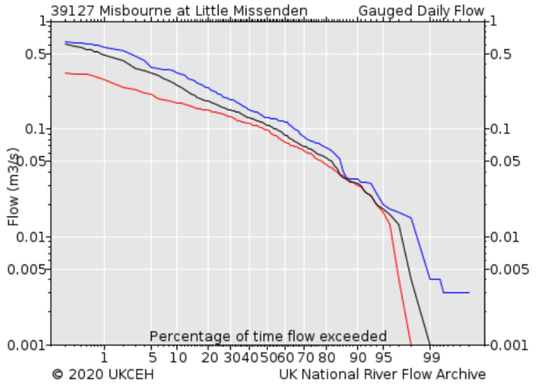
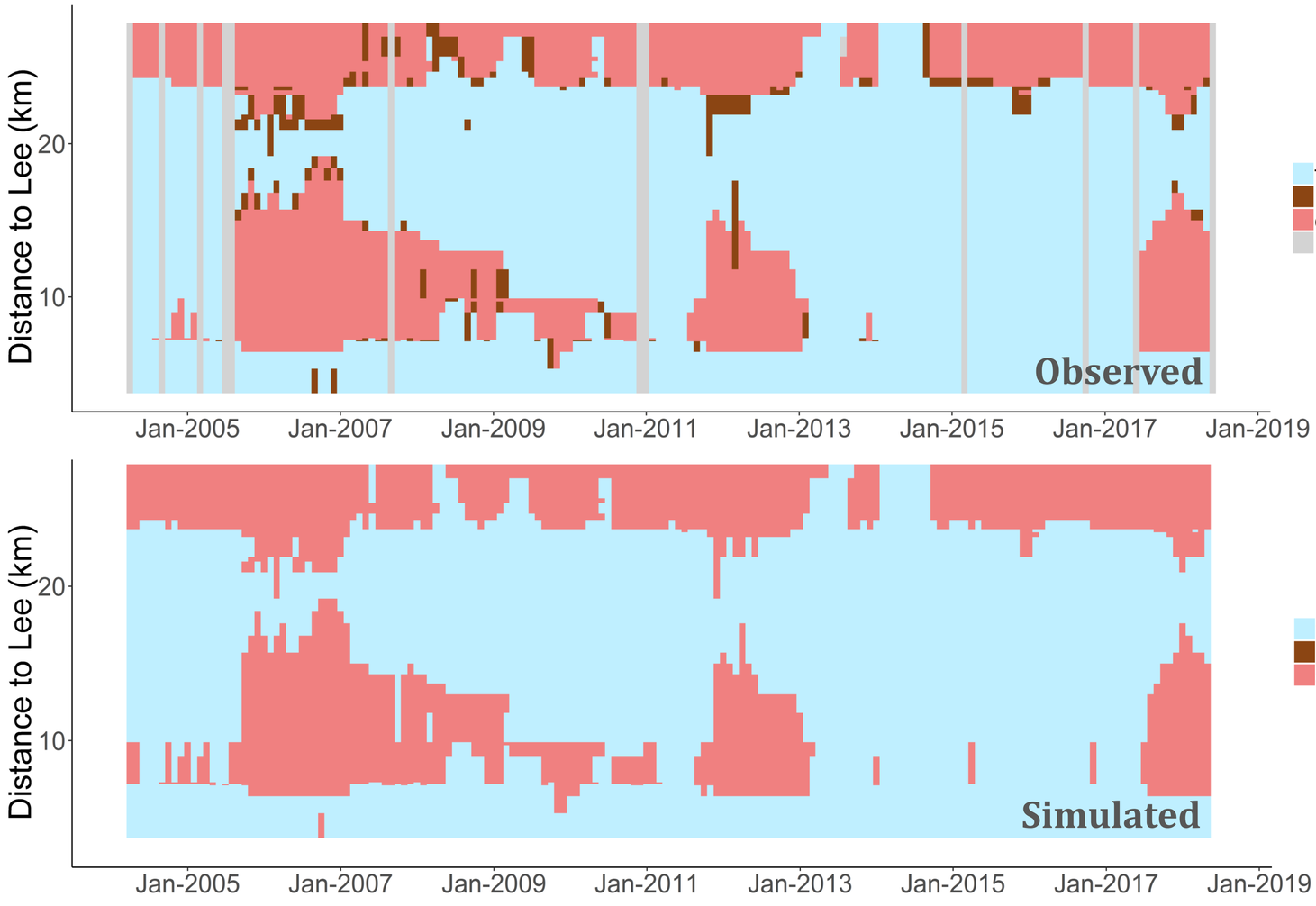
River Misbourne

Chalk (BFI = 0.96), influenced by historical mill workings and abstraction





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National Scale

Models are trained and tested on data from the UK and France, drawing on the temporal and spatial advantages, respectively, of hydrological state observations.

Hydrology

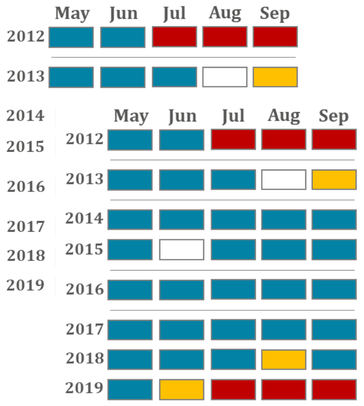
Meteorology

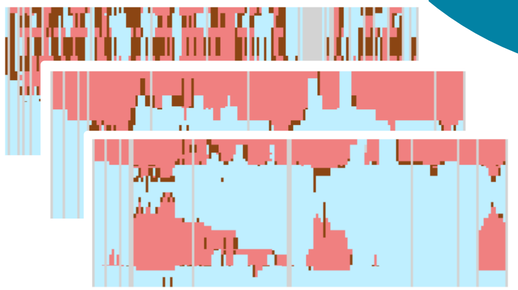
Groundwater

Geomorphology

Land cover

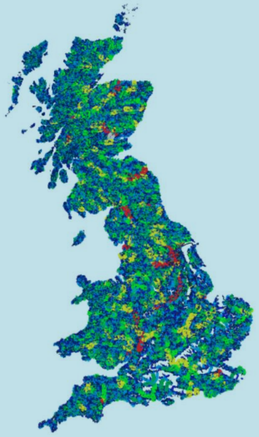
Hydrological state





Statistical Model

Intermittence metrics



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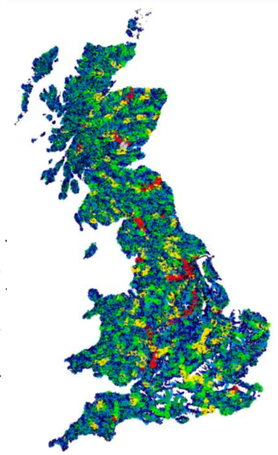
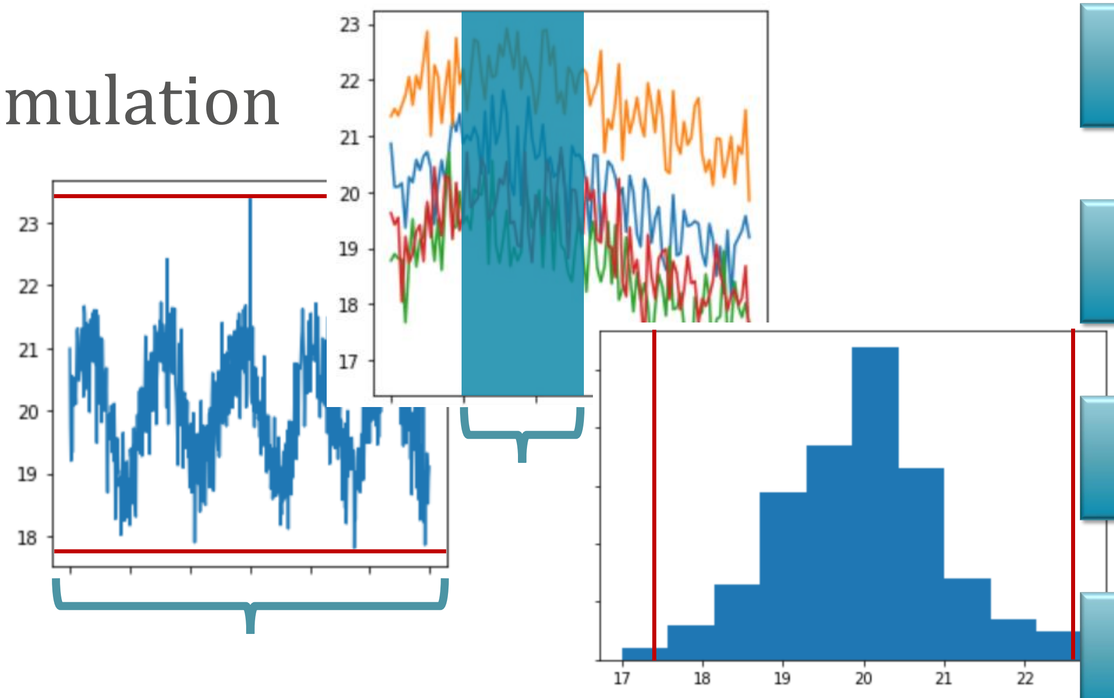
National Scale

- Extract metrics relevant for decision-makers
- Derive variables for metric simulation
- Training and validation of statistical models for mapping UK intermittence





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https://www.ceh.ac.uk/our-science/projects/assessing-statistical-models-temporary-river-intermittence-decision-makers

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Challenges

State data availability — High quality, spatiotemporally resolute hydrological state data that spans a wide range of environments and conditions is needed for the development of accurate models, but sparse.

Covariate data availability — Fine-scale processes that influence intermittence are not well captured in currently available environmental data.

State subjectivity — Hydrological state is typically assigned subjectively, resulting in inconsistencies that introduce noise.

Ponding — Ponding is a critical stage in the dying and rewetting of intermittent rivers, but infrequently observed.

Utility — Careful consideration is required to maximise the utility of model outputs to decision makers, given the challenges to the accuracy and resolution of intermittence simulation.

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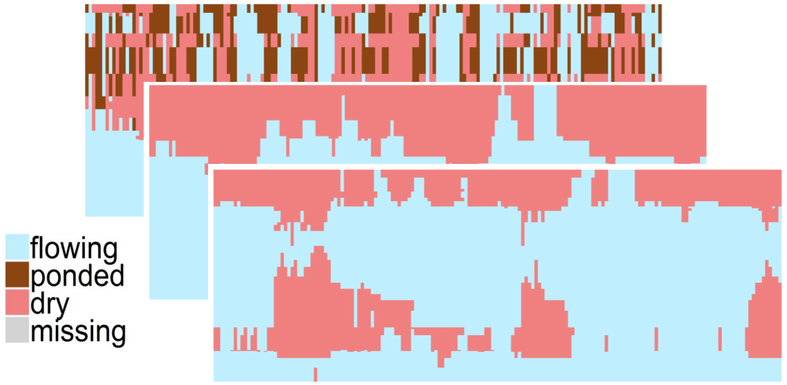
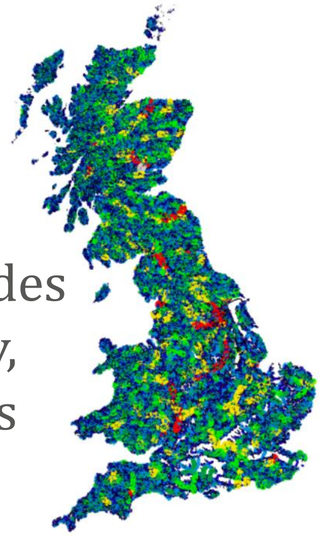


Catchment scale modelling demonstrates potential for simulating hydrological intermittence with high accuracy. However, the scarcity of hydrological state data means a different approach is needed to produce a national picture of intermittence in the UK.

The French ONDE dataset characterises intermittence in a wide variety of streams of similar conditions to those in the UK, and provides the opportunity to build on the catchment study, characterising hydrological intermittence across the UK.



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Thank you Eric Sauquet, Judy England, Geoffrey Angell, and Rebecca Ross for informing this work with your expertise and efforts.

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