

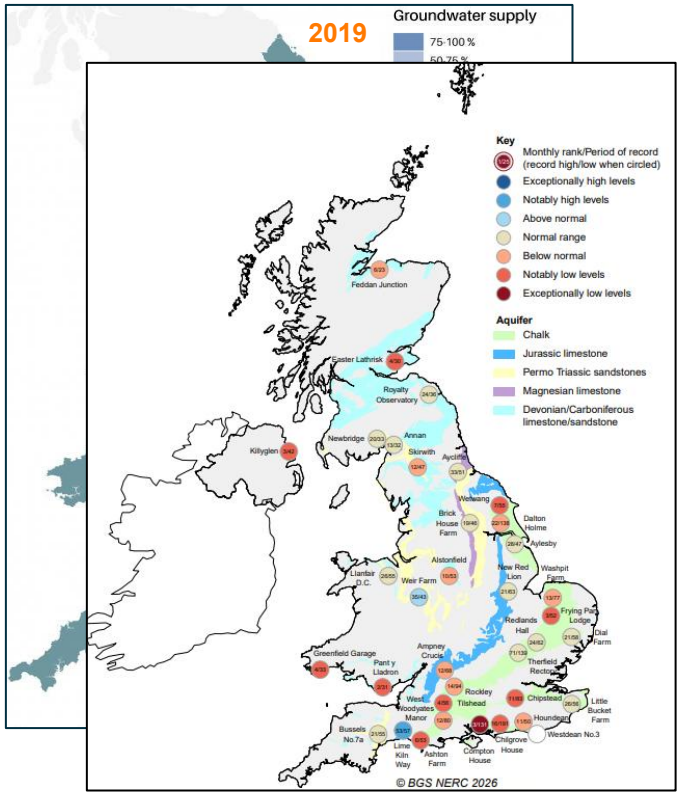
IAH 2026 WORLD GROUNDWATER CONGRESS

Forecasting Yields from Public Water Supply Boreholes

Kirsty Upton, Christopher Jackson, Setareh Nagheli, Matthew Arran, Ben Marchant

British Geological Survey

Groundwater as a public water supply source in the UK

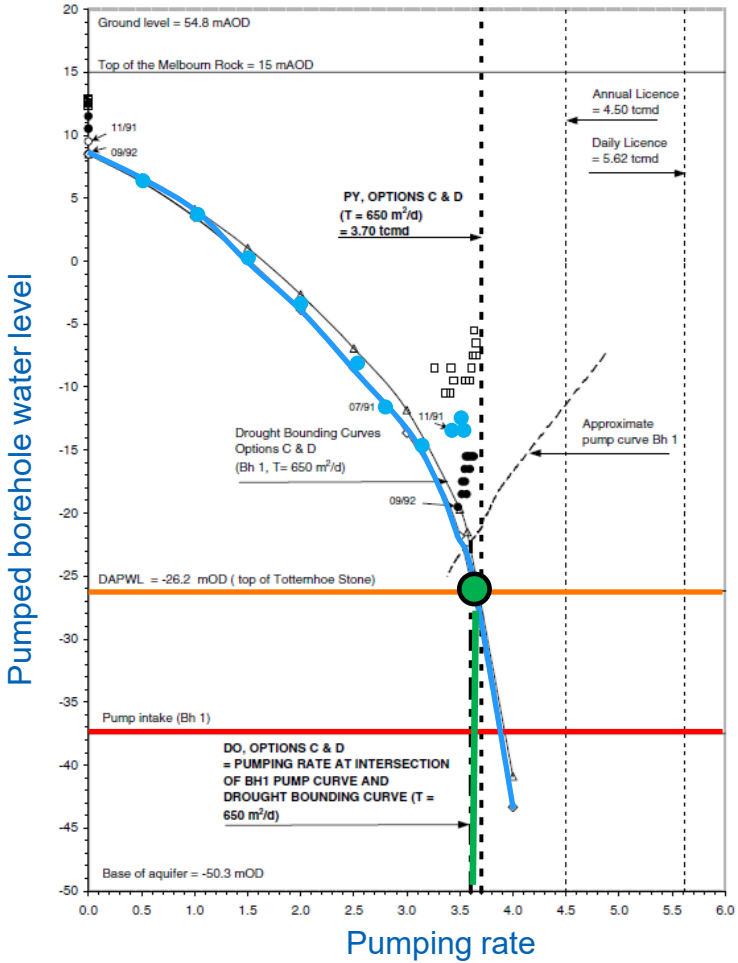


- Groundwater provides ⅓ of England's public water supply
  - Around 1,400 licensed boreholes
  - Total pumping around 1.7 billion m^3/year
- Need to understand the effect of droughts on groundwater systems and public groundwater supplies

Assessing borehole yields during droughts

- UK Government legislation - public water supply companies must determine how much groundwater they can supply during droughts
- Concept of *Deployable Output* (DO) - the maximum yield during the most severe drought
- Assessment methodology uses *historical* observations:
  - pumping rates
  - water levels in pumped boreholes

Figure adapted from: Beeson, S. (2000). Quarterly J. Engineering Geology & Hydrogeology, 33(3), 227-239.



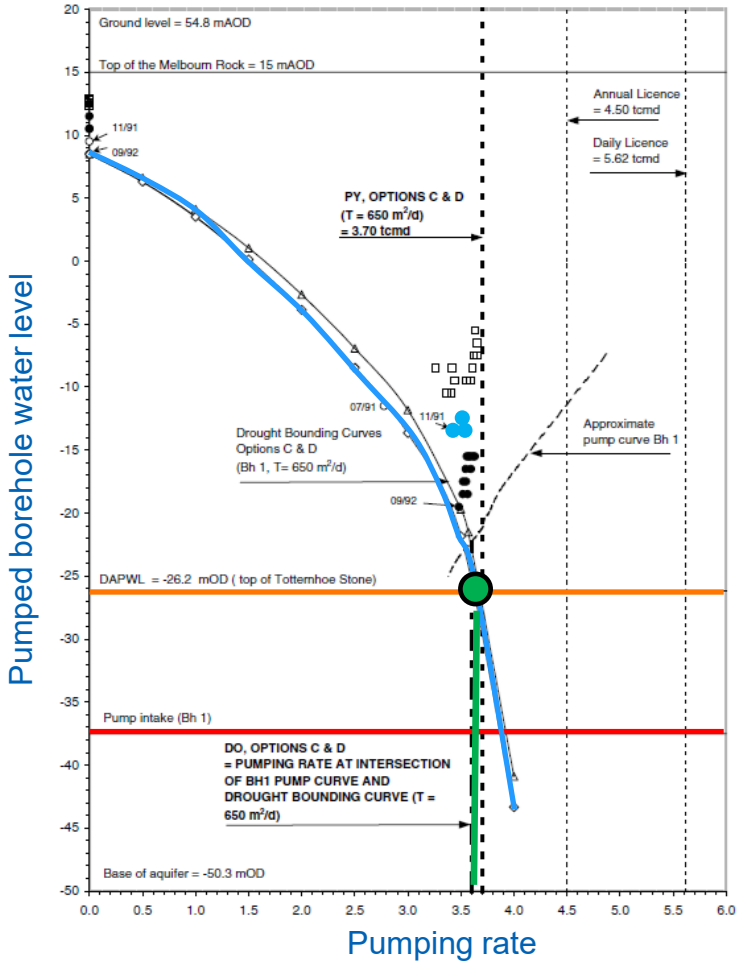
Assessing borehole yields during droughts

- Limited historical data, especially during drought periods
- Unable to predict what might happen in the future

- Need a continuous simulation methodology that can reproduce pumped borehole water levels in response to changing:
  - pumping rate
  - regional groundwater levels

- Enabling future prediction
  - Short-term seasonal
  - Long-term climate change

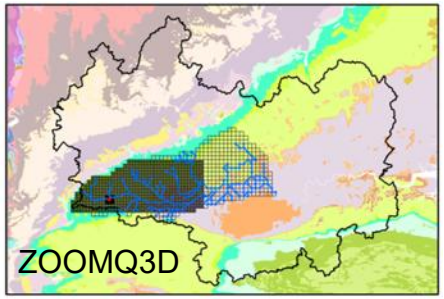
Figure adapted from: Beeson, S. (2000). Quarterly J. Engineering Geology & Hydrogeology, 33(3), 227-239.



Existing modelling framework

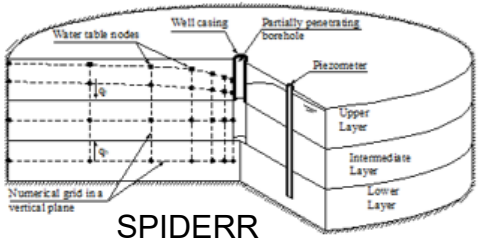
Upton et al 2020 10.1016/j.jhydrol.2020.125113

Regional groundwater model



200 km

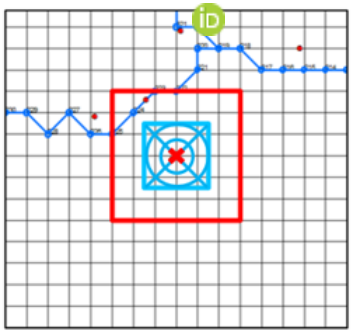
High resolution borehole-scale model



SPIDERR

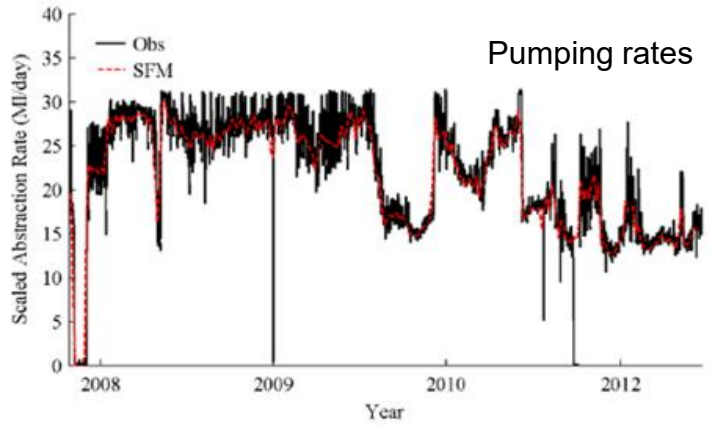
750 m

Coupled model

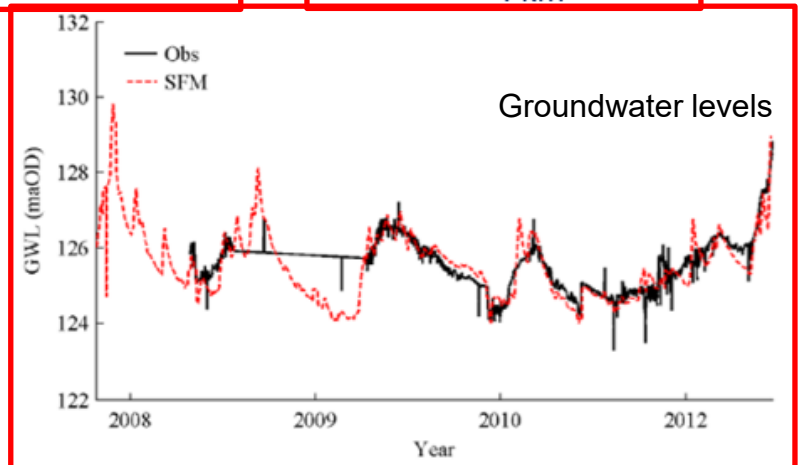


4 km

Pumping rates

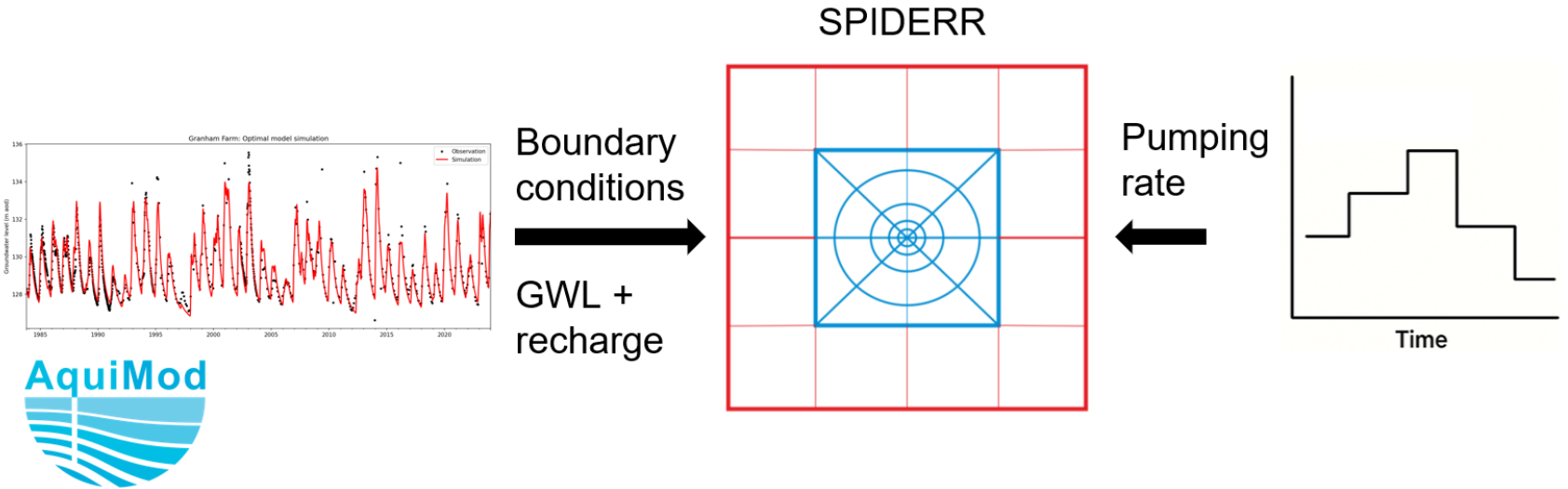


Groundwater levels

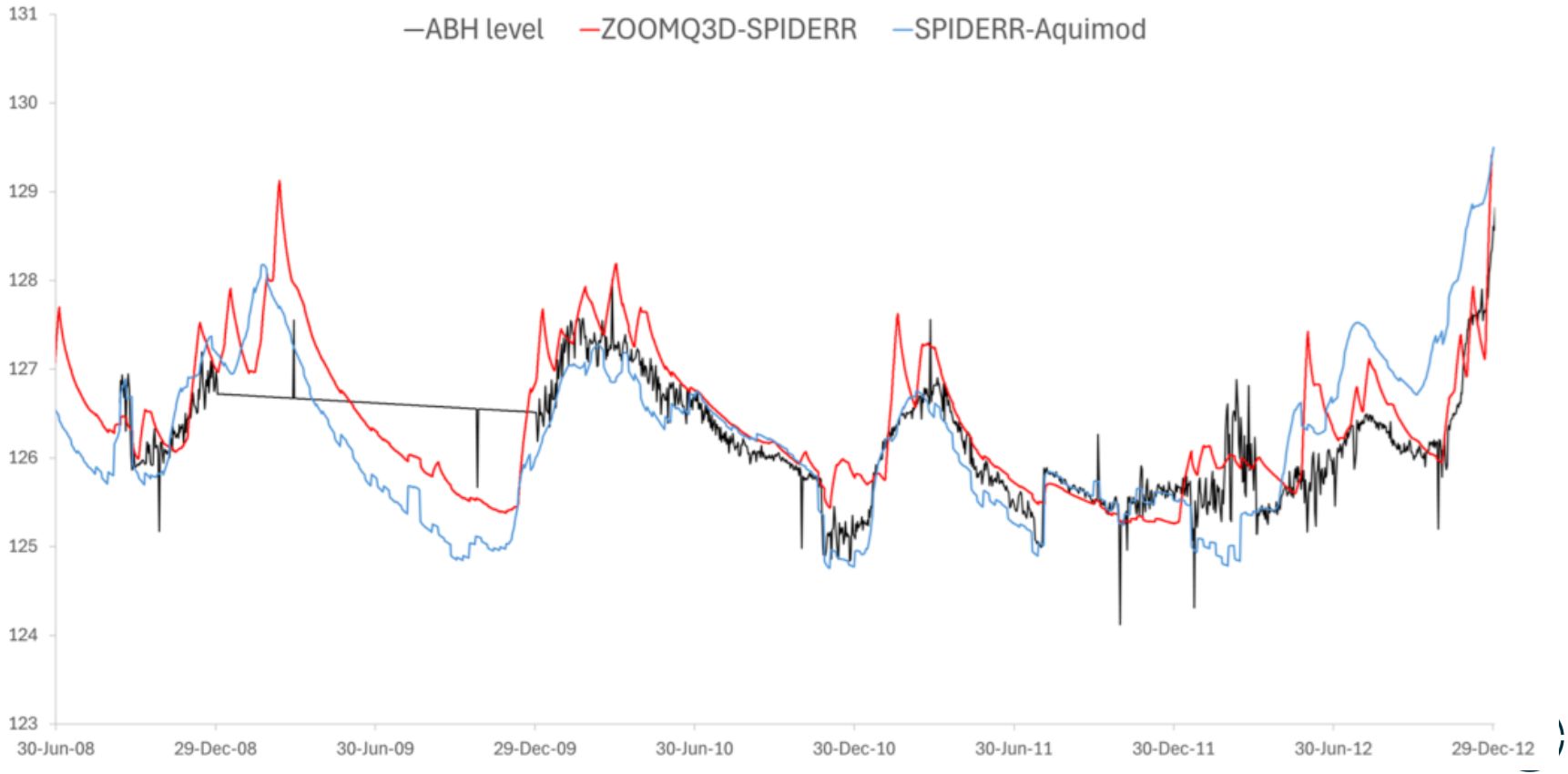


Problem 1: need a regional groundwater flow model

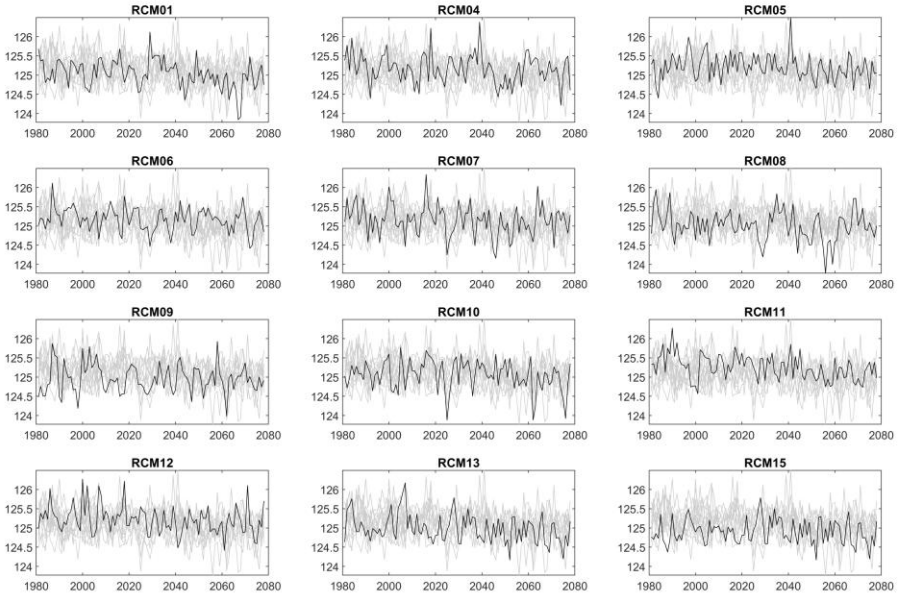
- Solution: replace regional model with groundwater level time-series based boundary condition at edge of high-resolution borehole-scale model

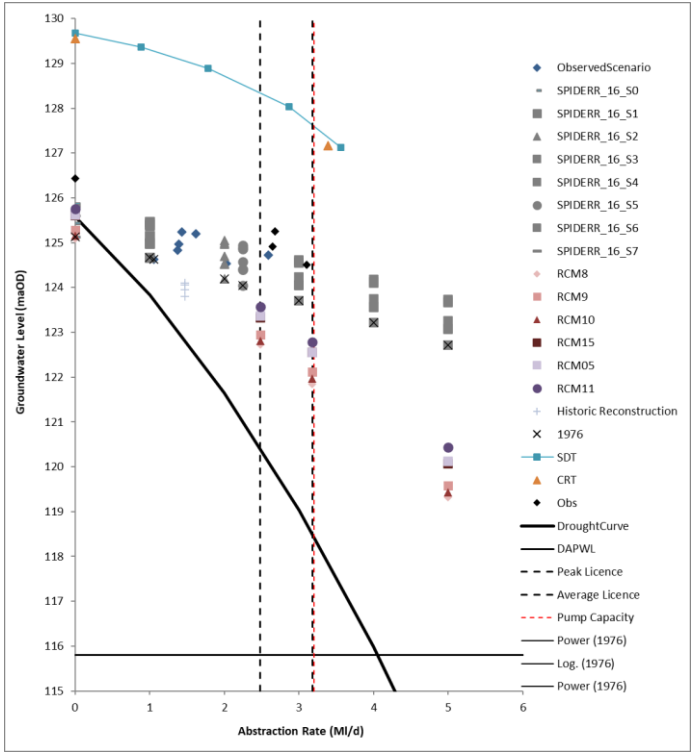


Observed response in abstraction borehole



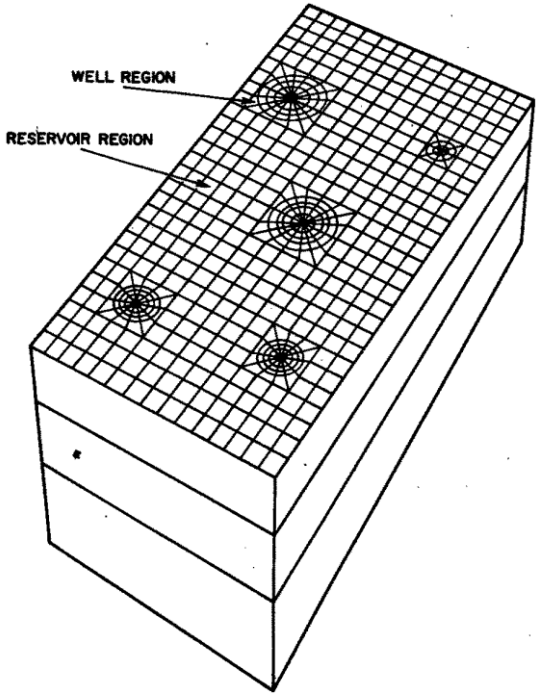
Future response in abstraction borehole

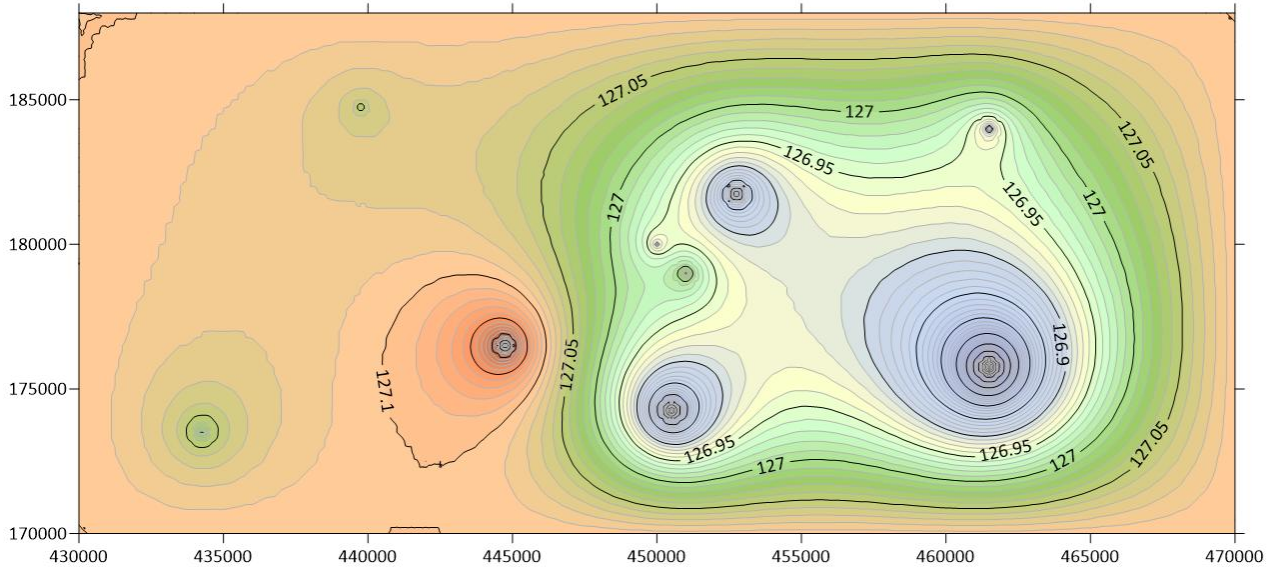




Problem 2: What if it is a multi-borehole supply source?

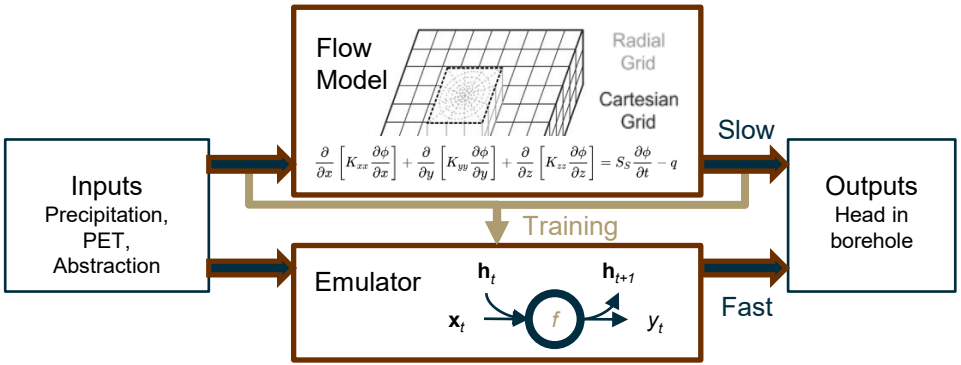
- Solution: Implement multiple, interacting pumped boreholes in SPIDERR code

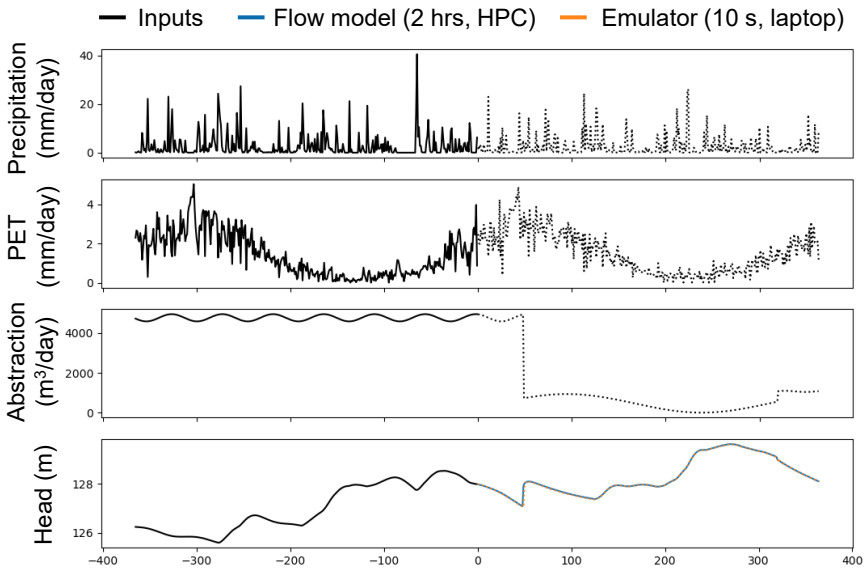




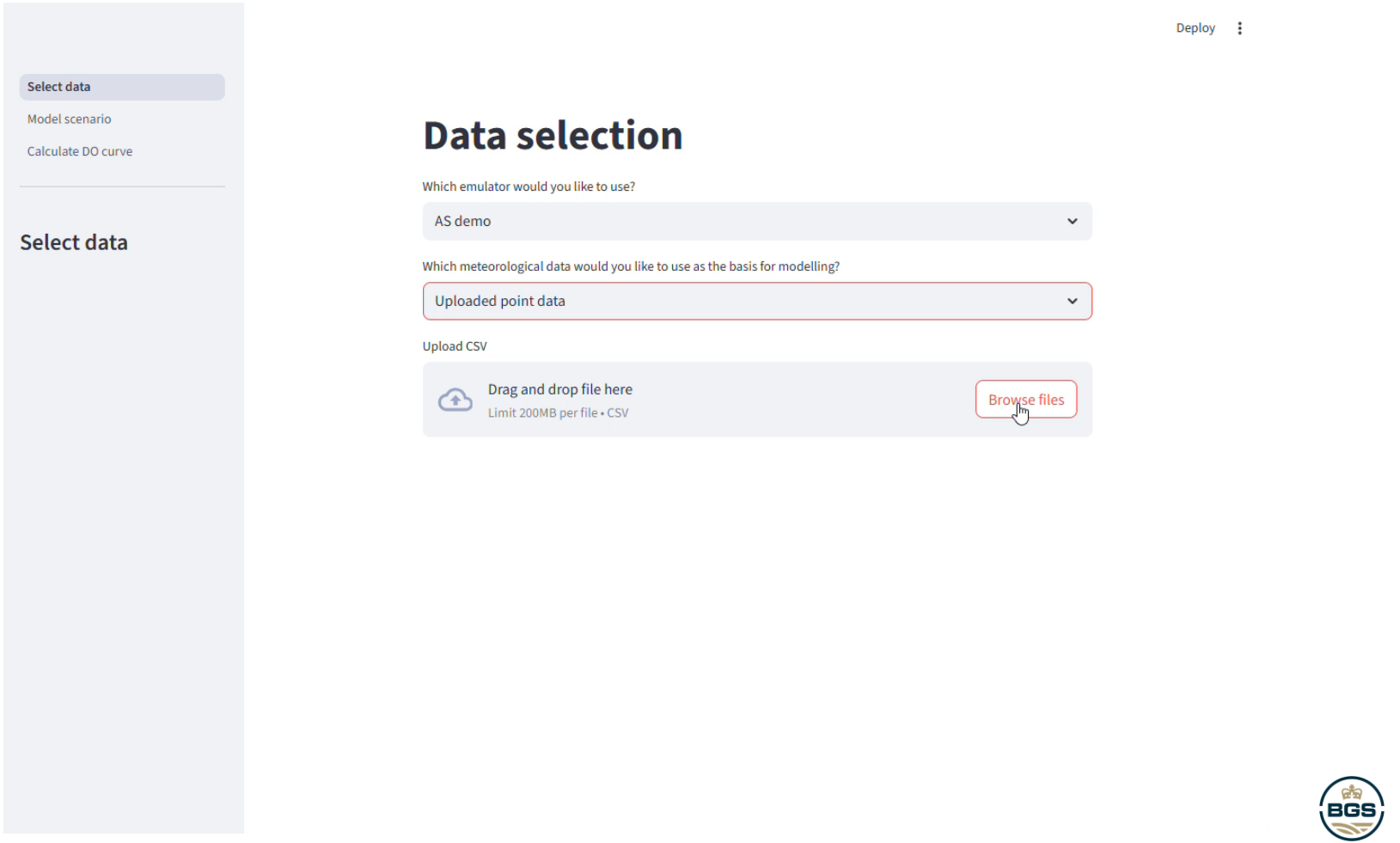
Problem 3: How can practitioners use it?

- Solution: Emulate the complex, coupled model using a neural network





Train a recursive neural network to rapidly approximate coupled groundwater model predictions


Deploy
Select data
Model scenario
Calculate DO curve
Select data
Data selection
Which emulator would you like to use?
AS demo
Which meteorological data would you like to use as the basis for modelling?
Uploaded point data
Upload CSV
Drag and drop file here
Limit 200MB per file • CSV
Browse files

Summary

- Developed new modelling framework for simulating water levels in multiple interacting boreholes
- Developed an emulator of our local physics-based groundwater model using a recurrent neural network
- Enabled practitioners to use the emulator to explore future drought scenarios and effect on deployable output

Thank you

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