

Advancing Water Resources Research: Use of JASMIN in Hydrological Innovation

Amulya Chevuturi

Richard Smith

Wilson Chan

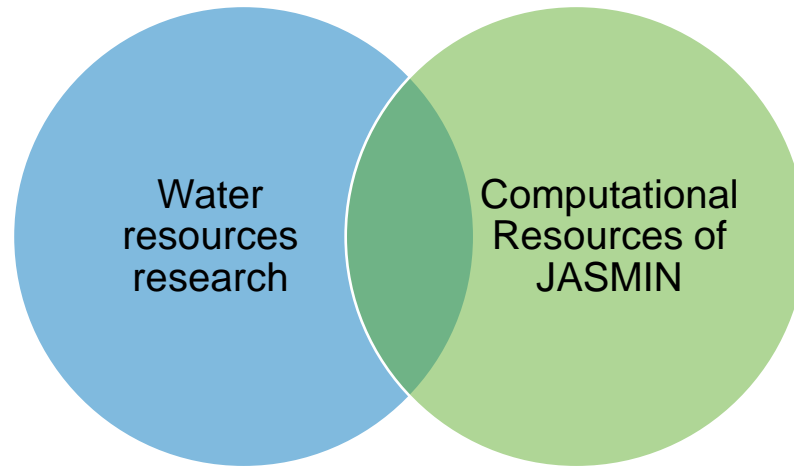
Burak Bulut

Nathan Rickards

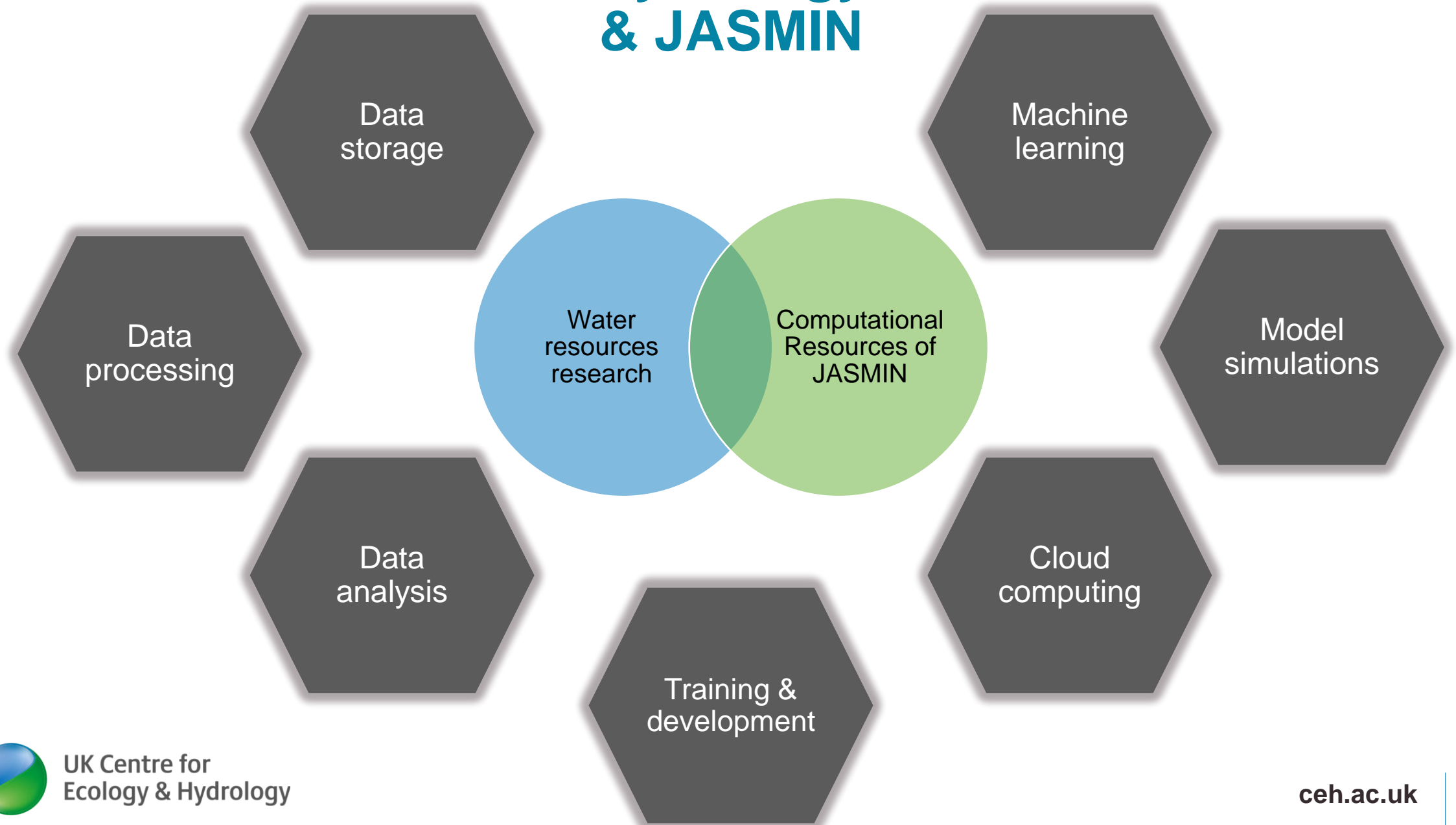
6th February 2024



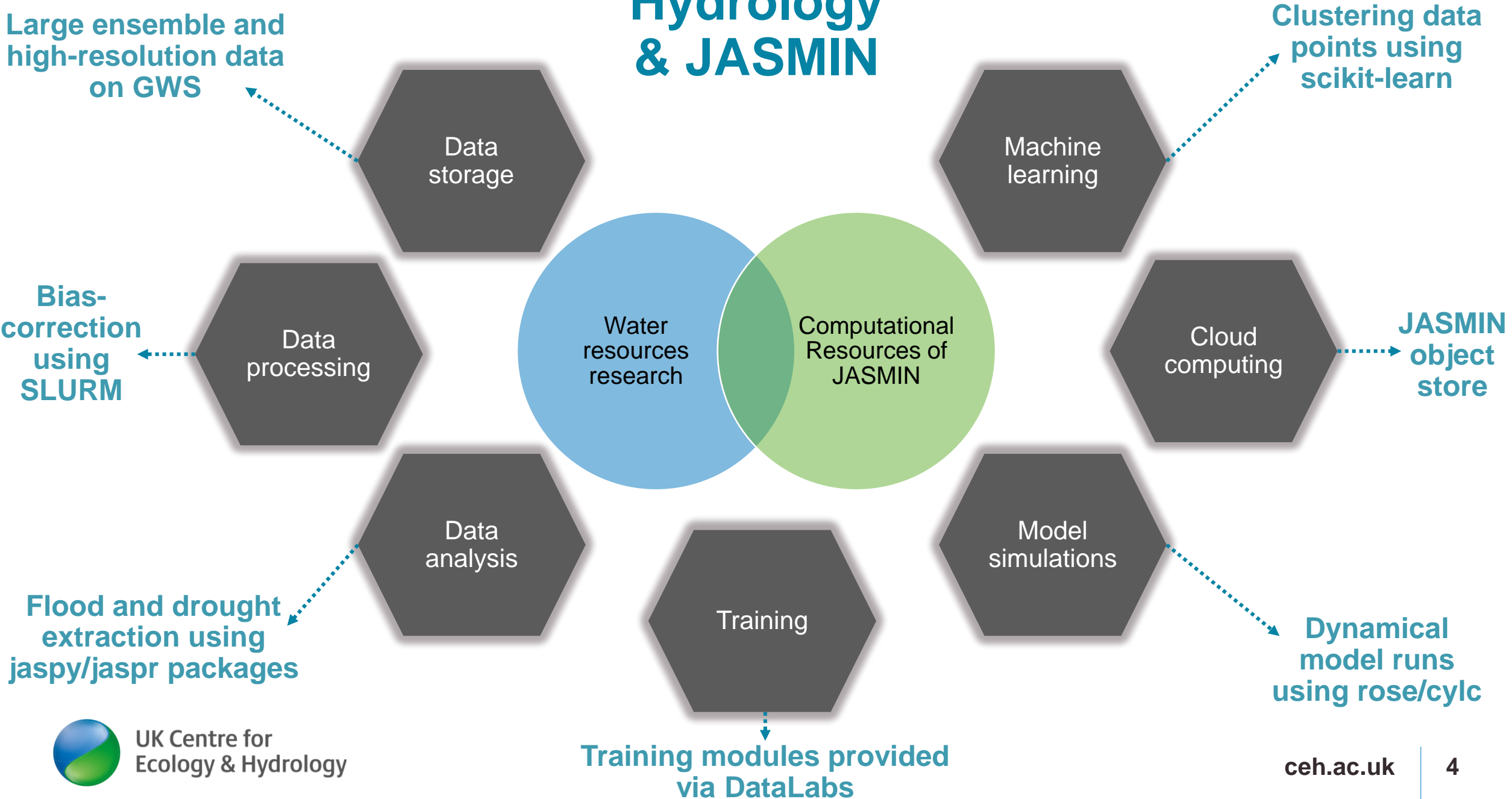
Hydrology & JASMIN



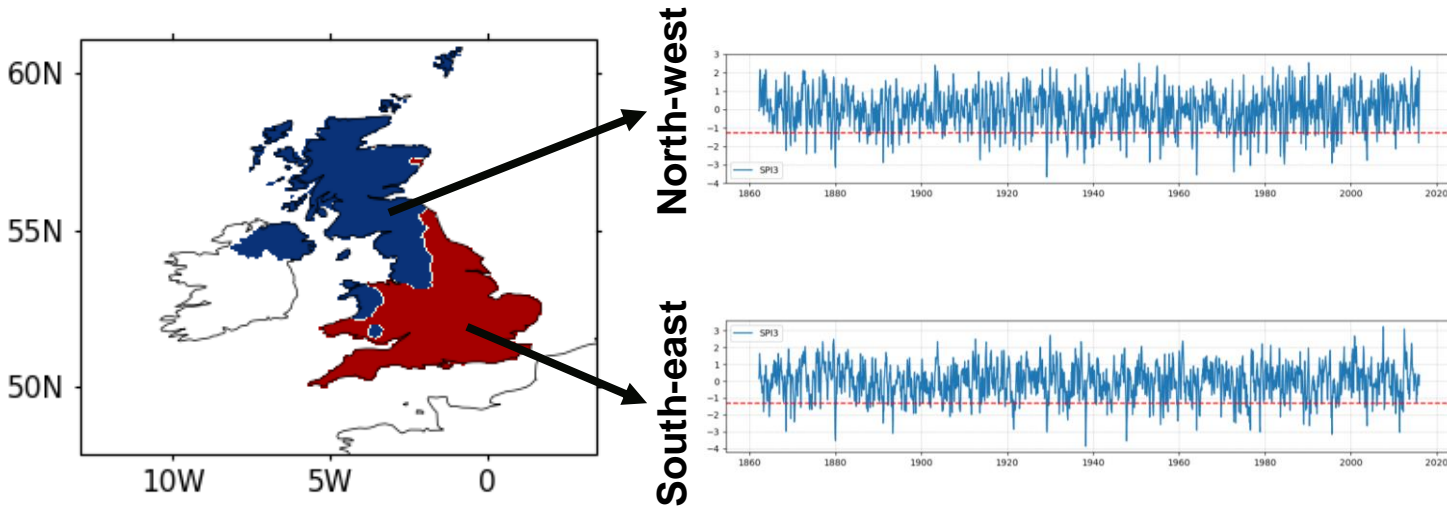
Hydrology & JASMIN



Hydrology & JASMIN



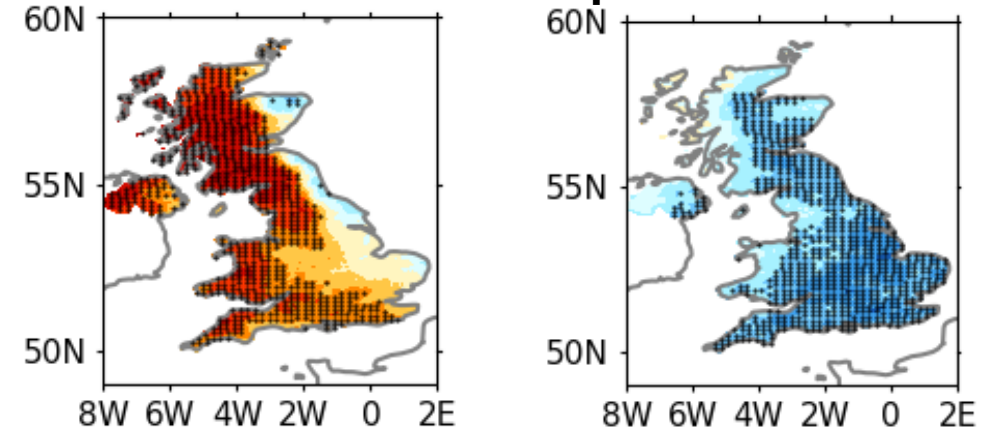
Homogenous rainfall regions: Regional clustering



SPI3 regional clusters identified using k-means clustering

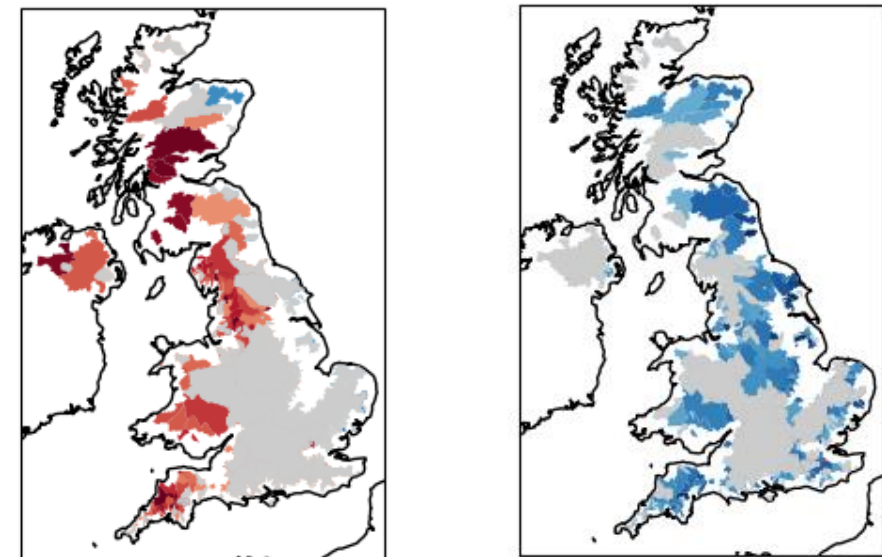
Regional area-averaged standardized SPI3 time series and the 10th percentile threshold

Standardised Precipitation Index

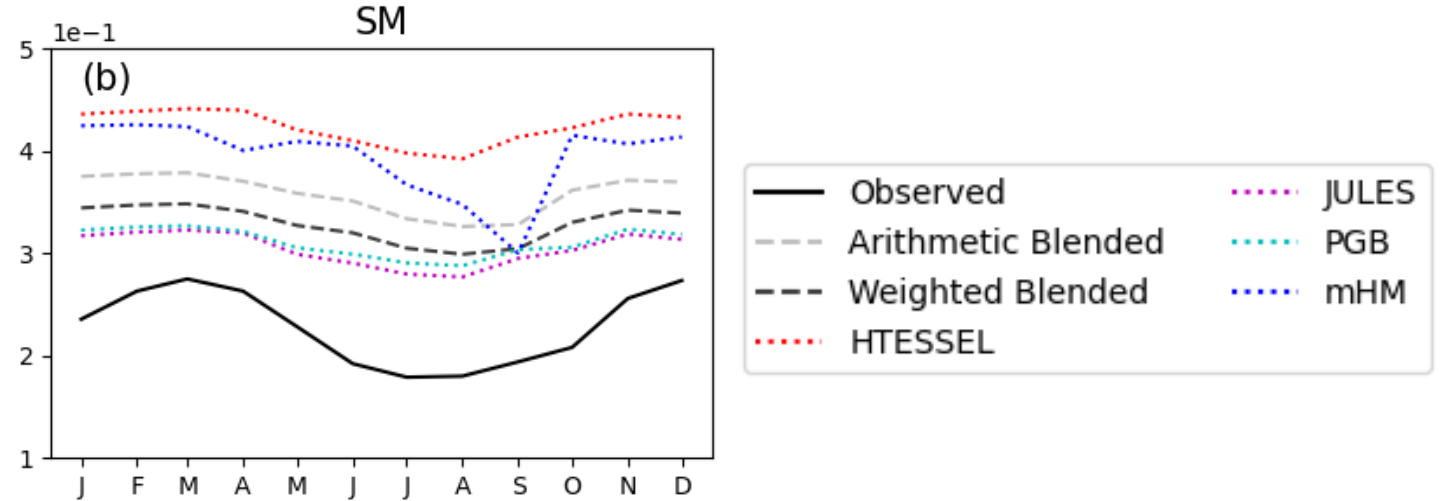
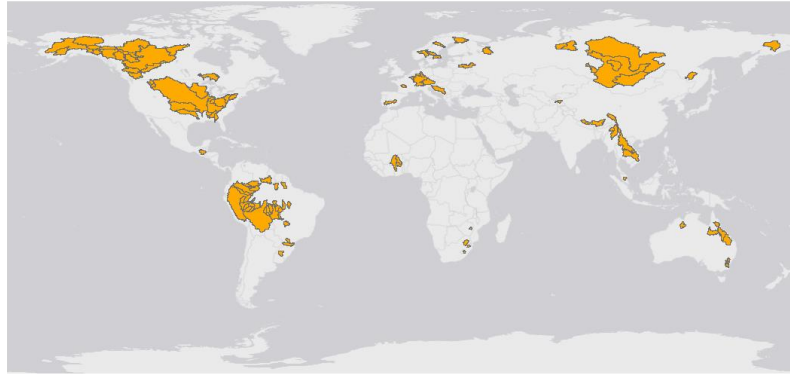


Regional homogeneity of Rainfall has impacts over streamflow too

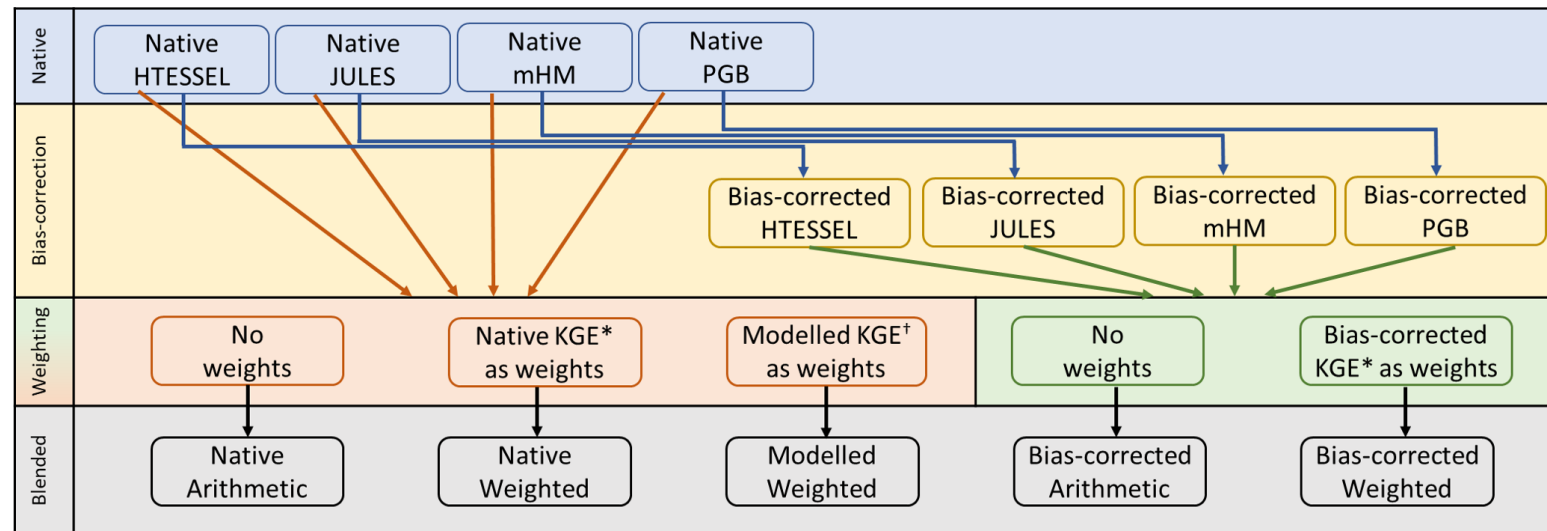
Standardised Streamflow Index



Forecasts for ungauged catchments: Multi-model blending & Bias-correction

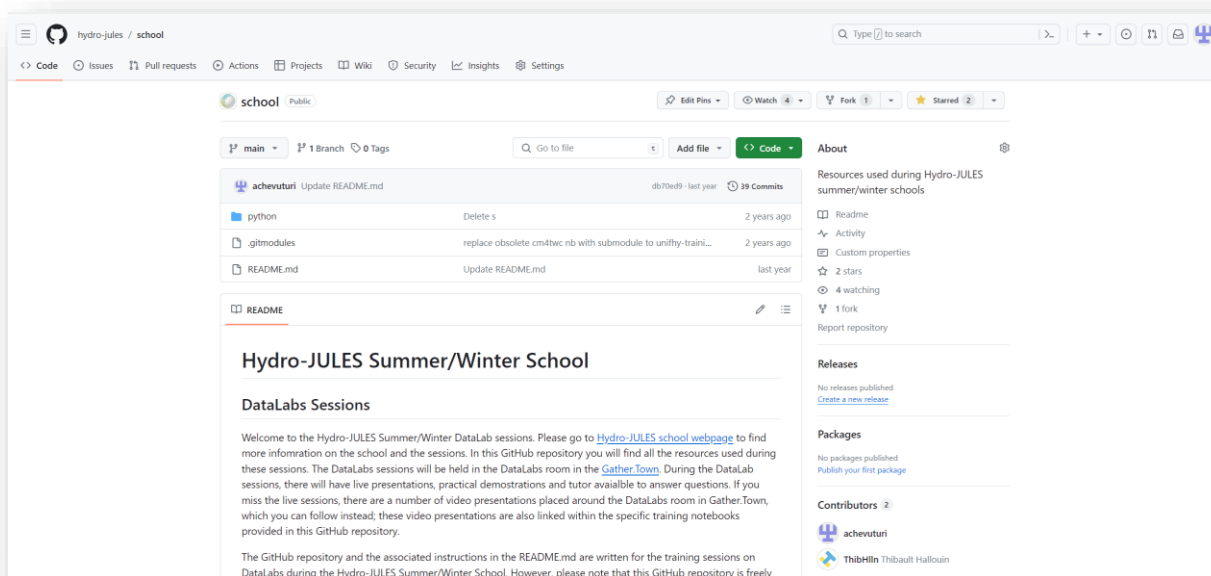


Bias-correction & Blending



Training & development: Hydro-JULES summer/winter school

GitHub repository

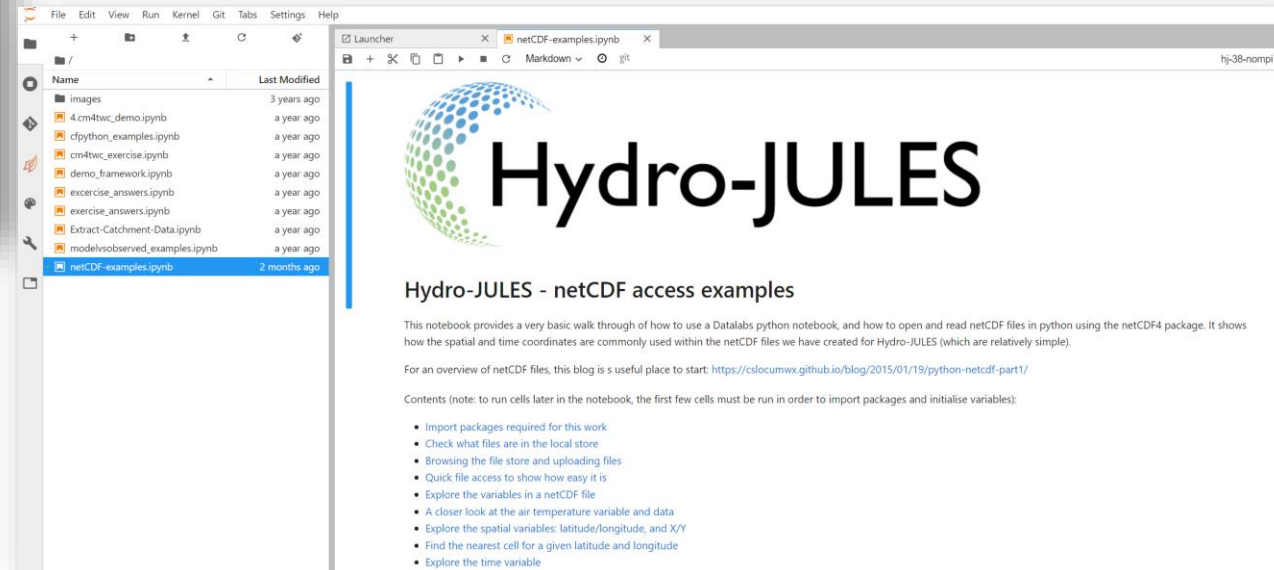


The screenshot shows the GitHub repository page for 'hydro-jules / school'. The repository is public and has 1 branch and 0 tags. The README file is selected, showing the title 'Hydro-JULES Summer/Winter School' and a section for 'DataLabs Sessions'. The README text includes a welcome message and instructions for attending the sessions. The repository also shows a list of files, including 'python', '.gitmodules', and 'README.md'. The 'About' section provides information about the resources used during the school.

DataLabs Sessions:

- HydroJULES model simulation
- NetCDF output analysis & visualisation

Training provided through DataLabs

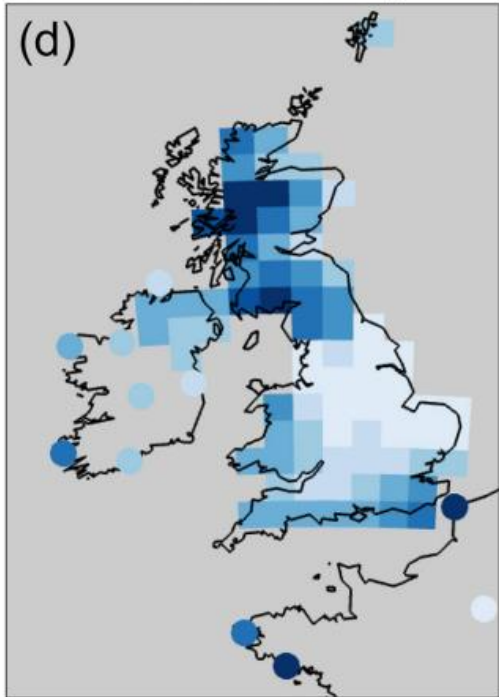


The screenshot shows a Jupyter Notebook interface with a file explorer on the left and a notebook cell on the right. The file explorer shows a list of files, including 'netCDF-examples.ipynb'. The notebook cell contains the title 'Hydro-JULES' and the subtitle 'Hydro-JULES - netCDF access examples'. The text in the cell describes the notebook's purpose and provides a list of contents to be run in order.

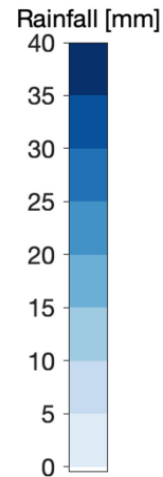
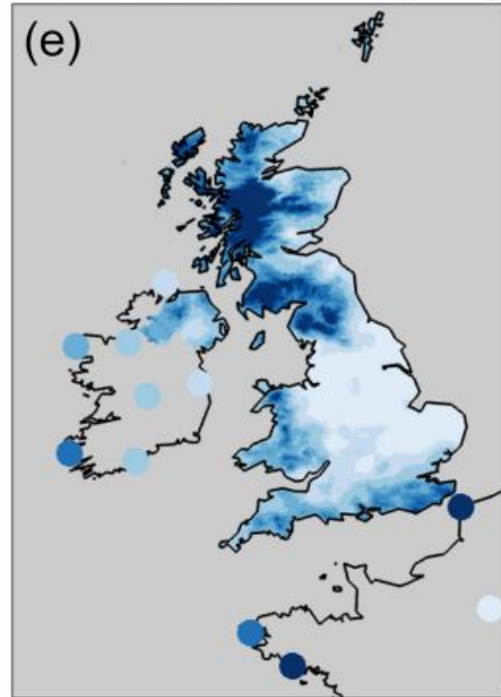
High resolution reanalysis: Downscaling

Weather Rescue Citizen Science Project

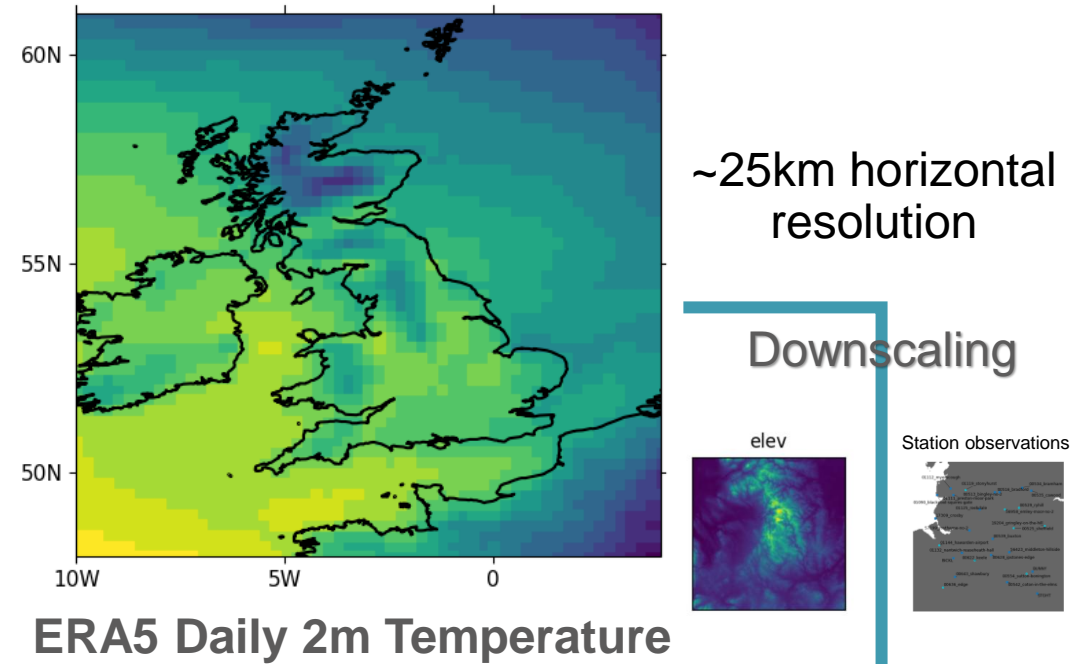
Rainfall observations (60 km)



Rainfall observations (1 km)

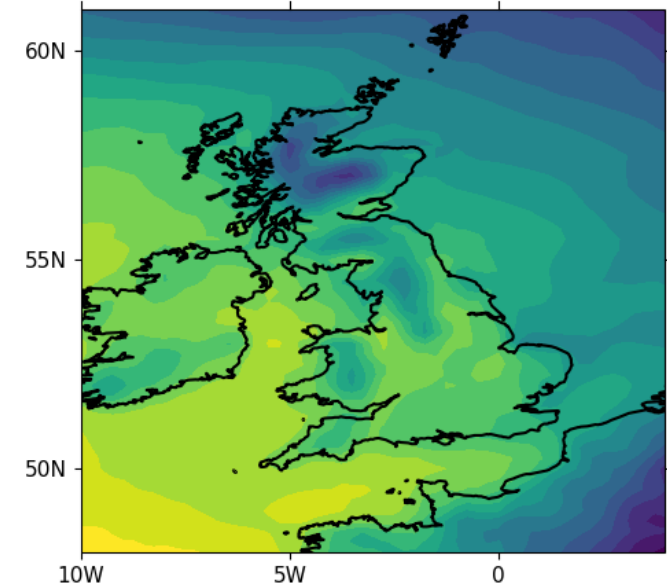


[Hawkins et al., 2023](#)



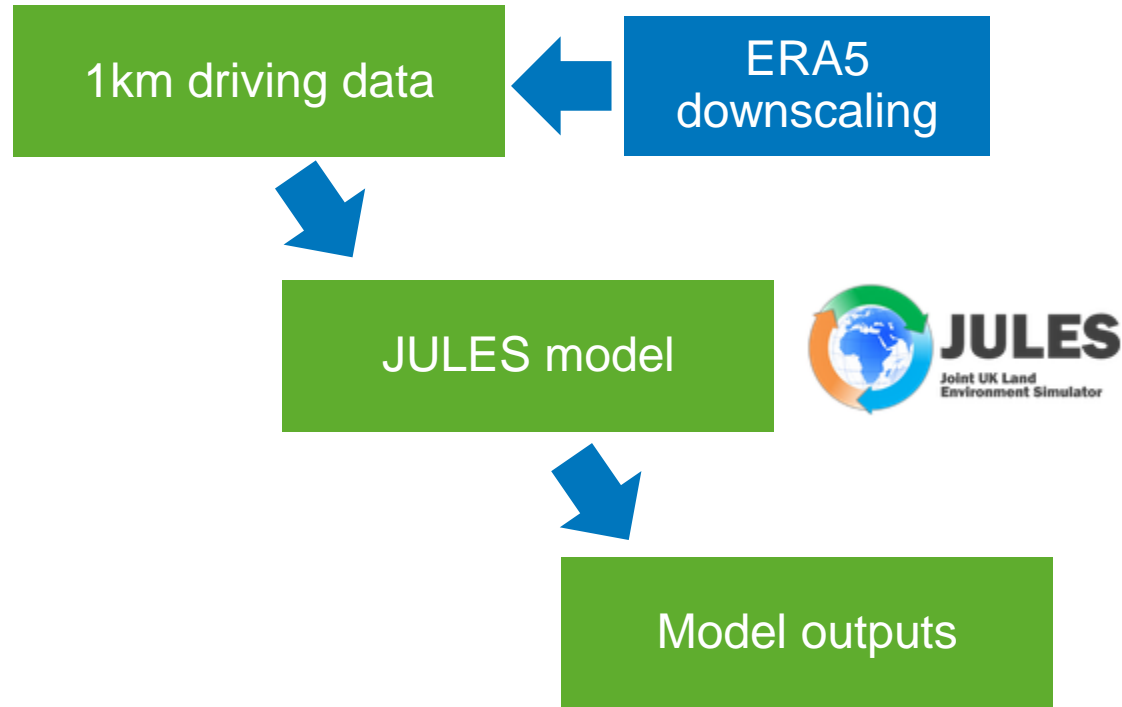
ERA5 Daily 2m Temperature

1km horizontal resolution

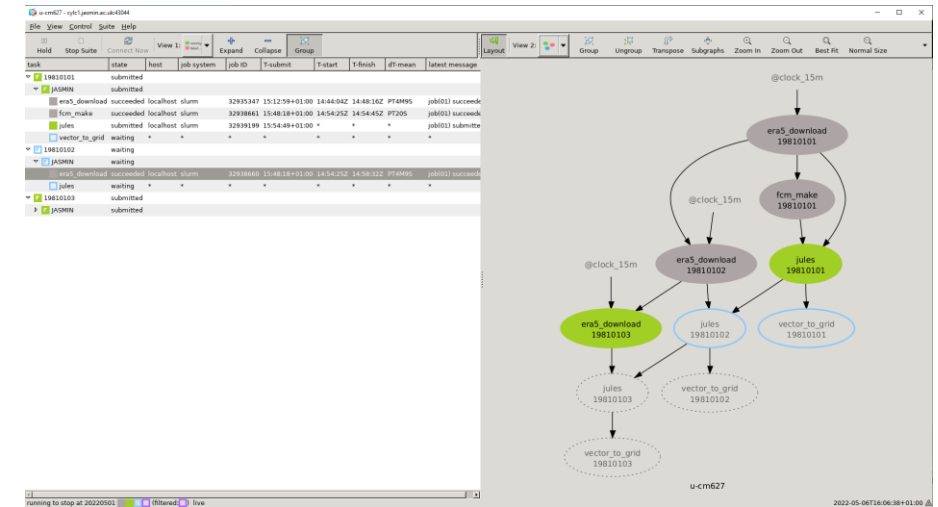


Infrastructure for near-real-time (NRT) modelling

NRT 1km UK based JULES model workflow



- Make data available to community
- JASMIN object store
- Datalabs

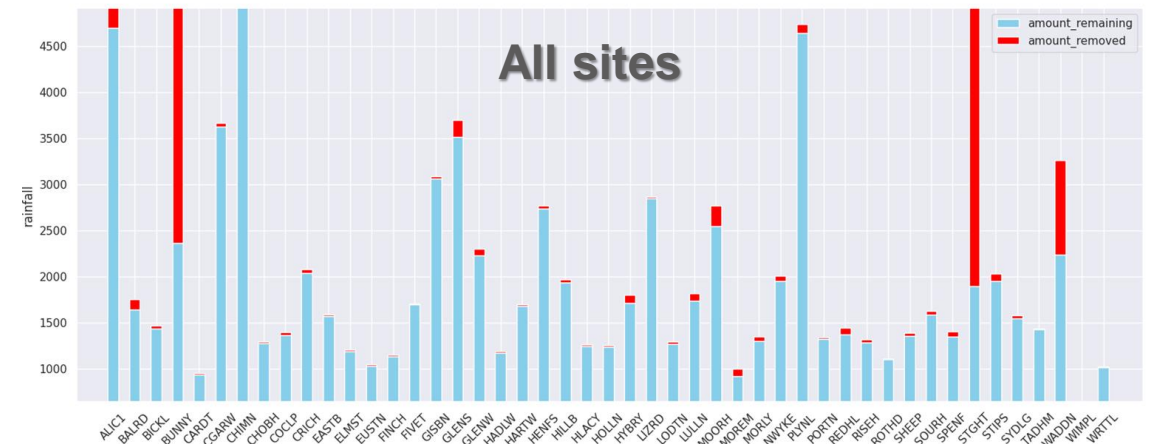
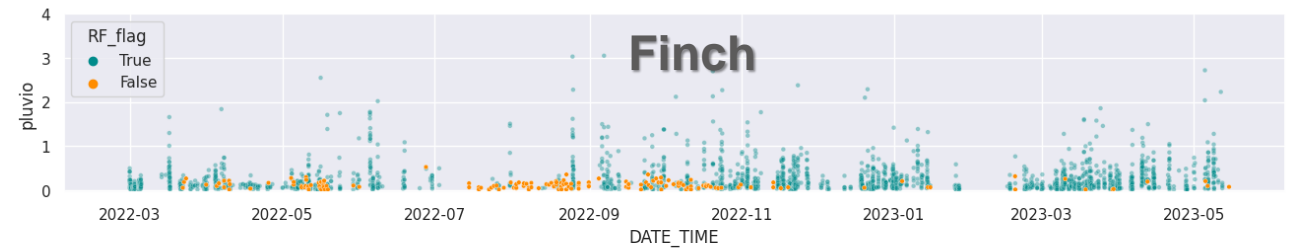
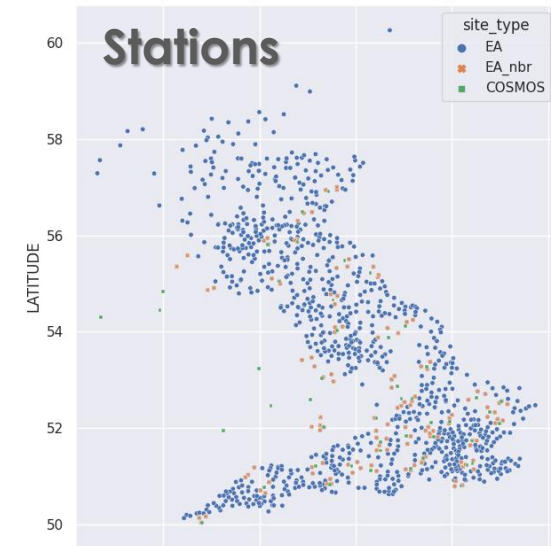


- Implementing these processes within a workflow engine on JASMIN (Cylc)

Quality control of observations: Rainfall and Soil Moisture



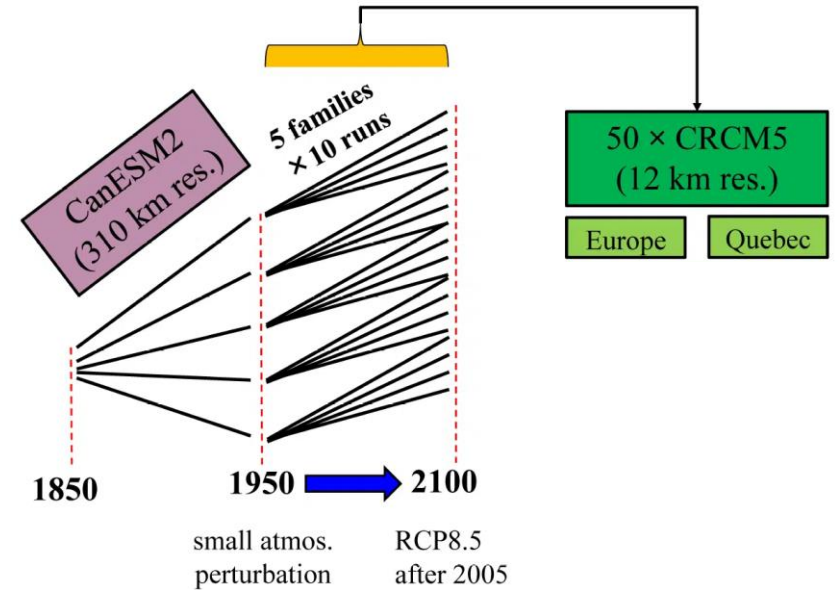
Cosmic-ray soil moisture monitoring
(COSMOS) network



Use of JASMIN in CANARI

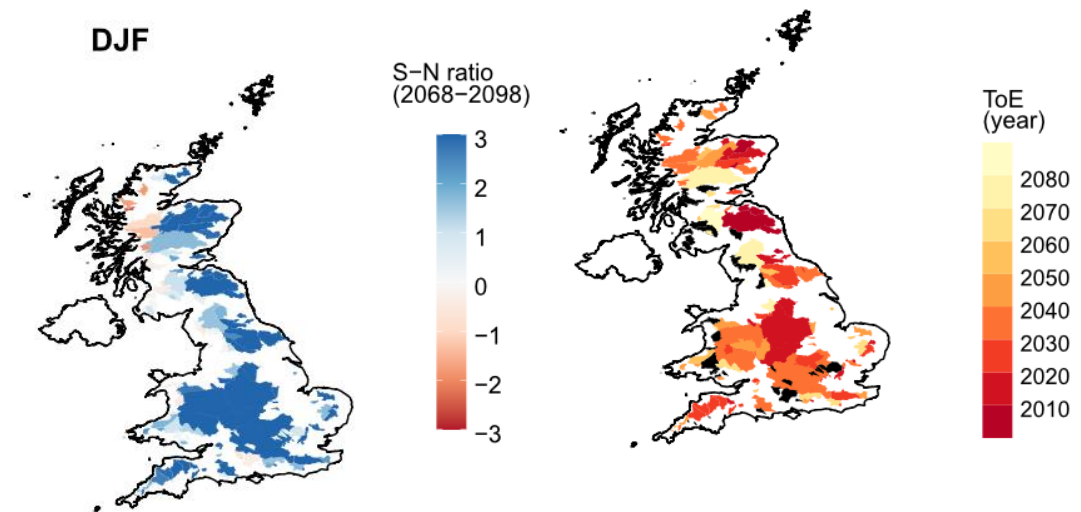


- Data access of observations to obtain the input data and ancillary information needed for hydrological modelling via **CEDA**
- Processing climate model data (MSLP, wind speed, pr, tas) using **LOTUS** (50 ensemble members)
- Hydrological model simulations of 200 UK catchments initiated through R to simulate river flows at catchments across Great Britain using **LOTUS**



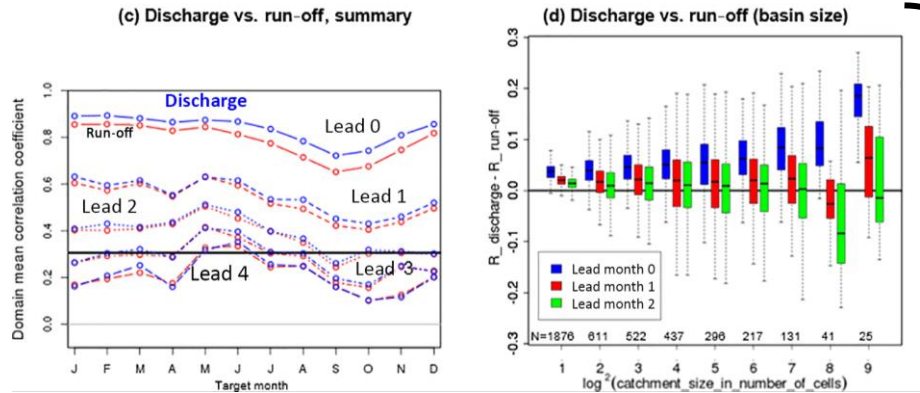
Plans in 2024

- Climate data processing of CANARI LE (calculation of PE, bias correction, downscaling)
- Hydrological simulations using historical runs of the CANARI LE



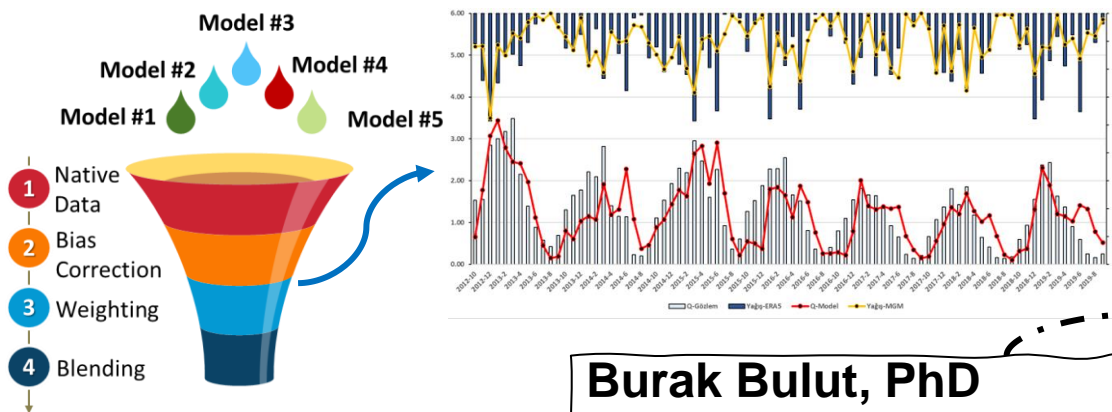
Hydrology

Seasonal Streamflow Forecast Verification Workbench



<https://doi.org/10.5194/hess-22-3453-2018>

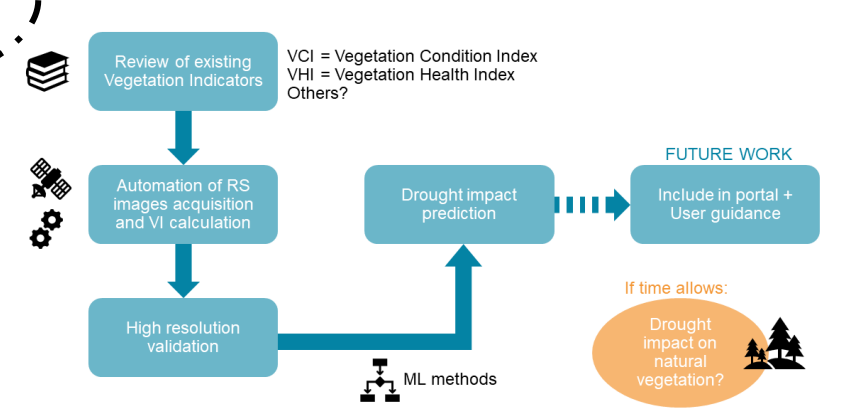
Model Blending and Bias-Correction for Forecasts



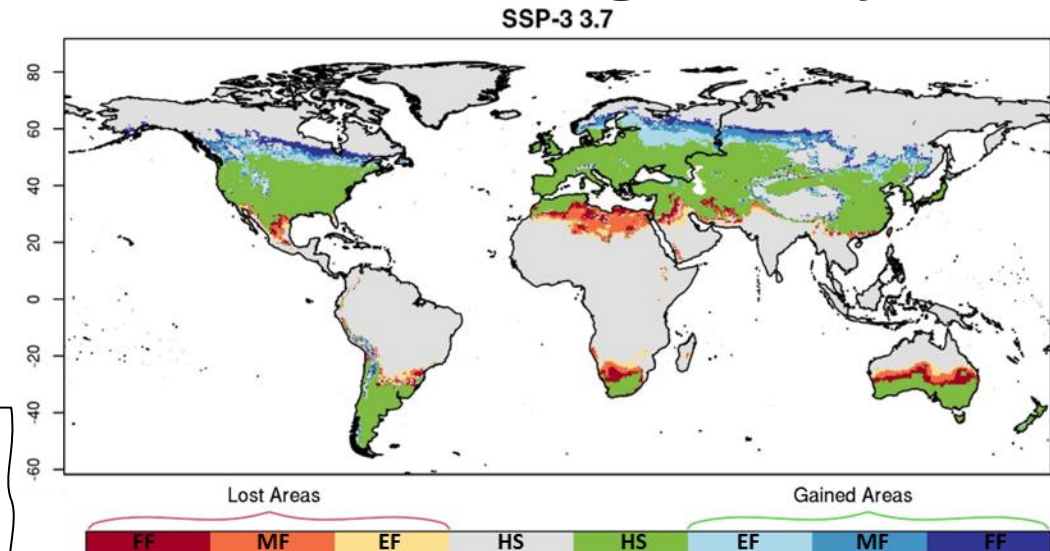
Burak Bulut, PhD
Hydrological & Crop Modelling
Climate Change Impacts on **Hyd.&Agr.**
Spatio-Temporal Analysis of Large Datasets

Agriculture

Drought Impact Estimation



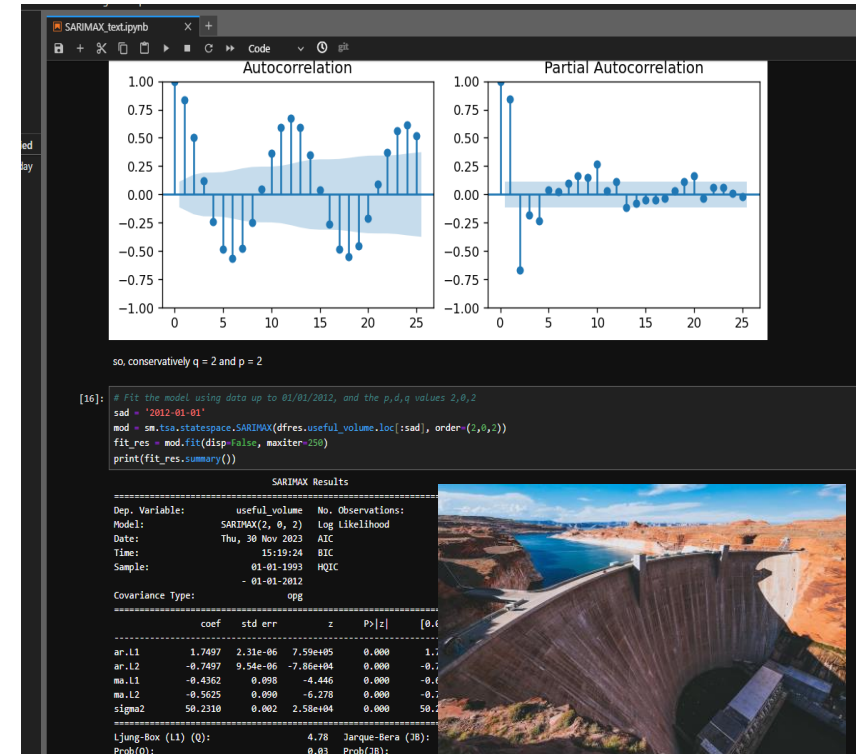
Global Scale Multi-Model & Scenario Drought Analysis



Hydrological modelling with anthropogenic influences

- Limited use of Jasmin up until now – attended training course in Nov 2022
- Jasmin notebooks used for machine learning task on reservoirs
- Jasmin will be used to develop and run JULES in ‘Big Thaw’. Collaboration with U. Edinburgh, U. Birmingham and BAS
- Water resources model runs using ensemble climate input and JULES outputs, as part of NERC NC International

Benefits around a shared workspace and data



Final points...

Open dialogue between JASMIN team and researchers

Examples for discussion topics for the future:

- GPU computing
- Cloud storage changes
- Kubernetes
- Group workspace migration
- FORTRAN compilers



Thank you

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UK Centre for
Ecology & Hydrology

JASMIN



Computing for Climate: JASMIN's Impact on Hydroclimatic Risk Science

Matt Brown

Mark Rhodes-Smith

Nathan Missault

6th Feb 2024



JASMIN

JASMIN Object Storage

Storing and accessing big data is a major concern with large amounts of climate data being produced

One of the newest solutions we are exploring is the *JASMIN Object Store*

Aim: To produce materials helping scientists make use of this new technology

Object Store

JASMIN Services / Object Store

My Services

- Discover services
- Login Services
- Sci Analysis VMs
- Group Workspaces
- Project VMs
- Cloud Tenancies
- Additional Services
- Object Store

Search Object Store

« Page 1 of 2 »

bas-data-o
Object store tenancy for BAS.

cci-ke-o
Object store tenancy for the CGI KE project.

cedadev-o USER
S3 object store tenancy for CEDA testing.

JASMIN Object Store

JASMIN Object Storage - GitHub Repository

NERC-CEH / jasmin_object_store

Code Issues Pull requests Actions Projects Security Insights

jasmin_object_store Public

main 1 branch 0 tags

Go to file Add file Code

achevuturi finalising the scripts 7a2fd88 6 minutes ago 23 commits

img	Add files via upload	2 days ago
notebooks	finalising notebooks	yesterday
scripts	finalising the scripts	6 minutes ago
.gitignore	Create .gitignore	2 days ago
.pre-commit-config.yaml	Create .pre-commit-config.yaml	2 days ago
README.md	Create README.md	2 days ago

README.md

README for the GitHub repository

This GitHub repository offers sample notebooks and guides for utilizing the JASMIN Object Store. This README introduces Object Store and provides instructions for using the resources within this repository for accessing the

About
Repository with examples on how to use the JASMIN high-performance object storage
Readme
Activity
0 stars
1 watching
0 forks
Report repository

Releases
No releases published
[Create a new release](#)

Packages
No packages published

https://github.com/NERC-CEH/jasmin_object_store

JASMIN Object Storage – Future Work?

- Develop training module/labs (e.g. HJ winter and summer school)
- Connect Object Store to API type interfaces??
- Use apache-beam on JASMIN for more robust processing of input data?
- Integrate with DataLabs?



<https://www.scd.stfc.ac.uk/Gallery/JASMIN.PNG>

JASMIN Notebook Service and Dask Gateway

- Recent addition of write access to GWS has meant I now use these for data visualisation and testing
- Unclear how sharing of notebooks works?
- Dask-gateway service makes using dask on LOTUS much easier!



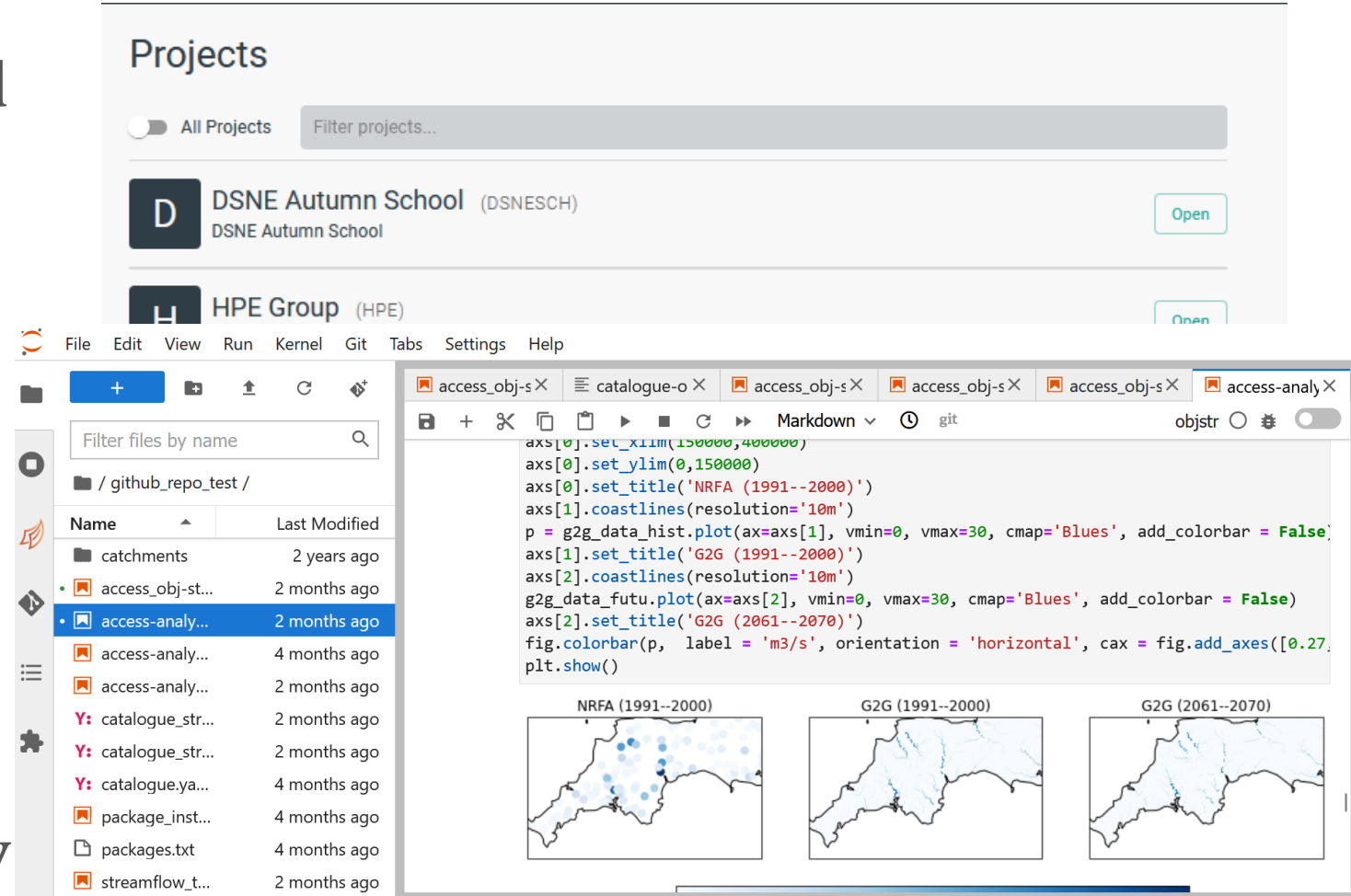
```
[19]: tsteps = 16
      comptsteps = {'s1': 1,
                    'ss': 4,
                    'ow': 2,
                    'ns1': 2,
                    'nss': 4,
                    'now': 1}

      # dictionary containing the transfers that go INTO each component
      inmap = {'s1': ['transfer_k', 'transfer_l', 'transfer_n', 'transfer_h'],
              'ss': ['transfer_i', 'transfer_m'],
              'ow': ['transfer_j', 'transfer_m'],
              'ns1': ['transfer_c', 'transfer_d', 'transfer_f'],
              'nss': ['transfer_a', 'transfer_f'],
              'now': ['transfer_b', 'transfer_e', 'transfer_p']}

      # dictionary containing the transfers that come OUT OF each component
```

DataLabs

- Built on JASMIN unmanaged cloud?
- Great for training, collaborative working
- But...
- Difficult to use for those unfamiliar with jupyter
- Unclear resource limits
- Storage (disk & obj) is fiddly to access/use



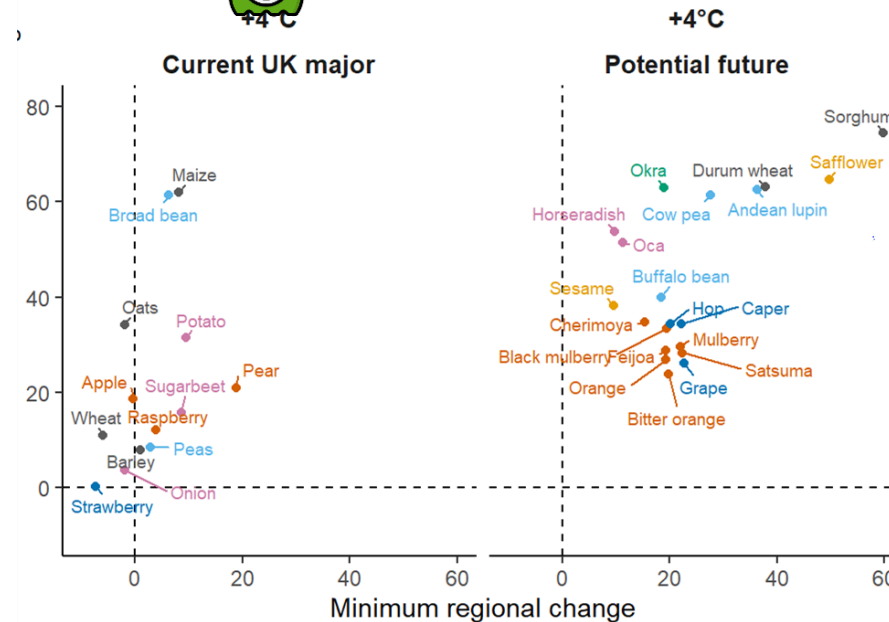
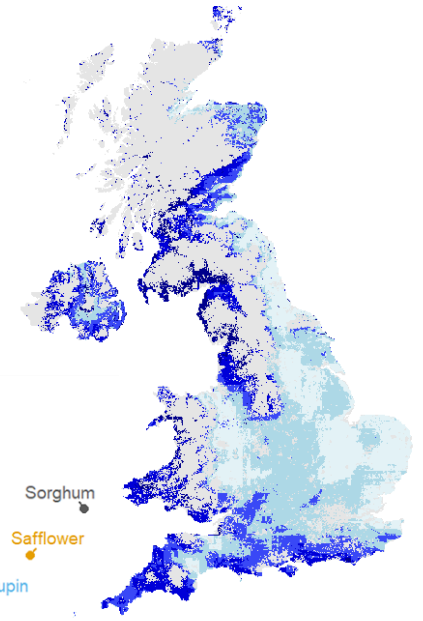
The screenshot shows a JupyterLab environment. On the left, a file browser displays a directory structure with files like 'catchments', 'access_obj-st...', 'access-analy...', 'catalogue_str...', 'catalogue_str...', 'catalogue.ya...', 'package_inst...', 'packages.txt', and 'streamflow_t...'. The main area shows a code editor with the following Python code:

```
axs[0].set_xlim(150000,400000)
axs[0].set_ylim(0,150000)
axs[0].set_title('NRFA (1991--2000)')
axs[1].coastlines(resolution='10m')
p = g2g_data_hist.plot(ax=axs[1], vmin=0, vmax=30, cmap='Blues', add_colorbar = False)
axs[1].set_title('G2G (1991--2000)')
axs[2].coastlines(resolution='10m')
g2g_data_futu.plot(ax=axs[2], vmin=0, vmax=30, cmap='Blues', add_colorbar = False)
axs[2].set_title('G2G (2061--2070)')
fig.colorbar(p, label = 'm3/s', orientation = 'horizontal', cax = fig.add_axes([0.27,
plt.show()
```

Below the code, three maps are displayed: 'NRFA (1991--2000)', 'G2G (1991--2000)', and 'G2G (2061--2070)'. Each map shows a geographical area with blue dots and lines representing data points and boundaries.

LOTUS

- In particular the high-memory queue has been super useful
- Used for high-RAM demand model runs when there is no option to run anywhere else
- Facilitated work on many projects, e.g. OpenCLIM

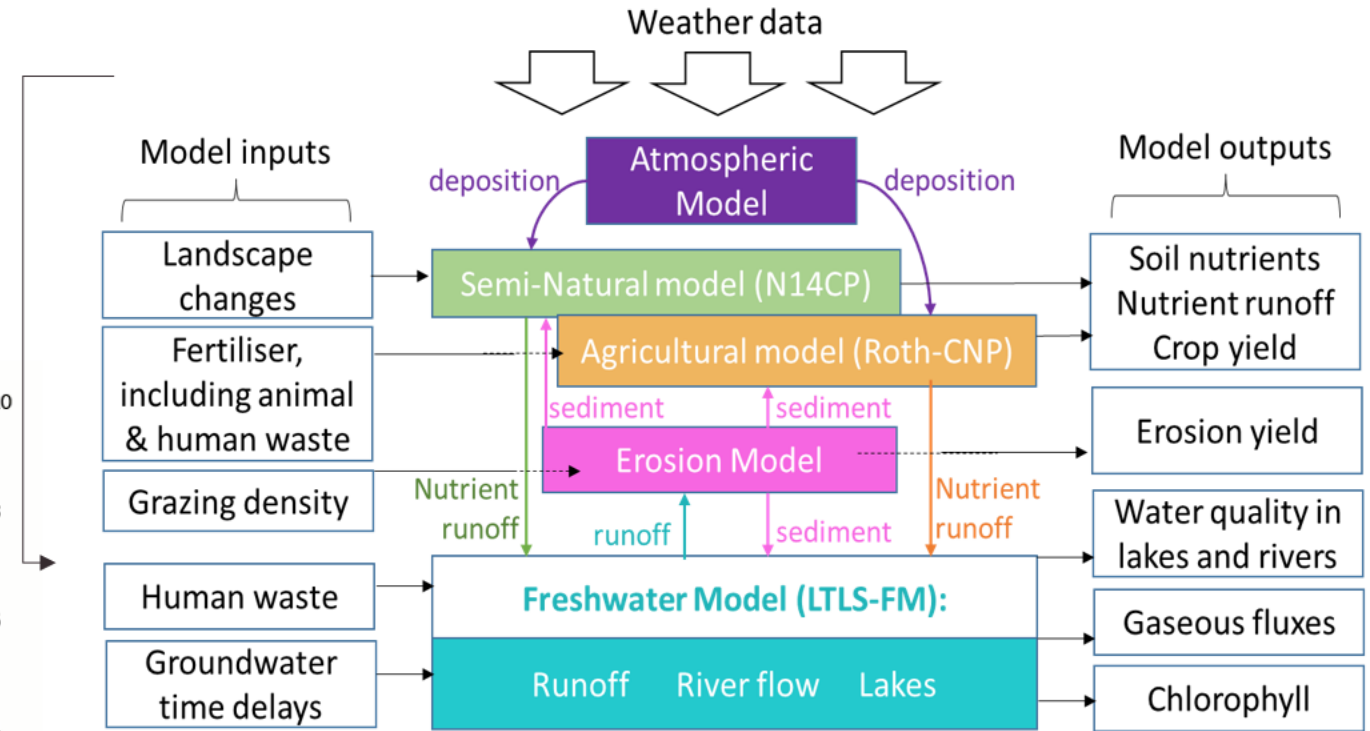
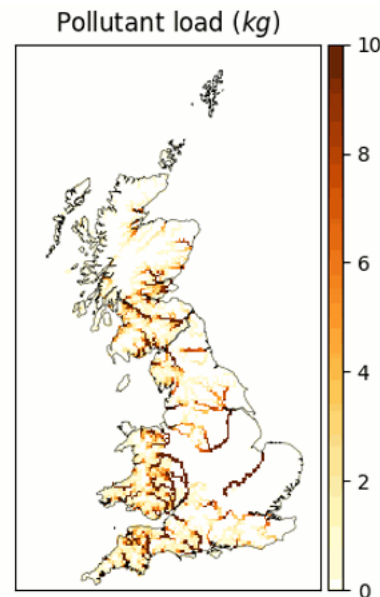


LTLS-FE Freshwater model

- Modelling **transport, transformation and fate of chemicals** in rivers, accounting for **projected hydrological changes under future scenarios**;
- Modelling **100-year period at 2-hour intervals** across a **5 km grid of the UK**.

JASMIN

- High performance computing using the **LOTUS** cluster, which enables **parallel processing** of different scenarios
- Direct access to the **CEDA archive** for climate data
- Group workspace (**GWS**) facilitates collaboration



Thank you

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Nathan: natmis@ceh.ac.uk