JULES Hydrology Module update

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The following branches have been developed under Hydro-JULES and are at different stages of being brought into the trunk (Doug Clark):

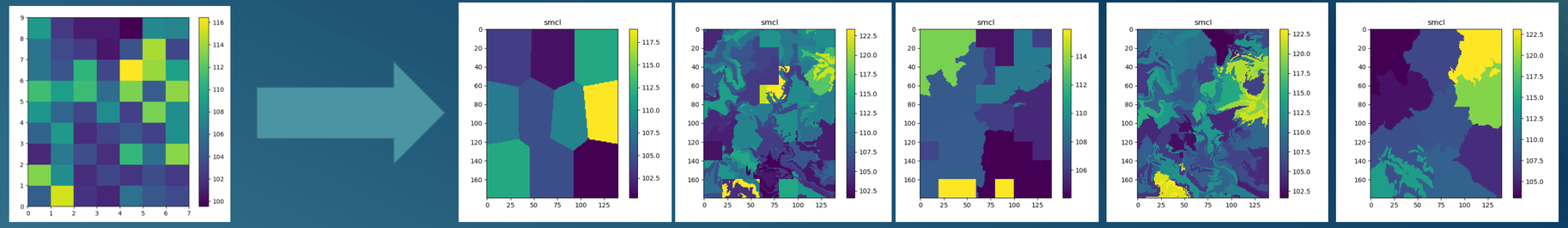
- Groundwater DGW (vn5.2, ported to vn6.3) under going testing and evaluation
- River routing/overbank inundation code (JULES - CaMaFlood), but tickets to tidy up init_riviers_props
- Surface ponding (plans to include full coupling of vertical fluxes)
- Anthropogenic water use (water abstractions/returns, dam operation)

Adding water tracers (Merve Gorguner, University of Bristol/BAS/MO - EU TiPES)

Land Response Units for JULES

Rather than running JULES in grid cells, we cluster the landscape into areas which are ‘similar’ in some way

Example JULES_LRU soil moisture outputs for Plynlimon, UK:

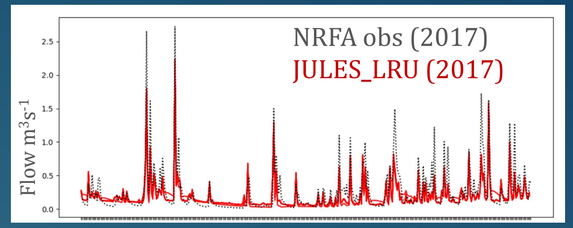


Gridded JULES soil moisture

Alternative clustering JULES soil moisture

JULES_LRU flow outputs can be routed -> river flow

Here we use the unifhy framework for routing and find a pretty good match to NRFA observations ☺



For basis of clustering code see: https://github.com/chaneyn/HydroBlocks For unifhy see: https://github.com/unifhy-org

Underlying data sets: CHESS: https://doi.org/10.5285/2ab15bf0-ad08-415c-ba64-831168be7293 IHDTM: https://catalogue.ceh.ac.uk/documents/242384d6-ce65-4360-bf4e-3f6b4ed53034

NRFA streamflow observations: https://nrfa.ceh.ac.uk/

UK Centre for Ecology & Hydrology Hydro-JULES

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British Geological Survey NATURAL ENVIRONMENT RESEARCH COUNCIL

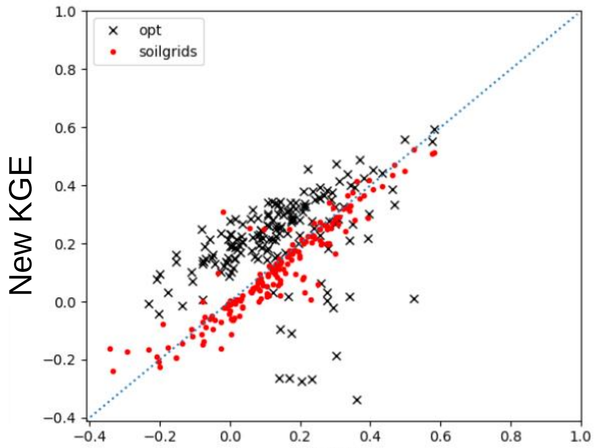
National Centre for Atmospheric Science NATURAL ENVIRONMENT RESEARCH COUNCIL

UKCEH (Doug Clark), Met Office, BGS

Evaluating the potential of Hydro-JULES developments for regional coupled modelling
Offline tests on ~2.2km grid, driven by meteorology from the UM

Soil ancillaries

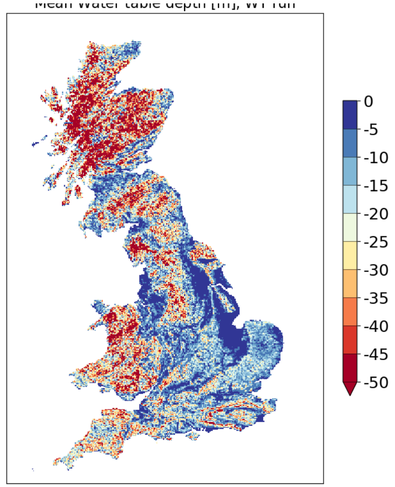
Using DA to improve pedotransfer functions
Reduced summertime evaporation, generally improved river flows



Groundwater (DGW)

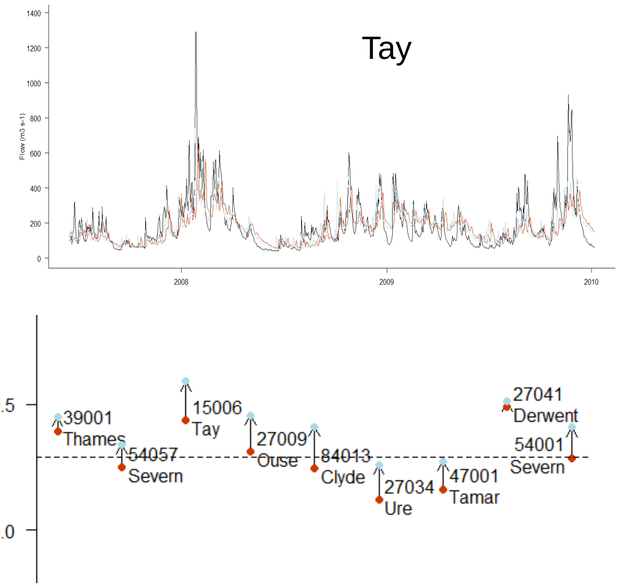
Parameterised and run for GB
GW acting as a buffer, effects on soil moisture and evaporation

Depth to water table



CaMa-Flood

Run for several large catchments – improved river flows



UK Centre for Ecology & Hydrology
Hydro-JULES

AutoAssess of 1979-2014 JJA 1.5m air-temperature for AMIP UM run with new soil ancillary

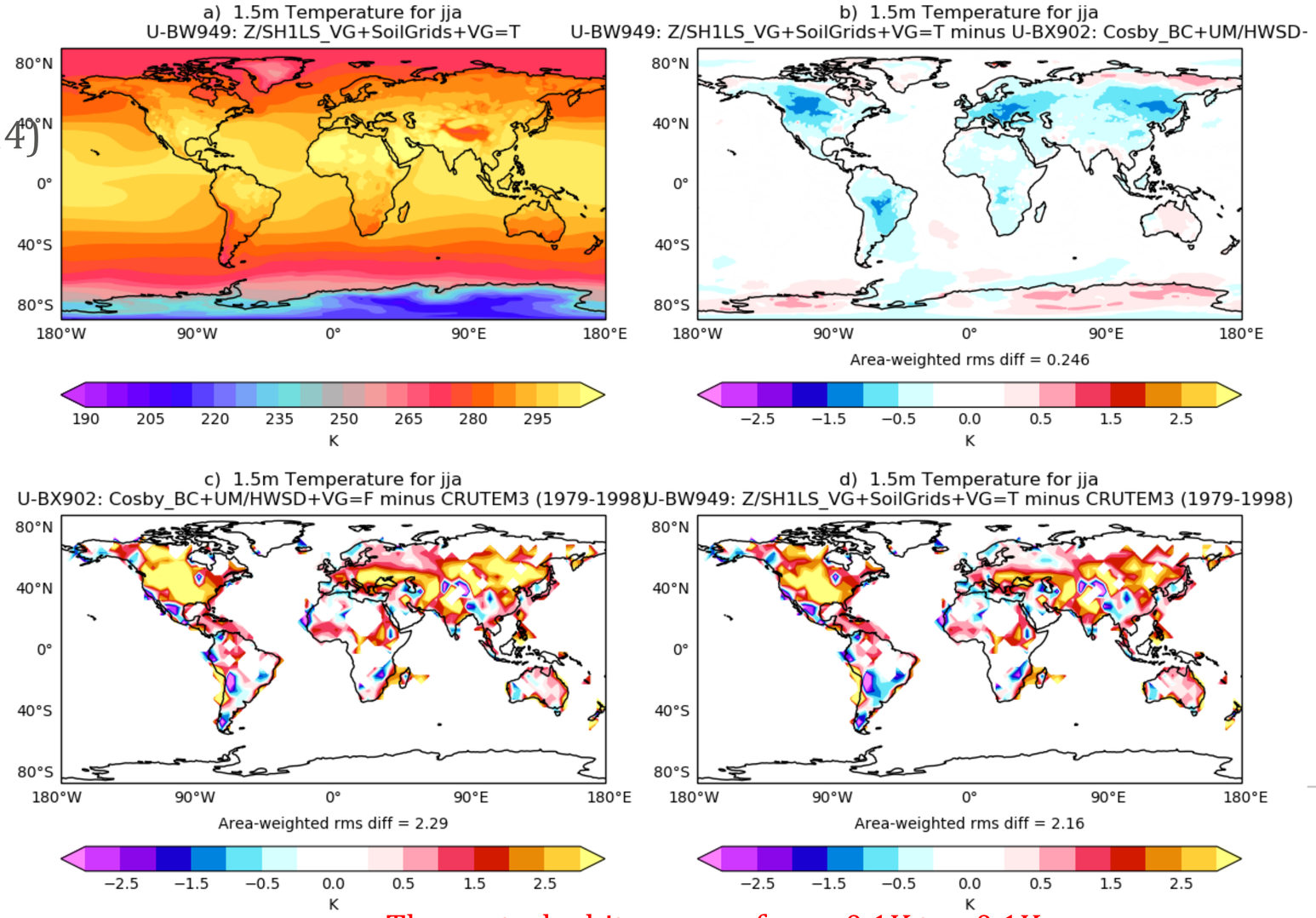
Excerpted from Patrick McGuire et al.'s talk at the annual JULES meeting (2022), entitled "AMIP-style global soil simulations with JULES and the Unified Model: The role of soil hydraulics model, pedotransfer function, and basic soil property map"

Both control & experiment
used the same standard start-dump,
without extra spinup.
These 35-year continuation runs (1979-2014)
used prior 1989-2008 runs as spinups.
Both control & experiment used
same constant-in-time&space
atmospheric CO2 (348.5ppm = 1988 level)

Control =
CosbyEtAl. BC PTF
UM/HWSD (0.0-0.3m) soil mineral maps
JULES flag: l_vg_soil = FALSE

Experiment =
Zhang&Schaap H1 LS ROSETTA3 VG PTF
SoilGrids (0.6m) soil mineral maps
JULES flag: l_vg_soil = TRUE

Much of the model<->model variance is due to l_vg_soil, but some is due to choice of PTF and mineral maps.



preliminary

The central white ranges from -0.1K to +0.1K

Publications

Buechel, M., Slater, L. & Dadson, S. **Hydrological impact of widespread afforestation in Great Britain using a large ensemble of modelled scenarios**. Commun Earth Environ 3, 6 (2022). https://doi.org/10.1038/s43247-021-00334-0

Hsi-Kai Chou, Boris F. Ochoa-Tocachi, Simon Moulds & Wouter Buytaert (2022) **Parameterizing the JULES land surface model for different land covers in the tropical Andes**, Hydrological Sciences Journal, DOI: 10.1080/02626667.2022.2094709

Parker, R. J., Wilson, C., Comyn-Platt, E., Hayman, G., Marthews, T. R., Bloom, A. A., Lunt, M. F., Gedney, N., Dadson, S. J., McNorton, J., Humpage, N., Boesch, H., Chipperfield, M. P., Palmer, P. I., and Yamazaki, D.: **Evaluation of Wetland CH4 in the JULES Land Surface Model Using Satellite Observations**, Biogeosciences Discuss. [preprint], https://doi.org/10.5194/bg-2022-2, in review, 2022.