Implementation of the FLake lake model in the Joint UK Land Environment Simulator (JULES)

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JULES and the Unified Model

- The Met Office Unified Model (UM) is used for both climate and NWP.
- The land surface in the UM is modelled by the Met Office Surface Exchange Scheme, MOSES (e.g. HCTN 30, or Rooney & Claxton, QJRMetS 2006)
- A stand-alone version of MOSES was produced at UM Version 5.5.
- This led to the release of the academic community resource JULES, **http://www.jchmr.org/jules/**

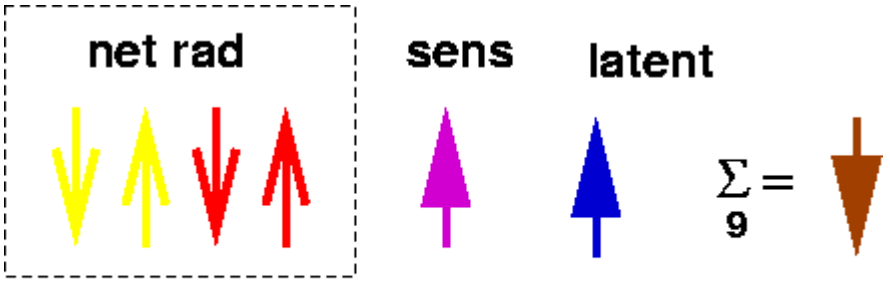
Overview of JULES

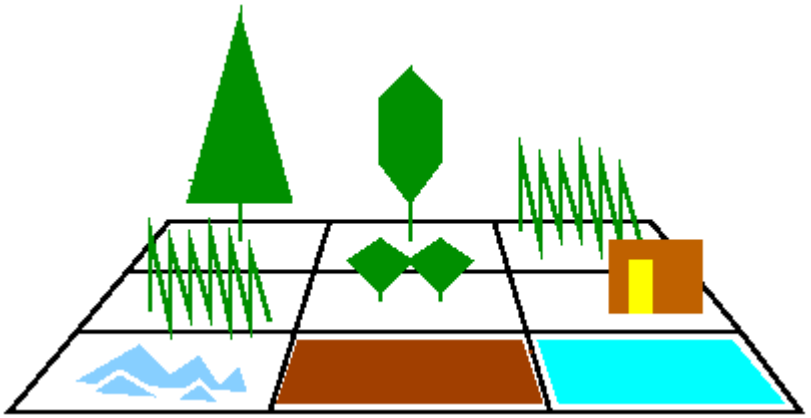
9 tiles, 5 veg + 4 non-veg

Forced with observables:
T, P, q, DWSW, DWLW,
windspeed, rain, snow

Yields:
surface (canopy) T,
sensible + latent heat fluxes,
soil temperature and moisture

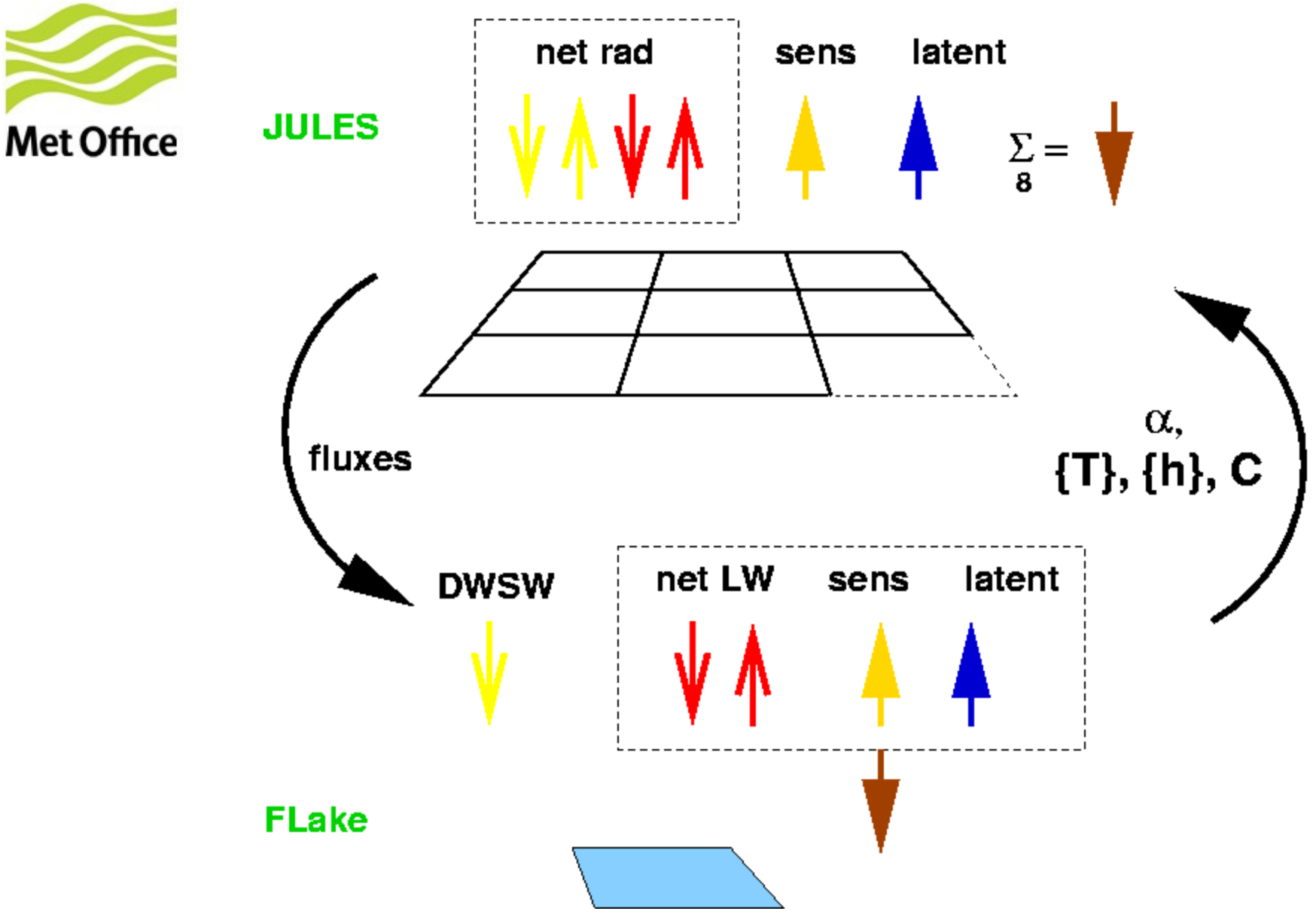
`Lake' tile is more like
a bog (soggy soil).





Interfacing Flake with JULES

- JULES already calculates surface fluxes, so the SfcFlx part of FLake is not used.
- The lake part of FLake replaces the lake tile.
- The forcings passed to FLake are DWSW, the sum of all other heat fluxes and the momentum flux.
- Also passed are the timestep, Coriolis parameter, lake depth.
- JULES stores FLake outputs between timesteps.



Fixes and adaptations (1)

Presently, JULES does not use the lake surface temperature as diagnosed by FLake.

Instead, the subsurface temperature is used in a diffusive calculation, with the (liquid) thermal conductivity increased by an effective Nusselt number, currently with a fixed value of Nu=100.

Fixes and adaptations (2)

The JULES snow scheme is used as on all other tiles.

JULES limits the surface temperature to 0C in the presence of a snow layer, however no such limit applies to snow-free `ground'. Thus a further limiting of the lake surface temperature is applied if an ice layer exists.

A check is applied such that snow cannot accumulate without the presence of an ice layer.

JULES / Flake comparisons

Since the I/O of the two models is similar, it is straightforward to compare model performance between JULES, FLake and J/F.

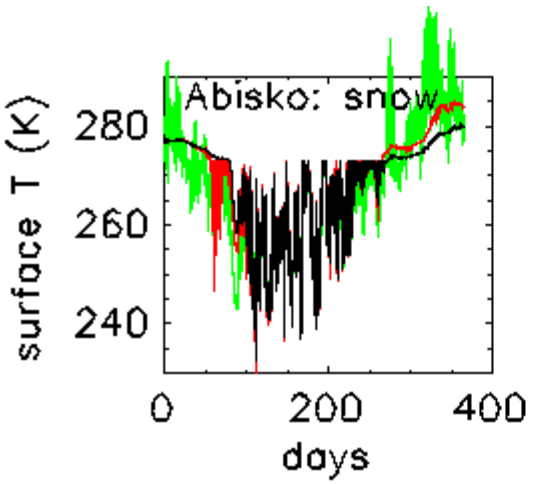
Year-long forcing, 30-minute resolution, from two sites:

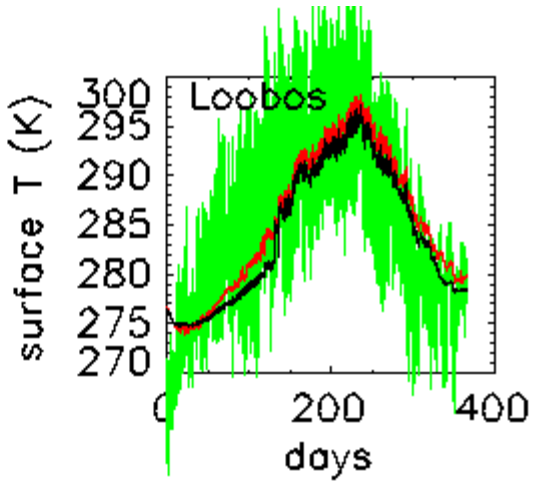
Loobos (Netherlands)
Example forcing provided with JULES, begins in January.

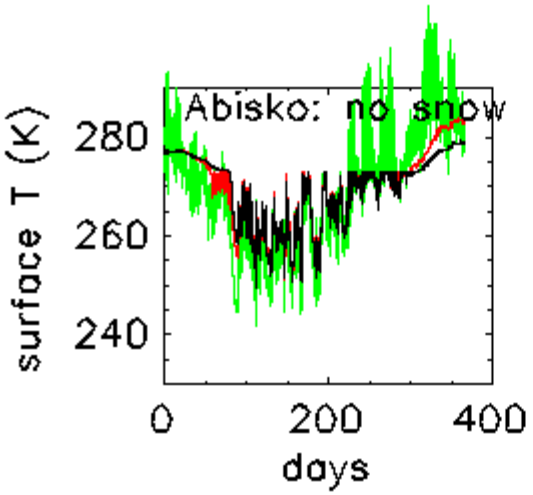
Abisko (Sweden)
Cold-region dataset (snowfall OFF or ON), begins in August.

Running with lake fraction =1.

Surface temperature

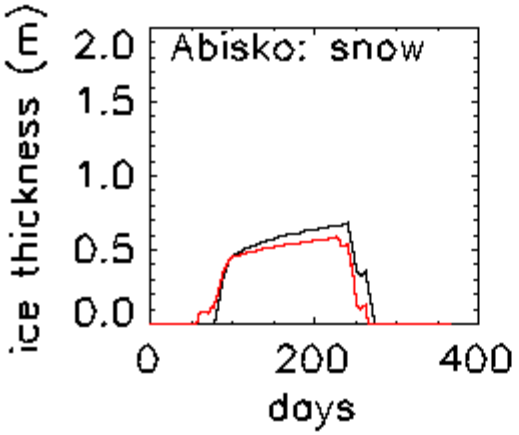


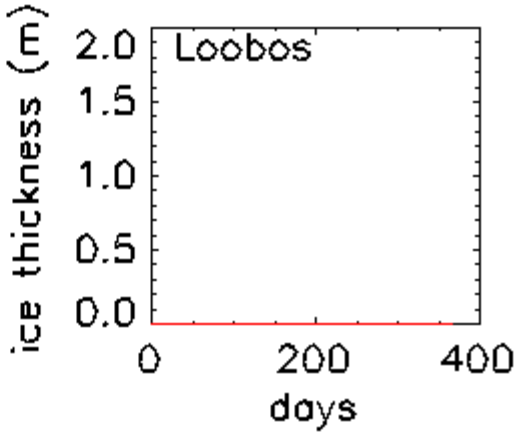


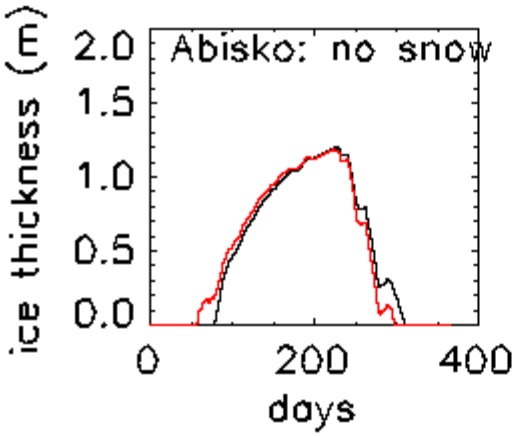


JULES+FLake
FLake
JULES

Ice thickness

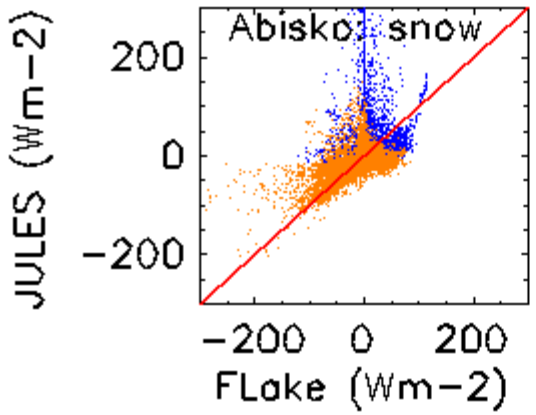


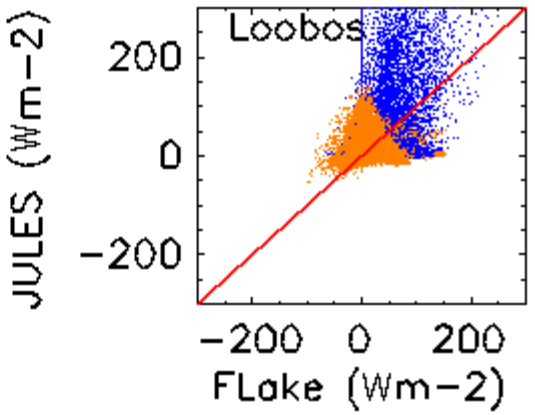


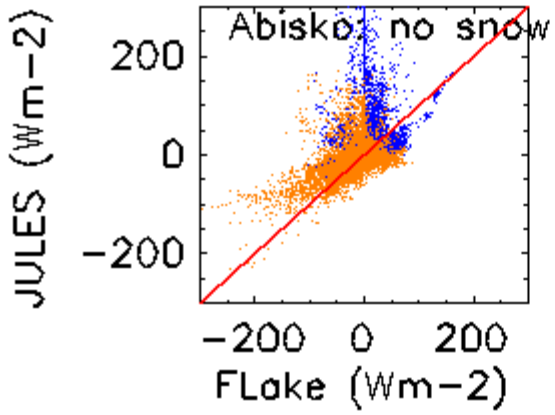


JULES+FLake
FLake

heat fluxes: unmodified JULES

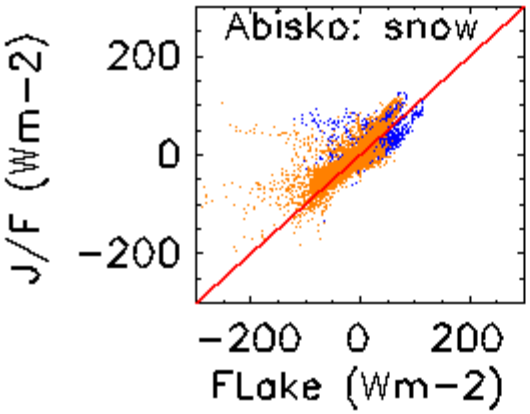


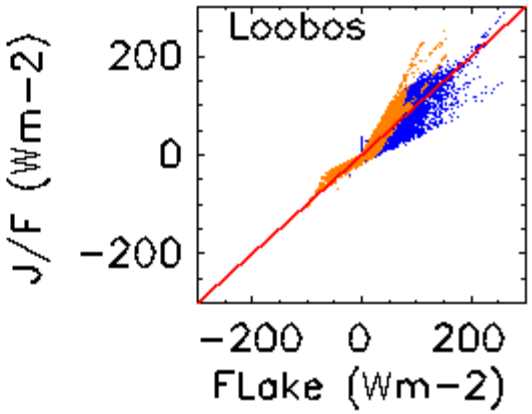


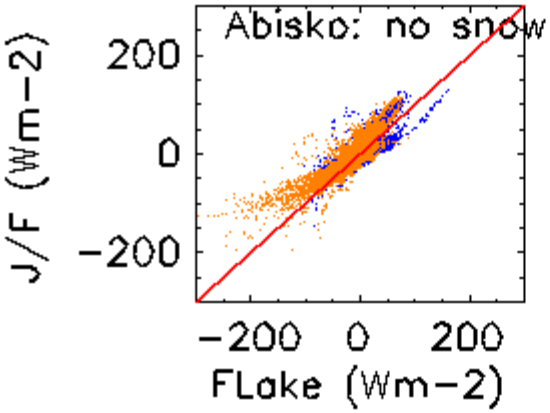


SENSIBLE
LATENT

heat fluxes: JULES/FLake

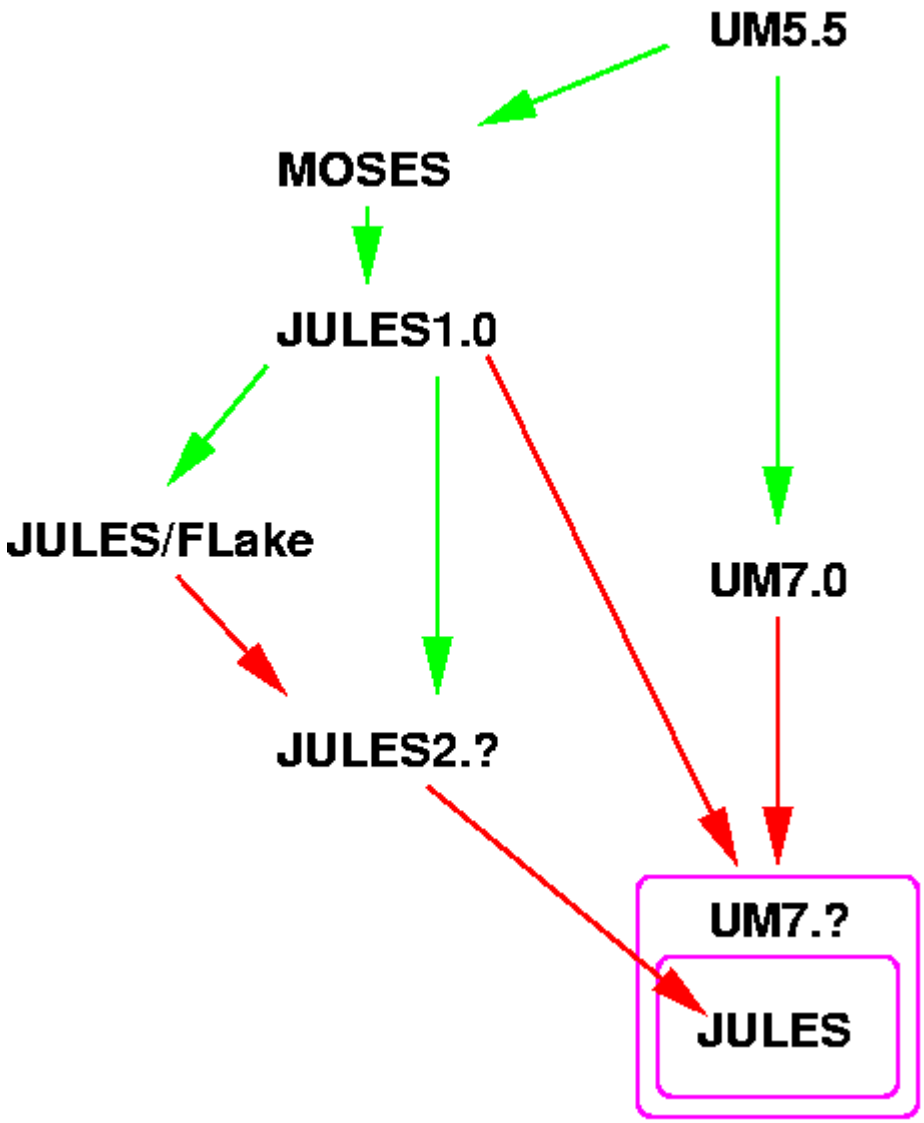






SENSIBLE
LATENT

Future plans



DONE

PLANNED

FLake in the UM

- ancillary data: lake database
- lakes covering more than one gridbox
- initialisation, data assimilation
- satellite lake products

(A)ATSR Lake Temperatures (1)

- (Advanced) Along-Track Radiometer
  - Space-borne instrument designed to observed ‘skin’ surface temperatures
- Spatial Resolution: ~1 km (global)
- Temporal Resolution: 1-3 days
- Lake surface temperatures included in operational Land Surface Temperature (LST) product
  - Available for ~1991 to present.
  - Accuracy ~0.5 K or better

(A)ATSR Lake Temperatures (2)

- Some issues:
  - Not all lakes processed correctly – to be rectified.
- Plans in pipeline to produce, consistent, high-accuracy, high-quality lake-surface temperature data set (>17 years)
- Reference:
  - Hook SJ et al., 2003, 'Retrieval of lake bulk and skin temperatures using Along-Track Scanning Radiometer (ATSR-2) data: A case study using Lake Tahoe, California', Journal of Atmospheric And Oceanic Technology Volume: 20, Issue: 4, Pages: 534-548

Operational info/data:

http://www.neodc.rl.ac.uk/ (select (A)ATSR multi mission)

http://envisat.esa.int/handbooks/aatsr/

Conclusion

FLake improves JULES…

…and will hopefully go on to improve the UM very soon!