Release of the first standard configurations for standalone JULES

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+ JULES Community input

JULES Annual Science meeting

15th - 16th September 2022

This work was presented by Doug Kelley

What is a configuration?

- A collection of settings, switches and parameter values used to define the scientific set up of the model

- A configuration is not:
  - ➢ Driving data
  - ➢ The resolution
  - ➢ The ancillary files (but the method to generate them is)
  - ➢ Application specific

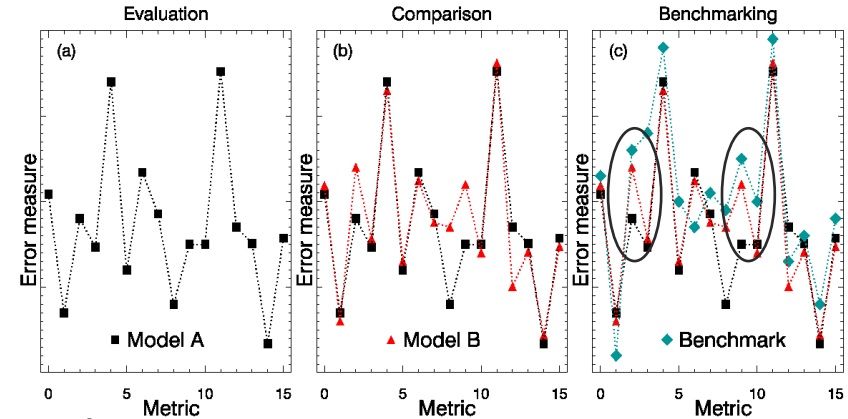 These are all part of the experiment but not the configuration

Aim: To create **standard configurations** that give the **best simulation** of the **physical and earth system environments**, demonstrated through **predefined benchmarks.**

What is benchmarking?

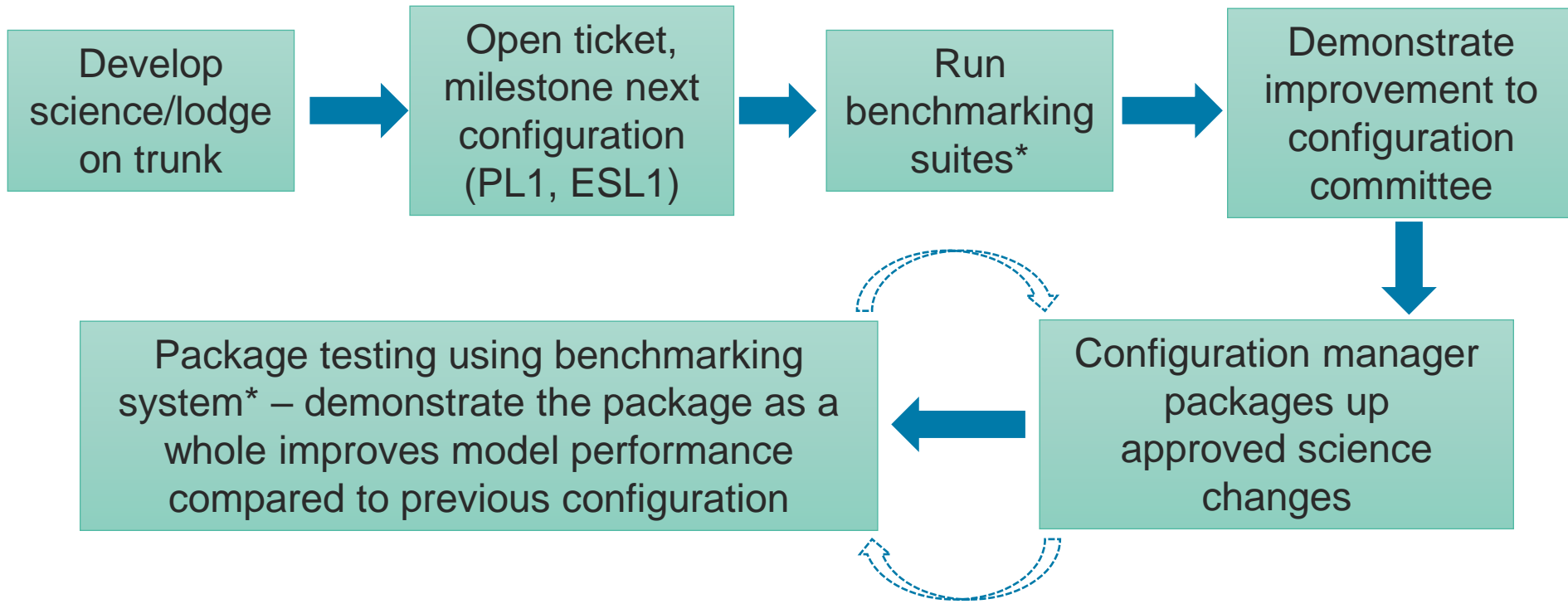★ Model outputs are compared to a predefined benchmark.

3 types of benchmark:

1. Is it better than another model? ⟵ e.g. previous model configuration

2. Is it fit for a particular application?

3. Can it effectively utilise available information?

Is the new JULES configuration better the previous model configuration? e.g. Does adding X piece of new science code improve JULES compared to the previous configuration?

Configurations for JULES

- **Global Atmosphere Land** (GAL), **Regional Atmosphere Land** (RAL) and **UKESM** are all configurations used for the **coupled** JULES-UM system.

- **GAL/RAL** - Underpins the weather and climate models, globally applicable, should be the best configuration for simulating exchange of heat, water and momentum.

- **UKESM** - Builds on GAL to include interactive carbon, nitrogen and methane cycles, land-use and cover change. The best configuration for understanding carbon cycle and ecosystem processes

- **Standalone JULES** requires configurations for:
  - Physical Land
  - Earth System Land

Development Process for standalone configurations

Develop science/lodge on trunk → Open ticket, milestone next configuration (PL1, ESL1) → Run benchmarking suites* → Demonstrate improvement to configuration committee

Package testing using benchmarking system* – demonstrate the package as a whole improves model performance compared to previous configuration ← Configuration manager packages up approved science changes

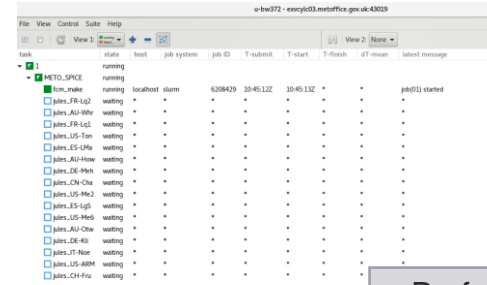*Benchmarking is an important part of this process!!

1. PLUMBER2 Benchmarking Suite Process

PLUMBER2 data
170 sites from
FLUXNET2015,
FLUXNET La Thuile
& OzFlux
+
canopy height, LAI
reference height &
IGBP vegetation
+
HWSD soils

Python script →
convert jules input
variables into json file

Rose suite
Run JULES for all
sites in json file

Calculate output
metrics*:
JULES vs. Obs for
every site, for LWup,
LE, H, Rnet, GPP &
Ustar, for each
configuration

Configuration/
benchmark are
ranked for each
metric, var, site

```
{
    "AR-SLu": {
        "data_start": "2010-01-01 00:00:00",
        "data_end": "2011-01-01 00:00:00",
        "data_period": 1800,
        "drive_file": "/data/users/hashton/PLUMBER2/met_f
        "latitude": -33.4648,
        "longitude": -66.4598,
        "spinup_start": "2010-01-01 00:00:00",
        "spinup_end": "2011-01-01 00:00:00",
        "main_run_start": "2010-01-01 00:00:00",
        "main_run_end": "2011-01-01 00:00:00",
        "timestep_len": 1800,
        "z1_tq_in": 11.0,
        "z1_uv_in": 11.0
    },
```

Perform the
average
ranking of
metrics for
every site and
variable

Plot output and
document ticket
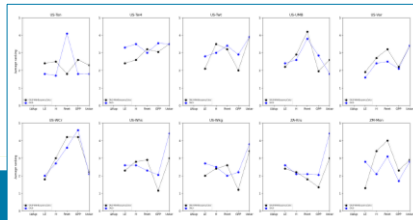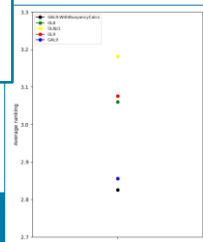
Benchmark configurations:
Standalone versions of
GL8, GL8.1, GL9 & GAL9

* Metrics: RMSE, MBE, NME,
StdDevdiff, Correlation, 5thdiff, 95thdiff,
PDFoverlap, Skewness, kurtosis

2. Benchmarking using ILAMB

ILAMB - International Land Model Benchmarking project software package

Will be used to benchmark gridded data to include carbon cycle, hydrology and surface fluxes.

JULES-ES historical land only standalone experiment driven with GSWP3

⬇

Output processed through ILAMB suite

⬇

Gridded metrics (bias, RMSE, max month), global scores (Mean bias/RMSE, global mean seasonal cycle) and results summary.
Benchmark: JULES-ES-1.0

Example results summary
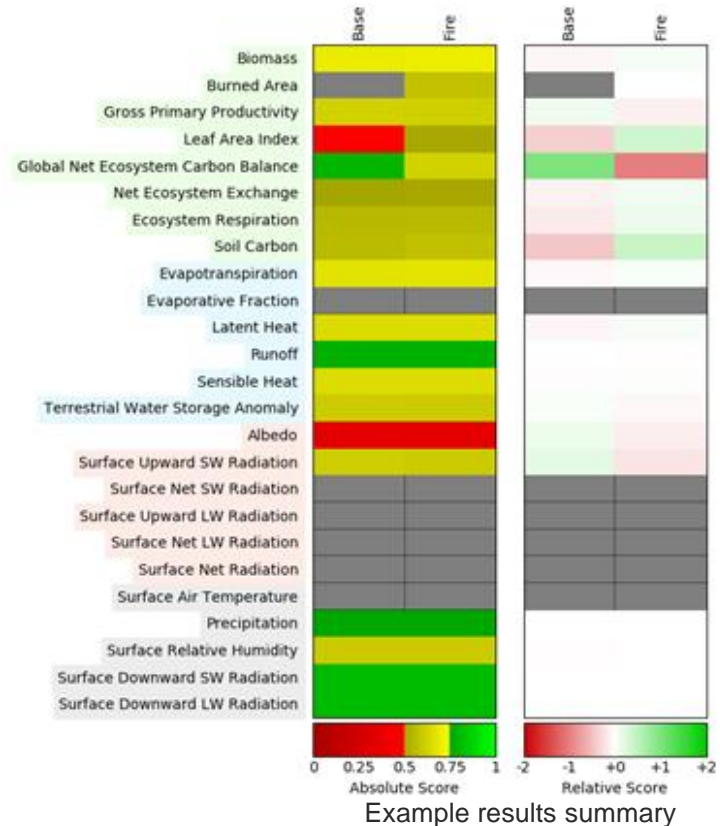
Land Model Evaluation & Development Trac Pages

https://code.metoffice.gov.uk/trac/lmed

Land Model Evaluation and Development

Search

wiki: WikiStart

Welcome to the Land Model Evaluation and Development Page

The aim of the LMED group is to track, record and document the evaluation, benchmarking and development of the standalone JULES configuration cycle for the Physical Land (PL) and Earth System Land (ESL) configurations.

Configuration Release Cycle

Version	Milestone	Release Date	Documentation
1	In review	Sept 2022	Evaluation Meeting Outcomes ⇒PL1 ⇒ESL1
2	...	May 2024	

Standard Tests for new JULES Configurations ⇒here

Timeline for configuration development

1. Module leaders to put forward components for next configuration through tickets.
2. Benchmark testing for individual tickets
3. Evaluation committee to meet to discuss package tests and decide on which tickets should be included for the recommended configurations
4. Package testing and followup of actions from evaluation committee meeting
5. Recommended configurations packaged together and presented to the JLMP for consideration 6. Prepare for the official release at JULES annual meeting
6. Standard suites distributed and paper submitted

Previous discussions with JLMP and science module leaders (meeting notes from 14th Oct 2021) ⇒here

Guidelines for accepting contributions to standalone JULES configurations

- For changes to be considered for a configuration, you will need to have an open ticket on the LMED trac page with results attached and the owner of the science area should make a case for its inclusion.

- The change must be mature enough that it is or will be shortly be committed to the latest JULES trunk. Therefore the code must have passed Sci Tech review and be accepted for the next version of JULES.

- Ideally, the code should also be tested in the standalone GAL9 configuration and results documented on the ticket.

- The change must be shown not only to lead to the desired impact of the change itself but also lead to neutral or positive changes when run through the benchmarking suite (and ILAMB).

- As this is the first configuration the configuration manager will run each set of configuration changes through the benchmarking suite and report the results on the ticket. In the future, this will be the responsibility of the ticket owner.

- If the metrics supplied in the PLUMBER2 suite or ILAMB do not benchmark your science sufficiently, then a test should be supplied to demonstrate this (this might be something which the user could implement as a metric for future configuration benchmarking). However, the PLUMBER2 and ILAMB benchmarking tests still need to be done to ensure changes do not have a detrimental impact on the fundamental fields.

- Changes being put forward and meeting the above requirements will be included in package testing. In the event that a particular change is subsequently found to have issues when packaged with other changes, a recommendation on the way forward will be put to JLMP for consideration, but JLMP will always have final sign-off on which changes are included.

Physical Land: Accepted Tickets

[#1](#) Switch soilhc_method to 3 – Eleanor Burke

[#2](#) Increase vegetation canopy water capacities – Adrian Lock

[#3](#) Switch on FLake – Helen Johnson

[#4](#) Upgrade urban scheme – Maggie Hendry

[#5](#) Fix for small snow amounts – Martin Best

[#6](#) Allow interactive buoyancy in Monin-Obukhov calculations – Martin Best

[#7](#) Set optimal tile roughness lengths – Martin Best

[#8](#) Increase in the number of plant functional types to 13 (17 tiles) – John Edwards

[#10](#) Select optimal parameters for the surface albedo – John Edwards

Physical Land Package: PLUMBER2 benchmarking output
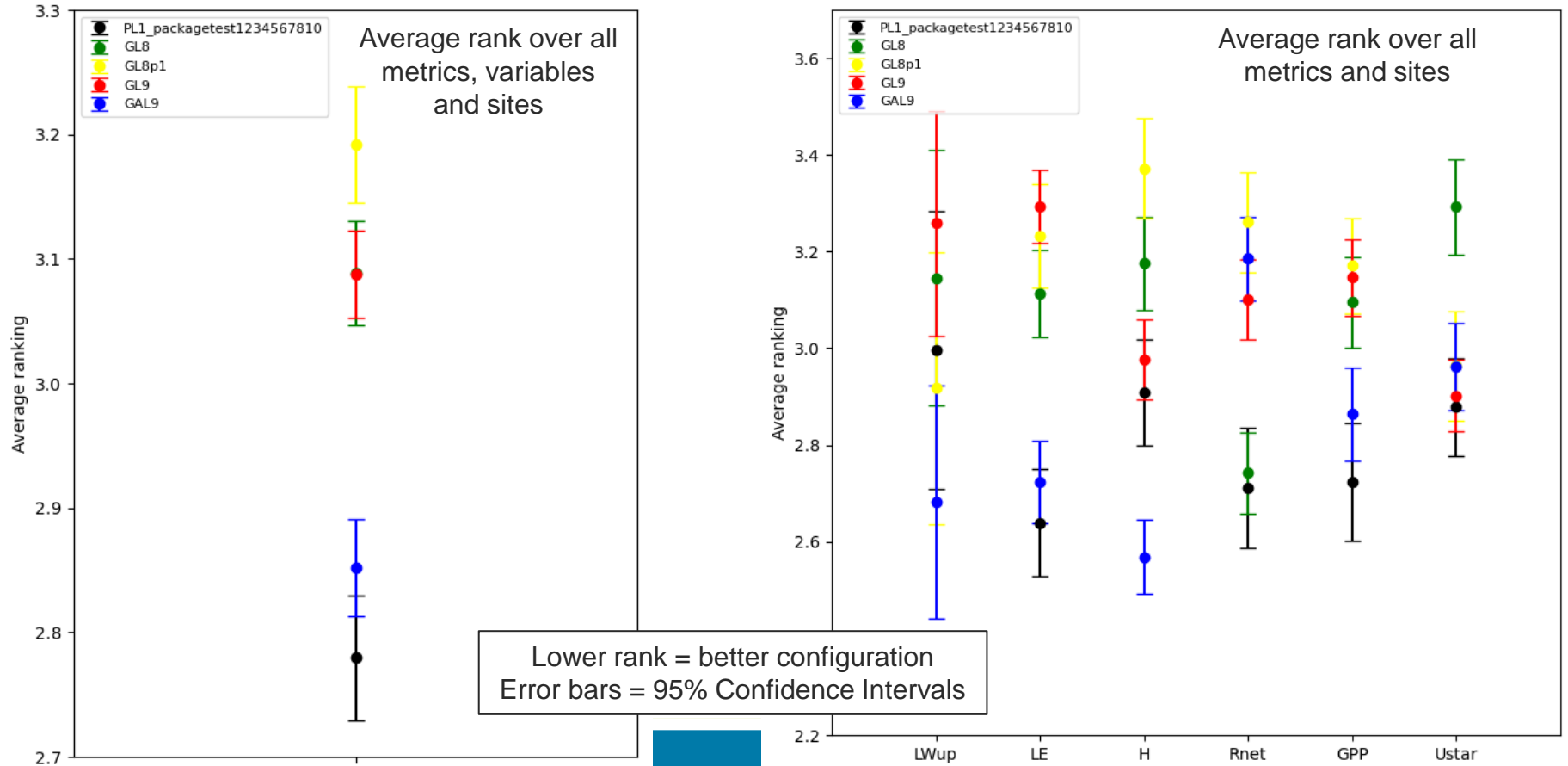
Earth System Land: Accepted Tickets

[#1](#) Switch soilhc_method to 3 – Eleanor Burke

[#2](#) Increase vegetation canopy water capacities – Adrian Lock

[#5](#) Fix for small snow amounts – Martin Best

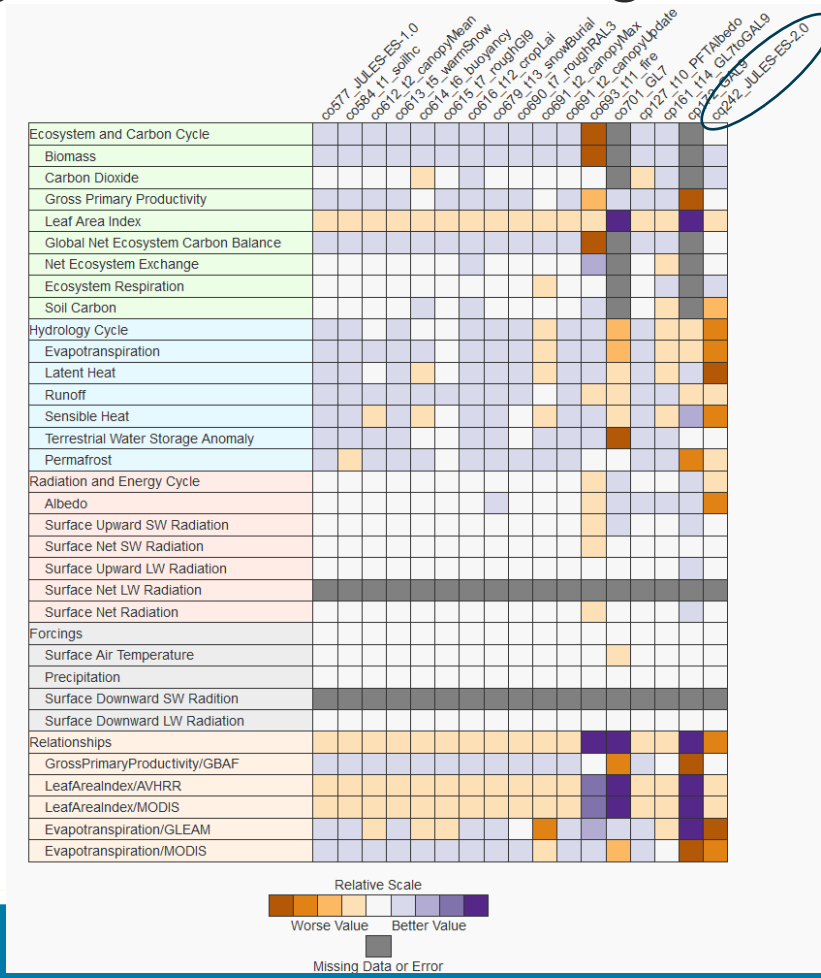[#6](#) Allow interactive buoyancy in Monin-Obukhov calculations – Martin Best

[#7](#) Set optimal tile roughness lengths – Martin Best

[#10](#) Select optimal parameters for the surface albedo – John Edwards

[#13](#) Reduce impact of snow cover on grassland albedo – Eddy Robertson

[#14](#) Provision of an ESM configuration based on GAL9 – John Edwards

Earth System Land Package: ILAMB output

Future outcomes

- Configurations are now "chilled" pending final package tests
- Require official sign off by the JLMP

- Official release naming:
    - Earth System: **JULES-ES-2.0**
    - Physical Land: **PL2**

- Anticipate future pull through of new science to JULES-ES-X.0 from ISIMIP
- Plus new science to be used by future configurations of TRENDY/UKESM/GAL.

- Standard Rose suites will be made available on Jasmin and Met Office SPICE in due course

- Publication of configuration papers for JULES-ES-2.0 and PL2

- **Next call** for contributions to standalone JULES configurations JULES-ES-3.0 and PL3: **Autumn 2023**

Thank you for listening