Adding Water Tracers and Isotopes to JULES

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- This work is part of the EU Tipping Points in the Earth System (TiPES) project developing an isotope enabled version of the UK Earth System Model (UKESM2).
- There is a corresponding ongoing development in the UM alongside our work on JULES.

Why?

- Stable water isotopes – to allow comparison between model and observations (both present day and past climates)
- Water tracers – to understand the model hydrological cycle and to infer information about the history of water while it passes through the hydrological cycle

Impact on the JULES model?

- Water tracers and isotopes are passive tracers with no impact on the model physics or dynamics.

Progress

- Basic water tracer code for JULES model is almost completed and will be submitted for review soon.

Next step

- Add isotopic processes to the model

University of BRISTOL

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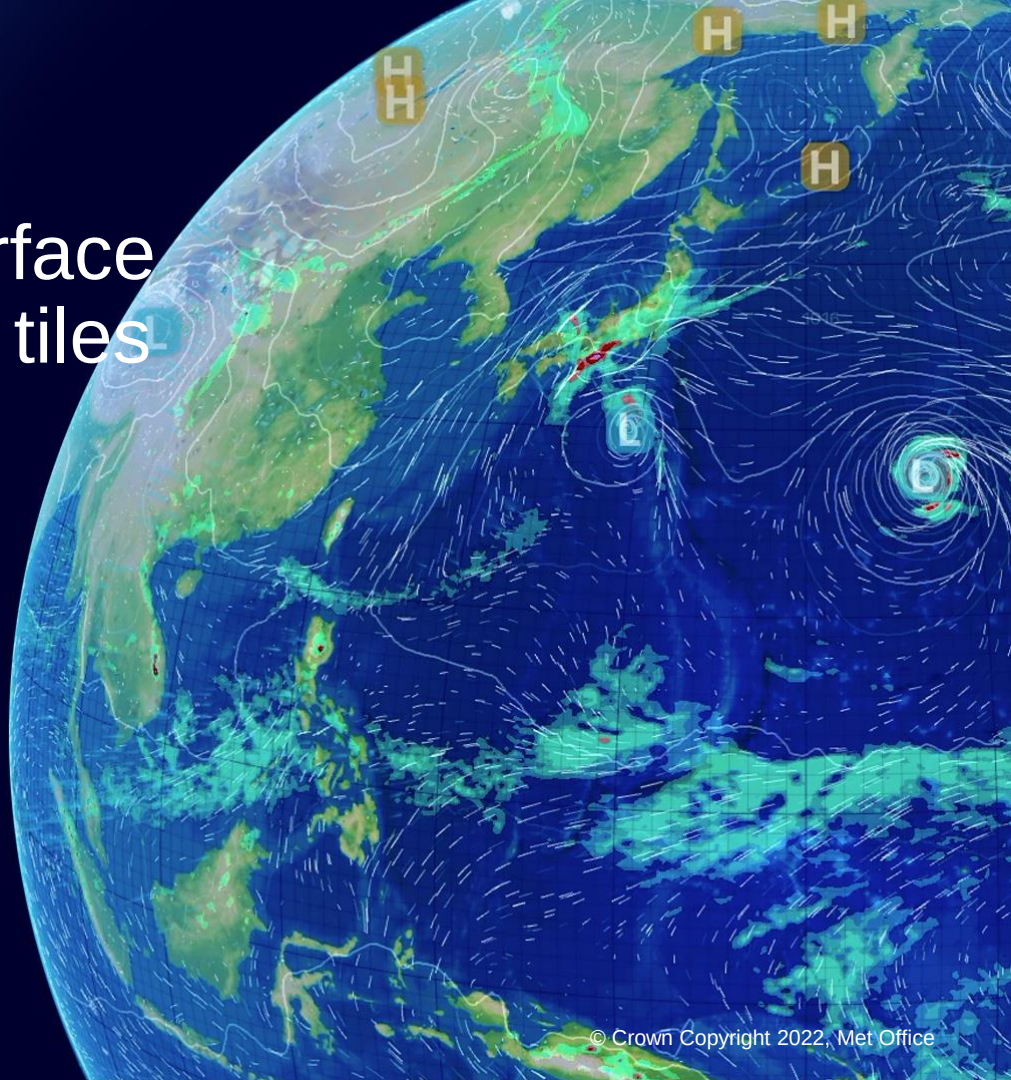
TiPES

https://www.tipes.dk/

Developments in the Surface Module: Albedos and 17 tiles

John Edwards



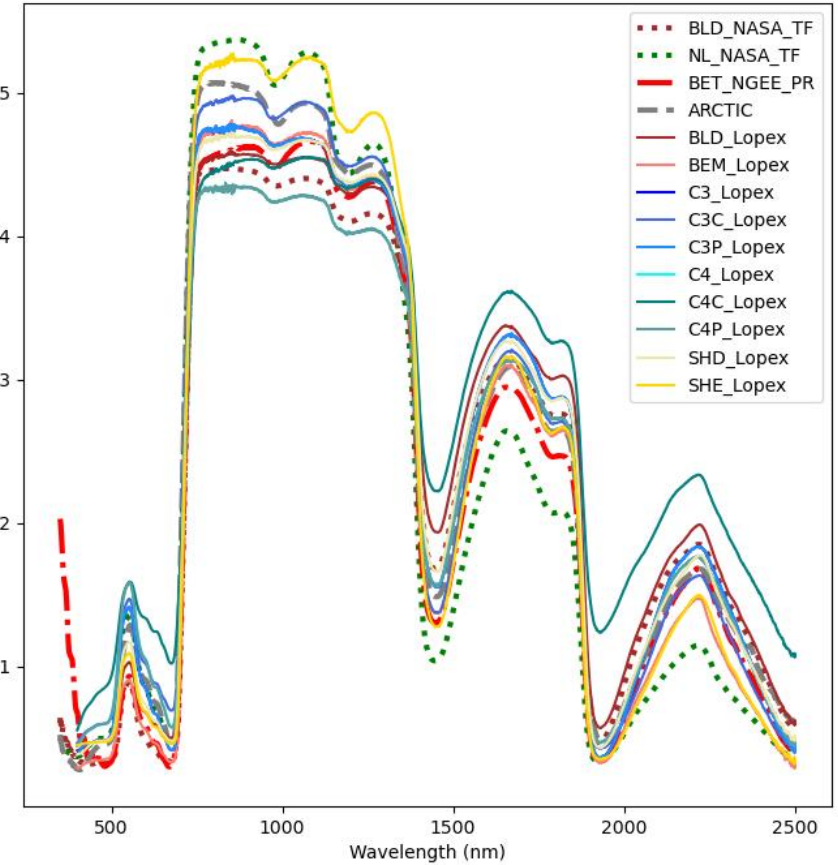
Background

- Standard configuration of JULES has 5 PFTs and 4 non-vegetated tiles
  - PFTs: Broad-leaved trees, Needle-leaved trees, C3 grass, C4 grass, shrubs
- Current ESM configuration has 13 PFTs + 4 non-vegetated tiles
  - PFTs:
    - Deciduous broad-leaved trees, Tropical evergreen broad-leaved trees, Temperate evergreen broad-leaved trees
    - Deciduous needle-leaved trees, Evergreen needle-leaved trees
    - C3 grass, C3 crop, C3 pasture
    - C4 grass, C4 crop, C4 pasture
    - Deciduous shrubs, Evergreen Shrubs

- Does the addition of the extra PFTs from the ESM configuration allow us to improve the physical model?
  - We need to set appropriate parameter values
- See Heather’s talk on PL1 and ESL1 for overall performance: here we discuss only the albedos for 13 PFTs / 17 tiles

Albedos

- Albedos on the original 5 PFTs were revised for GAL9
- PL1 allows us to move further towards traceable albedo parameters based on recent spectral data
  - Likely that further development will take place on the medium term
- Data are taken from https://ecosis.org/
  - Many reflectance spectra, but few transmittance spectra – we need both
  - Most data taken from Lopex93
  - Data for broad-leaved tropical evergreen trees taken from NGEE Tropics GLiHT Puerto Rico Campaign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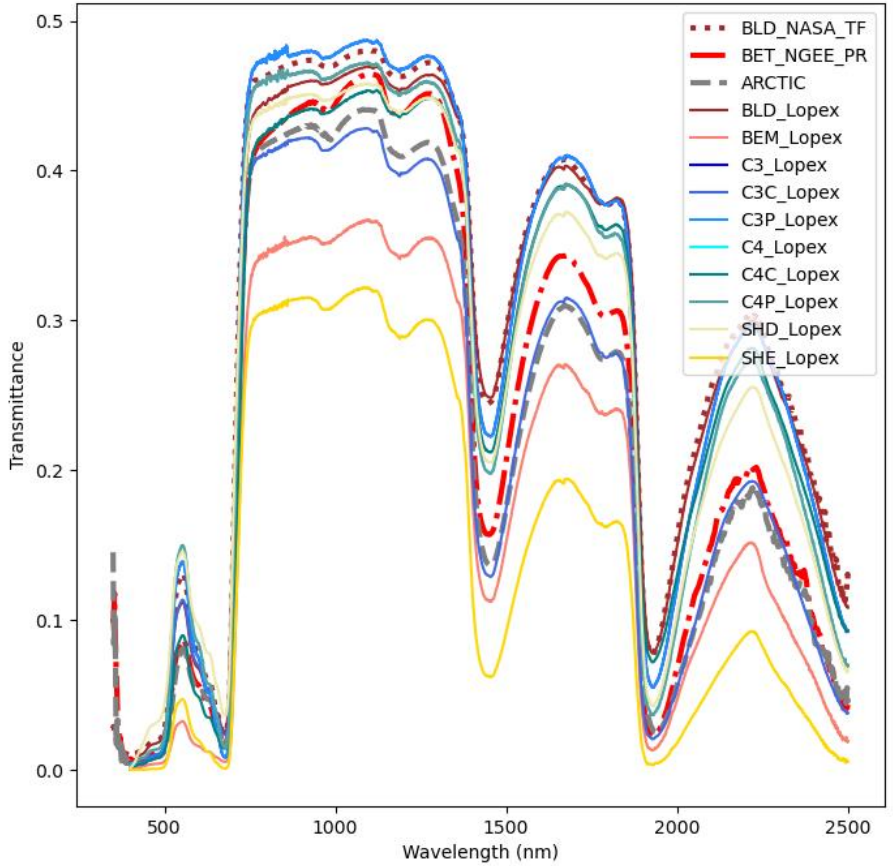
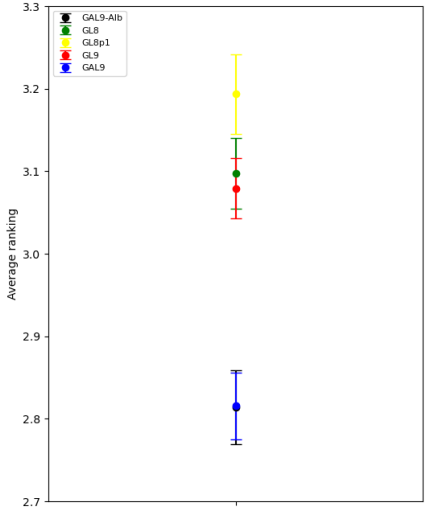
NL_NASA_TF
BET_NGEE_PR
ARCTIC
BLD_Lopex
BEM_Lopex
C3_Lopex
C3C_Lopex
C3P_Lopex
C4_Lopex
C4C_Lopex
C4P_Lopex
SHD_Lopex
SHE_Lopex
500
1000
1500
2000
2500
Wavelength (nm)

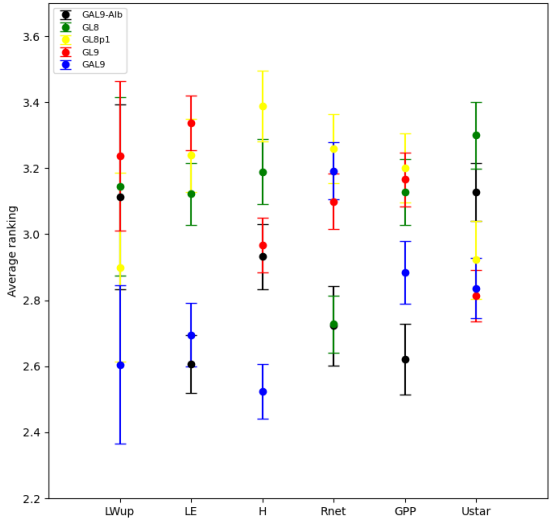

BLD_NASA_TF
BET_NGEE_PR
ARCTIC
BLD_Lopex
BEM_Lopex
C3_Lopex
C3C_Lopex
C3P_Lopex
C4_Lopex
C4C_Lopex
C4P_Lopex
SHD_Lopex
SHE_Lopex
Transmittance
0.0
0.1
0.2
0.3
0.4
0.5
500
1000
1500
2000
2500
Wavelength (nm)

Related Points

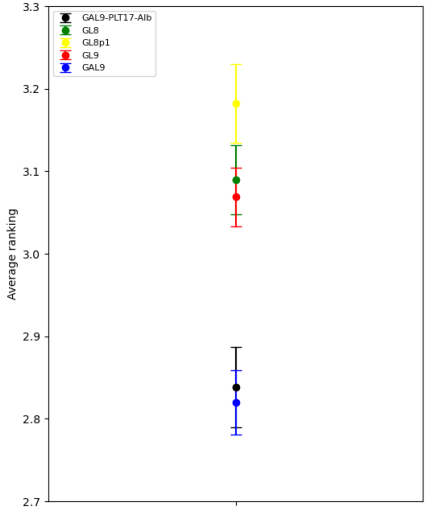
- We need to disaggregate the downward SW between direct and diffuse radiation, as well as between the VIS and NIR
- Historically in standalone JULES we have taken all downward SW as diffuse, but a large amount is direct
- A better partitioning can be implemented by setting **wght_alb = 0.3,0.2,0.34,0.16** instead of **wght_alb = 0.0, 0.5, 0.0, 0.5**
- Now that we have an explicit direct albedo, it matters whether the forcing data are in UTC or LST

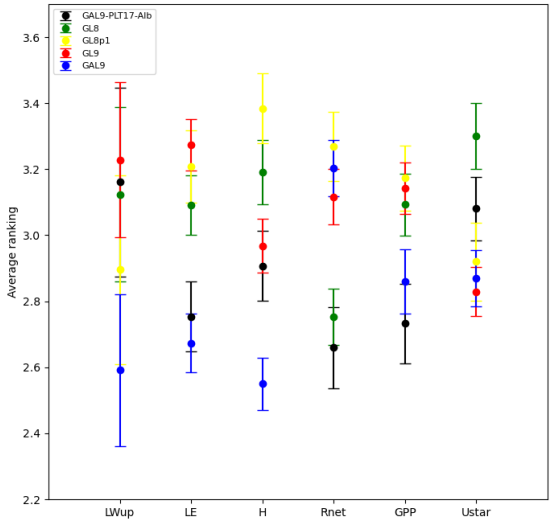
Benchmarking Results – 9 tiles





Benchmarking Results – 17 tiles physical





Code Changes and Fixes

- https://code.metoffice.gov.uk/trac/jules/ticket/1242: Interactive buoyancy in surface exchange to remove oscillation between stable and unstable surface stratification – removes isolated hotspots in the forecast model
- https://code.metoffice.gov.uk/trac/jules/ticket/1092: Reorder the numerics of infiltration into the snowpack to avoid last-digit rounding leading to negative ground infiltration and possible subsequent crashes
- https://code.metoffice.gov.uk/trac/jules/ticket/1279: Remove persistent small snow amounts