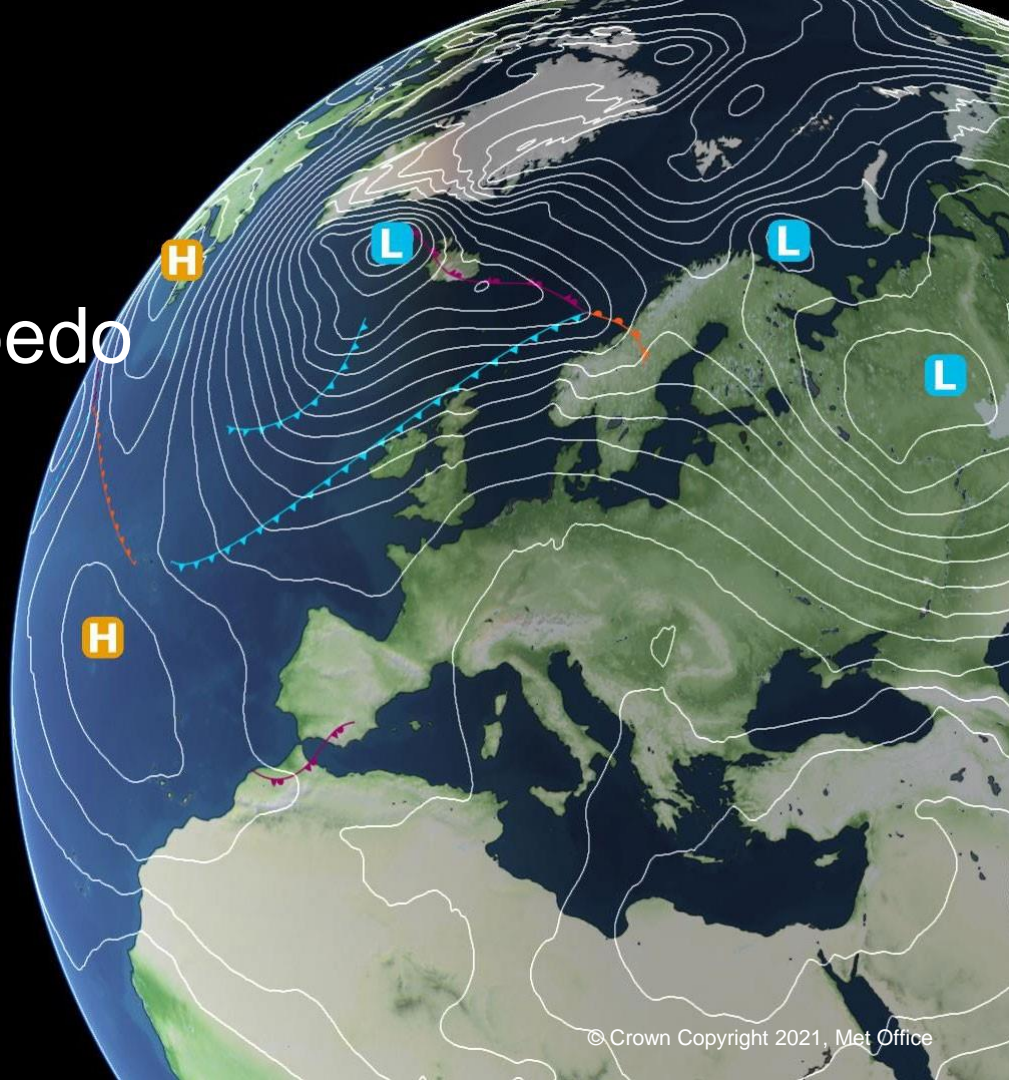# JULES Surface Module: Revising the Surface Albedo
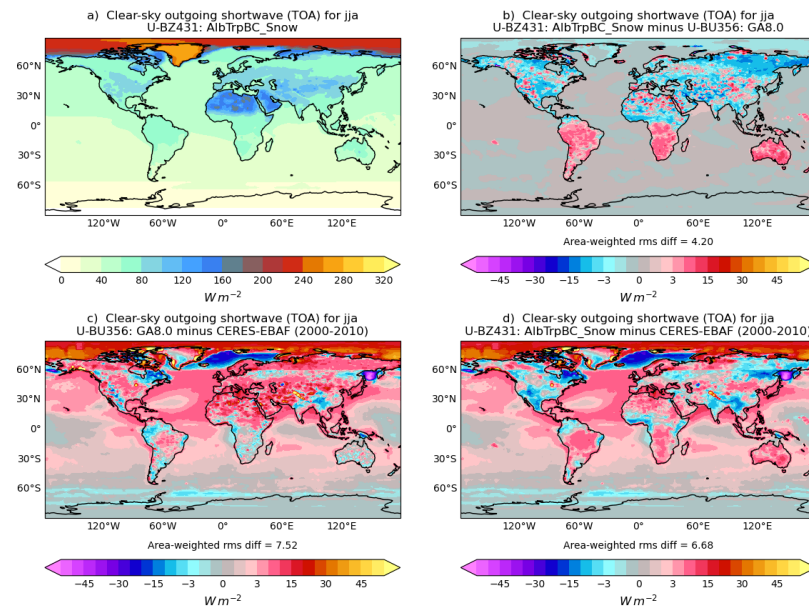
John Edwards

- Albedo of vegetation currently calculated using the scheme and spectral parameters of Sellars (1986)
  - In global configurations coupled to the UM the albedo is adjusted by a scaling towards the GlobAlbedo climatology to reduce the continental warm bias. (NB. **Not** done in standalone configurations.)

- Some issues:
  - The scaling to climatology is inappropriate in earth system modelling with changing vegetation
  - The equations in Sellars (1986) are for the special case of isotropic leaf-scattering, so we currently discard the direct albedo
  - The spectral parameters do not accord with more recent data
  - Spectral and zenith-angle dependence of bare soil albedo not included

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- For GAL9 and future ESM work we need to turn off the scaling to climatology and revise the albedo to maintain acceptable NWP performance.

- Changes for global configurations documented on https://code.metoffice.gov.uk/trac/gmed/ticket/527
  - Turn off scaling to climatology (l_albedo_obs -> .F.)
  - Introduce a scheme to disaggregate the albedo of bare soil between the VIS and NIR and impose a zenith angle dependence (darker when sun is higher in the sky). Code introduced into JULES 5.9 under https://code.metoffice.gov.uk/trac/jules/ticket/1020 (l_hapke_soil -> .T., l_partition_albsoil -> .T.)
  - Turn on non-isotropic scattering of sunlight by vegetation and use direct albedo. Code available since 4.6 and described on https://code.metoffice.gov.uk/trac/jules/ticket/257 (l_niso_direct -> .T., l_spec_alb_bs -> .F.)
  - Revise leaf-level optical properties of vegetation. Mainly based on Lopex93, with species chosen to give a good match to GlobAlbedo

Change in Clear-sky reflected SW in JJA

- Overall continents darkened in summer and brightened in winter
  - Motivates additional change to soil stress function to increase transpiration
- Further scope for improvement, especially to tropical trees, perhaps with more PFTs

a) Clear-sky outgoing shortwave (TOA) for jja
U-BZ431: AlbTrpBC_Snow

b) Clear-sky outgoing shortwave (TOA) for jja
U-BZ431: AlbTrpBC_Snow minus U-BU356: GA8.0
Area-weighted rms diff = 4.20

c) Clear-sky outgoing shortwave (TOA) for jja
U-BU356: GA8.0 minus CERES-EBAF (2000-2010)
Area-weighted rms diff = 7.52

d) Clear-sky outgoing shortwave (TOA) for jja
U-BZ431: AlbTrpBC_Snow minus CERES-EBAF (2000-2010)
Area-weighted rms diff = 6.68

• GPP is also improved over GA8.0 by full set of changes

a) Gross Primary Productivity for ann
U-BZ431: AlbTrpBC_Snow

carbon in $kg\,m^{-2}\,yr^{-1}$

b) Gross Primary Productivity for ann
U-BZ431: AlbTrpBC_Snow minus U-BU356: GA8.0

Area-weighted rms diff = 0.111

carbon in $kg\,m^{-2}\,yr^{-1}$

c) Gross Primary Productivity for ann
U-BU356: GA8.0 minus MODIS

Area-weighted rms diff = 0.498

carbon in $kg\,m^{-2}\,yr^{-1}$

d) Gross Primary Productivity for ann
U-BZ431: AlbTrpBC_Snow minus MODIS

Area-weighted rms diff = 0.435

carbon in $kg\,m^{-2}\,yr^{-1}$