Met Office

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Joint Weather & Climate Research Programme – a partnership in weather and climate research

UKESM

UKESM perspectives on JULES biases

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JULES PEG meeting 28 July 2017

National Centre for Atmospheric Science | National Oceanography Centre | Centre for Ecology & Hydrology | National Centre for Earth Observation | PML Plymouth Marine Laboratory | British Antarctic Survey | British Geological Survey | cpom

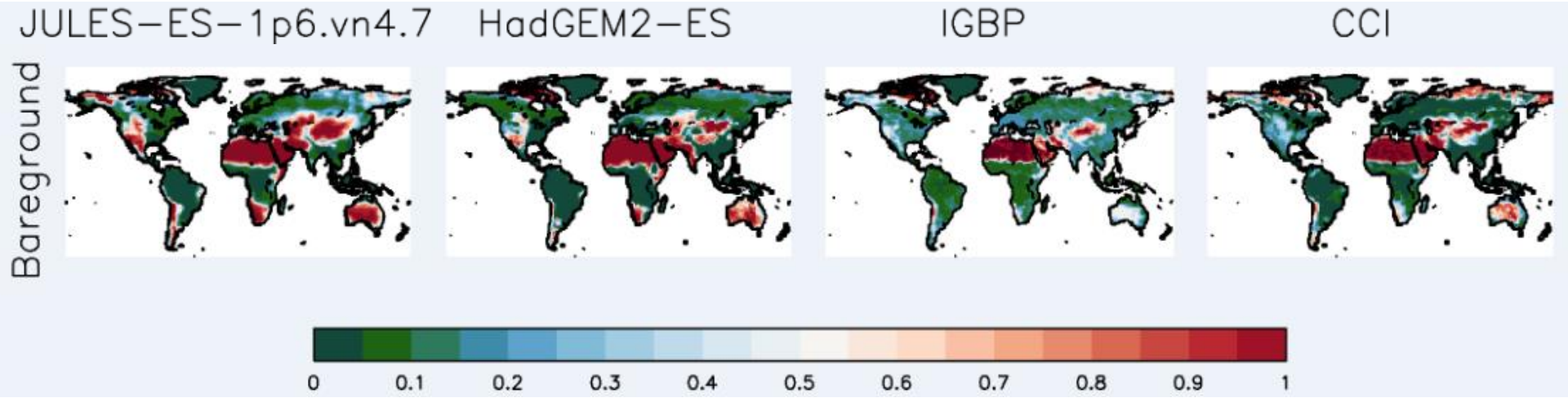
UKESM1

Components:

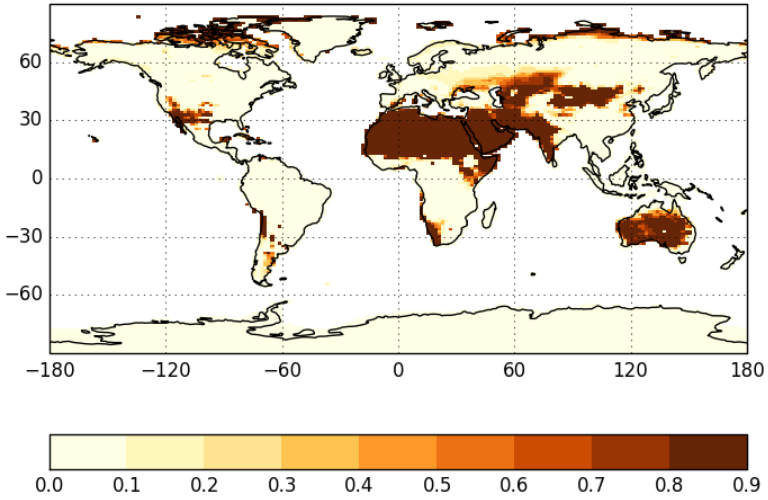
- HadGEM3-GC3.1 (including GA/GL7.1)
- Chemistry: UKCA stratospheric-tropospheric chemistry including trop. isoprene chemistry (Morgenstern 2009, O'Connor 2014)
- Aerosols: UKCA-GLOMAP-mode, 2-moment, 7-mode, strat-trop aerosol scheme (Mann 2014)
- Ocean BGC: MEDUSA2 intermediate complexity plankton ecosystem model (including prognostic DIC, alkalinity, dissolved oxygen, detritus carbon with variable C:N) (Yool 2013)
- Terrestrial carbon-nitrogen cycle: TRIFFID vegetation dynamics (9 PFTs), RothC soil carbon, simple N-limitation scheme (Wiltshire, in prep), diagnostic wildfire, improved diagnostic permafrost extent and wetland CH_4 emission
- Ice sheets (later): BISICLES land ice model over Antarctica and Greenland (Cornforth 2013)

Currently in final tuning phase. Aiming for freeze by end July.

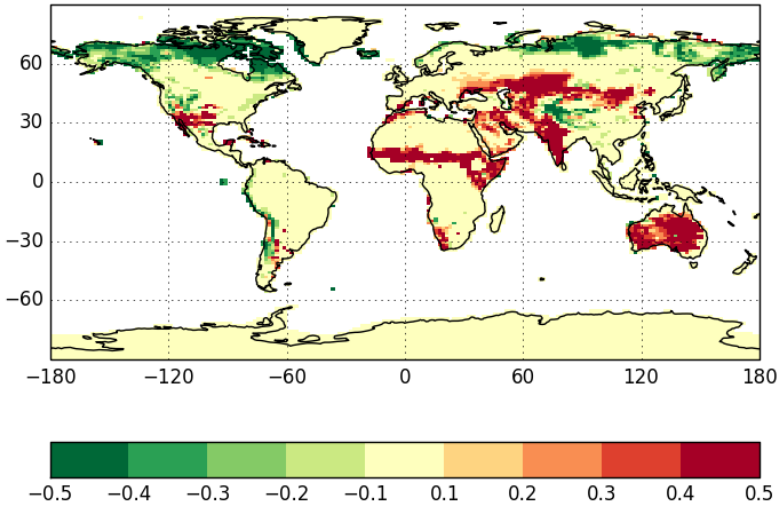
1. Bare soil bias



UKESM0.6

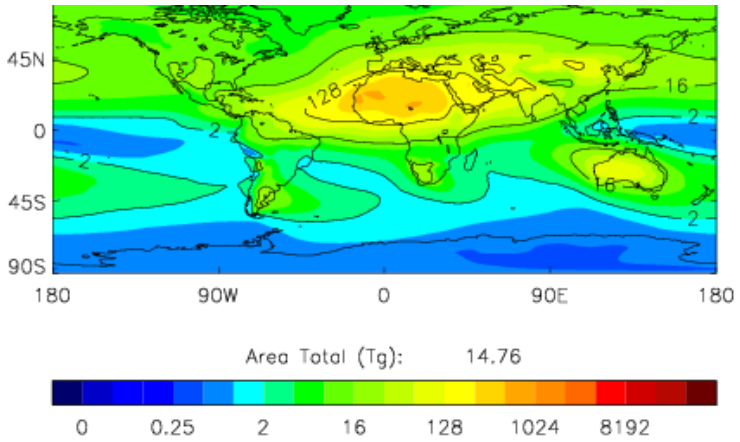


UKESM0.6 - IGBP

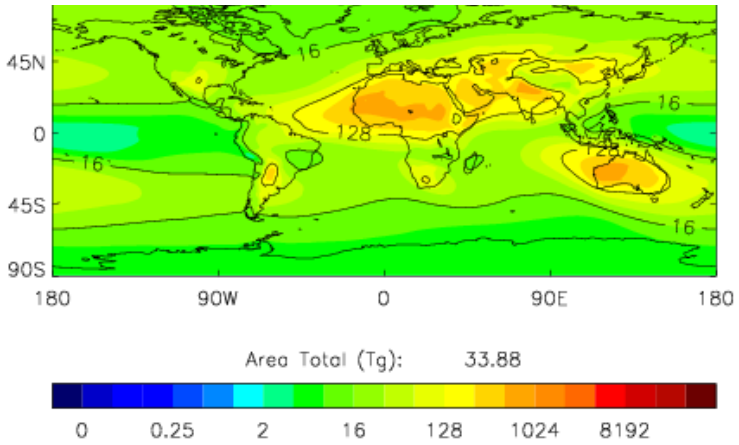


Dust load

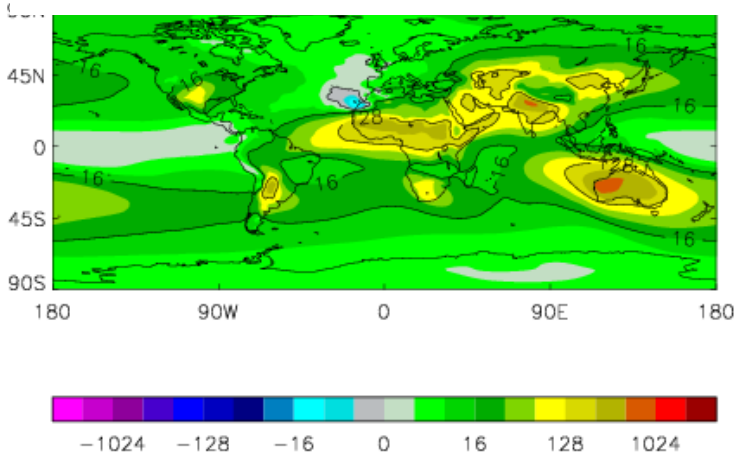
HadGEM3-GC3.1



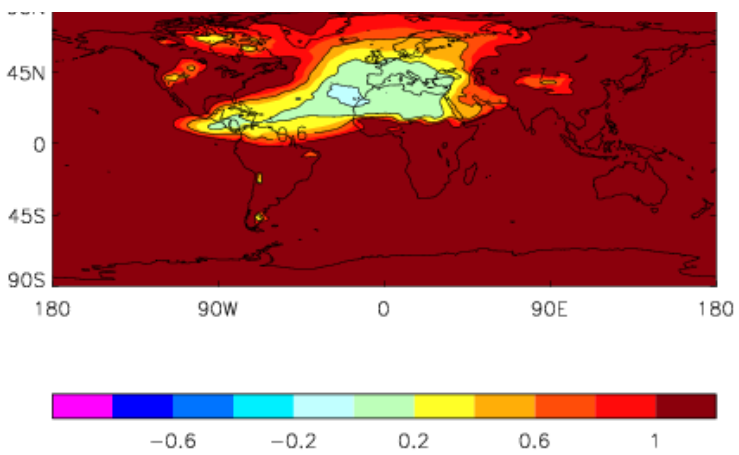
UKESM0.5-CN



UKESM0.5 - HadGEM3

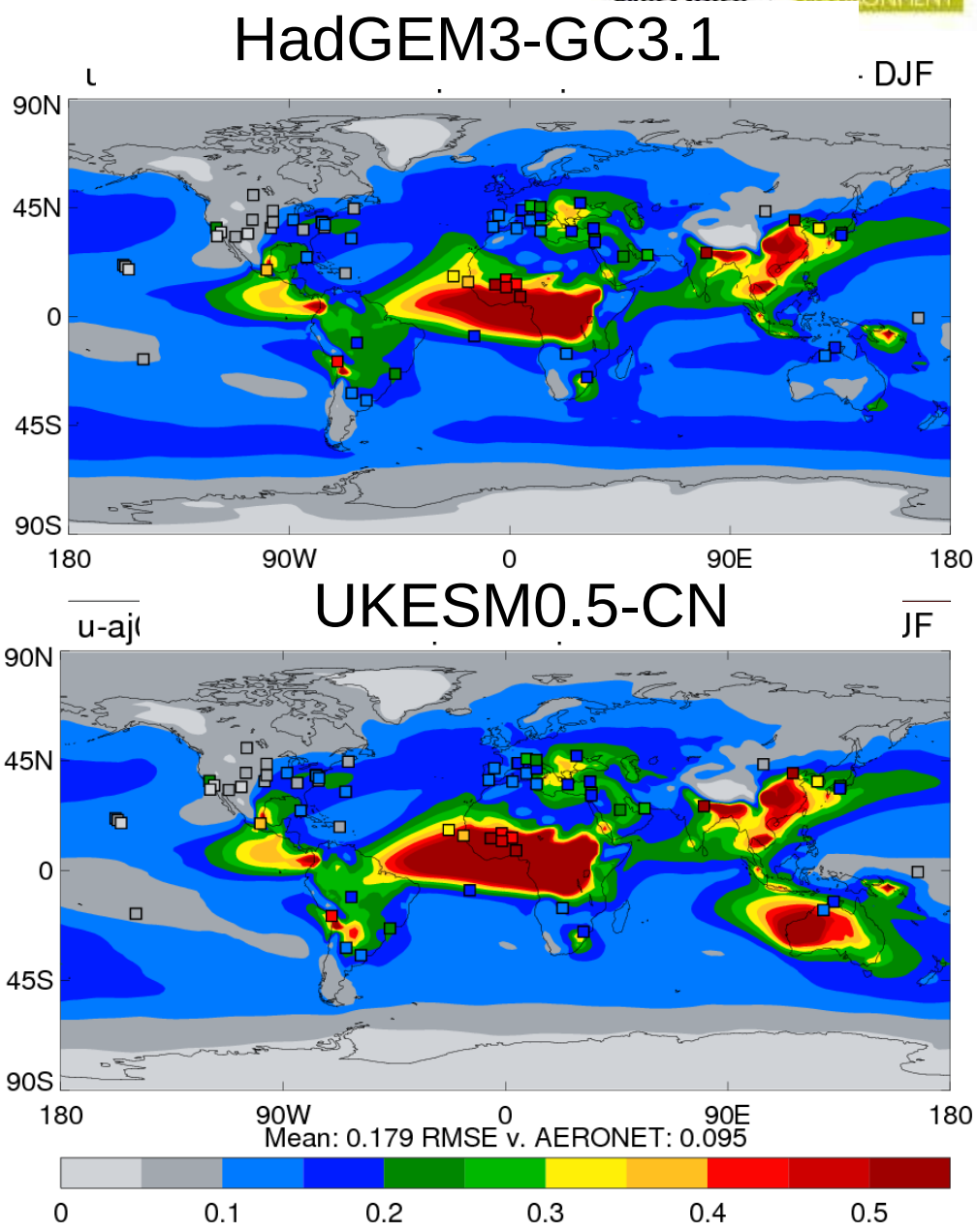


Fractional diff



Aerosol Optical Depth (DJF)

- Excessive AOD around Australia, esp W. Aus.
- Similar increases from S Asia are seen in JJA



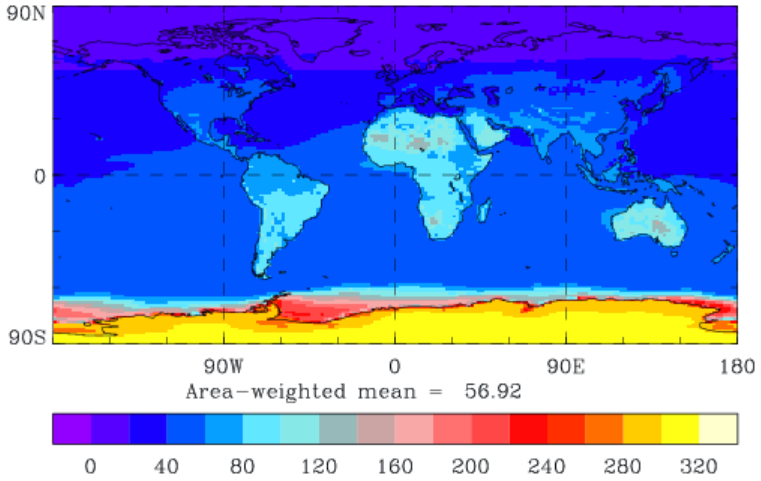
Bare soil: underlying issues

- Response of vegetation to moisture stress
- Excessive soil evaporation
- Soil hydrology (van Genuchten issue)
- Tropical precipitation biases in UM (not all regions)

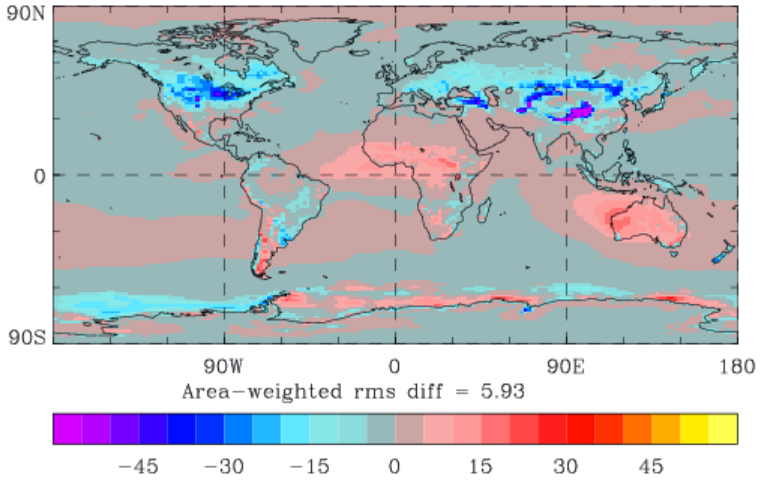
2. NH mid-latitude albedo

Reflected SW (clear-sky, DJF)

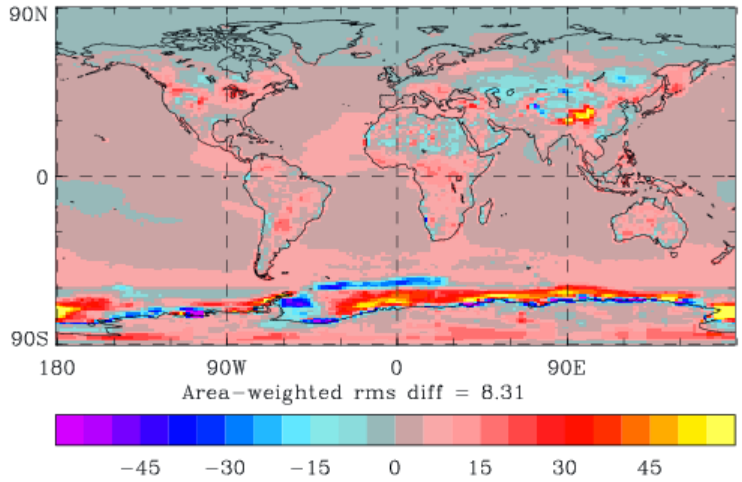
UKESM0.5-CN



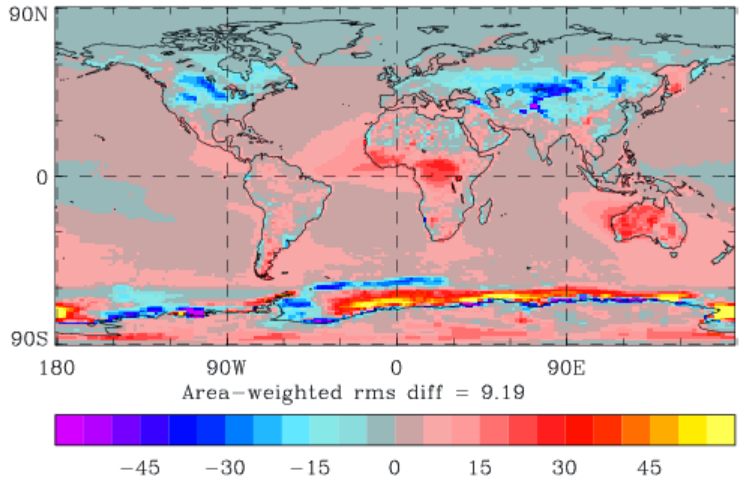
UKESM0.5 – HadGEM3



HadGEM3 – EBAF



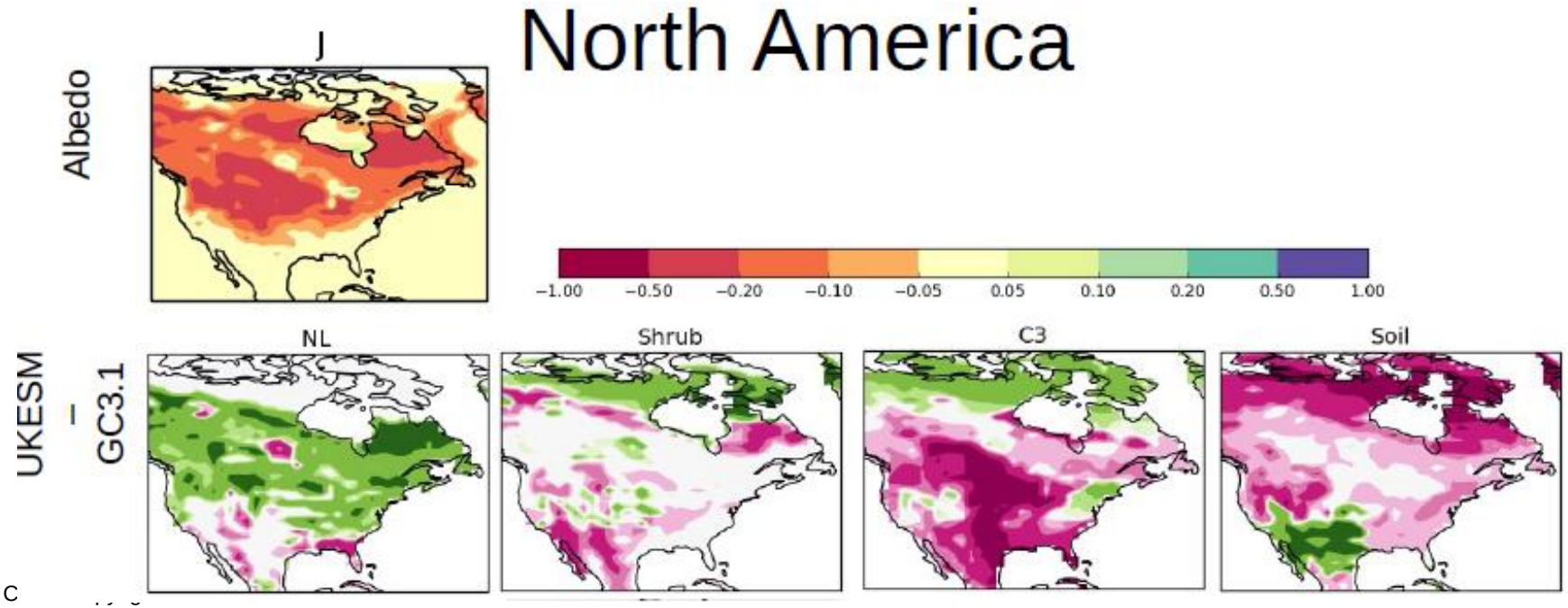
UKESM0.5 – EBAF



NH mid-latitude albedo: underlying issues

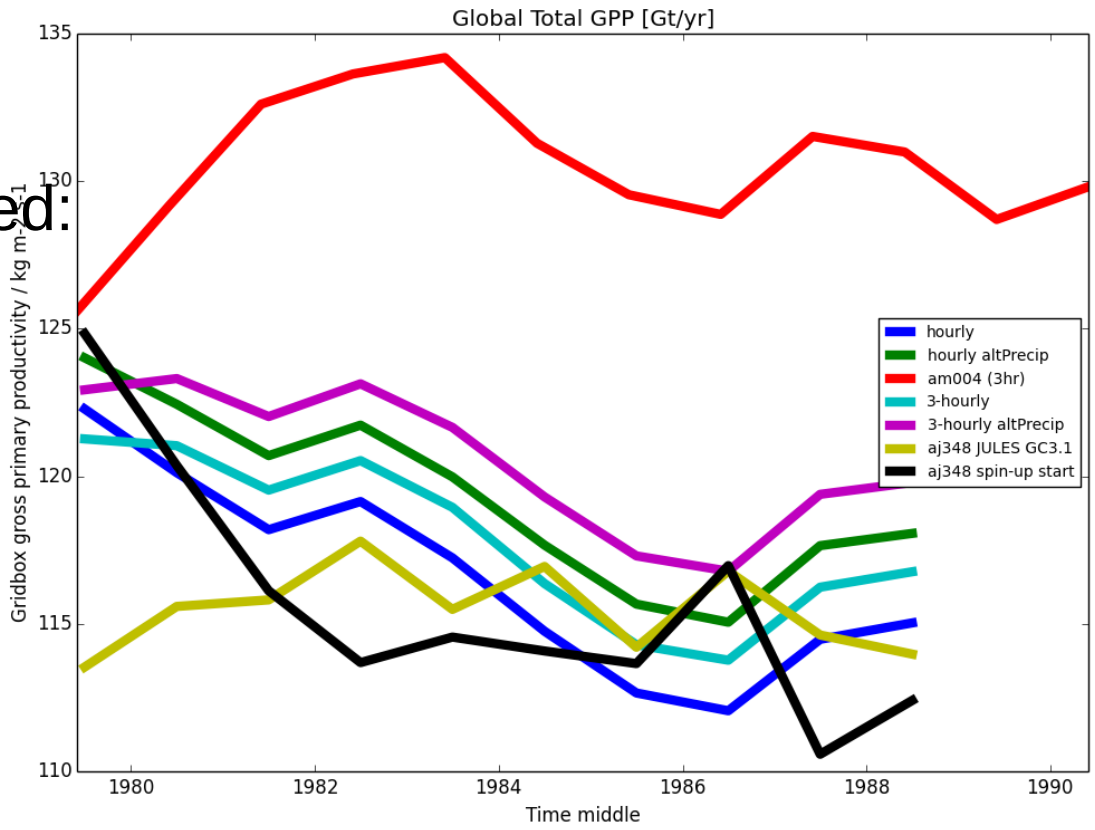
- Bias in vegetation distribution:
  - excessive shrub and NL tree in place of grasses

→ Less quickly covered by snow

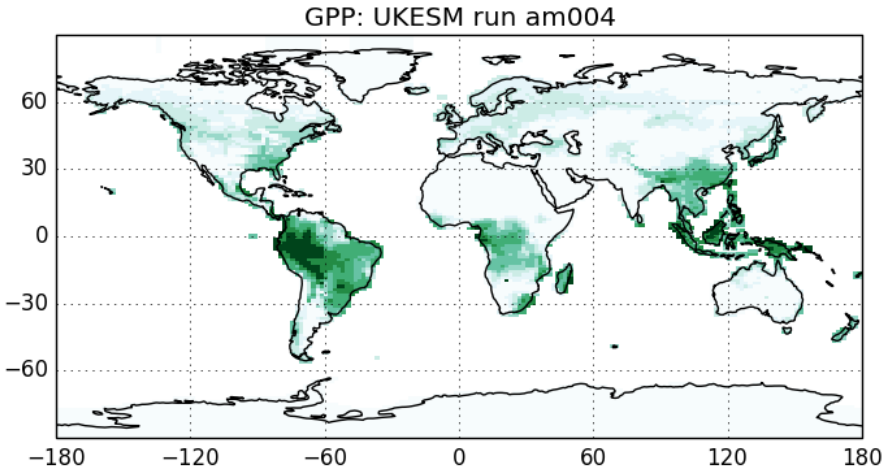


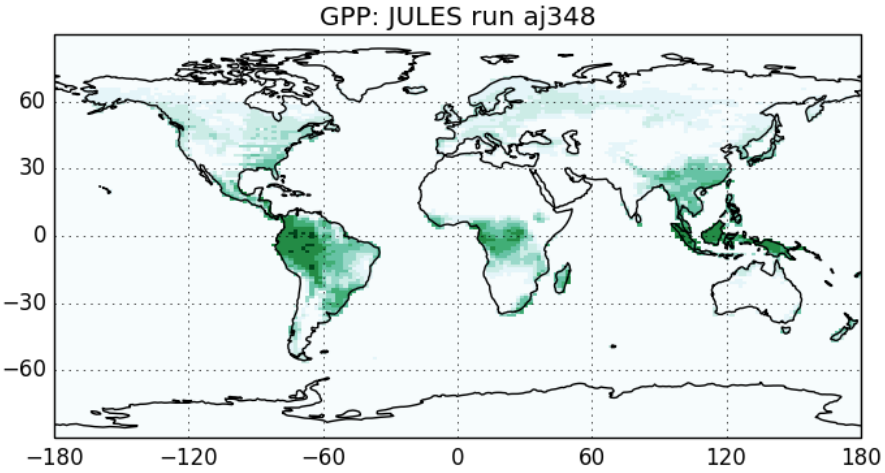
3. Online – offline differences

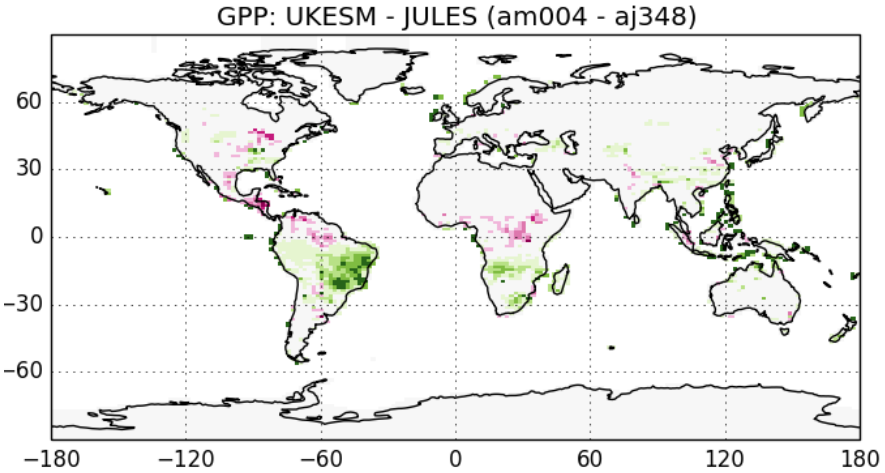
- We have been using JULES offline to tune UKESM land surface
- But they are not as consistent as we hoped:
  - GPP ~15% lower
  - Ppposite veg response to some soil moisture parameters

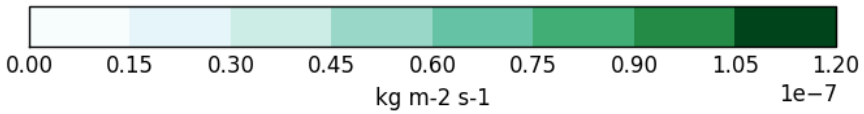


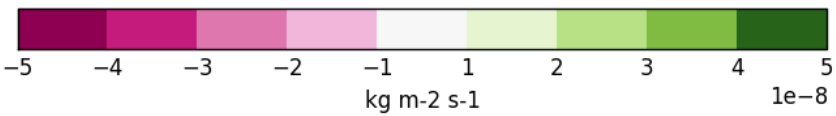
GPP difference







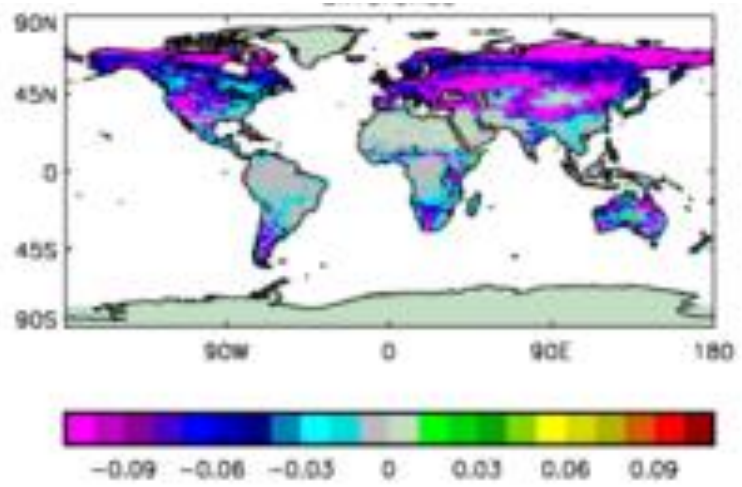




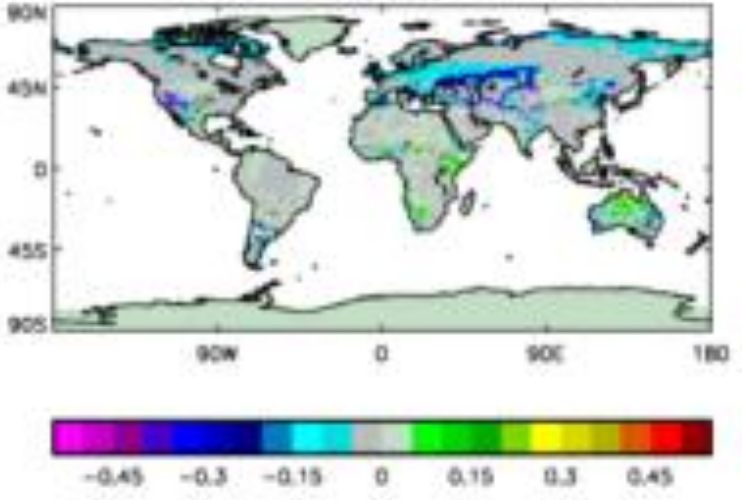
Differing response to tuning!

- Package of changes reduced bare soil in JULES-offline:
  - fsmc_p0 = 0.5 for grasses
  - decrease g_area for grasses
  - decrease N limitation
- Impact in UKESM...

Bare soil change: JULES-offline



Bare soil change: UKESM



Top priorities for UKESM long-term

1. Impacts of vegetation distribution on physical climate
    - Particularly excessive bare soil → dust, albedo, roughness
    - More generally: impacts of veg distribution biases on albedo, snow cover, energy fluxes
2. Online-offline differences
    - Reduces the usefulness of JULES for tuning and carbon cycle spinup