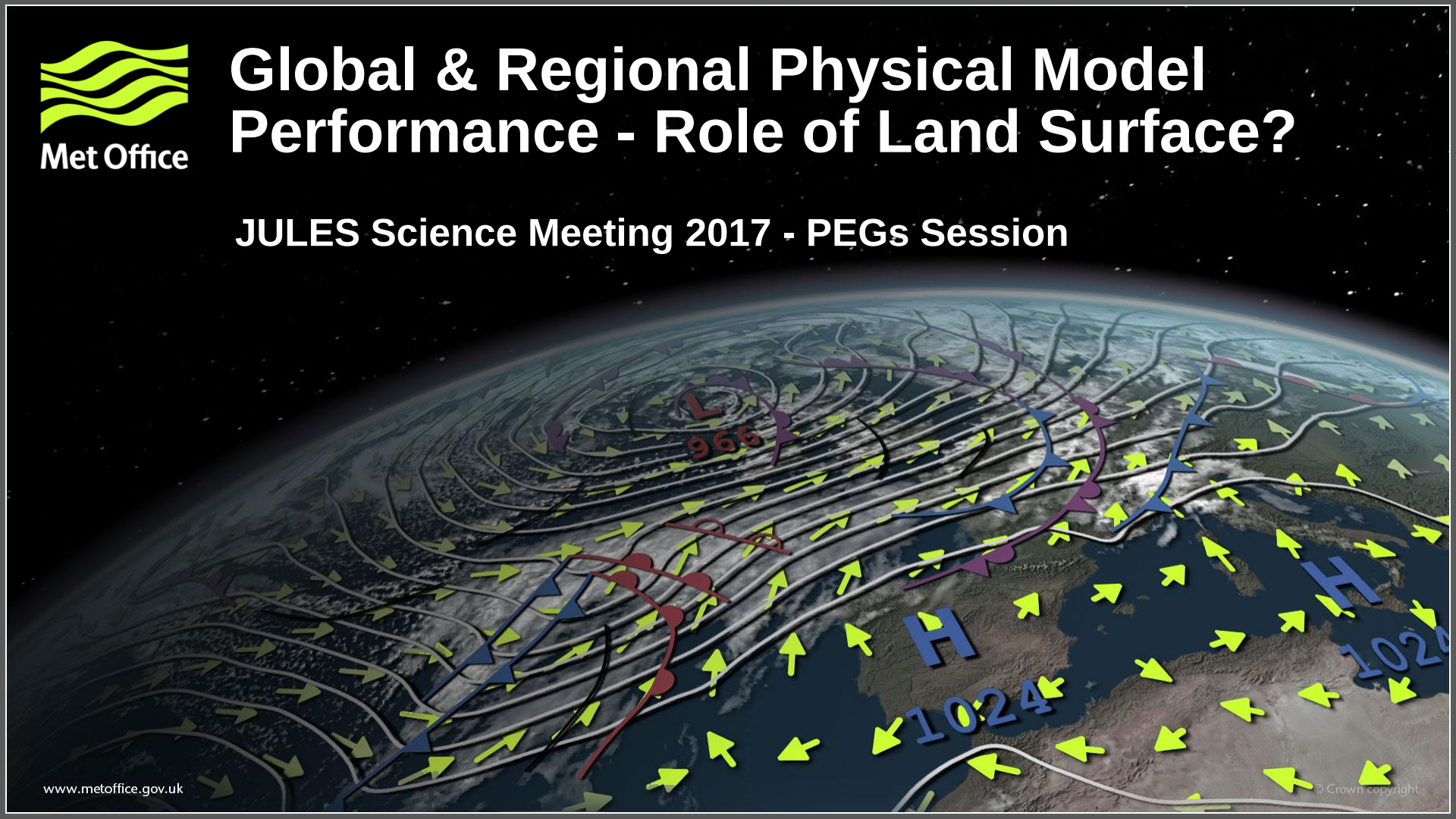
Global & Regional Physical Model Performance - Role of Land Surface?

JULES Science Meeting 2017 - PEGs Session



Outline

- Seamless GC Model Development Process - GL & JULES Science

- Mean State Errors - GC3 coupled climate & Global NWP
  - AirT, Precip, Soil Moisture, Surface Fluxes…
  - Role of Land-Surface?

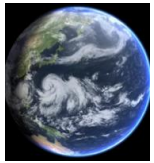
- Variability & Extremes - Drought & Flood

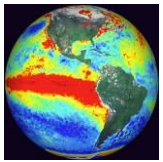
Global Physical Modelling

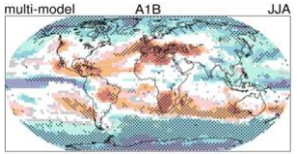
Unified Prediction across Timescales

Met Office

Hours *Days* *Weeks* *Months* *Seasons* *Decades* *Centuries*







NWP - Atmosphere, Ocean, Waves
Deterministic

MOGREPS

GloSea

Decadal

Climate Change &
UKESM1

Component Models
GA6 , GL6, GO5, GSI6

Coupled AOIL Model
GC2.0, GC3.0/3.1

Met Office Unified Model™ Global Atmosphere

N96 -130km
N216 - 60km
N512 - 25km
N1024 - 12km

JULES Global Land

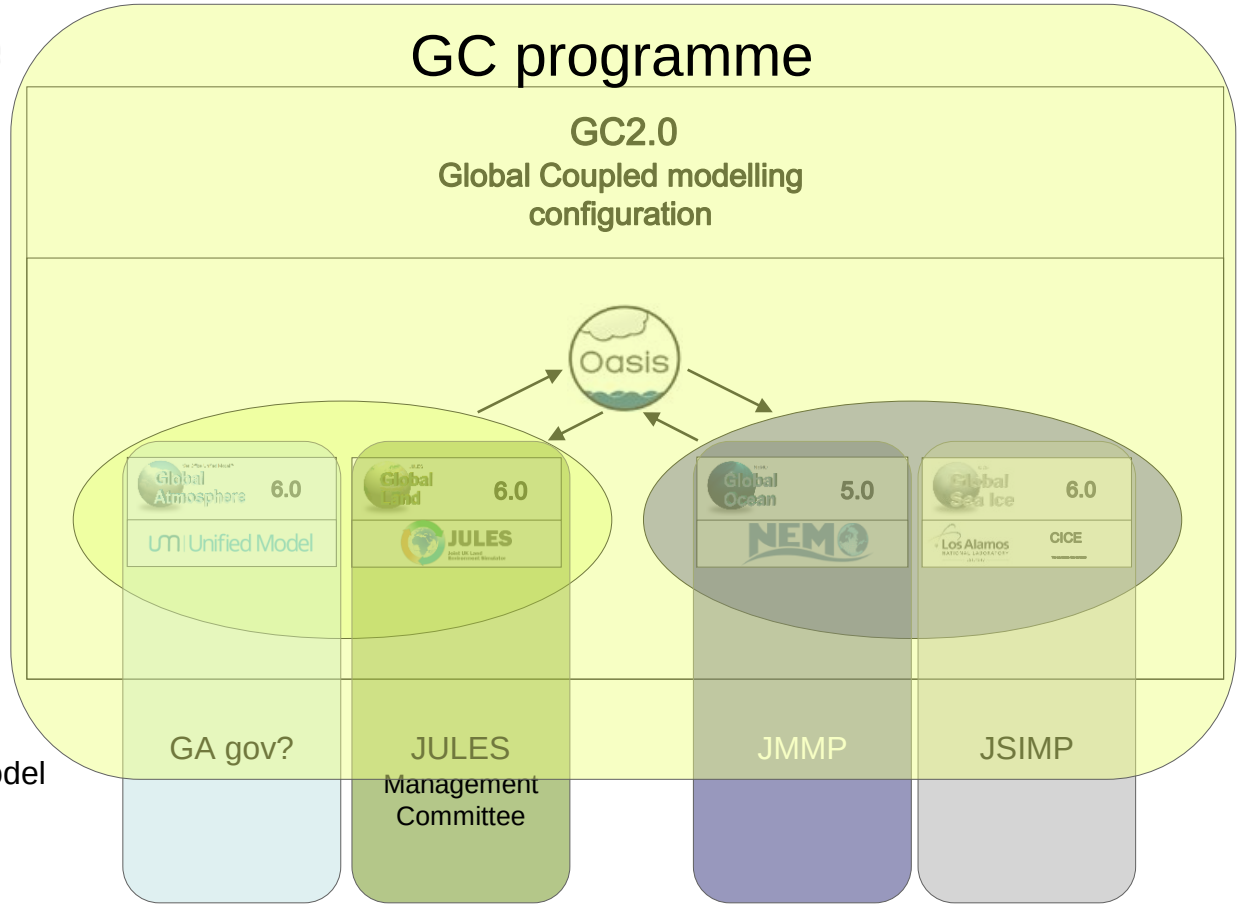
NEMO Global Ocean

1 deg
1/4 deg
1/12 deg

CICE Global Sea Ice

WaveWatch III Global Waves

GC Development & Governance



Component model development activities:

GL Changes

GL4 - Feb 2012

GL:#2 Calculation of the Obukhov length in very light winds
GL:#5 Surface Roughness (was Enhacements to Surface Exchange)
GL:#7 Perturbation sensitivity fixes
GL:#5 Conservative Discretization
GL:#15 Improved Numerics in Soil Hydrology
GL:#17 Consistent Calculation of Canopy Snow Depth
GL:#18 Surface Emissivity on Tiles

GL5 - Feb 2013

GL:#8: Improved treatment of the surface albedo
GL:#19: Calculation of sea ice surface temperature
GL:#32: Increase roughness lengths over sea-ice to GA3.1 values

GL6 - Oct 2013

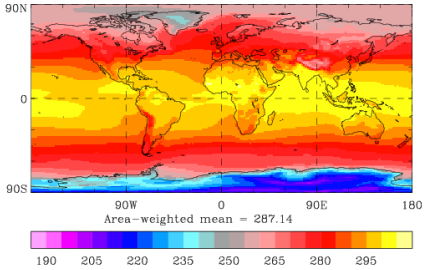
GL:#47 Consistent ice thermal conductivities in coupled and non-coupled runs
GL:#49 Improved treatment of non-unity emissivity of sea ice

GL7 - Jan 2016

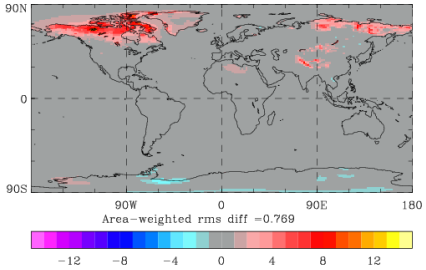
GL:#4 **Implementation of the multilayer snow scheme**
GL:#30 Further Improvements to the surface albedo
GL:#31 Implement the COARE4.0 Algorithm
GL:#38 Revised roughness lengths for sea ice
GL:#43 Improved parameterisation of the ocean surface albedo in JULES
GL:#45 Pass rain fraction to JULES surface hydrology
GL:#56 Fix bit-comparison issue with TRIP river routing in UM/JULES.

Multi-Layer Snow Impact on T1.5- MAM

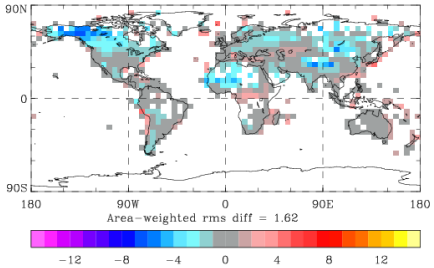
GA6/GL6



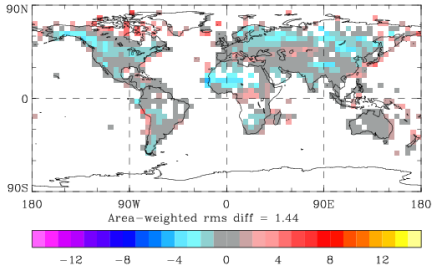
GL7 - GL6



GA6/GL6 bias



GA7/GL7 bias

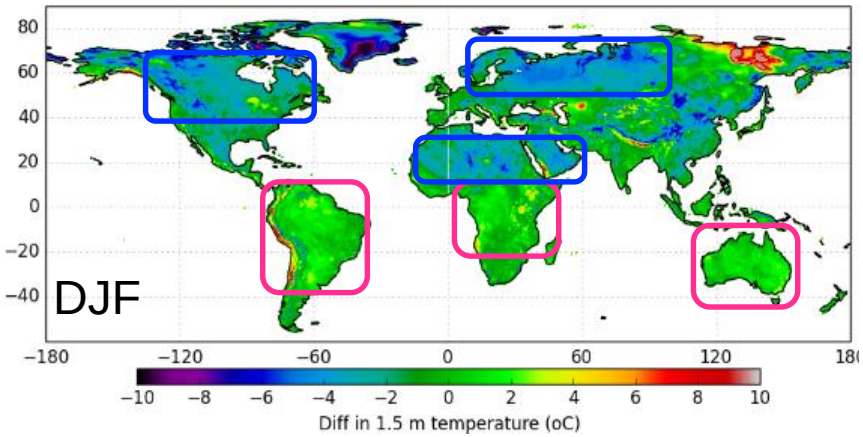


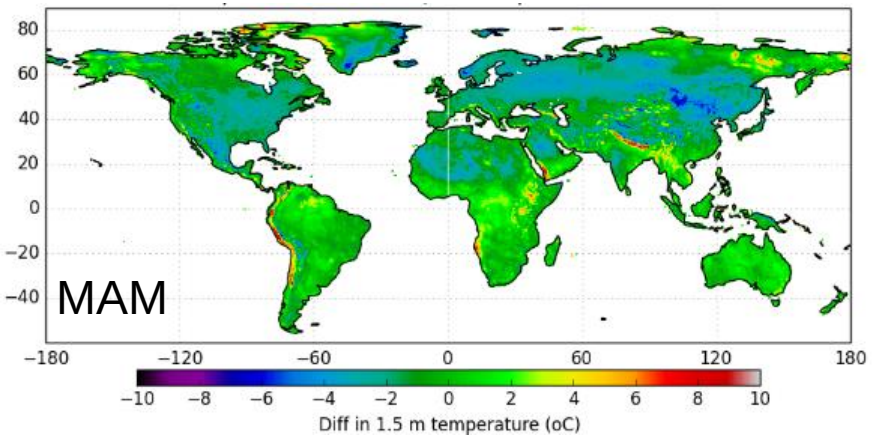
0805

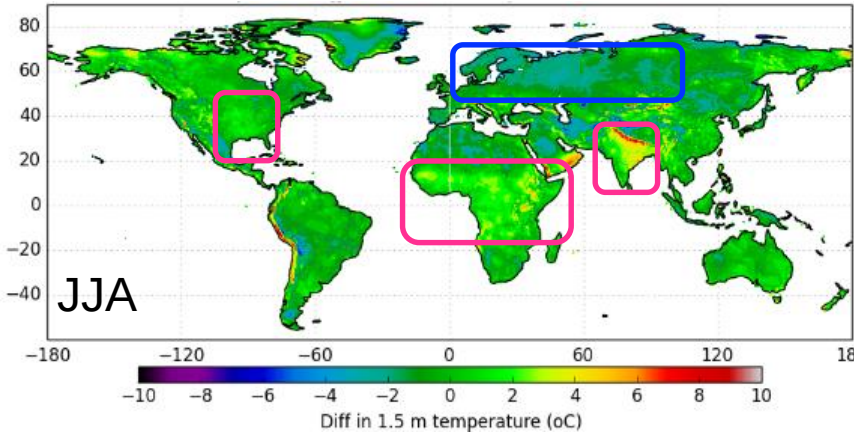
JULES Offline - Soil Temperature

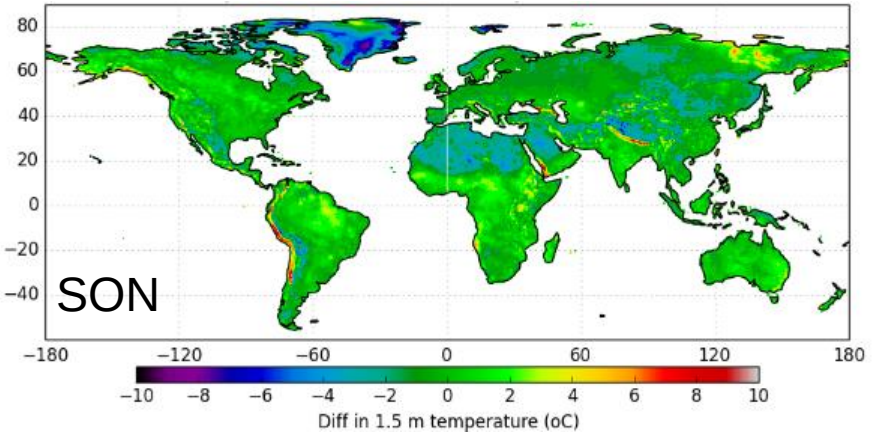
GC3 (GL7) Near-surface Temperature vs. **CRU TS3.21**

(GC3 N216 ORCA025 Land Surface Assessment UMUW 2016 - **G Weedon**)

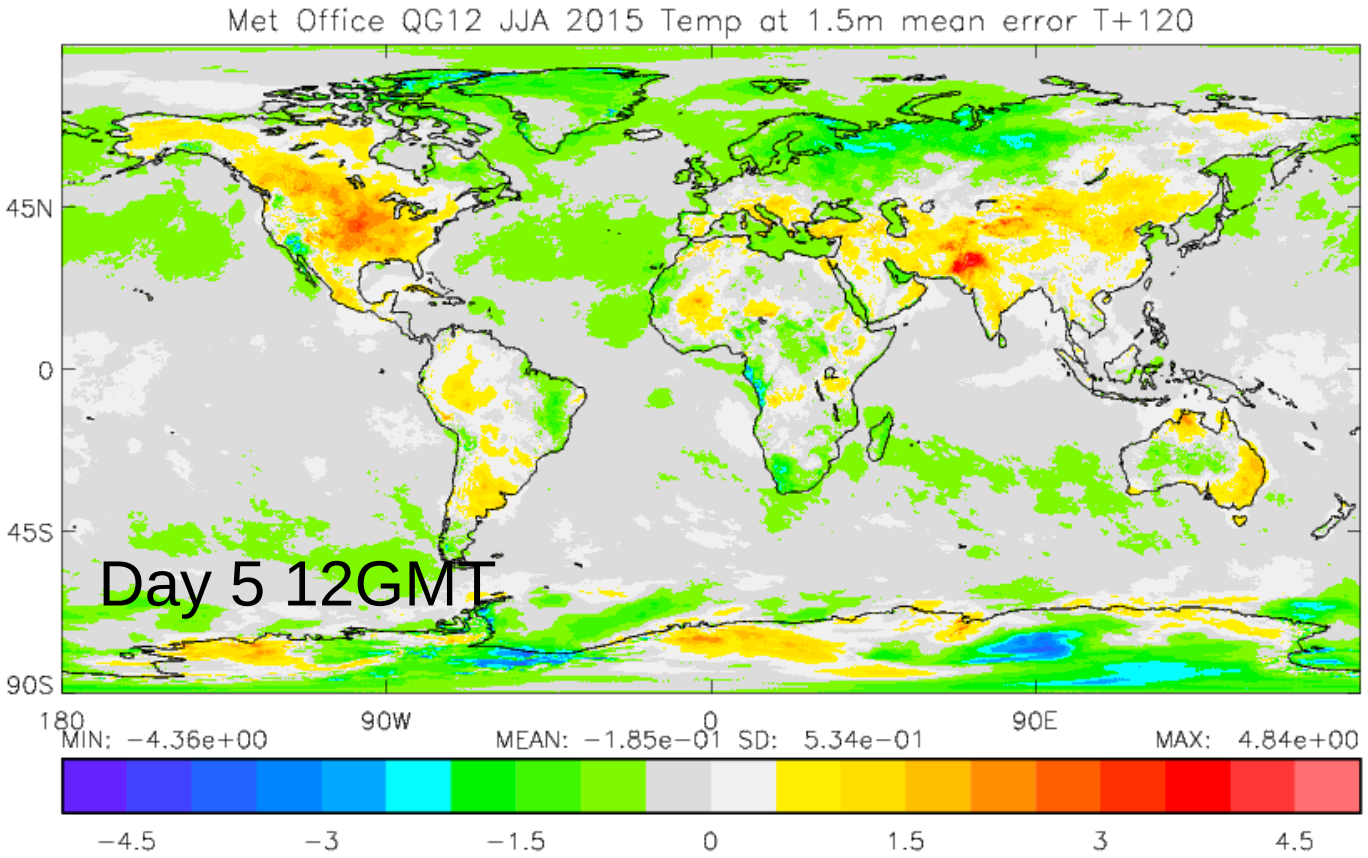








GA6.1/GL6 Global OP NWP Air Temperature Drift - JJA 2015

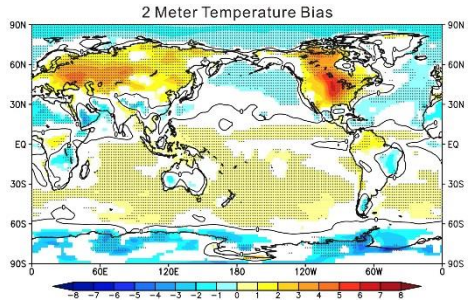


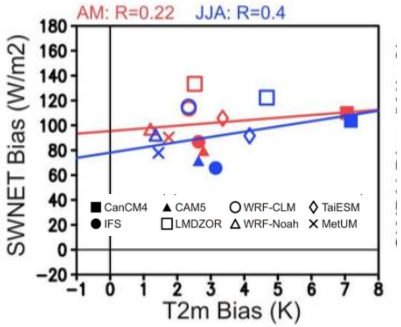
CAUSES

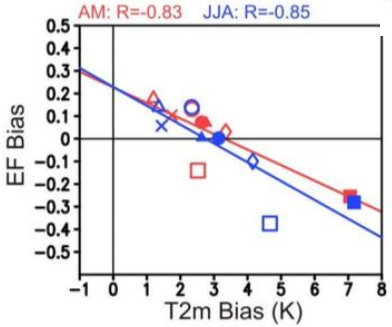
Cyril Morcrette and Kwinten Van Weverberg with Jon Petch (UKMO)
Hsi-Yen Ma with Steve Klein and Chengzhu Zhang (LLNL)

Clouds Above the United States & Errors at the Surface

CMIP5







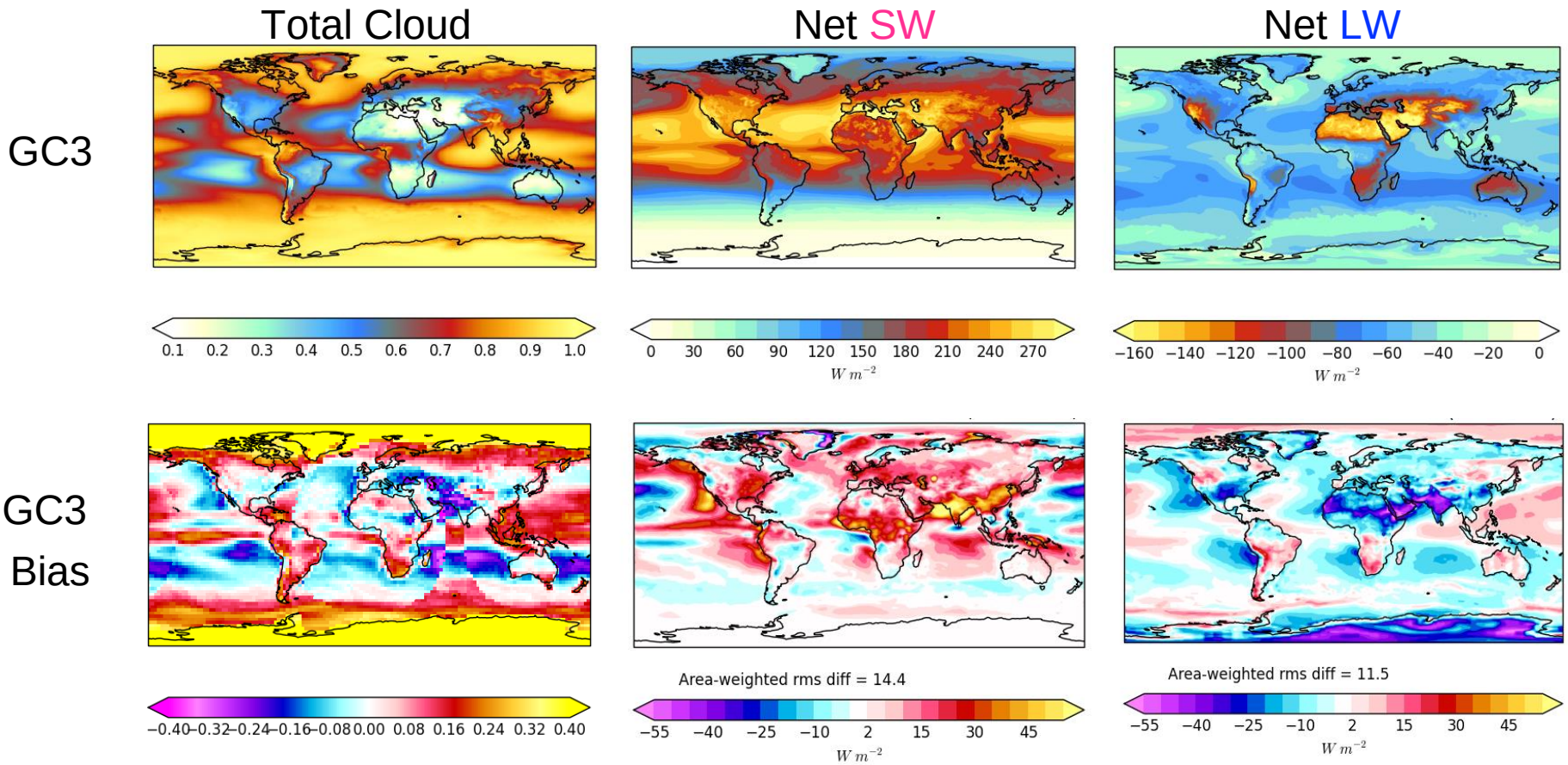
CAUSES - multi-model inter-comparison project to understand the contributors to the robust Central U.S.summer warm bias

9 global models (2 NWP, 8 climate), 1 regional model

- Model warm bias present in first few days of hindcasts and occurs in lowest ~3 km of the atmosphere during day and night throughout the Central U. S. including at SGP
- Warm bias is due to both overestimated downwelling shortwave radiation at the surface (atmosphere model problem) and underestimated surface evaporative fraction (land model problem?). Surface albedo is a minor contributor in some models.
- Shortwave radiation overestimates are due to underestimates in the radiative effects of deep convective clouds arising from either too infrequent deep convection or insufficiently reflective clouds when deep convection occurs.

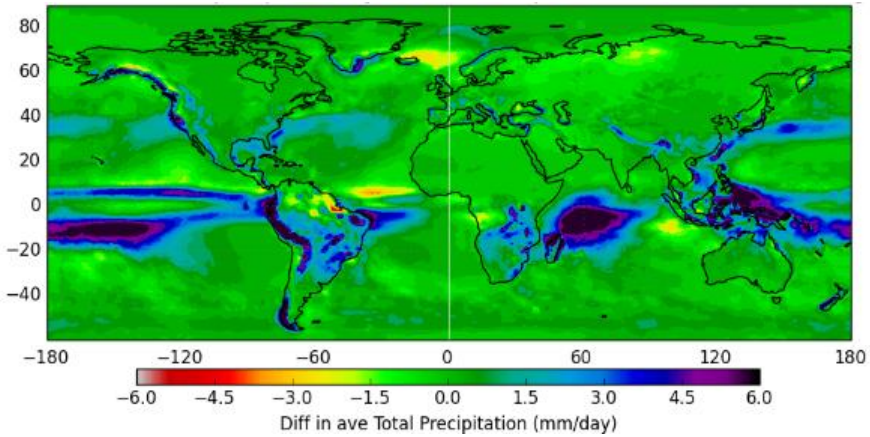
http://portal.nersc.gov/project/capt/CAUSES/

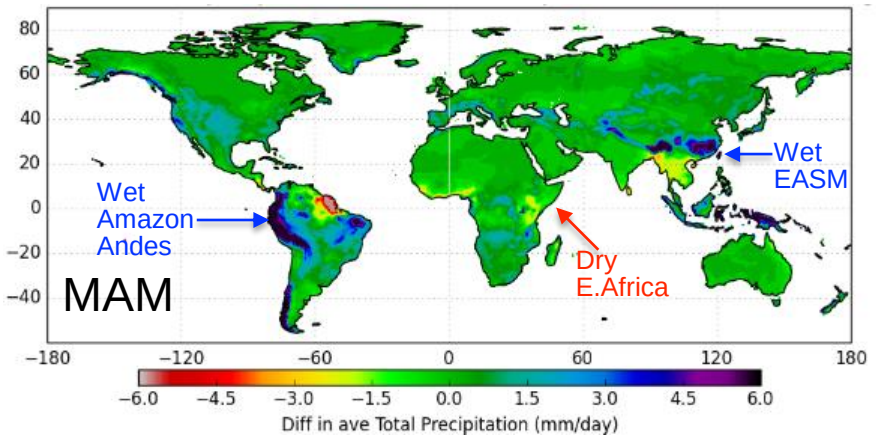
GC3 JJA Net Radiation & Cloud vs. **CERES-EBAF & ISCCP**

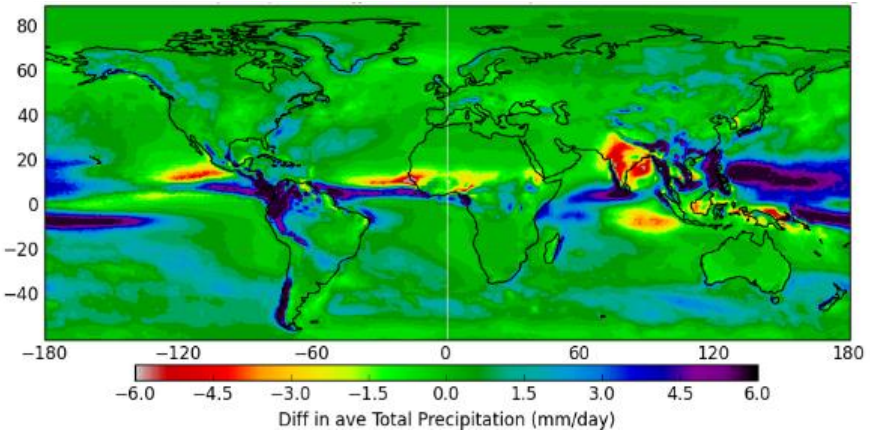


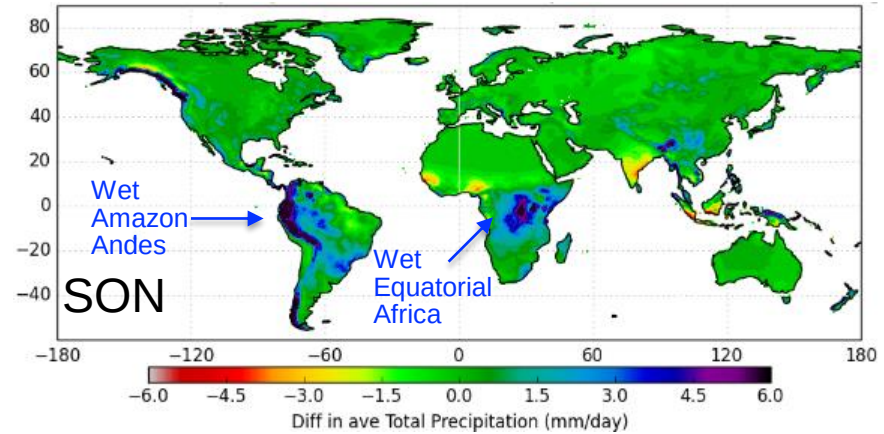
GC3 Precipitation v **GPCP2**

(GC3 Land Surface Assessment UMUW 2016 - **G Weedon**)

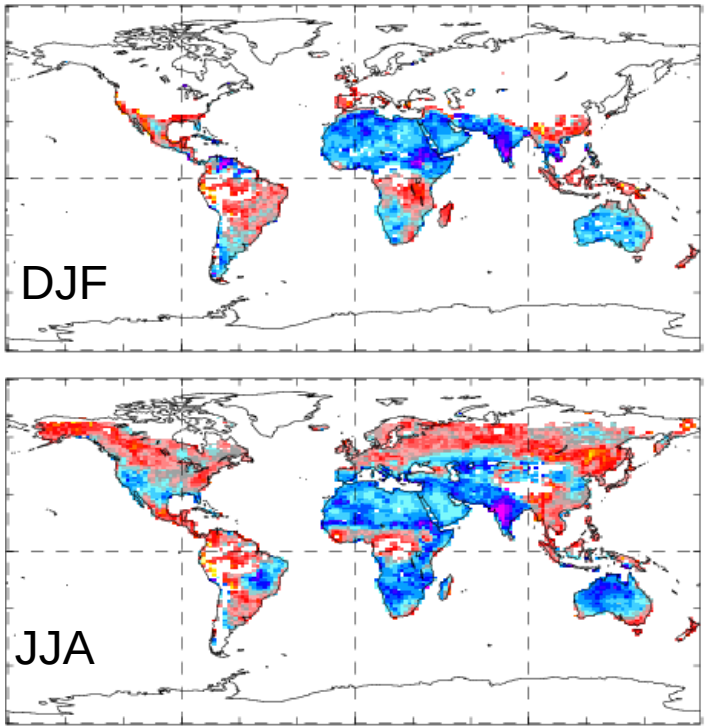




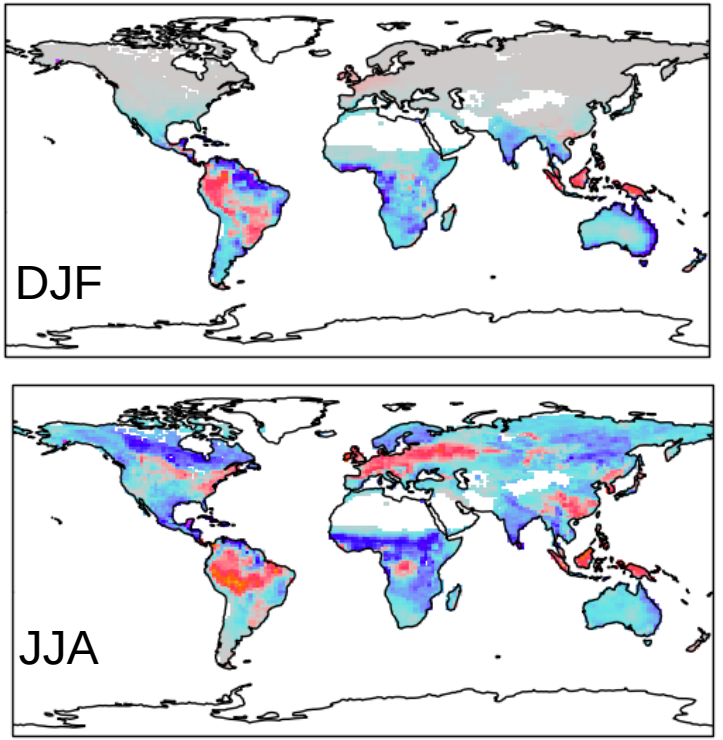




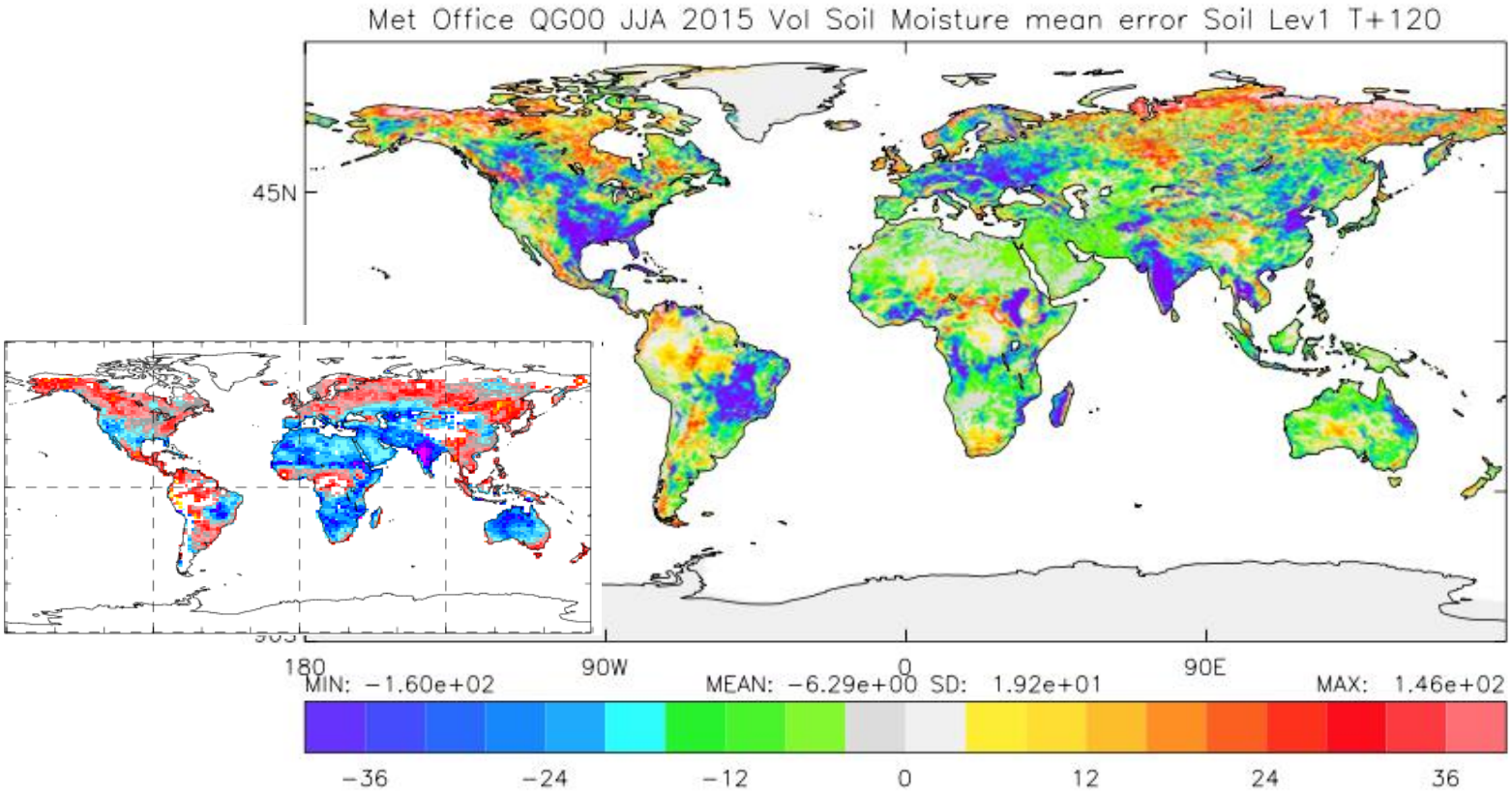
GC3 Soil Moisture vs. **ECV**



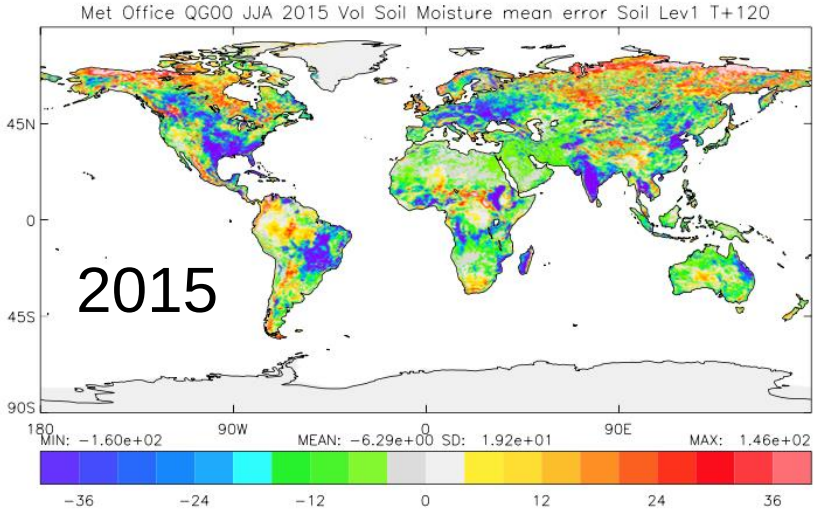
GC3 GPP vs. **MODIS**



GA6.1/GL6 Global OP NWP Soil Moisture Drift - JJA 2015

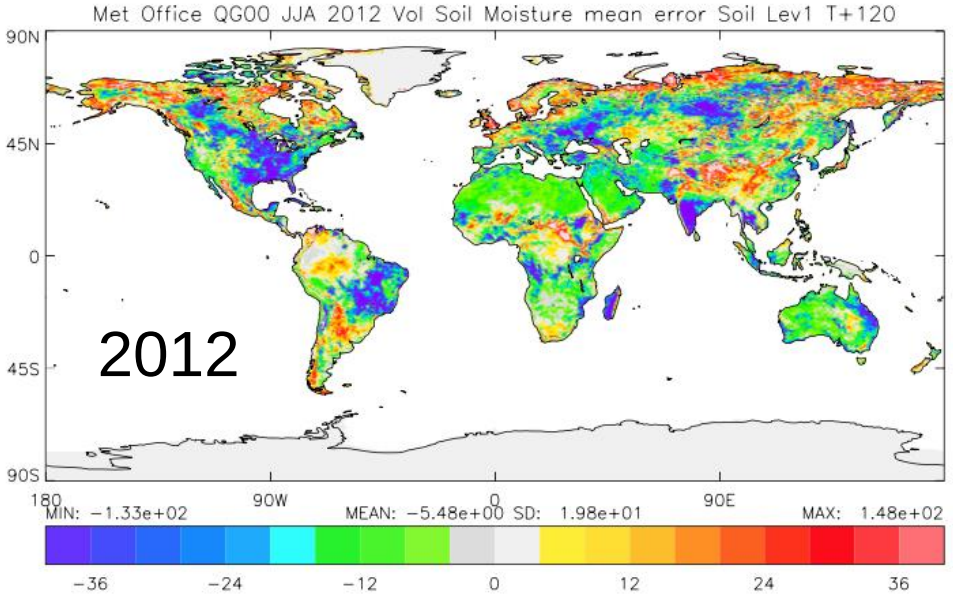


Global OP NWP Soil Moisture Drift - Robust Errors



N768 & ENDGame…

N512 & New Dynamics…



Summary

- Key global physical model systematic errors in AirT and near surface humidity, soil moisture, GPP….Focus of PEGs?
  - Warming over summer continents - Cooling in Winter in NHemisphere
  - Rapid warming-drying of summer monsoon regions - India, Africa.
  - Wet East Asian Summer Monsoon, Amazon & Andes/Himalayas

- How do known JULES biases (offline evaluation vs. Fluxnet) relate to water and energy cycle biases in fully coupled GC versions – CAUSES style study at other locations (e.g. India).

- More rapid translation of JULES science developments into GL versions - “Push” from JULES community?