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

<table>
<thead>
<tr>
<th>Hours</th>
<th>Days</th>
<th>Weeks</th>
<th>Months</th>
<th>Seasons</th>
<th>Decades</th>
<th>Centuries</th>
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<td><img src="Image" alt="Earth" /></td>
<td><img src="Image" alt="Mogreps" /></td>
<td><img src="Image" alt="GloSea" /></td>
<td><img src="Image" alt="Decadal Climate Change" /></td>
<td>MOGREPS</td>
<td>Decadal</td>
<td>Climate Change &amp; UKESM1</td>
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**Component Models**

| NWP - Atmosphere, Ocean, Waves | MOGREPS | GloSea | Decadal | Climate Change & UKESM1 |

**Coupled AOIL Model**

| GC2.0, GC3.0/3.1 | GC2.0, GC3.0/3.1 |

**WaveWatch III**

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

- 1 deg
- 1/4 deg
- 1/12 deg
GC Development & Governance

GC programme

GC2.0
Global Coupled modelling configuration

Component model development activities:
- GA gov?
- JULES Management Committee
- JMMP
- JSIMP
GL Changes

GL4 - Feb 2012
- GL#2: Calculation of the Obukhov length in very light winds
- GL#5: Surface Roughness (was Enhancements to Surface Exchange)
- GL#7: Perturbation sensitivity fixes
- 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

GL6 - GA6/GL6
- GL7 - GA7/GL7
- Bias comparison

JULES Offline - Soil Temperature
- Single layer snow
- Multi Layer Snow
- OBS

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

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

Total Cloud

Net SW

Net LW

GC3

Bias

Area-weighted rms diff = 14.4

Area-weighted rms diff = 11.5
Global OP NWP Soil Moisture Drift - Robust Errors

N768 & ENDGame…

2015

N512 & New Dynamics…

2012
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?