The UK Earth System Modeling project

Colin Jones (NCAS)

A collaboration between all 8 NERC centres and the UK Met Office
• The UKESM project is a collaboration between NERC and the Met Office to **develop, apply and analyse the** next generation of UK Earth system models

• UKESM1 has the global climate model HadGEM3 as its core, coupling in models for: (i) **terrestrial carbon cycle & vegetation**, (ii) **ocean biogeochemistry**, (iii) **atmospheric chemistry and aerosols** and (iv) **continental Ice sheets**.

• The UKESM core group was established in the summer of 2013, jointly funded by NERC and the Met Office.

• The core group is developing UKESM1, with a release date of late 2016.

• The UKESM LTSM funds the NERC component of the core group plus a number of NERC centre scientists to work on the analysis of UKESM1 and further development of UKESM component models.
Motivating UKESM
The Earth is experiencing (anthropogenic) forcing never before seen

Observed and projected anthropogenic GHG emissions

Data: CDIAÇ/GCP/IPCC/Fuss et al 2014

Scenario categories
- >1000 ppm CO₂eq
- 720–1000 ppm
- 580–720 ppm
- 480–580 ppm
- 430–480 ppm

Emissions from fossil fuels and cement (GtCO₂/yr)

2015 Estimate

Historical emissions

net-negative global emissions

RCP8.5
3.2–5.4°C relative to 1850–1900

RCP6
2.0–3.7°C

RCP4.5
1.7–3.2°C

RCP2.6
0.9–2.3°C

Global Carbon Project
To provide robust projections of the Earth system response to such forcing requires models containing all relevant processes and process interactions. Such models extend traditional physical climate models to also include key (potentially sensitive) aspects of the full Earth system, such as: the carbon cycle, atmospheric and ocean biogeochemistry, aerosols, ice sheets.
UKESM as a National Capability
• UKESM models, analysis tools and simulation data are intended to support national UK Earth system modeling requirements.

• UKESM models will be released to the entire NERC community and their use supported through a range of mechanisms.

• UKESM1 will be the main UK contribution to the 6th Coupled Model Intercomparison Project (CMIP6: 2016-2020).

• The LTSM supports the development, evaluation and application of UKESM1 models, focused on a number of specific science goals.

• The LTSM also supports component model development towards UKESM2.
Science goals of the UKESM LTSM
The global carbon cycle

investigating its sensitivity to, and role in, Earth system change

CMIP6: C4MIP, LUMIP
Aerosols in the climate system remains a key uncertainty in estimating historical radiative forcing and global climate sensitivity.

CMIP6: Historical and AerChemMIP
Short Lived Climate Pollutants

SLCP CLIMATE BENEFITS
Avoided Global Warming by 2050

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Temperature (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>BC + CH₄</td>
<td>0.5°C</td>
</tr>
<tr>
<td>HFCs</td>
<td>0.1°C</td>
</tr>
<tr>
<td>SLCPs</td>
<td>0.6°C</td>
</tr>
</tbody>
</table>

may offer potential for near term climate change mitigation

CMIP6: AerChemMIP
The cryosphere and Earth system change

Marine ice sheet instability

Projecting Arctic sea ice loss

CMIP6: ISMIP6, SIMIP
Develop and analyse a set of future Earth system projections to support impacts-adaptation-mitigation research and policy decisions

**CMIP6: ScenarioMIP**
The UKESM project

Collaboration:
- NERC LTSM projects
- NERC centre research
- UK university research
- European Horizon2020
- European ESM Groups
- International CMIP6 WCRP Future Earth

Met Office Hadley Centre:
- Contribute to UKESM1
- Shared CMIP6 runs
- Shared data submission to ESGF
- Shared development of evaluation tools
- Collaboration on analysis of UKESM1
- Development of future HadGEM versions
- Contribute to UKESM2

RT1
- Finalise UKESM1
- RT1.1 UKESM1 in CMIP6
- RT1.2 User support for UKESM1

RT2.1 Process level evaluation of UKESM1
RT2.2 Evaluation of coupled UKESM1
RT3 Analysis of UKESM1 future projections

RT4 UKESM component model development
RT5 Model development towards UKESM2

ESM evaluation tools
Emergent Constraints
Climate change impacts-adaptation mitigation research
Policy advice

IPCC AR6
UK Government
UK research
EU commission
For more information including the UKESM Newsletter

http://www.jwcrp.org.uk/research-activity/ukesm.asp

Project kick off meeting : Summer 2016

Following by a NERC community engagement workshop early 2017 subsequent to the release of UKESM1 models

UKESM1 users training school planned for 2017