The release and support of UKESM1

Jeremy Walton[1*], Alistair Sellar[1*], Yongming Tang[1*], Marc Stringer[2*], Richard Hill[1*], Julien Palmieri[3*], Rich Ellis[4*], Grenville Lister[2], Colin Jones[2*]

[1] Met Office Hadley Centre; [2] National Centre for Atmospheric Science (NCAS), [3] National Oceanography Centre (NOC); Centre for Ecology and Hydrology (CEH); * UKESM core group member.

Version 1 of the UK Earth System Model (UKESM1) has been in development for the past five years. Built as a joint venture by the Met Office Hadley Centre and the Natural Environment Research Council (NERC), UKESM1 consists of the HadGEM3 coupled physical climate model (which represents important processes in the atmosphere, ocean, land and sea-ice domains) plus additional components that model key biogeochemical, chemistry, aerosol and vegetation processes (see Figure 1).

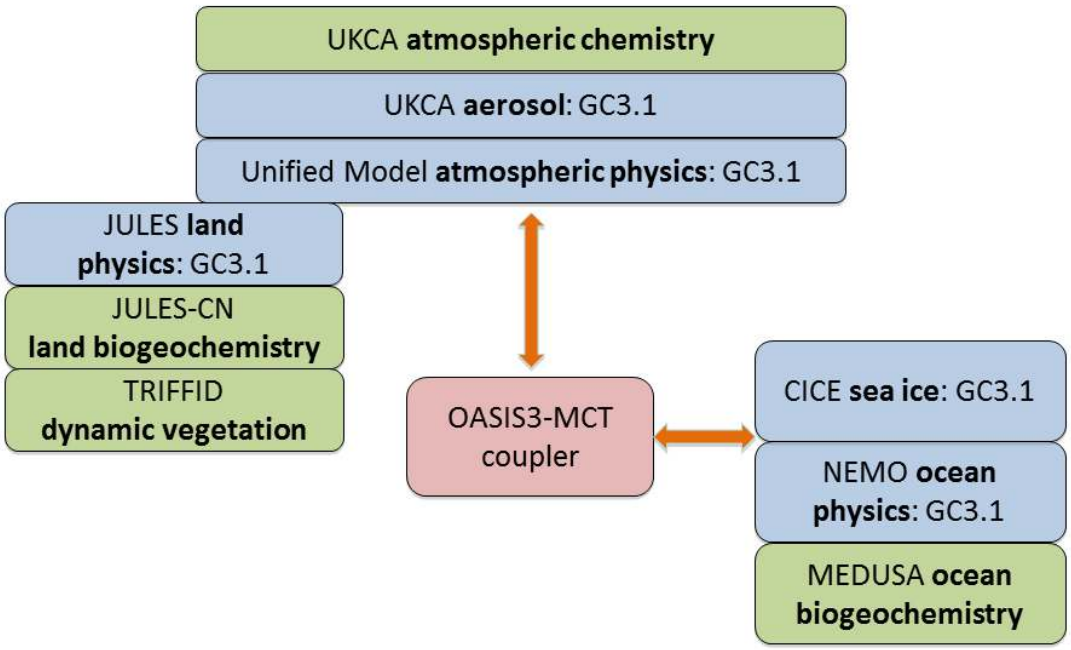

Figure 1. Schematic architecture of UKESM1. Components of the HadGEM3 physical model are coloured blue, additional earth system components are coloured green, and the coupler is coloured pink.

UKESM1 is currently being used as part of the UK contribution to the latest round of the World Climate Research Programme's Coupled Model Intercomparison Project (CMIP6). Some preliminary results from one of the so-called CMIP6 DECK experiments using UKESM1 are displayed in Figure 2. In these experiments, each UKESM1 historical run was started from a different coupled initial condition drawn from the UKESM1 pre-industrial control (piControl) simulation. Each historical member is plotted starting from 1850, the date at which anthropogenic emissions are introduced into the model. The large (and relatively short) negative spikes denote major volcanic eruptions in the historical period – Krakatoa (1883), Agung (1963) and Pinatubo (1991) being the three largest events – that cause a temporary global cooling. The gradual increase in positive energy entering the ocean from ~1980

onwards is a result of the imbalance in the top of atmosphere radiation budget caused by increasing anthropogenic emission of CO_2 and other greenhouse gases.

Plans have been drawn up for the release of UKESM1 to the climate research community. The model has already been ported to the shared MONSooN platform in order to aid collaboration between the Met Office and NERC, and will soon be made available on ARCHER, the UKRI national platform, thanks to our colleagues in the Computational Modelling Services (CMS) unit of the National Centre for Atmospheric Science. As with other models, CMS will also provide front-line support (in collaboration with the UKESM core group) for UKESM1 after its release later this year.

UKESM1 will be delivered as a Rose suite (see Figure 3 for a snapshot from the control panel for the UKESM1 Rose suite). Rose is the Met Office framework for developing and running meteorological applications. We plan to deliver two configurations of the model:

- a fully coupled configuration, making use of all the components in Figure 1, and
- an atmosphere-only (so-called AMIP) configuration, in which the model atmosphere is forced by observed sea surface temperature and sea ice boundary conditions.

The coupled configuration will be set up to run the CMIP6 historical experiment; switching it to run the pre-industrial control experiment will require only a different set of forcing data.

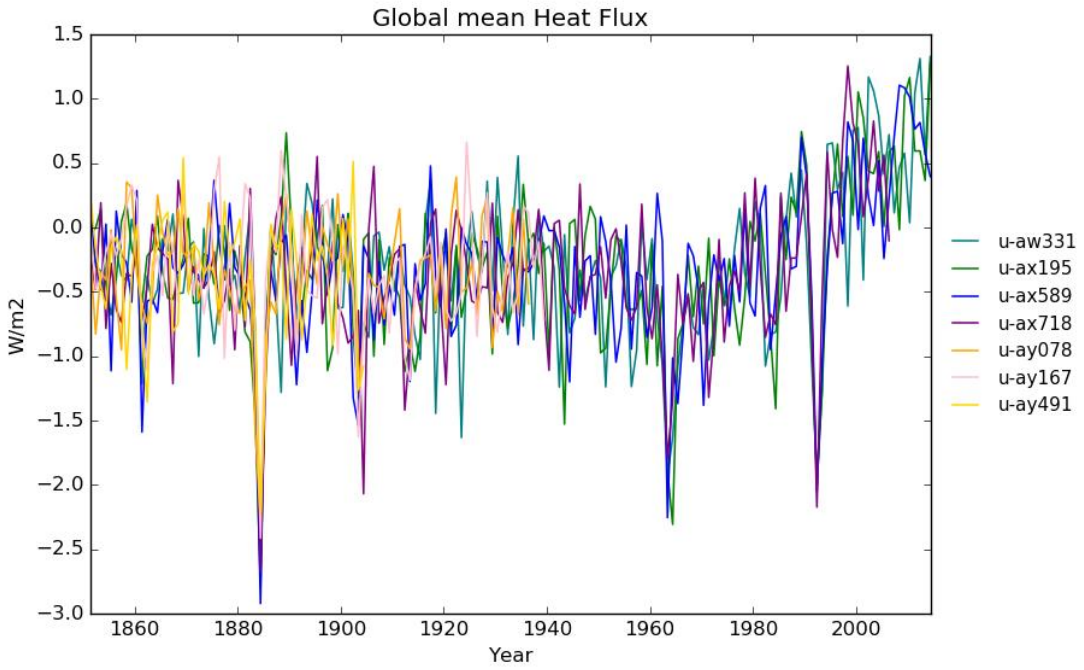

Figure 2. Preliminary results from historical simulations for seven UKESM1 runs showing global mean heat flux into the ocean in watts per square metre (positive values indicate heat entering the ocean).

The model is currently undergoing final scientific testing. Following its port to ARCHER and other platforms (specifically, MONSooN and NEXCS in the UK, plus those used by our overseas collaborators), UKESM1 will be made available as a beta version to a selected group

of users, before being released to the climate modeling community later this year. In addition to the full UKESM1 release, we are working on a number of extensions to this first release. These include; (i) A version of UKESM1 (referred to as UKESM1-CN) which retains the full interactive treatment of the global carbon cycle, but runs with prescribed chemical oxidants and ozone rather than interactive atmospheric chemistry. This configuration runs ~50% faster than the full model, and will be useful for experiments not requiring the more complete treatment of atmospheric chemistry available in the UKESM1. (ii) Inclusion of interactive modules for the Greenland and Antarctic ice sheets, referred to as UKESM1-IS. We aim to release these extensions to UKESM1 in late 2018 or early 2019.

For further information, or to be kept informed about the release, please contact Jeremy Walton (jeremy.walton@metoffice.gov.uk).

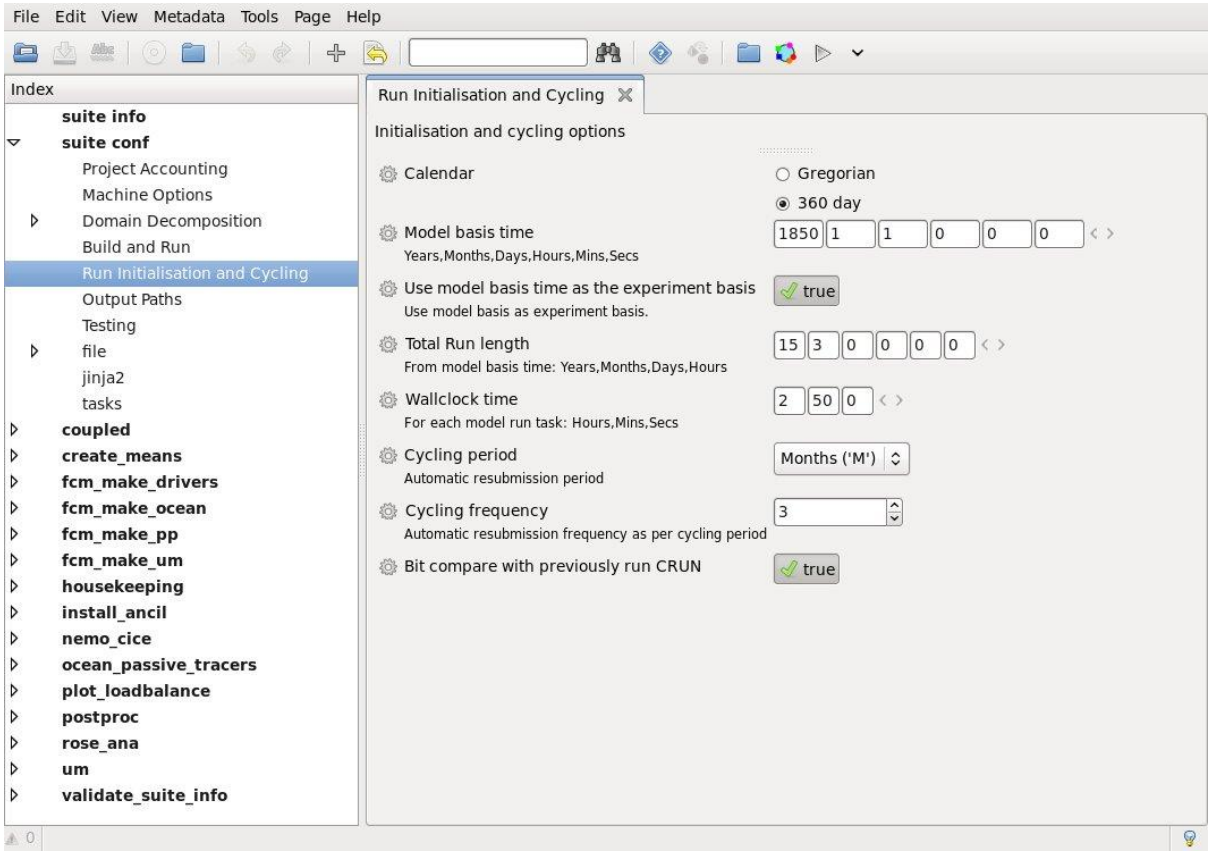

Figure 3. Part of the control panel in the UKESM1 Rose suite. This pane allows the user to set the run duration, wallclock time, job resubmission period and other parameters associated with the run.