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**PRIMAVERA**

Grant Agreement 641727

**PRocess-based climate sIMulation: AdVances in high resolution modelling and European climate Risk Assessment**

# Deliverable D*4.2*

*Datasets from all model integrations fully documented with appropriate meta-data*

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| Deliverable Title | Datasets from all model integrations fully documented with appropriate meta-data | |
| Brief Description | Summarising datasets produced in WP4 and their publication status | |
| WP number | 4 | |
| Lead Beneficiary | *MET OFFICE* | |
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| | | *P - Prototype* |
| | | *D - Demonstrator* |
| | | *O - Other* |
| Dissemination Level/ Audience | PU | *PU - Public* |
| | | *PP - Restricted to other programme participants, including the Commission services* |
| | | *RE - Restricted to a group specified by the consortium, including the Commission services* |
| | | *CO - Confidential, only for members of the consortium, including the Commission services* |

## Table of Contents

## 1. Executive Summary

This report is a brief summary of the datasets produced as part of the WP4 model simulations, and the progress made in producing appropriate metadata and publishing them to the Earth System Grid Federation (ESGF) as part of CMIP6, or for sharing in other ways.

## 2. Project Objectives

With this deliverable, the project has contributed to the achievement of the following objectives (DOA, Part B Section 1.1) WP numbers are in brackets:

| No. | Objective | Yes | No |
|---|---|---|---|
| A | To develop a new generation of global high-resolution climate models. *(3, 4, 6)* | | X |
| B | To develop new strategies and tools for evaluating global high-resolution climate models at a process level, and for quantifying the uncertainties in the predictions of regional climate. *(1, 2, 5, 9, 10)* | | X |
| C | To provide new high-resolution protocols and flagship simulations for the World Climate Research Programme (WCRP)'s Coupled Model Intercomparison Project (CMIP6) project, to inform the Intergovernmental Panel on Climate Change (IPCC) assessments and in support of emerging Climate Services. *(4, 6, 9)* | X | |
| D | To explore the scientific and technological frontiers of capability in global climate modelling to provide guidance for the development of future generations of prediction systems, global climate and Earth System models (informing post-CMIP6 and beyond). *(3, 4)* | | X |
| E | To advance understanding of past and future, natural and anthropogenic, drivers of variability and changes in European climate, including high impact events, by exploiting new capabilities in high-resolution global climate modelling. *(1, 2, 5)* | | X |
| F | To produce new, more robust and trustworthy projections of European climate for the next few decades based on improved global models and advances in process understanding. *(2, 3, 5, 6, 10)* | X | |
| G | To engage with targeted end-user groups in key European economic sectors to strengthen their competitiveness, growth, resilience and ability by exploiting new scientific progress. *(10, 11)* | | X |
| H | To establish cooperation between science and policy actions at European and international level, to support the development of effective climate change policies, optimize public decision making and increase capability to manage climate risks. *(5, 8, 10)* | | X |

## 3. Detailed Report on Progress

The frontiers simulations performed as part of WP4 comprised:

a. CMIP6 HighResMIP simulations with further enhanced model resolutions, specifically in the ocean reaching to eddy-rich resolutions around 10km – both with regular grids and with an unstructured mesh model
b. Higher resolution global atmosphere-only simulations to study the impact of the representation of convection at sub-10km scales
c. The impact that stochastic physics makes to model simulation

Only the simulations in (a) can be considered for publication to ESGF as these are the only CMIP6-compatible simulations. More details on each simulation type will now be given.

### 3.1 CMIP6 simulations

Five groups planned to run eddy-rich coupled simulations (with ocean resolution of 1/10° or finer) as part of WP4, following the HighResMIP experimental design, with models: HadGEM3-GC31-{MH,HH}, EC-Earth3P-VHR, MPI-ESM1-2-ER, CNRM-CM6-1-VHR, AWI-CM-1-1-VHR.

The HadGEM3-GC31-MH and HH simulations are completed. The MH spinup-1950 data has been published to ESGF (Roberts 2017a). The HH data is in the process of being published, with references (Roberts 2017b; Coward and Roberts 2017).

The EC-Earth3P-NHR simulations (control-1950 and hist-1950) are ongoing – this data will be published directly to the Barcelona ESGF node once processed, with reference EC-Earth Consortium (EC-Earth) (2018).

The CNRM-CM6-1-VHR suffered problems in model development, it now runs but still has some science issues. Once available, this data will be published directly to the French ESGF node.

The MPI-ESM-1-2-ER simulation will be published directly to the DKRZ ESGF node and searchable from https://cera-www.dkrz.de/WDCC/ui/cerasearch/.

The AWI simulation data (including the eddy-rich AWI-CM-1-1-VHR simulation) will also be published directly to the DKRZ ESGF node once completed and CMORised.

### 3.2 Higher resolution atmosphere-only

Two groups (ECMWF and UREAD-METOFFICE) contributed sub-5km global atmosphere-only model simulations to the DYAMOND project (Stevens et al. 2019), and these groups have been involved in the multi-model analysis of this data for both

PRIMAVERA and DYAMOND. The experimental design differs from HighResMIP, and the data sizes are even larger, so this data has been shared on a variable-by-variable basis by ECMWF and UREAD, and it has not been published. Some of it has been converted to a simpler netcdf format by UREAD for sharing with the DYAMOND project via the DKRZ site.

### 3.3 Stochastic physics simulations

Stochastic physics is a method of better sampling subgrid-scale variability in models, which can have significant impacts on the model evolution, variability and climatology.

Additional model simulations parallel to HighResMIP experiments were produced in WP4 to assess the impact that stochastic physics schemes have on model simulation. These were performed with the EC-Earth3P (UOXF) and HadGEM3-GC31-LL models (Met Office).

The HadGEM3-GC31-LL control-1950 simulation was CMORised as usual and uploaded to JASMIN with a rip code r1i1p2f1. The EC-Earth3P data was not uploaded but was given appropriate metadata locally to ensure correct analysis.

## References

Datasets

Roberts, Malcolm (2017a). MOHC HadGEM3-GC31-MH model output prepared for CMIP6 HighResMIP spinup-1950. Version YYYYMMDD[1].Earth System Grid Federation. https://doi.org/10.22033/ESGF/CMIP6.6327.

Roberts, Malcolm (2017b). MOHC HadGEM3-GC31-HH model output prepared for CMIP6 HighResMIP. Earth System Grid Federation. http://cera-www.dkrz.de/WDCC/meta/CMIP6/CMIP6.HighResMIP.MOHC.HadGEM3-GC31-HH

Coward, Andrew; Roberts, Malcolm (2017). NERC HadGEM3-GC31-HH model output prepared for CMIP6 HighResMIP. Earth System Grid Federation. http://cera-www.dkrz.de/WDCC/meta/CMIP6/CMIP6.HighResMIP.NERC.HadGEM3-GC31-HH

EC-Earth Consortium (EC-Earth) (2018). EC-Earth-Consortium EC-Earth3P-VHR model output prepared for CMIP6 HighResMIP. Earth System Grid Federation. http://cera-www.dkrz.de/WDCC/meta/CMIP6/CMIP6.HighResMIP.EC-Earth-Consortium.EC-Earth3P-VHR

Papers

Stevens, B., Satoh, M., Auger, L. et al. DYAMOND: the DYnamics of the Atmospheric general circulation Modeled On Non-hydrostatic Domains. Prog Earth Planet Sci 6, 61 (2019). https://doi.org/10.1186/s40645-019-0304-z