Call: H2020-SC5-2014-two-stage

Topic: SC5-01-2014

PRIMAVERA

Grant Agreement 641727

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

Deliverable D*6.5*

Stream 2 historical AMIP runs

Deliverable Title	*Stream 2 historical AMIP simulations*	
Brief Description	*Report on stream 2 historic AMIP simulations completed*	
WP number	6	
Lead Beneficiary	*Rein Haarsma KNMI*	
Contributors	*Rein Haarsma* *Jon Seddon* *Malcolm Roberts*	
Creation Date		September 23, 2019
Version Number		V1
Version Date		
Deliverable Due Date		09/30/2019
Actual Delivery Date		
Nature of the Deliverable	X	*R - Report*
		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

Version	**Date**	**Modified by**	**Comments**
V1	23/09/2019	Rein Haarsma	

Table of Contents

1. Executive Summary

The stream 2 historic AMIP simulations have been completed, post processed and uploaded to JASMIN. Part of the stream 2 historic AMIP simulations consist of simulations with improved model components of WP3 as described in the DoW. In addition to that it consists of extra stream 1 historic AMIP ensemble simulations for a better evaluation of natural variability. Output of stream 2 historic AMIP simulations is CMORized according to the CMIP6 and HighResMIP requirements, quality checked and stored on JASMIN. Quality control is performed and the data is now ready for analyses. First results are becoming available. The data is presently being made publicly available on the Earth System Grid Federation (ESGF) data nodes, providing the basis for publications which will enter the IPCC AR6 report.

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)*	Y	
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)*		N
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)*	Y	
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)*		N
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)*		N
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)*		N
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)*		N
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)*		N

3. Detailed Report

3.1 Model simulations

The stream 2 simulations as outlined in the DoW would consist of a focused subset of high-resolution runs with improved model components derived from WP2,3 with input from WP 11 from user requirements. Only a smaller number of high-resolution simulations compared to stream 1 was foreseen due to limitations in computing time and data storage.

The stream 1 simulations only consists of 1 ensemble member for each experiment. Due to natural variability this hampers the evaluation of the impact of resolution. For many analyses an ensemble size of one is insufficient for a proper evaluation of the added value of resolution due to natural variability. During the PRIMAVERA meeting on Monday November 12, 2018, it was decided to enhance the stream 1 ensemble size for better sampling of the natural variability.

In agreement with the original PRIMAVARA DoW new simulations with improved model components were also designed. The full set of stream 2 historical AMIP simulations is outlined in table II. Compared with stream 1 it consists of a much larger number of simulations. It shows that 4 models will provide ensembles with a size of 3 or larger. This is much larger than was foreseen in the DoW. The reason is that many hard and software issues with respect to high resolution simulation and data storage were resolved during stream 1, thereby enabling efficient production of high-resolution simulations. The additional ensemble members of the stream 1 *highresSST-present* simulations will be stored at JASMIN to facilitate multi-model ensemble analyses.

The simulations with improved model components were performed with improved land-surface components by CMCC and the Met. Office, and stochastic parametrizations by the Univ. of Oxford. The MPI did not contribute to the stream 2 historical AMIP simulations, because they used their resources for the ocean eddy resolving stream 2 coupled simulations.

In designing the plan for the stream 2 simulations we consulted outside PRIMAVERA (i.e. with our External Experts and other interested parties) so that we produced the most useful outputs.

All the runs are finished. Due to the large amount of data, much more than was originally planned in the DoW, and the limited band with for uploading the data to JASMIN, a small amount the runs still has to be uploaded to JASMIN. This limited band with also motivated CERFACS to upload part of their simulations to the ESGF nodes to allow investigation of the data for the AR6 IPCC report. Also because of the limited storage capacity of JASMIN, it was decided that the simulations with new parametrizations will be stored at the local institutions. Other PRIMAVERA partners can approach those institutions for the data.

In conclusion the amount of stream 2 AMIP simulations delivered is much more than was foreseen in the DoW and will substantially enhance the outcome and impact of PRIMAVERA on science, stakeholders and policy.

Model	Institute	Country	Atmos
CMCC	CMCC	Italy	100 km 25 km
CNRM-CM6	CNRM-CERFACS	France	T127 (~ 100km) T359 (~35km)
EC-Earth3	KNMI/ BSC/ SMHI/ CNR	EU	T255 (~50km) T511 (~25km)
ECMWF-IFS	ECMWF	EU	Tco199 (~50km) Tco399(~25km)
ECHAM	MPI	Germany	T127 (~100km) T255 (~50km)
HadGEM-GC3.1	Met Office	UK	130km 60km 25km

Table I. PRIMAVERA models and their resolutions (standard and high) that have performed the historical AMIP stream 2 simulations. The Met. Office. has performed those simulations for three resolutions (standard, medium and high).

model/institution	Additional stream 1 members. CMORized and	Runs with new parametrizations.

	uploaded to JASMIN.	Stored at local institute.
HadGEM3-GC31	4 LM 2 MM 2 HM All available on JASMIN 1 MM still to CMORize Sub-period 1979-2014: 10 LM, 10 MM, 2 HM; no CMORisation planned	Land component physics (1-3 depending on offline) Experiments ongoing (rivers mostly done, soils ~30% done).
EC-Earth consortium (KNMI, SMHI, BSC, Oxford Univ.)	2 LR 2 HR All runs finished. 2 LR and 1 HR still being CMORized and uploaded.	LR + different stochastic parameterisations (3 members). CMORized and stored locally at Oxford. Covers 1950-2015.
CMCC		Land component physics 1979-2014. Experiments with new high-resolution soil mineral maps (SoilGrids at 1-Km resolution). AMIP runs in preparation.
MPI-M		
CNRM-CERFACS	9 LR (runs completed - CMORized - Direct publication to ESGF started for r2) 9 HR (runs completed - CMORized)	
ECMWF	7 LR 5 HR (2 of which with 6hr output, rest 24hr output), 1950-2014	

Table II. Stream 2 historical AMIP simulations. The additional stream 1 simulations are uploaded to JASMIN. The others are stored on the local institutions that have performed the simulations.

3.2 Data

The data request for the *highresSST-present* Tier1, data is described in the CMIP6 and HighResMIP data requests outlined by the Working Group on Climate Models (WGCM)

https://earthsystemcog.org/projects/wip/CMIP6DataRequest.

The requested output data volume for HighResMIP Tier 1 is by far the largest (http://clipc-services.ceda.ac.uk/dreq/tab01_1_1.html) of all CMIP6 MIPs due to high

spatial and temporal resolution of the data. This is further enhanced by the increased ensemble size.

The PRIMAVERA additional members of *highresSST-present* are uploaded to the JASMIN infrastructure of the Centre for Environmental Data Analysis (CEDA). It is hosted at the Science and Technology Facilities Council Rutherford Appleton Laboratory.

(http://www.ceda.ac.uk/projects/jasmin/).

Full details of JASMIN can be found at the JASMIN site http://www.jasmin.ac.uk/

The PRIMAVERA data available at JASMIN can be searched and queried using the Data Management Tool (DMT) https://prima-dm.ceda.ac.uk/, developed for PRIMAVERA. It is a graphic web based tool. The DMT's Variable Received Query can be used to search through the *highresSST-present* data.

Because of the large amount of data the philosophy of PRIMAVERA for analyzing the data is to bring your script to the data instead bringing the data to your analysis. To facilitate this JASMIN has a set of scientific analysis servers and a batch processing cluster. For the PRIMAVERA partners the documentation of JASMIN, including training video's, is available from the PRIMAVERA wiki.

All PRIMAVERA data received at JASMIN is checked using the primavera-val tool (https://github.com/PRIMAVERA-H2020/primavera-val). This checks that the essential metadata is correct and that a random data point can be read, ensuring that the file has not been corrupted during transfer. Additionally, data that has been received since the CMIP6 PrePARE validation tool was released is also checked with PrePARE. PrePARE ensures that a file fully complies with the CMIP6 meta data standards. Files that were received before PrePARE was available will be checked with PrePARE before publication on the Earth System Grid Federation (ESGF). Software has been developed to correct any meta data issues that are identified by PrePARE before submission to the ESGF.

All of the PRIMAVERA partners providing stream 1 data have now developed and optimised their own systems to interface to their HPCs, CMORize the data and transfer it to JASMIN. These systems are unique to each partner's own IT systems, although best practice was shared with other partners during the development. The use of these optimised systems allowed stream 2 data to be easily generated and shared amongst partners.

4. Lessons Learnt

The impact of increasing horizontal resolution on the weather and climate simulated by the models appears often hard to evaluate due to natural variability. Increasing the ensemble size appeared to be essential for a better evaluation.

Developing and running climate models, post-processing the data and uploading it to JASMIN at a resolution which is at the edge of what is presently technically feasible caused difficulties and problems that had to be solved for the stream 1 simulations. This was a main factor in the delay of the stream 1 simulations. Ones these difficulties and problems were solved, enhancing the ensemble size was much more feasible than was originally foreseen.

5. Links Built

During the Stream 1 simulations strong links have been built with the high resolution global modelling community outside Europa, in particular with modelling groups in Asia and the USA, and with international climate research initiatives such as CLIVAR. PRIMAVERA has been the initiator of HighResMIP, which places Europe at the forefront of the high resolution global modelling community. Enhancing the ensemble size will even more emphasize the importance of PRIMAVERA.

Also the very high frequency output of atmospheric quantities such as near-surface air temperature and wind speed provides the basis for user engagement such as energy companies. Their interest motivated the PRIMAVERA partners to provide for some variables additional high frequency output that is relevant for those sectors.