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 D9.5

Publication of the PRIMAVERA Stream 2 Data Set

Deliverable Title	Publication of the PRIMAVERA Stream 2 data set	
Brief Description	Publication of PRIMAVERA data set for Stream 2 through data DOIs and data description publication	
WP number	9	
Lead Beneficiary	Met Office	
Contributors	Jon Seddon, Met Office	
Creation Date Version Number Version Date	22nd May 2020 1.0 27th May 2020	
Deliverable Due Date Actual Delivery Date	31st May 2020 27th May 2020	
Nature of the Deliverable	R	*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**
1.0	27th May 2020	Jon Seddon	First version

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Acknowledgements

Deliverable 9.5 was achieved through the work of many PRIMAVERA project members across work packages 9, 6 and others. There are too many people involved to credit each individually but this deliverable wouldn't have been achieved without their hard work.

1. Executive Summary

The PRIMAVERA Stream 2 simulations have now been published. The data has either been uploaded to JASMIN, the metadata for each file published on the PRIMAVERA data management tool and the files published to the Earth System Grid Federation (ESGF) for permanent archive, or the files have been published directly to the ESGF. DOIs have been published for all of the datasets. PRIMAVERA users have been accessing the published data since 2018 and it is now freely available to the global community through the ESGF. The data is fully described through the CMIP6 citation and ES-DOC services, and through model description papers.

2. Project Objectives

With this deliverable, the project has contributed to the achievement of the objectives shown in Table 1 (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)*	Yes	
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)*	Yes	
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)*	Yes	
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)*	Yes	
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)*	Yes	
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)*	Yes	
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)*	Yes	
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)*	Yes	

Table 1 – The objectives that this deliverable has contributed to.

3. Detailed Report

Stream 2 data from the PRIMAVERA modelling centres has been published to the Earth System Grid Federation (ESGF) where it has been placed in long-term archive and made freely available to the global community. The combined Stream 1 and Stream 2 simulations consist of 3.5 million netCDF files containing 1.8 petabytes of data. The data complies with the HighResMIP protocol (Haarsma et al. 2016) and all data files strictly comply with the CMIP6 project (Eyring et al. 2016) model output requirements and metadata standards.

The publication has proceeded according to the PRIMAVERA Data Management Plan that was published as deliverable D9.1 in May 2016 and according to the Stream 2 Data Management Plan that was published as milestone MS25 in December 2018.

The HighResMIP protocol includes the following experiments at standard and high resolution:

- *highresSST-present* atmosphere-only simulation from 1950 to 2014
- *highresSST-future* an extension of the atmosphere-only simulation to 2050
- *spinup-1950* at least 30 years for the spin-up of the coupled model
- *hist-1950* coupled simulation from 1950 to 2014 with historic forcings
- *control-1950* 100 years of coupled simulation with a constant 1950s forcing
- *highres-future* an extension of hist-1950 to 2050

The models and experiments run by each of the modelling groups are shown in Table 2 in Appendix A. Descriptions of each of these models are available on the PRIMAVERA external website at https://www.primavera-h2020.eu/modelling/our-models/ including links to the model description journal papers. Full information is also included in the CMIP6 citation and ES-DOC services, which are linked from the ESGF interface and from the further_info_url attribute in each file.

Initially the data was published to JASMIN and made available to project members. Selected external users working with PRIMAVERA users were also granted access to the data at JASMIN using the instructions available on the external website at https://www.primavera-h2020.eu/modelling/data-code/. The data began to be added to the CEDA archive and published to the ESGF in March 2019.

Digital Object Identifiers (DOIs) to provide a persistent link to the data have been generated by the CMIP6 data citation team. The DOIs at model level are summarised on the PRIMAVERA external website at https://www.primavera-h2020.eu/modelling/ and have been included in Appendix B. The DOIs at the experiment level and Handle persistent identifiers at the variable level are shown for every variable in the ESGF interface.

An example of the Stream 2 additional ensemble members being used is shown in plot of differences in summer surface temperature trends shown in Figure 1 in Appendix C, which was reproduced with permission from (Boe et al. 2020). In this study the Stream 2 ensemble members were used to demonstrate the range of possible temperature trends from each model.

4. Lessons Learnt

The Stream 2 data has been published according to the Data Management Plan published in deliverable D9.1 and milestone MS25. The DMT has been developed iteratively from this plan. The evolution of the DMT can be seen in its repository at https://github.com/PRIMAVERA-H2020/primavera-dmt.

All members of the project will contribute to a full lessons learnt report for deliverable D9.6 towards the end of the project.

5. Links Built

Work Package 9 (WP9) has worked with all of the other work packages to make the Stream 1 data available in a useful format. WP9 has worked closely with the global CMIP6 project to identify and fix bugs in the CMIP6 data request and to test the ESGF.

References

Boe, Julien, Laurent Terray, Marie-Pierre Moine, Sophie Valcke, Alessio Bellucci, Sybren Drijfhout, Reindert Julius Haarsma, et al. 2020. “Past Long-Term Summer Warming over Western Europe in New Generation Climate Models: Role of Large-Scale Atmospheric Circulation.” *Environmental Research Letters*, April 2020. https://doi.org/10.1088/1748-9326/ab8a89.

Eyring, Veronika, Sandrine Bony, Gerald A. Meehl, Catherine A. Senior, Bjorn Stevens, Ronald J. Stouffer, and Karl E. Taylor. 2016. “Overview of the Coupled Model Intercomparison Project Phase 6 (CMIP6) Experimental Design and Organization.” *Geoscientific Model Development* 9 (5): 1937–58. https://doi.org/10.5194/gmd-9-1937-2016.

Haarsma, Reindert J., Malcolm J. Roberts, Pier Luigi Vidale, Catherine A. Senior, Alessio Bellucci, Qing Bao, Ping Chang, et al. 2016. “High Resolution Model Intercomparison Project (HighResMIP v1.0) for CMIP6.” *Geoscientific Model Development* 9 (11): 4185–4208. https://doi.org/10.5194/gmd-9-4185-2016.

Appendix A

	highresSST-present	highresSST-future	spinup-1950	hist-1950	control-1950	highres-future
AWI-CM-1-1-LR			*r1i1p1f2*	*r1i1p1f2*	*r1i1p1f2*	
AWI-CM-1-1-HR			*r1i1p1f2*	*r1i1p1f2*	*r1i1p1f2*	
CMCC-CM2-HR4	*r1i1p1f1*	*r1i1p1f1*		*r1i1p1f1*	*r1i1p1f1*	*r1i1p1f1*
CMCC-CM2-VHR4	*r1i1p1f1*	*r1i1p1f1*		*r1i1p1f1*	*r1i1p1f1*	*r1i1p1f1*
CNRM-CM6-1	*r1i1p1f2*, r2i1p1f2, r3i1p1f2, r4i1p1f2, r5i1p1f2, r6i1p1f2, r7i1p1f2, r8i1p1f2, r9i1p1f2, r10i1p1f2	*r1i1p1f2*, r2i1p1f2, r3i1p1f2, r4i1p1f2, r5i1p1f2, r6i1p1f2, r7i1p1f2, r8i1p1f2, r9i1p1f2, r10i1p1f2	*r1i1p1f2*	*r1i1p1f2*, r2i1p1f2, r3i1p1f2	*r1i1p1f2*	*r1i1p1f2*, r2i1p1f2, r3i1p1f2
CNRM-CM6-1-HR	*r1i1p1f2*, r2i1p1f2, r3i1p1f2, r4i1p1f2, r5i1p1f2, r6i1p1f2, r7i1p1f2, r8i1p1f2, r9i1p1f2, r10i1p1f2	*r1i1p1f2*, r2i1p1f2, r3i1p1f2, r4i1p1f2, r5i1p1f2, r6i1p1f2, r7i1p1f2, r8i1p1f2, r9i1p1f2, r10i1p1f2		*r1i1p1f2*, r2i1p1f2, r3i1p1f2	*r1i1p1f2*	*r1i1p1f2*, r2i1p1f2, r3i1p1f2
EC-Earth3P	*r1i1p1f1*, r2i1p1f1, r3i1p1f1	*r1i1p1f1*, r2i1p1f1, r3i1p1f1	*r1i1p2f1*	*r1i1p2f1*, r2i1p2f1, r3i1p2f1	*r1i1p2f1*, r2i1p2f1, r3i1p2f1	*r1i1p2f1*, r2i1p2f1, r3i1p2f1
EC-Earth3P-HR	*r1i1p1f1*, r2i1p1f1, r3i1p1f1	*r1i1p1f1*, r2i1p1f1, r3i1p1f1	*r1i1p1f1*	*r1i1p2f1*, r2i1p2f1, r3i1p2f1	*r1i1p2f1*, r2i1p2f1, r3i1p2f1	*r1i1p2f1*, r2i1p2f1, r3i1p2f1

ECMWF-IFS-LR	*r1i1p1f1*, r2i1p1f1, r3i1p1f1, r4i1p1f1, r5i1p1f1, r6i1p1f1, r7i1p1f1, r8i1p1f1		*r1i1p1f1*	*r1i1p1f1*, r2i1p1f1, r3i1p1f1, r4i1p1f1, r5i1p1f1, r6i1p1f1, r7i1p1f1, r8i1p1f1	*r1i1p1f1*	
ECMWF-IFS-MR			r1i1p1f1	r1i1p1f1, r2i1p1f1, r3i1p1f1	r1i1p1f1	
ECMWF-IFS-HR	*r1i1p1f1*, r2i1p1f1, r3i1p1f1, r4i1p1f1, r5i1p1f1, r6i1p1f1		*r1i1p1f1*	*r1i1p1f1*, r2i1p1f1, r3i1p1f1, r4i1p1f1, r5i1p1f1, r6i1p1f1	*r1i1p1f1*	
HadGEM3-GC31-LL			*r1i1p1f1*	*r1i1p1f1*, r1i1p2f1, r1i2p1f1, r1i3p1f1, r1i4p1f1, r1i5p1f1, r1i6p1f1, r1i7p1f1, r1i8p1f1	*r1i1p1f1*	*r1i1p1f1*, r1i2p1f1, r1i3p1f1, r1i4p1f1
HadGEM3-GC31-LM	*r1i1p1f1*, r1i2p1f1, r1i3p1f1, r1i14p1f1, r1i15p1f1	*r1i1p1f1*, r1i2p1f1, r1i3p1f1, r1i14p1f1, r1i15p1f1				
HadGEM3-GC31-MM	*r1i1p1f1*, r1i2p1f1, r1i3p1f1	*r1i1p1f1*, r1i2p1f1, r1i3p1f1	*r1i1p1f1*	*r1i1p1f1*, r1i2p1f1, r1i3p1f1	*r1i1p1f1*	*r1i1p1f1*, r1i2p1f1, r1i3p1f1
HadGEM3-GC31-MH			*r1i1p1f1*	*r1i1p1f1*	*r1i1p1f1*	*r1i1p1f1*
HadGEM3-GC31-HM	*r1i1p1f1*, r1i2p1f1, r1i3p1f1	*r1i1p1f1*, r1i2p1f1, r1i3p1f1		*r1i1p1f1*, r1i2p1f1, r1i3p1f1	*r1i1p1f1*	*r1i1p1f1*, r1i2p1f1, r1i3p1f1
HadGEM3-				*r1i1p1f1*	*r1i1p1f1*	*r1i1p1f1*

GC31-HH						
MPI-ESM1-2-HR	*r1i1p1f1*	*r1i1p1f1*		*r1i1p1f1*	*r1i1p1f1*	*r1i1p1f1*
MPI-ESM1-2-XR	*r1i1p1f1*	*r1i1p1f1*		*r1i1p1f1*	*r1i1p1f1*	*r1i1p1f1*

Table 2 – The Stream 1 and Stream 2 ensemble members.

Table 2 shows all of the ensemble members produced during PRIMAVERA. Ensemble members in italic text are from Stream 1 and the members in roman text are Stream 2.

Appendix B

AWI-CM-1-1-LR	https://doi.org/10.22033/ESGF/CMIP6.1209
AWI-CM-1-1-HR	https://doi.org/10.22033/ESGF/CMIP6.1202
CMCC-CM2-HR4	https://doi.org/10.22033/ESGF/CMIP6.1359
CMCC-CM2-VHR4	https://doi.org/10.22033/ESGF/CMIP6.1367
CNRM-CM6-1	https://doi.org/10.22033/ESGF/CMIP6.1925
CNRM-CM6-1-HR	https://doi.org/10.22033/ESGF/CMIP6.1387
EC-Earth3P	https://doi.org/10.22033/ESGF/CMIP6.2322
EC-Earth3P-HR	https://doi.org/10.22033/ESGF/CMIP6.2323
ECMWF-IFS-LR	https://doi.org/10.22033/ESGF/CMIP6.2463
ECMWF-IFS-MR	https://doi.org/10.22033/ESGF/CMIP6.2465
ECMWF-IFS-HR	https://doi.org/10.22033/ESGF/CMIP6.2461
HadGEM3-GC31-LL	https://doi.org/10.22033/ESGF/CMIP6.1901
HadGEM3-GC31-LM	https://doi.org/10.22033/ESGF/CMIP6.1321
HadGEM3-GC31-MM	https://doi.org/10.22033/ESGF/CMIP6.1902
HadGEM3-GC31-MH	https://doi.org/10.22033/ESGF/CMIP6.1762
HadGEM3-GC31-HM	https://doi.org/10.22033/ESGF/CMIP6.446
	https://doi.org/10.22033/ESGF/CMIP6.1824
HadGEM3-GC31-HH	https://doi.org/10.22033/ESGF/CMIP6.445
	https://doi.org/10.22033/ESGF/CMIP6.1822
MPI-ESM1-2-HR	https://doi.org/10.22033/ESGF/CMIP6.762
MPI-ESM1-2-XR	https://doi.org/10.22033/ESGF/CMIP6.10290

Table 3 – The DOIs allocated to each model's data in the ESGF archive.

Appendix C

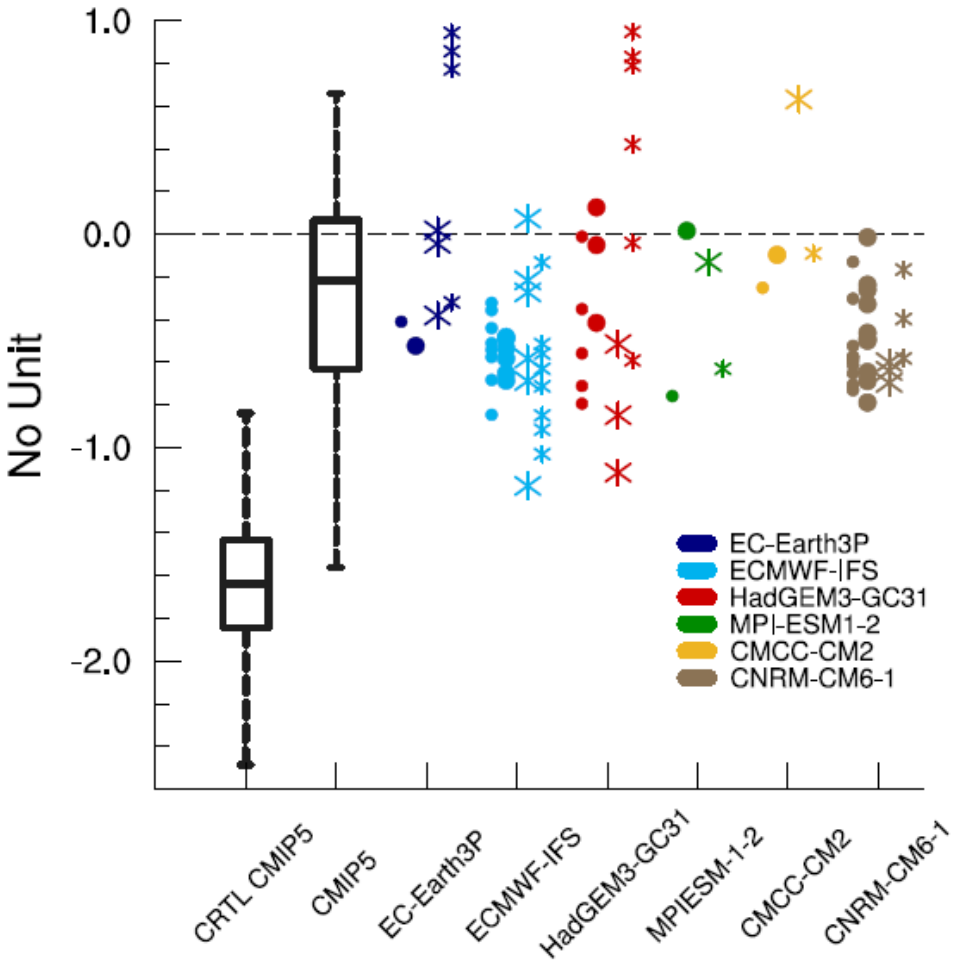

Figure 1 - Differences of JJA surface temperature trends.

Figure 1 shows the differences of JJA surface temperature trends (K over period) averaged over western Europe (35°N, 72°N, -10°E, 15°E, land points only) between different climate simulations and observations (BEST estimate). The trends are computed on the 1951-2014 period except for CTRL CMIP5. For CTRL CMIP5, 64-year overlapping trends in CMIP5 preindustrial simulations are computed. The distribution of the difference of trends with the observed one is then computed independently for each model, and the ensemble mean distribution is shown. For the six PRIMAVERA models, the 1951-2014 trends are computed for all the members available at lower (small symbols) and higher resolution (large symbols), for the forced atmospheric (circle) and coupled (star) simulations. The box-and-whiskers plots show the minimum, the 25th percentile, the median, the 75th percentile and the maximum of the distribution. Reproduced with permission from (Boe et al. 2020).