PRIMAVERA

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

PRIMAVERA climate models: does high-resolution global modelling matter?

The PRIMAVERA project develops and uses a new generation of high-resolution climate models, which feature improvements in physics and in the simulation of small scale processes. All of these advances are intended to better represent processes and extreme phenomena that have a high impact on society and the environment, compared to existing lower-resolution models.

Outcomes of the project will be used to support climate risk assessment activities focused on several sectors across Europe.

In some example studies in Europe, PRIMAVERA models were found to outperform previous climate models drawn from the CORDEX and CMIP5 datasets.

PRIMAVERA – new global high-resolution climate models

A new generation of high-resolution, global climate models (GCMs) is developed and used within the PRIMAVERA project. They feature improved model physics and representation of small scale processes. The goal is to improve our understanding of the key processes affecting European climate, and therefore to obtain more credible simulation of extreme events that impact society, in support of risk assessment activities in Europe.

The table below shows the PRIMAVERA modelling teams, and the climate models they are using. The spatial resolution of the models can be as high as 25 km and the temporal resolution (not shown) can be sub-daily. Models are also run at spatial and temporal resolutions comparable to existing lower resolution GCMs, to explore the effect of resolution within PRIMAVERA on the simulation of climate and extreme events. This also allows for comparison with other modelling activities, such as the Coupled Model Inter-comparison Project – phase 5 ("CMIP5"). Simulations from coupled as well as from atmosphere-only models are being performed in PRIMAVERA, to allow studying climate processes in both model configurations.

Table 1. The PRIMAVERA models and their resolutions

Institution → Model details and resolution ↓	Met Office, U Reading, NERC (United Kingdom)			EC-Earth, KNMI, SHMI, BSC, CNR (International)		CERFACS (France)		MPI-M (Germany)		AWI (Germany)		CMCC (Italy)		ECMWF (Europe)	
Model name	HadGEM3 GC3.1			EC-Earth3		CNRM-CM6		MPIESM-1-2		AWI-CM 1.0		CMCC-CM2		ECMWF-IFS	
Component – Atmosphere / Ocean / Ice	Unified Model / NEMO / CICE			IFS / NEMO / LIM		ARPEGE / NEMO / GELATO		ECHAM / MPIOM / MPIOM		ECHAM / FESOM / FESIM		CAM / NEMO / CICE		IFS / NEMO / LIM	
Atmosphere only – grid spacing at 50deg N, km	135	60	25	71	36	142	50	67	34	129	64	64	18	50	25
Ocean resolution, km	100	25	25	100	25	100	25	40	40	50	25	25	25	100	25

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Info

PRIMAVERA is a collaboration between 19 leading European research and technology organisations with complementary expertise in climate science, climate change modelling, and high performance computing.

The project is led by the Met Office and the University of Reading.

Media

www.primavera-h2020.eu

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Does high-resolution global modelling matter?

High-resolution information can be obtained either by running high-resolution GCMs, or by downscaling lower-resolution global models (either statistically or dynamically). Compared with low-resolution GCMs, **high-resolution GCMs** resolve and represent various processes and interactions much more explicitly (within the limitations of the modelling set-up) at high spatial resolution (i.e. with small grid boxes) and temporal resolution (i.e. with output saved at multiple time steps per day). **Downscaling approaches** have some advantages, but also drawbacks compared to high resolution global modelling:

- **Statistical**: Fast methods, but rely on the assumption that a past or current relationship between large scale and local variables will remain the same in a future warmer climate. This may not be true**.**
- **Dynamical**: using Regional Climate Models (RCMs). Require less computing time than GCMs and are physically more plausible than the statistical methods, but various factors may lead to their not simulating the climate well: they may acquire any biases in the GCM (or other boundary conditions source); the RCM physics may interact non-linearly with these biases; and there may still be limitations in RCM physics and resolution (Barsugli et al. 2013).

All of these issues need to be considered when using finer-scale climate projections information provided by global high-resolution or downscaled coarser climate model simulations.

A comparison: PRIMAVERA GCMs, CMIP5 GCMs, and CORDEX RCMs

Atmosphere-only **climate model projections of monthly temperature** and **precipitation** from three PRIMAVERA high-resolution models were compared to low-resolution versions of these models, to CMIP5 GCMs, and to high-resolution CORDEX RCMs for the historical period over the Upper Danube region. The figure shows the bias for the variability of precipitation. The bias is normalized and values above 1 (black line) show models that are worse than the multi-model median, while values below 1 show models better than the multi-model median. The PRIMAVERA models output outperforms most of the CORDEX (12.5 km resolution) RCMs and CMIP5 GCMs.

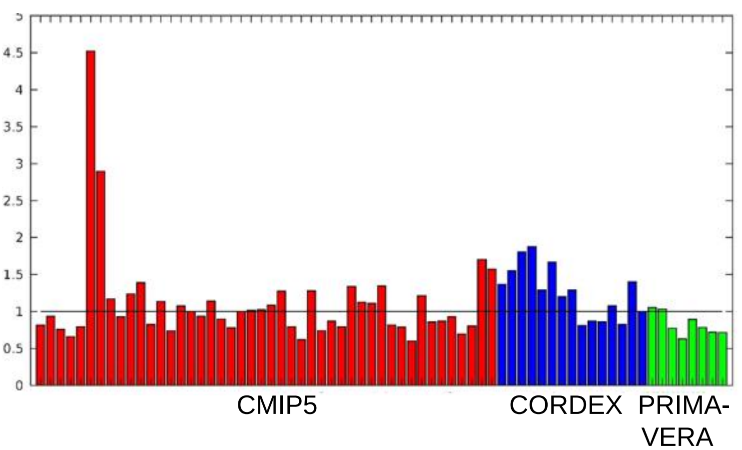

Figure 1. Normalised bias for the variability of precipitation in the Upper Danube region as compared with CRU TS3.25 dataset. CMIP5 models in red, CORDEX models in blue, PRIMAVERA models in green (Strandberg et al., 2018).

References

Barsugli J. et al. (2013) – The practitioner’s dilemma: How to assess the credibility of downscaled climate projections. EOS, vol. 94, #46, 424-425.

Strandberg et al. (2018) - Comparison of statistics of selected meteorological events in CMIP5, CORDEX and in PRIMAVERA models. PRIMAVERA D10.2

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