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

Representation of windstorms by PRIMAVERA models

PRIMAVERA models have high spatial and temporal resolution and feature improved representation of some physical processes. This factsheet includes examples of how the PRIMAVERA models are able to represent European wind storms, also called extra-tropical cyclones. We compare the PRIMAVERA models with the older CMIP5 Global Climate Models (GCMs). Results of the PRIMAVERA models show reduced biases in the frequency of more intense storms, and also improvements in the representation of the track density of wind storms.

Wind storms

Extra-tropical cyclones, also known as European wind storms, can bring violent winds, intense rain and battering waves to Europe (Fig. 1). They can result in major disruption, causing damage to transport networks, energy infrastructure, and even loss of life. The wind storm intensity is represented here by the maximum vorticity (Fig. 2 – to the right). Vorticity is a measure of rotation in a fluid flow. The higher the vorticity, the more intense and potentially more impactful the storm.

Figure 1. High waves from storm Brian batter Southsea coastal path, UK, October 2017

Wind storm intensity

Fig. 2 shows the extent to which CMIP5 and PRIMAVERA models can reproduce the observed vorticity distribution of storms based on the ERA Interim reanalysis. A longer bar indicates a bigger difference (bias) between ERA Interim and a model at a given maximum vorticity.

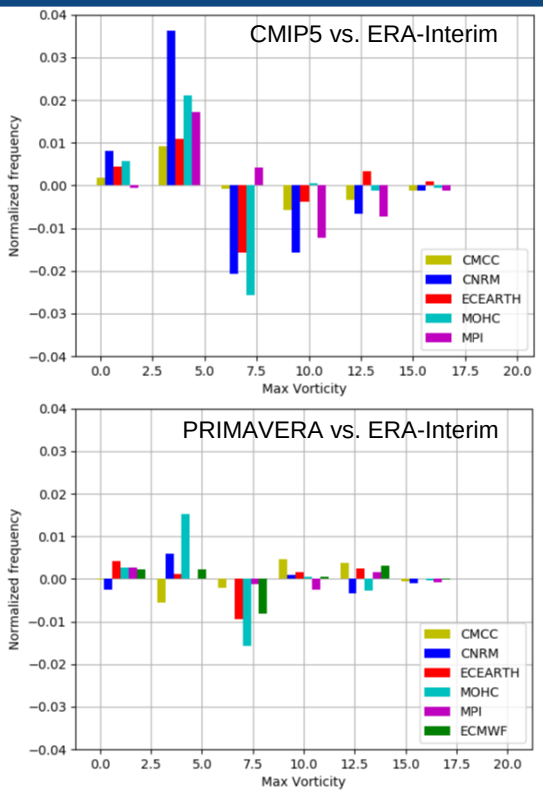

Figure 2. Comparison of bias in frequency of storms with different intensities as represented by the PRIMAVERA and CMIP5 models, and the ERA Interim reanalysis.

The CMIP5 models tend to overestimate the frequency of less intense storms while underestimating the frequency of more intense storms. The PRIMAVERA models show greatly reduced biases (Fig. 2), especially with regard to the underestimation of the frequency of stronger storms with vorticity greater than 7.5 $10^{-5}s^{-1}$.

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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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PRIMAVERA

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Wind storms track density

The track density of wind storms is important for determining over which parts of Europe the storms generally pass and where the most impacts could be expected. The track density is calculated using the method in Economou et al (2015) where we count the number of storms passing around each grid point of a template grid. The storm track density based on the ERA Interim data is represented in Fig.3 (to the right). The main North Atlantic storm track is clearly evident extending from northeast North America across the Atlantic towards northern Europe. Higher storm track density is evident over the Mediterranean as well.

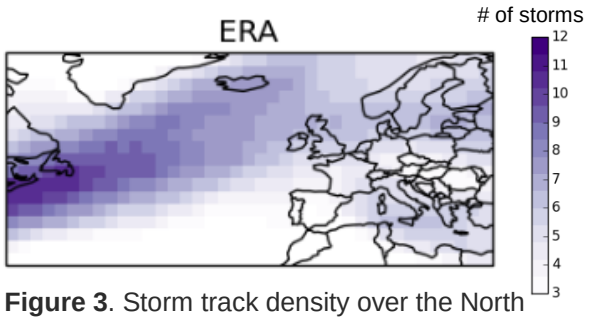

Figure 3. Storm track density over the North Atlantic-European region as represented by the ERA Interim data

Track density comparison between CMIP5 and PRIMAVERA models

Most of the PRIMAVERA models are characterized by smaller biases overall compared to the CMIP5 models (Table 1, Fig. 4 – see red areas), especially over the main North Atlantic track and also over northern Europe or the Mediterranean, which means that they are generally better than CMIP5 models at representing the observed track density. A notable exception is the CMCC model, which shows an increase in bias over northern Europe. Reasons for this are being investigated.

Modelling centre	PRIMAVERA model analysed	CMIP5 model analysed
CMCC	CMCC-CM2-VHR4 (18km)	CMCC-CM (70km)
CNRM	CNRM-CM6-1-HR (50km)	CNRM-CM5 (100km)
ECEARTH	ECEARTH3-HR (36km)	ECEARTH (80km)
MOHC	HadGEM3-GC31-HM (25km)	HadGEM2-A (90km)
MPI	MPIESM-1-2-XR (34km)	MPI-ESM-MR (130km)
ECMWF	ECMWF-IFS-HR (25km)	Unavailable

Table 1. GCMs used in the analyses. Number in parentheses indicates model's atmospheric resolution at 50ºN

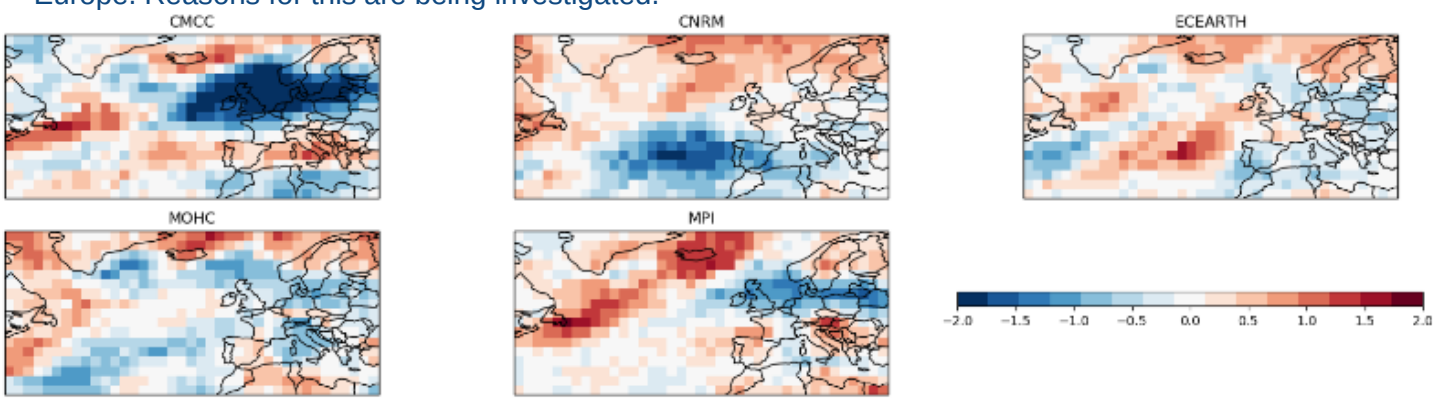

Figure 4. Change in storm track bias between CMIP5 and PRIMAVERA (|CMIP5 bias| - |PRIMAVERA bias|, shown in red and blue), as compared to ERA Interim; Red colour shows areas where there is improvement (reduction in bias)

References:

Economou, T., Stephenson, D. B., Pinto, J. G., Shaffrey, L. C. and Zappa, G. (2015), Serial clustering of extratropical cyclones in a multi-model ensemble of historical and future simulations. Q.J.R. Meteorol. Soc., 141: 3076-3087. doi:10.1002/qj.2591

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