First steps of the regional climate model MAR over the Euro-CORDEX domain

Chloé Scholzen (cscholzen@ulg.ac.be) and Xavier Fettweis
Laboratory of Climatology, University of Liège, Belgium

1 Objectives

As part of WCRP-sponsored CORDEX (COordinated Regional climate Downscaling EXperiment) program, the Laboratory of Climatology of the University of Liège, Belgium, is currently contributing to the task force using the regional model MAR to perform dynamically downscaled high-resolution climate simulations over the European domain.

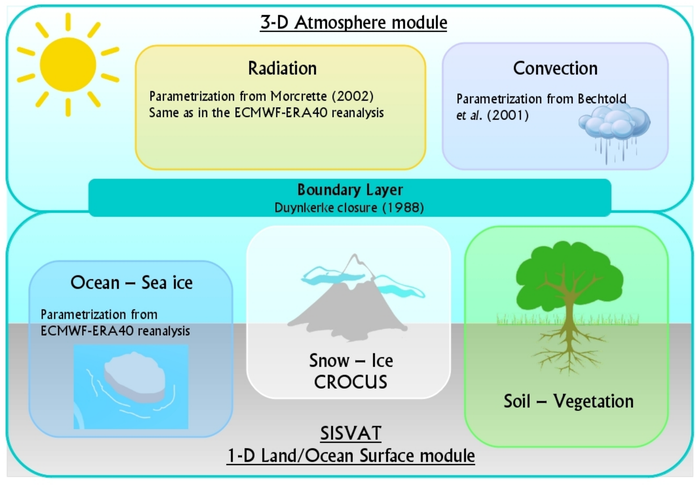
The first goal of this work is to contribute to the production of an improved generation of **regional climate projections**, which will be used as input into impact and adaptation studies. The second aim is to assess the performance of the MAR model compared to other RCMs involved in the Euro-CORDEX initiative.

Although MAR was originally designed for modelling climate in polar regions, the RCM has also proved its ability to simulate climate in temperate latitudes. Indeed, as commissioned by the Belgian branch of the CORDEX initiative, MAR has recently been run over a small domain fully included within the European domain and centered over Belgium, at a 0.05° (5 km) spatial resolution. The model results and their documentation are both available on the FTP site of the Laboratory of Climatology, University of Liège, Belgium:

ftp://ftp.climato.be/fettweis/MARv3.6/CORDEX-BE/

2 Model Description

Figure 1: Modules of the MAR model



The RCM used in this work is the version 3.6 of the MAR model (Modèle Atmosphérique Régional), which consists of a **3-D atmosphere module** coupled to a **1-D land/ocean surface module**, SISVAT (Soil Ice Snow Vegetation Atmosphere Transfer). The atmosphere component of MAR is a hydrostatic primitive equation model which uses the sigma-pressure as vertical coordinates. Convection is parametrized according to Bechtold *et al.* (2001). The SISVAT module includes both a soil-vegetation component and a snow-ice component. The snow-ice part is the model CROCUS, developed at the CEN (Centre d'Etudes de la Neige).

3 Setup and Forcing

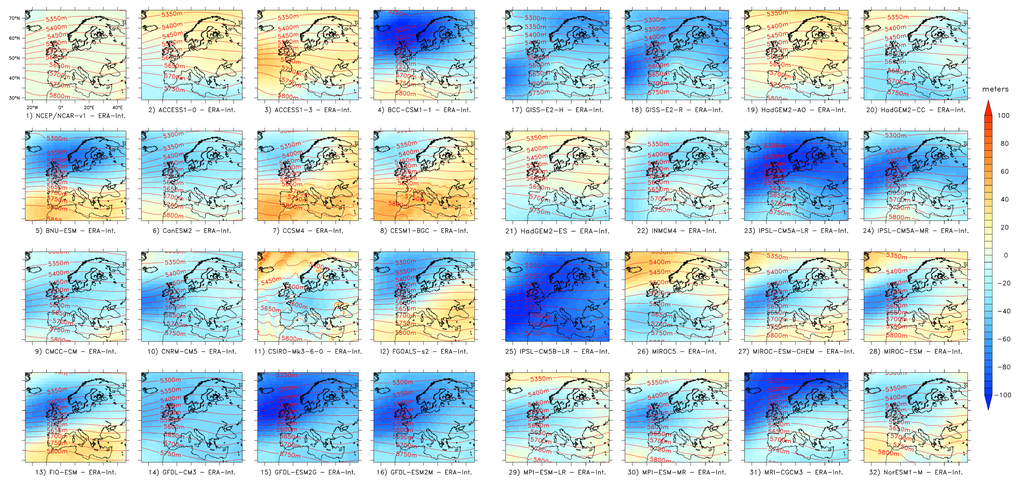


Figure 2: Bias in 500 hPa geopotential height between each CMIP5–GCM and the ERA-Interim reanalysis

MAR is used as a horizontal **nested grid** defined in a rotated pole coordinate system. Simulations are to be run at two spatial resolutions, namely 0.44° (50 km) and 0.11° (12.5 km), as requested by the CORDEX experiment protocol. The time scale of interest spans hours to multi-decades. Outputs are provided at 1-hourly, daily, seasonal and monthly temporal resolutions.

The nested model is initialized every 6 hours with temperature, specific humidity, eastward and northward wind velocity, as well as surface pressure and SST at each vertical level of MAR. These forcing conditions are derived from four different global simulations: two reanalyses (**NCEP/NCAR-v1** and **ERA-Interim**) and two GCMs (**NorESM1-M** and **MIROC5**).

Both GCMs were selected from the CMIP5 archive after evaluation of their ability to represent the current (1980-2005) mean climate over Europe. This assessment is based on the **skill score** methodology used by Connolley & Bracegirdle (2007).

4 Results and Discussion

So far, **test simulations** have been performed over the period 1979-2015, at a spatial resolution of 0.44° (50 km) and with two forcing conditions: NCEP/NCAR-v1 and NorESM1-M. Model results have been compared against observational data from the European Climate Assessment & Dataset (ECA&D) over the normal period 1980-2009.

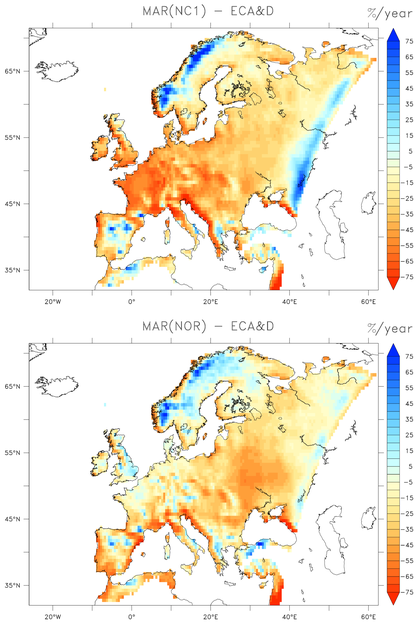


Figure 3: Relative bias (%) in total annual precipitation between model results (MAR) and observations (ECA&D)

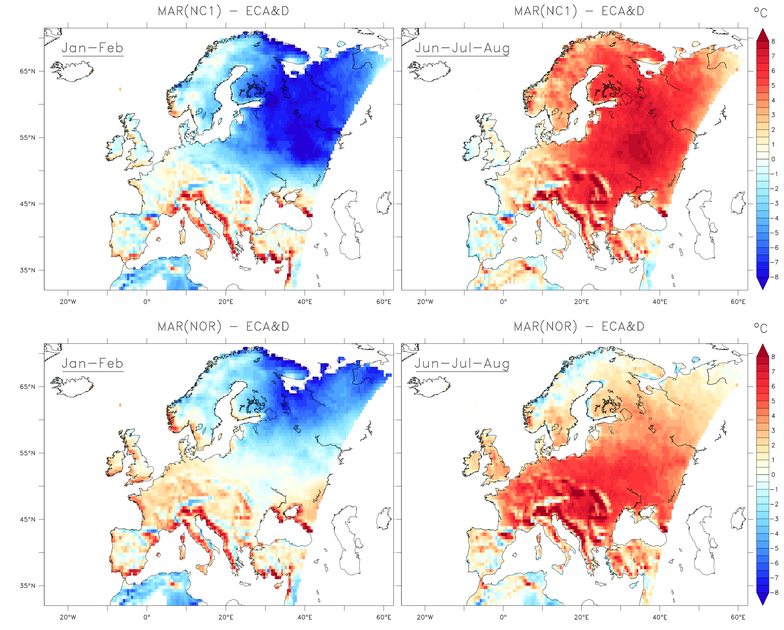


Figure 4: Absolute bias (°C) in seasonal near-surface air temperature between model results and observations

MAR produces a **strong dry bias** in the total amount of precipitation, which clearly derives from the failure of the model to represent convection (both rainfall and clouds). Consequently, modelled seasonal temperature is also flawed.

5 Summary and Outlook

- **Work in progress**
- Discrepancies between the observed and the modelled precipitation are caused by the inadequacy of the convective scheme.
- The next steps are to:

1) Revising the convective scheme (in progress);
2) Continue past and present-day climate simulations with the two other forcing conditions, namely the ERA-Interim reanalysis and the MIROC5 global model;
3) Run all simulations at both 0.44° (50 km) and 0.11° (12.5 km) spatial resolutions;
4) Validate model results with observations;
5) Perform future projections over Europe, with NorESM1-M and MIROC5 as forcing conditions.

References

Bechtold P, Bazile E, Guichard F, Mascart P, Richard E. (2001). A mass-flux convection scheme for regional and global models. *Quarterly Journal of the Royal Meteorological Society*, 127(573): 869-886.

Connolley WM, Bracegirdle TJ. (2007). An Antarctic assessment of IPCC AR4 coupled models. *Geophysical Research Letters*, 34(22).

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