Assessing the future evolution of climate extremes favouring floods using the regional climate model MAR over the CORDEX.be domain

EGU2018-17761

Session CL 5.06

Coraline WYARD (*coraline.wyard@uliege.be*), Sébastien DOUTRELOUP and Xavier FETTWEIS

Laboratory of climatology, University of Liège, Liège, Belgium

1. CONTEXT

In **the Ourthe river** (catchment area = 3500 km^2), floods mainly occur in **winter** and are caused by **rapid snowpack melting** (Flood Type (FT) 1) and/or **by heavy rainfalls** (FT 2).

These **climatic conditions favouring floods** have decreased for the period 1959-2010 as a result of a reduction in snow accumulation (Wyard et al., 2017).

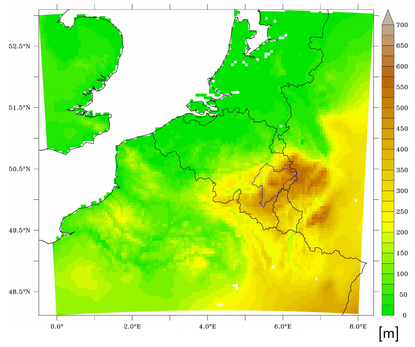

Figure 1: The MAR integration domain used for the CORDEX.be simulations is a 120x110 grid (23 vertical levels). The grid spacing is 5 km. The orography used by MAR and the limits of the Ourthe catchment (dark blue) are displayed in this map.

In this study, we perform future projections using the **MAR (Modèle Atmosphérique Régional)** RCM over the **CORDEX.be** domain (Figure 1) in order to assess the future evolution of the hydroclimatic conditions favouring floods in the Ourthe river.

2. SETUP and FORCINGS

Two GCMs from the CMIP5 archive were selected by using the skill score methodology of Connolley & Bracegirdle (2007) (Figure 2).

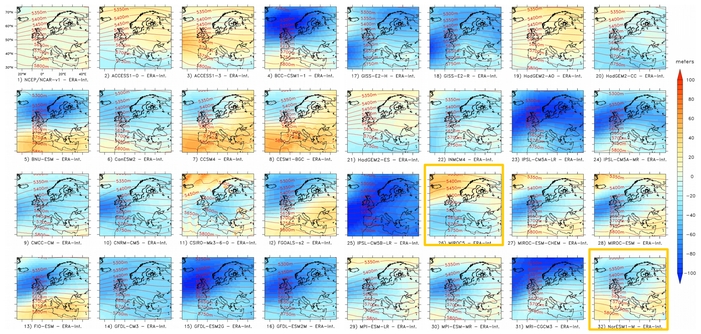

Figure 2: Bias in Z500 between each CMIP5–GCM and the ERA-Interim reanalysis over 1980-2005 (Scholzen and Fettweis, 2016).

Historical runs were obtained by nesting MAR into the **ERA-interim** reanalysis, **NorESM1-M** and **MIROC5** over **1976-2005.**

→ MAR-ERA, MAR-NorESM1-histo, and MAR-MIROC5-histo

Future projections were obtained by nesting MAR into **NorESM1-M** and **MIROC5**, under the **RCP8.5** scenario over **2071-2100**.

→ MAR-NorESM1-RCP8.5 and MAR-MIROC5-RCP8.5

Conditions favourable to floods were defined as in Wyard et al. (2017). **One day is considered as favourable to floods if the run-off integrated over the Ourthe catchment is larger than its P95 calculated over 1976-2005.**

3. EVALUATION OF MAR RUNS OVER THE 1976-2005 WINTERS (DJF)

Compared to MAR-ERA,

- MAR-NorESM1-histo is warmer and wetter while MAR-MIROC5-histo is colder and dryer (Figures 3, 4 and 5);
- Snow accumulation is larger in MAR-MIROC5-histo (Figure 6);

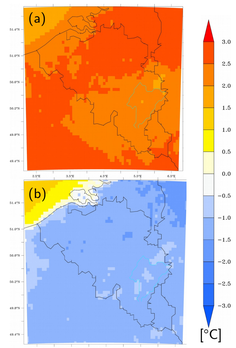

*Figure 3: **Mean winter temperature** anomaly of (a) MAR-NorESM1-histo, and (b) MAR-MIROC5-histo with respect to MAR-ERA for the period 1976-2005.*

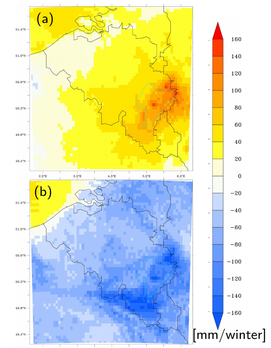

*Figure 4: **Winter PPN amount** anomaly of (a) MAR-NorESM1-histo, and (b) MAR-MIROC5-histo with respect to MAR-ERA for the period 1976-2005.*

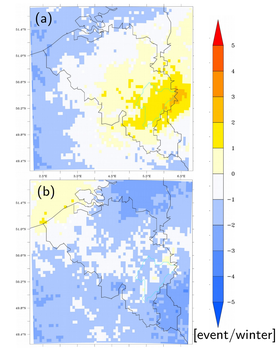

*Figure 5: **Winter extreme PPN event frequency** anomaly of (a) MAR-NorESM1-histo, and (b) MAR-MIROC5-histo with respect to MAR-ERA for the period 1976-2005.*

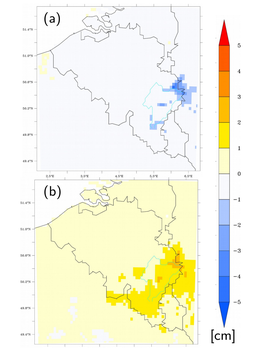

*Figure 6: **Mean winter snow height** anomaly of (a) MAR-NorESM1-histo, and (b) MAR-MIROC5-histo with respect to MAR-ERA for the period 1976-2005.*

- MAR-MIROC5-histo overestimates FT1 and underestimates FT2 (Table 1).

1976-2005	FT1 (days/winter)	FT2 (days/winter)	TOTAL (days/winter)
MAR-ERA	4.2	5.5	9.6
MAR-NorESM1-histo	4.3	6.6	10.9
MAR-MIROC5-histo	7.0	3.5	10.5

*Table 1: **Average number of days favourable to floods per winter** due to snowpack melting (FT1) and due to rainfalls (FT2) modelled by MAR-ERA, MAR-NorESM1-histo and MAR-MIROC5-histo for the period 1976-2005.*

4. HYDROCLIMATIC CONDITIONS FAVOURING FLOODS IN WINTER: 2071-2100 vs 1976-2005

Both MAR-NorESM1-RCP8.5 and MAR-MIROC5-RCP8.5 simulate an increase in rainfall amount (Figure 7), a decrease in snowfall amount (Figure 8) and a decrease in snow accumulation (Figure 10).

MAR-NorESM1-RCP8.5 simulates an increase in extreme PPN event frequency except in the Ardennes (Figure 9).

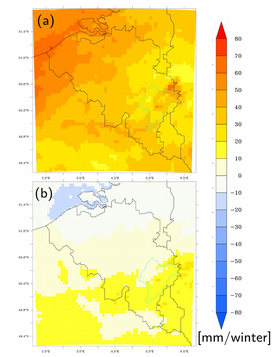

*Figure 7: Change in **rainfall amount** in winter of (a) MAR-NorESM1-RCP8.5, and (b) MAR-MIROC5-RCP8.5 for the period 2071-2100 with respect to 1976-2005.*

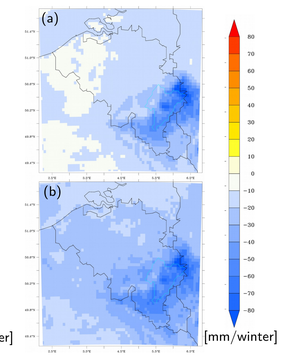

*Figure 8: Change in **snowfall amount** in winter of (a) MAR-NorESM1-RCP8.5, and (b) MAR-MIROC5-RCP8.5 for the period 2071-2100 with respect to 1976-2005.*

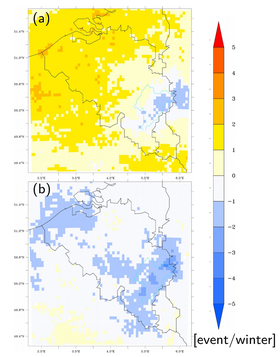

*Figure 9: Change in **extreme PPN event frequency** in winter of (a) MAR-NorESM1-RCP8.5, and (b) MAR-MIROC5-RCP8.5 for the period 2071-2100 with respect to 1976-2005.*

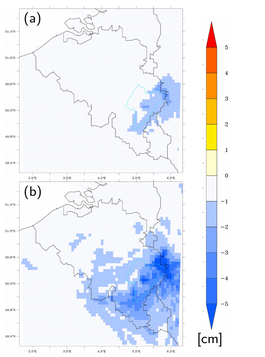

*Figure 10: Change in **mean winter snow height** of (a) MAR-NorESM1-RCP8.5, and (b) MAR-MIROC5-RCP8.5 for the period 2071-2100 with respect to 1976-2005.*

Both MAR-MIROC5-RCP8.5 and MAR-NorESM1-RCP85 simulate a decrease in FT1 which is not counterbalanced by the increase in FT2.

2071-2100	FT1 (days/winter)	FT2 (days/winter)	TOTAL (days/winter)
MAR-NorESM1-RCP8.5	1.2 (-73%)	8.3 (+26%)	9.4 (-13%)
MAR-MIROC5-RCP8.5	1.8 (-74%)	4.8 (+39%)	6.6 (-37%)

*Table 2: **Average number of days favourable to floods per winter** due to snowpack melting (FT1) and due to rainfalls (FT2) modelled by MAR-NorESM1-RCP8.5 and MAR-MIROC5-RCP8.5 for the period 2071-2100. The numbers in brackets refer to changes with respect to 1976-2005*

5. CONCLUSION

RCP8.5 favours a decrease in snowfall amount, in snow accumulation, and consequently in conditions favourable to floods generated by snowpack melting.

Regarding total PPN amount and extremes, the signal is less clear as both GCMs simulate different patterns and trends. We plan to use a third GCM (MPI-ESM-LR?) in order to refine our analysis.

References

Connolley, W.M., and Bracegirdle T.J. (2007), An Antarctic assessment of IPCC AR4 coupled models. Geophysical Research Letters, 34(22).

Scholzen, C., and Fettweis, X. (2016), First steps of the regional climate model MAR over the Euro-CORDEX domain. EGU General Assembly 2016, Vienna, Austria.

Wyard, C., et al. (2017), Decrease in climatic conditions favouring floods in the south-east of Belgium over 1959-2010 using the regional climate model MAR, International Journal of Climatology, 37(5), 2782–2796, doi:10.1002/joc.4879.