Multiscale performance of the ALARO-0 model for simulating extreme summer precipitation climatology

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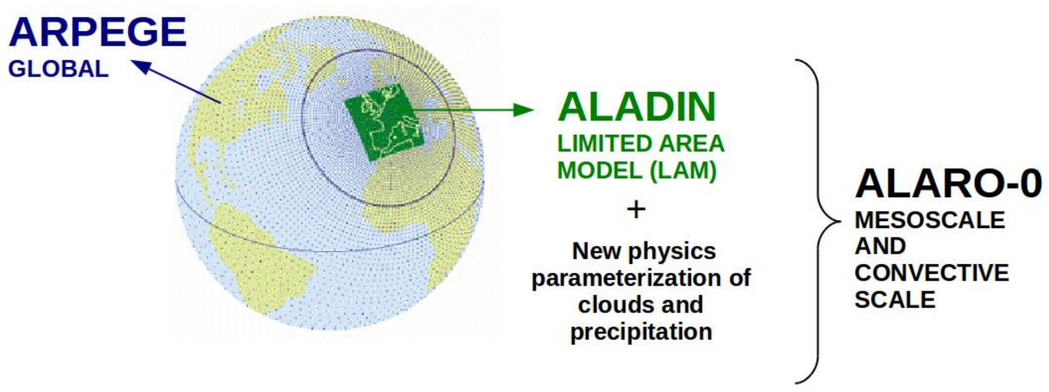
1 Motivation

- Extreme precipitation events have a **large impact** on societies through damage caused by floodings and landslides
- IPCC 4th Assessment Report: model skill to simulate realistic extreme daily precipitation strongly depends on the model's **spatial resolution** and its **convective parameterization** [1]
- **Assessing ability of Regional Climate Models (RCMs)** in reproducing observed extreme precipitation events for the **recent past climate (1961-1990)** = first and necessary step before these models can be employed for confident projections of future changes in extreme precipitation at the regional scale

2 Aim

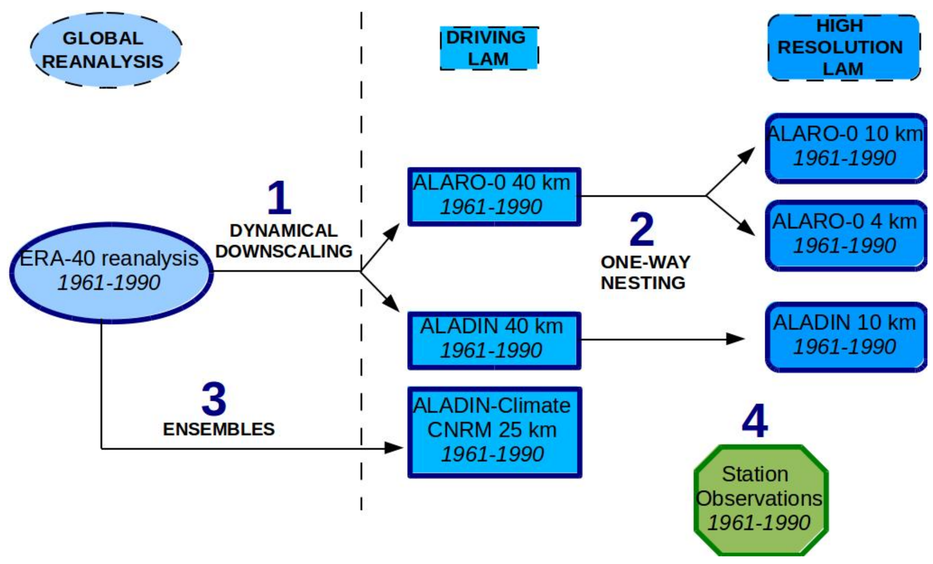
- **Study the relative importance of spatial resolution versus parameterization formulation on the model skill to simulate correctly extreme daily precipitation over Belgium**

3 Models



Overview of the used models: ALADIN and ALARO-0.

4 Data and experimental design



Schematic overview of the experimental design.

1 ERA-40 reanalyses are dynamically downscaled using ALADIN and ALARO-0 on a horizontal resolution of 40 km → **ALD40 and ALR40**

2 One-way nesting on the ALD40 and ALR40 modeldata to get high spatial resolution data at 10 and 4 km → **ALD10, ALR10 and ALR04**

3 In order to put our model simulations into a larger context of the state-of-the-art regional climate modeling, we add to our evaluation the ALADIN-Climate model developed by the Centre National de Recherches Météorologiques (CNRM) which took part in the European ENSEMBLES project (http://www.ensembles-eu.org/) → **CNRM**

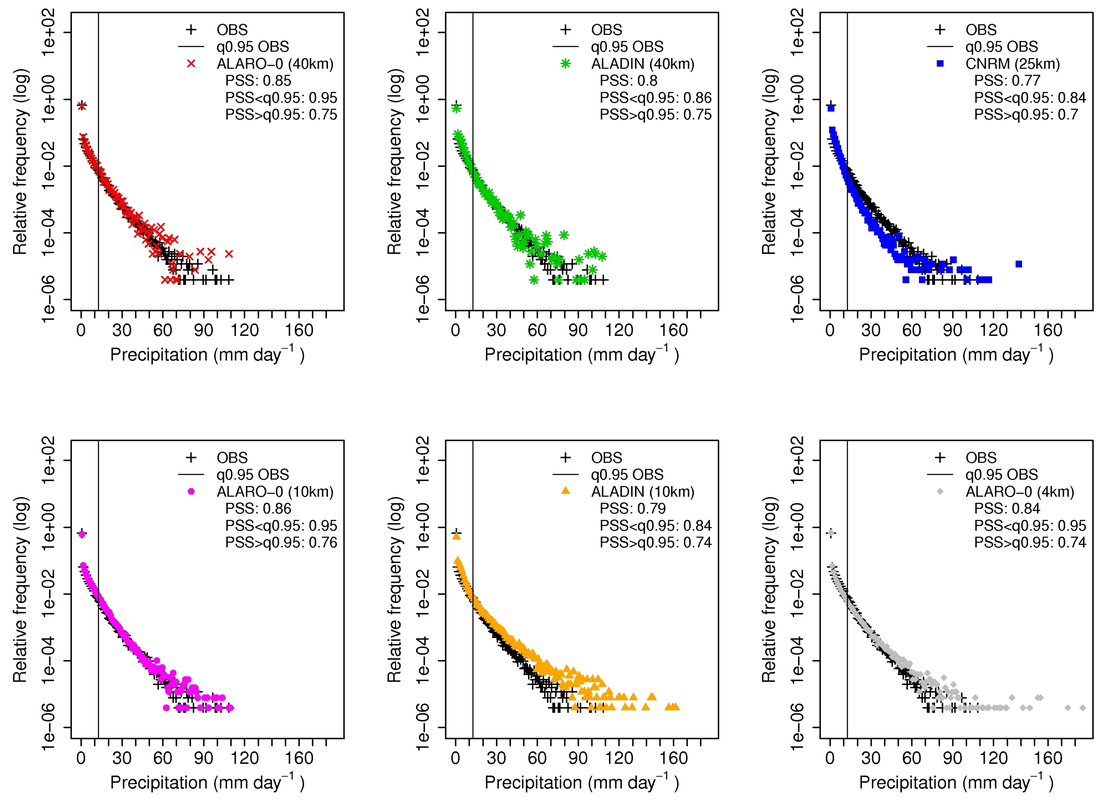
4 Daily summer precipitation over Belgium from the models is compared with respect to **observations from 93 stations** for the period 1961-1990

5 Results

Relative frequencies are calculated for observed and modeled daily precipitation amounts which are binned into bins of 1 mm day^{-1}. The 'Perkins skill score' (PSS) [2] is calculated to provide a measure of similarity between observed- and modelled frequencies:

$$PSS = \sum_{1}^{n} minimum(Z_1, Z_2) \quad (1)$$

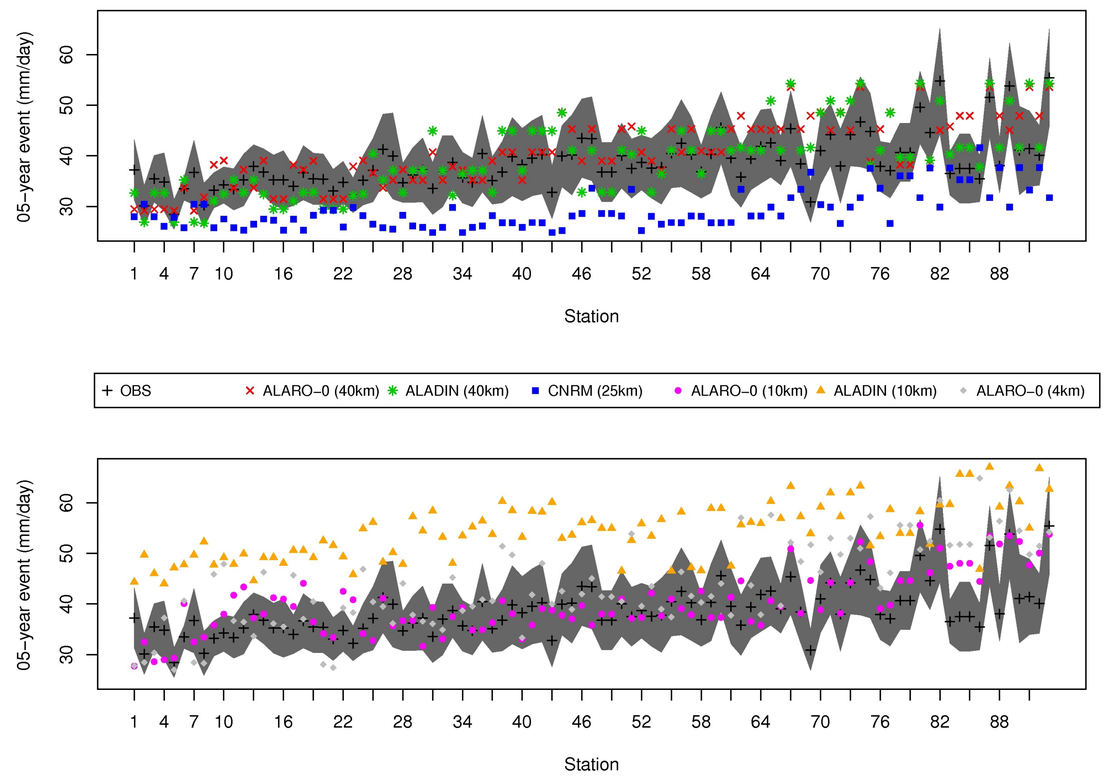
where n is the number of bins and Z1,2 is the frequency of values in a given bin from the observations and model data respectively.



Graphical representation of observations and model data in terms of relative frequencies versus rainfall amount (top: ALR40, ALD40 and CNRM, bottom: ALR10, ALD10 and ALR04).

- **PSS for ALARO-0 is close to one and higher than for ALADIN and CNRM**

To explore the ability of the models to reproduce extreme precipitation events, 5-year return levels for the observations and models are calculated for each station:



5-year return levels for the observations and model simulations (top: ALR40, ALD40, CNRM and bottom: ALR10, ALD10 and ALR04). The shaded area represents the 95% confidence interval of observed return levels.

- **ALARO-0: For most stations the return levels lie within the 95% confidence range of the observed return levels <> ALD10 and CNRM: Not able to produce the observed 5-year return events, return levels lie for a great number of stations outside the observed confidence interval**

6 Conclusion

- **Improvement in the representation of extreme summer precipitation by ALARO-0 w.r.t. the observations**
- **New parameterization scheme of ALARO-0 contributes to the amelioration in the modeling of extreme summer precipitation events at various horizontal resolutions, rather than the increase in spatial resolution**

References

[1] Randall et al., 2007, Climate models and their evaluation. *Climate Change 2007: The Physical Science Basis, Solomon S., Qin D., Manning M., Chen Z., Marquis M., Averyt K. B., Tignor M., Miller H. L., Eds., Cambridge University Press*, 589–662.

[2] Perkins S. E., Pitman A. J., Holbrook N. J., McAneney J., 2007, Evaluation of the AR4 climate models simulated daily maximum temperature, minimum temperature, and precipitation over Australia using probability density functions. *J. Climate*, **20**, 4356–4376.