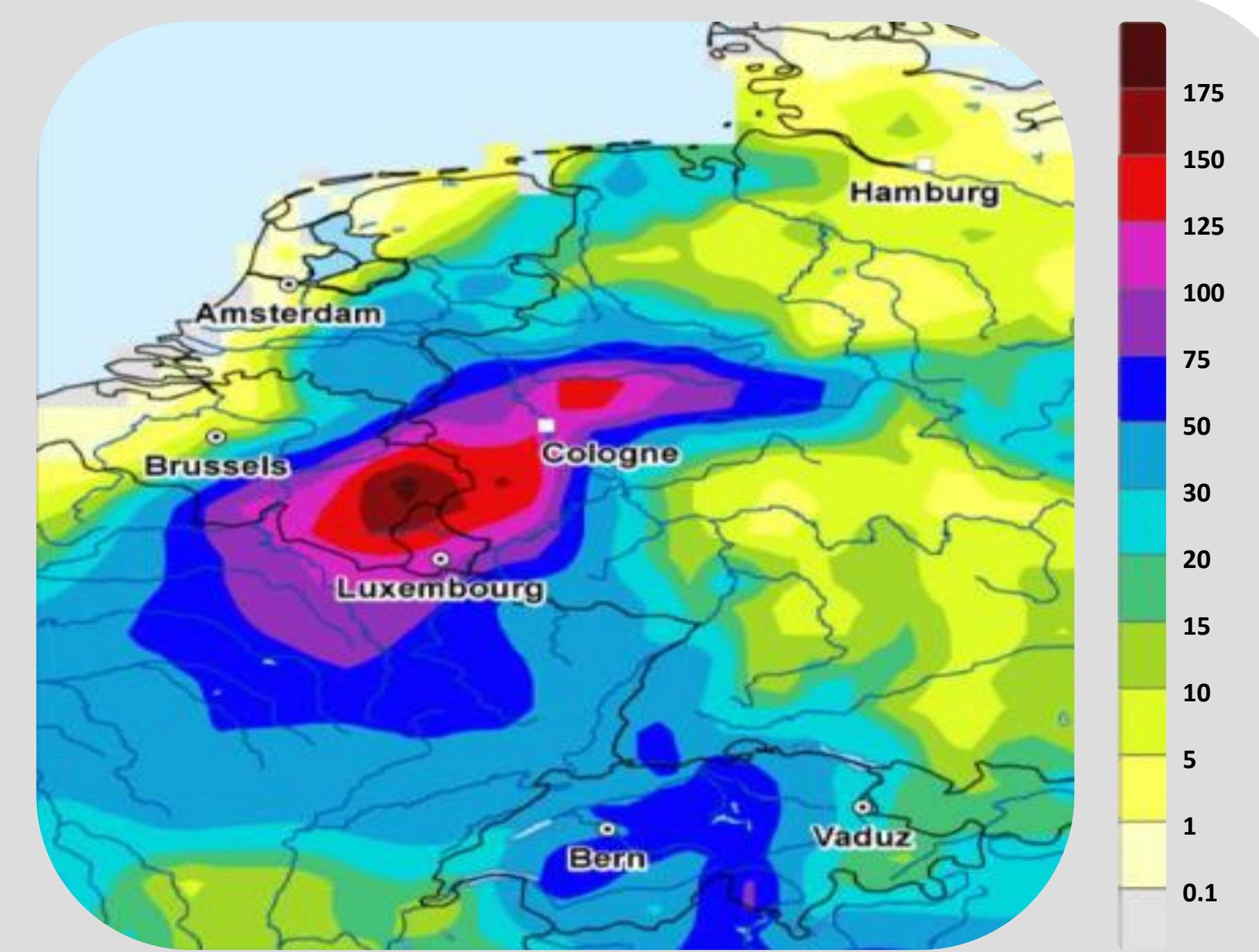# Development of a case-selective dynamical downscaling strategy for extreme precipitation over Belgium

Wout Dewettinck, Kobe Vandelanotte, Steven Caluwaerts, Hans Van De Vyver, Daan Degrauwe, Rafiq Hamdi, Piet Termonia

In 2021 a devastating extreme precipitation-driven flood struck Belgium, the Netherlands and Germany. Afterwards, the World Weather Attribution group performed a rapid attribution study of the event. This study emphasized the limited availability of climate simulations with convection-permitting models (CPMs) due to their high computational cost. To address this limitation, we aim to:

- Reduce the computational cost by developing an innovative **case-selective dynamical downscaling technique**.
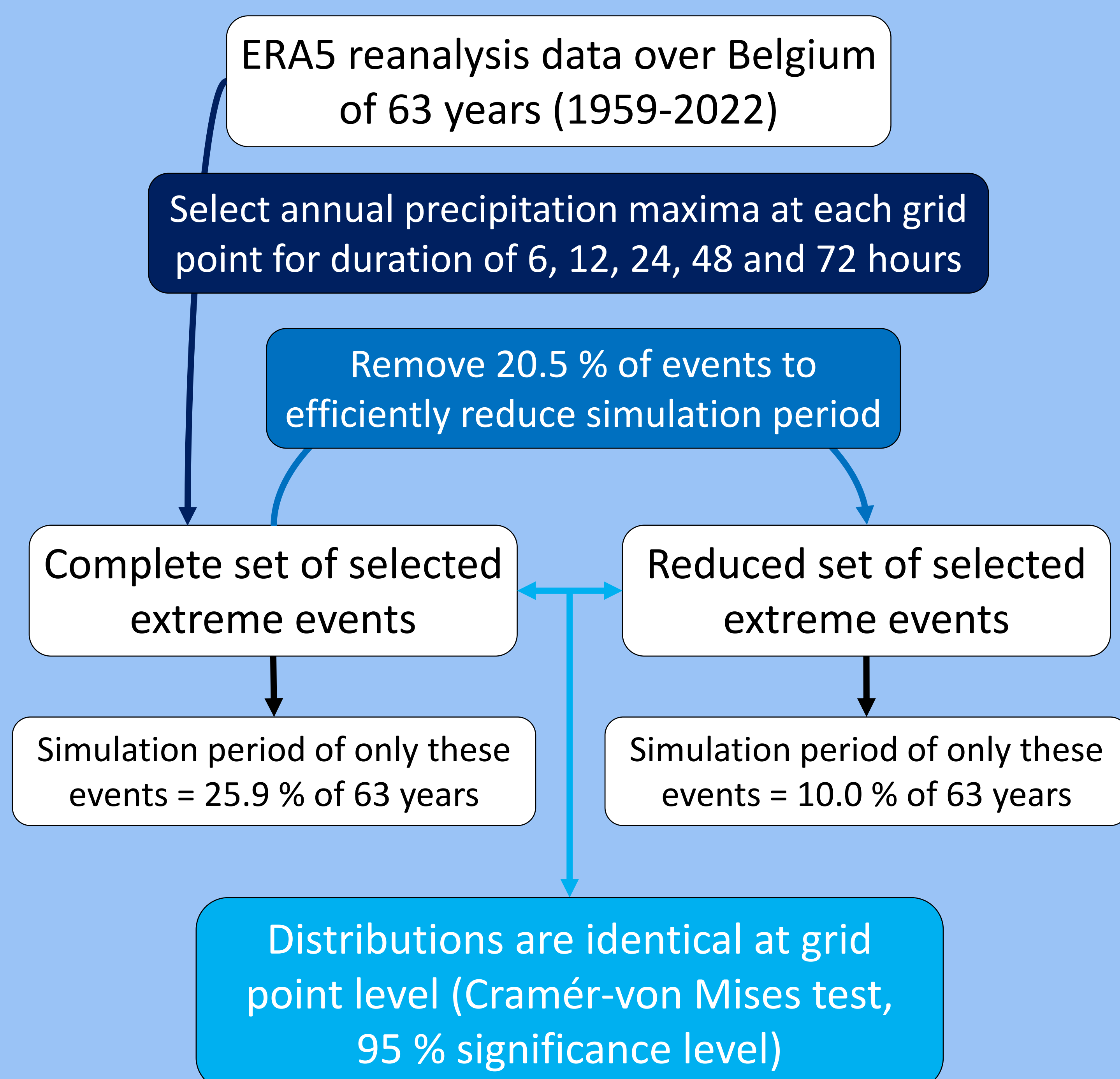- Create a large CPM ensemble over Belgium with the **CORDEX.be** projects.

Accumulated 48-hour precipitation starting from 13 July 2021, 00:00 UTC (adapted from [1]). Precipitation sum is expressed in mm.

Case-selective dynamical downscaling technique

Method: To dynamically downscale only periods with extreme precipitation instead of the full simulation period.

Aim: To reproduce the statistics of extreme precipitation at only 10 % of the original computational cost.

Feasibility: The feasibility of the case-selective dynamical downscaling technique is preliminarily studied with ERA5 reanalysis data:

ERA5 reanalysis data over Belgium of 63 years (1959-2022)

Select annual precipitation maxima at each grid point for duration of 6, 12, 24, 48 and 72 hours

Remove 20.5 % of events to efficiently reduce simulation period

Complete set of selected extreme events

Reduced set of selected extreme events

Simulation period of only these events = 25.9 % of 63 years

Simulation period of only these events = 10.0 % of 63 years

Distributions are identical at grid point level (Cramér-von Mises test, 95 % significance level)

Conclusion: It is feasible to dynamically downscale only periods with extreme precipitation at just 10 % of the full computational cost.
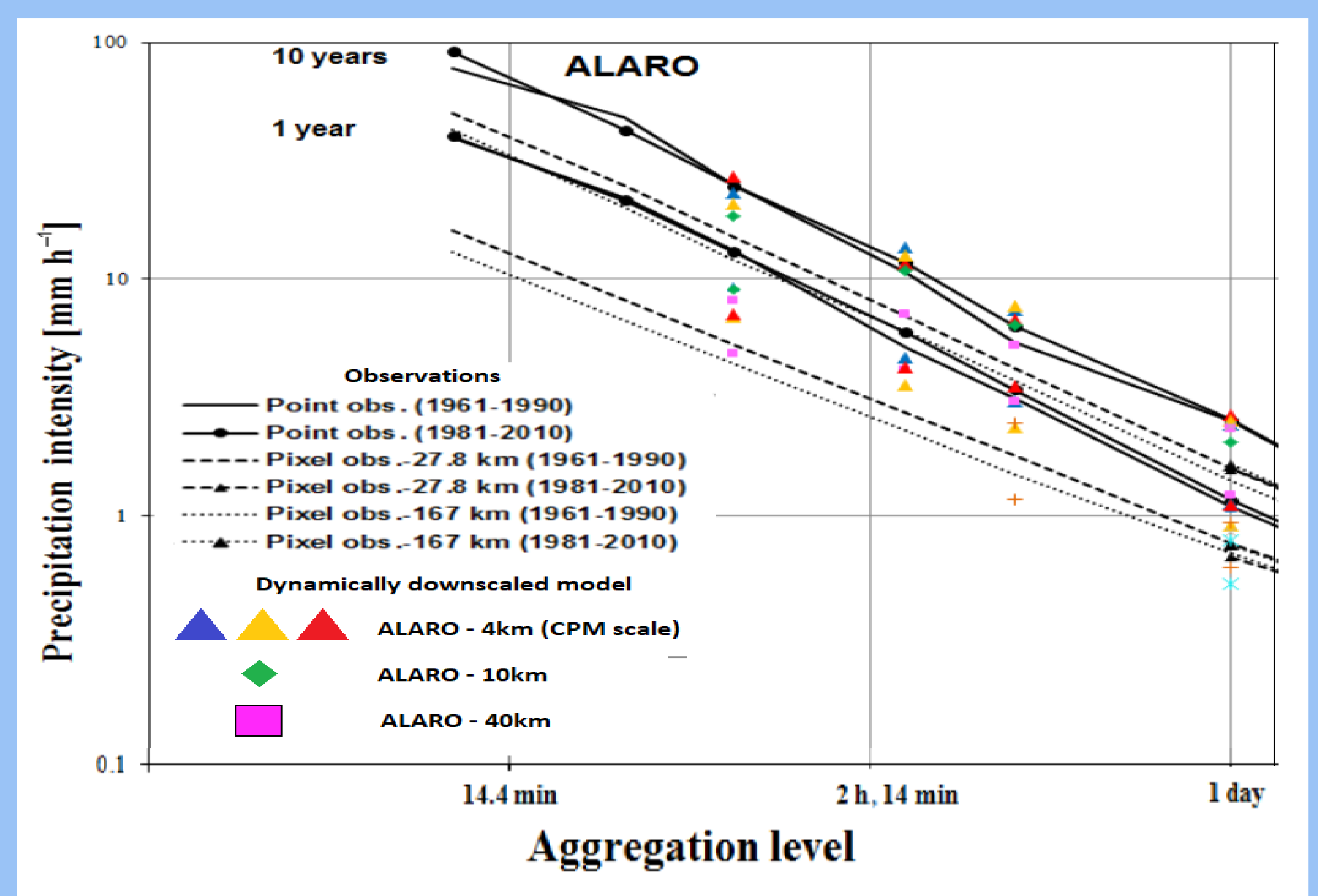
CORDEX.be

CORDEX.be I [2] has:

- Created a small CPM ensemble over Belgium
- Performed local-impact model simulations
- Contributed to EURO-CORDEX

Why CPMs over RCM/GCMs?

CPMs more accurately reproduce observed precipitation IDF curves at sub-daily time scales.

Intensity-duration-frequency curves for summer precipitation in Uccle, Belgium at different sub-daily timescales. At the shortest timescales, the higher resolution CPM model runs (Δ) are closer to the observations than lower resolution ALARO runs. (Adapted from [3].)

CORDEX.be II will build on its predecessor by updating and enlarging the CPM ensemble over Belgium through dynamically downscaling multiple CMIP6 GCMs with 3 CPMs over Belgium.

Conclusion:

Case-selective dynamical downscaling aims to reduce the computational cost of downscaling by 90 %, enabling larger CPM ensembles. The CORDEX.be II project will create a large CPM ensemble over Belgium.

REFERENCES: [1] Kreienkamp, Frank, et al. "Rapid attribution of heavy rainfall events leading to the severe flooding in Western Europe during July 2021." World Weather Atribution (2021).
[2] Termonia, Piet, et al. "The CORDEX. be initiative as a foundation for climate services in Belgium." Climate Services 11 (2018): 49-61.
[3] Tabari, Hossein, et al. "Local impact analysis of climate change on precipitation extremes: are high-resolution climate models needed for realistic simulations?." Hydrology and Earth System Sciences 20.9 (2016): 3843-3857.

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