

An ensemble climate projection of extreme precipitation by the end of the 21st century using three convection-permitting climate models for Belgium

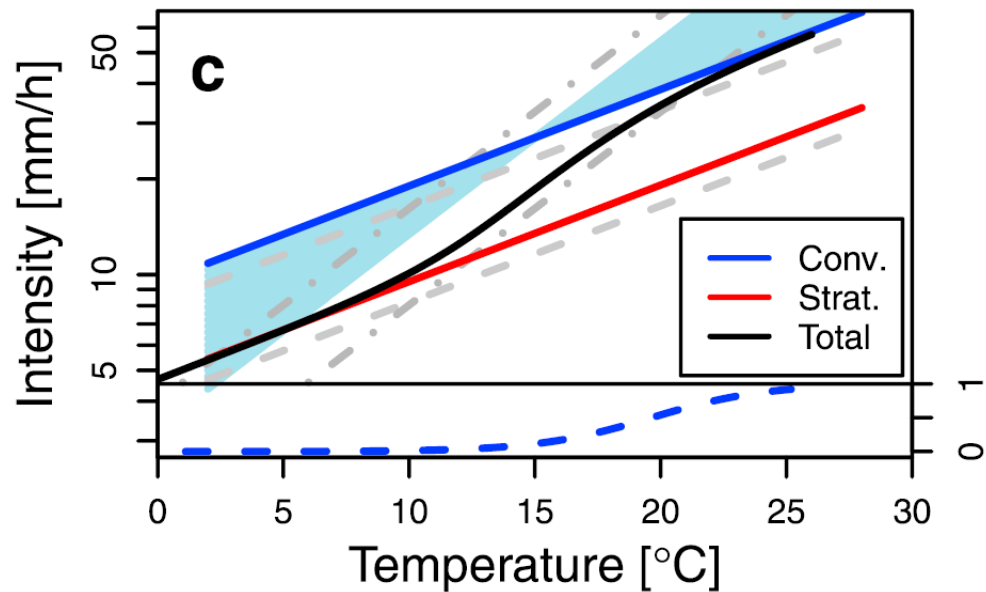


Master thesis project of Samuel Helsen, Master student Geography

Supervisors:

Nicole van Lipzig, Hendrik Wouters, Sam Vanden Broucke

Context: climate change

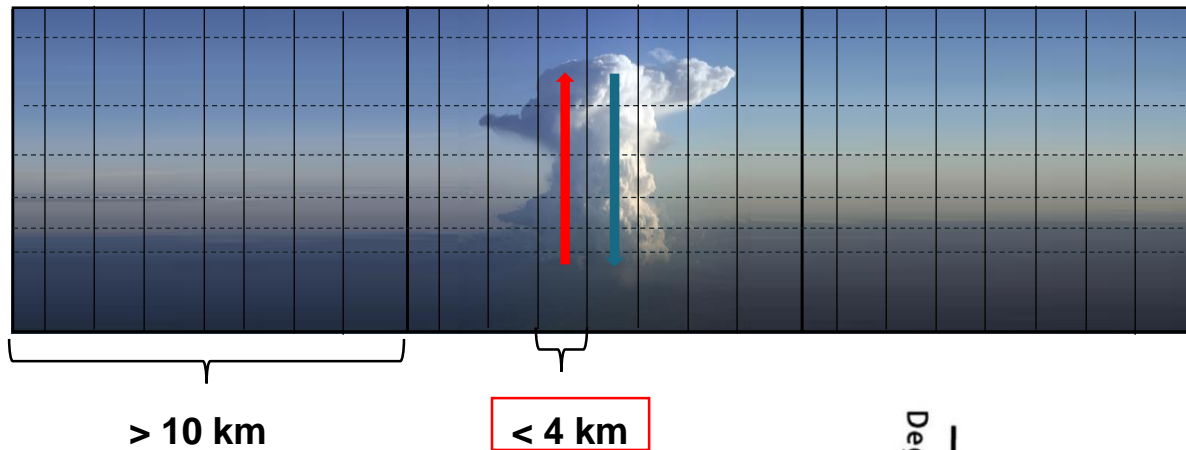


[Westra et al. 2014]

- Increase in frequency and intensity extreme events
- Local impact! → High resolution spatial information needed

Theoretical advantage of CPMs

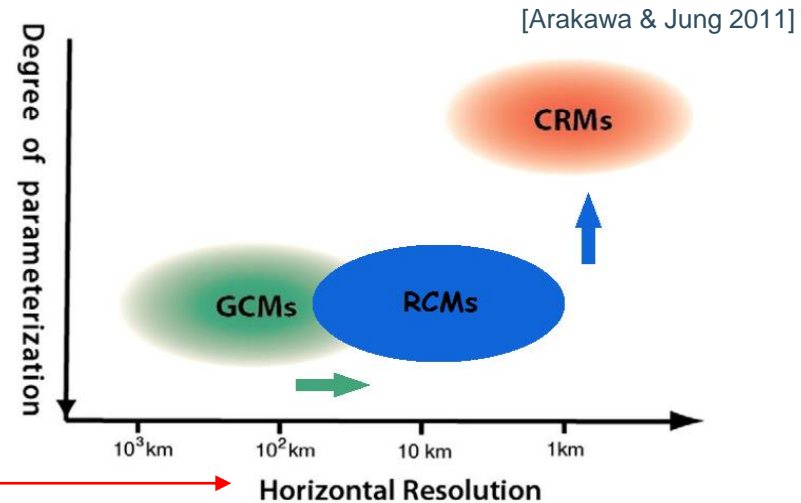
1) Omitting error-prone convective parameterizations



< 4 km

Deep moist convection explicitly simulated

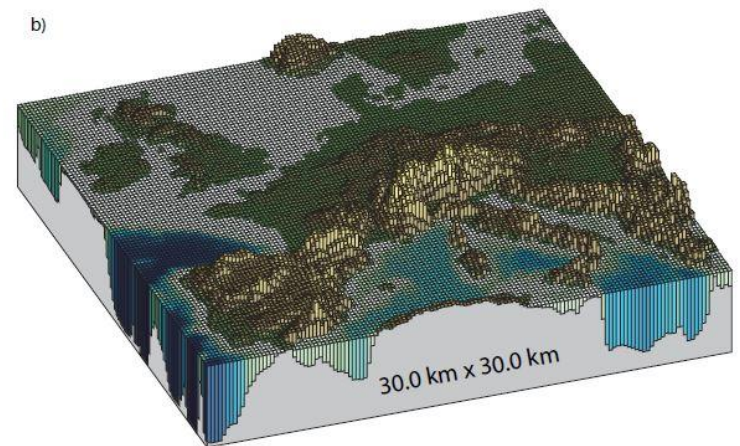
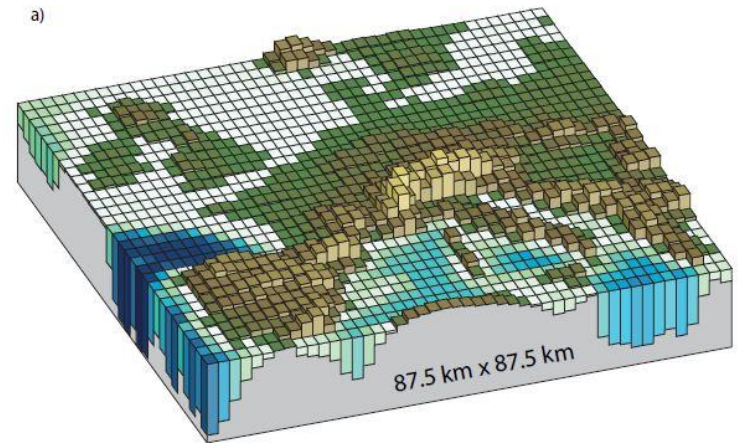
Moist convection highly parameterized



Theoretical advantage of CPMs

2) Improved representation of **orography** and surface fields

(e.g. coastlines, lakes, forestry, soil characteristics, urbanization...)

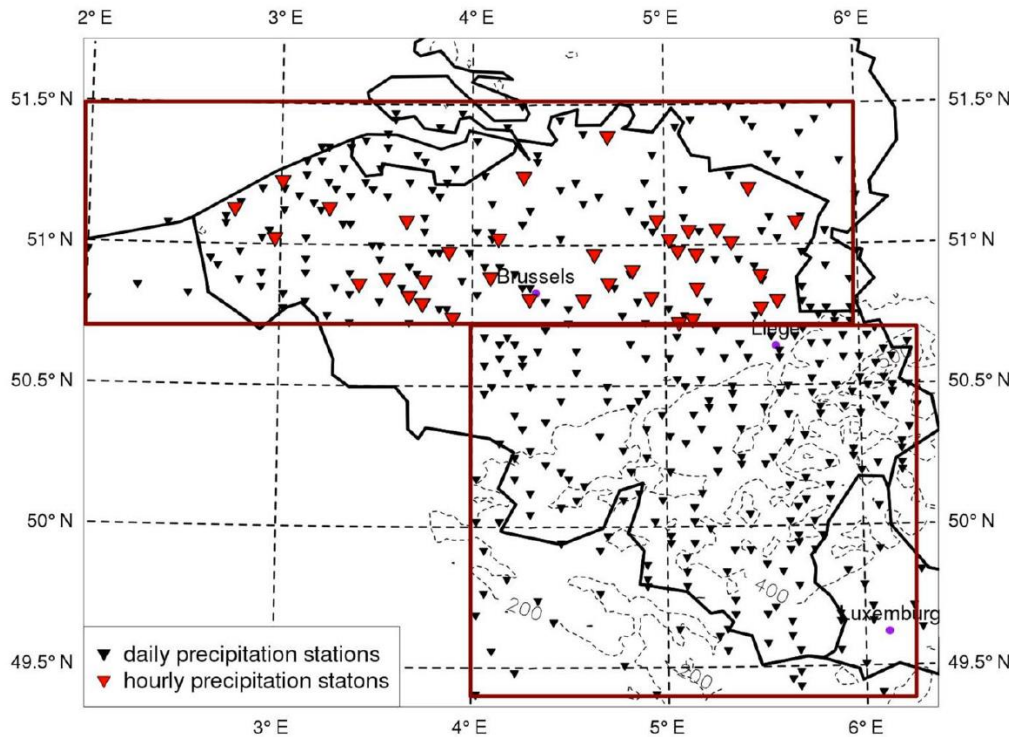


[Cubasch et al. 2013]

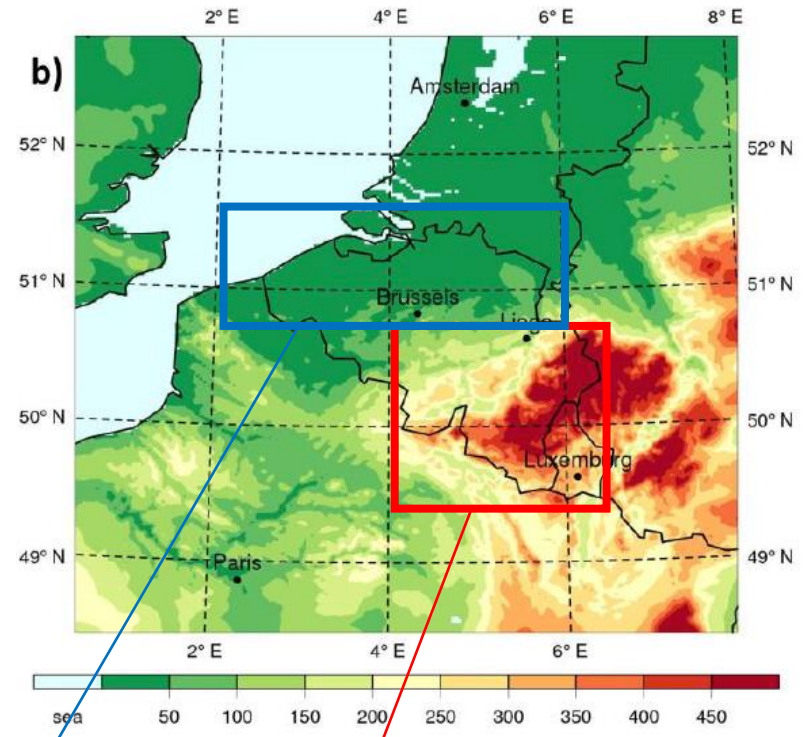
State of the art

Study	Type	Timescale	Model	Location	Topography
Chan et al. 2013	eval.	daily/ hourly	MetUM	southern UK	mostly flat
Ban et al. 2014	eval.	daily/ hourly	COSMO- CLM	Alps	mountainous
Chan et al. 2014 cc	eval. / cc	daily/ hourly	MetUM	southern UK	mostly flat
Kendon et al. 2014	eval. / cc	hourly	MetUM	southern UK	mostly flat
Fosser et al. 2014	eval.	daily/ hourly	COSMO- CLM	southwest Germany	mountainous
Ban et al. 2015 cc	eval. / cc	daily/ hourly	COSMO- CLM	Alps	mountainous
Brisson et al. 2016	eval.	daily/ hourly	COSMO- CLM	Belgium	mixed
Tabari et al. 2016 cc	eval. / cc	daily/3hourly /hourly	ALARO & COSMO- CLM	Brussels	flat
Fosser et al. 2017	cc	daily/hourly	COSMO- CLM	southwest Germany	mountainous
Saeed et al. 2017	cc	daily	COSMO- CLM	Belgium	mixed

State of the art: example for Belgium



Observation network



Topography [m]

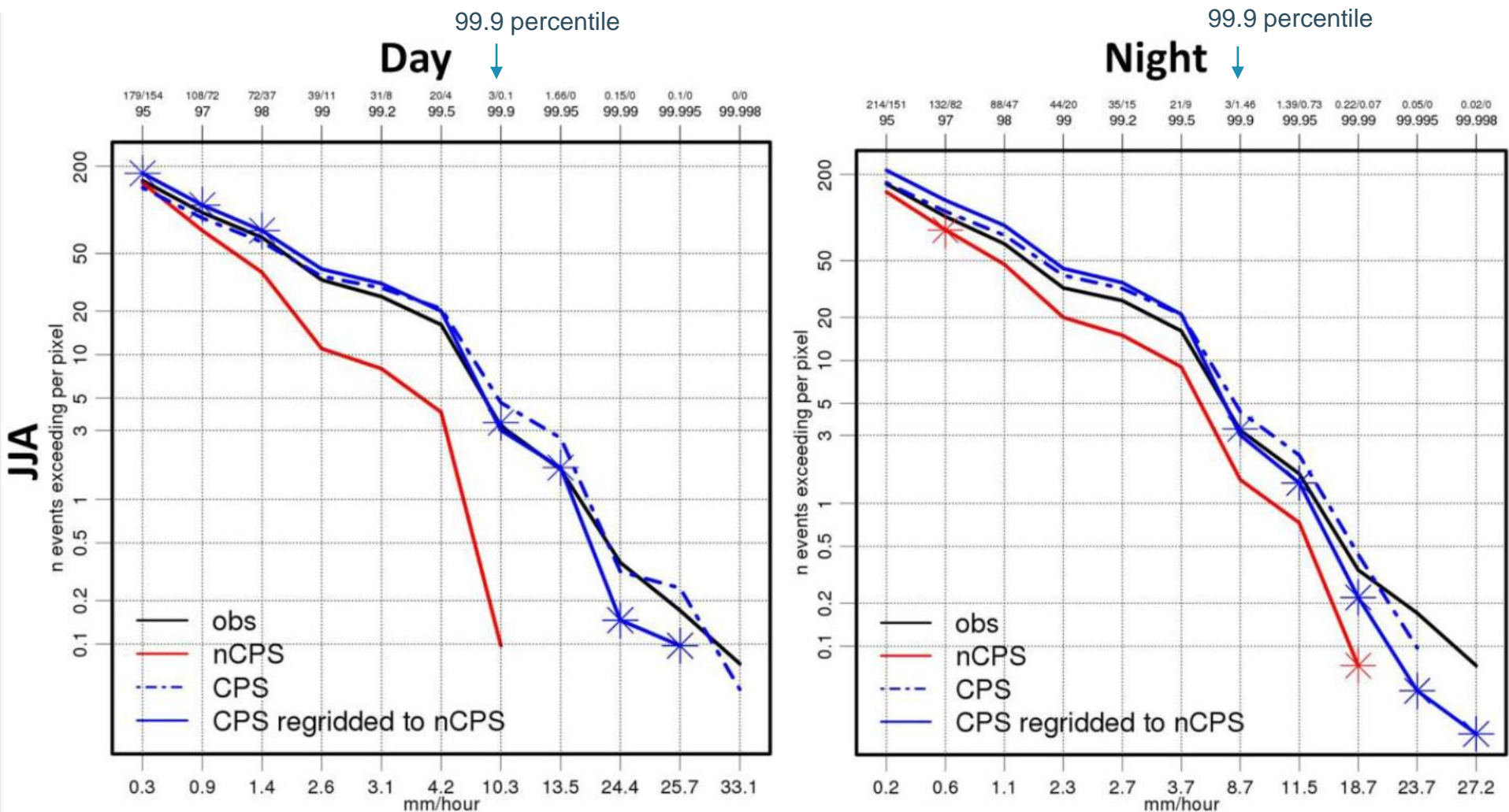
Flanders

Ardennes

[Vanden Broucke et al. 2017]

State of the art: example for Belgium

Evaluation summer hourly precipitation

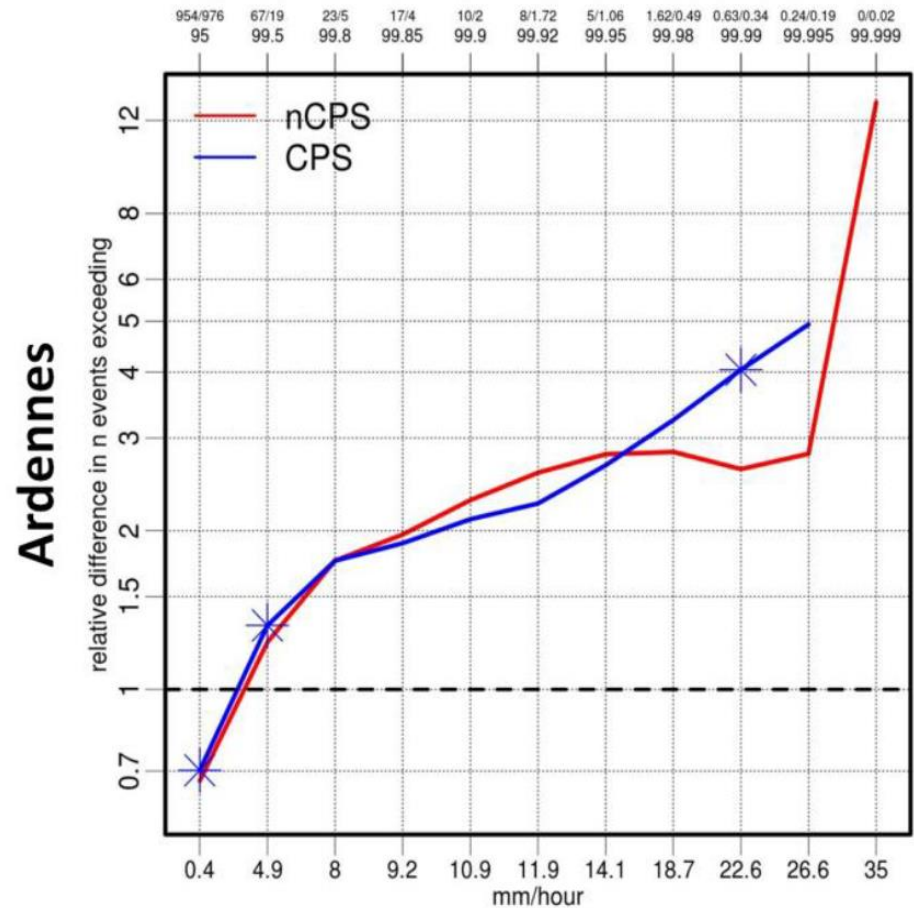
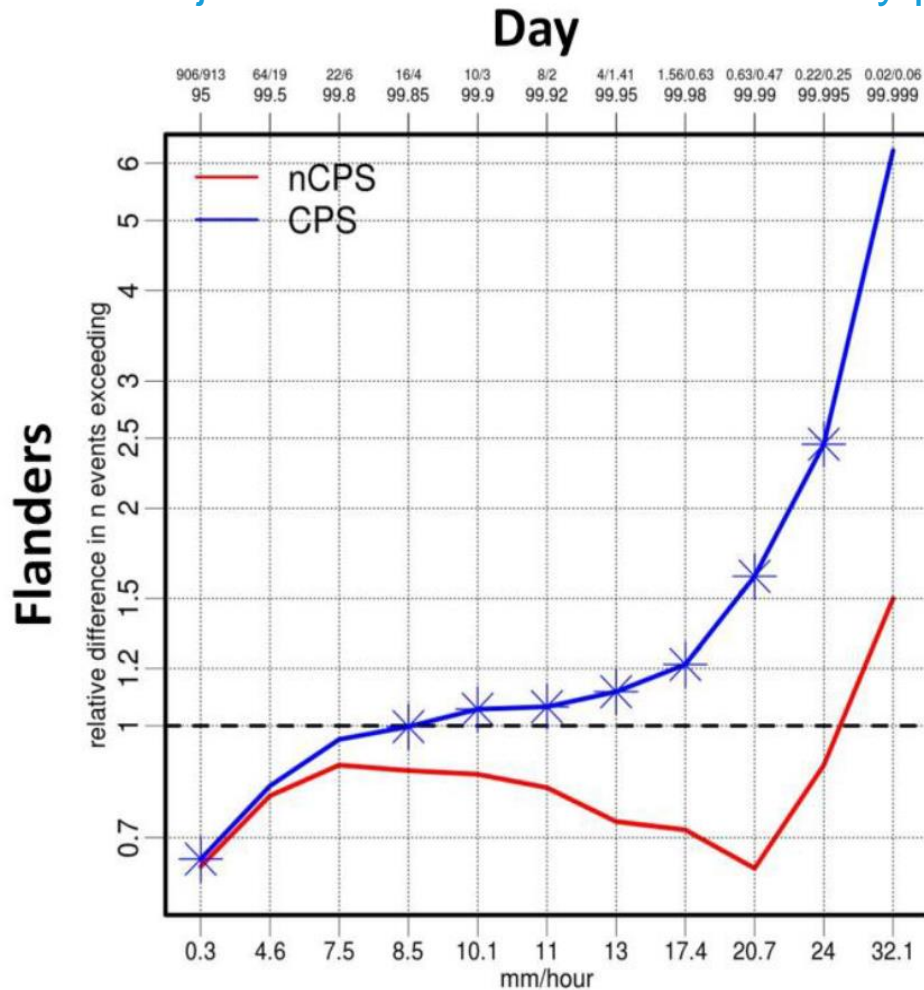


- CPS represents extreme precipitation better!

[Vanden Broucke et al. 2017]

State of the art: example for Belgium

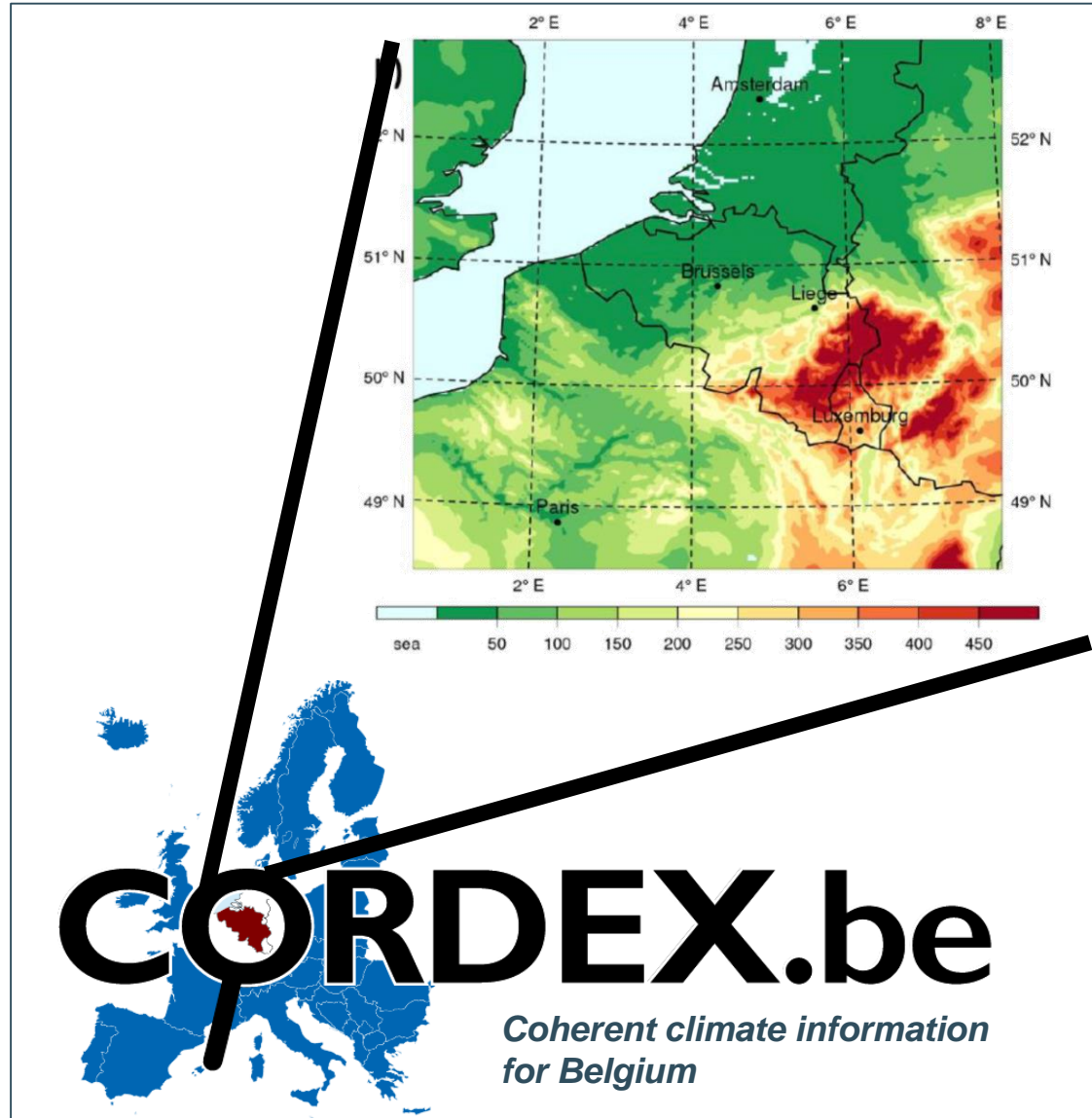
Projected increase in summer hourly precipitation



- Increase in extremes despite projected summer drying
- Replicated by nCPS only in the Ardennes
- Orography vs. convection

[Vanden Broucke et al. 2017]

The CORDEX.be initiative (RMI)



- 30-year climate simulations:
 - Historical
 - Hindcast
 - Future (RCP)
- **Micro-ensemble of CPMs:**
 - ALARO
 - COSMO CLM (x2)
 - (MAR)

= uncertainty information!

[Termonia et al. 2017]

Thesis Objectives



- To provide a **micro-ensemble of climate projections** of extreme precipitation for Belgium using three CPMs
- To determine the **robustness** of the climate change signal of extreme precipitation between the three CPMs

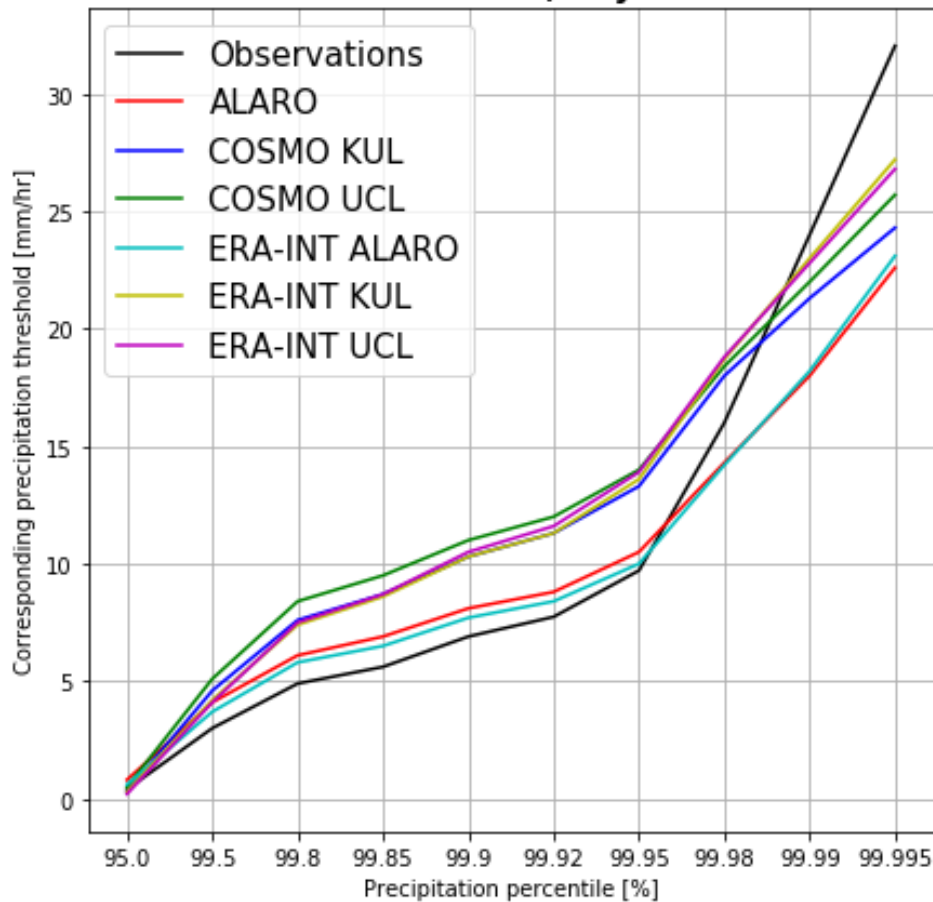
Central questions:

- Is the CC signal robust between the models?
- Is the **resolution/regional dependency** of the CC signal found with COSMO CLM (KUL) confirmed by the other models?
 - ~ Is there a difference between the CC signal for Flanders and the Ardennes and between the CPS and nCPS?

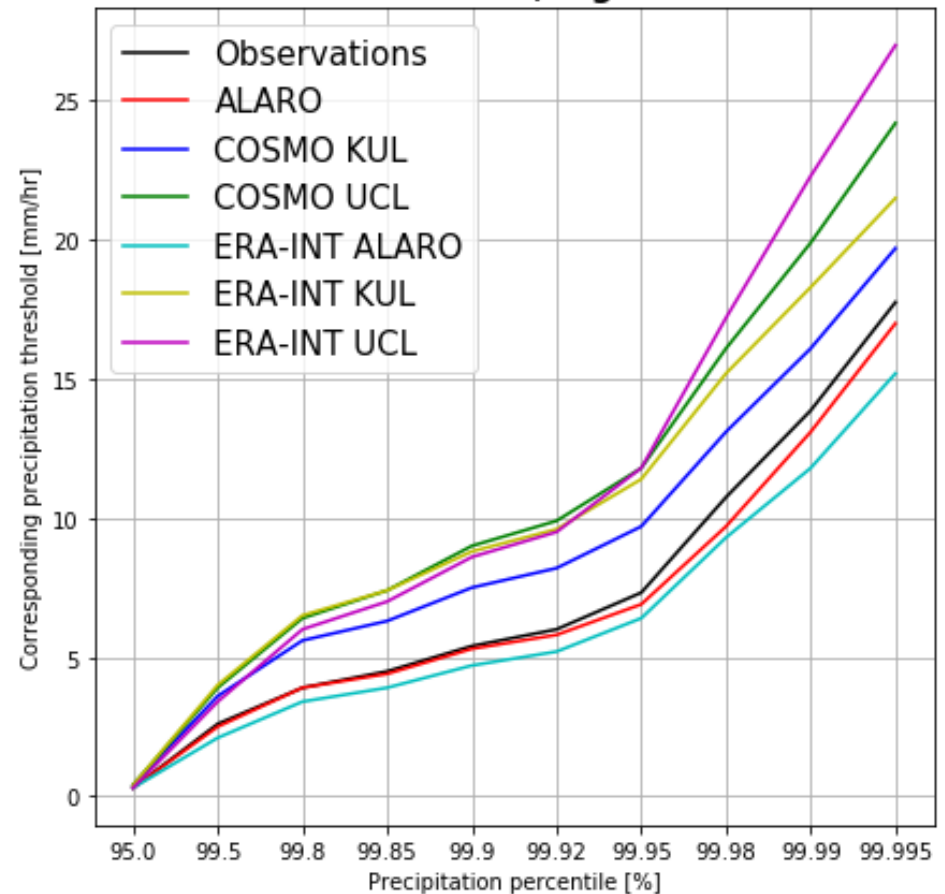
Results

Extreme precipitation thresholds per CPM compared with observations (Flanders)

Flanders, day



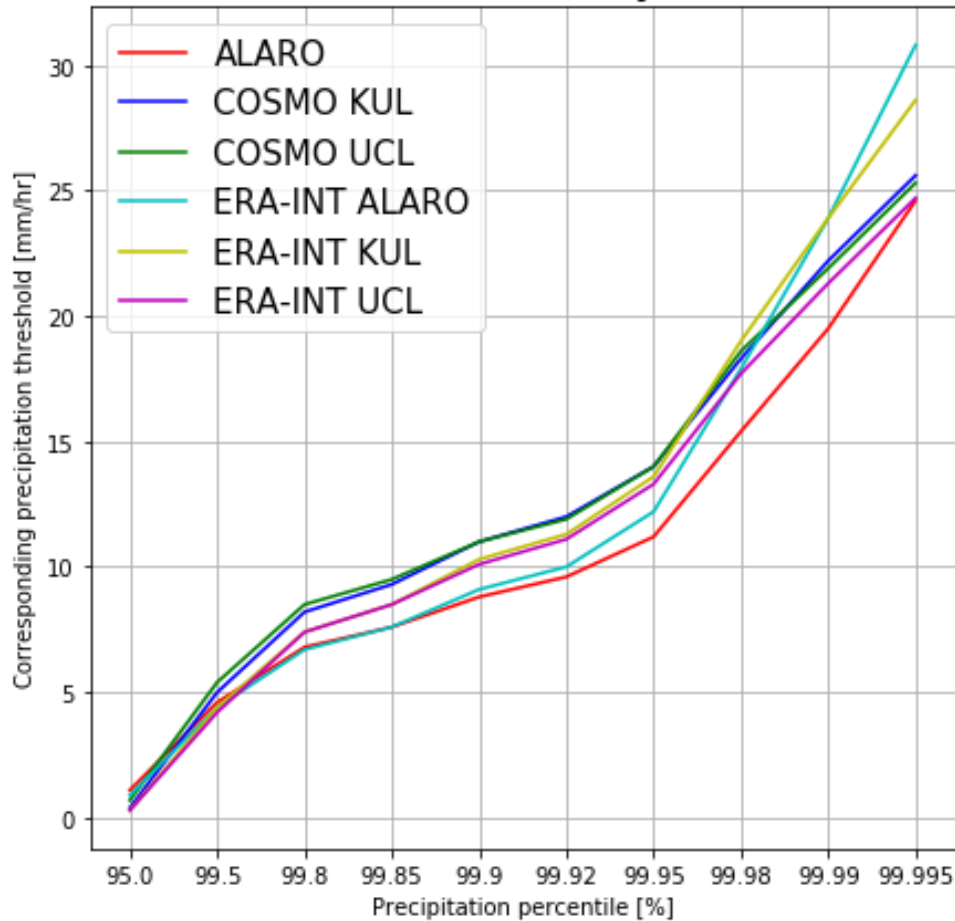
Flanders, night



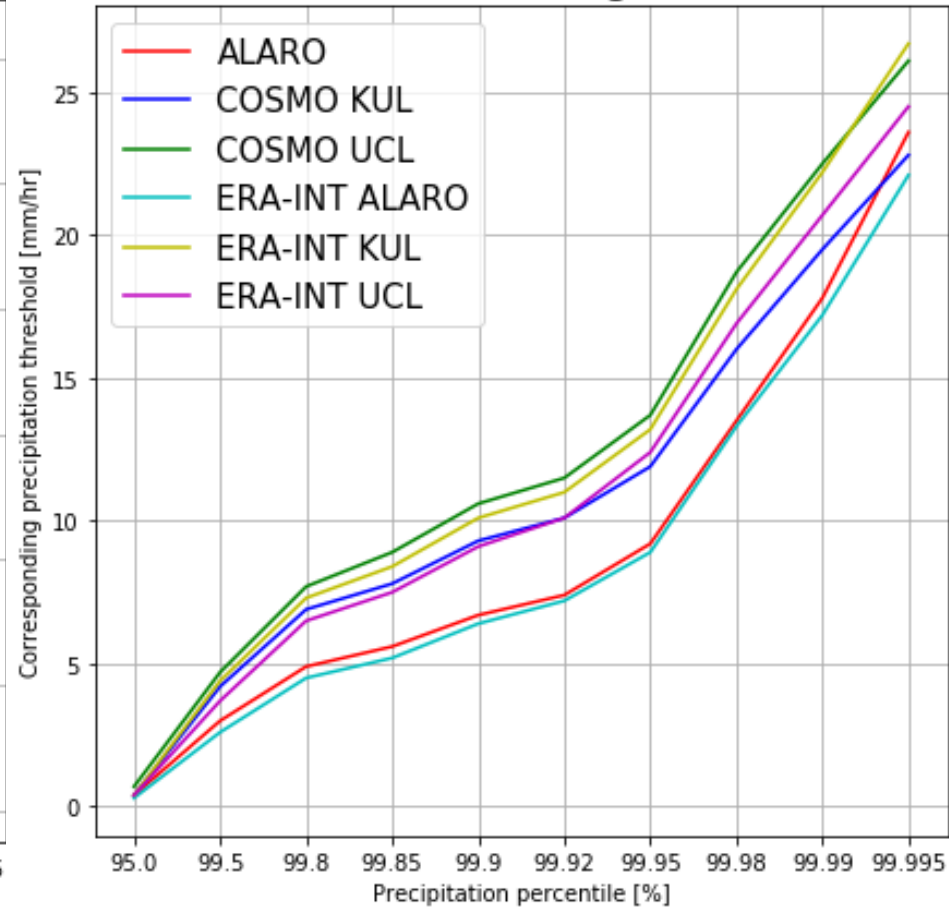
Results

Extreme precipitation thresholds per CPM (Ardennes, no hourly observations)

Ardennes, day

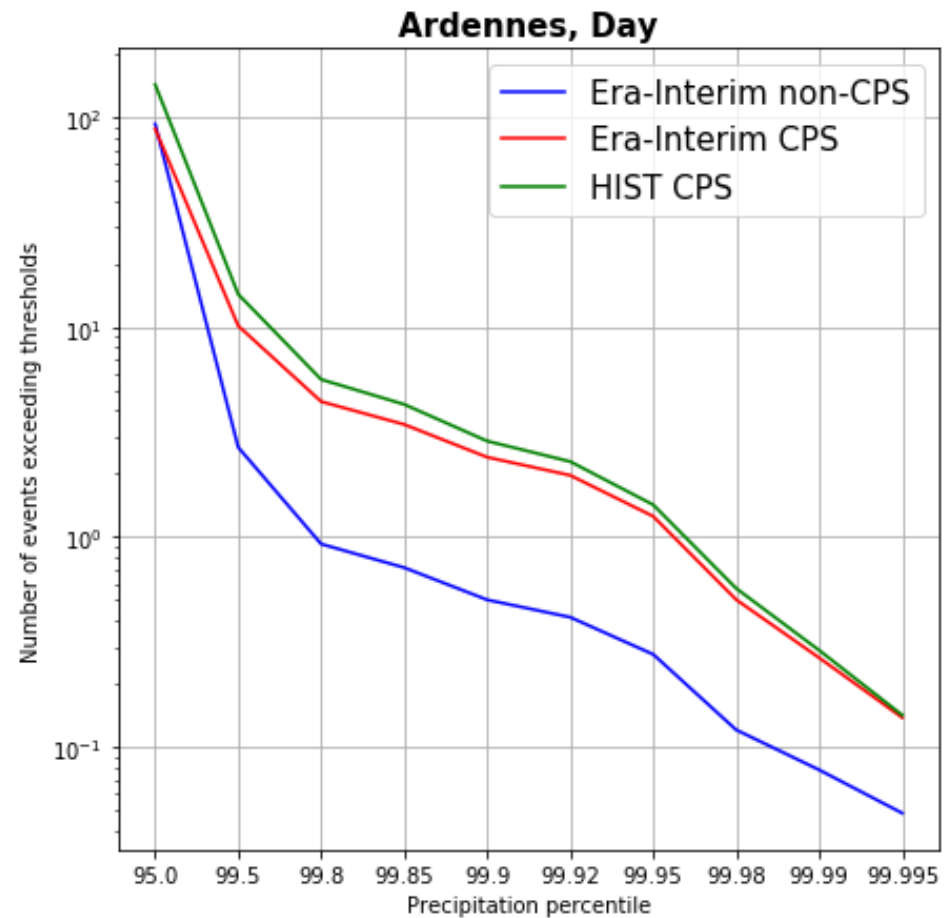
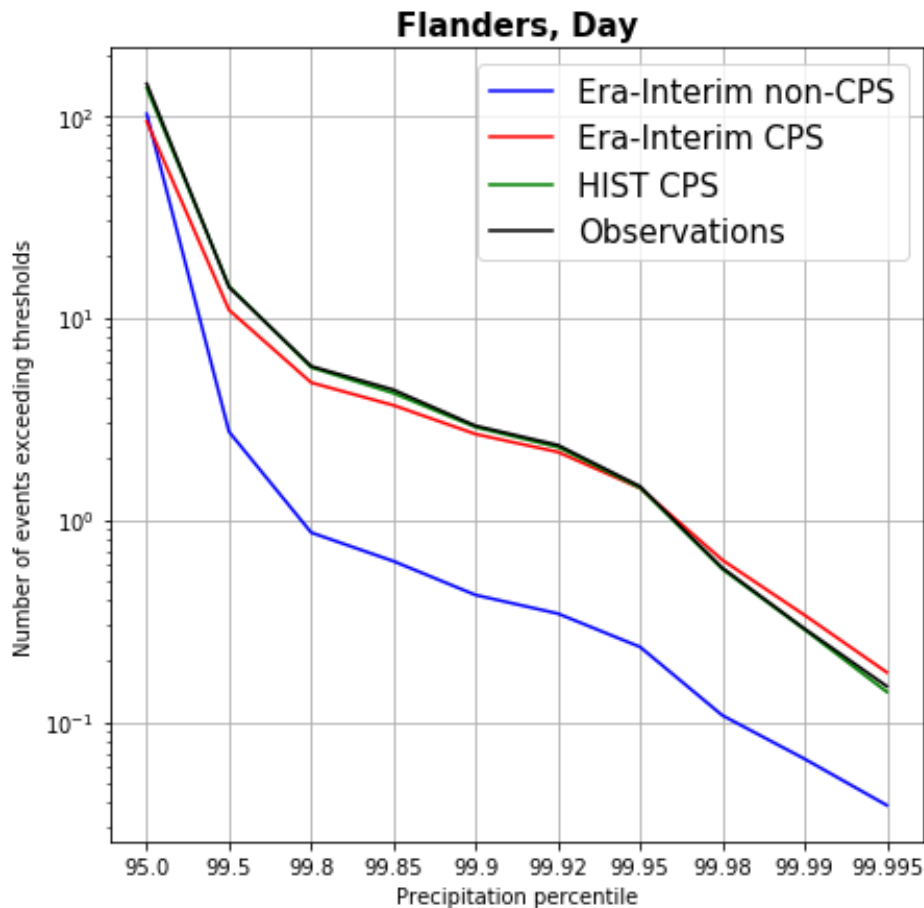


Ardennes, night



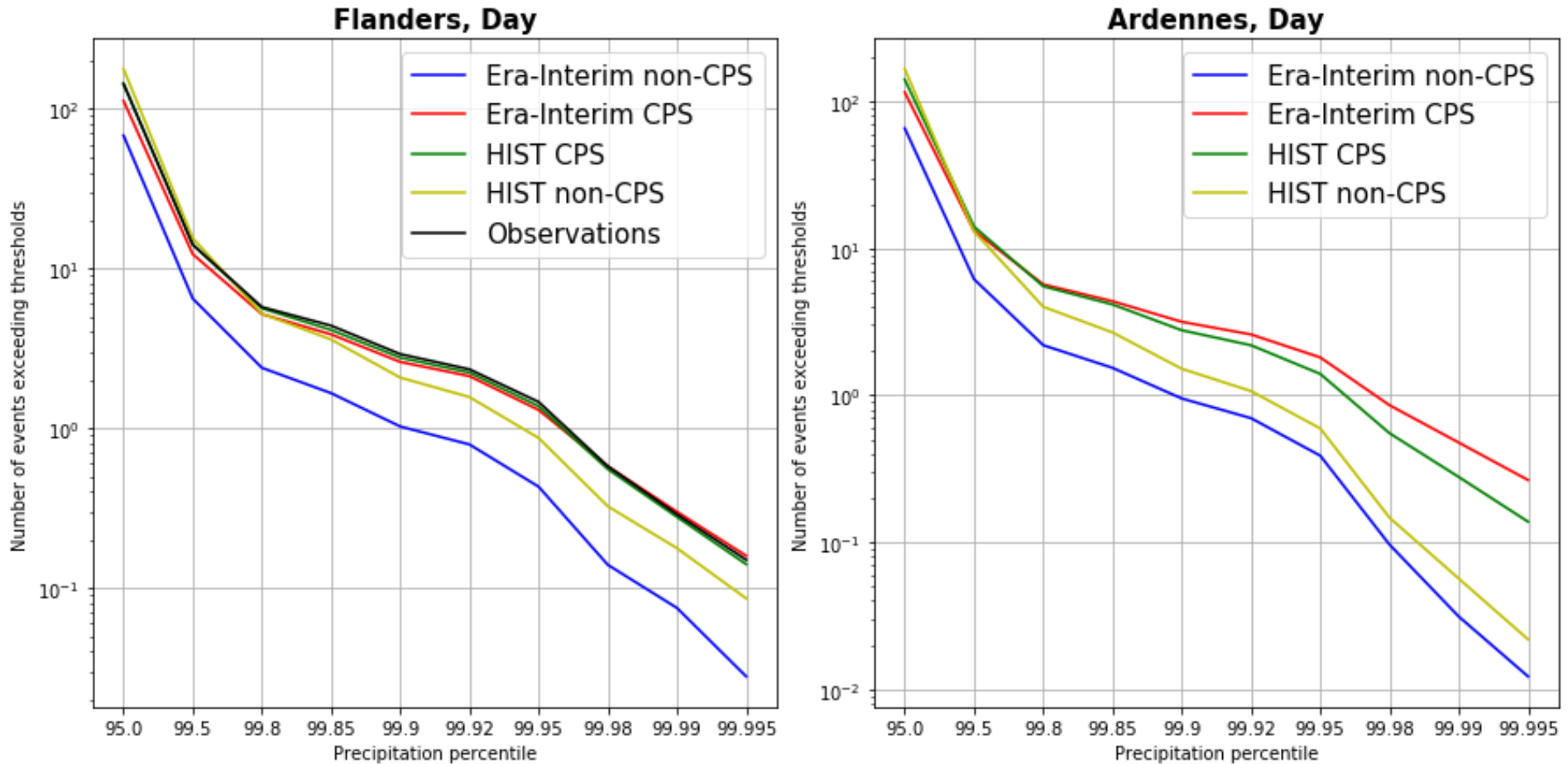
Results

Evaluation summer hourly precipitation (COSMO UCL, daytime)



Intermediate results

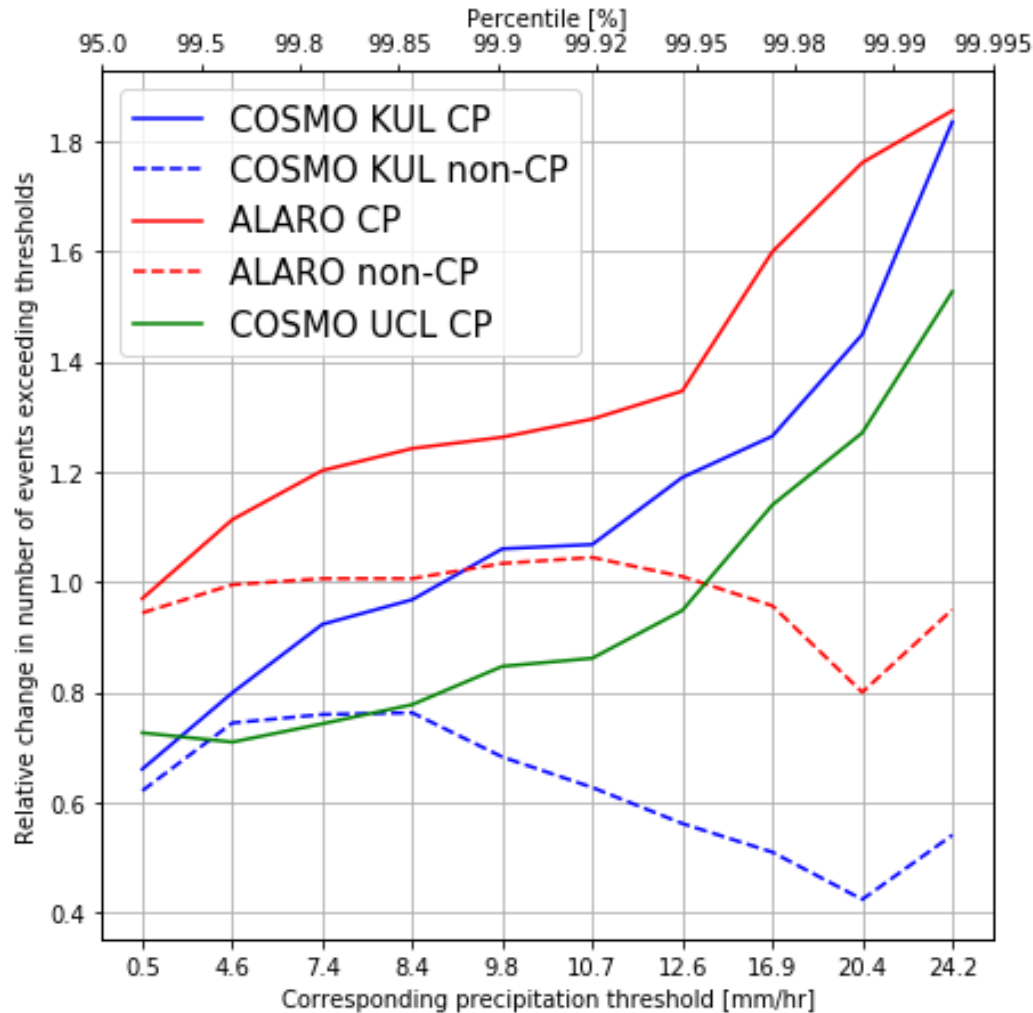
Evaluation summer hourly precipitation (ALARO, daytime)



Results

Projected increase in summer hourly precipitation (daytime)

Flanders (day)



CPS projects increase



Non-CPS does not see the increase

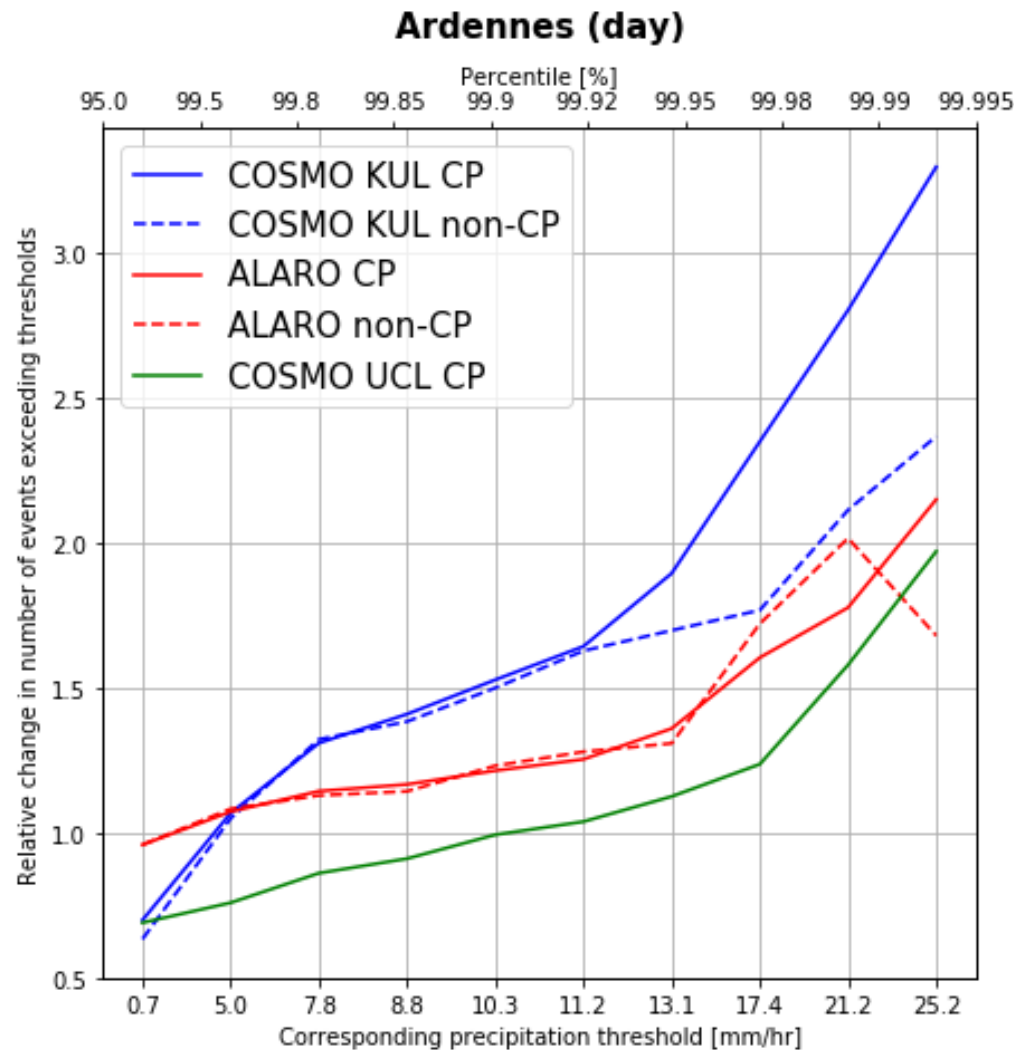


Trend is **robust** among the models (despite small differences)!

Results do NOT depend on the chosen model

Results

Projected increase in summer hourly precipitation (daytime)



Both CPS and non-CPS see increase



Trend is **robust** among models (despite small differences)!

Results do NOT depend on the chosen model

Conclusions

- CPS better represent precipitation extremes
- Minimal difference between GCM-driven results and ERA-INTERIM-driven results

MAIN CONCLUSIONS:

- *Is the CC signal robust between the models?*
- **CC signal is robust among the models**
 - *Is the **resolution/regional dependency** of the CC signal found with COSMO CLM (KUL) confirmed by the other models?*
 - ~ *Is there a difference between the CC signal for Flanders and the Ardennes and between the CPS and nCPS?*
- **CC signal differs between Flanders and Ardennes:**
- **CC signal differs between CPS and non-CPS:**
 - Flanders: only increase in extremes by CPS
 - Ardennes: both CPS and non-CPS project increase

 **CC signal depends on the chosen region, not on the chosen model!**

Questions?



Thank you!