Meteorological extremes for Belgium

Bert Van Schaeybroeck

Royal Meteorological Institute Belgium

Ukkel, 25th September 2017

Goal of presentation

GOAL = **Overview a few meteorological extremes and their potential climate changes in Belgium**

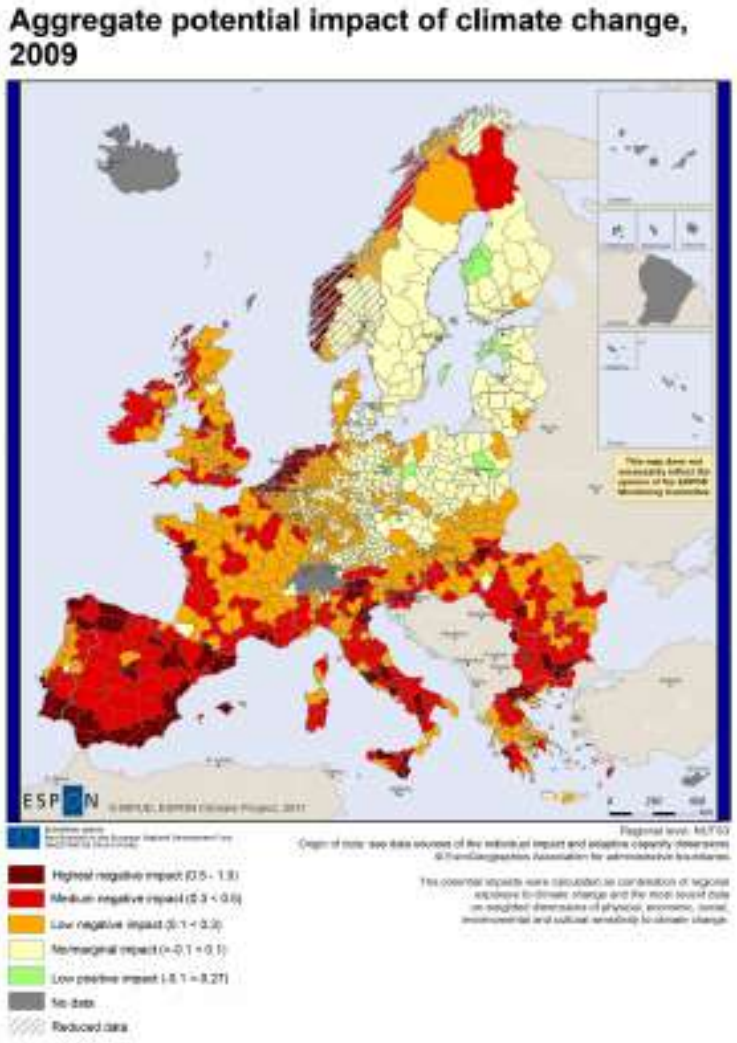
Discussed here are hail, extreme precipitation, droughts and thunderstorms.

Why are extremes so important?

Extremes events have a large impact on societies and through economic, material, crop or physical damage or even casualties.

Pentecost storm June 2014.

Importance: Climate change risks over Europe

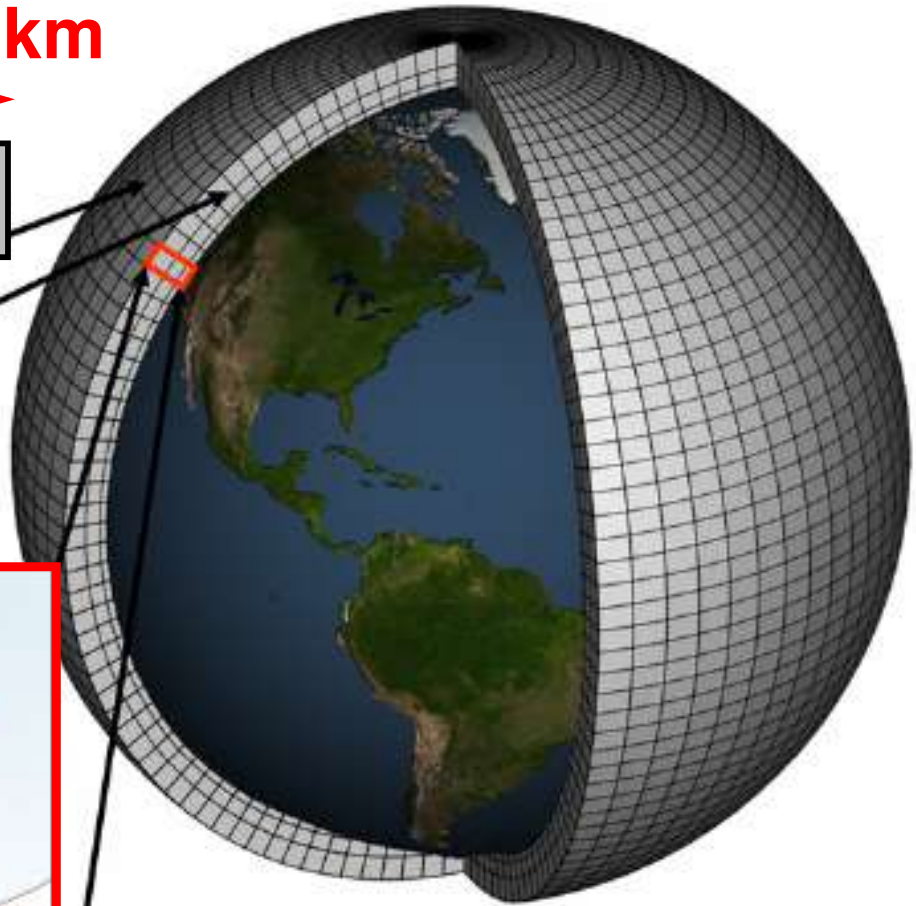


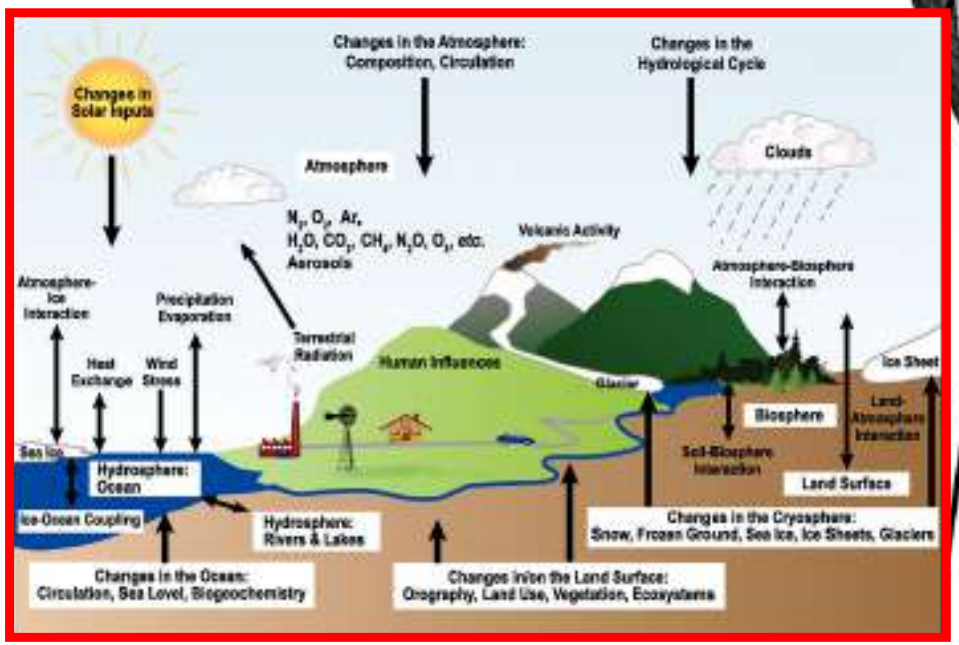
Why need to go to smaller model scale?

100-200 km

Horizontal resolution

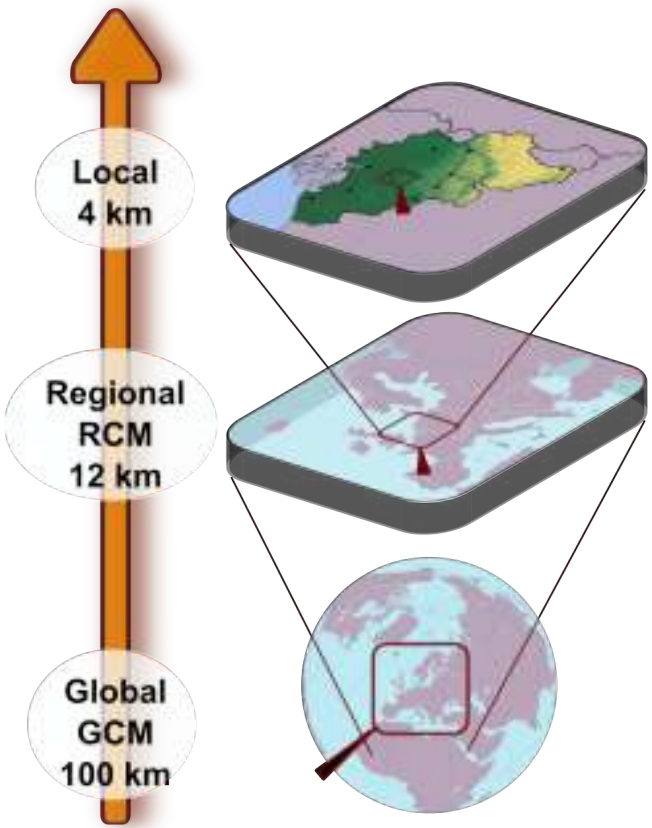
Vertical resolution





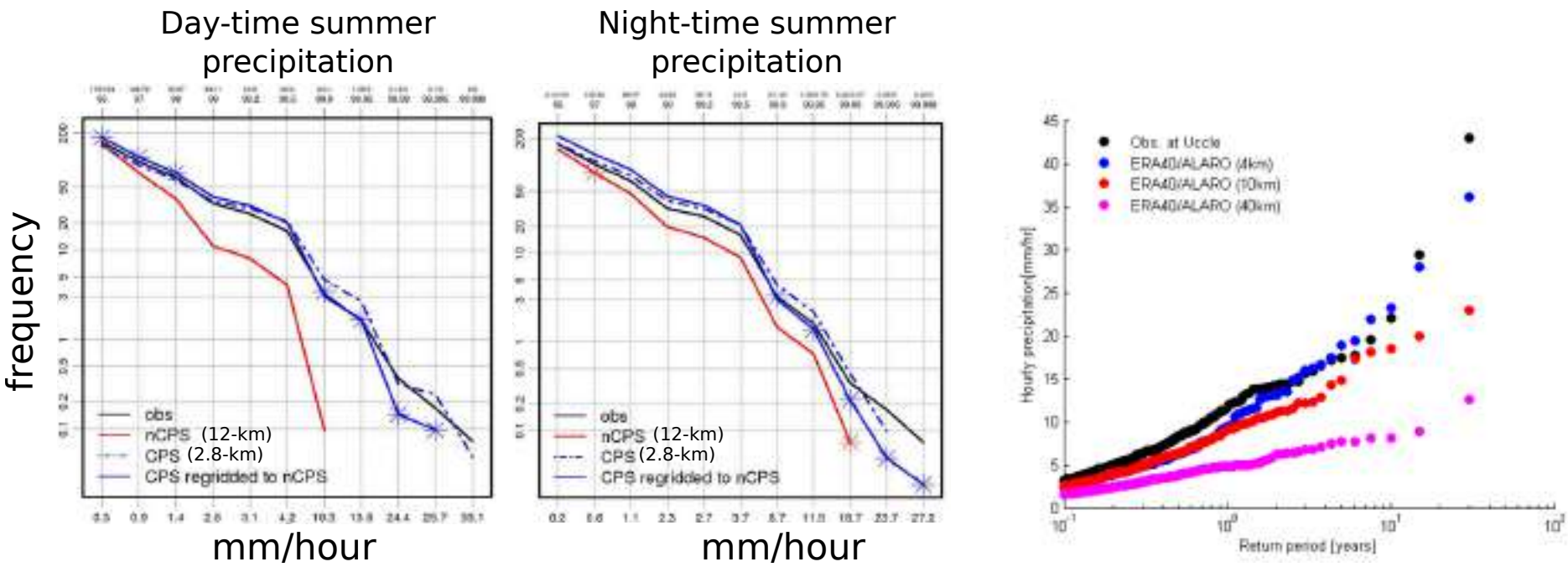
Dynamical downscaling

From global to local scale



Project	Report
CORDEX.be	Local impact reports
CORDEX	EAA (European Environment Agency)
CMIP5	AR5 (IPCC)

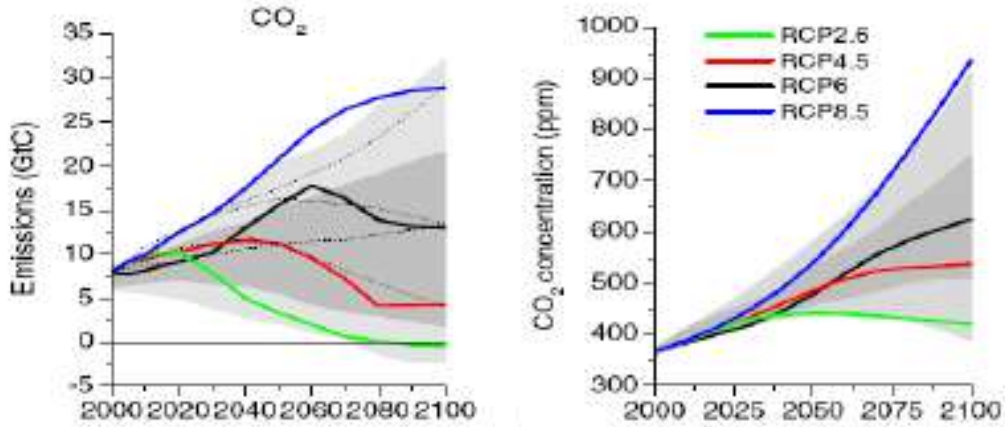
Why need to go to smaller model scale?

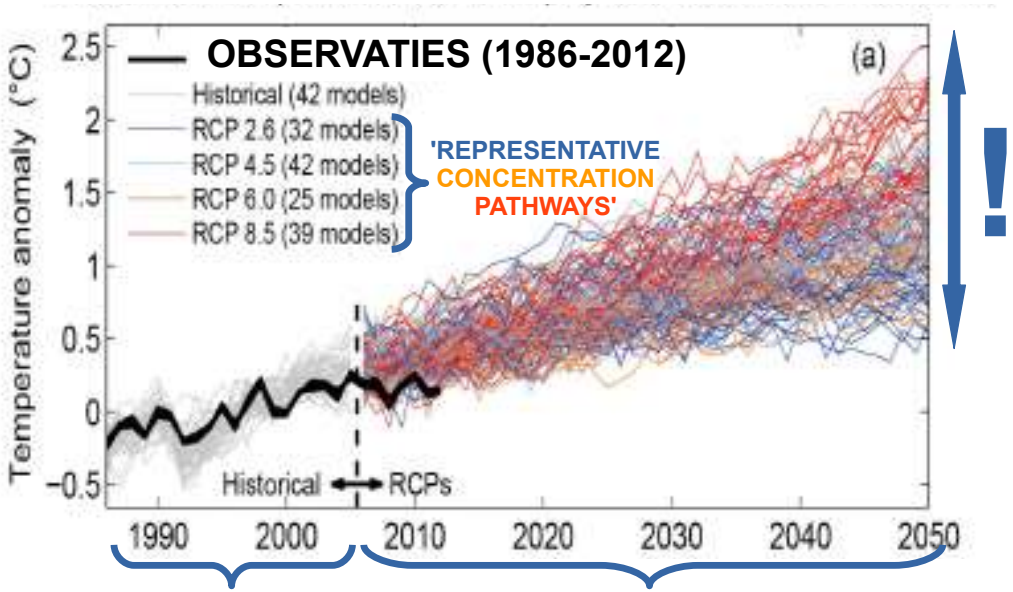


Details: Vanden Broucke et al., 2017 (KULeuven, in preparation) & De Troch et al., RMI publication 65 (2014).

Climate projections

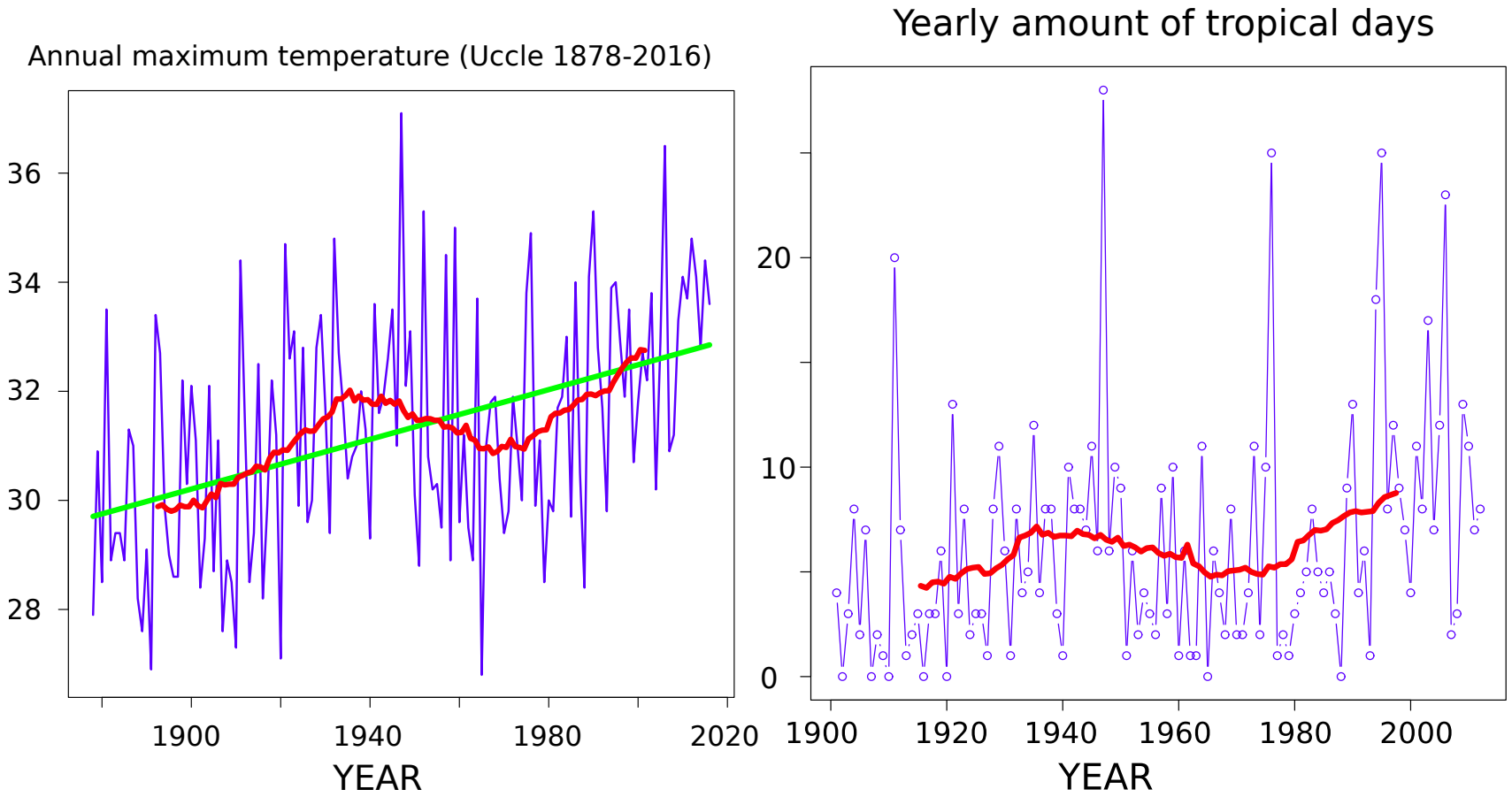
Models and scenarios differ





CMIP5: SIMULATIES + PROJECTIES

Extreme yearly temperatures in the past



Tropical has maximum temperature $\geq 30°$ C.

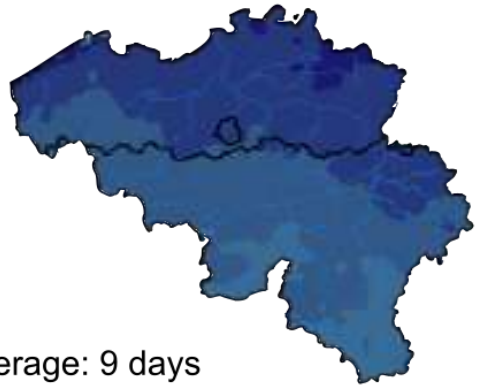
Details: H. Van de Vyver, RMI

Temperature extremes in the past

On average 5 tropical days per year in past.

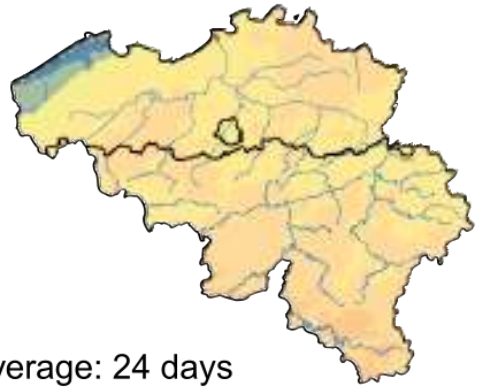
Average change of tropical days following RCP8.5 period 2070-2100

ALARO-0 model



Average: 9 days

COSMO-CLM KUL model



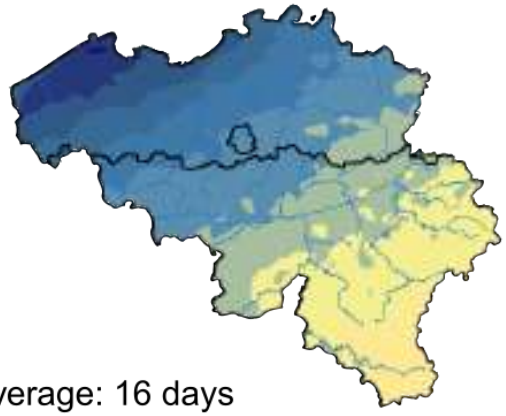
Average: 24 days

Days

20

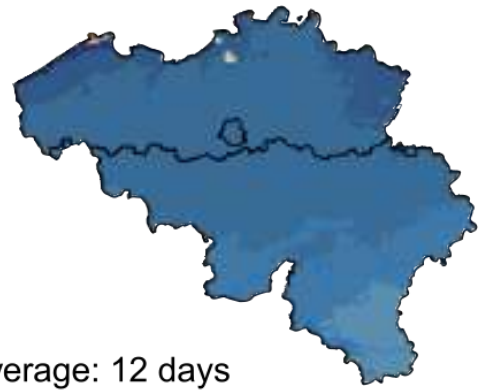
10

MAR model



Average: 16 days

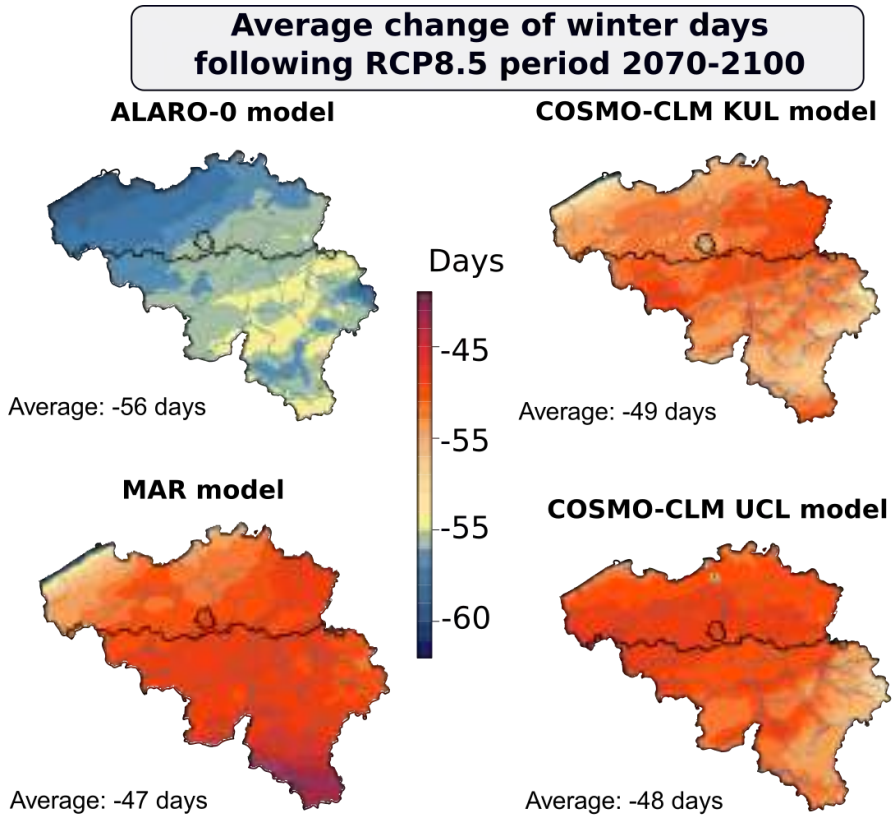
COSMO-CLM UCL model



Average: 12 days

Climate change of winter and summer days

Winter (summer) days have mean temperature below 5°C (above 15°C).



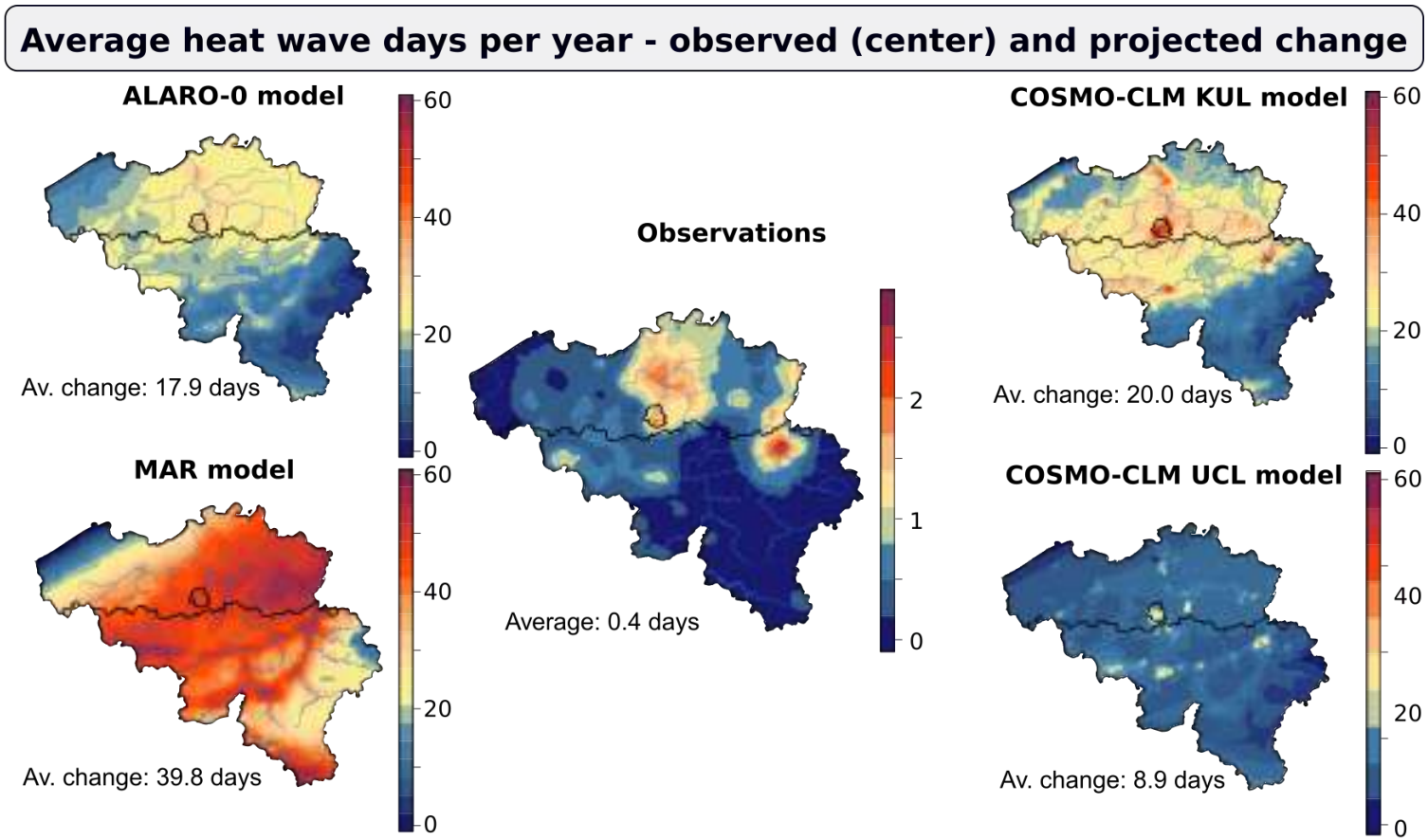
For summer, an average change of +52 days

Details: CORDEX.be end report.

Heat waves and climate change

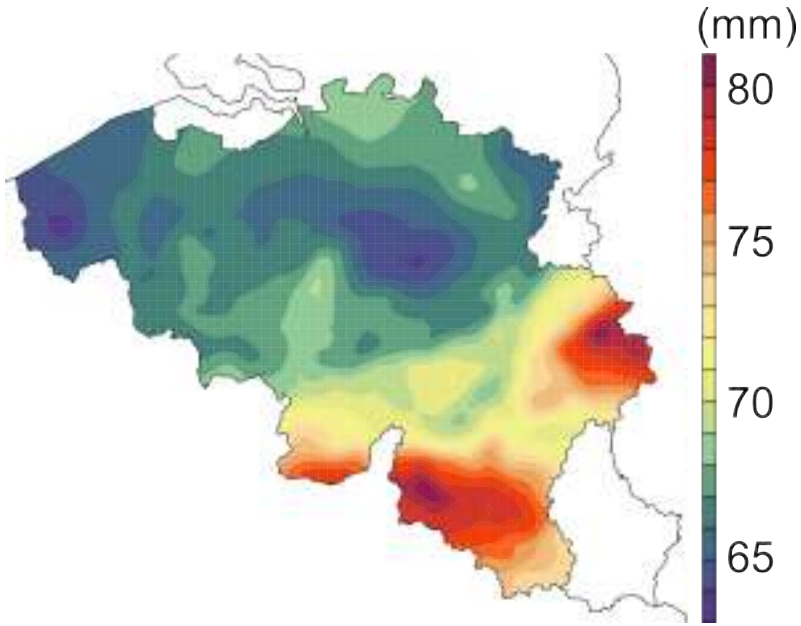
A **heat wave** is a period within which (FOD Health definition):

- minimum temperature $\geq 18°$C at least 3 consecutive days
- maximum temperature $\geq 30°$C at least 3 days.



Details: CORDEX.be end report, observations from Delvaux et al. 2015, Adv. Sci. Res., 12: 103.

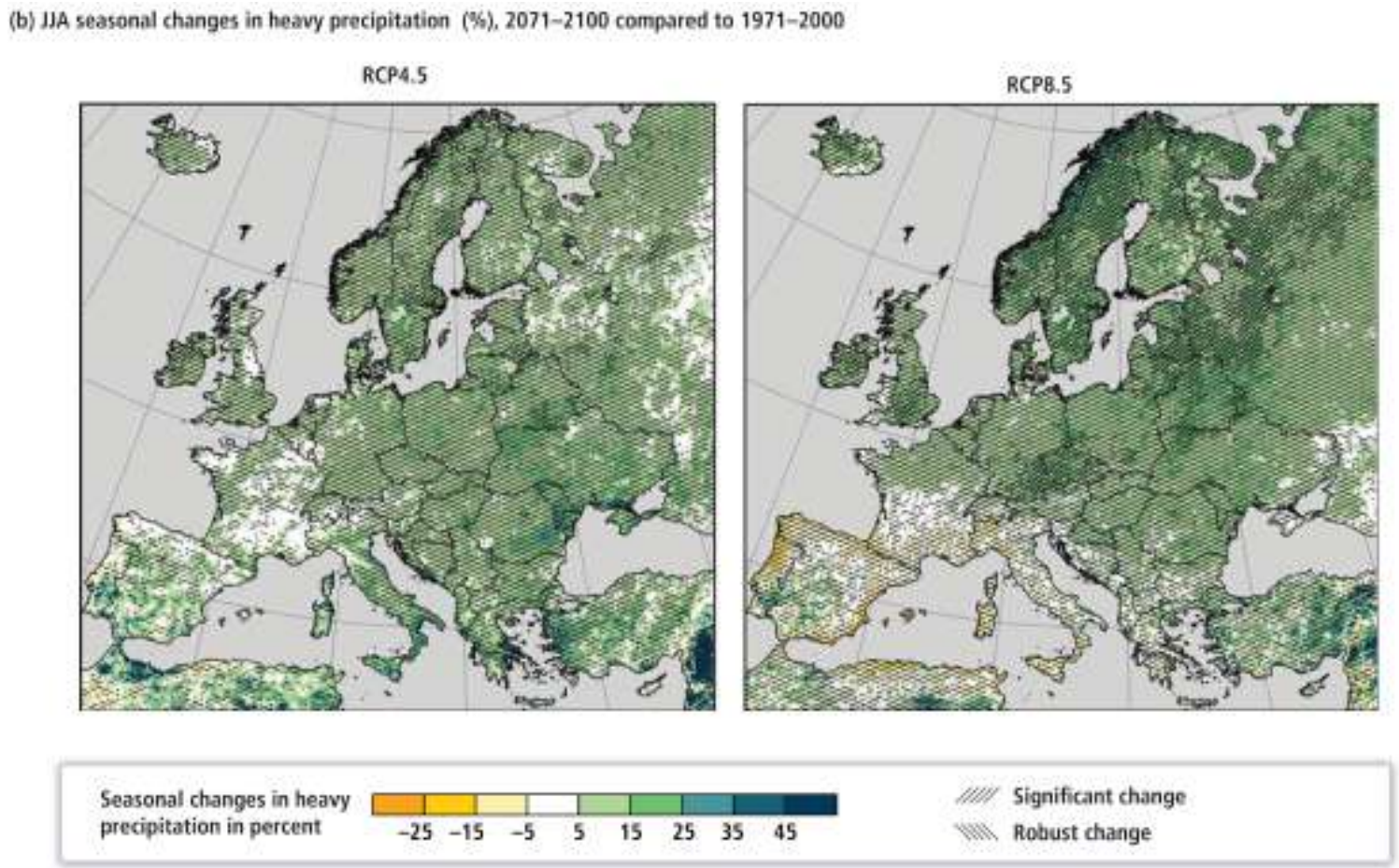
Precipitation extremes in the past



20-year return level map (mm) for daily rainfall.

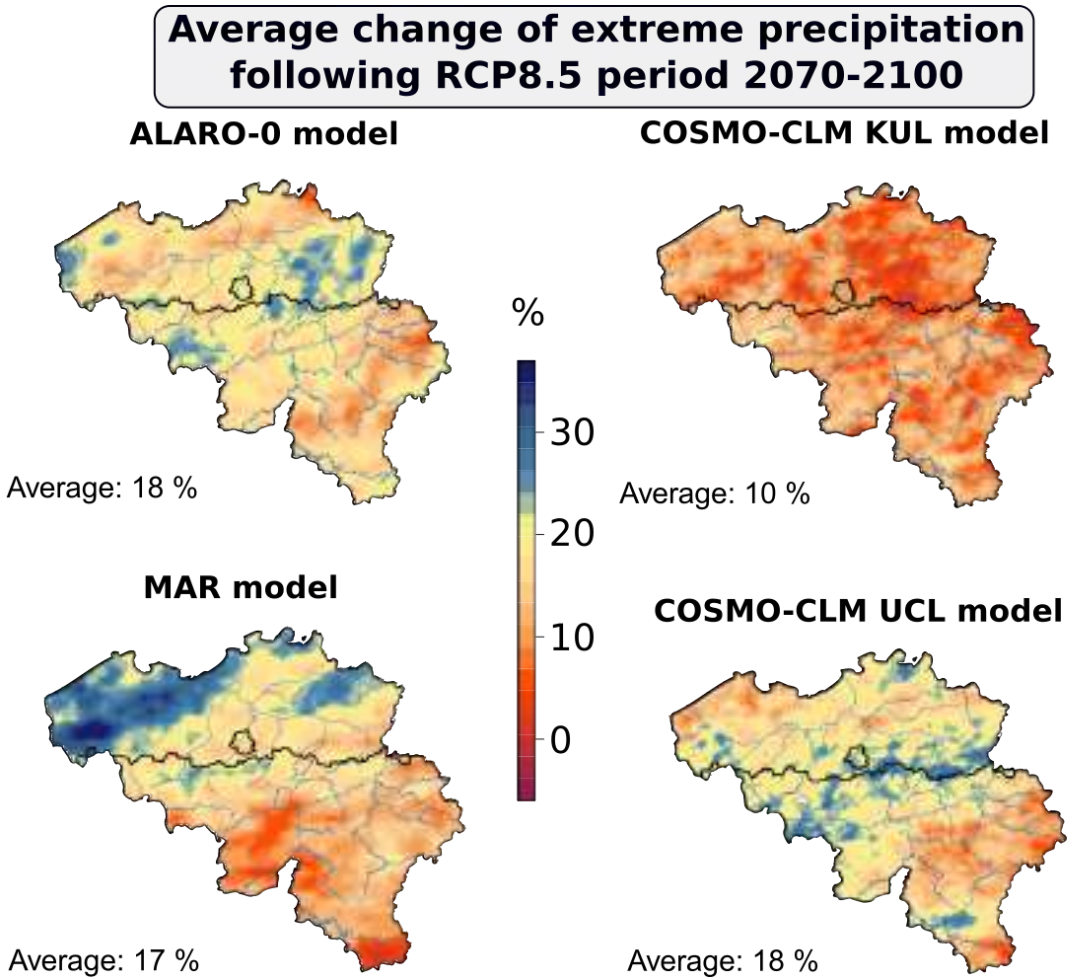
Details: Van de Vyver, (2012), Water Resour. Res., 48, W09549

Climate change of heavy precipitation



source: IPCC WGII (Impacts, Adaptation, and Vulnerability)

Climate change of extreme daily rainfall

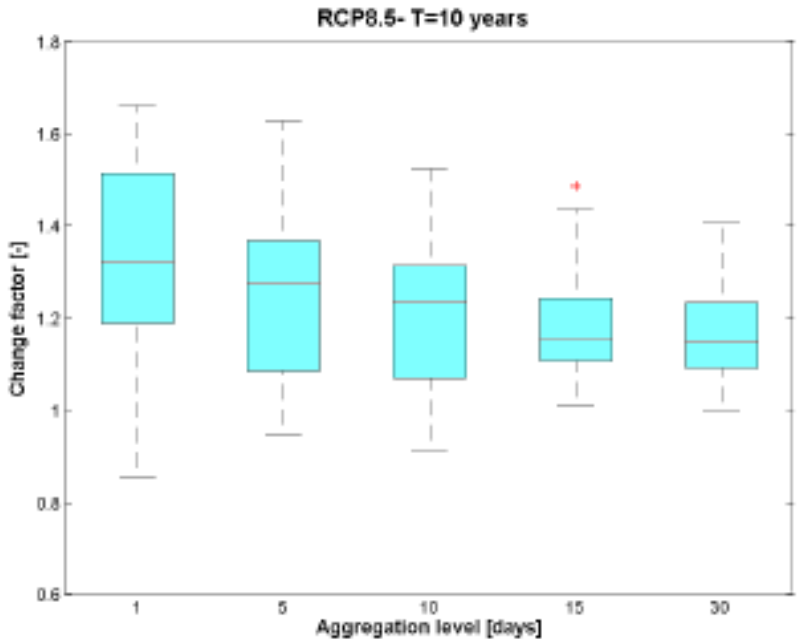


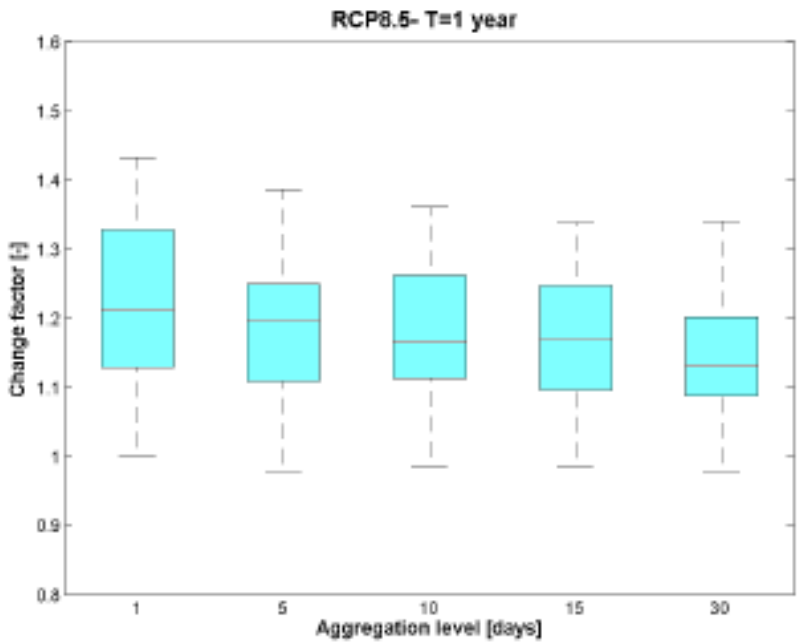
Extreme precipitation defined as 99 percentile of daily precipitation.

Details: CORDEX.be end report

Uncertainties of extreme precipitation

Change factors for extreme precipitation of different durations and return periods, based on EURO-CORDEX models.



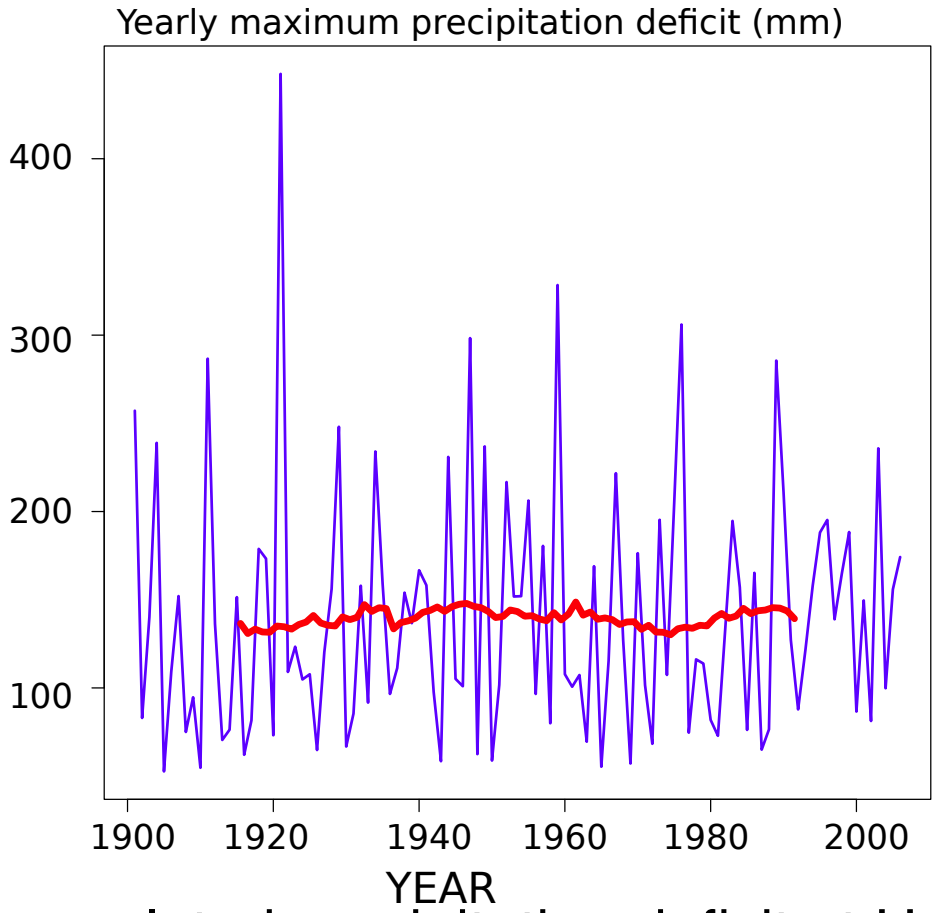


Details: results from KULeuven, see Hosseinzadehtalaei et al. (2017), Int. J. of Clim., 37(S1), 1105

Droughts

- Historically droughts have had huge impact on people.
- **Meteorological drought** takes into account rainfall.
- **Atmospheric drought** takes into account rainfall, evaporation and transpiration.
- **Hydrological drought** occurs when low water supply becomes evident (rivers, reservoirs, etc. . .).
- **Agricultural drought** happens when crops become affected.
- Many different severity indices have been developed over the decades to measure drought in these various sectors.

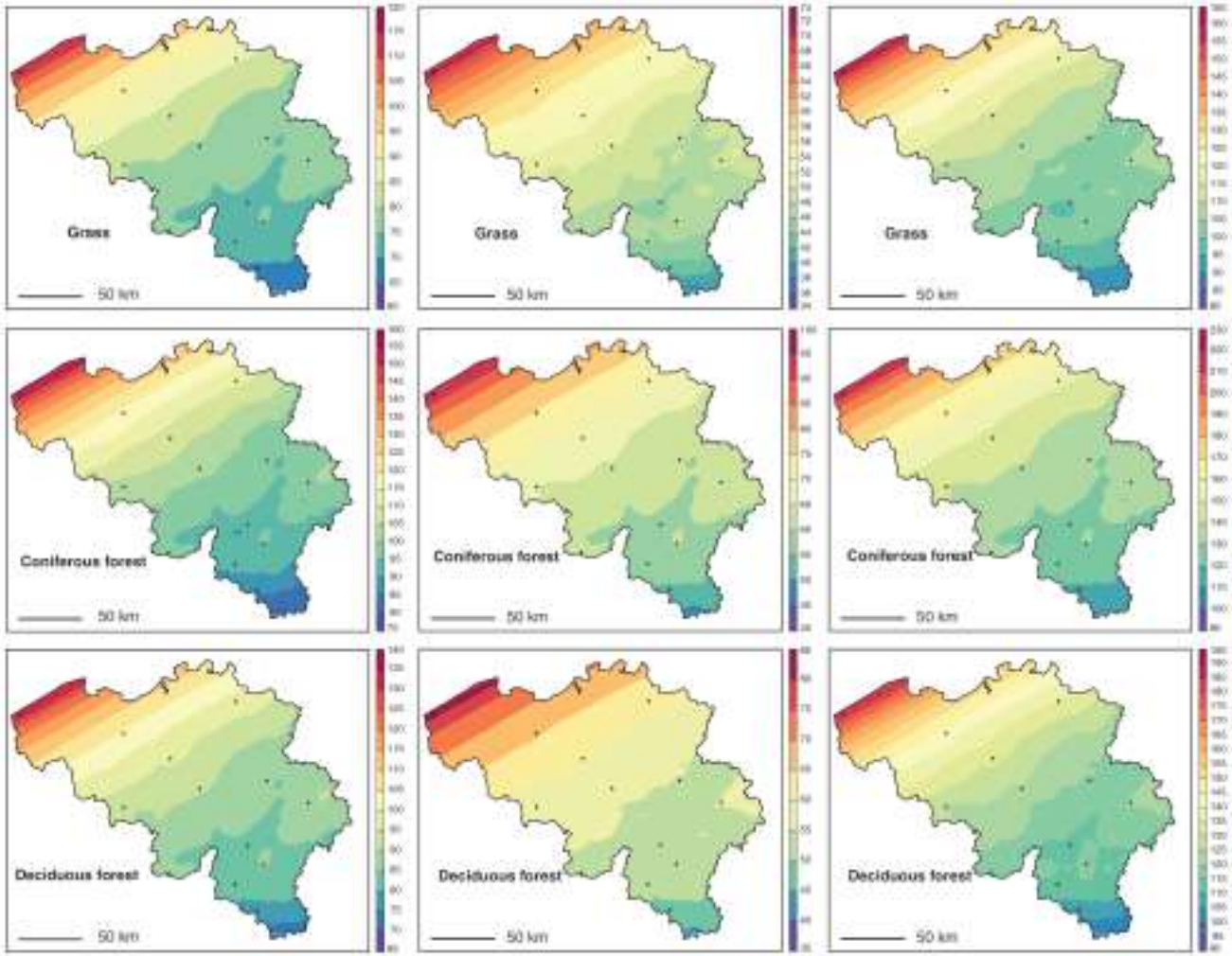
Atmospheric droughts in the past



Summer half-year maximum cumulated precipitation deficit at Uccle $(1901 - 2005)$. Vegetation type: short grass. Red line: 30-year average.
Details: Van de Vyver

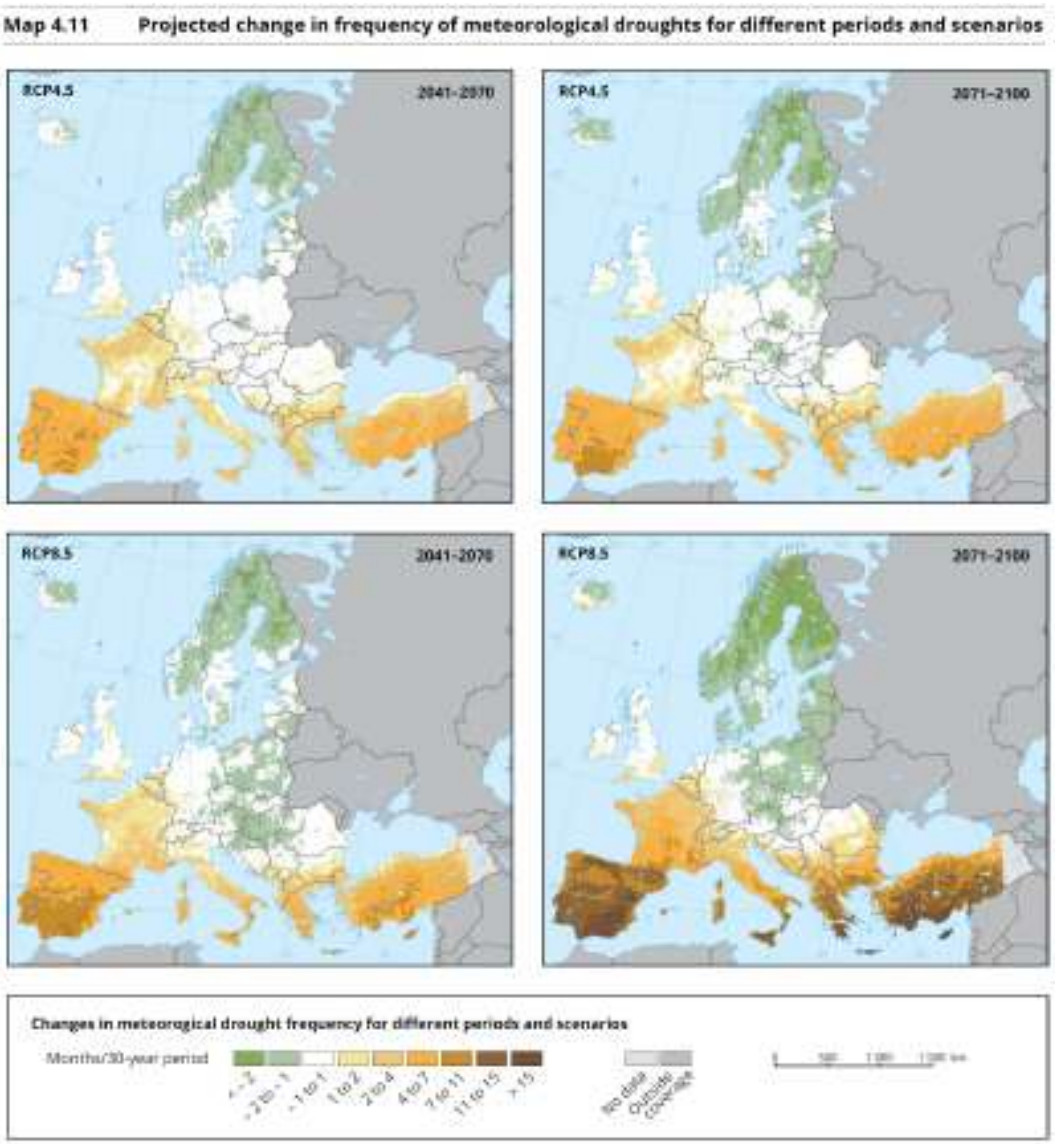
Atmospheric droughts in the past

20-Year return levels for precipitation deficit (mm), using spatial GEV



Details: Zamani et al, Int. J. Climatol. 36 (8), 3056 (2016).

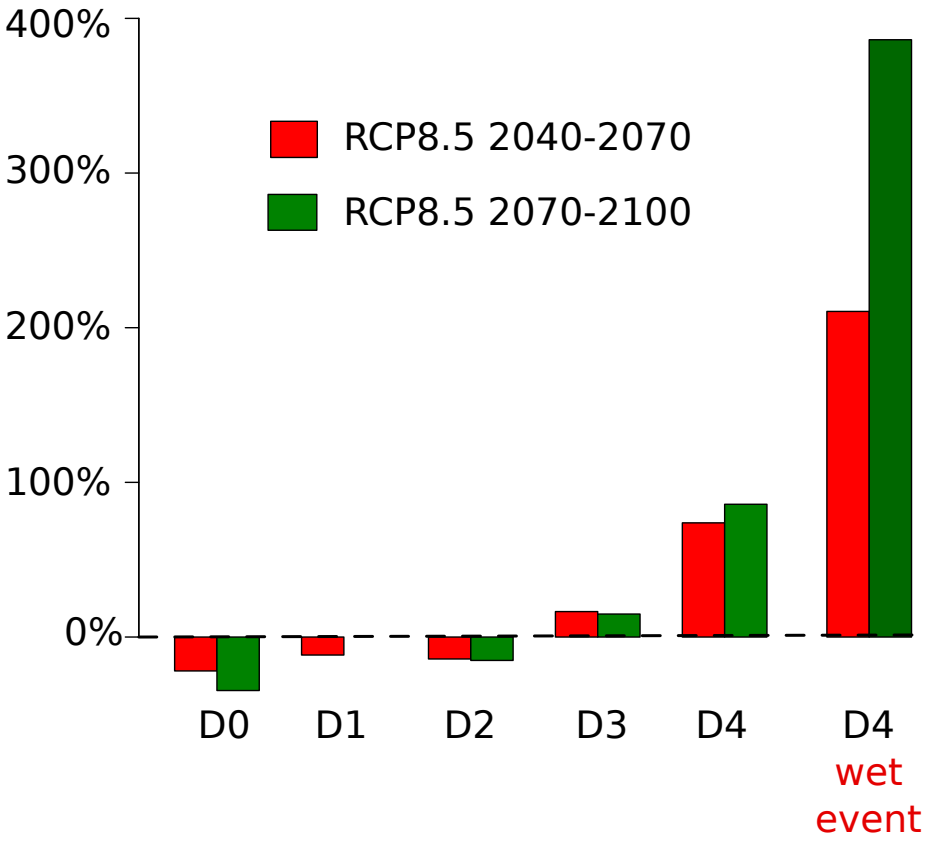
Climate change of meteorological drought



Details: EEA report 2016.

Climate change of meteorological drought

Based on 15 EURO-CORDEX models climate change of meteorological drought for Uccle:



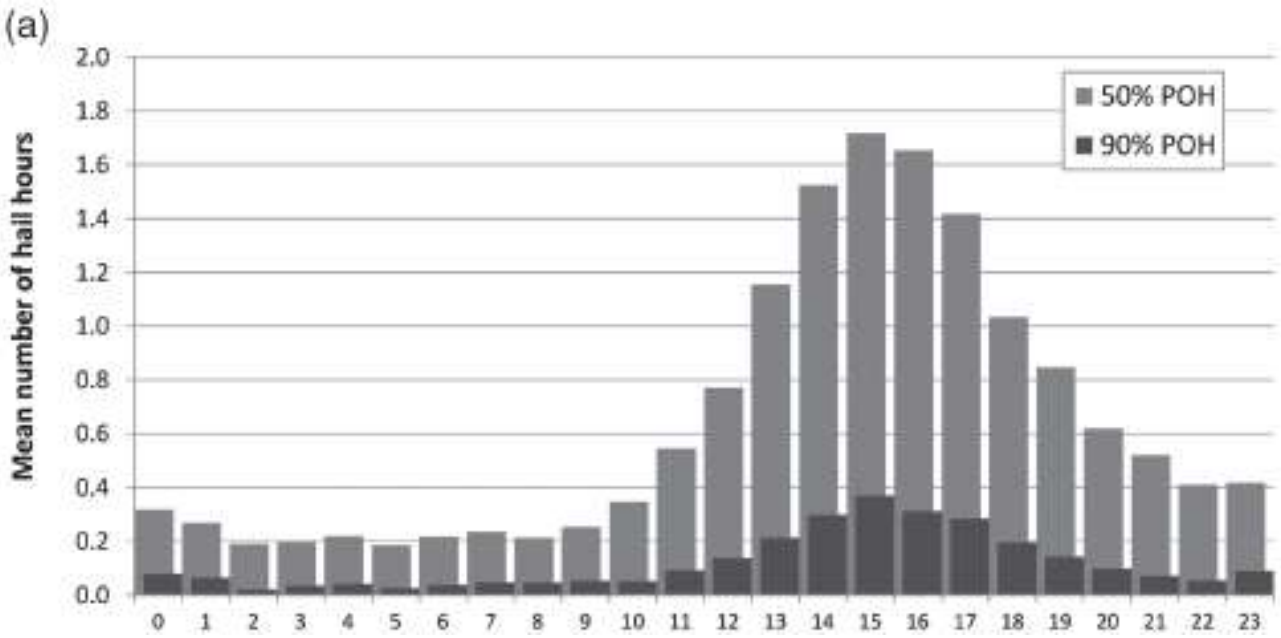
Category	Drought condition	Probability of occurrence (%)
D0	Abnormally dry	20 – 30
D1	Moderate drought	10 – 20
D2	Severe drought	5 – 10
D3	Extreme drought	2 – 5
D4	Exceptional drought	2

Drought index takes into account monthly up to yearly precipitation.

Details: Van de Vyver & Van den Bergh (2017). *The Gaussian copula model for the joint deficit index for droughts*.

Observed hail climatology from radar

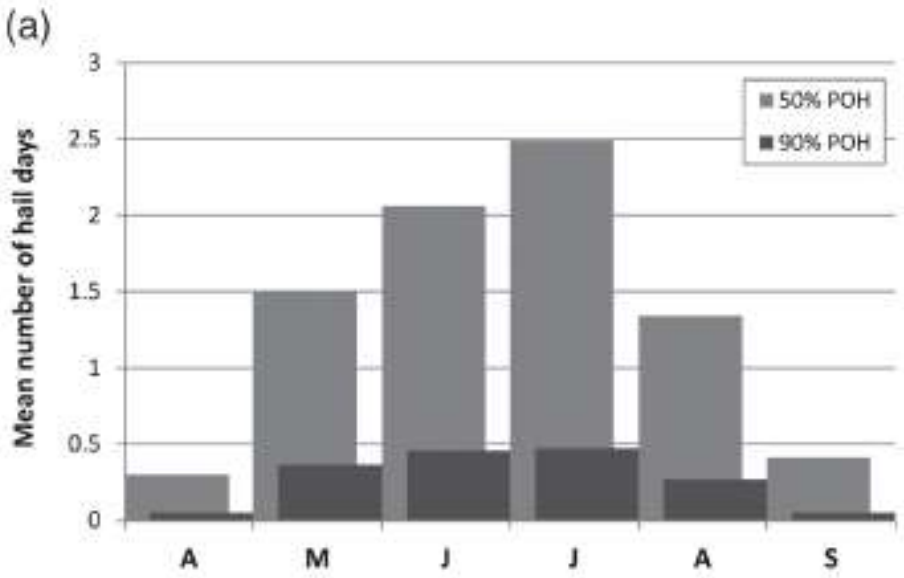
POH: probability of hail derived with RMI Wideumont radar data (2003-2012)

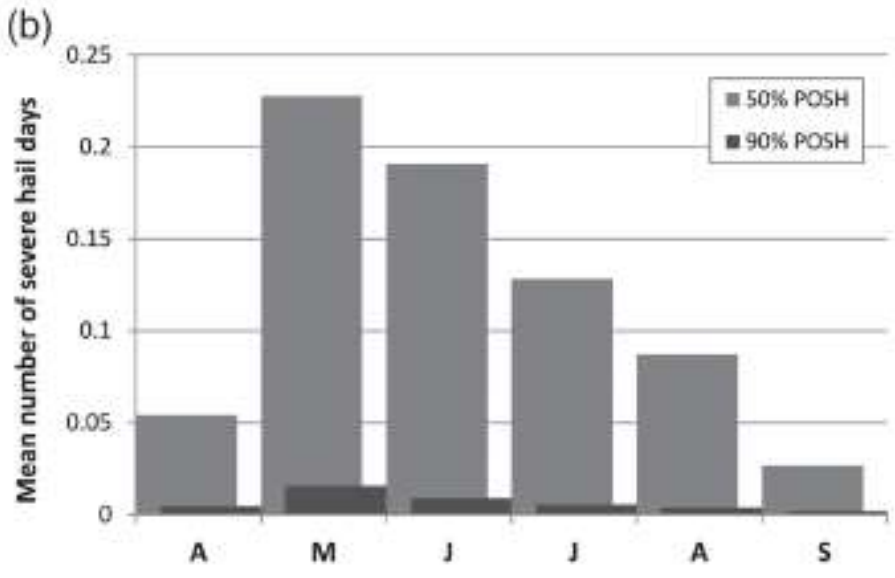


Details: Lukach et al., Meteorol. Appl. (2017), DOI: 10.1002/met.1623

Hail observations with radar: yearly cycle

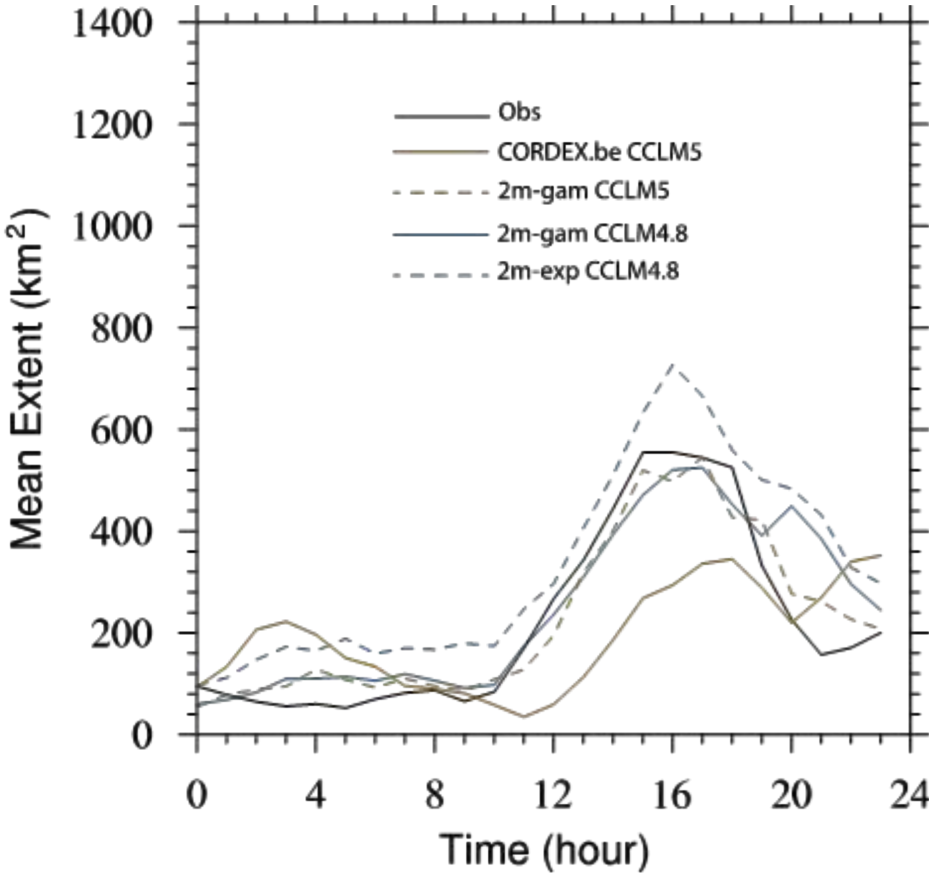
POH: Probability Of Hail
POSH: Probability Of Severe Hail





Details: Lukach et al., Meteorol. Appl. (2017), DOI: 10.1002/met.1623

Hail from COSMO-CLM model: daily cycle

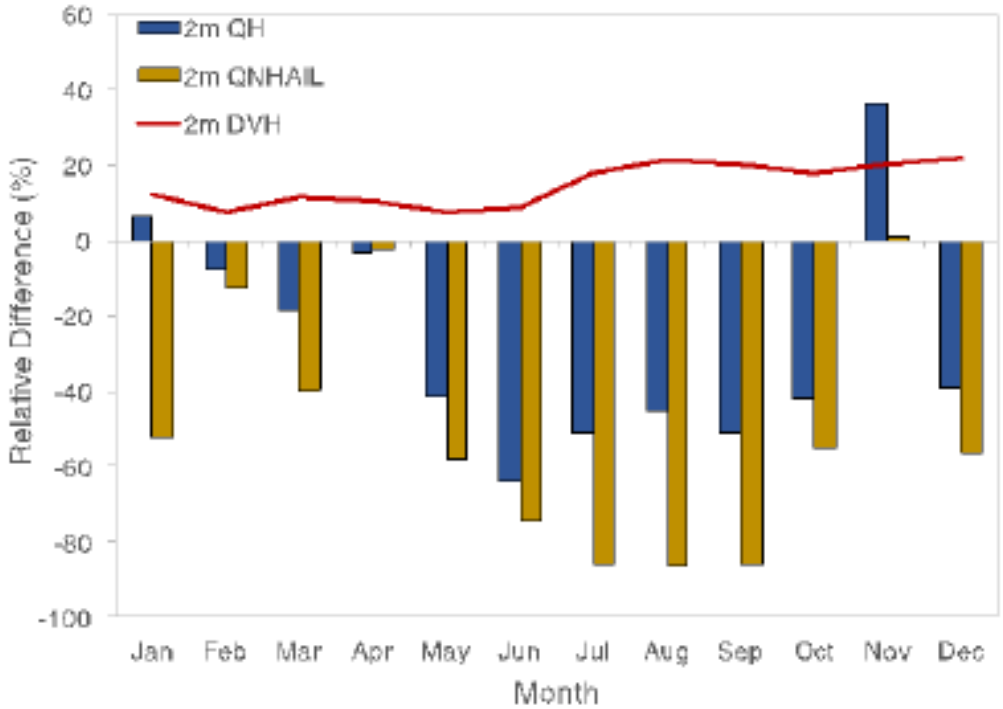


Observed and modelled mean area extent containing surface hail.
Model is COSMO-CLM from UCL.

Details: UCL group, CORDEX.be end report

Climate change of hail events

Climate change of **2m QH** (hail content), **2m QNHAIL** (hail number concentration), **2m DVH** (mean hail size) following RCP8.5 (2070-2100).



Details: UCL group, see CORDEX.be end report

Climate change of severe convective events

Climate change of severe thunderstorm events following RCP8.5. Obtained using ALARO-0 model

	2040-2069	2070-2099
Hail	-4.9% ±4.7%	+12.0% ±5.3%
Wind gusts	-4.8% ±4.2%	+10.9% ±4.7%
Tornadoes	-1.9% ±3.0%	+5.2% ± 3.2%
Rainfall	-3.6% ±3.6%	+5.9% ±4.0%

Details: P. Maesen, Masters Thesis, RMI & UGent

Conclusion

For the most pessimistic GHG scenario, period 2070-2100:

With high degree of confidence:

- a lot more tropical days and heat waves
- more extreme precipitation
- more exceptional wet periods

With moderate confidence:

- more extreme and exceptional droughts

Indications exist that:

- there will be less hail events but increase of mean hail size

References:

- Oog voor klimaat / vigilance climatique, RMI publication.
- CORDEX.be final report (to be published by BELSPO).