Gridding of precipitation and air temperature observations in Belgium

Michel Journée

Royal Meteorological Institute of Belgium (RMI)

Gridding of meteorological data

A variety of hydrologic, ecological, natural resource, and other models and decision support tools are **linked to geographic information system (GIS)**.

Need for accurate information about weather and climate for any place at any time, even at **places with no observations**.

→ Need for **consistent estimates** of meteorological elements at any location at any time

→ Interpolation of unevenly distributed station's data onto a regular grid

Gridded data at RMI

Only few gridded data based on in situ measurements can currently be delivered to users (except for solar radiation).

➔ develop a **new data processing line** to generate gridded data in an operational way

This will be done in several steps:

In this talk:
Climate maps for **precipitation** and **air temperature**

1. **1981-2010 climate maps**
2. Annual, seasonal and monthly grids
3. Daily grids

Climatological observations in Belgium

Manual stations daily precipitation (RR)
daily min + max temperature (TX/TN)
observed at 08:00 local time.

RR	230 stations mean distance: 8km
TX/TN	140 stations mean distance: 12 km

(January 2014)

Climatological observations in Belgium

Manual stations daily precipitation (RR)

daily min + max temperature (TX/TN)

observed at 08:00 local time.

Automatic stations

observations on a 10-min average basis

29 stations

1981-2010 climate maps

several possible approaches

1. gridding of daily data
2. derive climate maps from the daily grids

\+ all data can be considered

\- ancillary data/covariate

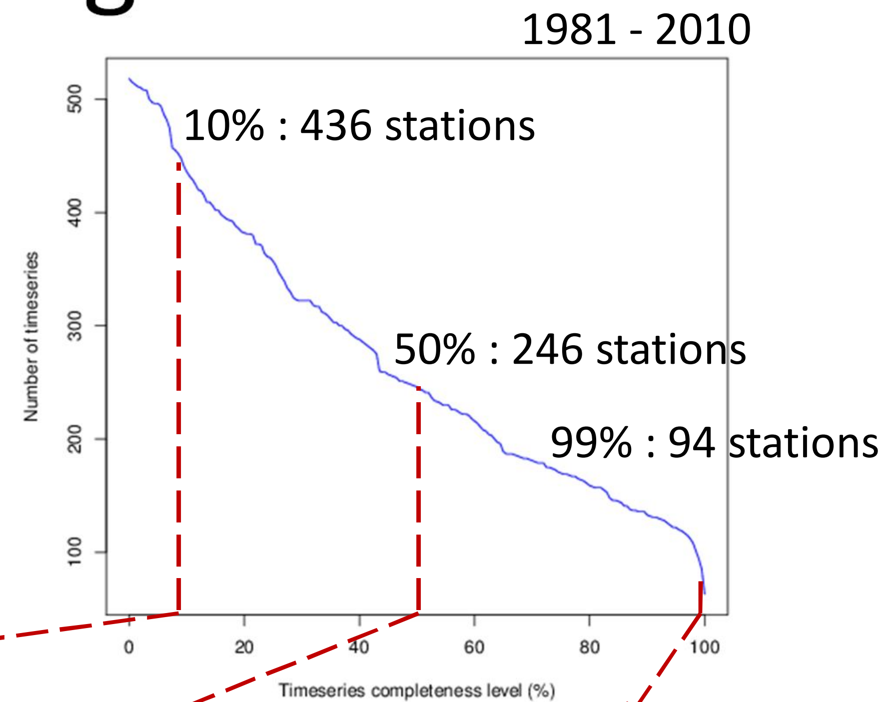
1. derive in-situ climate values
2. spatial interpolation of these climate values

\- only long data timeseries can be considered

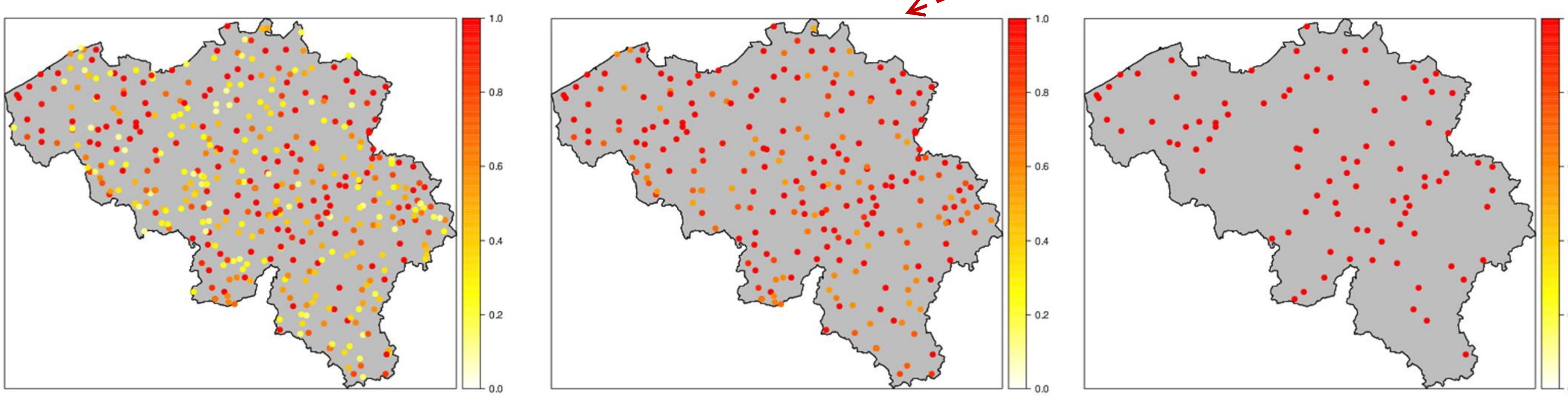
\+ several possible covariate (topography, etc.)

Gaps/missing data

Tradeoff between the number of stations and timeseries completeness



Case of precipitation

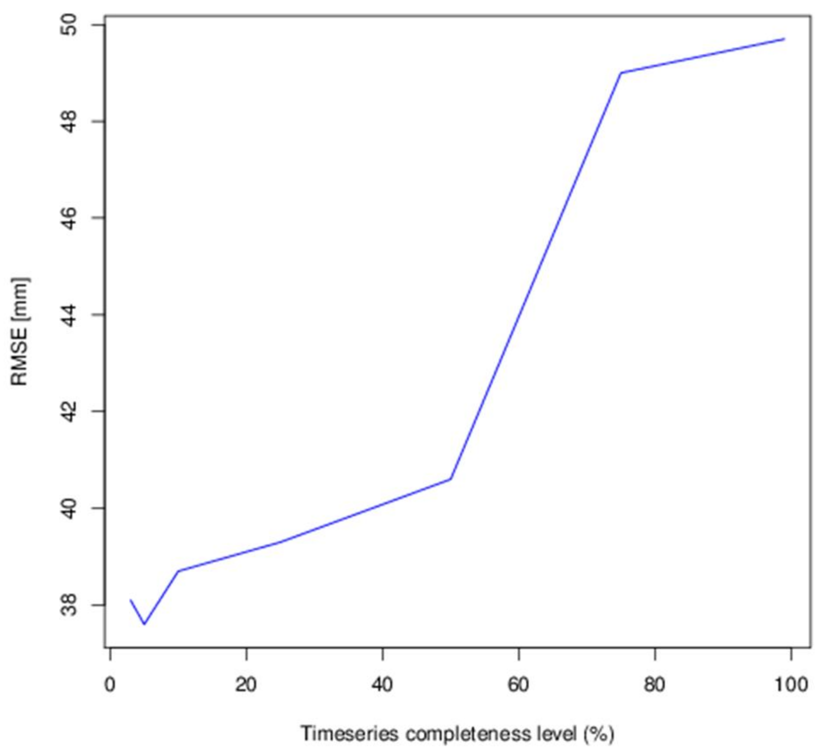


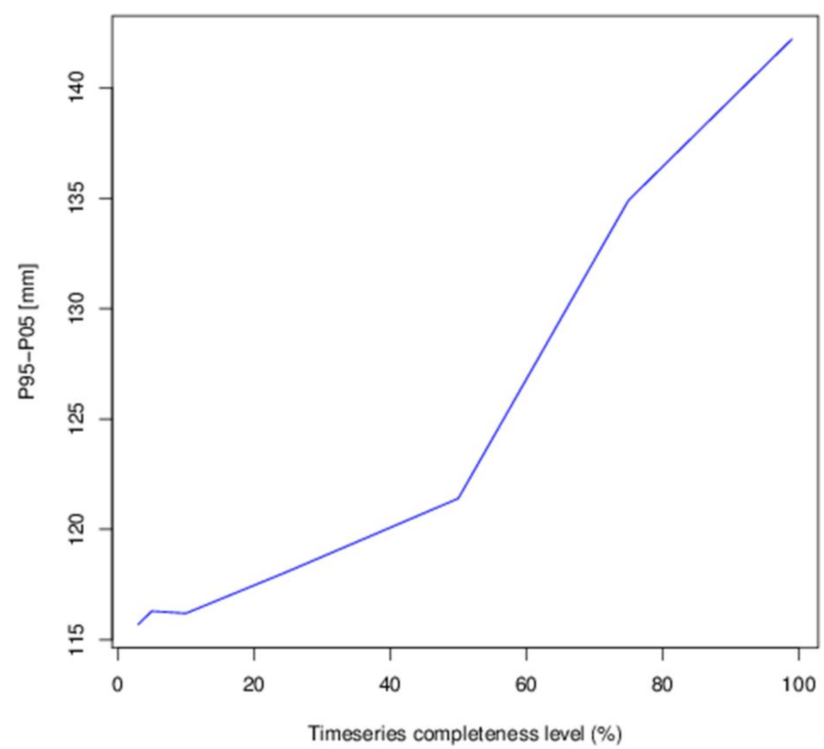
General approach

1. Select stations with a minimum level of data completeness
2. Fill gaps by spatial interpolation of daily data
3. Derive climate values at stations
4. Spatial interpolation of these climate values

Minimum level of timeseries completeness

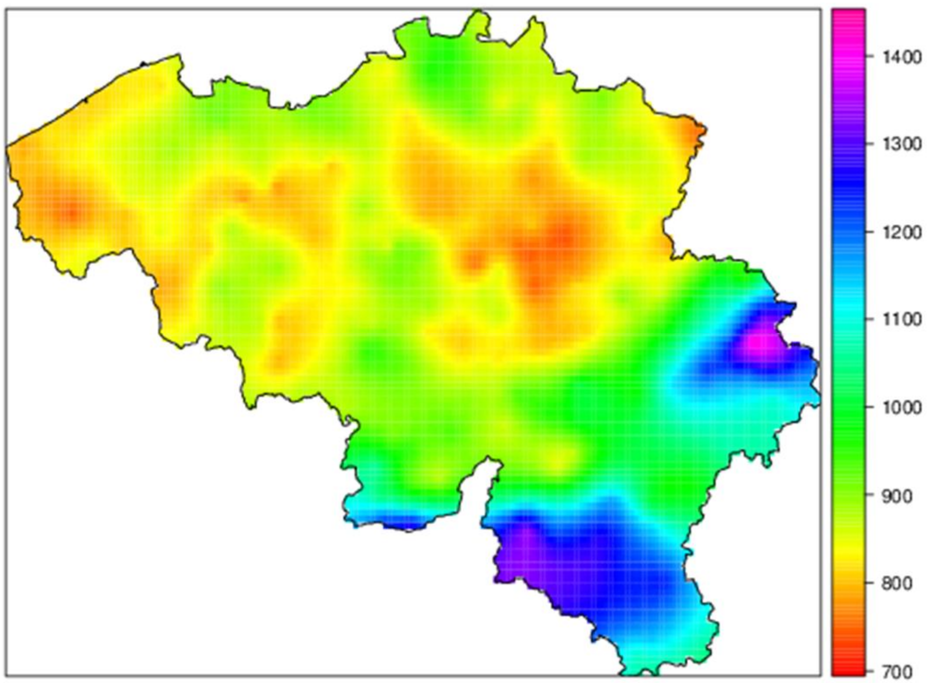
Cross-validation study based on 94 stations complete at 99% (mean annual rainfall)





Mean annual rainfall

1981 - 2010



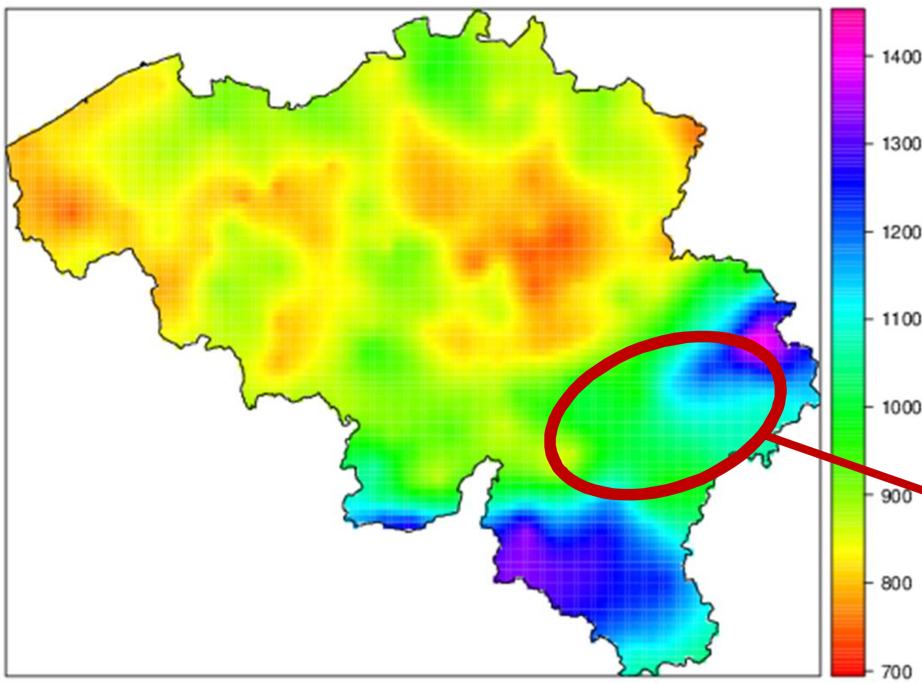
Ordinary kriging

Spherical variogram
with **zero nugget**

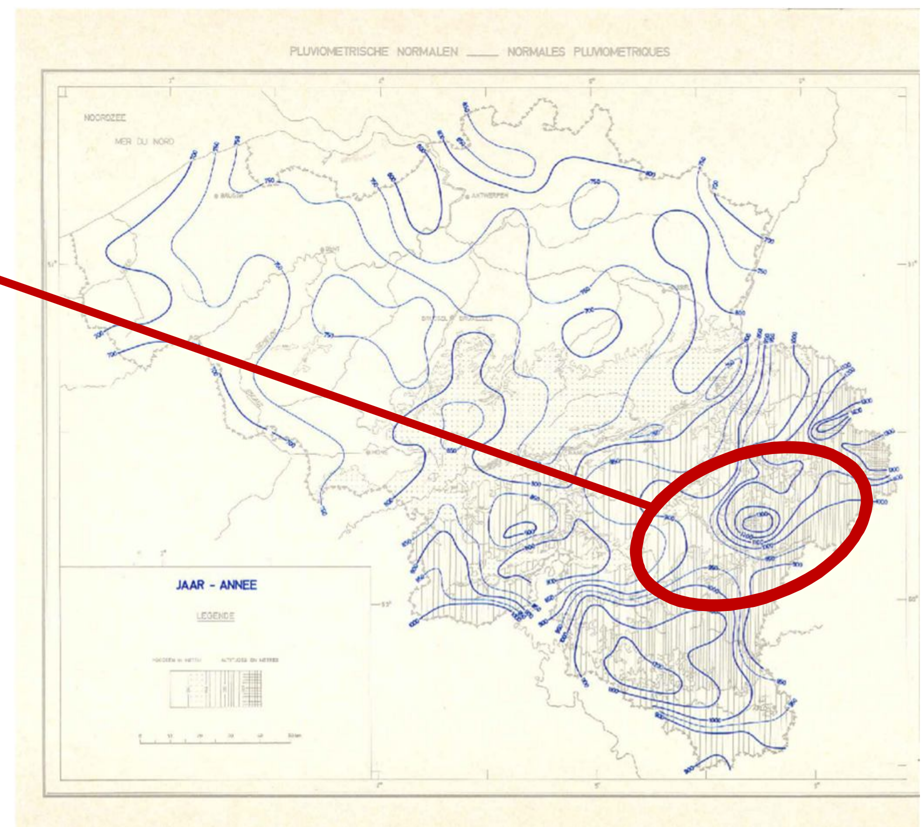
to force exact interpolation
+ smooth map

Mean annual rainfall

1981 - 2010

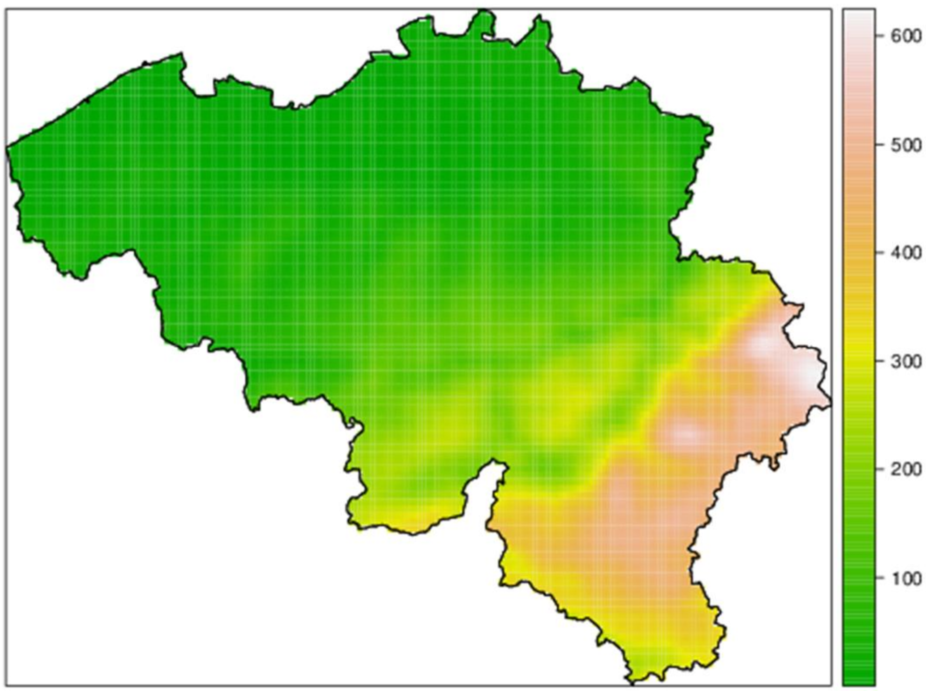


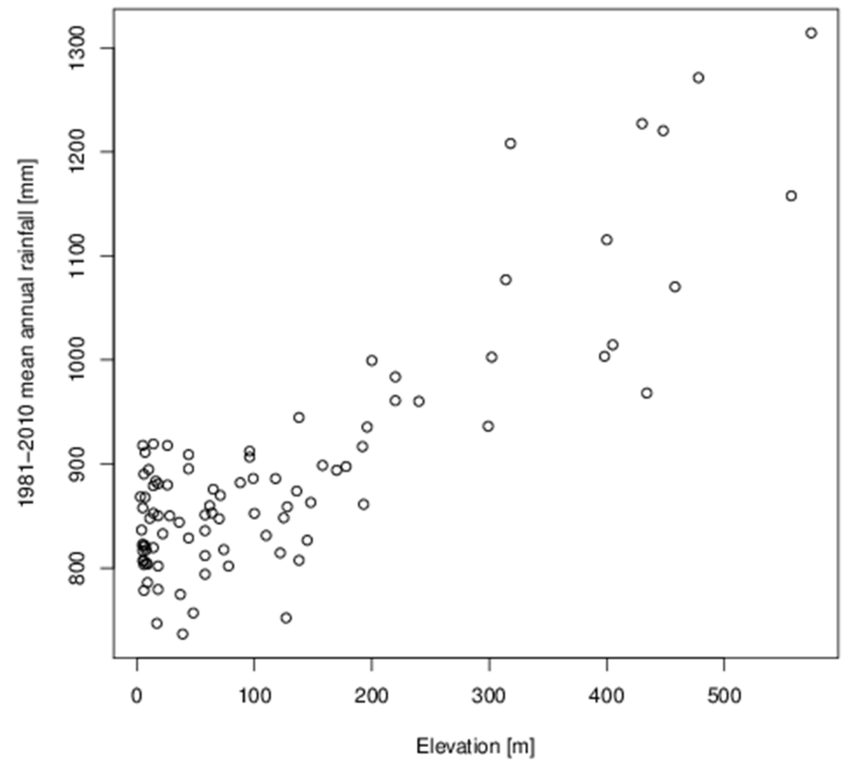
1833 - 1975



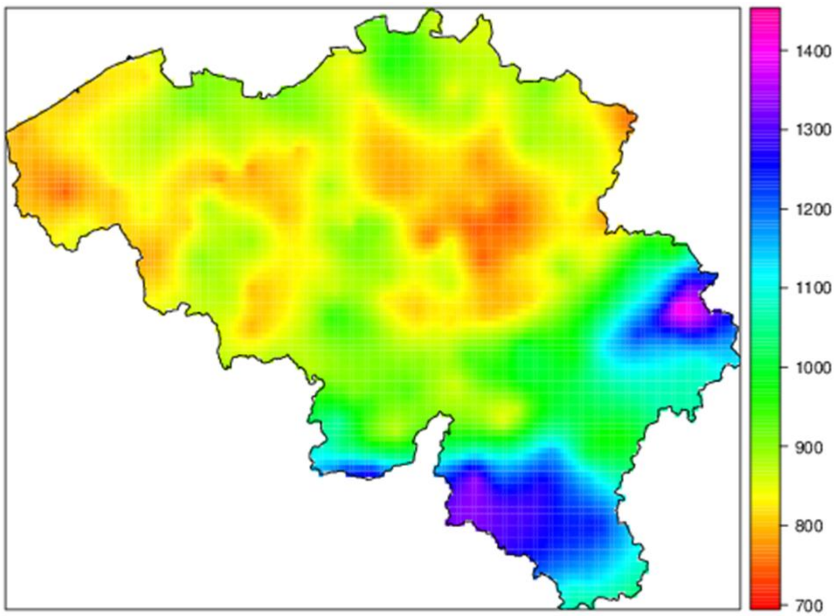
Exploitation of covariate data !

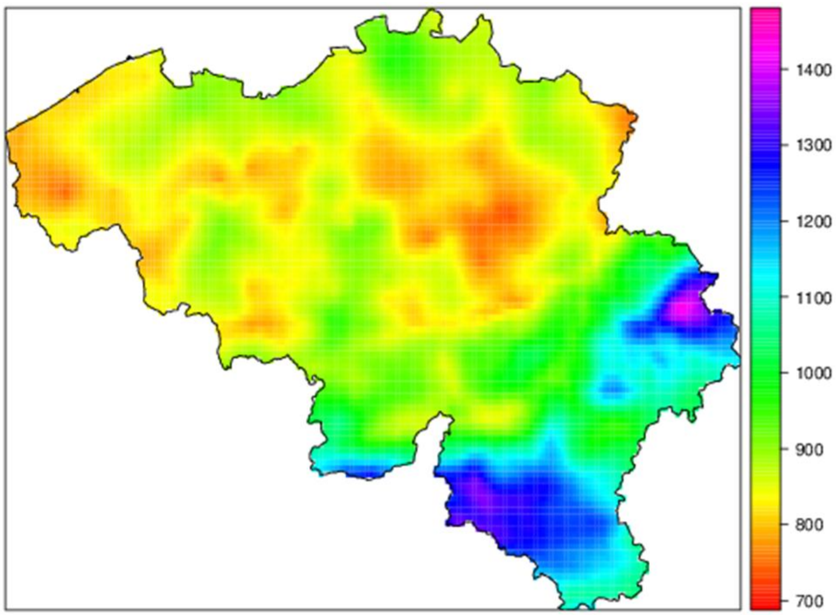
Terrain elevation as covariate





Terrain elevation as covariate

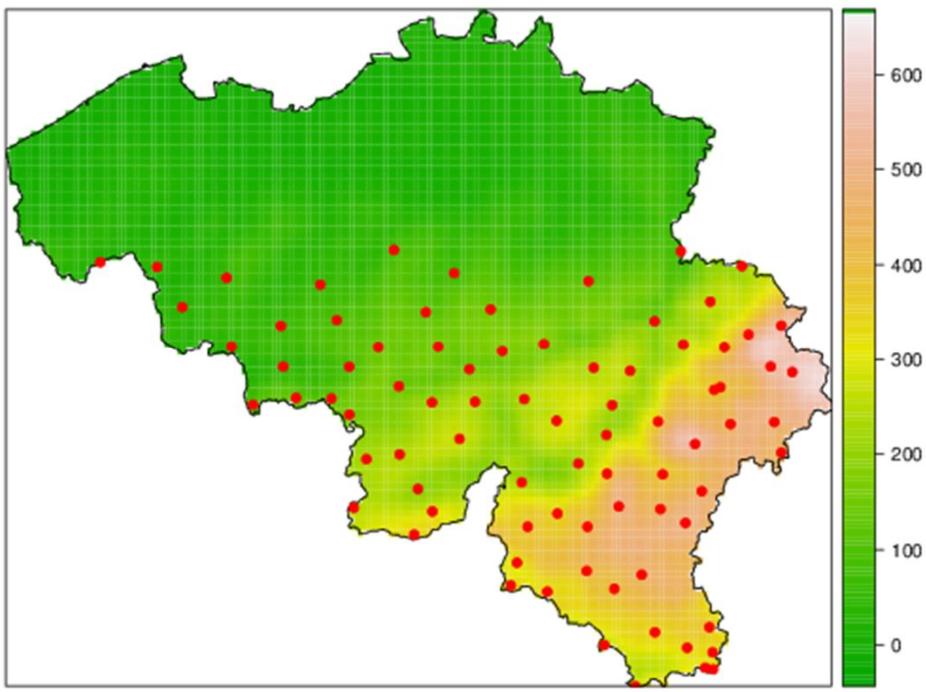




Kriging with external drift (KED)

Exponential variogram with zero nugget

Ancillary rain gauges network

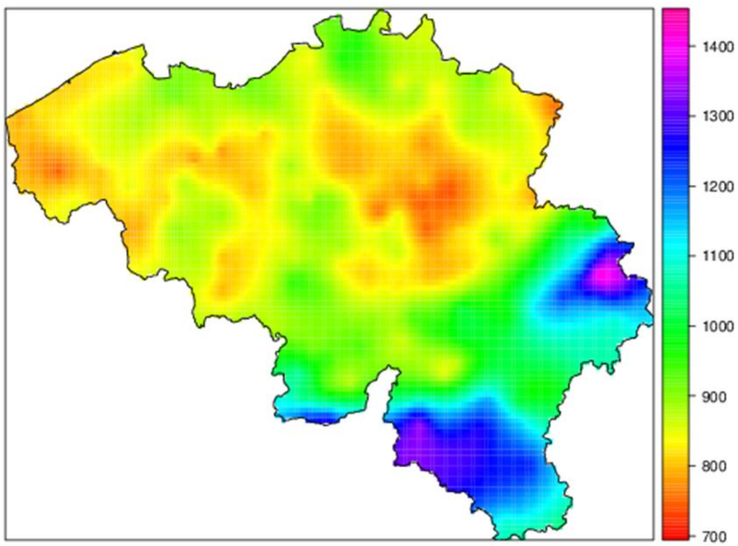


Regional network of rain gauges

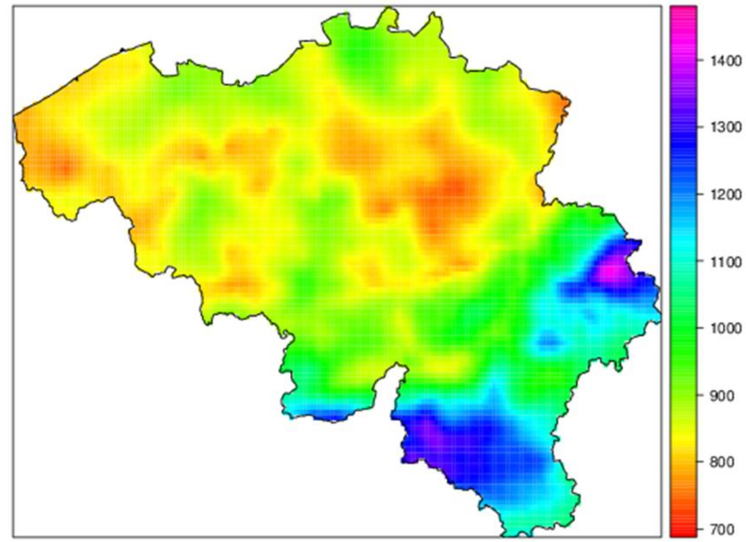
operational since March 2004

→ **exploit 2005 - 2012 mean values**

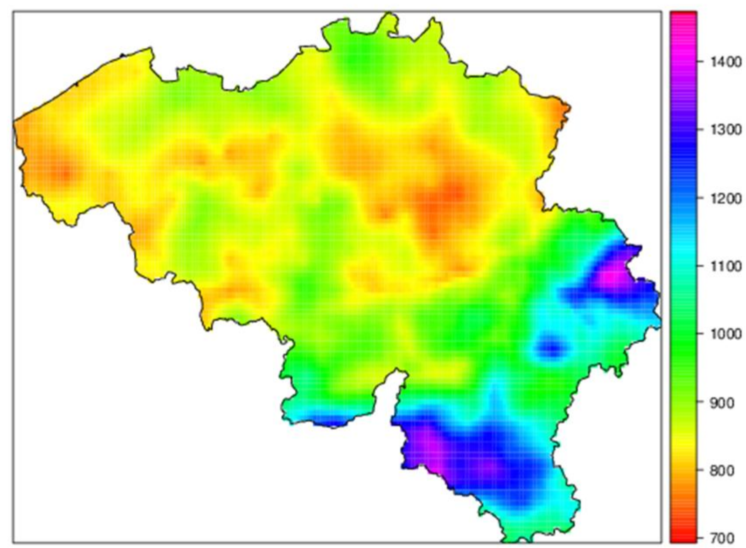
Ancillary rain gauges network



+ Terrain elevation

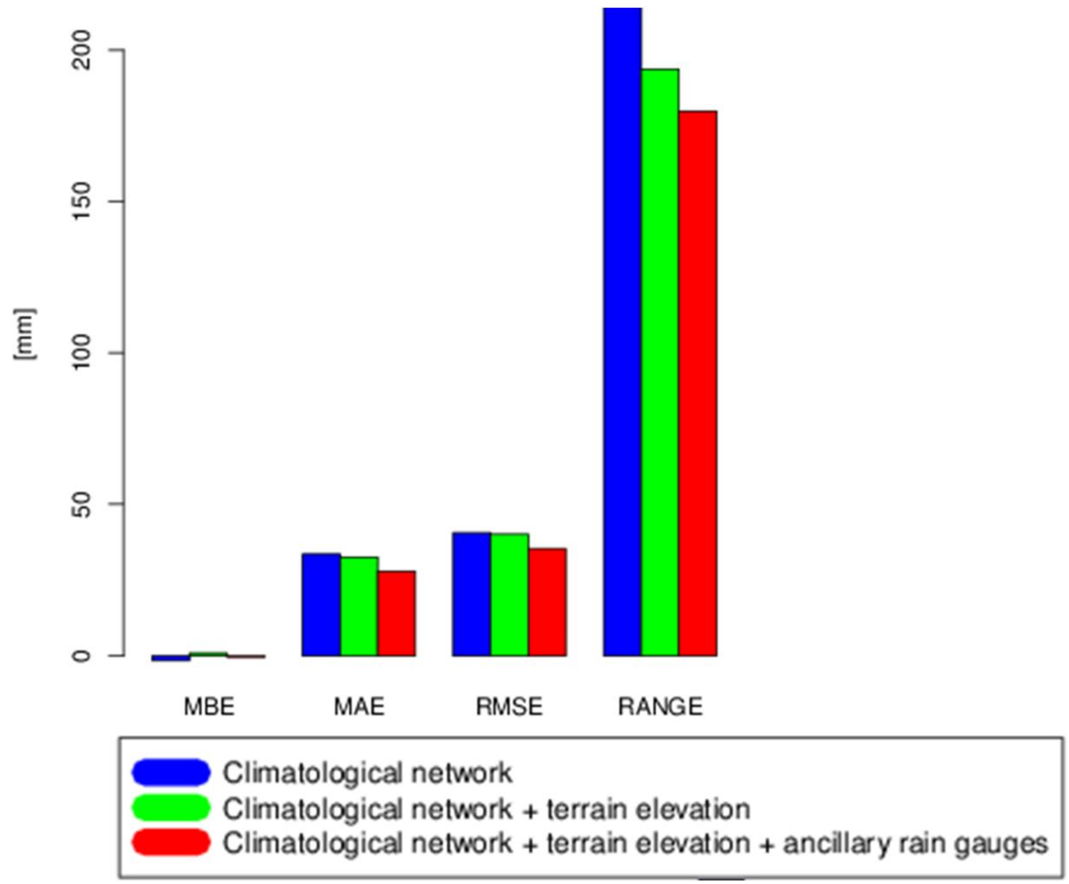


+ Terrain elevation
+ ancillary rain gauges

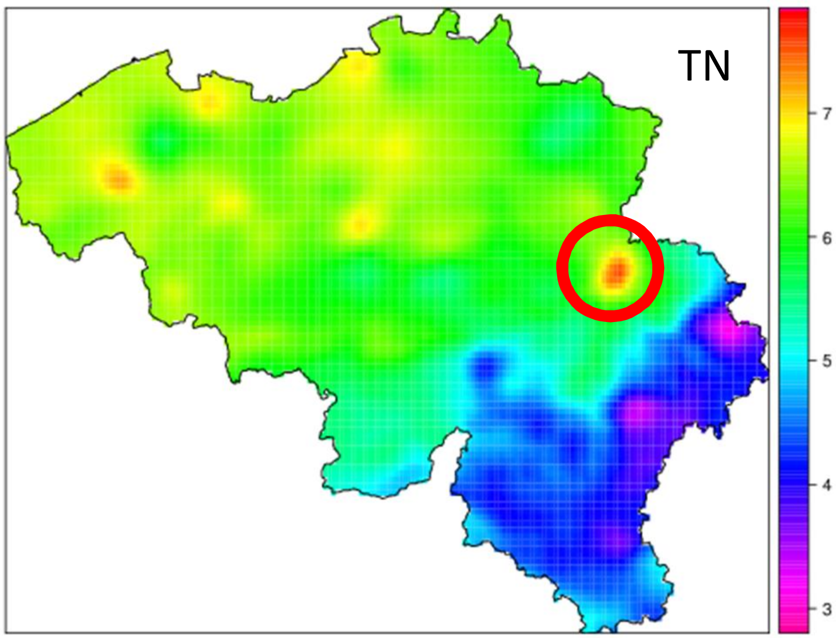


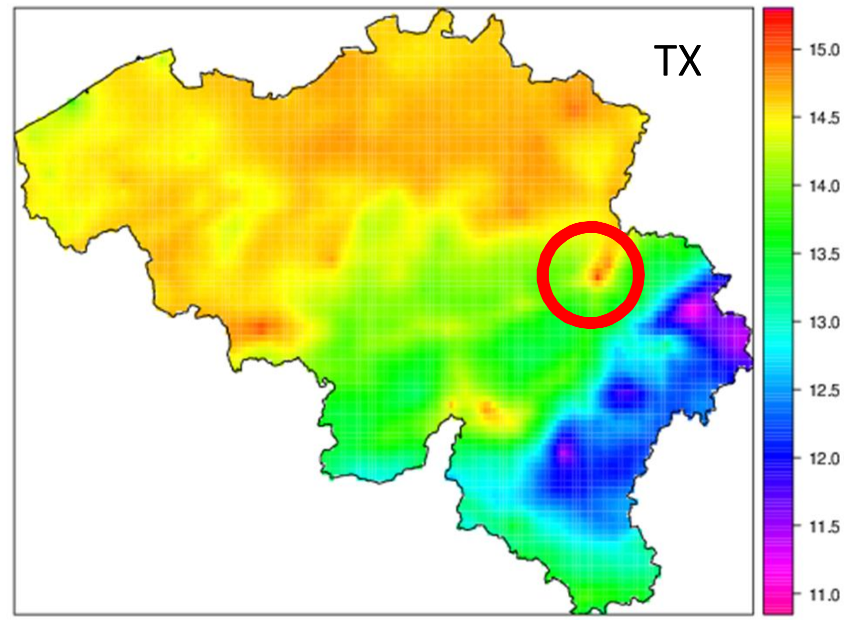
Validation (precipitation)

Cross-validation based on 94 stations complete at 99%



Annual mean air temperature



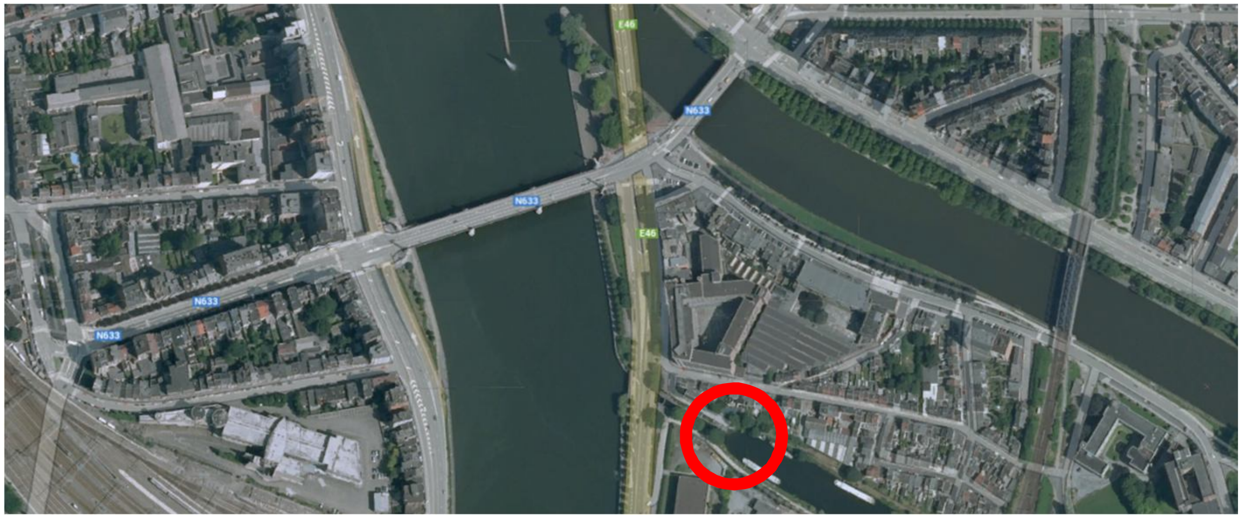


Kriging with external drift (KED)

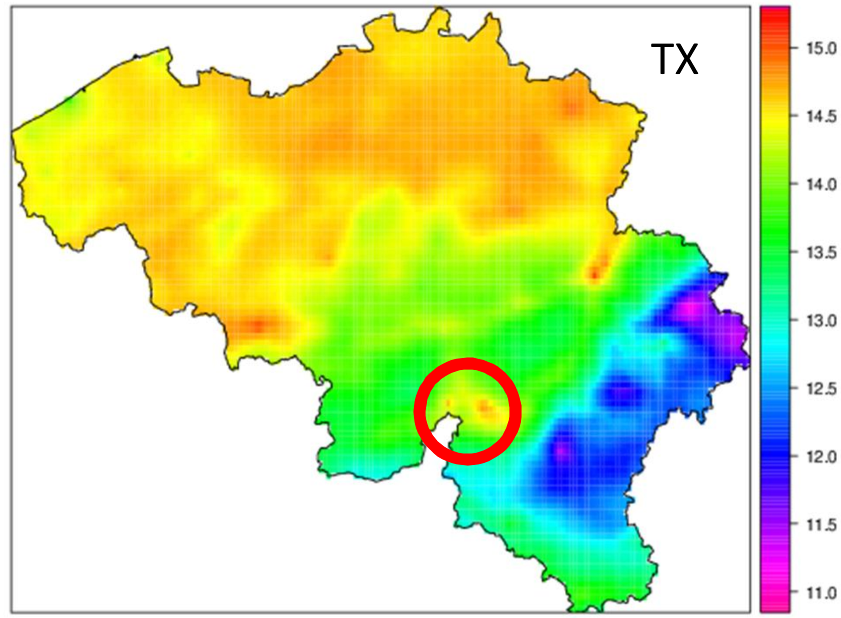
Spherical variogram with zero nugget

Terrain elevation as covariate

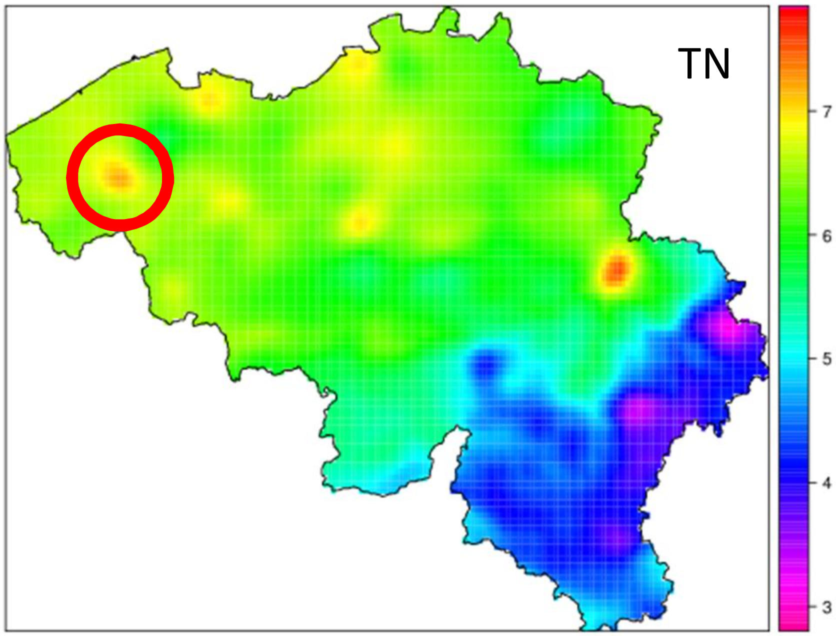
Proximity of water surfaces + urban environment

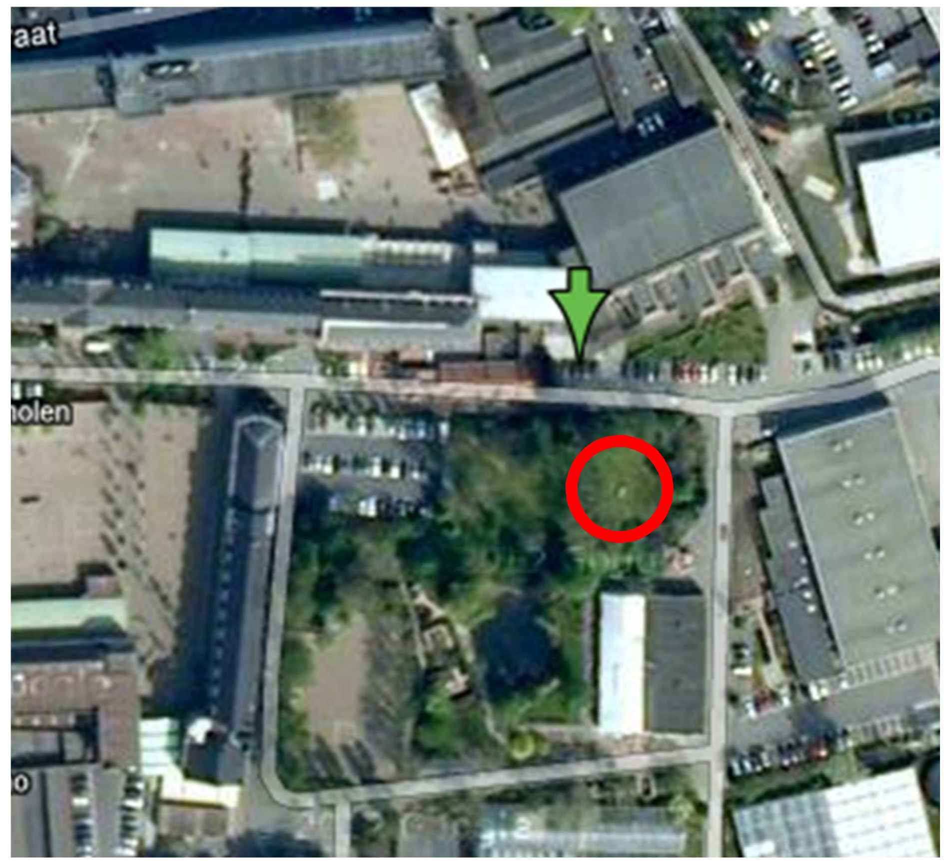


Annual mean air temperature



Annual mean air temperature





Spatial representativeness

WMO: " Air temperature is measured over level ground, freely exposed to sunshine and wind and not shielded by trees, buildings and other obstructions."

In some climatological stations, air temperature is affected by the close surroundings (obstacles, water surfaces, buildings, etc.)

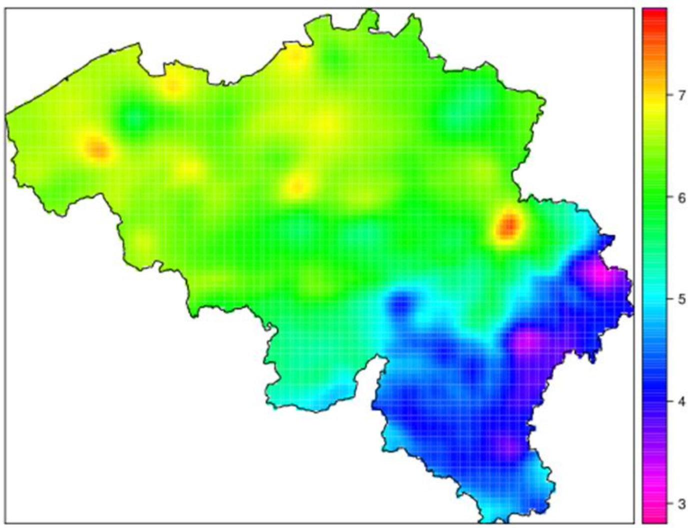


Kriging with "known" measurement uncertainty

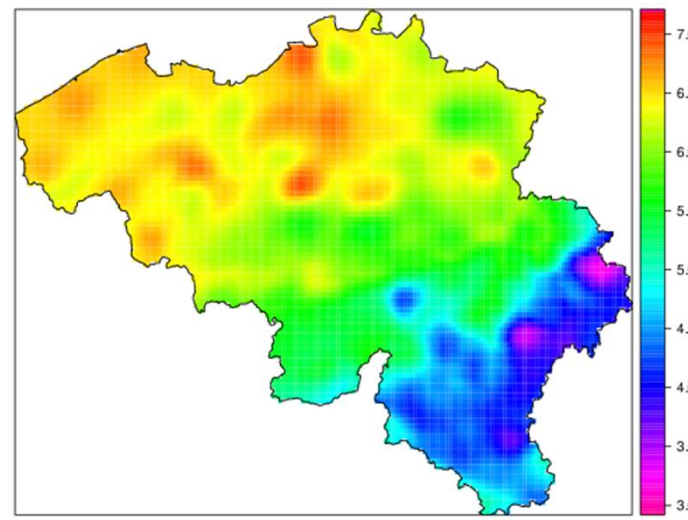
Either **exclude stations** affected by water surfaces and/or urban environment

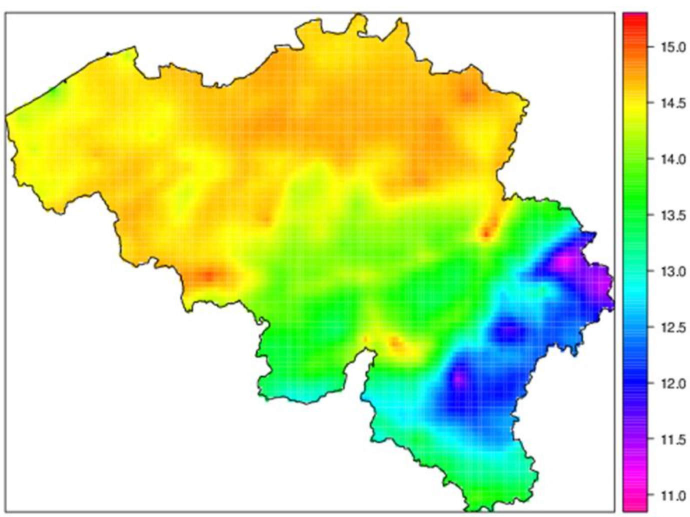
or **relax the exact interpolation** assumption
→ define a measurement variance for each station

Resulting air temperature maps

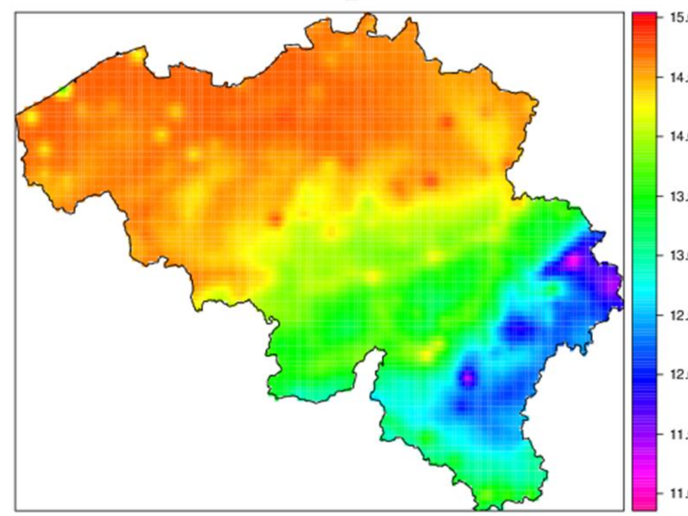


TN



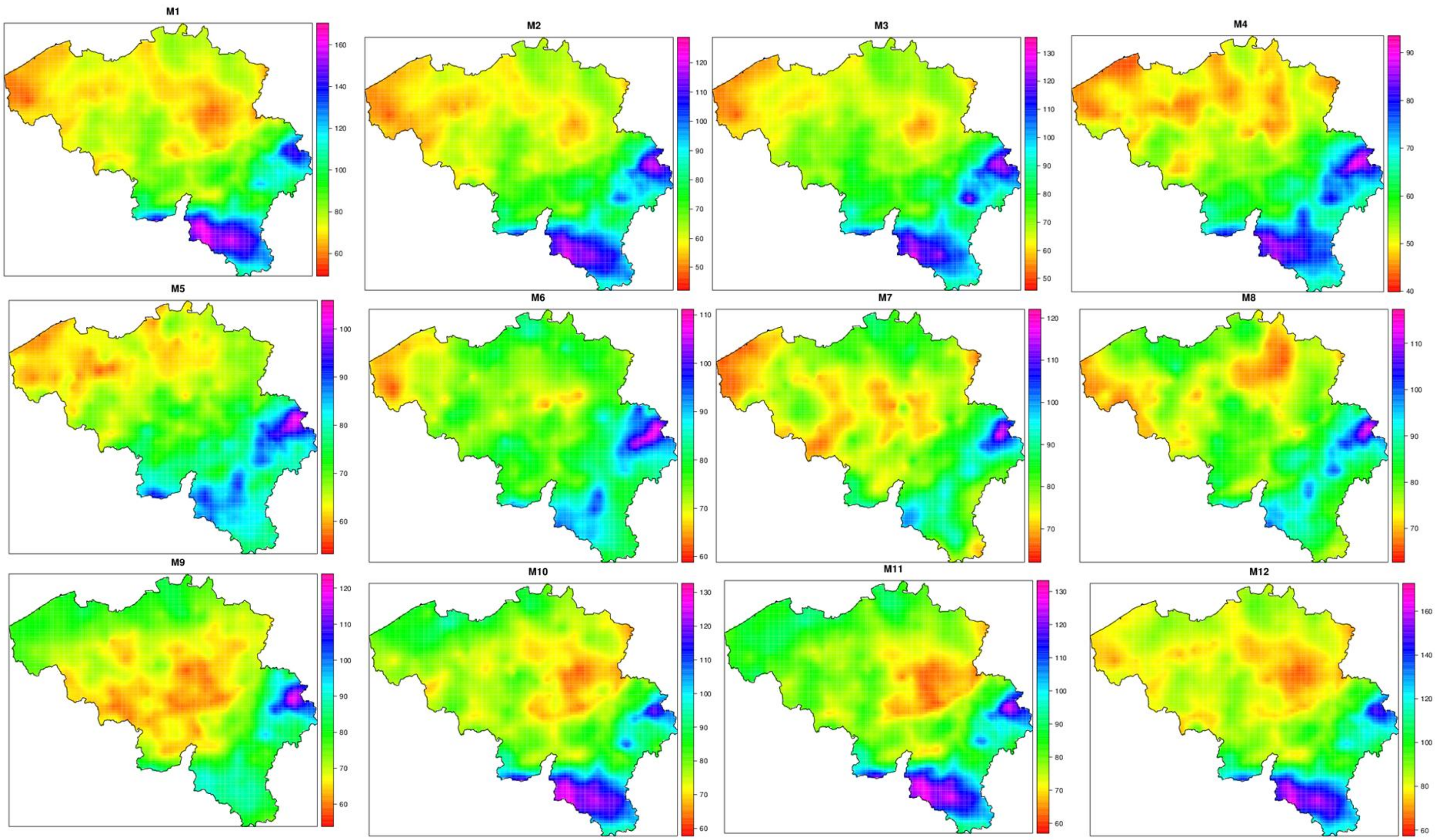


TX



Large panel of climate maps

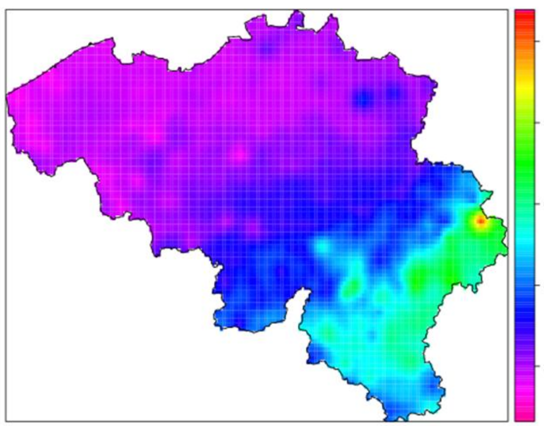
Monthly + seasonal maps



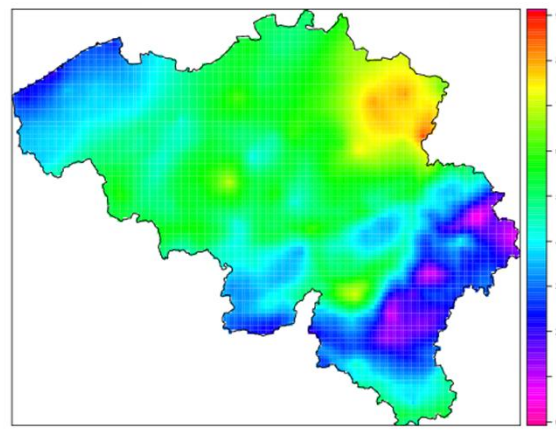
Large panel of climate maps

Number of days per year with …

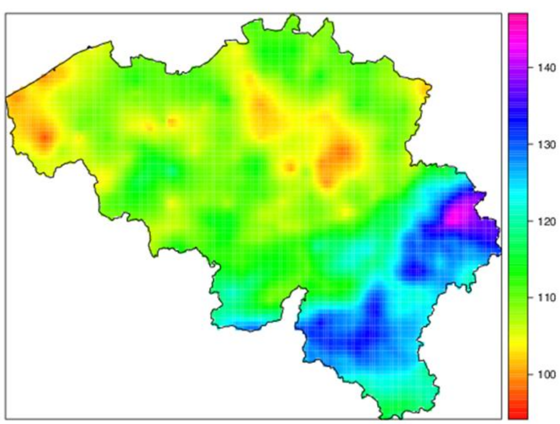
TN < -10 °C



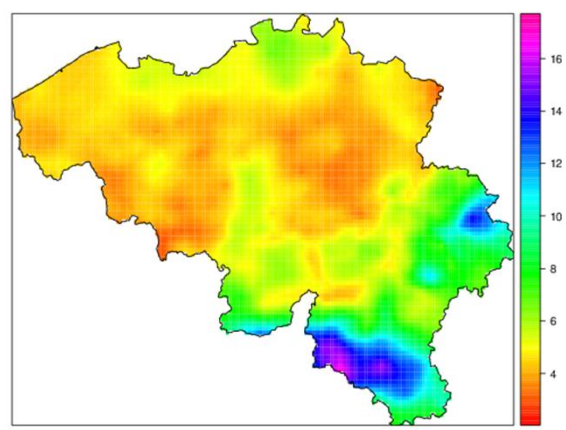
TX ≥ 30 °C



RR ≥ 2 mm



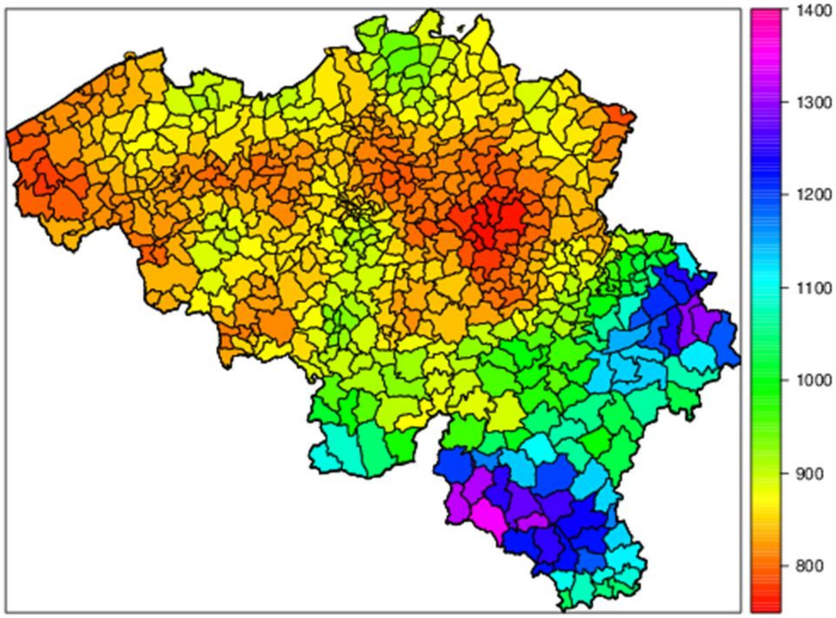
RR ≥ 20 mm



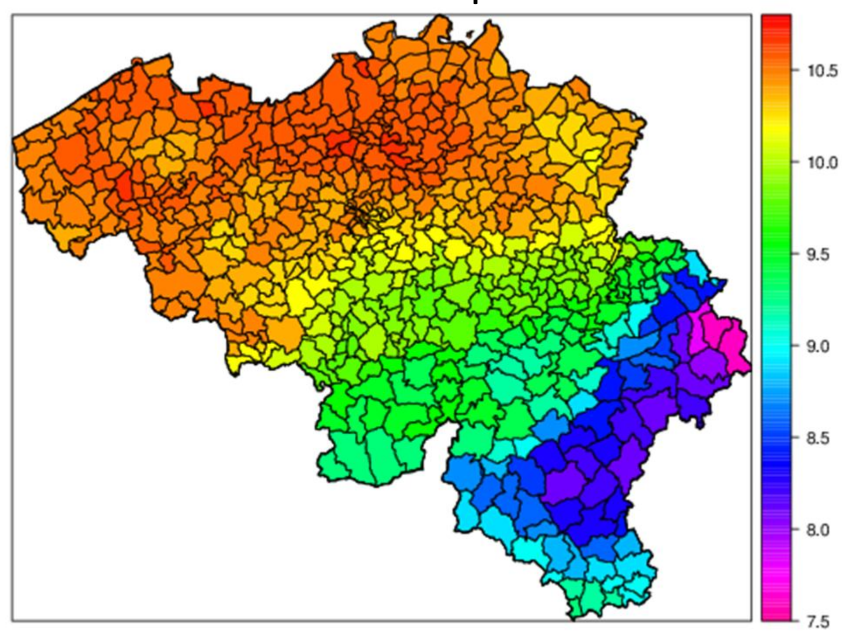
Large panel of climate maps

Areal means (municipalities, regions, etc.)

Mean annual rainfall



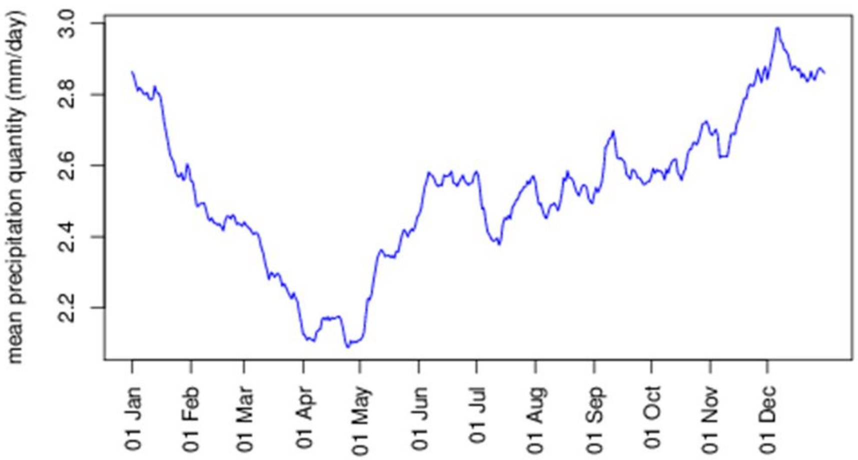
Mean annual temperature



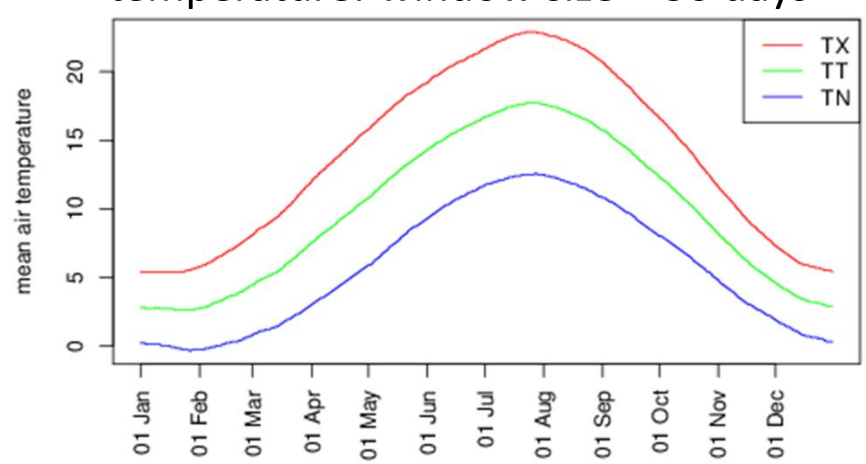
Mean annual cycle

Sliding window average of the Belgian mean

precipitation: window size = 60 days



temperature: window size = 30 days



Summary

- First steps towards gridded climate products at RMI
- Based on geostatistics
- *Discussed issues*
  time series completeness, covariates, exact interpolation
- Large panel of climate maps
- Developed in **R** thanks to the **gstat** package