Some details about the theoretical background of CarpatClim – DanubeClim gridded databases and their practical consequences

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Outline

- Some feature of MISH
- The CarpatClim – DanubeClim data series
  - Main characteristics
  - Methodology
  - Possibilities of application
- Case studies

Optimal interpolation formula (linear)

$$\hat{Z}(\mathbf{s}_0) = \sum_{i=1}^{M} \lambda_i \left(E(\mathbf{s}_0) - E(\mathbf{s}_i) \right) + \sum_{i=1}^{M} \lambda_i Z(\mathbf{s}_i)$$

Where

$Z(\mathbf{s}_0)$ predictand

$Z(\mathbf{s}_i)$ $(i = 1,\ldots,M;\ \mathbf{s}\ \text{location vector})$

predictors

$E(\mathbf{s}_i) = \mathrm{E}(Z(\mathbf{s}_i))$ $(i = 0,\ldots,M)$

expected values

λ_i $(i = 0,\ldots,M)$

weighting factors

Unknown statistical parameters

$$E(\mathbf{s}_0) - E(\mathbf{s}_i)$$

$$\boldsymbol{\lambda} = \mathbf{C}^{-1}\left(\mathbf{c} + \frac{\left(1 - \mathbf{1}^{\mathrm{T}}\mathbf{C}^{-1}\mathbf{c}\right)}{\mathbf{1}^{\mathrm{T}}\mathbf{C}^{-1}\mathbf{1}}\mathbf{1}\right)$$

where

$\mathbf{c}$ predictand-predictors covariance vector

$\mathbf{C}$ predictors-predictors covariance matrix

They are the function of $D(\mathbf{s}_0)/D(\mathbf{s}_i)\ \ (i = 1,\ldots,M\ ),\ \mathbf{r},\ \mathbf{R}$

- Advantage of the meteorology:
  - Modelling from long term data series belonging to the stations
  - Sample in space and in time as well

Main features of MISH

- MISH is based on these theoretical considerations
- It is divided on two parts:
  - Modelling and the interpolation systems
  - The interpolation system can be operated on the results of the modelling system
- Modelling system for climate statistical parameters in space:
  - Based on long homogenized data series and supplementary deterministic model variables (e.g. topography)
  - **Modelling procedure must be executed only once before the interpolation applications**
- Interpolation system:
  - Additive (e.g. temperature) or multiplicative (e.g. precipitation) model and interpolation formula can be used depending on the climate elements
  - Daily, monthly values and many years' means can be interpolated
  - Few predictors are also sufficient for the interpolation
  - Capability for application of supplementary background information (stochastic variables) e.g. satellite, radar, forecast data
  - Capability for gridding of data series automatically

The CarpatClim – DanubeClim data series

- Freely available
- CarpatClim
  - Project of 9 countries, lead partner OMSZ
  - Daily gridded dataseries for 1961-2010
  - 0,1° spatial resolution
  - 16 variables (temperatures, precipitation, wind, relative humidity, sunshine duration, etc)
  - Additional 37 indicators (extremes, drought indices, etc)
  - **Unified methods for homogenization and interpolation**
- DanubeClim
  - Extension of Carpatclim for the catchment area of the Danube

CARPATCLIM
Climate of the Carpathian Region

DANUBECLIM
Climate of the Danube Region

Applied methods

- MASHv3.03
  - Multiple Analysis of Series for Homogenization; Szentimrey, T.

- MISHv1.03
  - Meteorological Interpolation based on Surface Homogenized Data Basis;
  - Szentimrey, T.and Bihari, Z.

Modelling of statistical parameters in the CarpatClim-DanubeClim projects

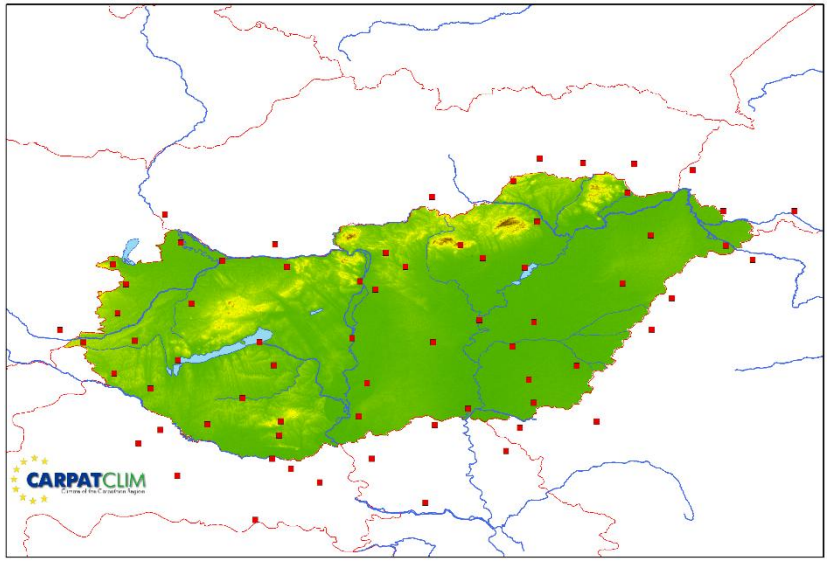
- Based on national level
- Long homogenized data series
  - 50 years long monthly data series (for modelling correlations)
  - Near border stations
- Deterministic model variables
  - AURELHY parameters for each participating countries calculated from the same DEM
  - Additional parameters for wind (roughness length and height of anemometer)
  - Distance of the sea (DanubeClim)
- Results:
  - 5 parameter files in 0.05’ (<1 km) resolution/meteorological variables /months

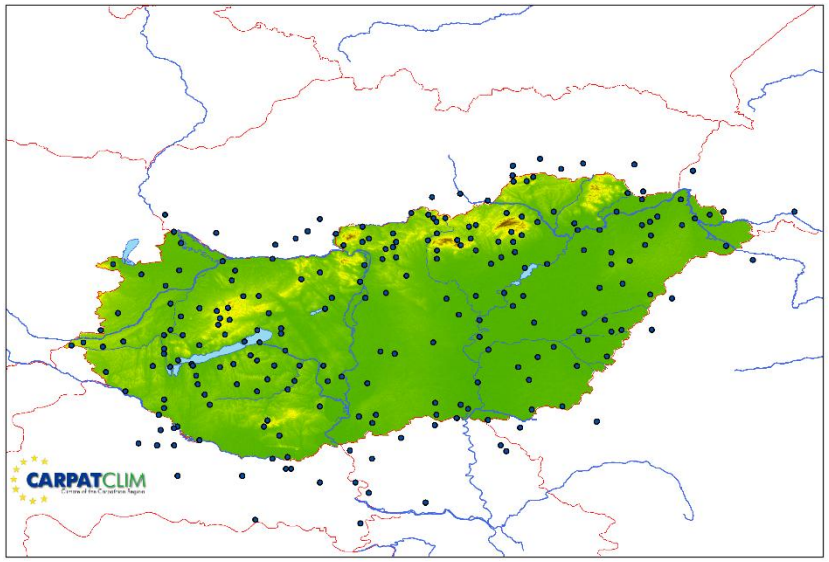
Consequences

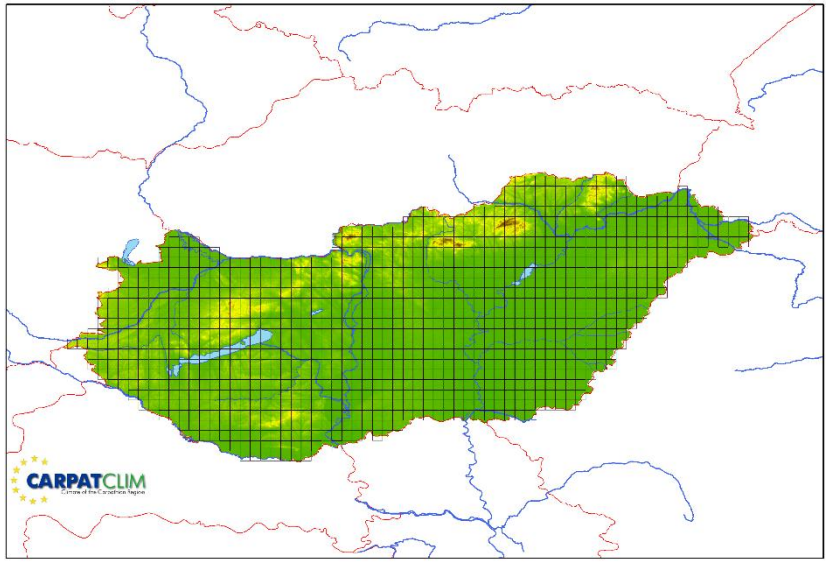
- The parameter files have to be stored for the interpolation procedure
- They include detailed information about the climate of the region for a reference period (1961-2010)
- They can be applied:
  - Interpolation on any grid or special grid points
    - Gridding on any resolution depending on the aim of the gridding (maximum is the resoltution of the parameter files)
    - Interpolation for the highest points in the region
  - Interpolation for a new time period
    - Temporal extension of CarpatClim- DanubeClim dataseries
  - Interpolation applying sparse station density
    - For the first half of the 20. century
  - Interpolation applying gridded data series as input instead of station data series
    - Convert a grid from a given resolution to another one (to compare with other gridded data)

CarpatClim-Hu

- Based on
  - 68 stations for temperature
  - 233 stations for precipitation
- 1104 grid points



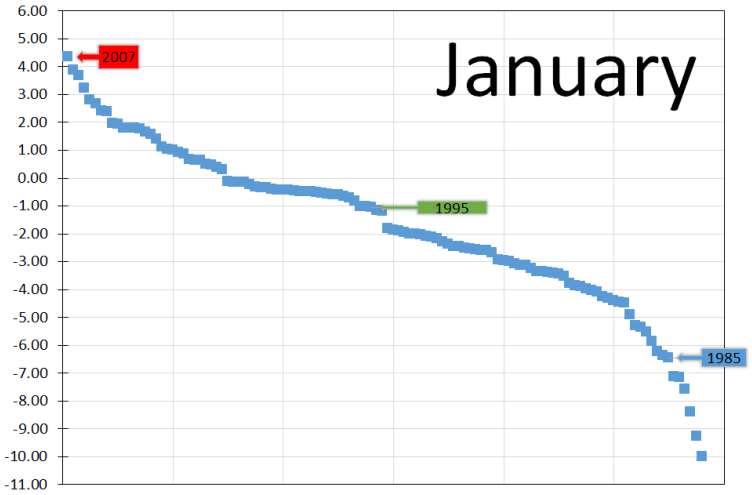




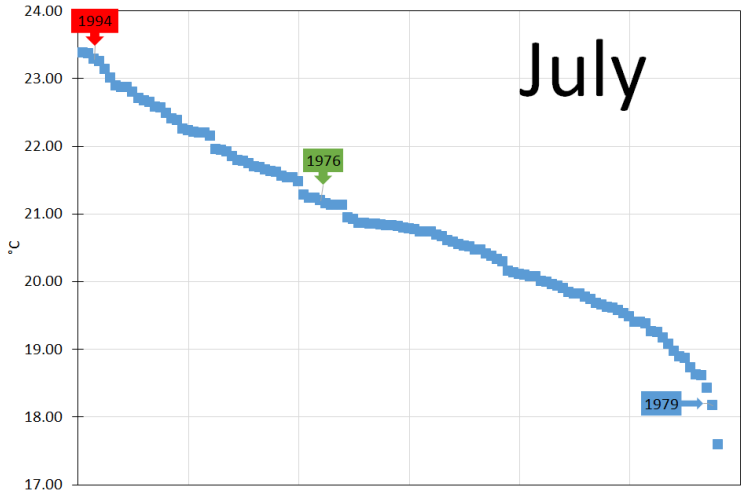
Case studies

- Interpolation of T_{min}, T_{max}, P from station data and from the CarpatClim-Hu grid points
  - Spatial resolution: 30” (appr 1 km)
  - Monthly and daily values
  - Extreme and close to average cases

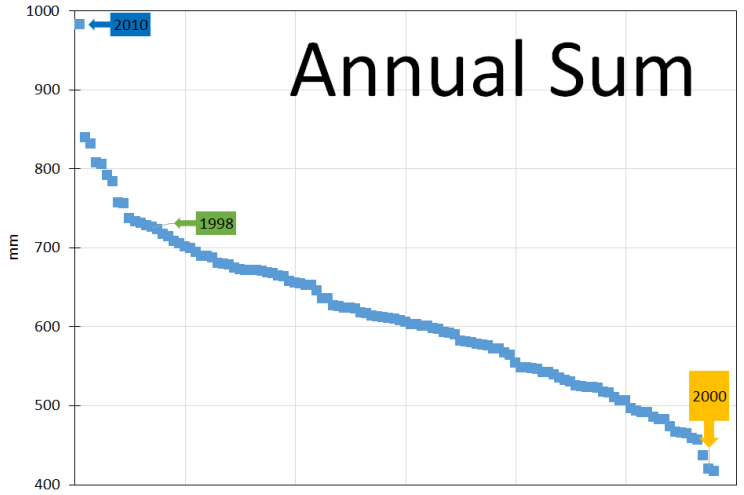
T_{min}



T_{max}

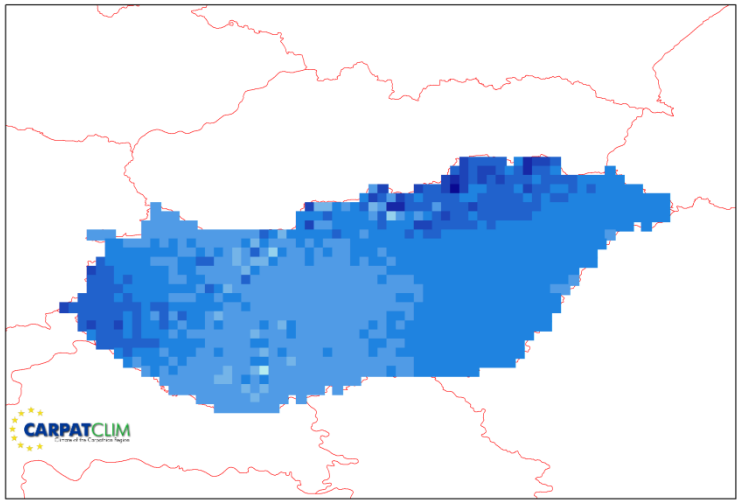


P

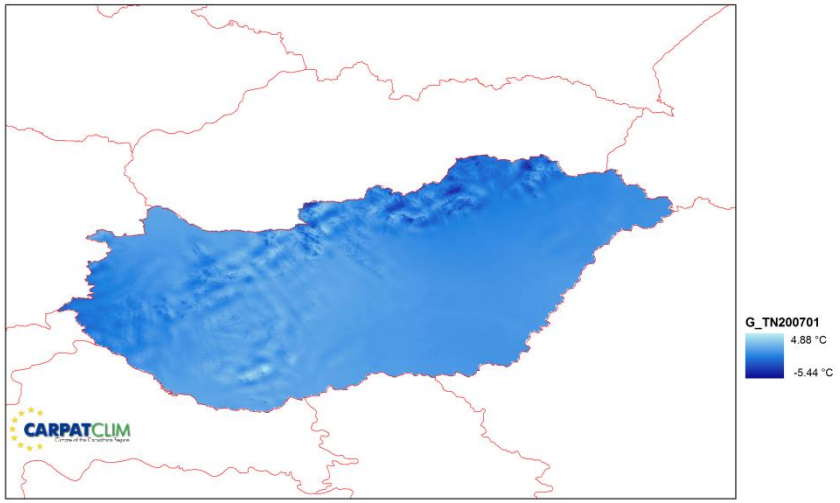


T_{min} , January 2007 (extremely warm)

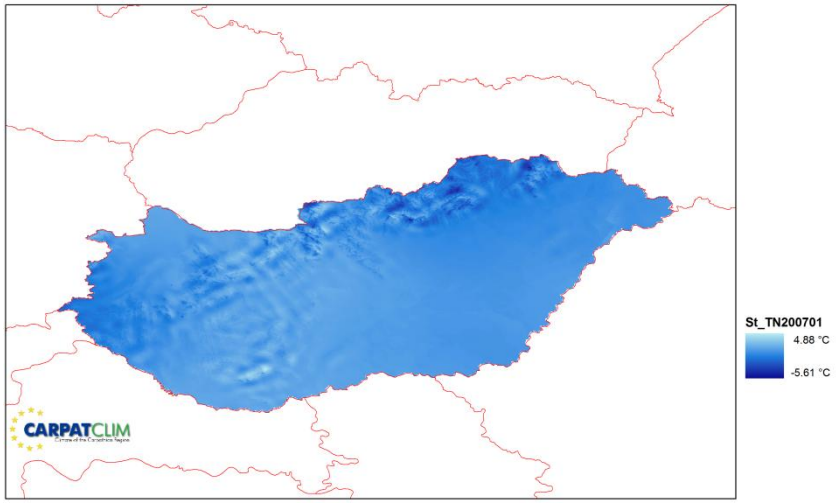
Carpatclim



From CarpatClim grid



From station data

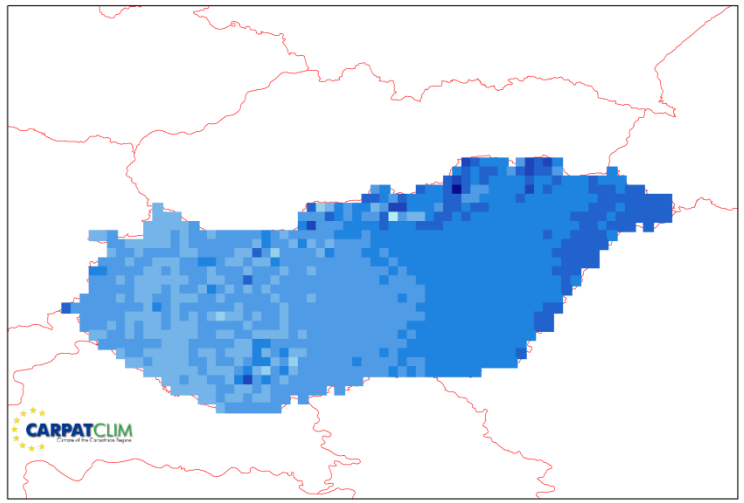


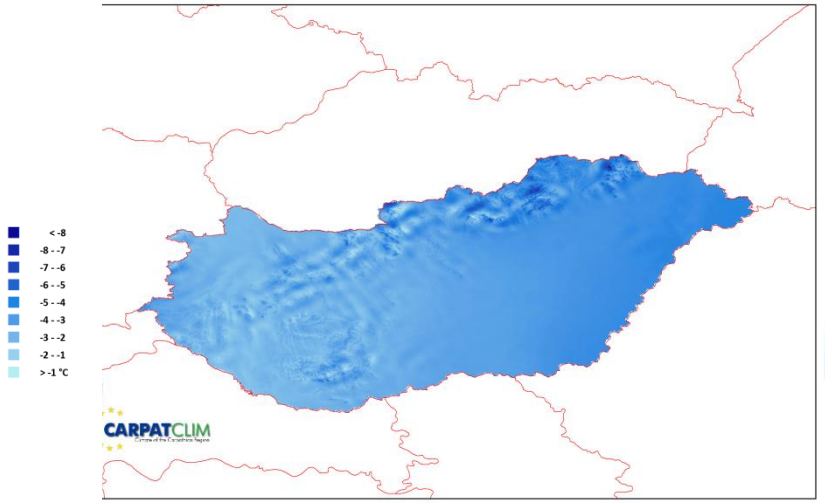
T_{min} , January 1995 (close to average)

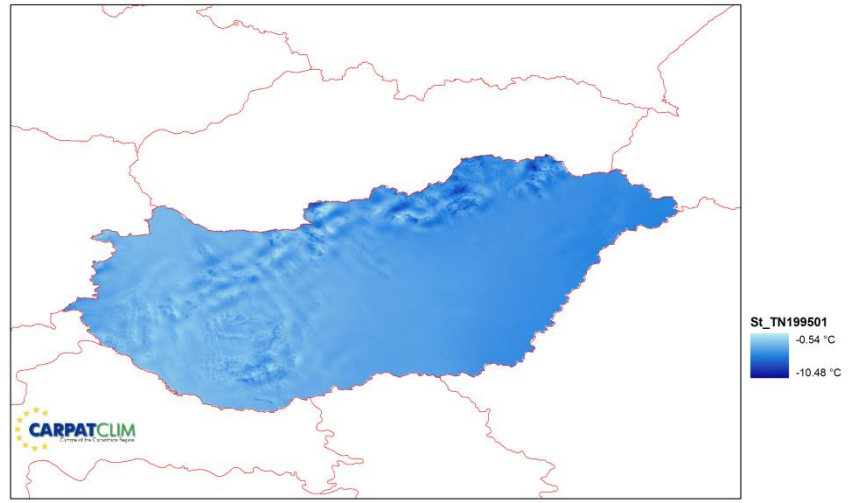
Carpatclim

From CarpatClim grid

From station data





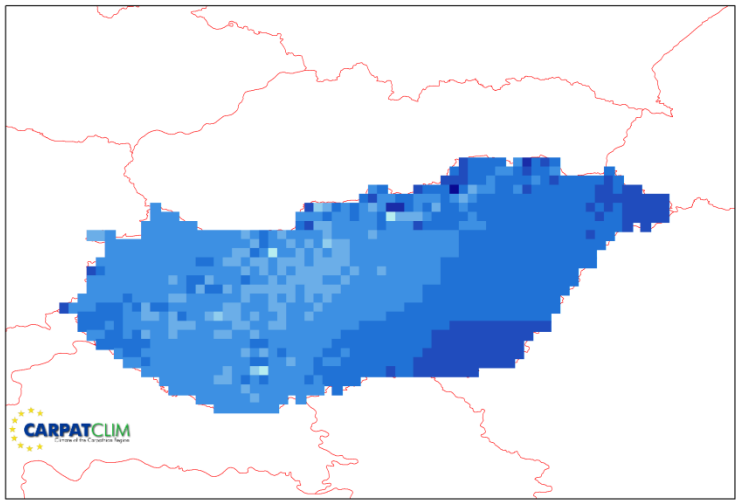


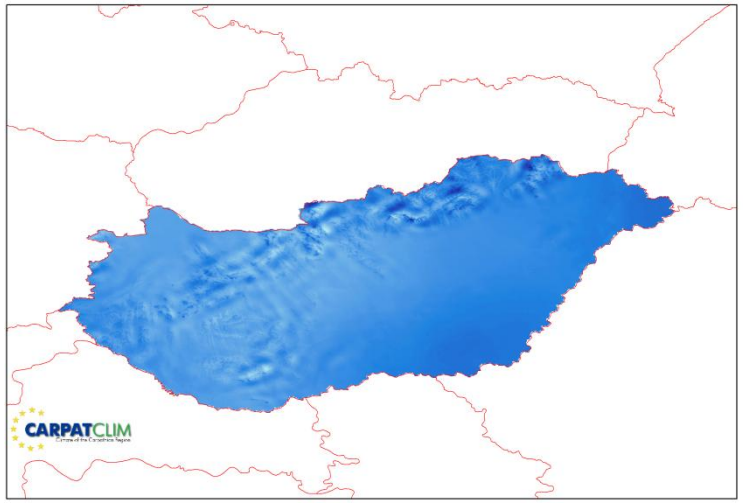
T_{min} , January 1985 (extremely cold)

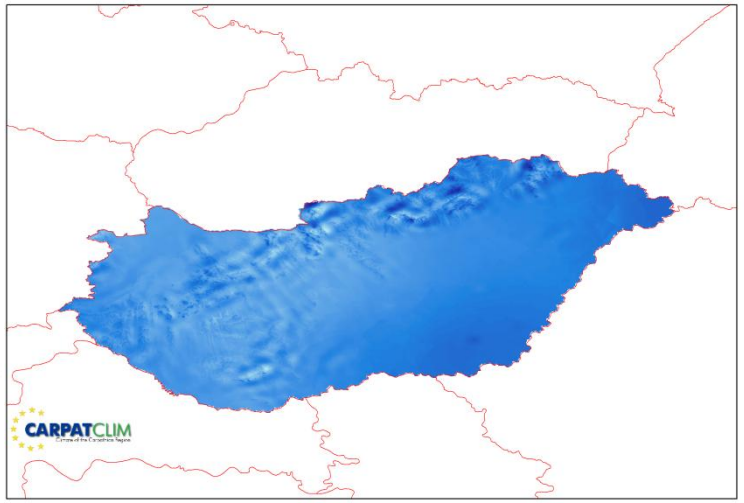
Carpatclim

From CarpatClim grid

From station data







T_{min} , Mean Absolute Error (MAE) [°C]
MISH Interpolation from CarpatClim-Hu grid and from stations

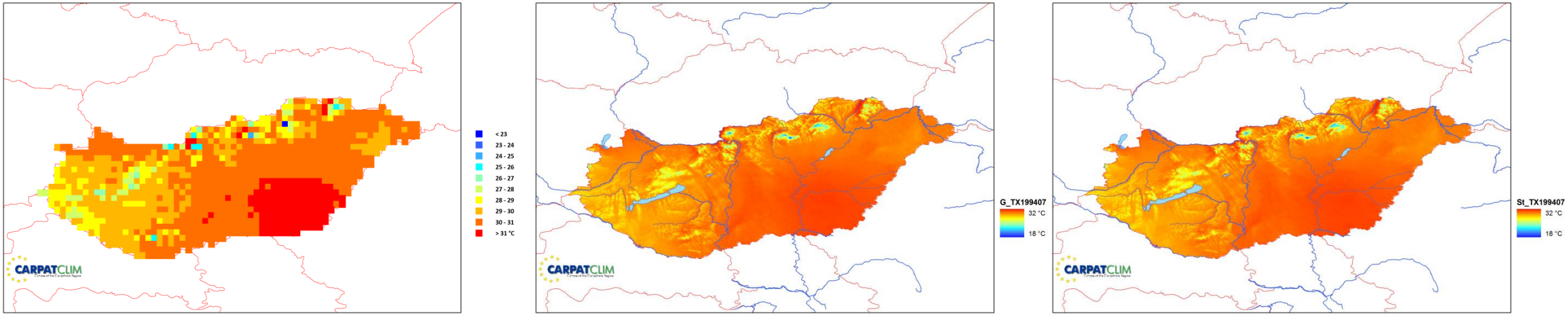
	Extremely warm winter January 2007	Close to long time average (1981-2010) January 1995	Extremely cold winter January 1985
MAE	0.02	0.02	0.03

T_{max} , July 1994 (extremely warm)

Carpatclim

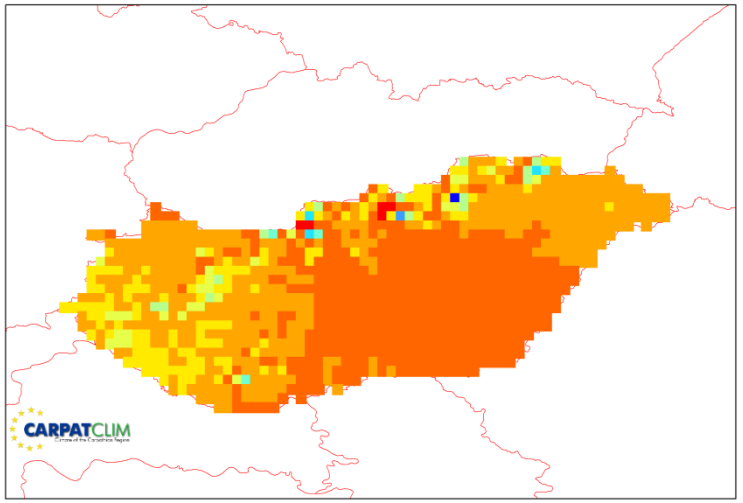
From CarpatClim grid

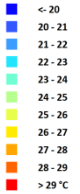
From station data



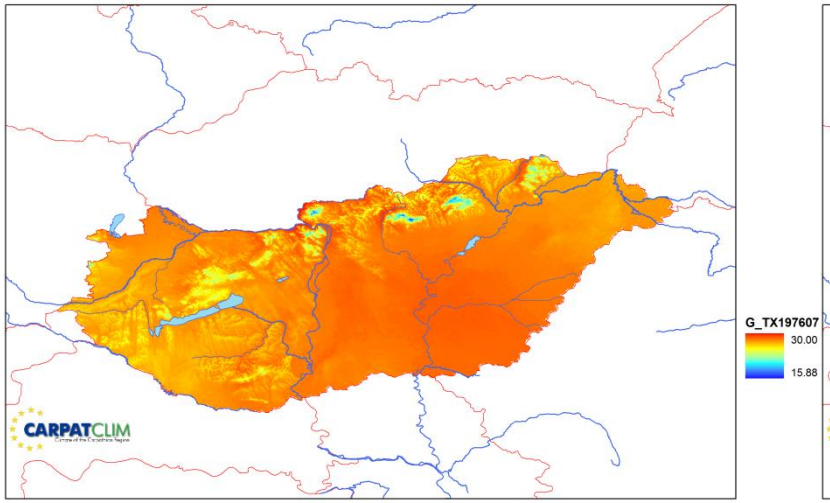
T_{max} , July 1976 (close to average)

Carpatclim

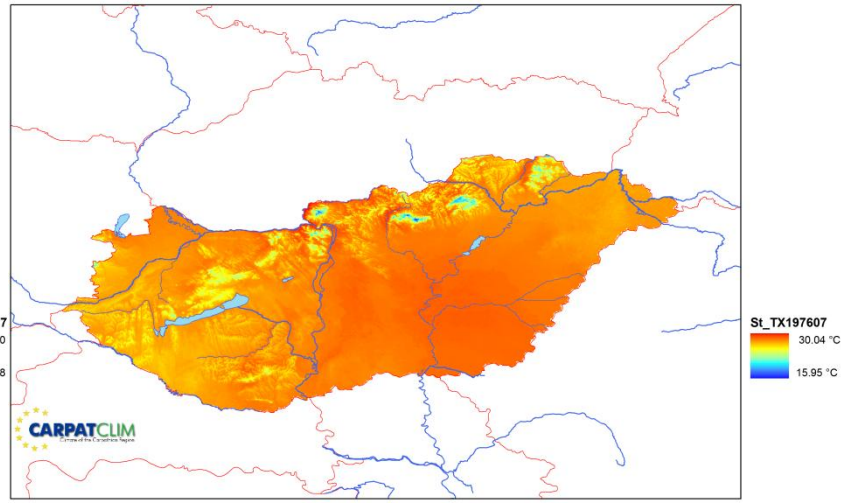




From CarpatClim grid

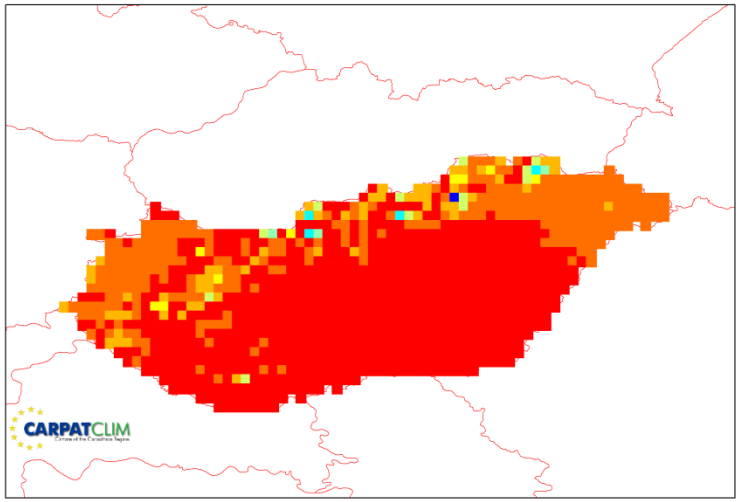


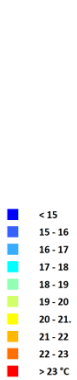
From station data



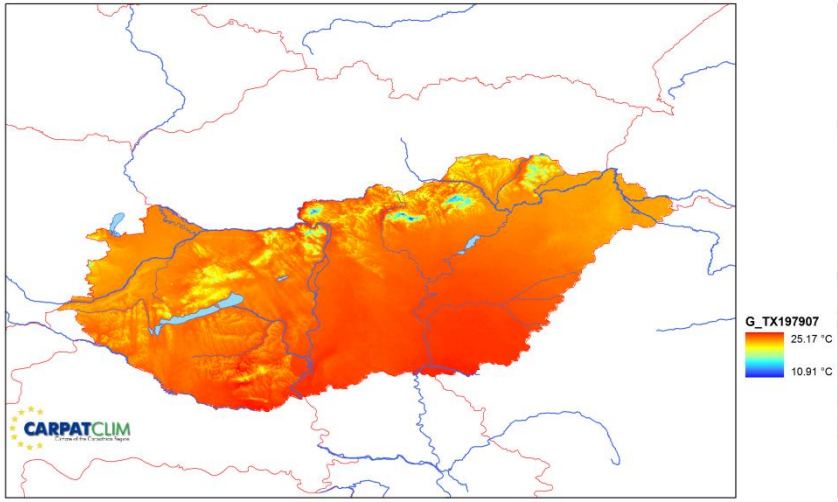
T_{max} , July 1979 (extremely cold)

Carpatclim

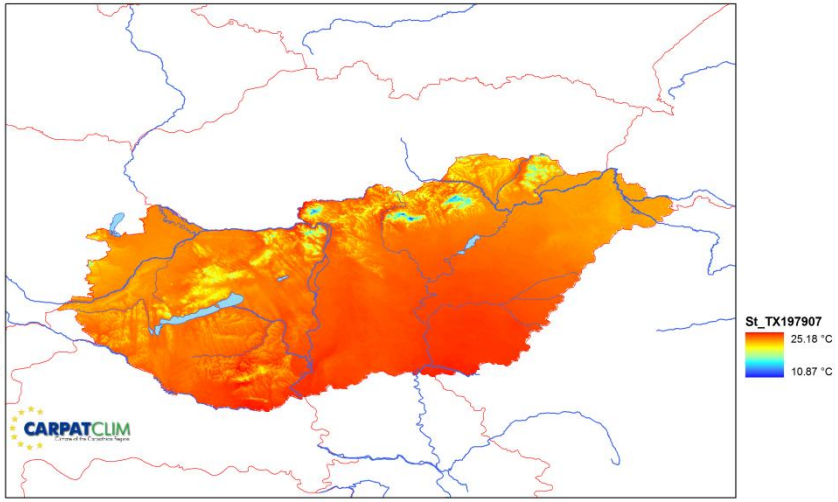




From CarpatClim grid



From station data



T_{max} , Mean Absolute Error (MAE) [°C]
MISH Interpolation from CarpatClim-Hu grid and from stations

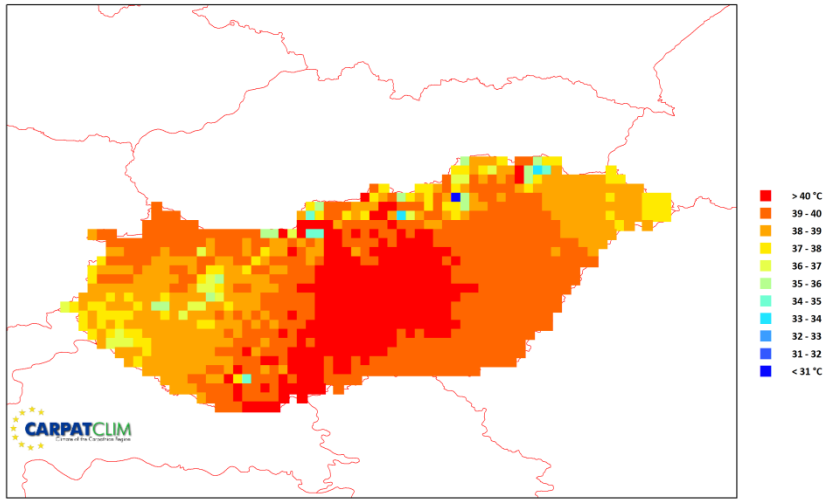
	Extremely warm July July 1994	Close to long time average (1981-2010) July 1976	Extremely cold July July 1979
MAE	0.02	0.01	0.01

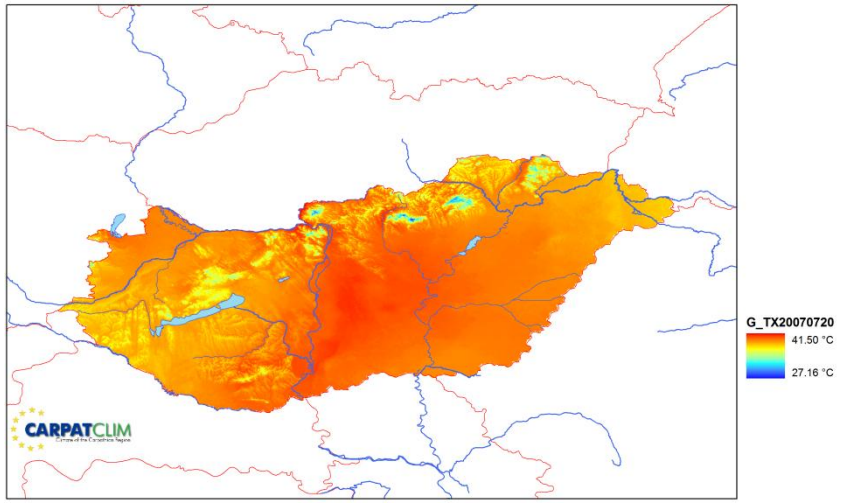
T_{max} , 20 July 2007 (41.9 °C, absolute maximum)

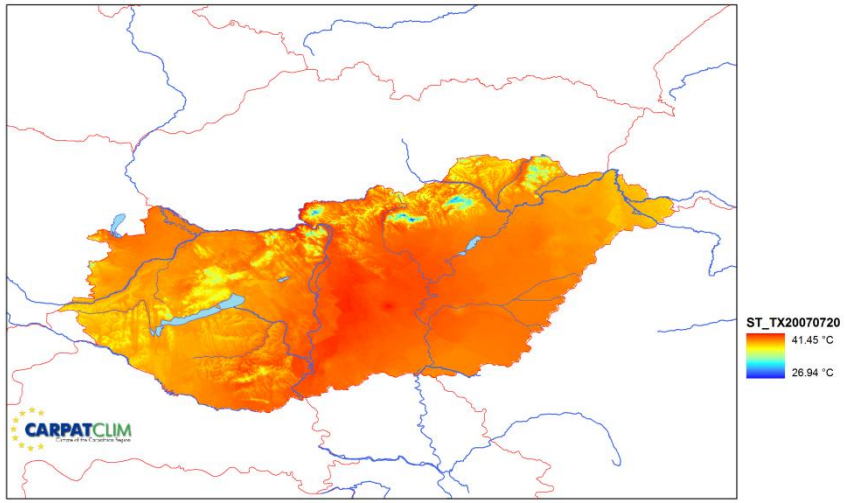
Carpatclim

From CarpatClim grid

From station data





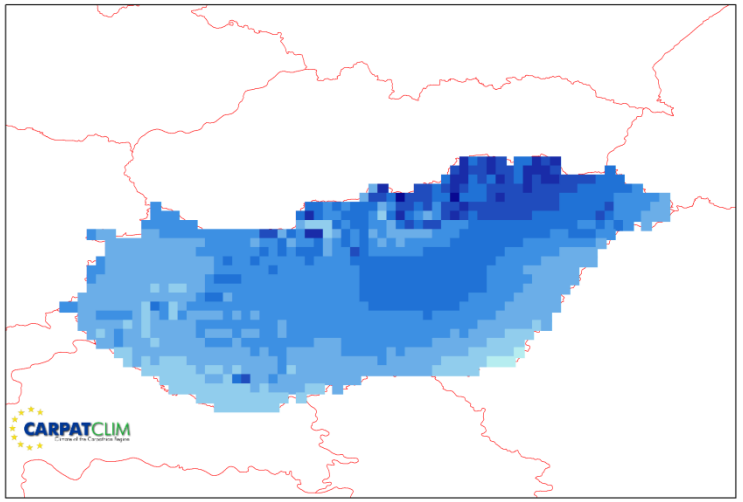


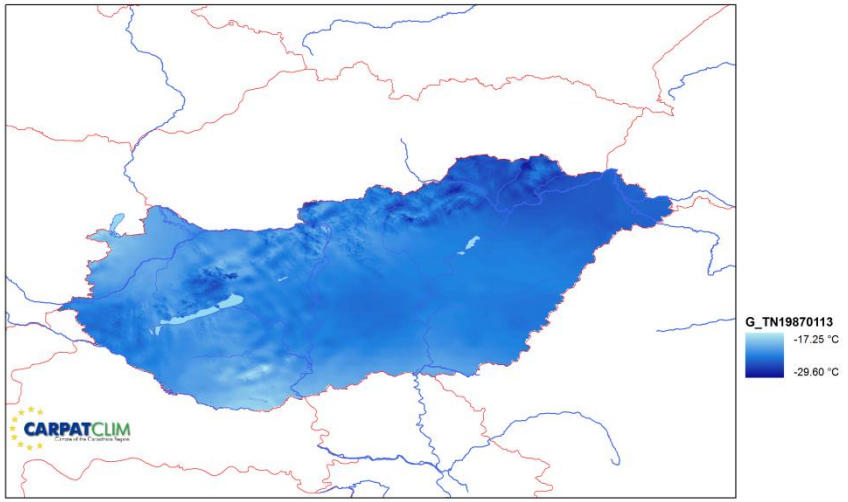
T_{min} , 13 January 1987 (extremely cold)

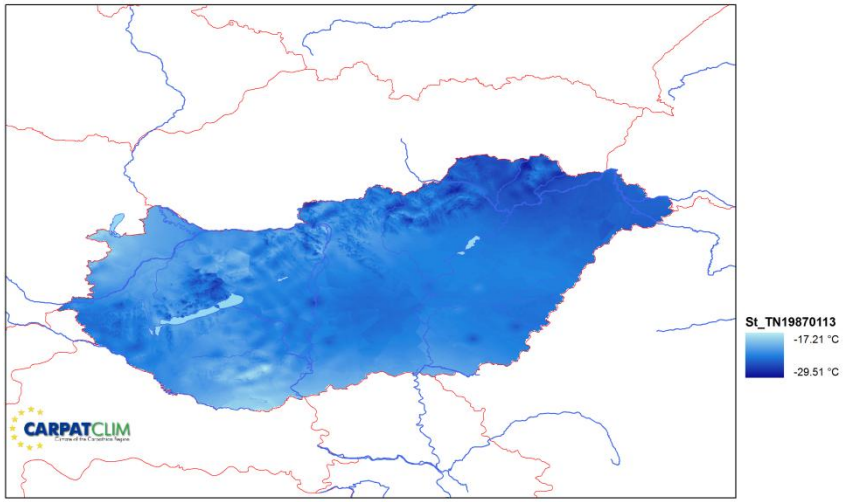
Carpatclim

From CarpatClim grid

From station data





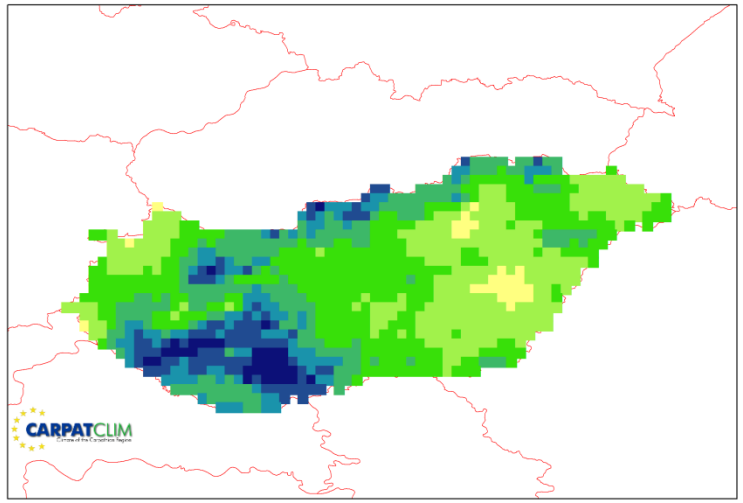


Mean Absolute Error (MAE) [°C]
MISH Interpolation from CarpatClim-Hu grid and from stations

	T_{max} Extremely warm day 20 July 2007	T_{min} Extremely cold day 13 Januar 1987
MAE	0.04	0.12

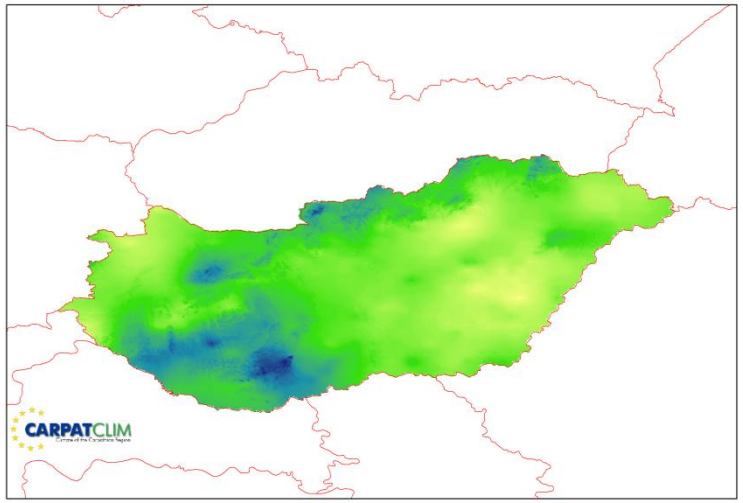
Precipitation , June 2010 (extremely wet)

Carpatclim



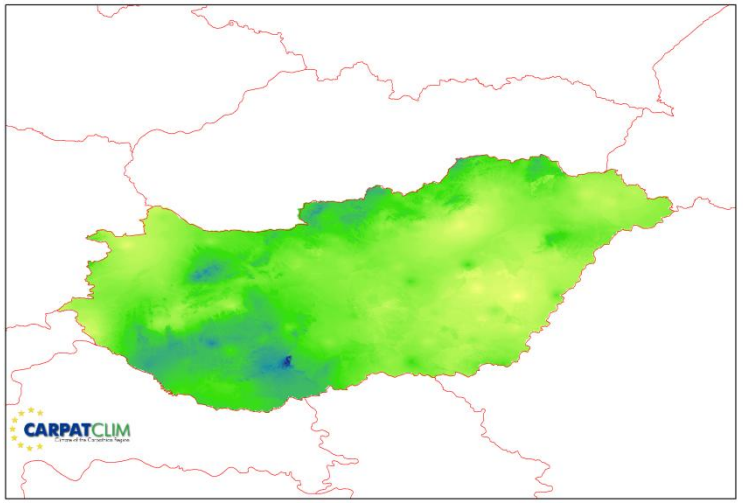
< 80
80. - 100
100 - 120
120 - 140
140 - 160
160 - 180
> 180 mm

From CarpatClim grid



G_CS201006
231.94 mm
66.52 mm

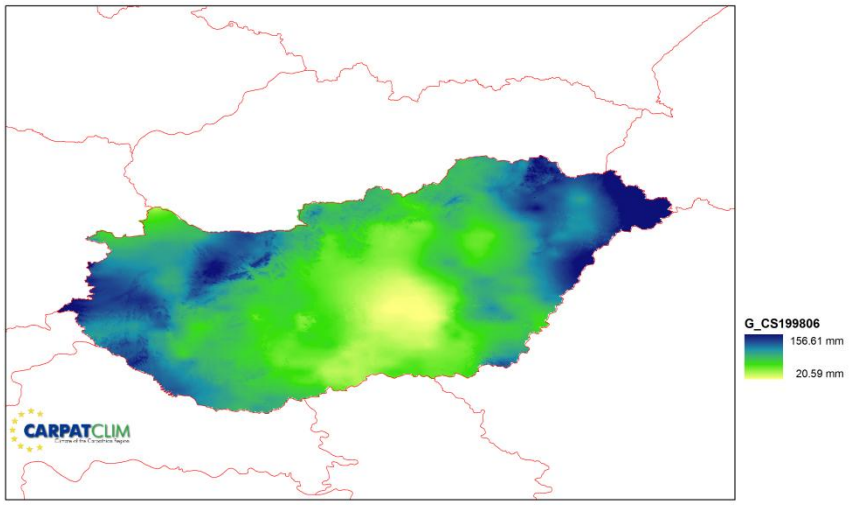
From station data



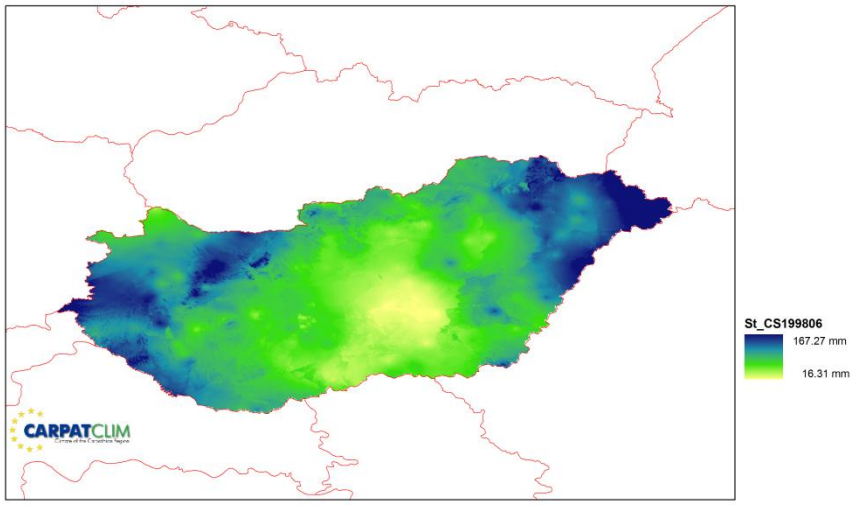
St_CS201006
286.35 mm
58.77 mm

Precipitation , June 1998 (close to average)

From CarpatClim grid

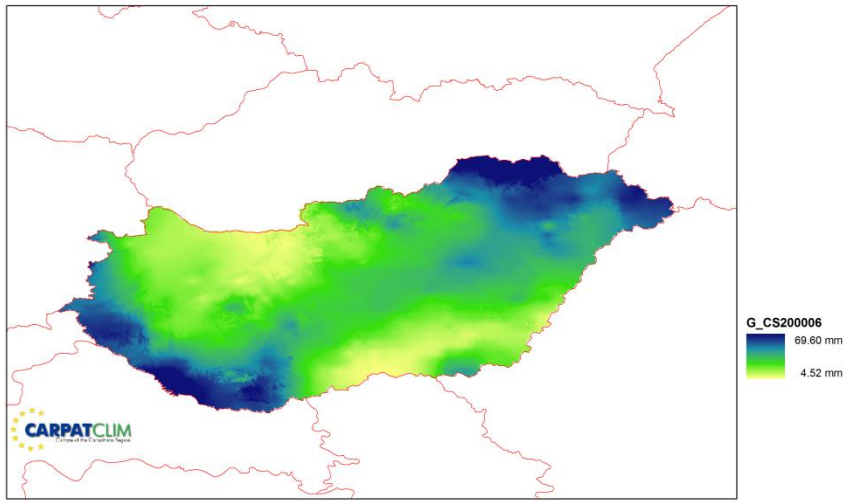


From station data

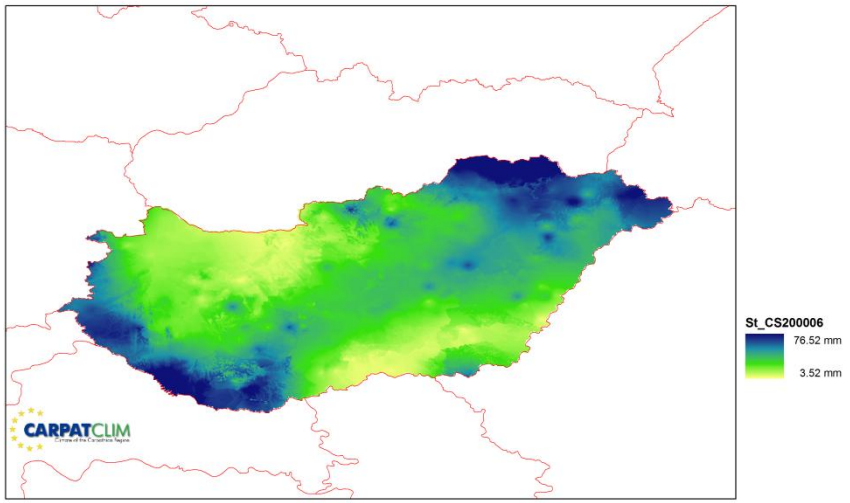


Precipitation , June 2000 (extremely dry)

From CarpatClim grid



From station data

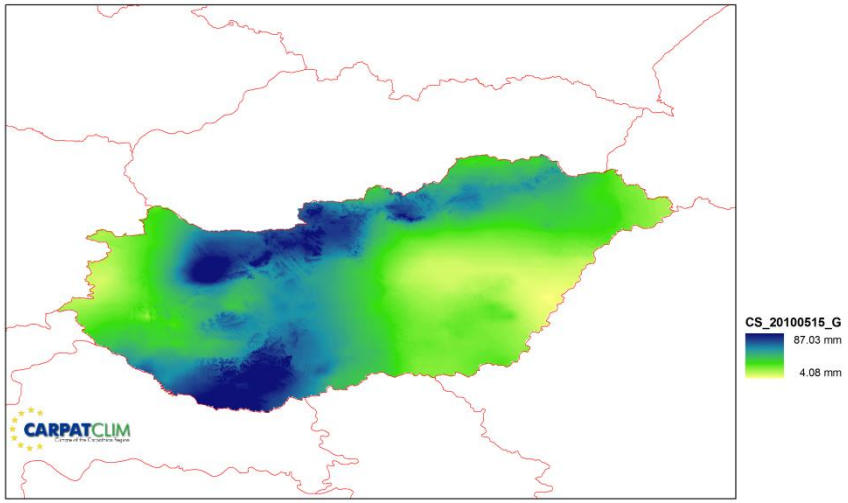


Precipitation, Mean Absolute Error (MAE) [mm]
MISH Interpolation from CarpatClim-Hu grid and from stations

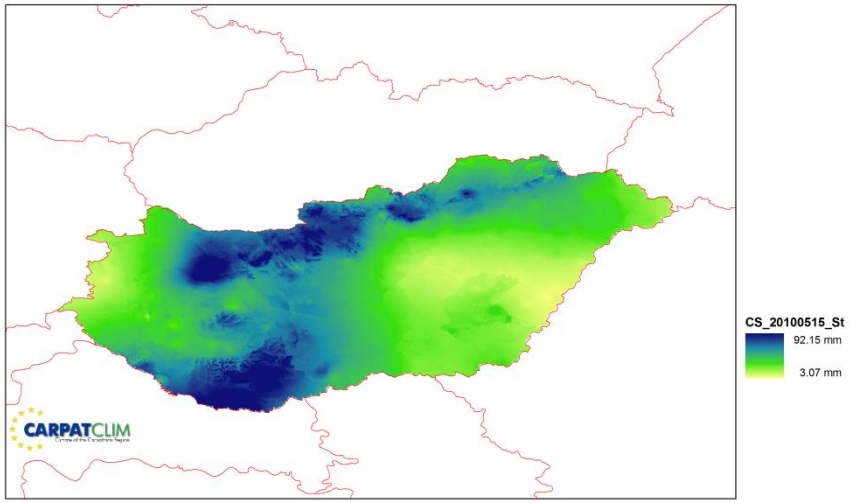
	Extremely wet year June 2010	Close to long time average (1981-2010) June 1998	Extremely dry year June 2000
MAE	2.81	2.45	0.70

Precipitation , 15 May 2010 (extremely wet)

From CarpatClim grid

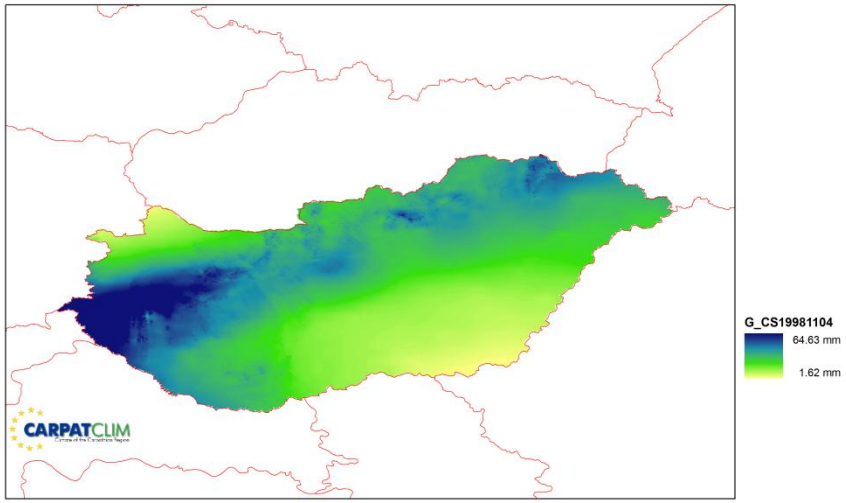


From station data

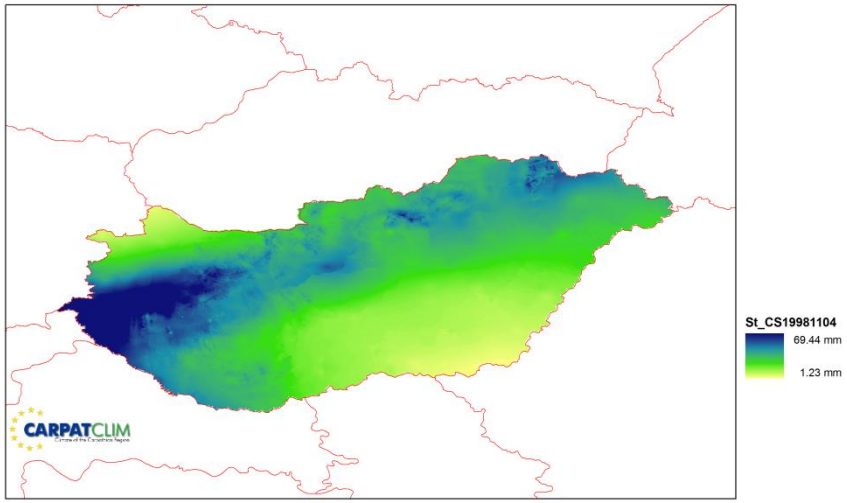


Precipitation , 04 November 1998 (extremely wet)

From CarpatClim grid



From station data



Precipitation, Mean Absolute Error (MAE) [mm]
MISH Interpolation from CarpatClim-Hu grid and from stations

	Extremely big precipitation 15 May 2010	Extremely big precipitation 04 November 1998
MAE	0.83	0.39

Thank you for your attention