Observed climate change in Hungary from the 20th century to present

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Budapesti Műszaki Szakképzési Centrum
PETRIK LAJOS
Két Tanítási Nyelvű Technikum

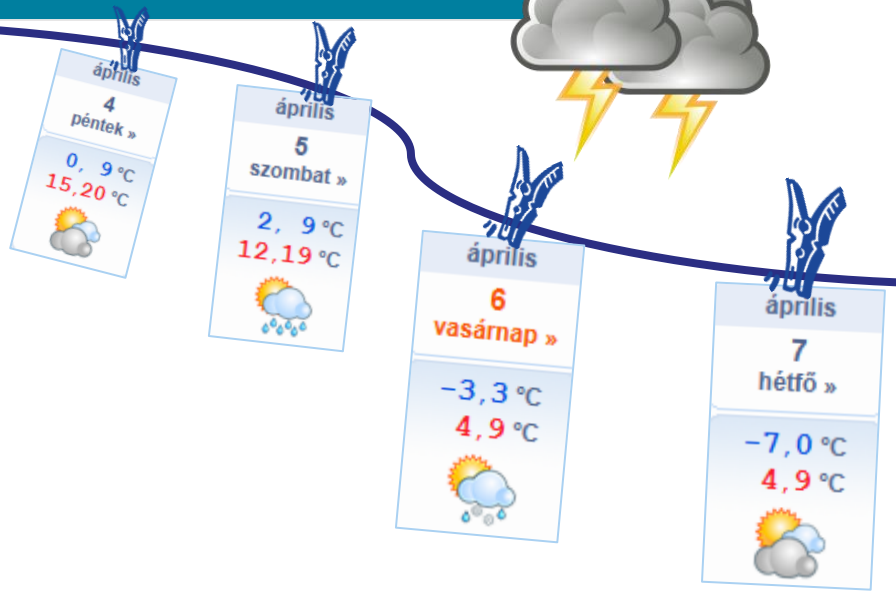
CONTENT

- What is climate?
- Why are measurements important for the analysis of climate trends?
- What are the observed changes in Hungary?

WEATHER

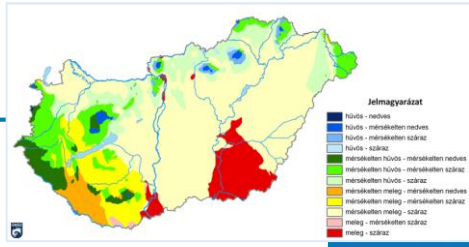
- The **temporary** condition of the atmosphere at a place
- It can change very quickly
- It can be different within a city

What's the weather like today?



Which is the season with the highest and lowest rainfall in Hungary?

CLIMATE



- **Average** weather conditions over a long time period for a given region

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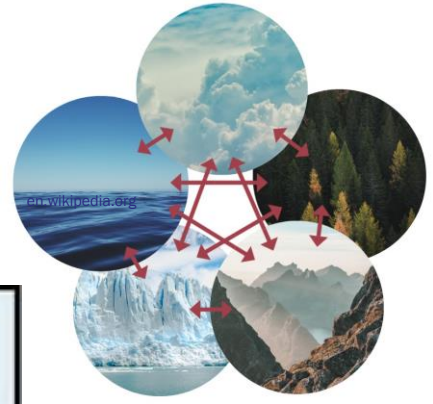
The climate system

- The interaction between the following spheres:



Atmosphere

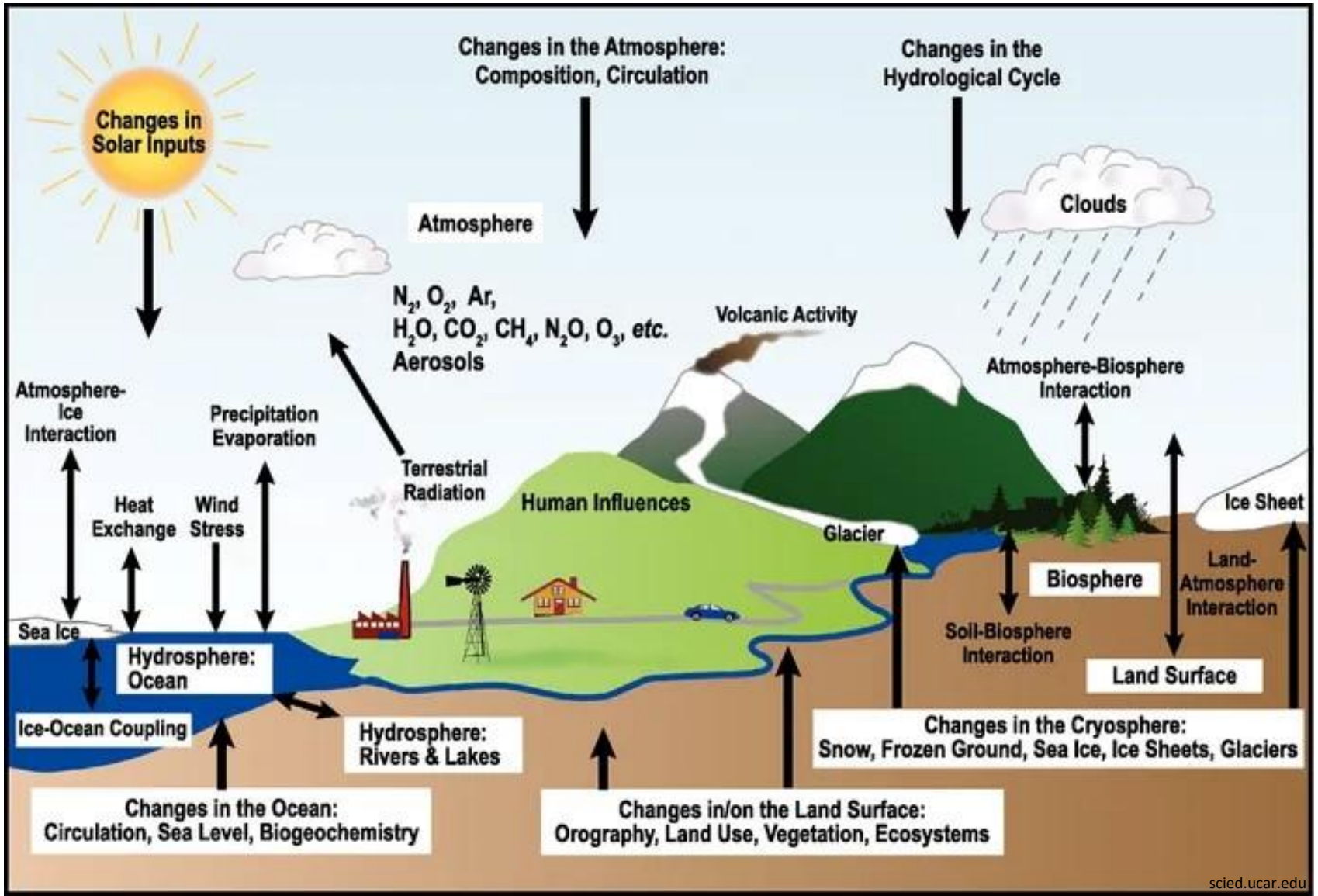
- most unstable and rapidly changing part
- 78% N_2, 21% O_2, 1% trace gases
- Greenhouse effect

Cryosphere

- Solid water: sea ice, ice sheets, glaciers, permafrost, snow

Hydrosphere

- all the liquid water on Earth



Biosphere

- Living organisms: plants, animals, humans

Lithosphere

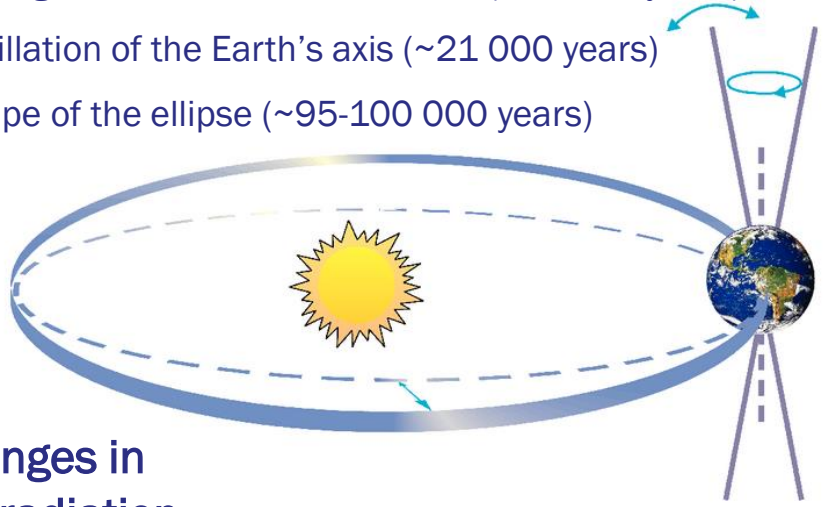
- Earth's upper rocky layer: rocks, mountains, soil, sand

The reasons of climate change

➢ Natural

Changes in the orbital elements of the Earth

- The tilt angle of Earth's rotational axis (~41 000 years)
- The oscillation of the Earth's axis (~21 000 years)
- The shape of the ellipse (~95-100 000 years)



Changes in solar radiation

Volcanic eruptions

➢ Human-caused (anthropogenic)

Greenhouse gas emission

Air pollution

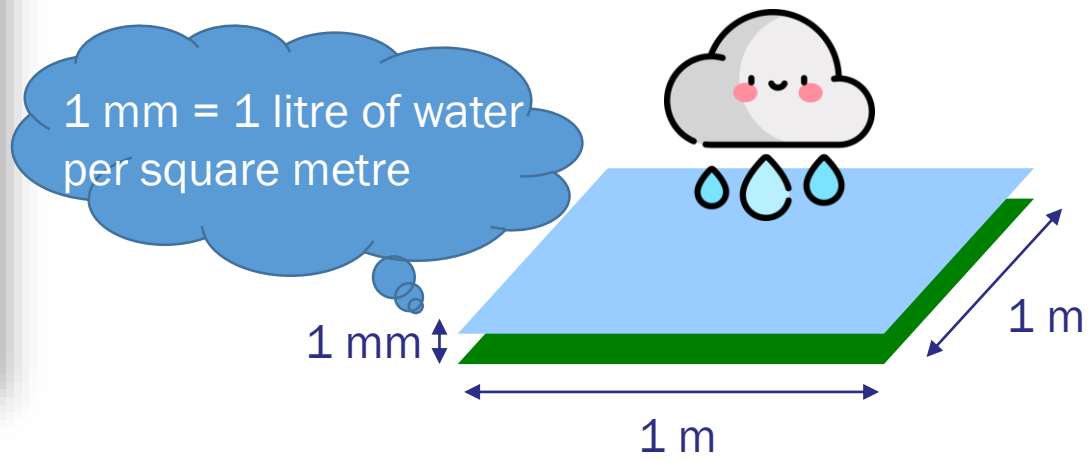
Waste of energy

Deforestation

Meteorological measurements and observations

- The basis of describing the weather and climate
- Meteorological stations

- **Temperature (°C)**
- **Precipitation (mm)**
- **Wind**
  - **speed (m/s)**
  - **direction (from where the wind blows)**



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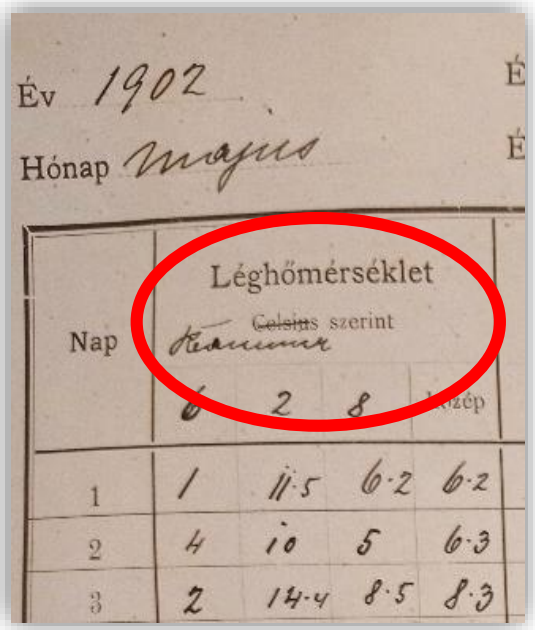
Meteorological measurements and observations

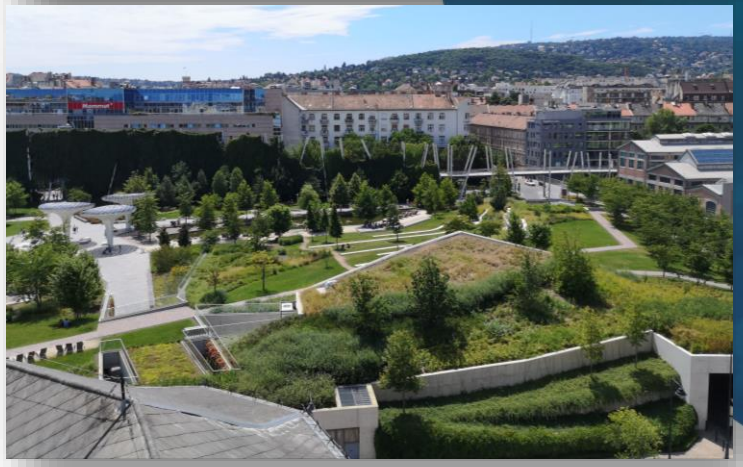
➢ Changes in measurement conditions over time


Év 1902
Hónap május
Léghőmérséklet
Celsius szerint
Nap
7 2 8 Közép
1 1 11·5 6·2 6·2
2 4 10 5 6·3
3 2 14·4 8·5 8·3

- **The location of the station**
- **The time of measurement**
- **The measurement method**
- **Instrument changes**

These cause inhomogenities in the data series

➢ **Does that mean a problem?**



Képek: Szentes Olivér

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Meteorological measurements and observations

➢ Why databases of high-quality are important?

- **Climatological studies can be only carried out on long, high-quality homogeneous data series**

➢ Homogenization

- **The point: to correct for the inhomogeneity of the data series in a way that does not make climate change signal disappear**
- **What if we had measured under the same conditions all the time?**

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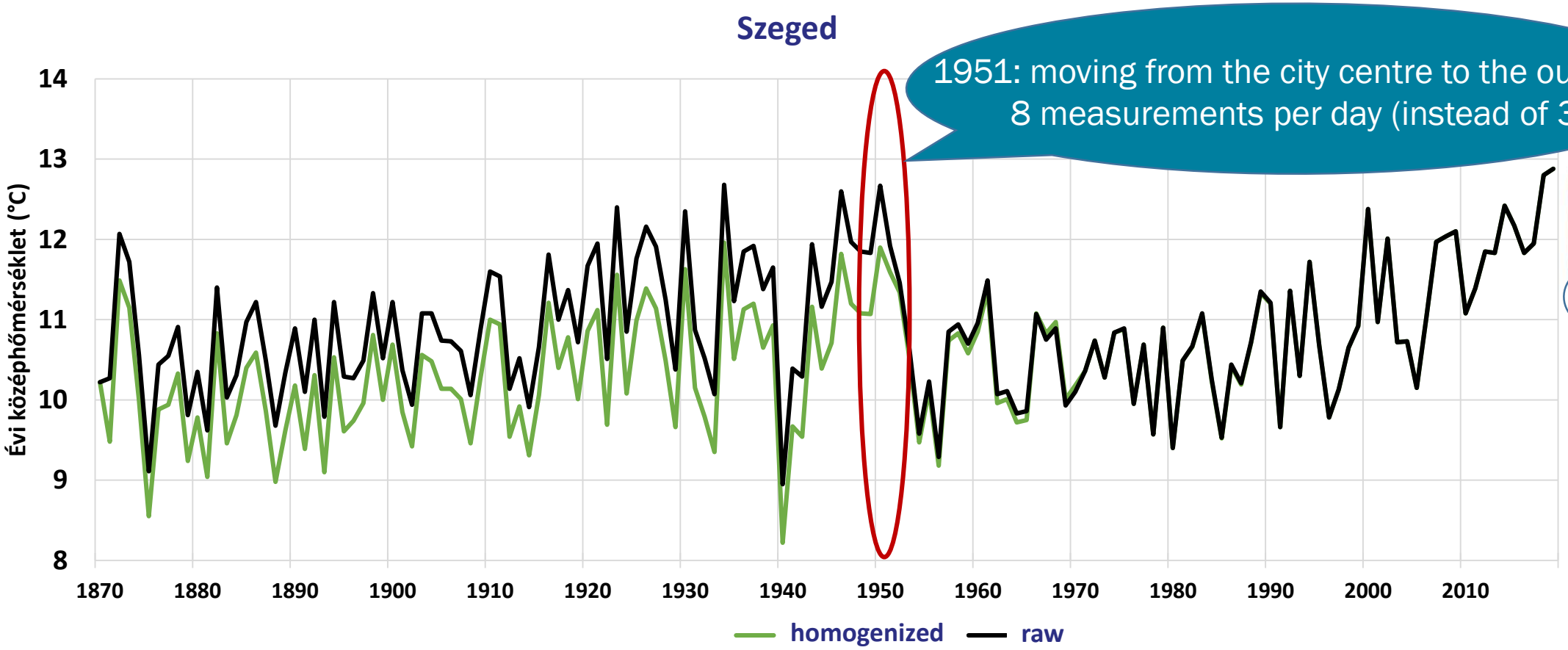
Meteorological measurements and observations

- The effect of homogenization



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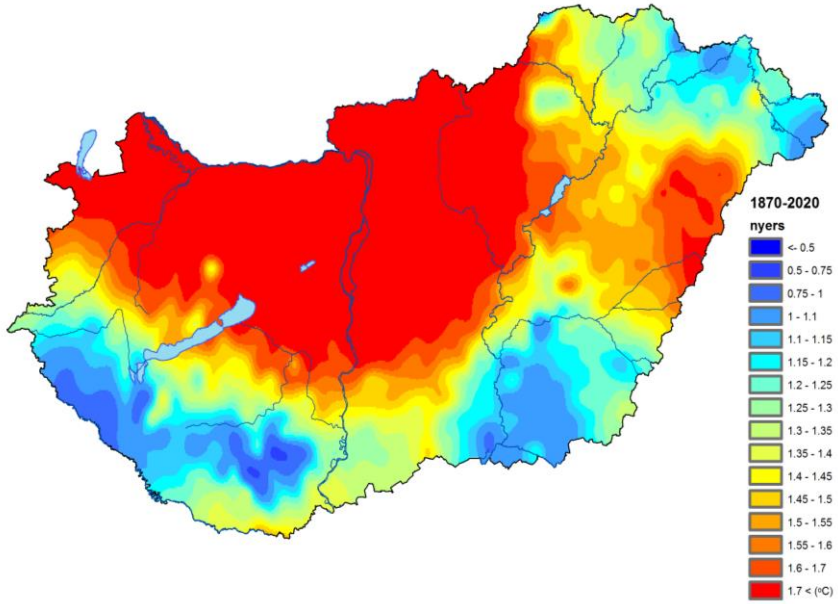
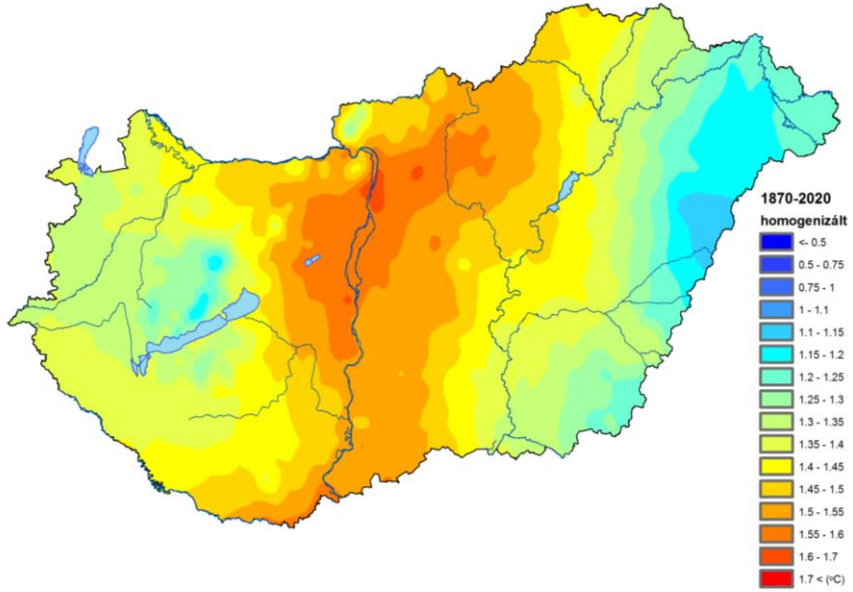
Meteorological measurements and observations

So much difference!?

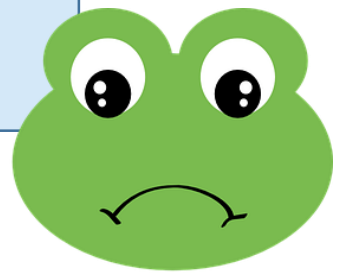
- The effect of homogenization

Change of annual mean temperature (°C)





- Raw data series
- Conditions of measurements have changed
- There is no quality control



- Homogenized, quality controlled data series
- Missing data is filled
- Appropriate mathematical softwares and methods are used

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Analysis of climate trends

- Averages over 30-year periods are used = climate normal periods
  - Recommended by WMO (World Meteorological Organization)
  - Natural climate variability is smoothed
  - Signs of climate change is not masked
  - Renewed in every 10 years

- For current state of the climate: 1991-2020

Analysis of climate trends

- For current state of the climate: 1991-2020

What is the mean annual temperature over Hungary based on the 1991-2020 time period?

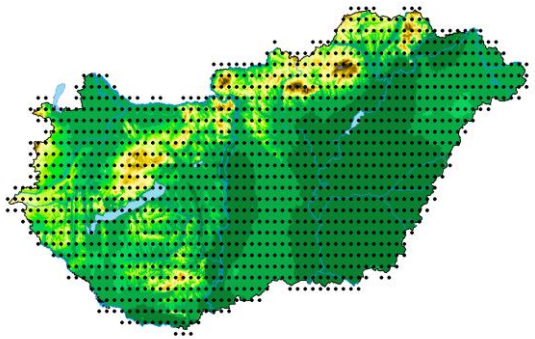
a) 9,75 °C

b) 10,2 °C

c) 10,75 °C

d) 11,5 °C

Over Hungary = Average of the 1233 grid point values covering Hungary



Analysis of climate trends

- For current state of the climate: 1991-2020

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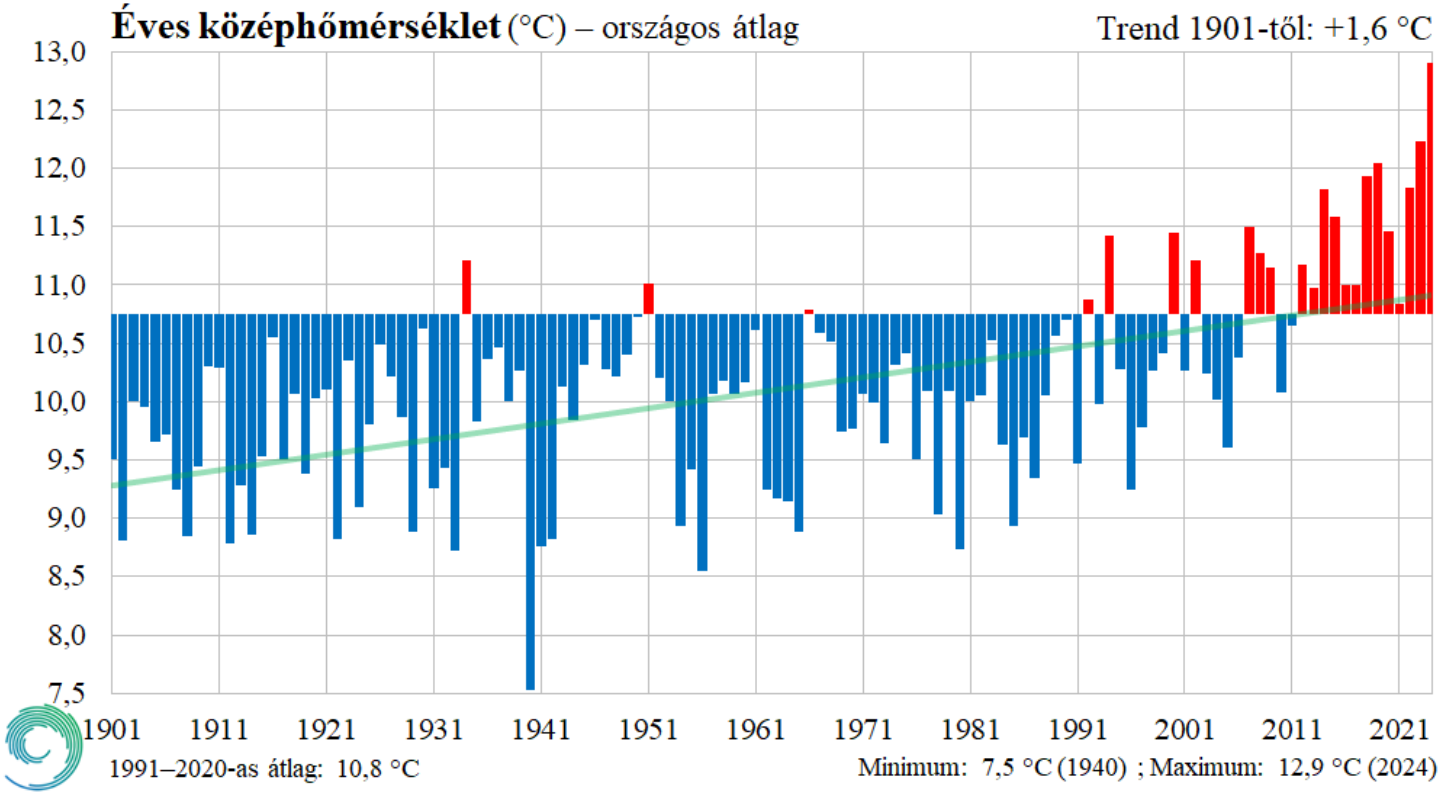
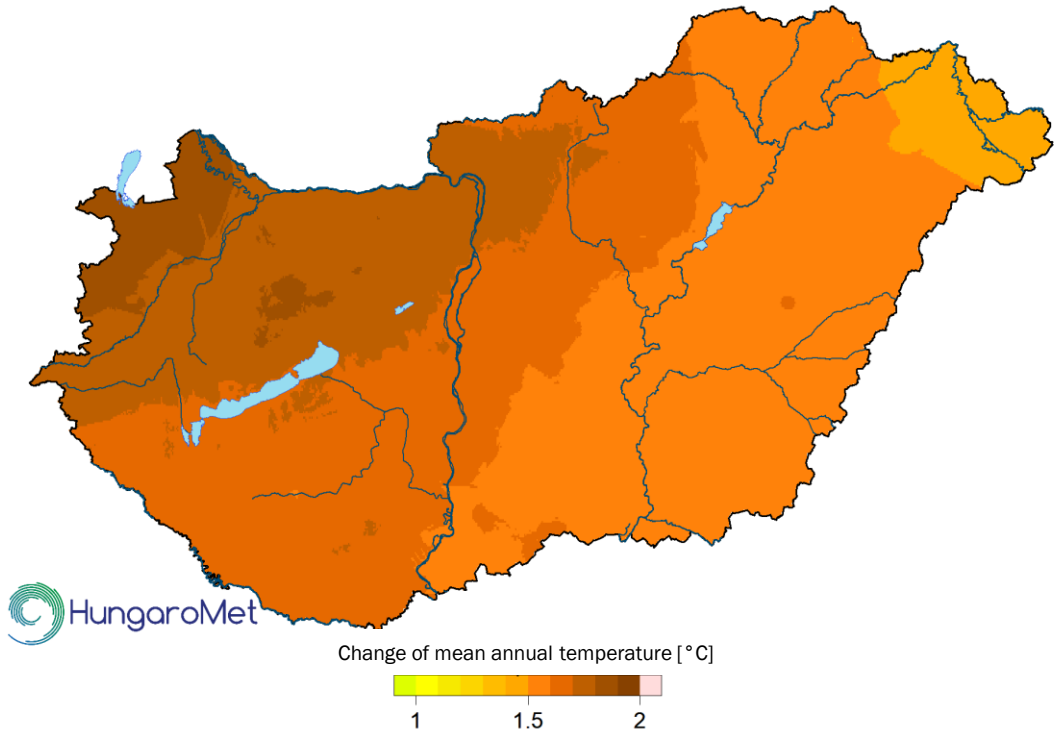
Observed trends in Hungary

- Mean annual temperature 1901-2024



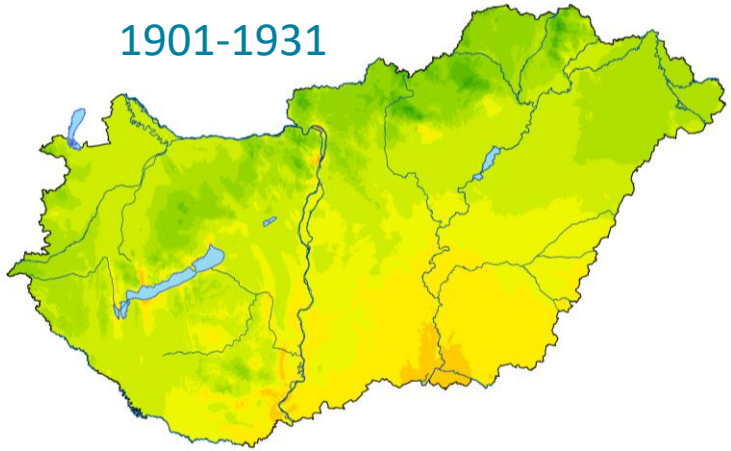


Figures: Olivér Szentes

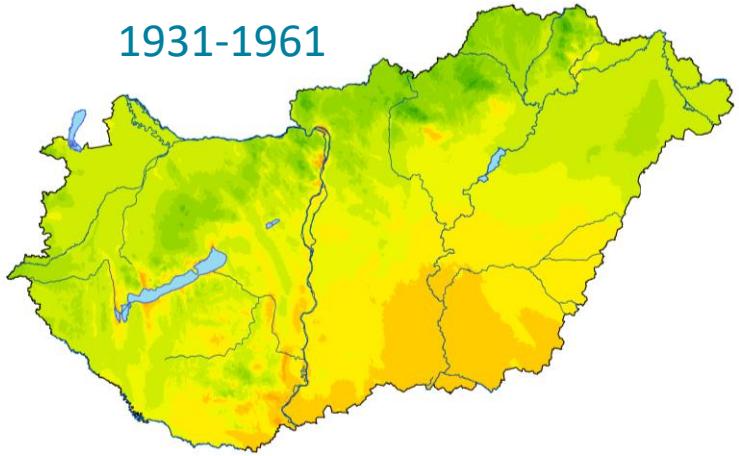
Observed trends in Hungary

- Mean annual temperature

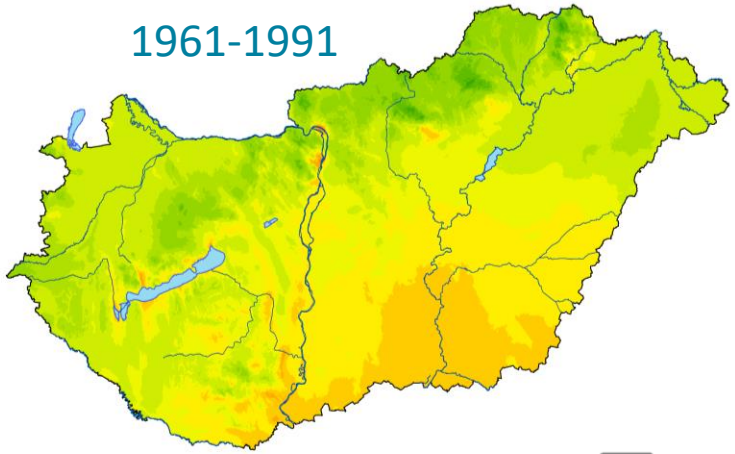
1901-1931



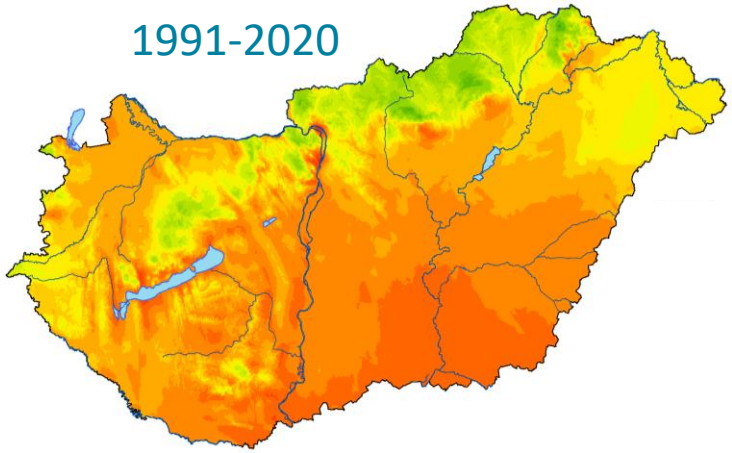
1931-1961

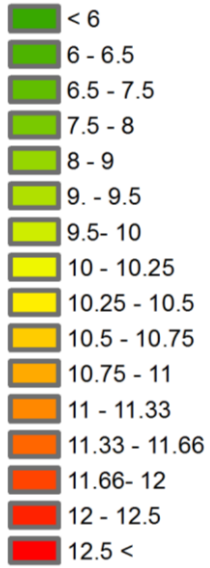


1961-1991



1991-2020





Observed trends in Hungary

- Temperature records

What was the highest measured daily maximum temperature in Hungary since 1901?

a) 40,0 °C

b) 41,9 °C

c) 42,5 °C

d) 44,2 °C

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Observed trends in Hungary

- Temperature records

What was the highest measured daily maximum temperature in Hungary since 1901?

a) 40,0 °C

b) 41,9 °C

c) 42,5 °C

d) 44,2 °C

Kiskunhalas, 20th July, 2007

Observed trends in Hungary

- Temperature records

What was the lowest measured daily minimum temperature in Hungary since 1901?

a) -40,1 °C

b) -38,0 °C

c) -36,8 °C

d) -35,0 °C

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Observed trends in Hungary

- Temperature records

What was the lowest measured daily minimum temperature in Hungary since 1901?

a) -40,1 °C

b) -38,0 °C

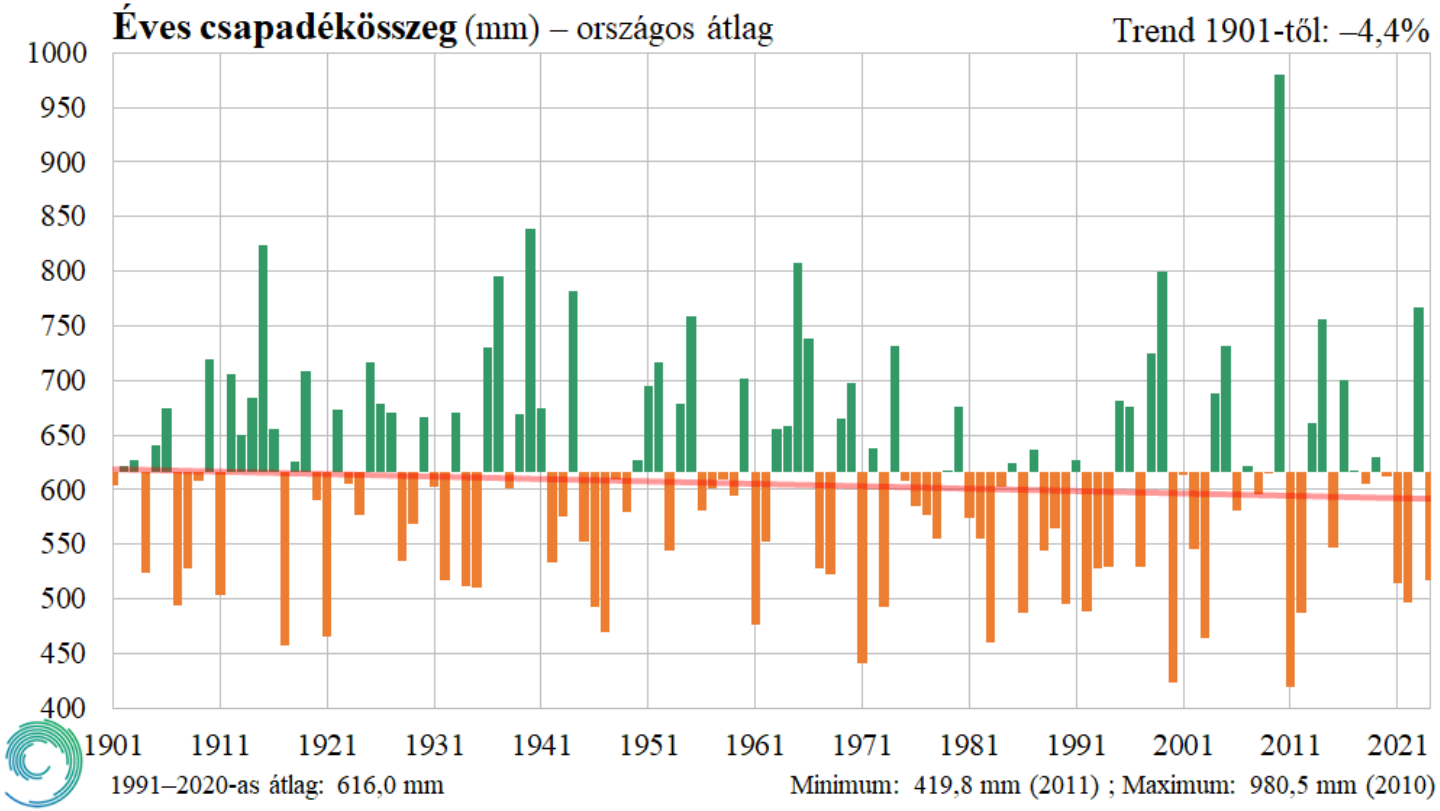
c) -36,8 °C

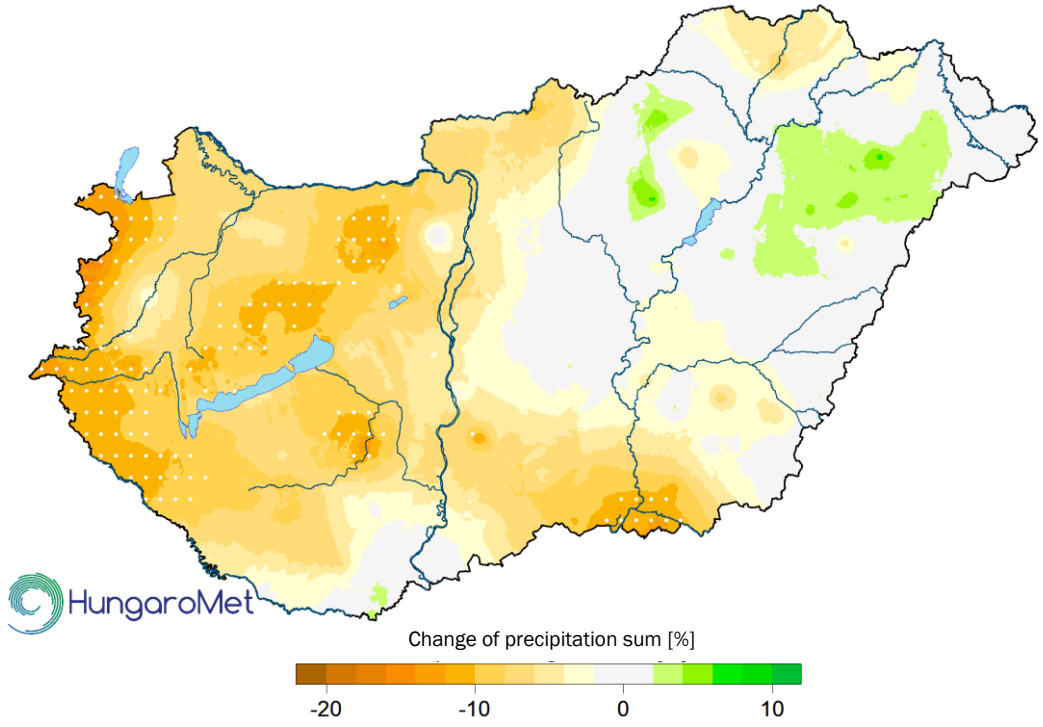
d) -35,0 °C

Miskolc-Görömbölytapolca, 16th February 1940

Observed trends in Hungary

- Mean annual precipitation sum 1901-2024





Figures: Olivér Szentes

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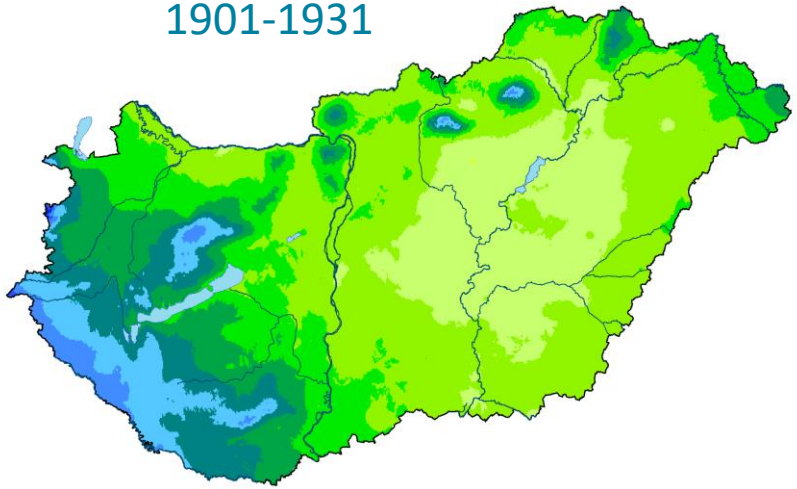
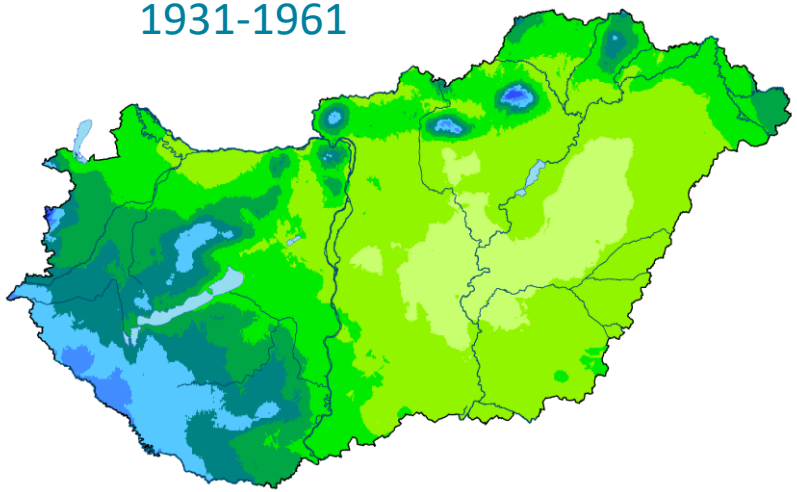
Observed trends in Hungary

- Mean annual precipitation sum

1901-1931



1931-1961



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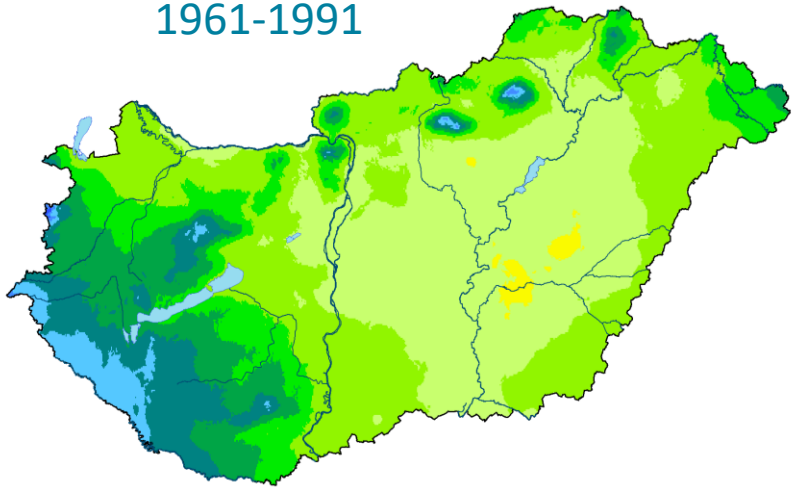
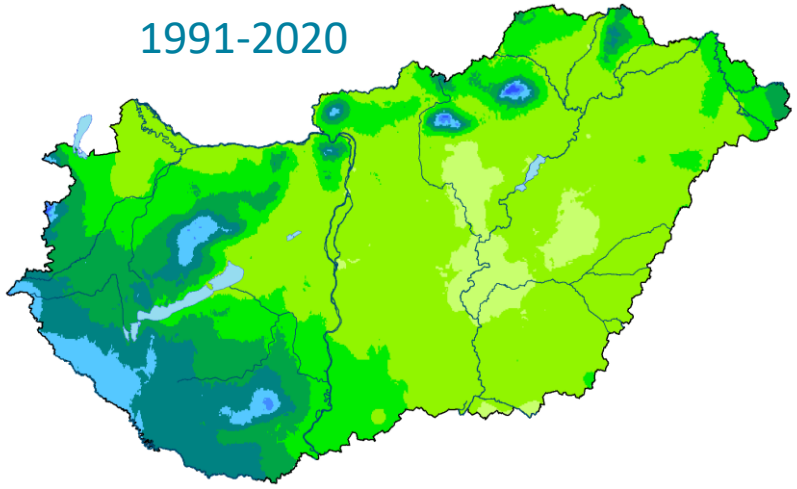
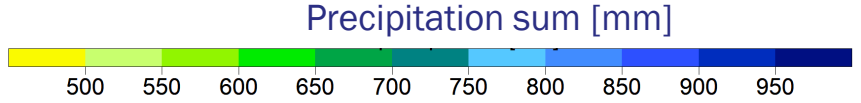


1991-2020





Figures: Olivér Szentes

Observed trends in Hungary

- Precipitation records

What was the highest measured daily precipitation sum in Hungary since 1901?

a) 158 mm

b) 186 mm

c) 203 mm

d) 350 mm

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Observed trends in Hungary

- Precipitation records

What was the highest measured daily precipitation sum in Hungary since 1901?

a) 158 mm

b) 186 mm

c) 203 mm

d) 350 mm

Gyömrő,
8th September, 1963

Observed trends in Hungary

- Climate indices – monitoring the changes in extremes

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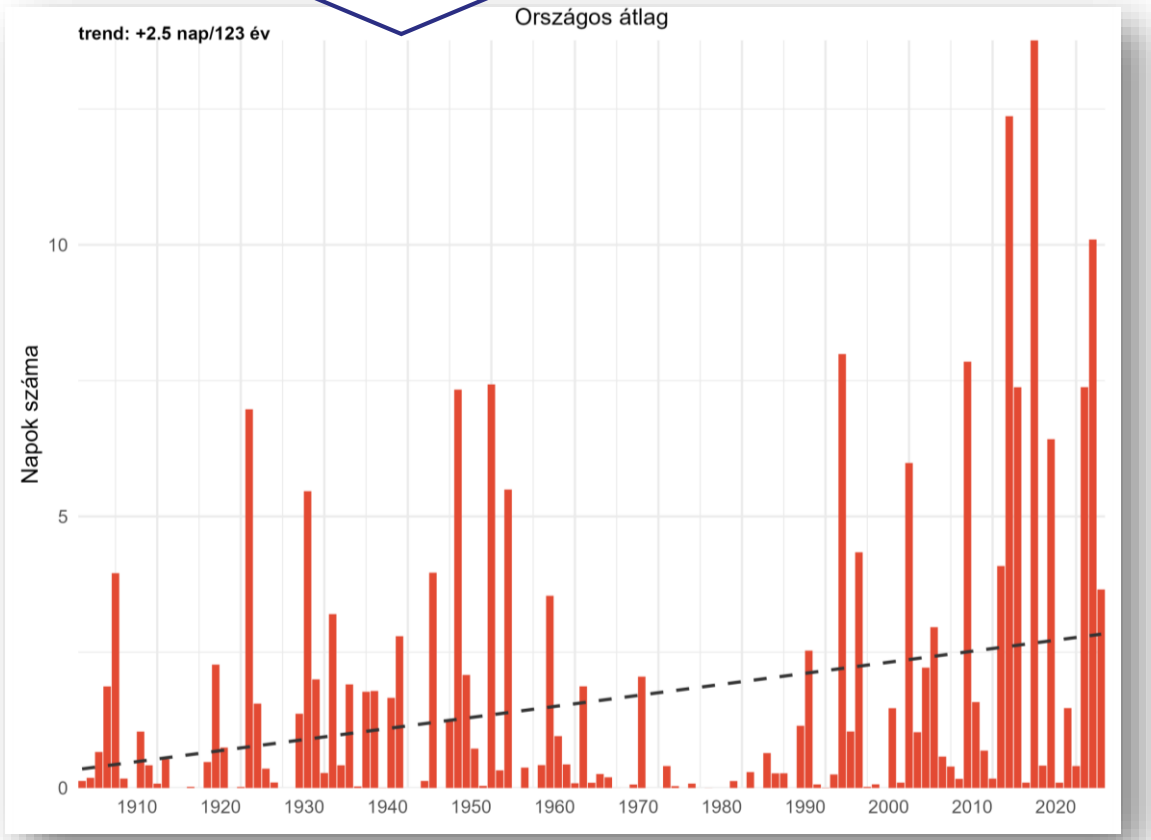
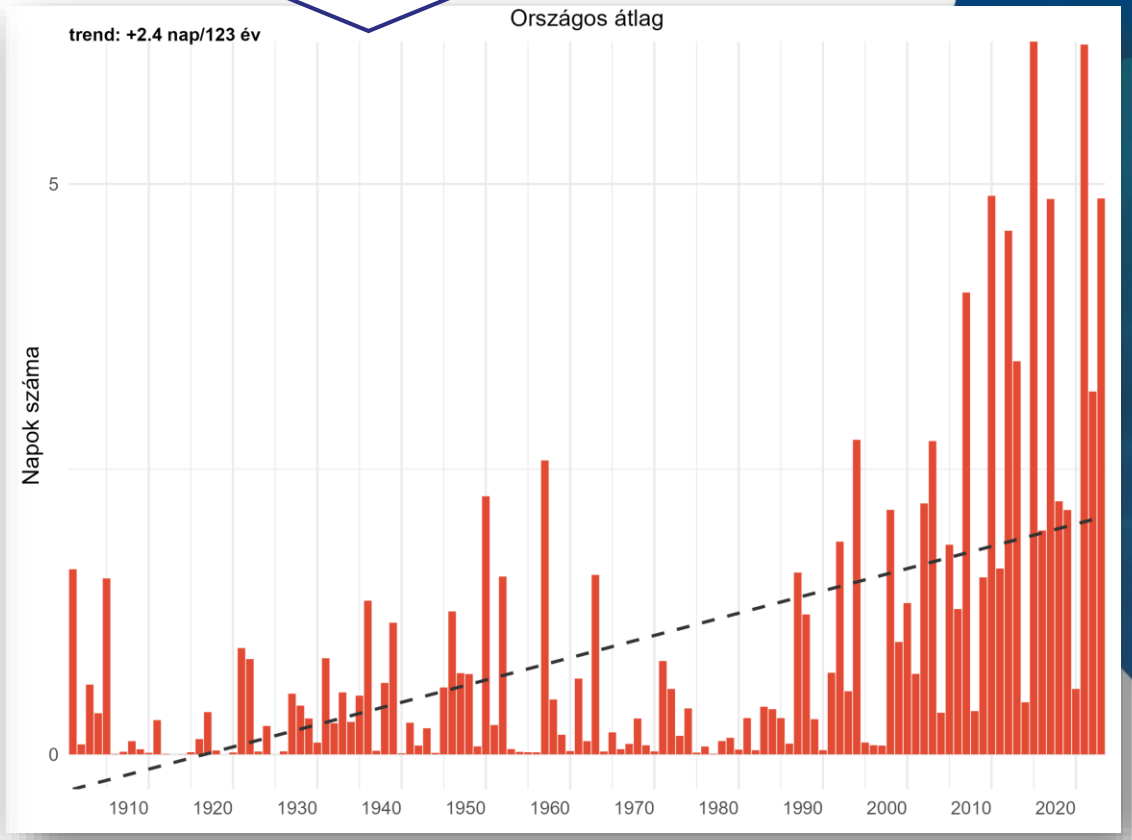
Observed trends in Hungary – climate indices

- Increasing frequency of high temperature extremes

The number of hot days (1901-2023)
- T_{max} >= 35 °C



The number of tropical nights (1901-2023)
- T_{min} > 20 °C)



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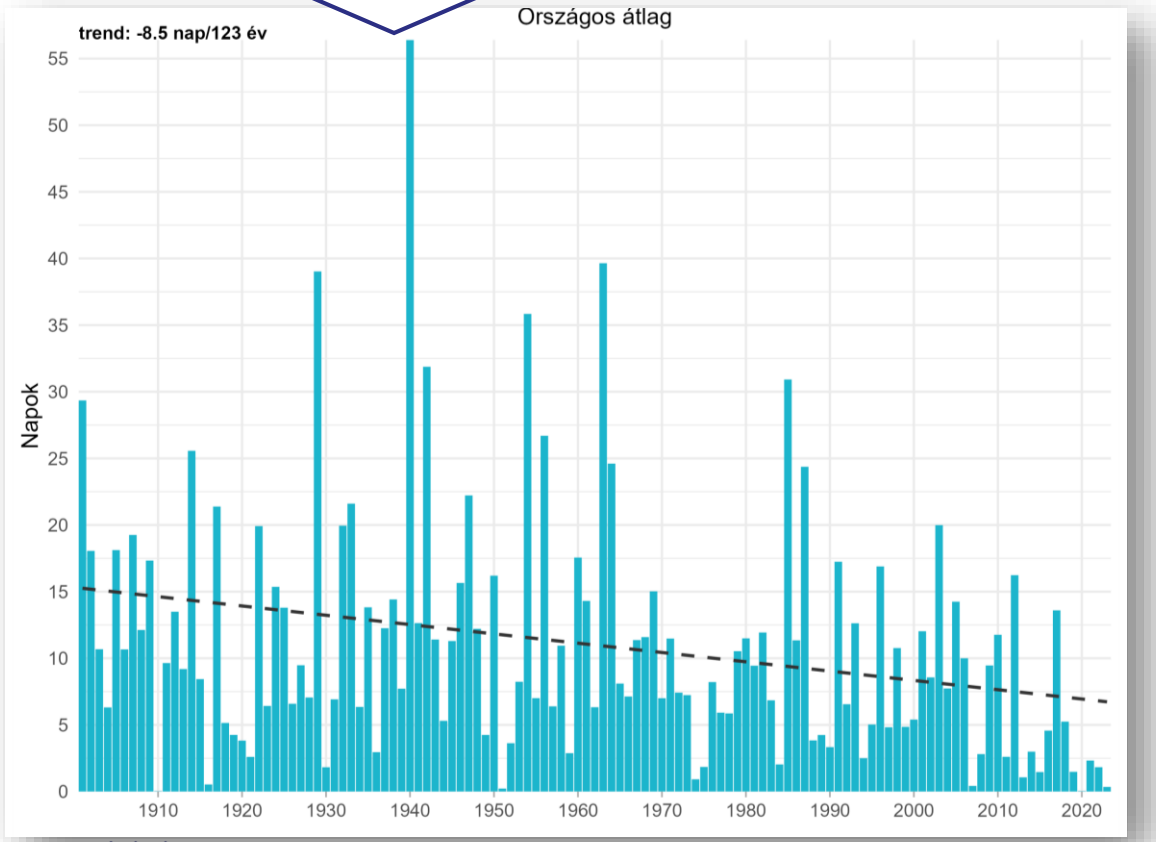
Observed trends in Hungary – climate indices

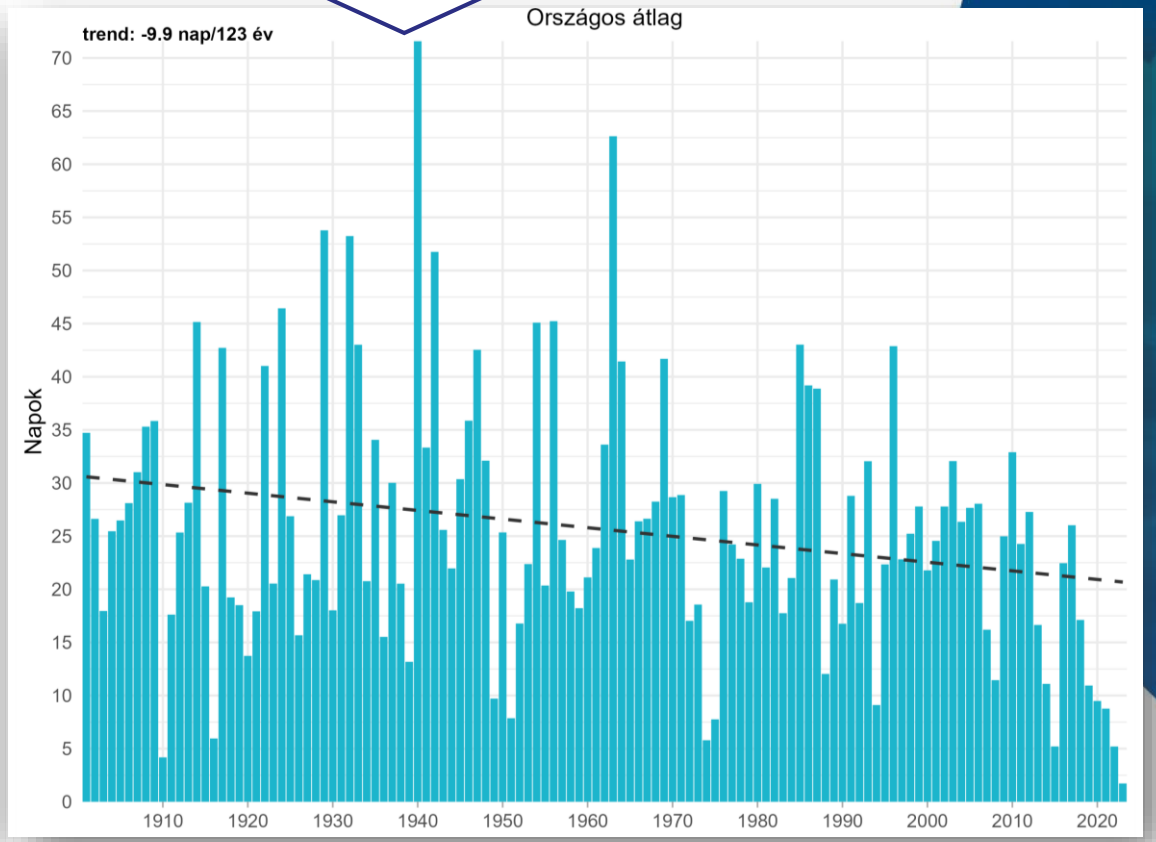
- Decreasing frequency of low temperature extremes

The number of days when T_{min} < -10 °C (1901-2023)



The number of ice days (1901-2023)

- T_{max} < 0 °C)



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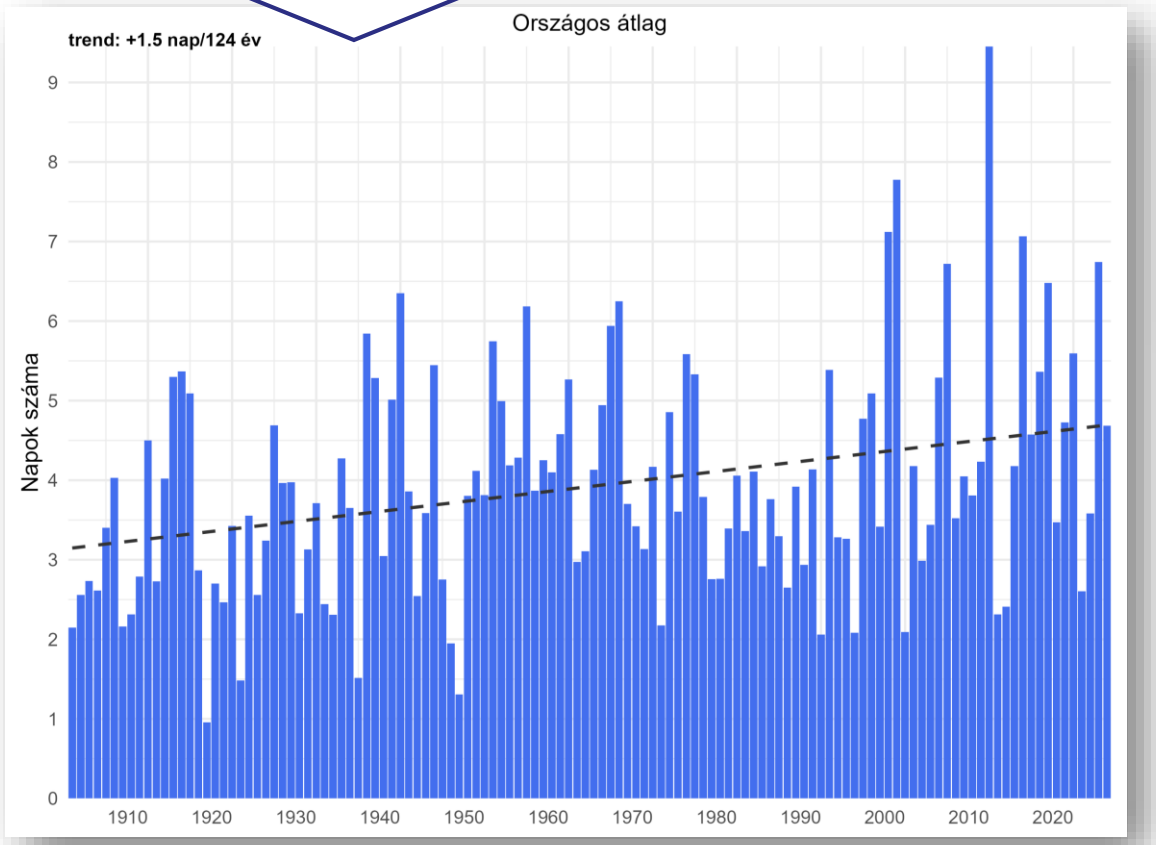
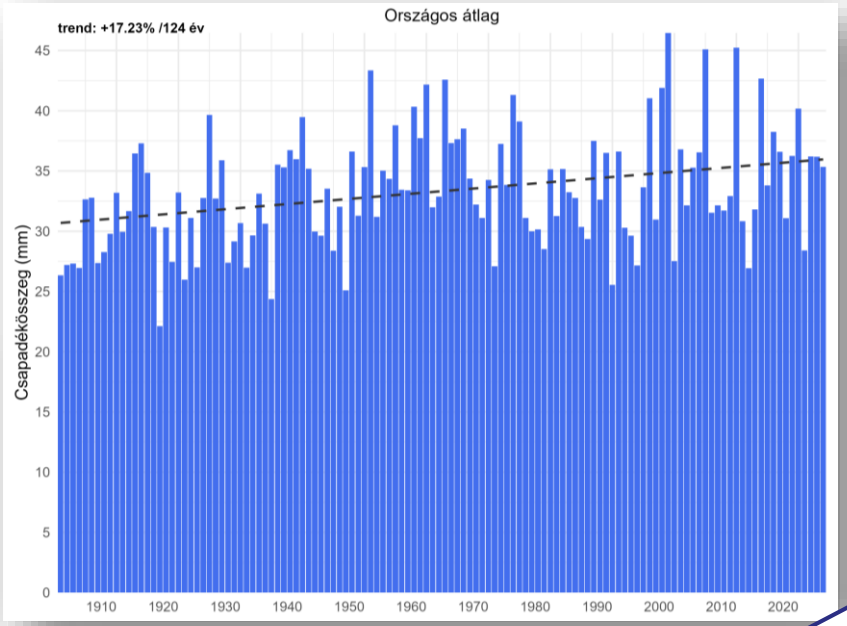
Observed trends in Hungary – climate indices

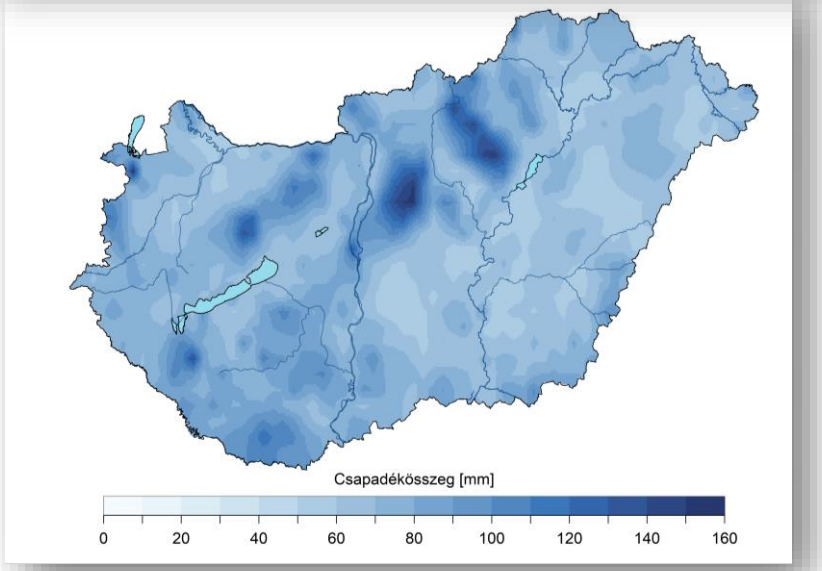
➢ Extreme precipitation

Very heavy precipitation days (1901-2024)
➢ R_{daily} > 20 mm





The highest daily precipitation sum (1901-2024)



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SUMMARY

- Good quality data series are important for climate trend analysis
- High temperature extremes have become more frequent, decrease in low temperature extremes
- Heavy rainfall events show an increasing trend

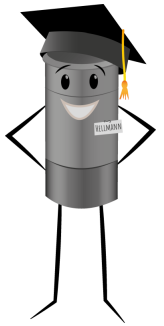
The presentation was carried out within the framework of the Széchenyi Plan Plus program with the support RRF 2.3.1 21 2022 00014 project.

SUMMARY

- Good quality data series are important for climate trend analysis
- High temperature extremes have become more frequent, decrease in low temperature extremes
- Heavy rainfall events show an increasing trend

How can we get information about climate characteristics of the future?

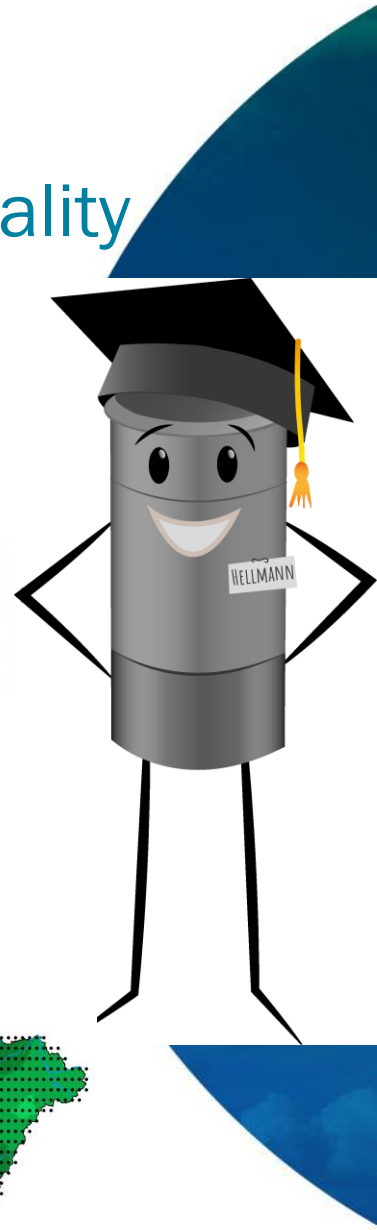
➢ Topic of the next presentation



Thank you for your attention!

Meteorological measurements and observations

➢ Mathematical softwares – to obtain data series of high-quality



- **MASHv3.03**

  Multiple Analysis of Series for Homogenization
  (*Szentimrey, T.*)

➡ For homogenization of data series, quality control and filling in the missing data

- **MISHv1.03**

  (Meteorological Interpolation based on Surface Homogenized Data Basis
  (*Szentimrey, T. and Bihari, Z.*)

➡ For obtaining spatially representative data series