Relationship between heating/cooling period and changing temperature conditions in the urban areas of Hungary

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Motivation

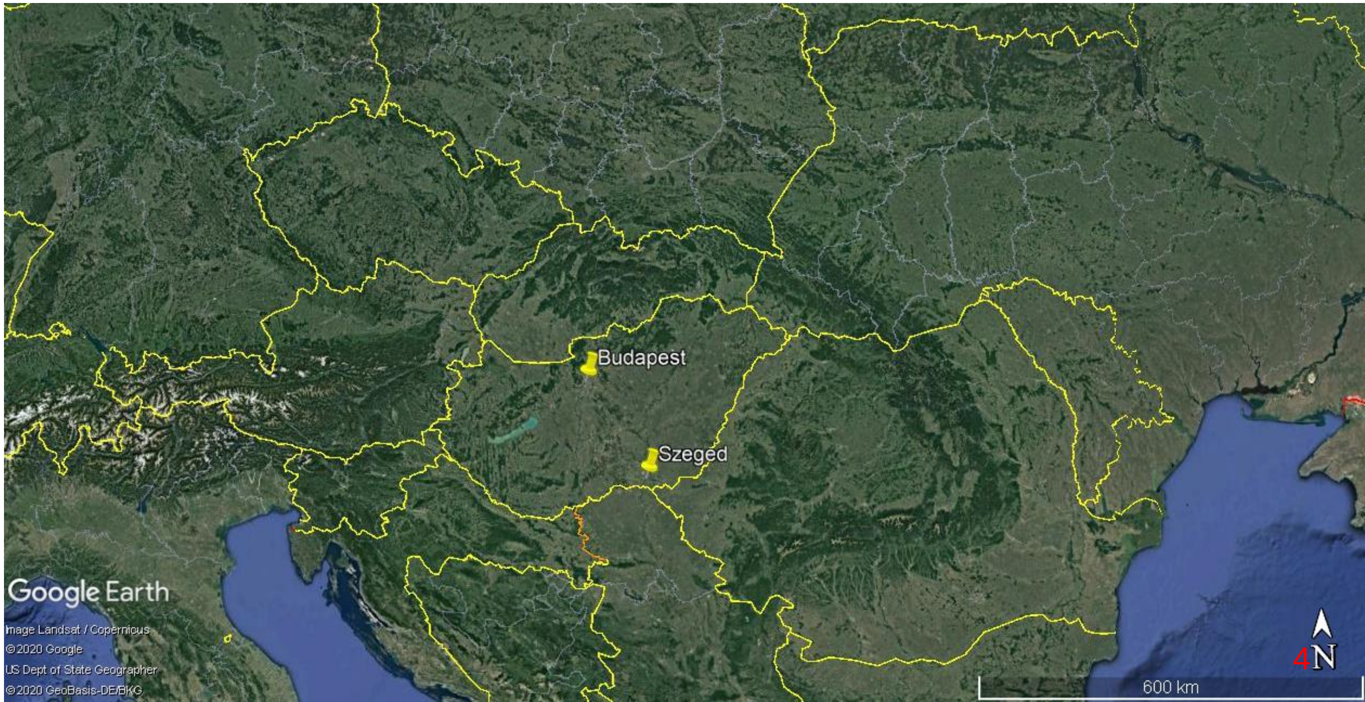
- Climate change, extreme weather conditions, and local scale urban heat island (UHI) effect altogether have substantial impacts on people's health and comfort.
- The urban population spends most of its time in buildings, therefore, it is important to examine the relationship between weather/climate conditions and indoor environment.
- The role of buildings is complex in this context. On the one hand UHI effect is mostly created by buildings and artificial surfaces. On the other hand they account for about 40% of energy consumption on European average.
- When estimating energy consumption, daily average temperatures are taken into account. The design parameters (e.g. for heating systems) are determined using temperature-based criteria.
- However, due to climate change, these critical values are likely to change as well. Therefore, it is important to examine the temperature time series affecting the energy consumption of buildings.

Aim of the study

- The main aim of this study is to investigate the effect of changing daily average temperatures and the rising extreme values on building design parameters, especially heating and cooling periods (including the length and average temperatures of such periods).

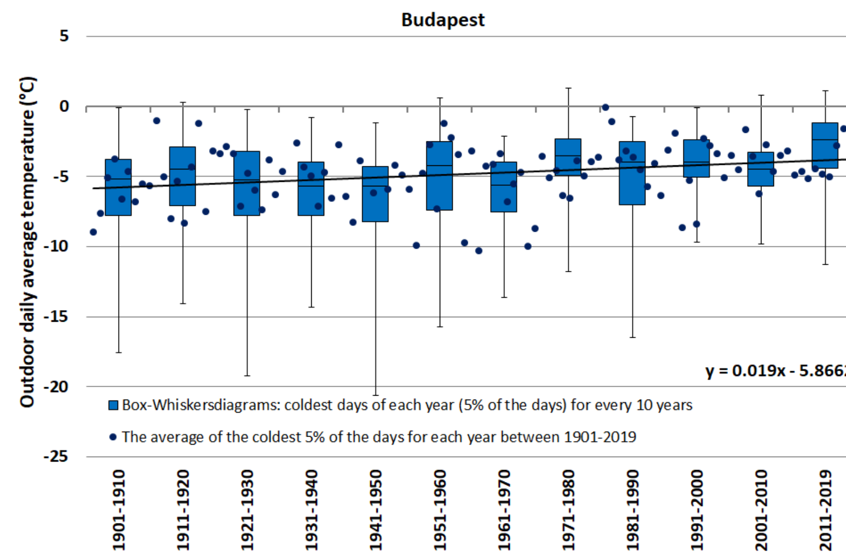
Dataset

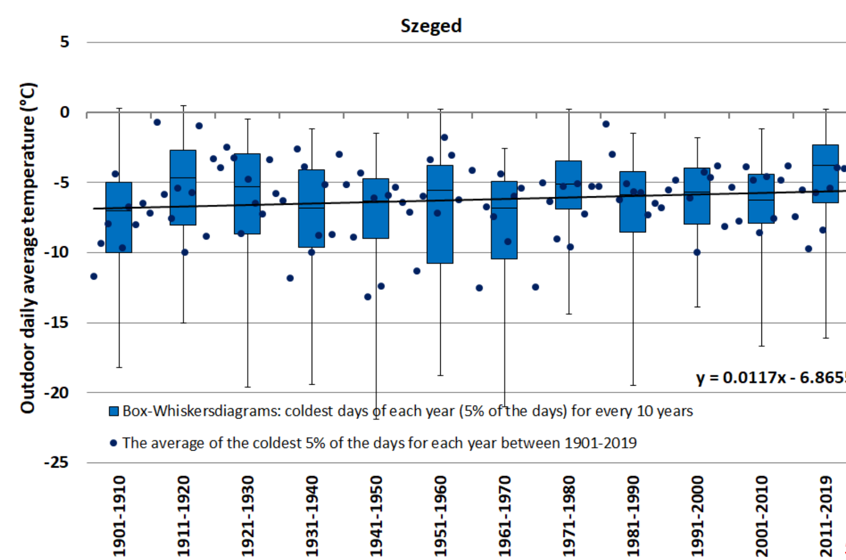
- Using the publicly available daily mean temperature time series of two Hungarian cities (Budapest, Szeged)
- Studied period: 1901-2019



Analysis of extreme cold days

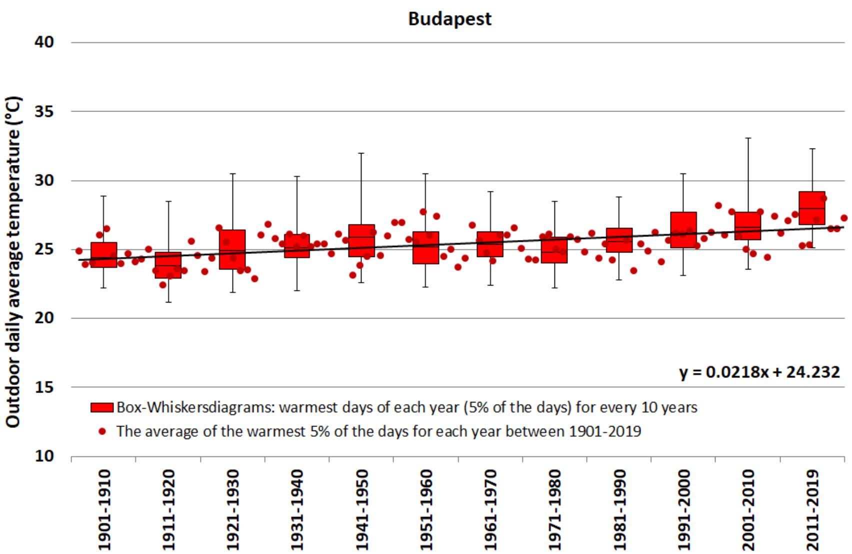
- Coldest 5% of the years
- Warming trend can be observed on the coldest days, both in Budapest and Szeged
- The intervals are wider in the beginning of the studied period than the end of the period

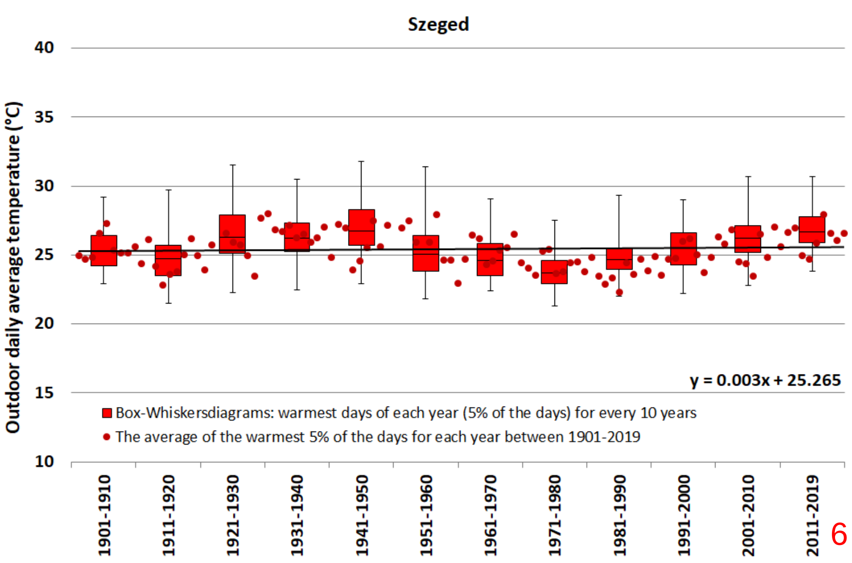




Analysis of extreme warm days

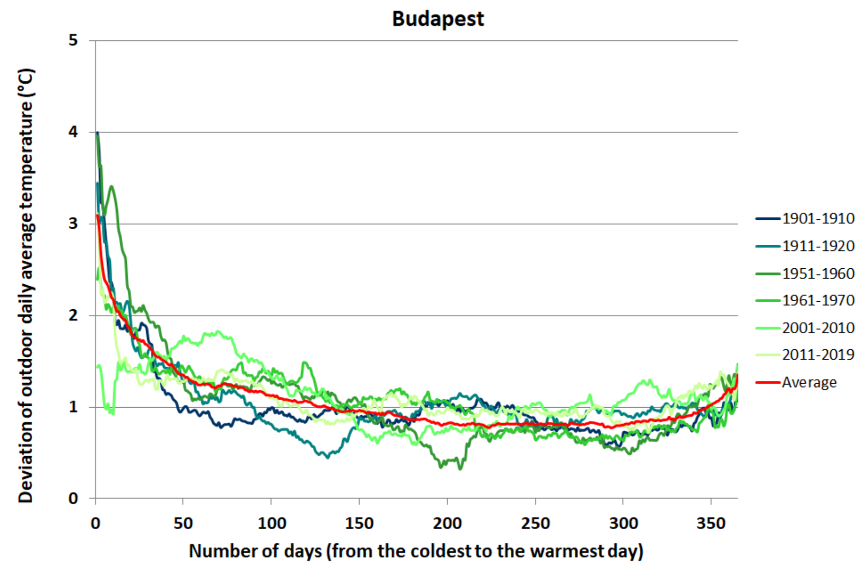
- Warmest 5% of the years
- The temperature intervals are narrower than the intervals of the cold days
- Higher warming trend can be detected in Budapest than in Szeged

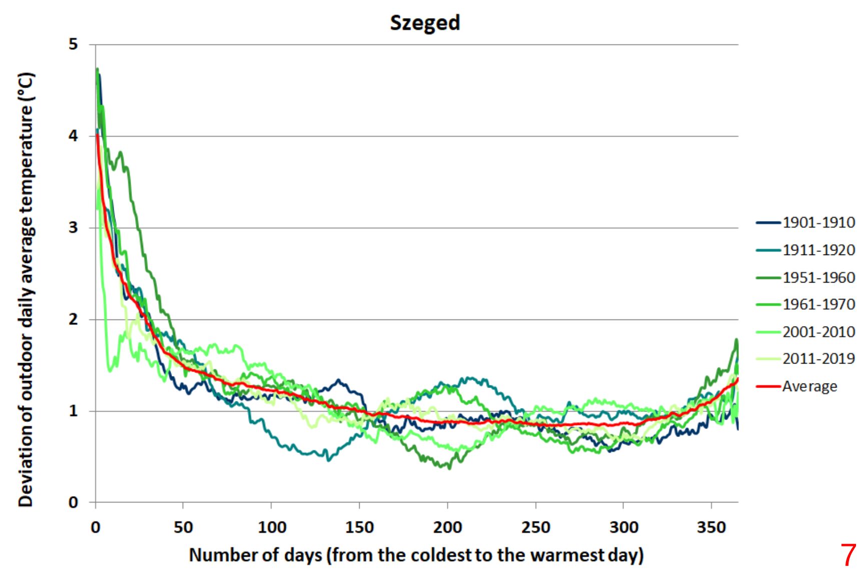




Analysis of standard deviaton

- Average standard deviation of the 119 years and 6 selected decades
- Standard deviations of the temperature values are higher in cold days than warm days
- Standard deviations of Szeged are higher than Budapest





Heating and cooling periods I.

- It is important to determine the heating and cooling periods for the building energy designing.
- The variability of lower temperatures is greater than that of higher temperatures, thus the warm days are more recommended to use in energy planning.
- The heating and cooling periods have been defined based on the calendar days in Hungary (see SM and OA definitions, on the next slide)
- Now we used a third definition, which is based on daily mean temperature (see TA definition, on the next slide)

Heating and cooling periods II.

- TA (Talamon, 2014) definition:
  virtual heating and cooling periods are based on outdoor daily average temperature (lengths vary)

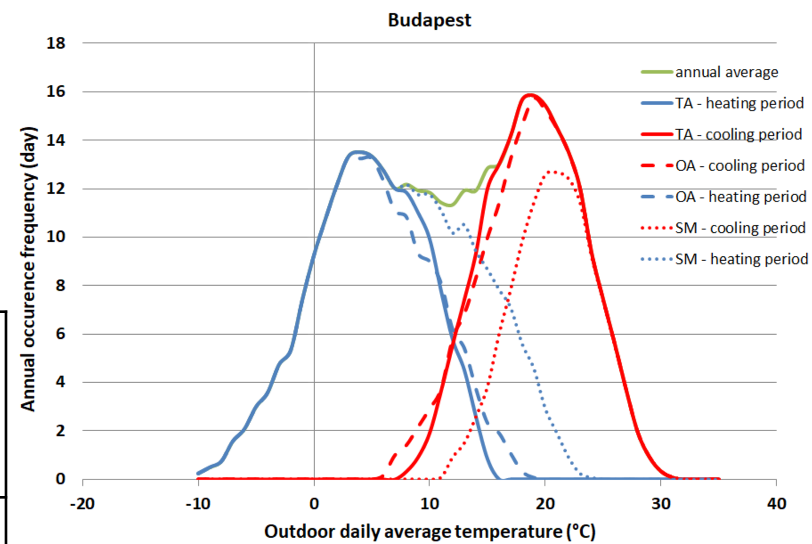
- OA (October-April) definition:
  heating period is between 15th October and 15th April (length: 183 days)
  cooling period is between 16th April and 14th October (length: 182 days)

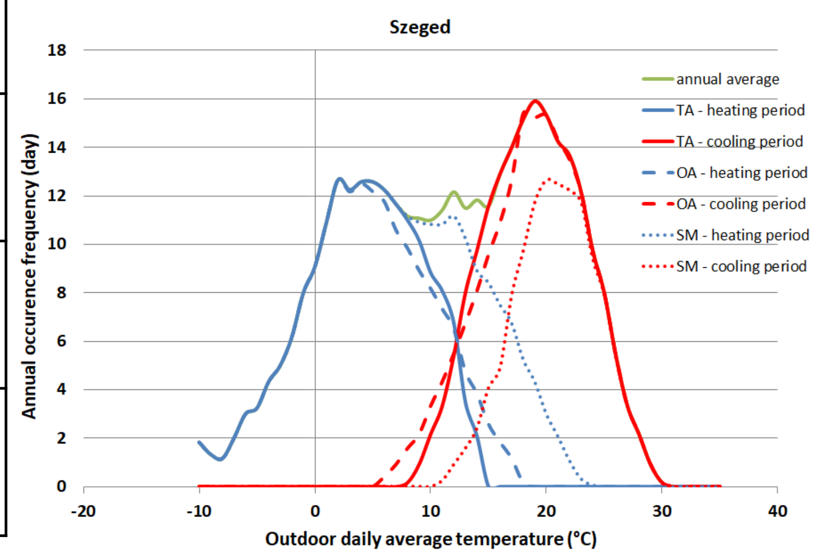
- SM (September-May) definition:
  heating period is between 15th September and 15th May (length: 243 days)
  cooling period is between 16th May and 14th September (length: 122 days)

Heating and cooling periods III.

- OA and TA definitions are quite similar
- Using TA definition:

		Average length of the period (day)	Average temperature (°C)
Budapest	Heating period	181	4.5
	Cooling period	185	19.0
Szeged	Heating period	181	4.0
	Cooling period	185	19.0





Summary

- The variability of lower temperatures is greater than that of higher temperatures, both in Budapest and Szeged
- The temperature-based heating and cooling periods definition (TA definition) well describes the actual periods currently used in Hungary (OA definition).
- It is recommended to use a temperature-based definition due to the warming trend.

References

- Hungarian Meteorological Service: http://www.met.hu/
- Oke, T.R., 1973: City size and the urban heat island. Atmospheric Environment. 7. 769−779. http://www.theurbanclimatologist.com/uploads/4/4/2/5/44250401/post6oke1973uhiscaling.pdf
- Talamon, A., 2012: Global renewable energy trends and Hungary. Int. Rev. Appl. Sci. Eng 3 (1), 81-85.
- Talamon, A., 2014: Alacsony energiafelhasználású épületek lehetőségei Magyarországon. PhD dissertation. University os Debrecen. 146p. (in Hungarian) https://dea.lib.unideb.hu/dea/bitstream/handle/2437/204765/PhD_Disszertacio_TA_FINAL_t.pdf?sequence=5&isAllowed=y