Comparison of UTCI between the ERA5 reanalysis and the ALADIN model for Czechia

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Motivation

The PERUN (Prediction, Evaluation and Research for Understanding National sensitivity and impacts of drought and climate change for Czechia) project includes bioclimatological mapping of the Czech Republic. For the purpose of mapping human thermal comfort, it is necessary to use one of the available indices, that is, UTCI (Universal Thermal Climate Index) in our case. Currently, two main sources with the UTCI values are available: the ERA5-HEAT reanalysis (Di Napoli et al, 2021) and data from the CHMI ALADIN-CLIMATE (Novák, 2021) model. Here, the most interesting results arising from the comparison between both datasets are presented.

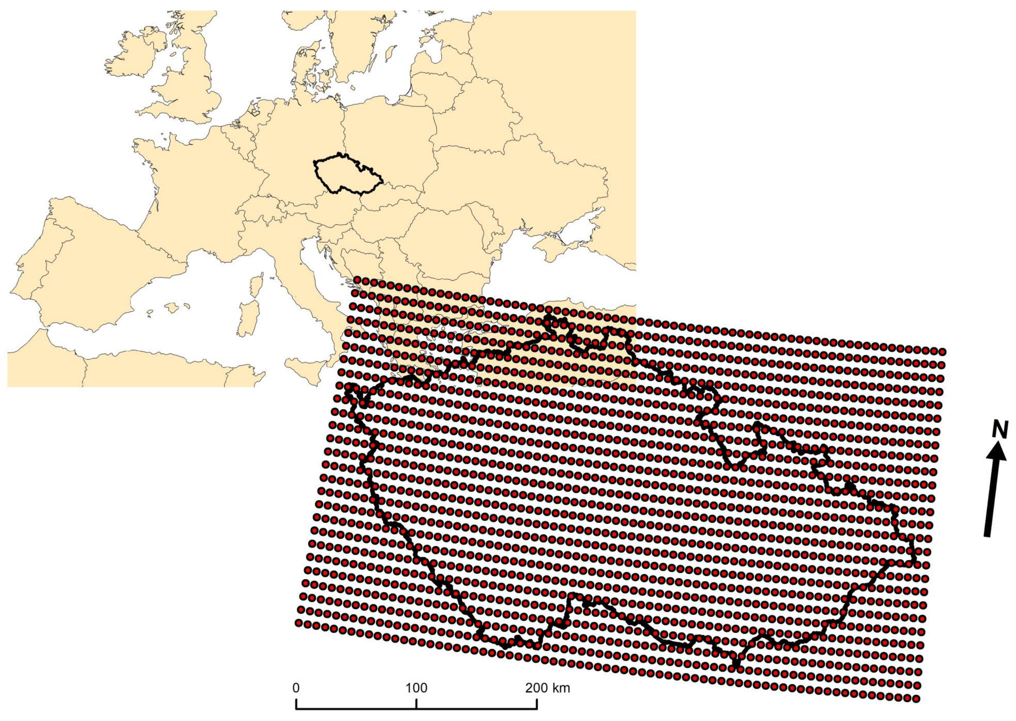


Fig. 1 *Map of the Czech Republic with gridpoints*

Methods

Both datasets, that is ERA5 (Hersbach et al. 2020) and Aladin, are firstly interpolated by spline interpolation (in the R environment) to the same regular grid with 7.1 km step (bottom map in Fig. 1). Subtraction of UTCI between ERA5 and ALADIN is made at every gridpoint in hourly temporal resolution. Hourly differences are consequently aggregated in daily and monthly step, and further analyzed from both spatial and temporal perspectives.

CONCLUSIONS

- Overall, the spatial differences in UTCI between both datasets are generally small.
- Temporal differences are pronounced in the hourly data: Aladin shows higher UTCI values shortly after sunrise, while ERA5 has higher UTCI values shortly before sunset. Different calculation of MRT between both datasets is likely the main cause of those differences.
- For a more detailed mapping of thermal comfort in smaller areas, it will be more appropriate to use Aladin data, as this model has a higher resolution and a more accurate description of the orography compared to ERA5.

References

Hersbach, H, Bell, B, Berrisford, P, et al. (2020). The ERA5 global reanalysis. *Q J R Meteorol Soc.* 2020; 146: 1999– 2049. https://doi.org/10.1002/qj.3803.

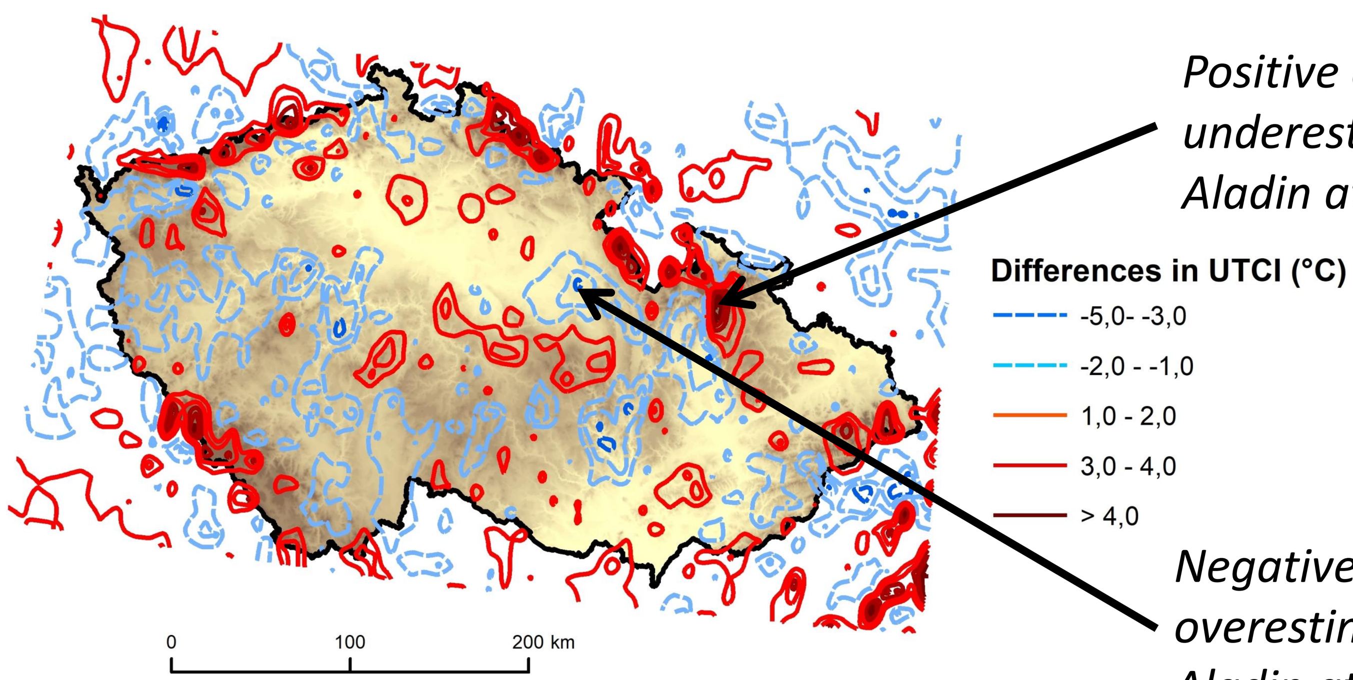
Di Napoli, C, Barnard, C, Prudhomme, C, et al. (2021). ERA5-HEAT: A global gridded historical dataset of human thermal comfort indices from climate reanalysis. *Geosci. Data J.*, 2021;8:2-10. https://doi.org/10.1002/gdj3.102.

R Core Team (2022). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria.

Novák M (2021). UTCI as the NWP model ALADIN (CHMI) output - first experiences. Geographia Polonica 94:237-249. https://doi.org/10.7163/gpol.0203.

SPATIAL DIFFERENCES

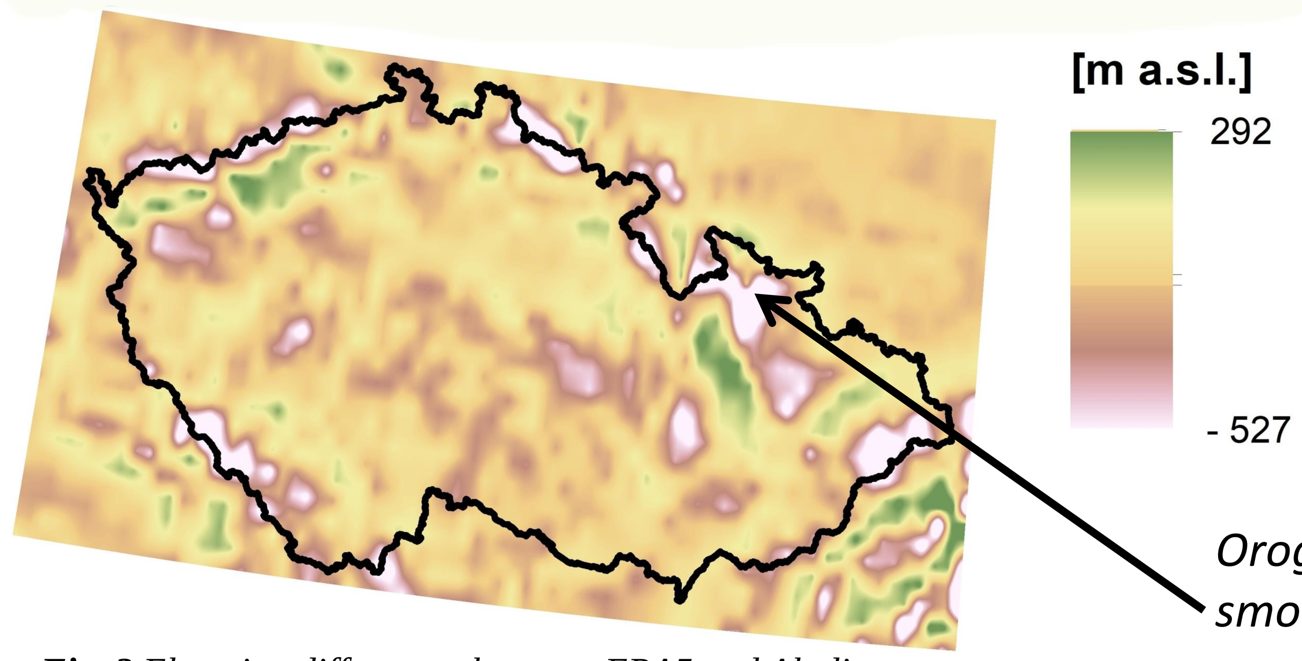
Differences in UTCI between both datasets (ERA5 minus Aladin) are mostly small at majority of gridpoints, although underestimation of UTCI in ALADIN is detected at higher altitudes (above 500/600 m), where differences at some gridpoints reach up to 6.5 °C. On the contrary, overestimation of UTCI in Aladin is evident at lower elevations, although those differences are less pronounced (Fig. 2).



Positive differences represent underestimation of UTCI in Aladin at higher elevations

Negative differences represent overestimation of UTCI in Aladin at low elevations

Fig. 2 *Medians of interpolated differences in UTCI (ERA5-Aladin)*



Orography in ERA5 is smoothed due to its coarser resolution

Fig. 3 *Elevation differences between ERA5 and Aladin*

Spatial differences in UTCI are mainly caused by different grid resolution of both datasets, that is, 30 km in ERA5 and 2.3 km in Aladin. The coarse grid resolution of ERA5 is associated with flattened orography mask (Fig. 3), which manifests in larger differences in UTCI at higher altitudes.

TEMPORAL DIFFERENCES

No substantial differences are evident when analyzing monthly differences over all gridpoints (Fig. 4). Interesting results are evident when examining hourly data (00-24): it is shown that UTCI in Aladin is overestimated in the morning (by approximately 1-2 °C) whereas the opposite is found for the late afternoon and early evening (by approximately 1-3 °C) in all seasons (Fig. 5).

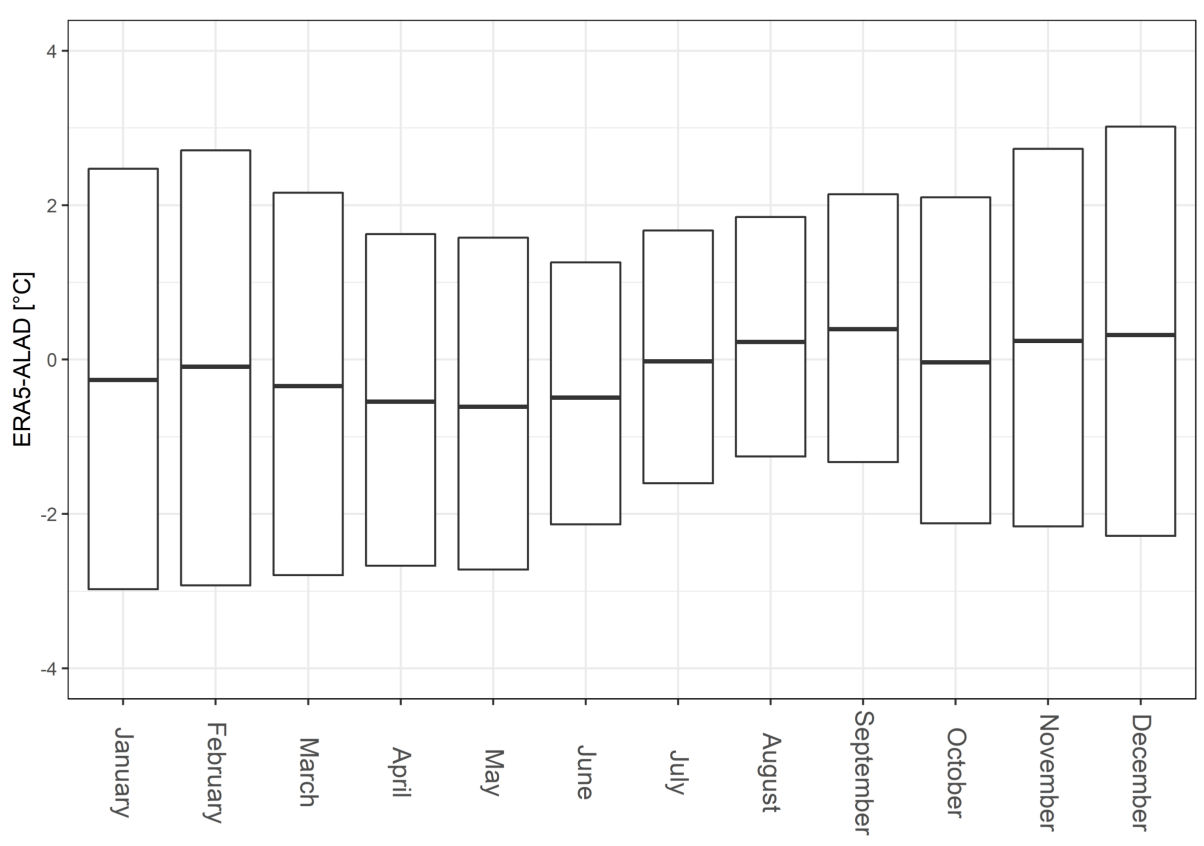


Fig. 4 *Boxplots of monthly differences between ERA5 and Aladin over all gridpoints*

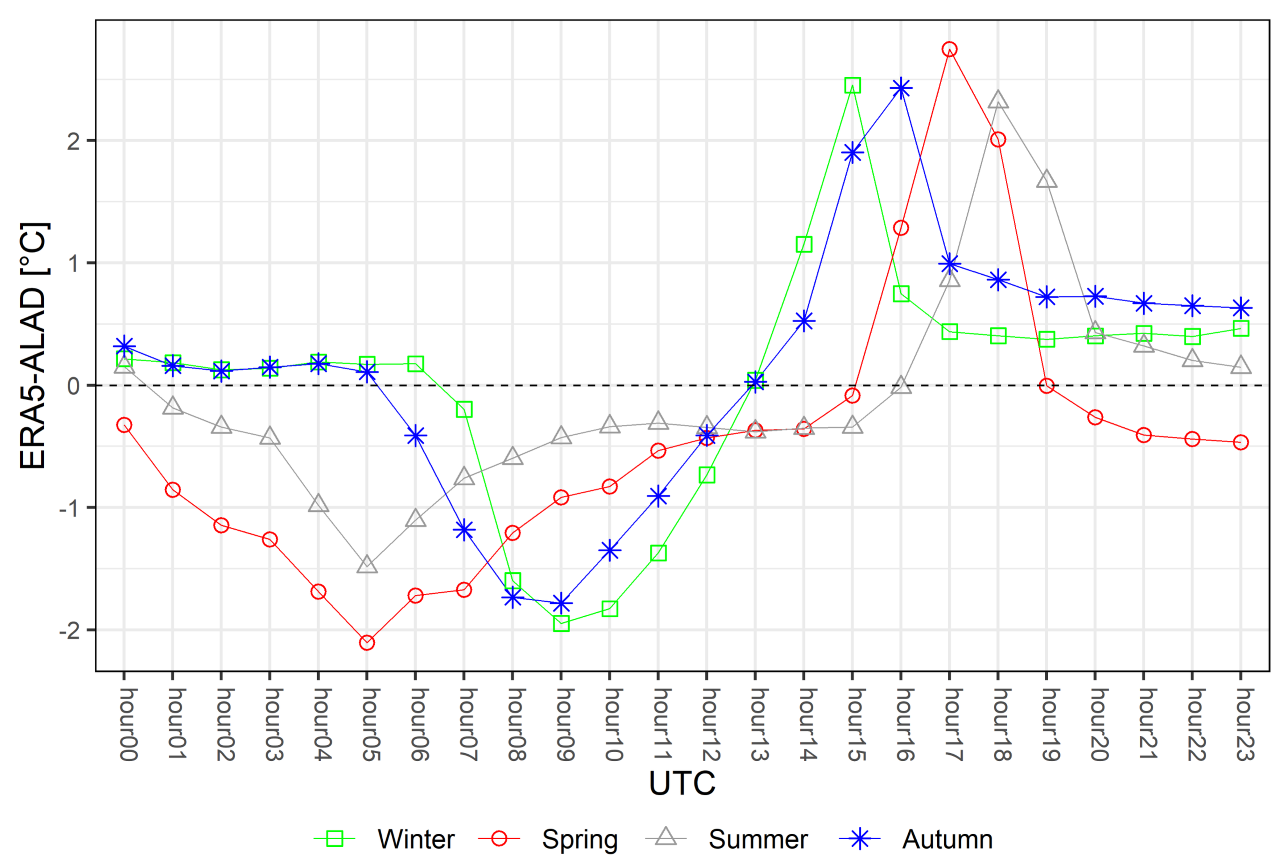


Fig. 5 *Medians of hourly differences between ERA5 and Aladin over all gridpoints.*

The temporal shift in the diurnal pattern of ERA5-ALAD differences (Fig. 5) corresponds to changes in Earth's surface radiation balance. In the morning, the contribution of shortwave radiation reverses the balance into positive values, in the evening the longwave component dominates again and the radiation balance becomes a loss. The temporal dissimilarity between both datasets may be explained by different approaches to calculation of the mean radiant temperature (MRT) and also different characteristics that can directly affect the MRT calculation (such as humidity, cloud cover, etc.).

The research was partially funded by the Technology Agency of the Czech Republic (grant no. SS02030040, PERUN). We acknowledge ECMWF for providing the ERA5 reanalysis. Also thanks to people from development group of Aladin in CHMI.