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The first estimates of winter urban heat island intensity for medium-sized cities in the Eurasian Arctic

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The Urban Heat Island (UHI) effect is well studied for moderate and low latitudes. But the knowledge about the UHIs in the Arctic was extremely poor until the nowadays. It was limited by few studies for Alaskan towns (e.g. Hinkel et al. 2003), while the biggest Arctic cities located in Russian sector of Northern Eurasia were the terra incognita of urban climatology.

In this study we present the first estimates of winter-time UHI intensity for the medium-sized cities of Russian Arctic. They are based on the UHIARC (Urban Heat Island Arctic Research Campaign) seasonal-scale experimental meteorological observations in the five cities: Apatity in Kola peninsula, Vorkuta in the north-east of the European Russia and Nadym, Novy Urengoy and Salekhard in the north of Western Siberia. All of them have quite similar population (from 50 to 115 thousands inhabitants) and typical dense building by medium-rise blocks of flats. Observations were made by the automatic weather stations and low-cost temperature loggers.

The measurements in Vorkuta, Nadym, Novy Urengoy and Salekhard have shown quite similar values of the UHI intensity and patterns of its temporal variation. The average winter UHI intensity is 1-1.5 K, while extremes up to 6-7 K are observed in frosty anticyclonic weather. Such results proof the existence of the UHI effect during the Arctic winter and polar night and could be considered as the first seasonal estimates of its intensity for typical medium-sized cities in the considered region.

The Arctic UHIs could be strongly amplified by local relief features. For Apatity town, located in complex terrain, the extremely high urban-rural temperature differences up to 12 K were found between the city, located at the top of the hill, and local WMO weather station located at the lowland (Konstantinov et al. 2015). The complex analysis with application of remote sensing data and regional climate model COSMO-CLM revealed that anthropogenic contribution to the observed urban-rural temperature contrasts is about 50% (Varentsov et al., 2017), which is approximately similar to the estimates of UHI intensity for the four other cities, located within flat terrain.

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