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Intensive Urban Heat Island Research Campaign in the Arctic: the first results and application for model verification

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The Urban Heat Island (UHI) effect is well studied for moderate and low latitudes, but remains poorly studied for the Arctic region. Specifically, the biggest Arctic cities, which are located in Russia, until recently, remained terra incognita for the urban meteorology and climatology until recently. The recent Urban Heat Island Arctic Research Campaign (UHIARC) revealed the existence of the intensive wintertime UHIs in five medium-sized cities of Russian Arctic (Konstantinov et al., 2018; Varentsov et al., 2018). Such winter UHIs develop during the calm and clear weather, typically on the background of severe frosts, and are often accompanied by air pollution events.

This study presents the results of a new UHIARC intensive experiment, which was held in Nadym town in the West-Siberian Arctic (65.53N, 72.52E) in December 2018. The intensive campaign was aimed to the in-depth investigation of the wintertime Arctic UHI, including its spatial patterns and the linkages with meteorological forcing and atmospheric stratification. The intensive observations were significantly extended in comparison to the previous UHIARC studies. Canopy-layer observations included the temperature measurements at 25 sites in the city and its surroundings with an application of iButton temperature loggers and two-level Hobo loggers. Observations at the basic rural site included the measurements of the vertical temperature profile in the lowest 1000 m by MTP-5 microwave profiler, and the measurements of the net longwave radiation. In addition, several vertical temperature profile measurements over the city were performed with an application of the DJI Phantom 4 Pro quadcopter, equipped by the meteorological sensors.

The intensive campaign allowed to reveal the clear dependence between the UHI intensity and the temperature stratification of the lower atmosphere. The strongest UHI was observed in the presence of intense surface inversions. Specifically, our measurements covered an episode with the extreme frosts (temperature below 46 °C), strong temperature inversion (difference up to 20°C in the lowest 300 m) and the UHI intensity up to 5 °C. Since the temperature stratification of the lower atmosphere is densely linked with a mixing ration and atmospheric pollution, the revealed dependence becomes especially important in terms of the air-quality and environmental issues.

The obtained dataset opens an opportunity for verification of the high-resolution atmospheric and urban climate models for the stably-stratified conditions. This is especially important due to the known, but still not solved problems of reproduction of the stably-stratified conditions in the modern atmospheric models. To illustrate the potential of the data for model verification, we provide a model-to-observation comparison for high-resolution simulations with COSMO model.

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References:

Konstantinov et al., 2018, Environmental Res. Lett, https://doi.org/10.1088/1748-9326/aacb84
Varentsov et al., 2018. Atmos. Chem. Phys., https://doi.org/10.5194/acp-18-17573-2018