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Investigation of microclimate and spatio-temporal structure of surface inversions in urban area in the Eastern Arctic

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The features of temperature stratification in the surface boundary layer of the atmosphere have a great influence on the microclimatic conditions, as well as on the spatial distribution of various pollutants. Temperature inversion is one of the key phenomena creating severe meteorological conditions and contributing to the accumulation of pollutants in the surface layer of the atmosphere. In accordance with long term observations, it can be stated that the Arctic region is prone to the formation of temperature inversions (observed on more than 30% of the days), especially on the winter season. What is more, the cities in the described area experience a formation of strong “urban heat islands”. This phenomenon of spatial distribution is characterized by an increase of air temperature in the city center compared with its surroundings. It reaches its greatest strength and prominence in the cold season, when the differences in the temperature are the greatest.

In consideration of the aforementioned climatic patterns, the city of Apatity, Murmansk region, was chosen as a testing ground for studying the climatology of polar cities, in particular, in order to study the fine structure of surface inversions, their changes over time, and interaction with the urban heat island.
To study the fine vertical structure of inversions, vertical sounding was performed using thermal “braid” (rising to a height of 100 m, the sensors were installed every 10 m) and quadrocopters equipped with temperature sensors (rising to 200-250 m). To study the characteristics of the inversion within the urban heat island and in the background area temperature profiles through the city of Apatity were created using iButton temperature sensors. All observations were carried out in homogenous synoptic conditions set by an anticyclone ridge of an area of high pressure centered over the Kara sea.

During the study, the fine structure of the surface inversion was considered for the first time, both at night and at daytime. Under the conditions of an intensive surface inversion, vertical soundings of the surface layer of the atmosphere were carried out in the lower 100 meters using a DJI 4 quadrocopter. As a part of the experiment, temperature profiles obtained by iMet-XQ, iMet-XF sensors and the 10 iButton thermal “braid” were compared. The acquired results showed great similarities with each other. Also, simultaneous sounding in the urban and background points demonstrated noticeable differences in the intensity of surface inversions, which, apparently, is the result of the influence of the urban heat island of Apatity.

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