Development of the real-time system for thermal comfort conditions monitoring in Moscow metropolis

Perkhurova Anastasia[1] (*an.perkh@gmail.com*), **Konstantinov Pavel [1], Varentsov Mikhail[2],**
Samsonov Timofey [1], Kargashin Pavel [1]

[1] *Lomonosov Moscow State University, faculty of geography,* [2] *Lomonosov Moscow State University, Research computing center, Moscow, Russia*

Abstract: Comfort indices are used to assess the harm to human health caused by unfavorable thermal conditions. All indices are calculated based on both meteorological and physiological parameters. Authors used RayMan model-based algorithm for calculating two most common thermal indexes: PET, UTCI, which are based on a balance of human energy or models of human heat fluxes. The purpose of this research was to develop a real-time system of calculating comfort indices based on the data of the web service for monitoring weather conditions in Moscow and Moscow region. The technology is based on the use of specialized libraries of the Python language ("pyautogui", "pywinauto") to interact with the keys of the keyboard and mouse, because it is necessary to write paths to files and make keystrokes in the model. The result is presented in a visually understandable form with a spatial distribution of thermal stress in the form of punsons with signed index values at the location of weather stations throughout Moscow and surrounding areas.
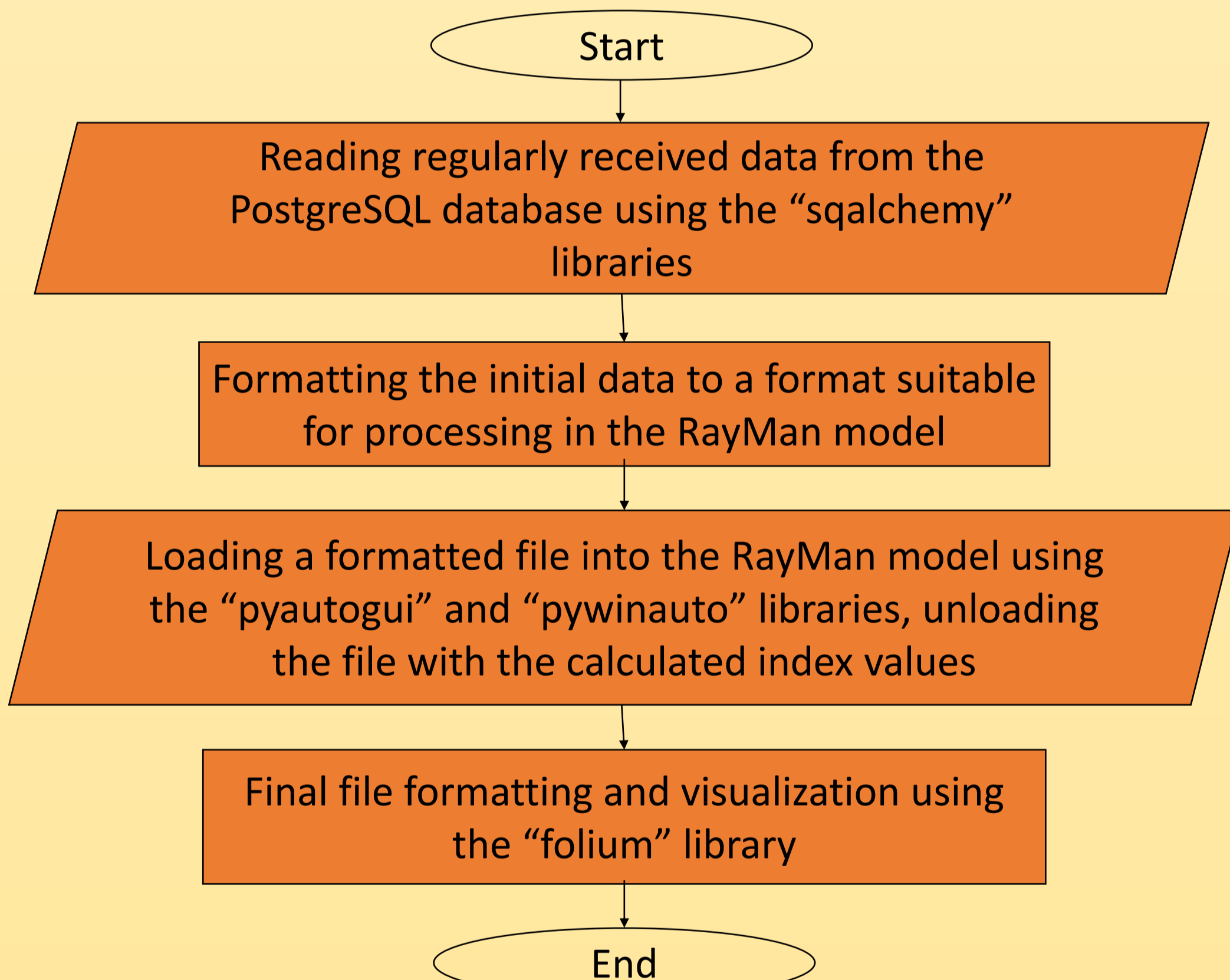
Main issue:
Development of a block for modeling thermal comfort conditions in a weather monitoring system in Moscow

Objectives of the research:
❖ To develop a block for calculating comfort in the monitoring system,
❖ To test the model's sensitivity to changes in the sky view factor,
❖ To assess the repeatability of various thermal comfort conditions in summer, taking into account the sky view factor for selected stations in Moscow and the Moscow Region.

The block diagram of the technology of the real-time calculating thermal comfort indices

Start

Reading regularly received data from the PostgreSQL database using the "sqalchemy" libraries

Formatting the initial data to a format suitable for processing in the RayMan model

Loading a formatted file into the RayMan model using the "pyautogui" and "pywinauto" libraries, unloading the file with the calculated index values

Final file formatting and visualization using the "folium" library

End

In 2019 cartographic web service for monitoring weather conditions in Moscow and Moscow region was developed by joint efforts of the staff of the Department of Cartography and Geoinformatics and the Department of Meteorology and Climatology of the Geography Department of MSU. In the research, comfort indices were calculated based on the data of the web service, so that in the future it was possible to connect the index calculation unit to the general system. The code for model calculations of indexes is hidden from the user. Therefore, to calculate the comfort indices, it is necessary to interact directly with the program. Interaction with the program was carried out using specialized libraries in Python language. The last step is to visualize the obtained values. At the moment visualization is a spatial distribution of points with parameter values on a interactive map of Moscow using Python tools. In the future, integration into a web application is planned.

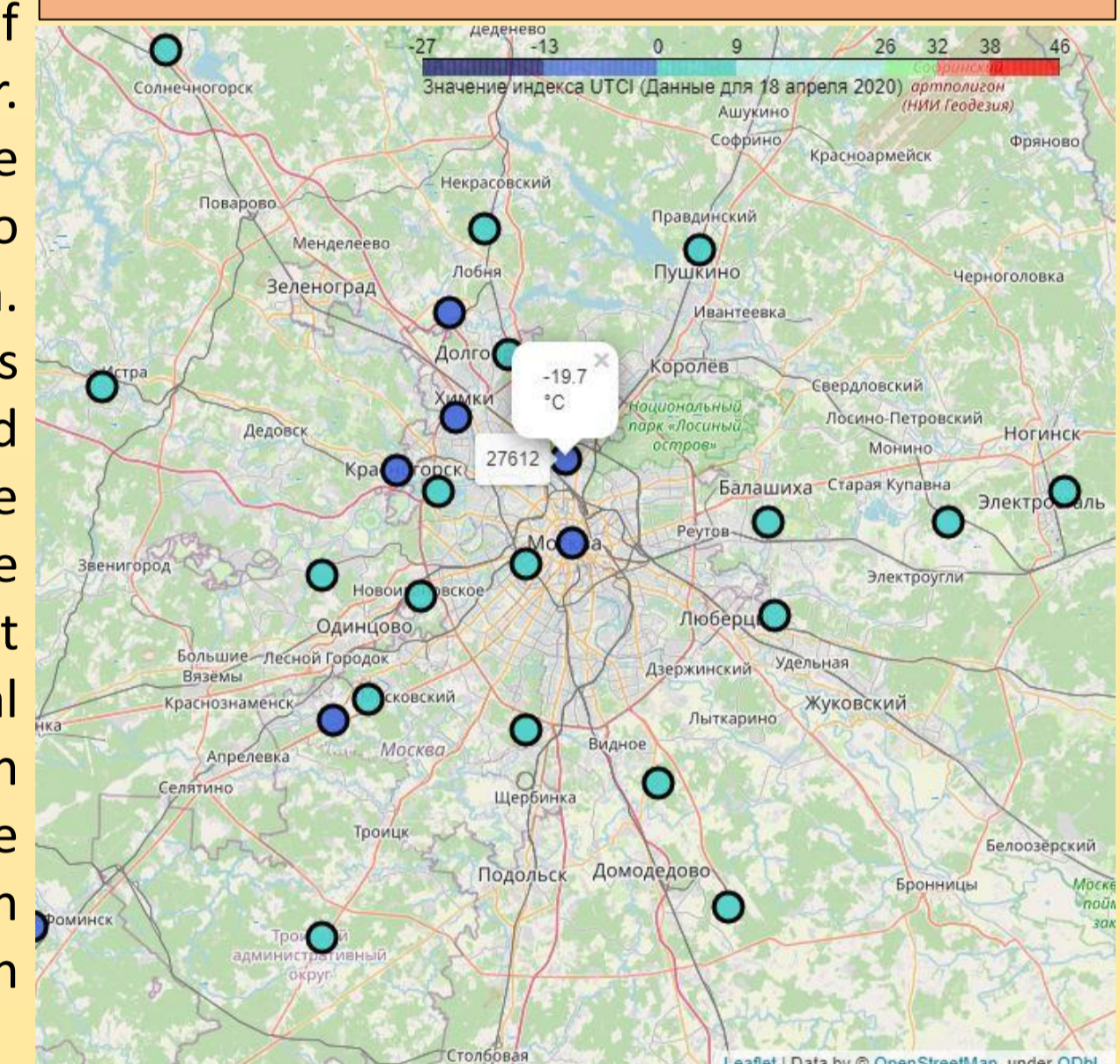### Visualization of thermal comfort indices for Moscow region

Sensitivity test

Within the spatial framework of one city, the index values vary greatly due to changes in shading conditions. SVF (sky view factor) is the fraction of the sky open from obstacles, visible from a certain point. Based on the fixed initial data on temperature (25 ° C), humidity (30%), wind (2 m/s) and cloudiness (4 octants) and changing SVF from 1 to 0.2, the comfort indices were calculated, the dependences were plotted and trend equation. The trend equation can be used to determine which index has the maximum sensitivity.
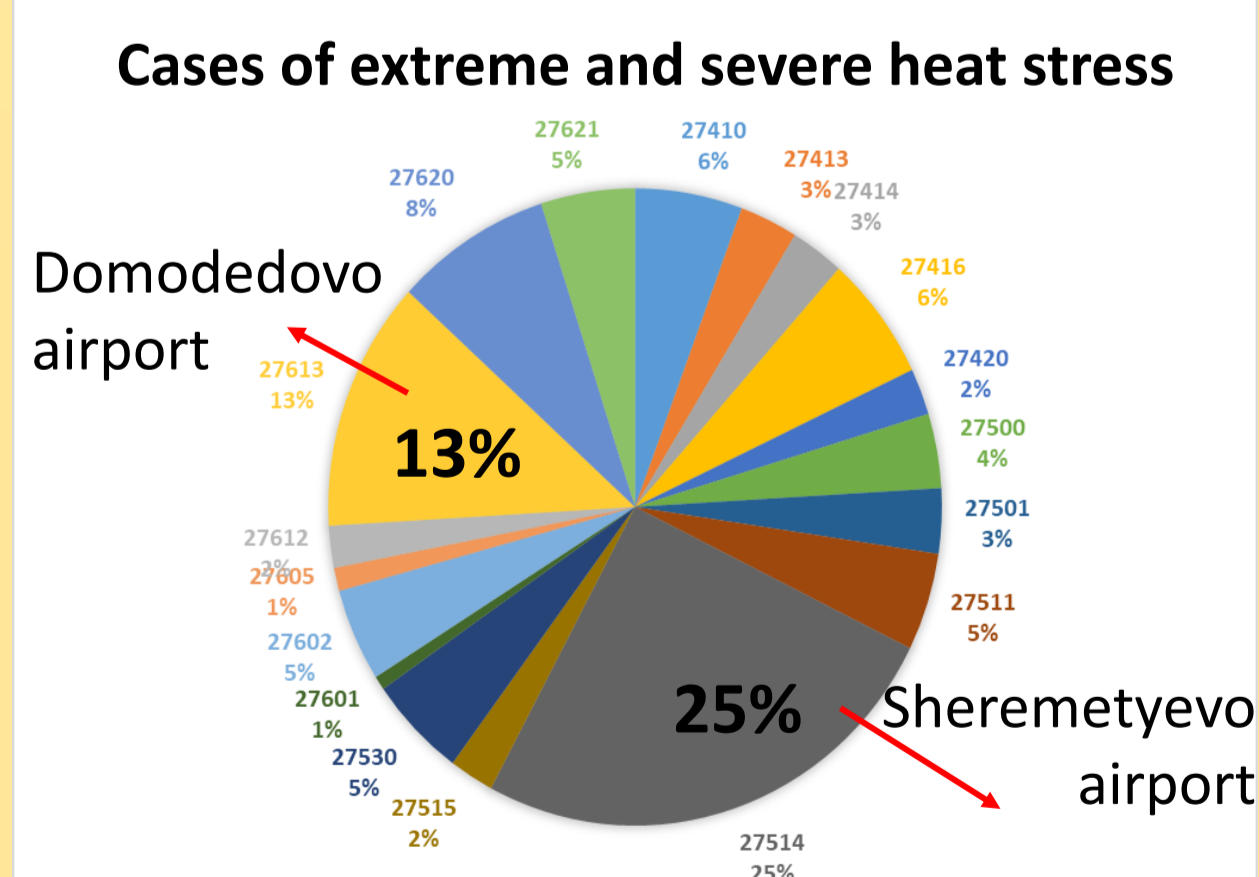
PET	UTCI
0,53	0,38

Evaluation of the repeatability of thermal stress levels for different stations, taking into account SVF

Cases of extreme and severe heat stress

For meteorological stations for which the aspect ratio is known, the values of the comfort indices were calculated based on the data for August 2019. Then, it was calculated how many cases of severe and extreme thermal stress fall on one or another meteorological station from the total number of cases with these gradations. The result is visualized in the form of a pie chart.

Conclusions

• ***For the first time in Russia, a system for monitoring thermal comfort conditions was created*** for the territory of the Moscow Region. It is part of a large project for the development of a cartographic web service for monitoring meteorological parameters. In the future, integration into a web application is planned.

• A test was carried out for the sensitivity of comfort indices to changes in the sky view factor. The most sensitive to SVF variation is PET, the least sensitive to variations in SVF is UTCI.

• All stations in the Moscow region were ranked according to the frequency of occurrence of extremely unfavorable gradations of heat stress, taking into account the SVF coefficient. Most of all cases are observed in open areas of airports: Sheremetyevo and Domodedovo (38% jointly).