In-situ and ground based observations/ data in support SES (from Arctic zone to Moscow)

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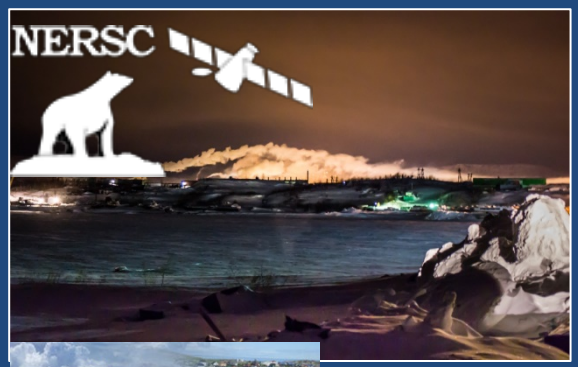
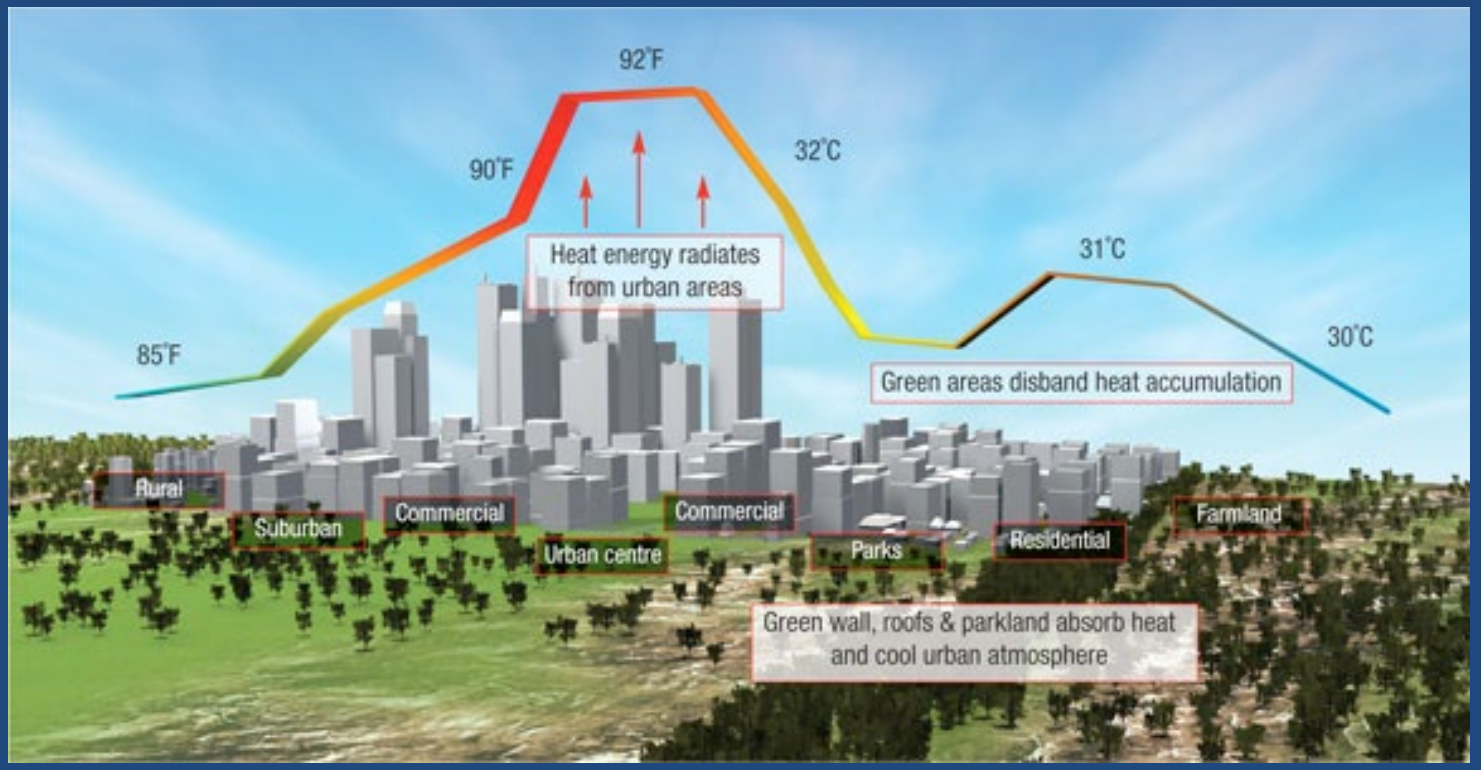


2020 Helsinki Workshop on Arctic Urbanization under Environmental Change 14-16 January 2020

Now we use special Arctic Network:

UHIARC

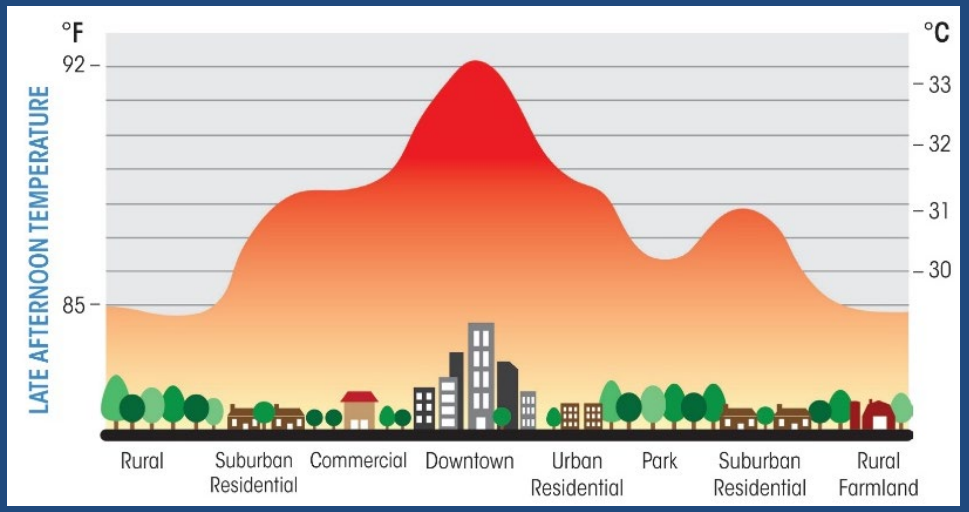
Urban Heat Island Arctic Research Campaign



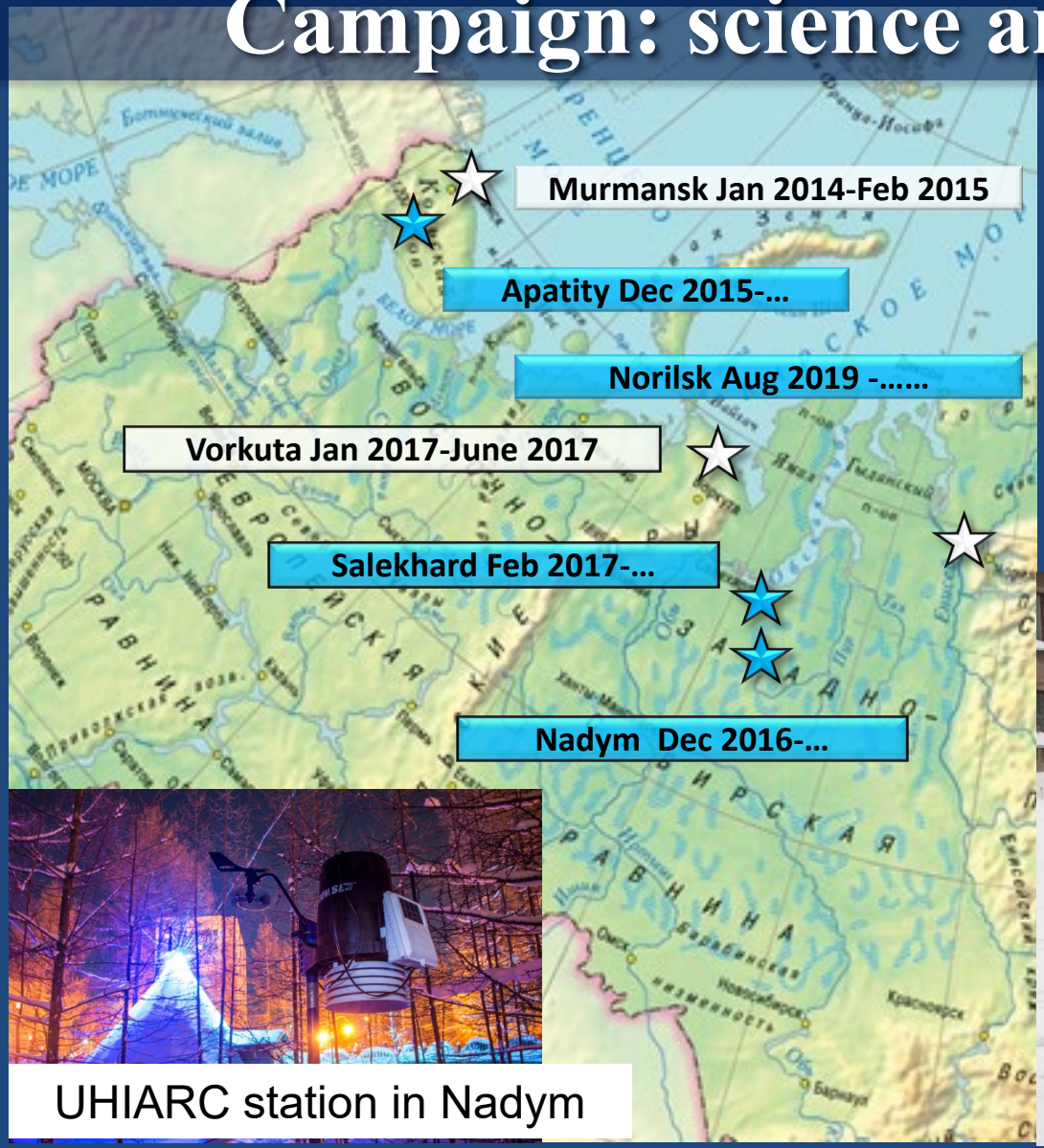
Urban Heat Island has influence on:

1. House heating systems
2. Human health
3. Air quality
4. Permafrost melting

Luke Howard
(1772-1864)



UHIARC- Urban Heat Island Arctic Research Campaign: science and education



Now operating sites

Now disabled sites

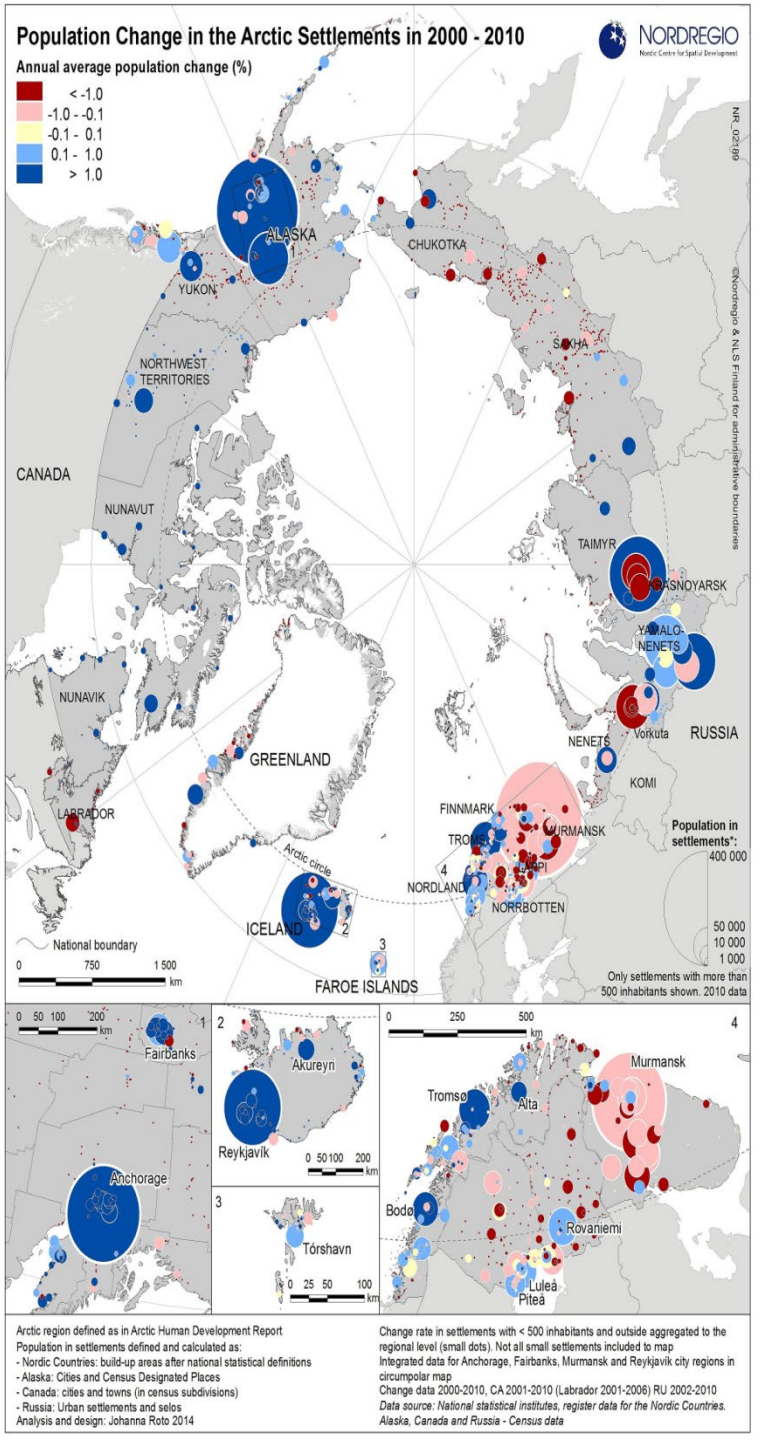
Lomonosov MSU students mounting UHIARC station in Vorkuta, Feb 2017

UHIARC station in Nadym

Northern Urbanization

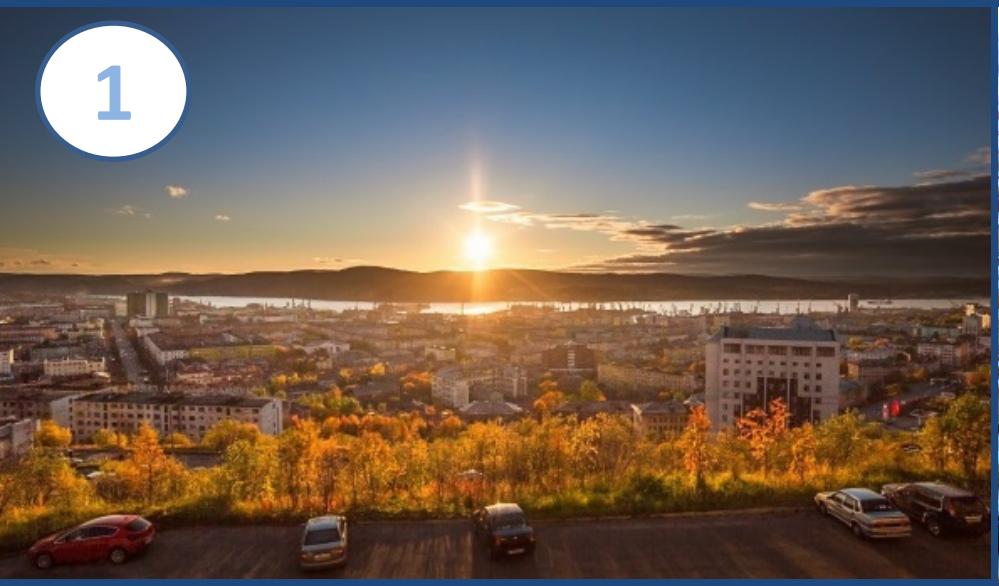
Arctic and Northern PEEX region is characterized by:

- Much **lower population density** and not fast growing
- Highly urbanized with ≈ **90%** of population living in cities
- **Small size cities** are dominating, but not less problems
- About **100** urban settlements with > 5000 inhabitants
- Much **higher vulnerability** and lower sustainability
- **Cold climate is a dominant environmental factor**
- Urban nexus includes:
  - Snow – impact on management and planning
  - Frozen soil & permafrost – infrastructure stability
  - Frozen surface water – water supply and sewage
  - Dormant vegetation – reduced ecosystem services
  - Stagnant atmosphere – air pollution and urban heat island
  - Low temperatures – health issues and working routines -
  - **high energy consumption**
- **Migration is a dominant societal factor** in the region
  - More than 60% of urban population are 1st generation migrants
  - High skills but little sense-of-place
  - External, unsustainable development agenda



Why can UHI properties in Arctic be different from other cities?

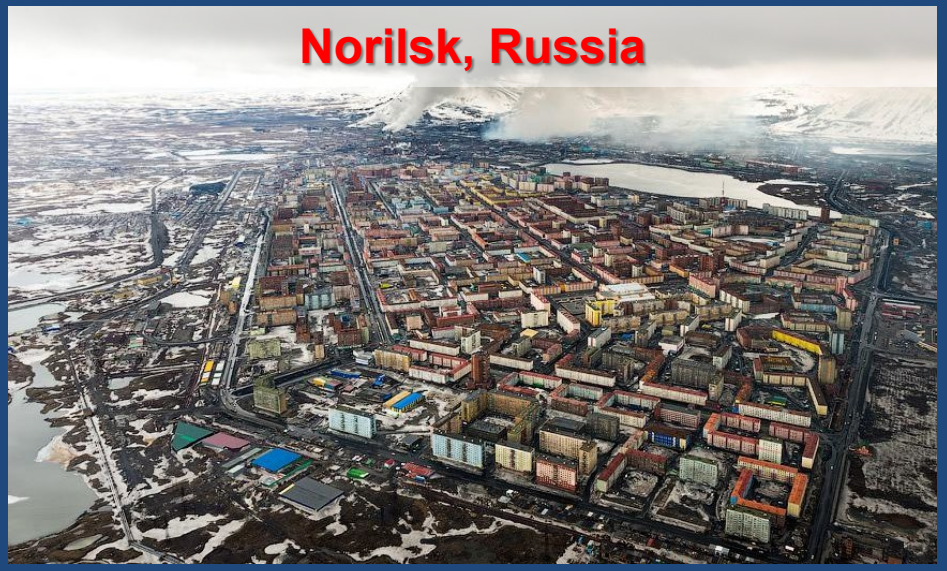
1. Polar day in summer and polar night in winter
2. Polar urban planning strategies

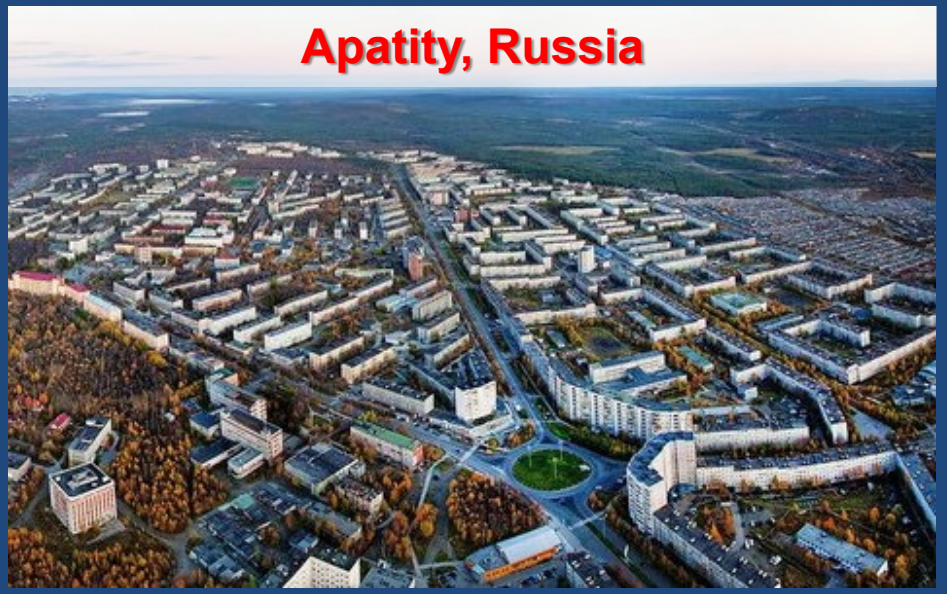


(c) www.bergan.ru

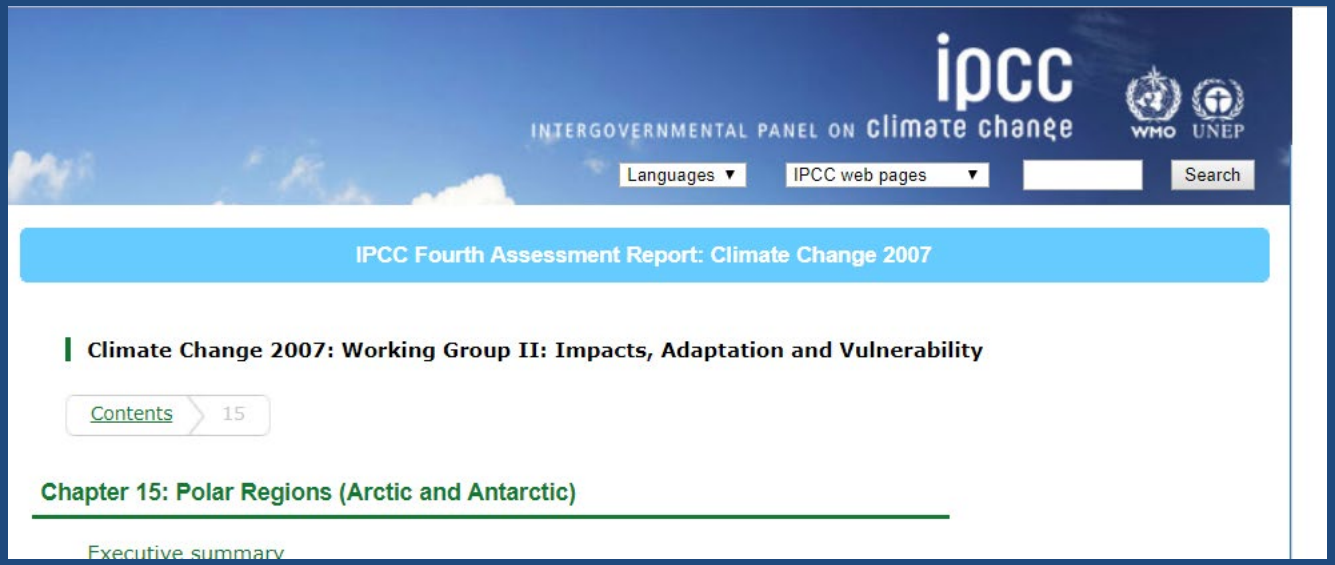
http://www.languagesoftheworld.info/

Urban landscapes of the Arctic cities



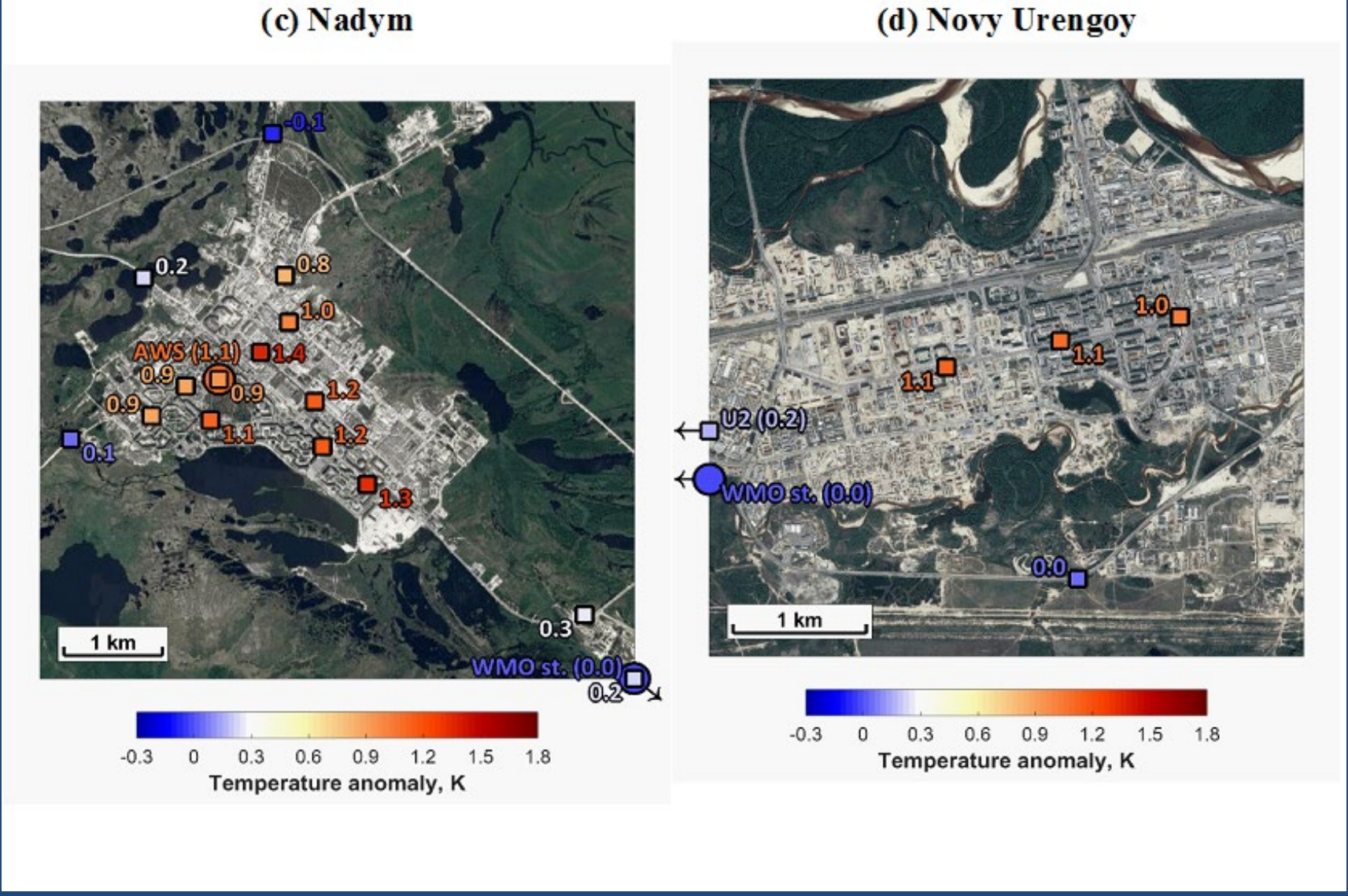


Primary target: fill the “Arctic gap” in Global Urban Climatology and its SE-connections

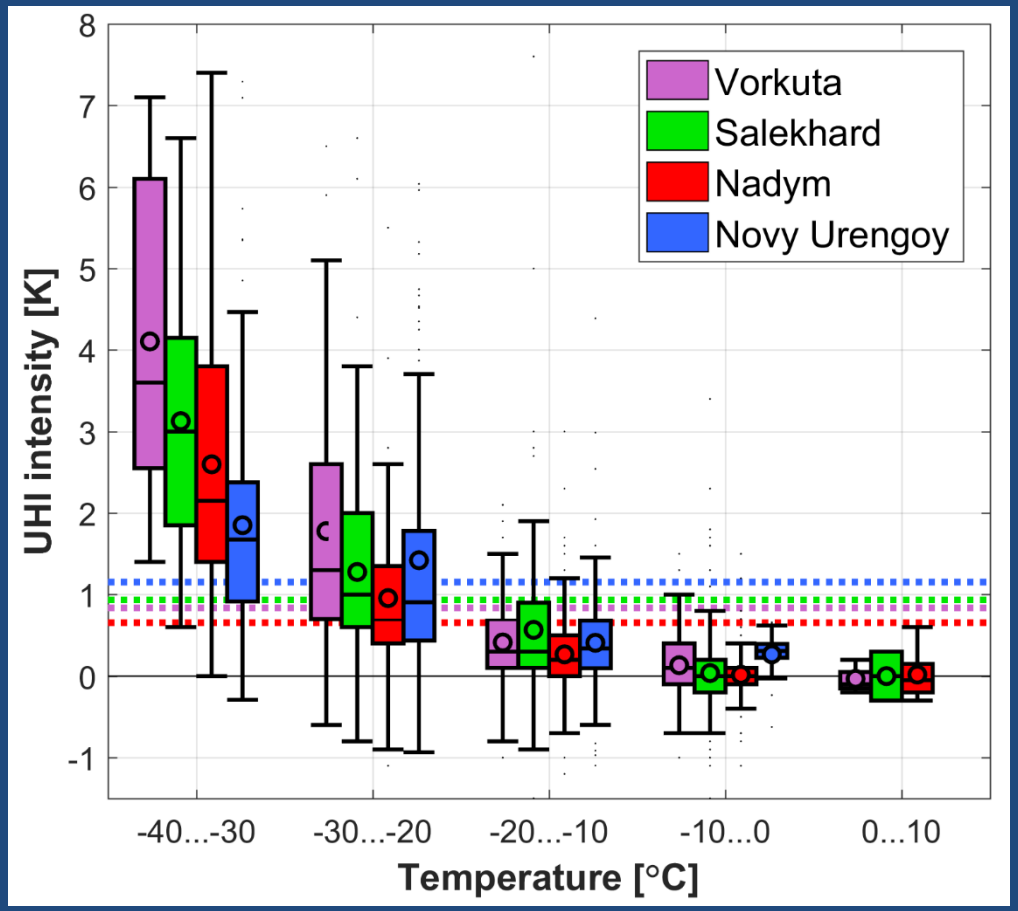


First UHIARC's long-term measurement system results

UHI in Nadym & Novy Urengoy



UHIARC results for Ural-Siberia Artic region



Dependence between UHI intensity and air temperature

OK, UHIs exist in the Arctic cities in winter, and we know their typical features.

What's next?

Ground-level thermal Inversions monitoring

Nadym

Apatity

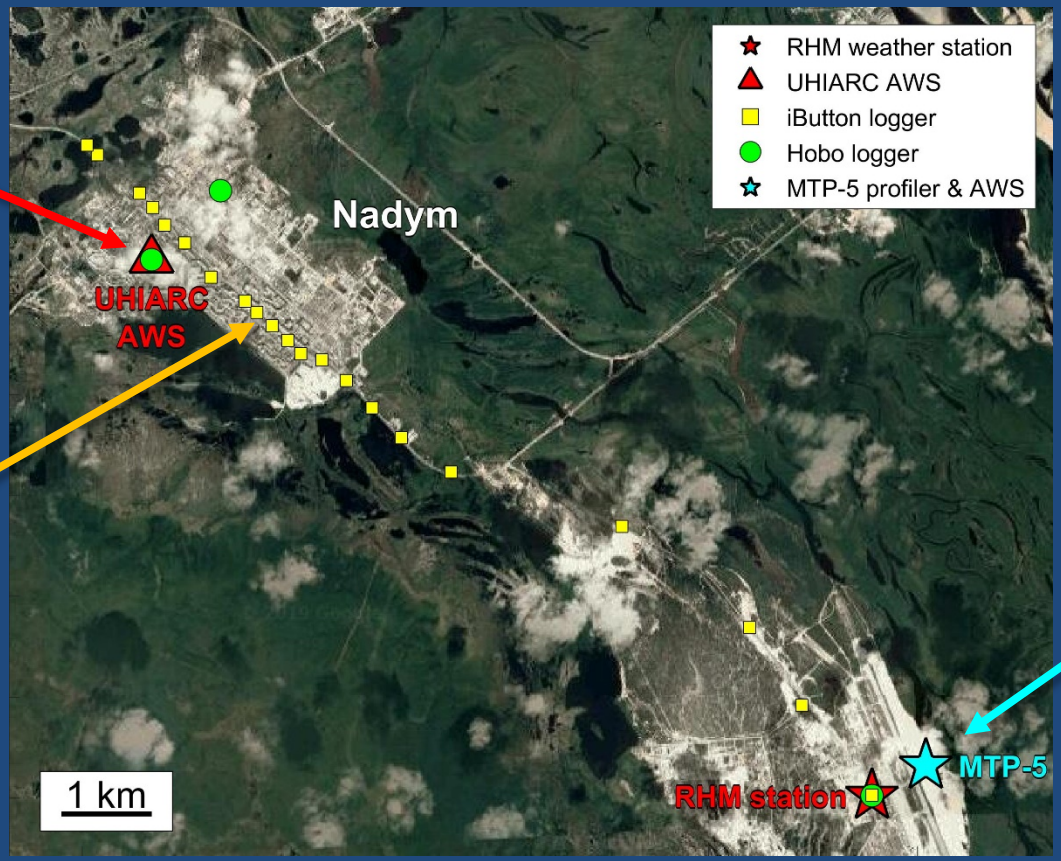
Intensive campaign in Nadym

Intensive campaign in Nadym

Aim of the research is to investigate the ABL behavior over the Arctic city in winter, under strongly stable atmospheric stratification

UHIARC AWS in the city center

Quadcopter-based vertical temperature sounding over the city



22 iButton & Hobo temperature loggers

MTP-5 microwave temperature profiler

Intensive campaign in Nadym

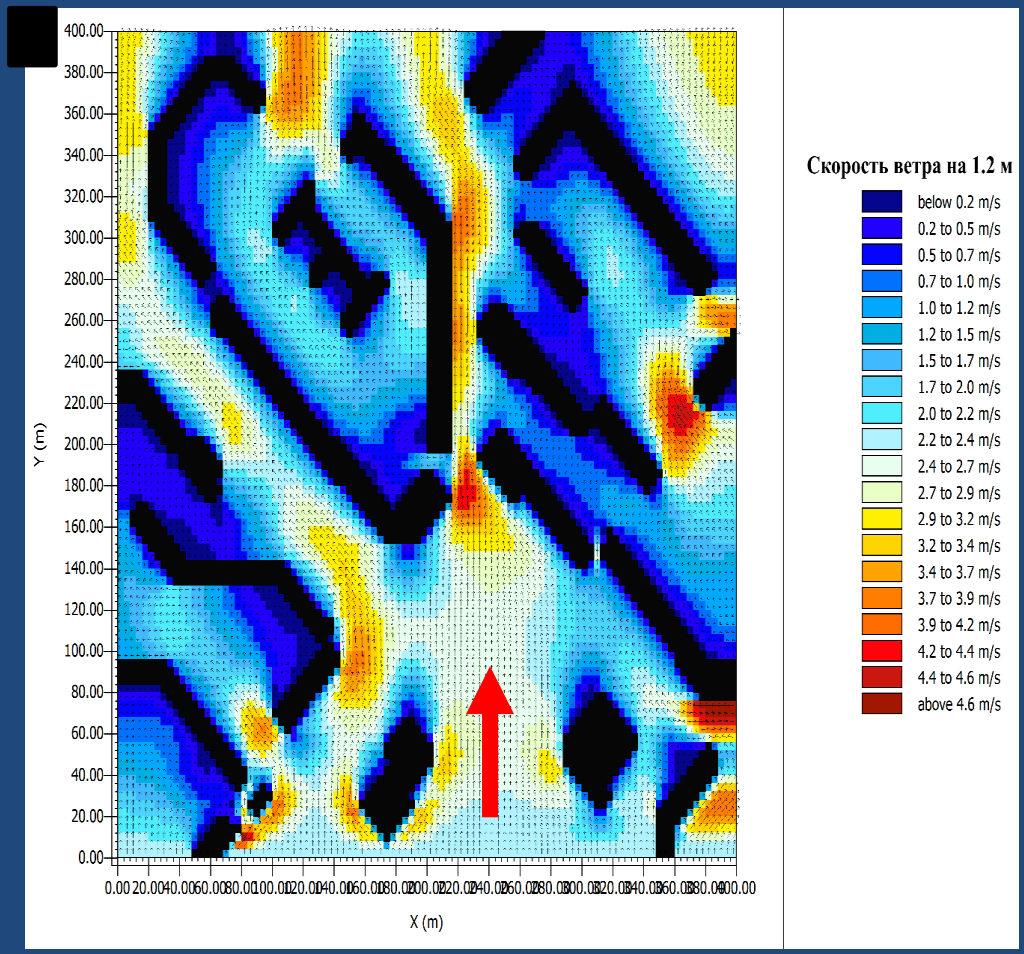
Quadcopter-based measurements at -42 °C

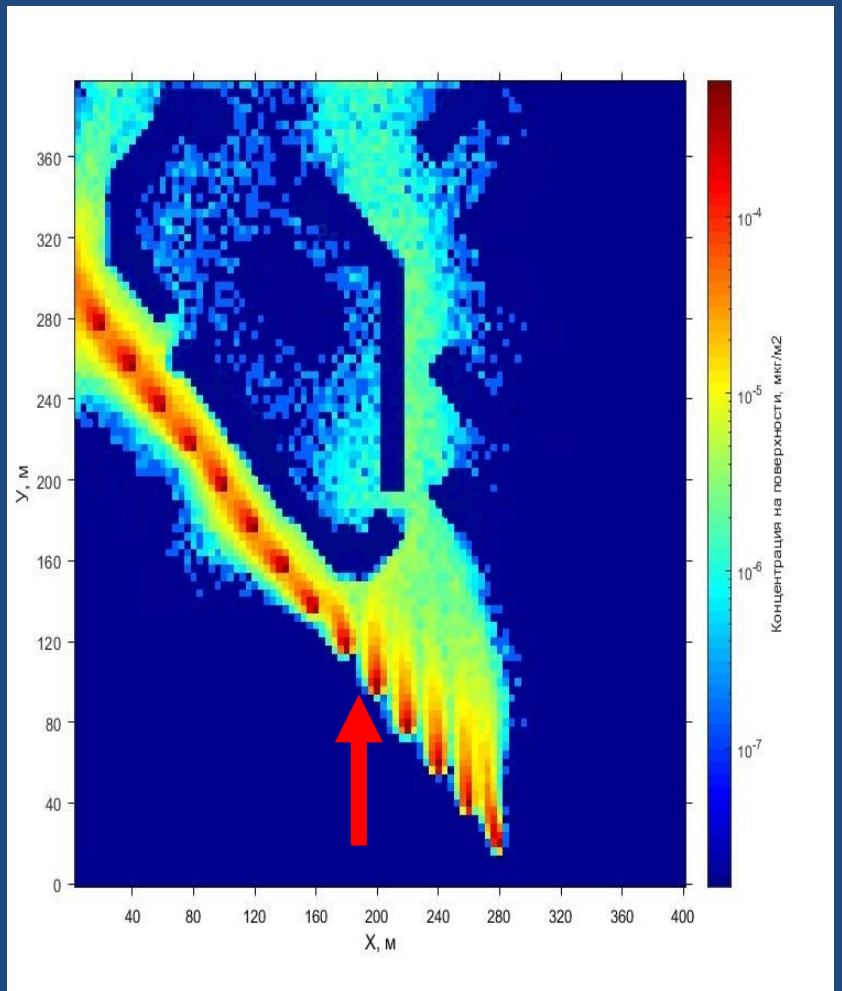
Air quality modeling (largangian aerosol modeling)

Wind speed 1.2 м

:

Concentrations





The consequences of antropogenic heat load and Urban Heat Island in Arctic:


Photo by: O. Anisimov, SGI

Thermokarst

Cherskij, 2002

Photo by: V. Romanovki, SGI

Norilsk, 2006 г.,

Photo by V.Konischev, MSU

Thermal Comfort measurements and modeling

Thermal comfort

Thermal comfort is a parameter of the feeling of comfort.

In this condition the thermoregulatory system is at rest.

A human feels comfortable. He is neither cold, nor hot. (Isaev, 2003)

Thermal Comfort // Innova Air Tech Instruments A/S, 2002

Factors affecting thermal comfort

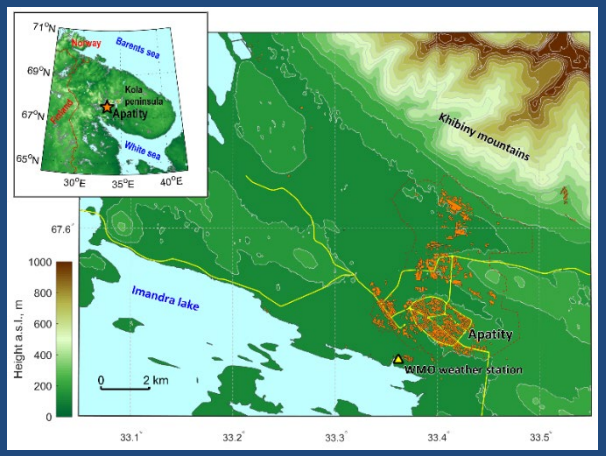
- meteorological parameters:

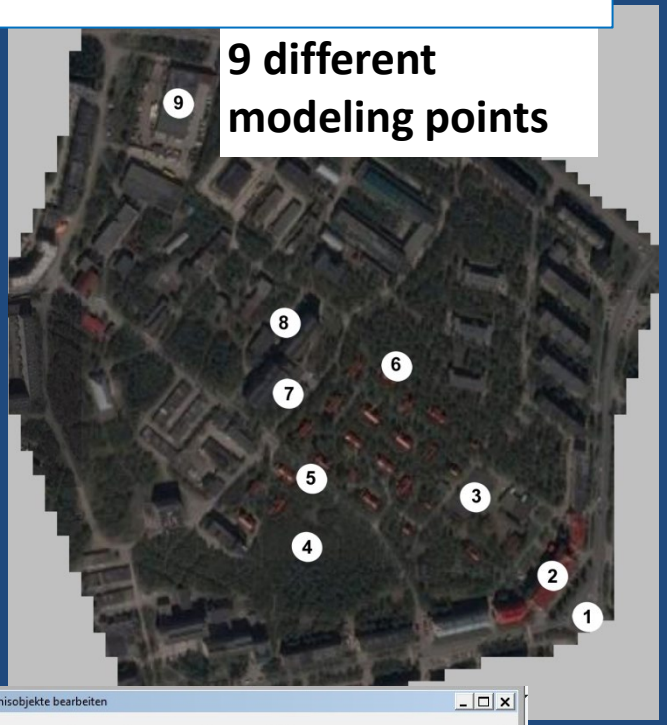
air temperature, wind speed,

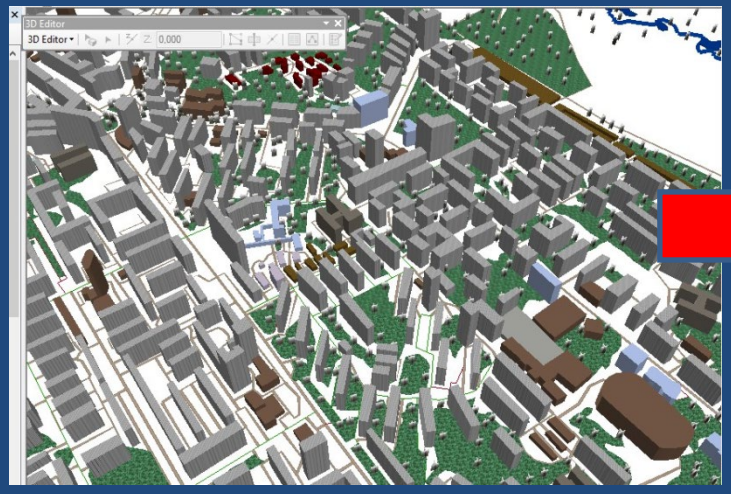
air humidity

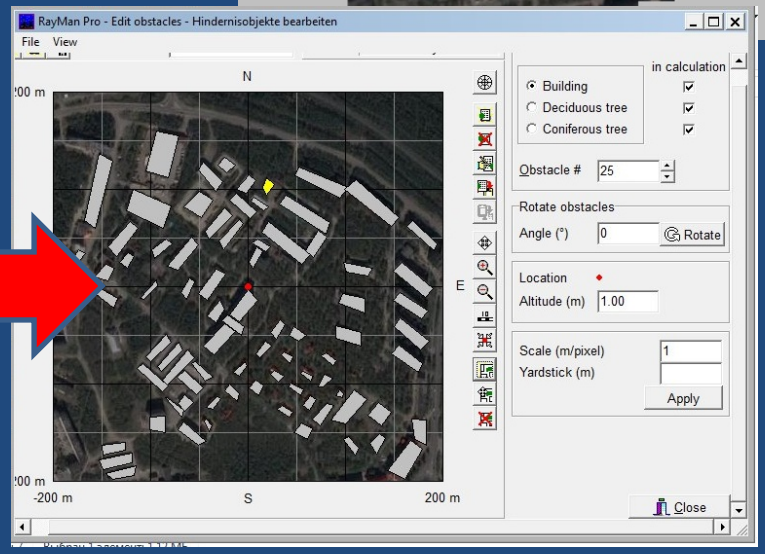
- metabolic rate (depends on human physiological parameters: height, weight, age)
- the level of physiological activity
- thermo-insulating properties of clothing

It is possible to meet with thermal stress during last summer in Arctic latitudes?

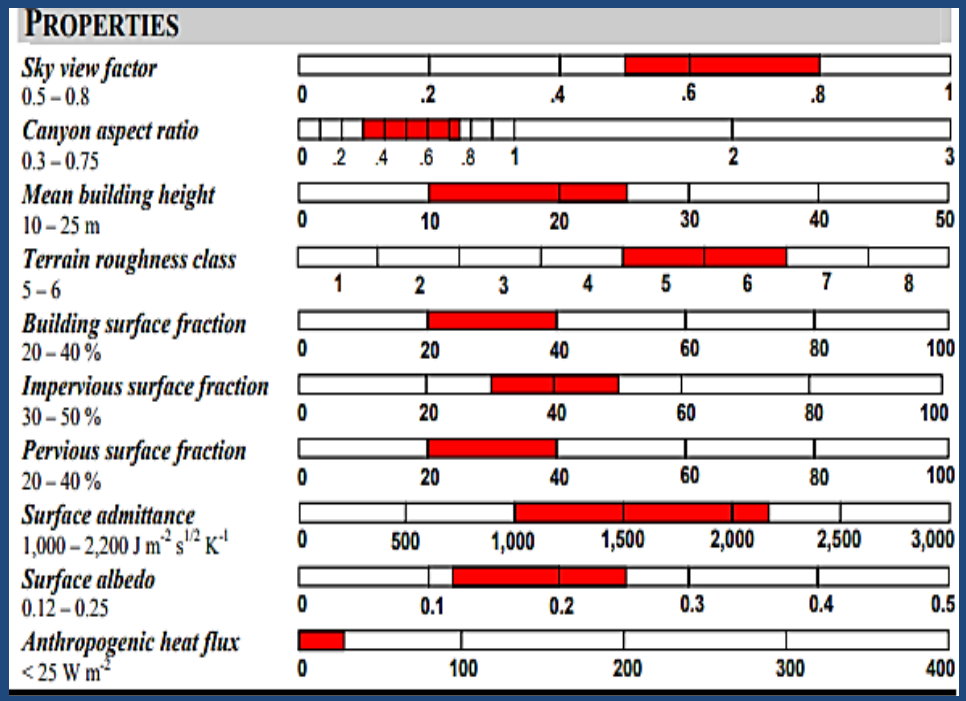


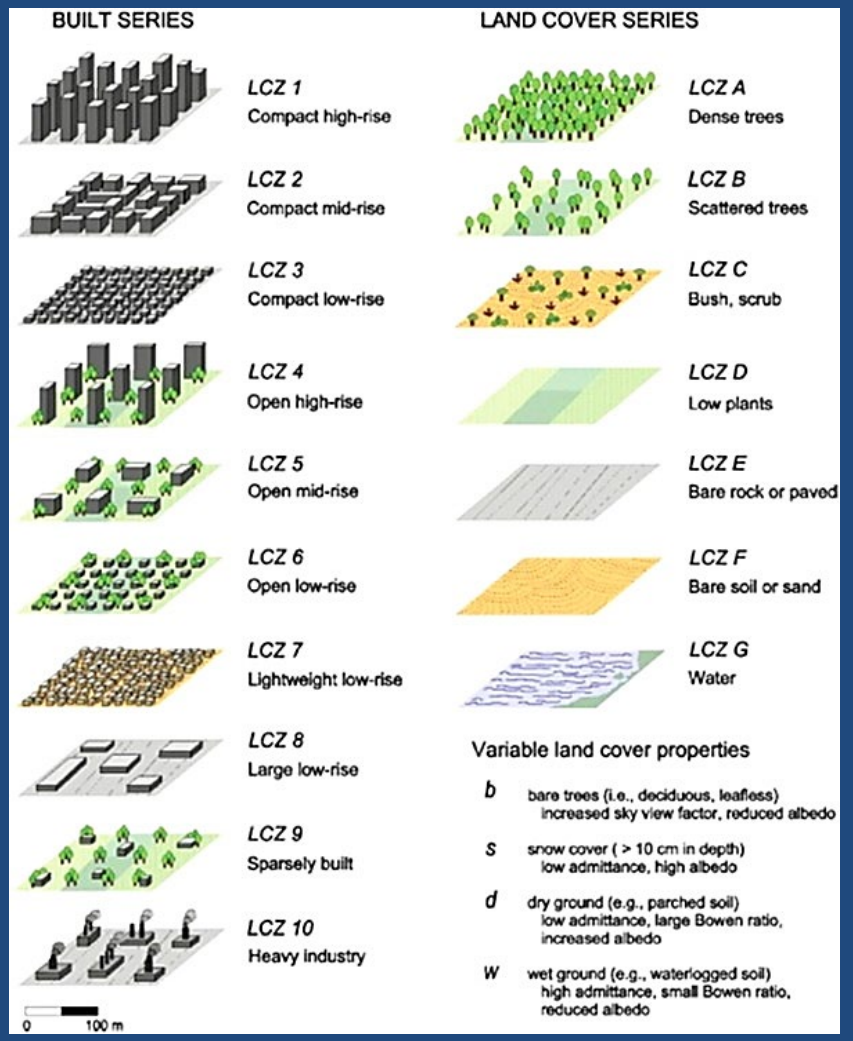






Regionalization of cities by LCZ





Local Climate Zones -
these areas have relatively uniform surface coverage:

- height and building density,
- the number of green spaces
- building materials surfaces
- the nature of human activity

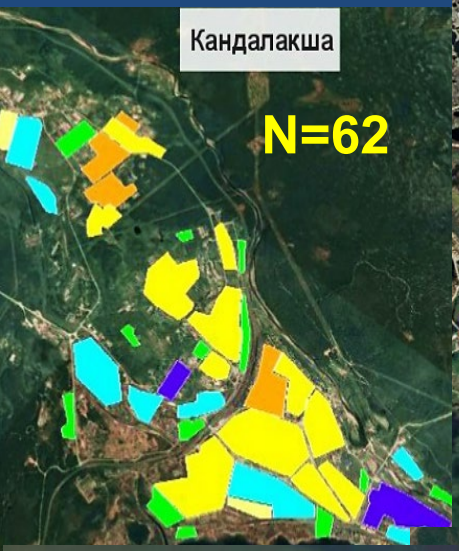
Iain Stewart and Tim Oke

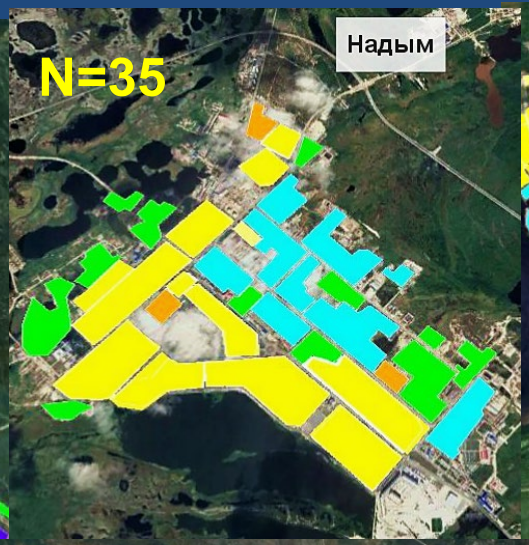
Department Geography
University of British Columbia
Vancouver CANADA

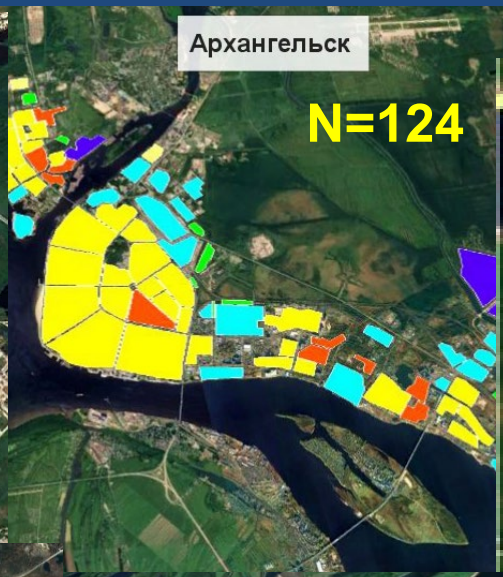
Annual Meeting of the American Association of Geographers, April 11-16, 2011, Seattle, WA

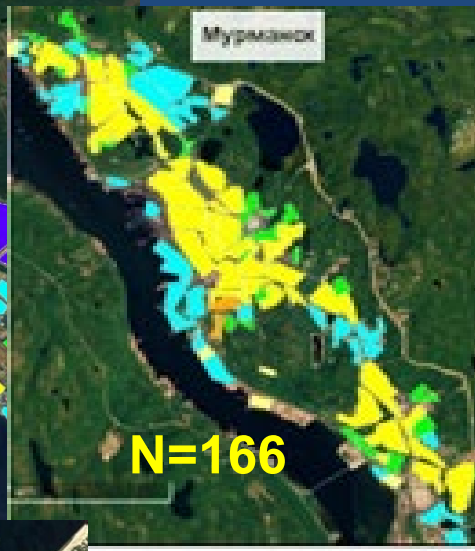
Regionalization of cities by LCZ

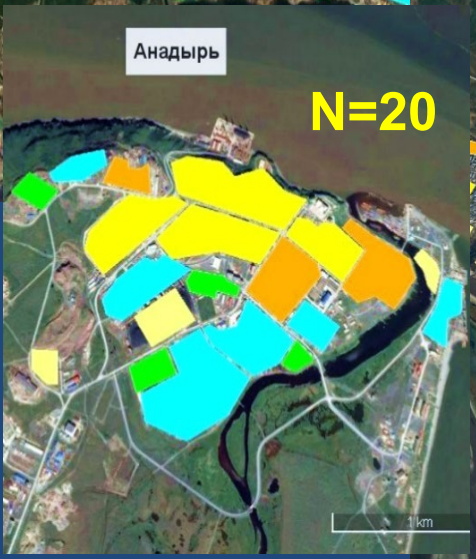
N – number of polygons

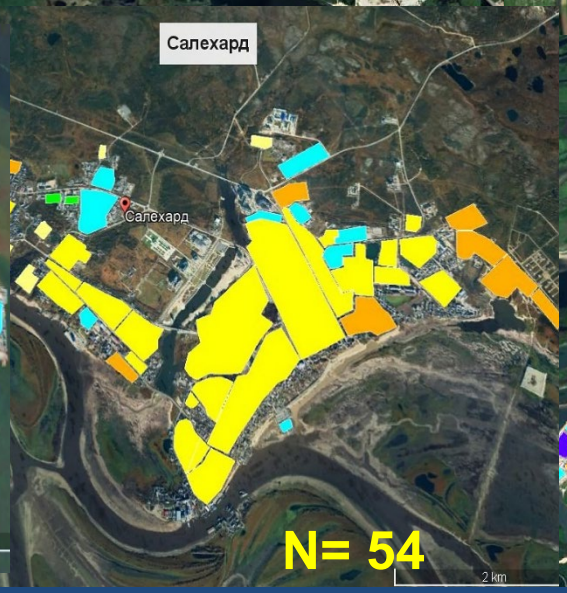


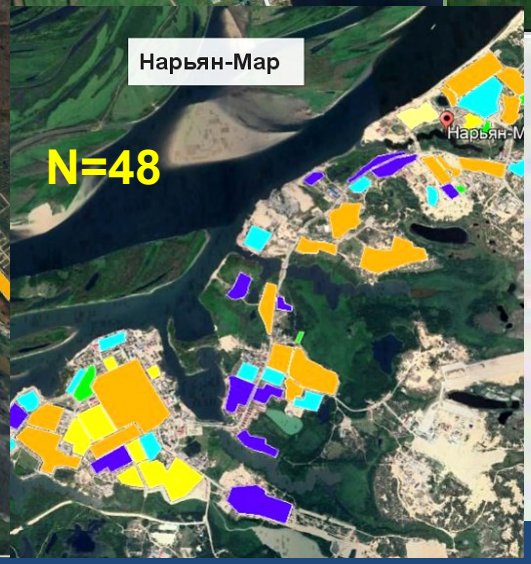




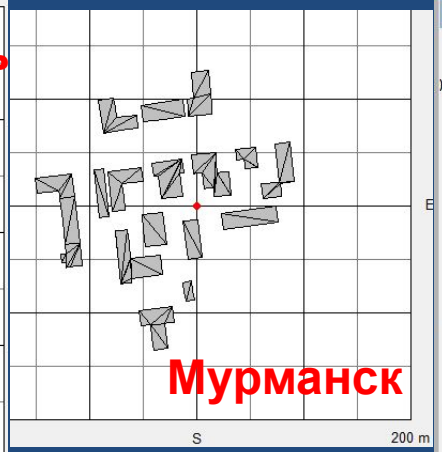


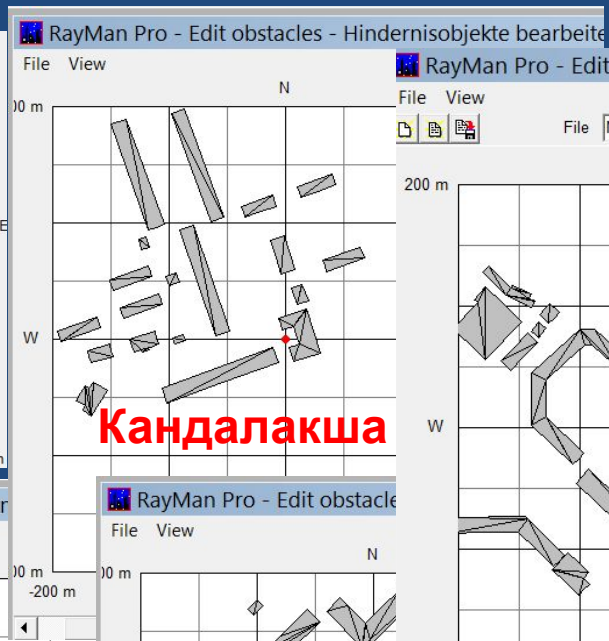


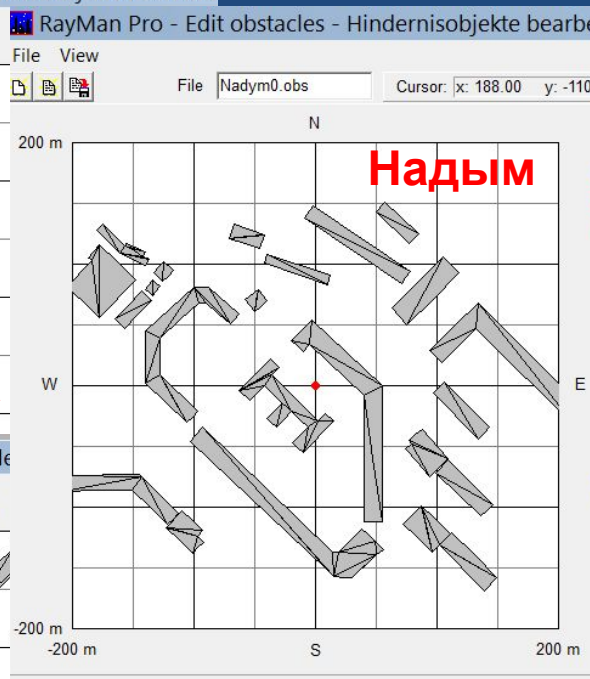


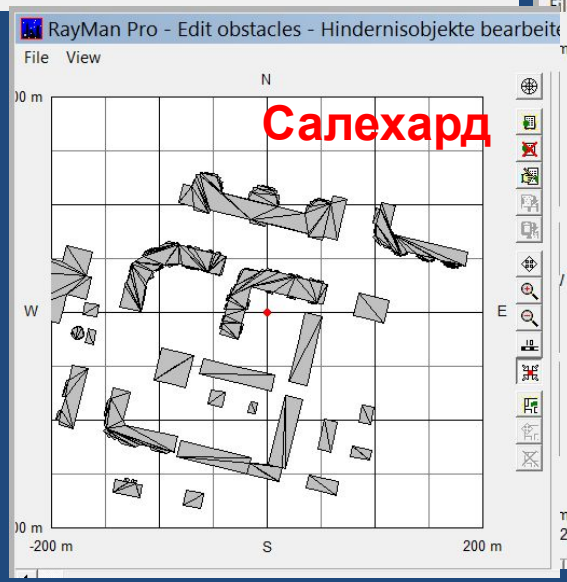


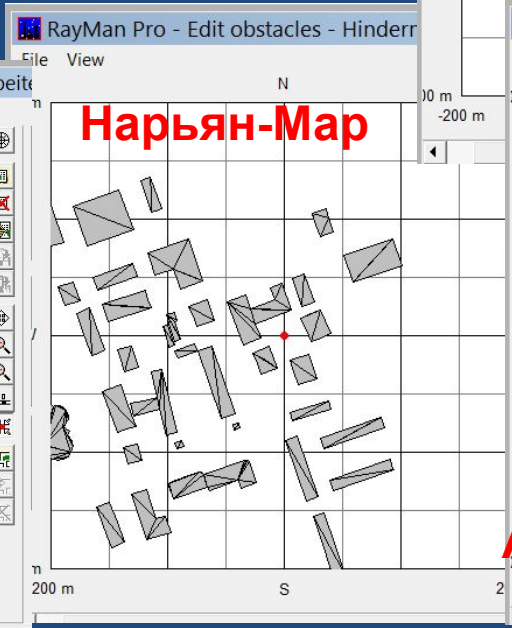
Selected urban areas

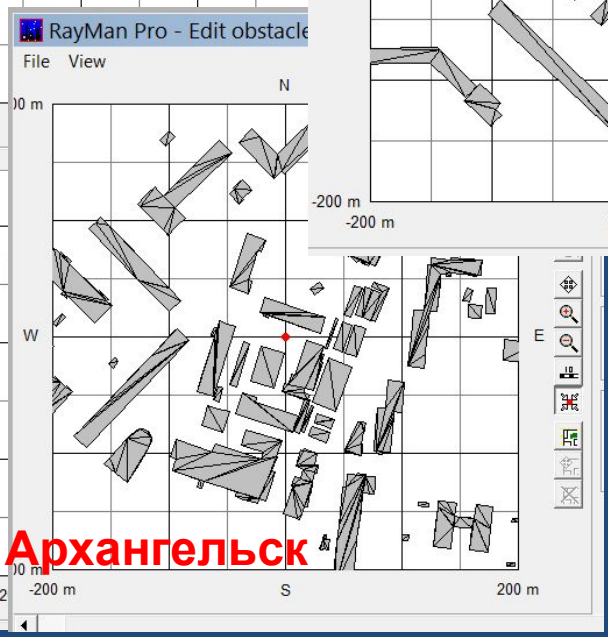




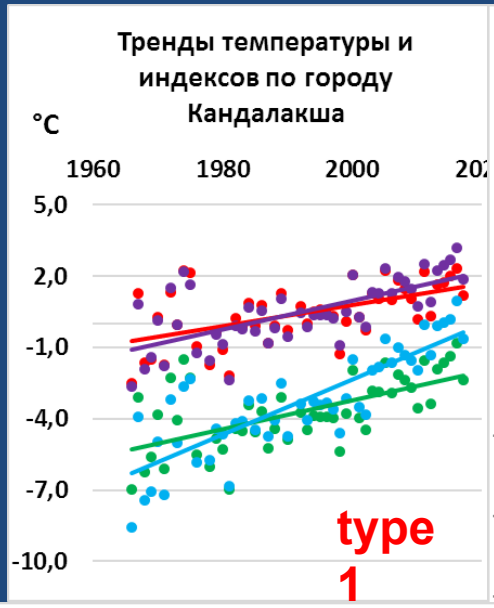


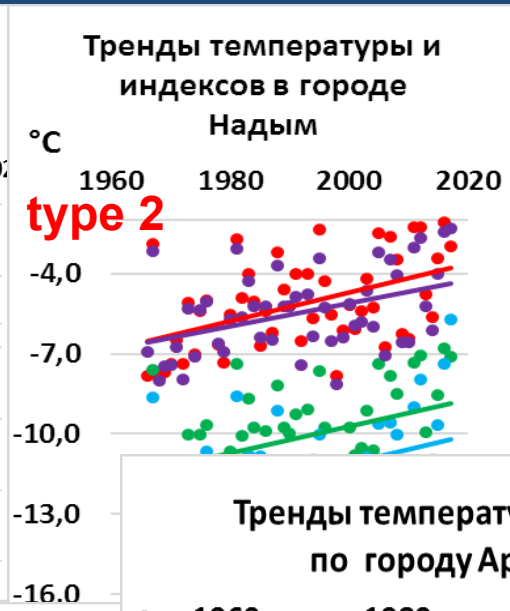


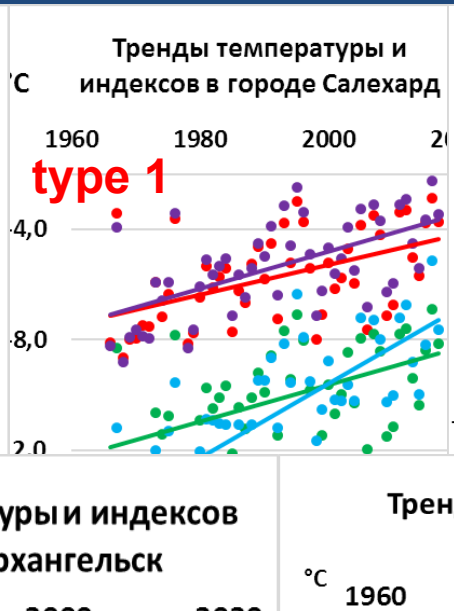


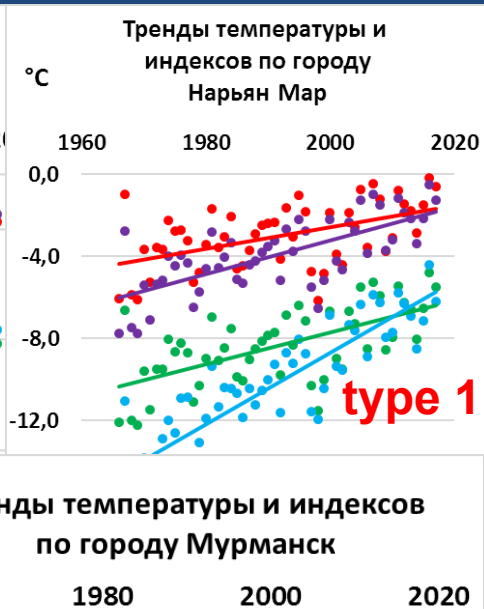


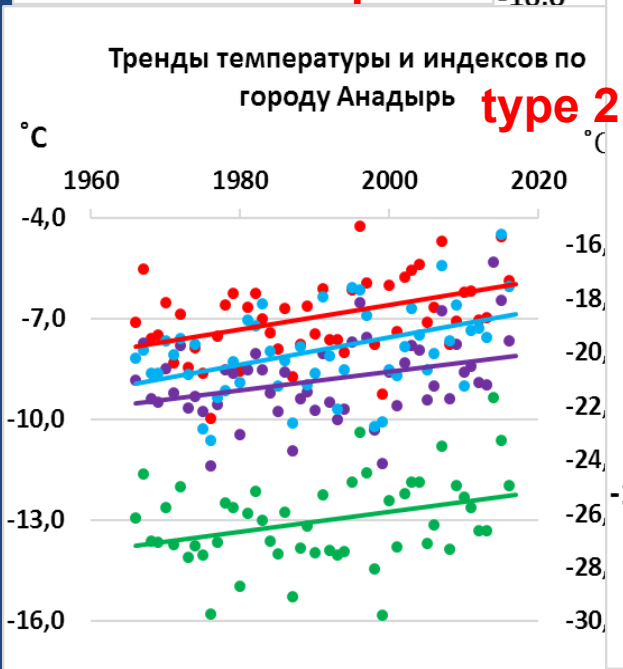
Model experiment results

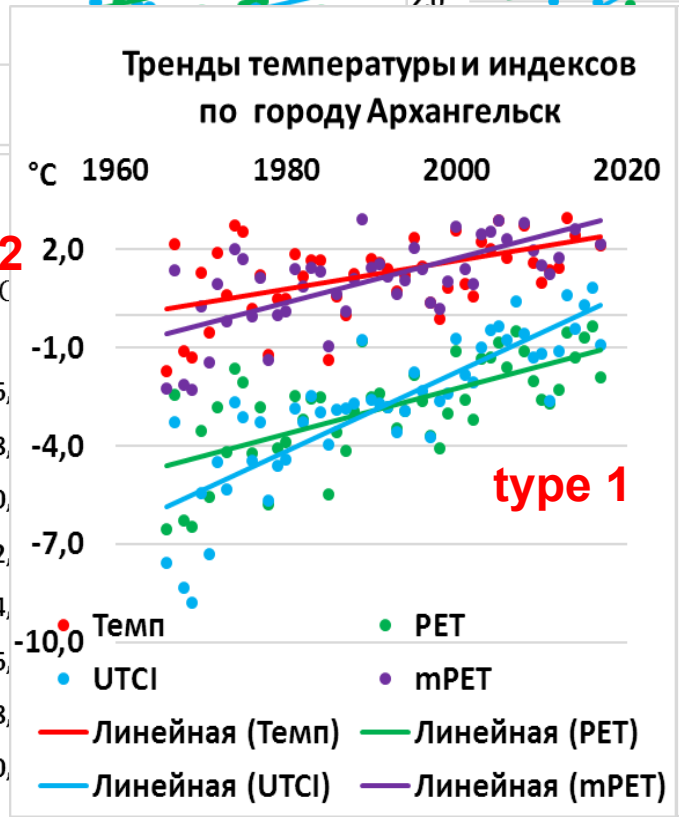


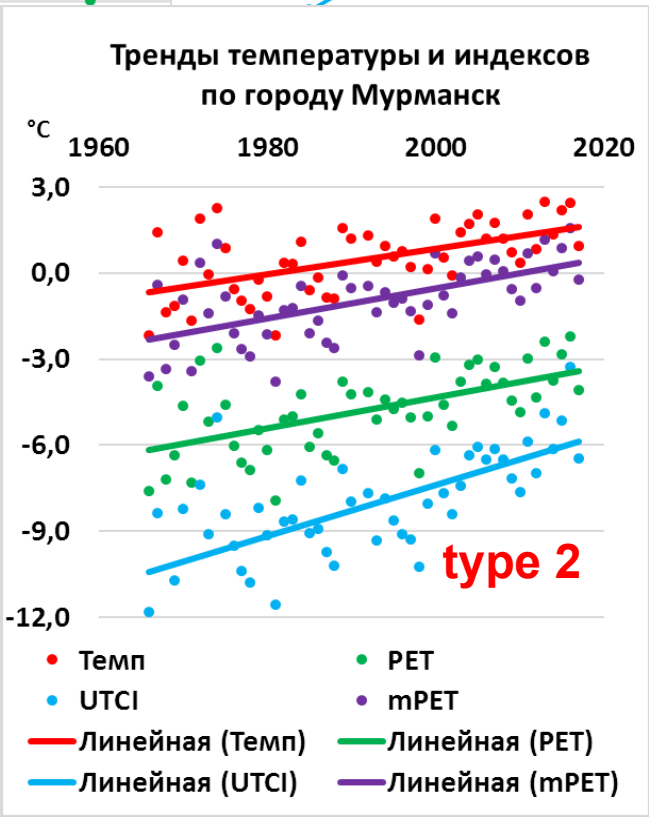










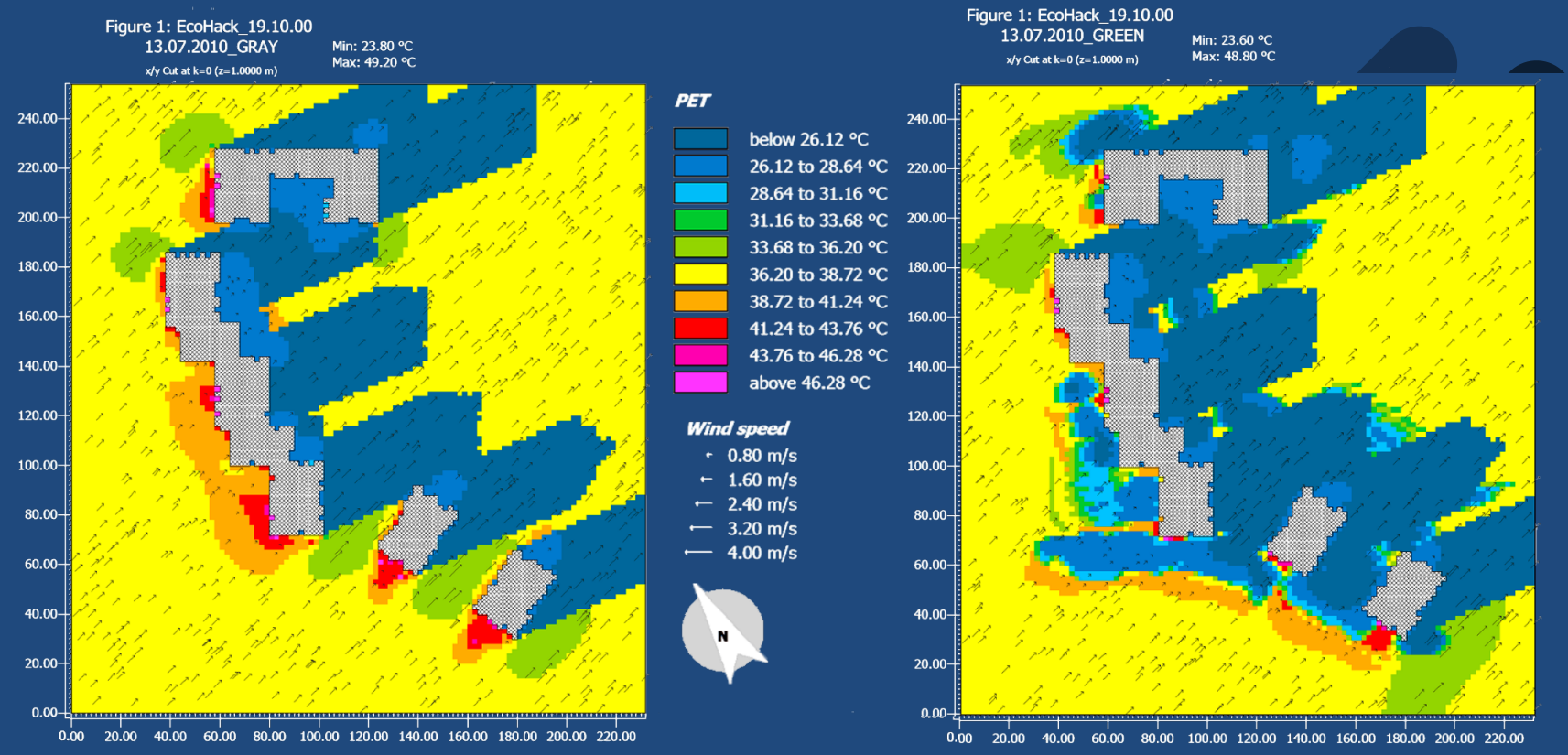


Thermal comfort trends /10 years

Город	ΔT	ΔPET	ΔmPET	ΔUTCI	ΔWind Chill
Murmansk	0.45	0.54	0.53	0.68	0.60
Kandalaksha	0.45	0.61	0.61	1.10	0.65
Arkhanelsk	0.45	0.69	0.67	1.22	0.72
Narjan Mar	0.52	0.78	0.83	1.68	0.93
Salekhard	0.53	0.67	0.68	0.82	0.41
Nadym	0.54	0.50	0.43	0.47	0.60
Anadyr	0.36	0.30	0.28	0.29	0.56

Thermal Comfort and Urban Planning

Microscale evaluation of urban planning

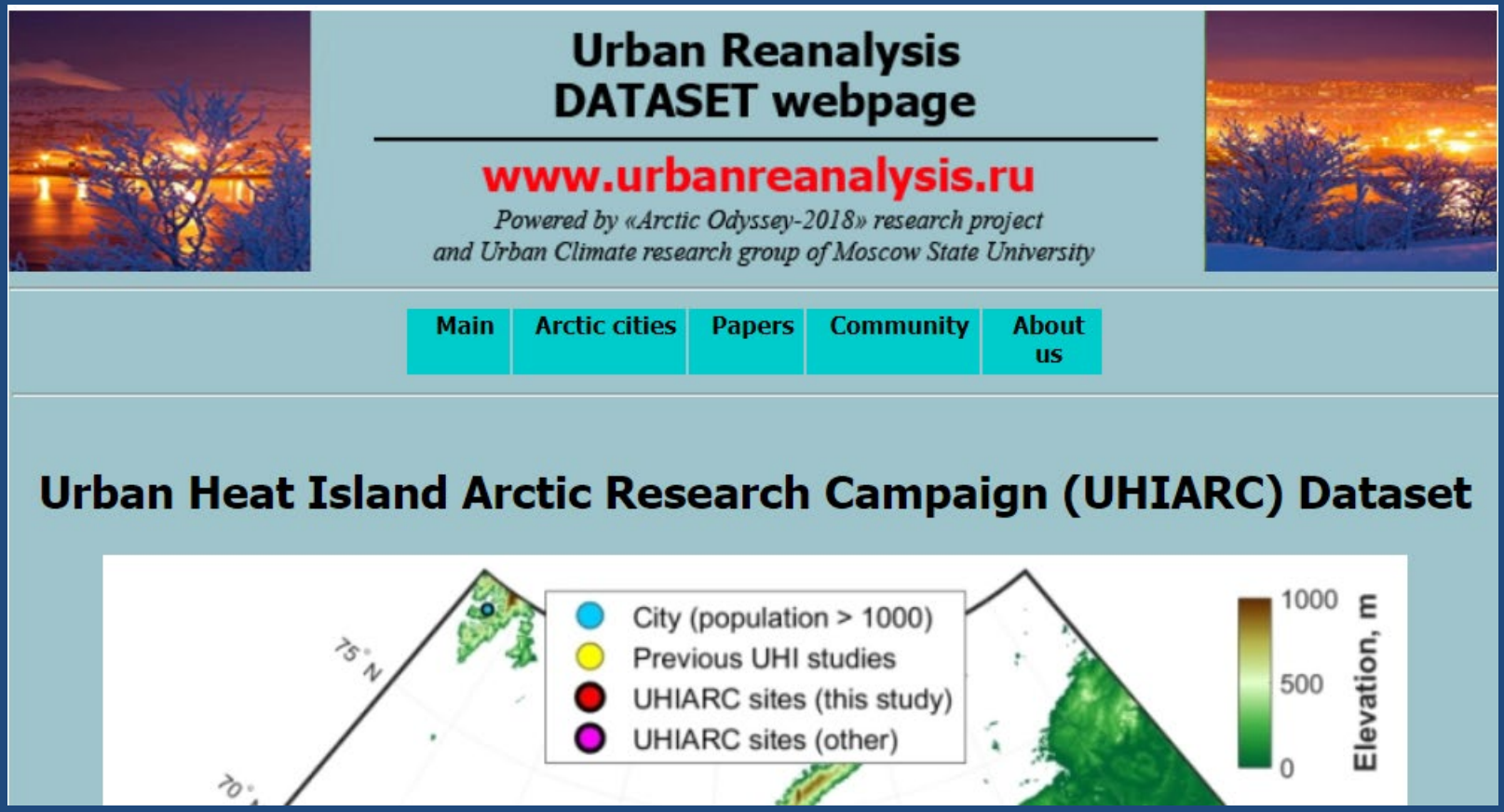


Design building experimental site, GREEN (with trees) vs GRAY (without trees) cases

Trees help to decrease thermal stress

Since July 2018 UHIARC AWS dataset is available online:

http://urbanreanalysis.ru/uhiarc.html



Pavel Konstantinov, Mikhail Varentsov, and Igor Esau. A high density urban temperature network deployed in several cities of Eurasian Arctic. Environmental Research Letters, 13(7), 2018. https://doi.org/10.1088/1748-9326/aacb84