SMART URBAN NATURE

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The effect of urban heat island and other mesoclimatic anomalies on C stocks and CO_2 emissions in Moscow megapolis

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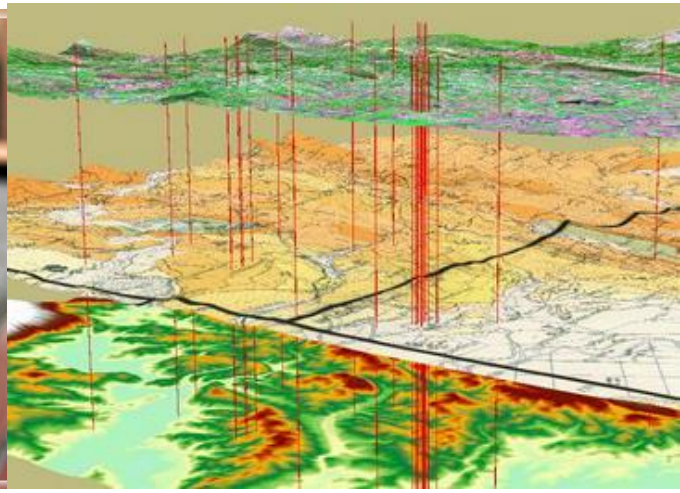

Why soil carbon? Soil functions

Blum, 2005	BBodSchG, *1998*	Andrews et al, *2004*
➢ Protection of humans and environment	➢ Water and nutrient cycling	➢ Nutrient cycling
➢ Biomass production	➢ Ground water protection	➢ Water filtering and buffering
➢ General reservoir	➢ Basis for organisms' life	➢ Biodiversity and habitat
➢ Physical basis of human activities	➢ Land for settlements	➢ Resistance and resilience
➢ Source of raw materials	➢ Land for agriculture	➢ Physical stability and support
➢ Geogenic and cultural heritage	➢ Deposition of raw materials	
	…	

30 to 50% of distinguished soil functions are directly or indirectly related to soil carbon balance

Why soil carbon? Ecosystem services (ES)

ESs' categories (TEEB, 2010)

Provisioning	Regulating	Cultural
➢Food ➢Water ➢ Raw materials ➢Genetic resources ➢Medical resources ➢Ornamental resources	➢Air quality regulation ➢Climate regulation ➢Moderation of extreme events ➢Regulation of water flows ➢Water treatment ➢Erosion prevention ➢Maintenance of soil fertility	•Aesthetic information •Opportunities for recreation and tourism •Inspiration of culture, art and design •Spiritual experience

Habitat
➢Maintenance of life cycles of migratory species ➢Maintenance of genetic diversity

25 to 40% of distinguished ecosystem services are directly or indirectly related to soil carbon balance

Background

The Development of Approaches to Assess the Soil Organic Carbon Pools in Megapolises and Small Settlements

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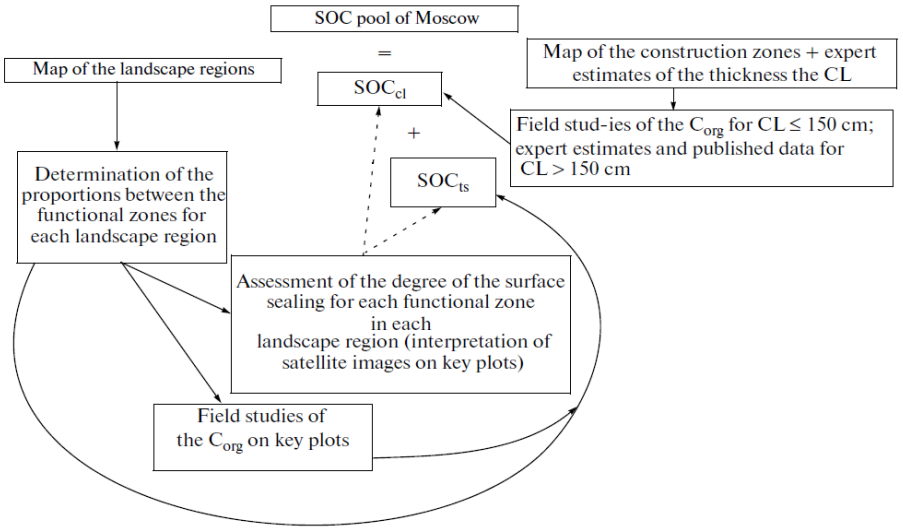

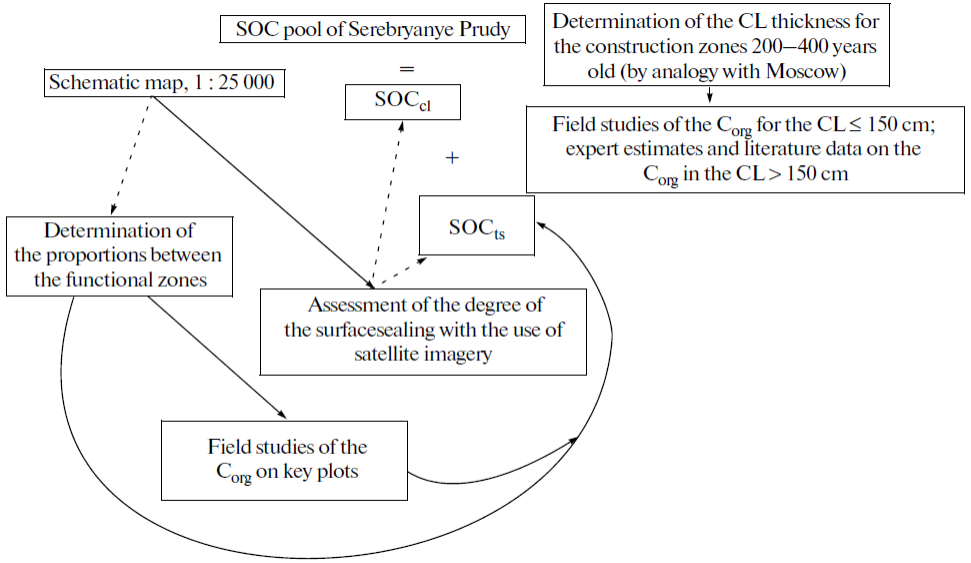

SOC stocks in 0-150 cm of urban soils in Moscow

From 70 to 800 t ha^{-1}

SOC stocks in 0-150 cm of urban soils Serebryanye Prudy village

From 900 to 1100 t ha^{-1}

Background

Contents lists available at ScienceDirect

Geoderma

journal homepage: www.elsevier.com/locate/geoderma

How to map soil organic carbon stocks in highly urbanized regions?

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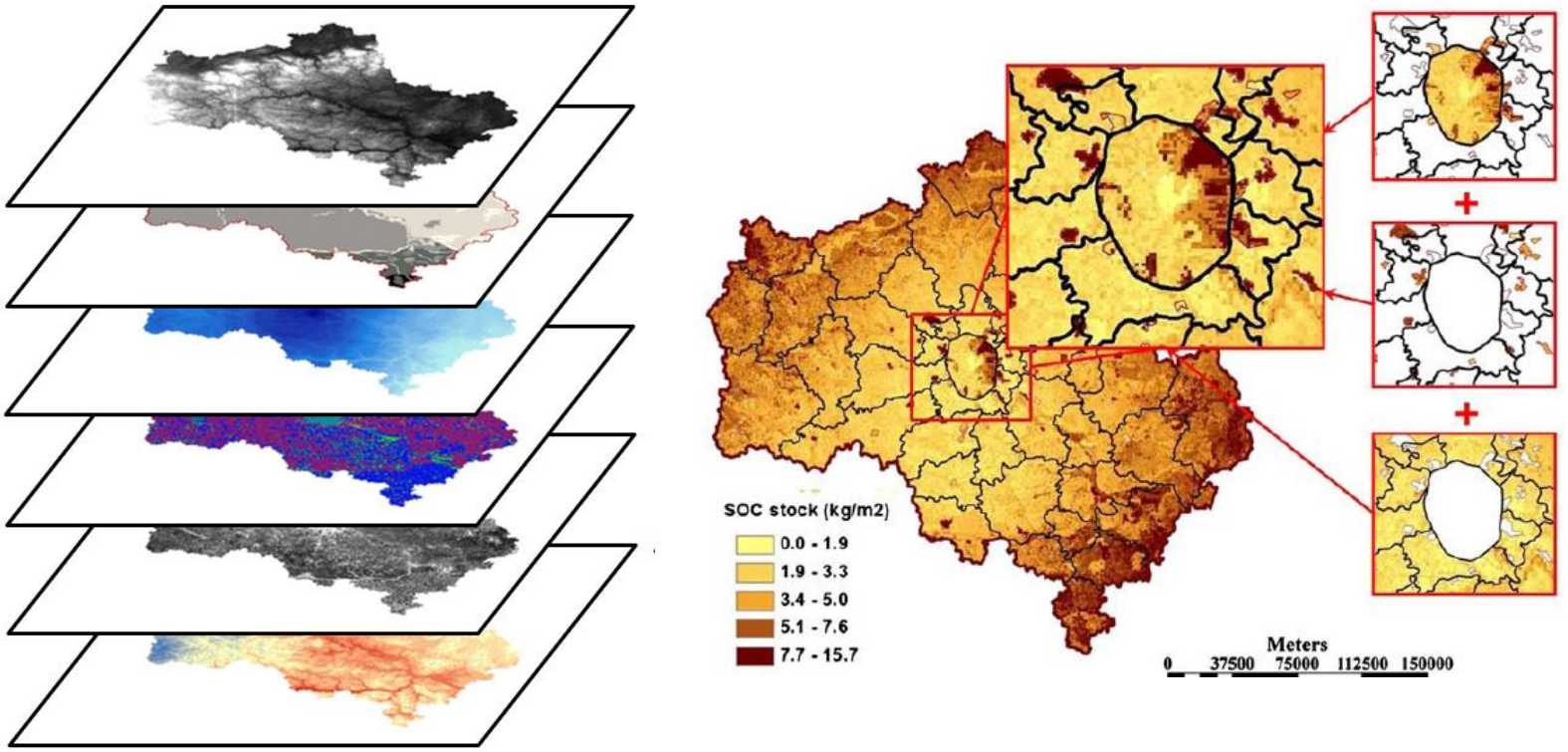


SOC stocks in 0-150 cm of urban soils in Moscow region

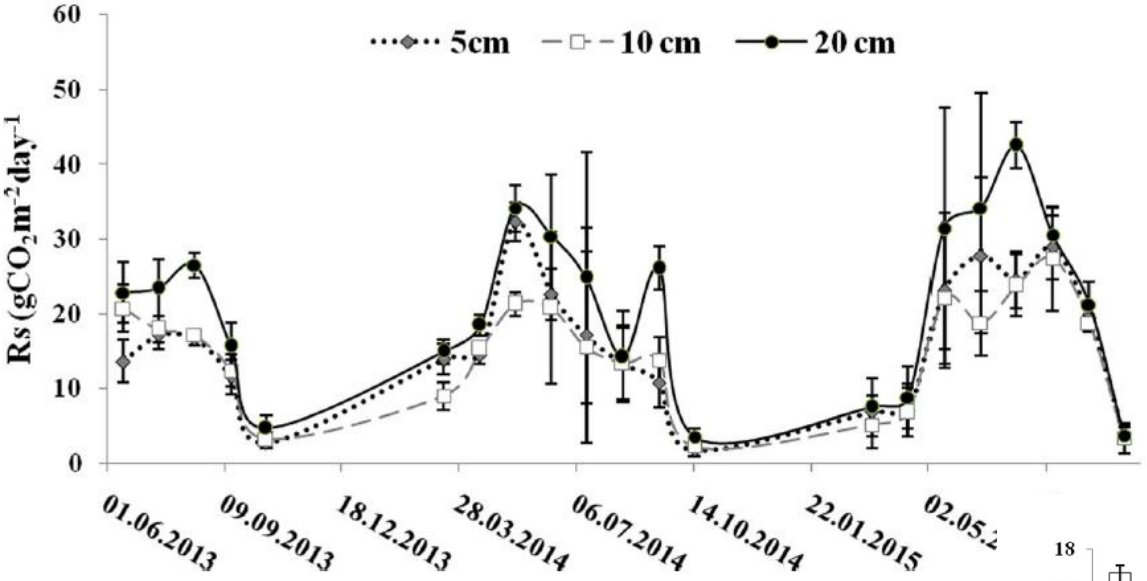
From 200 to 300 t ha^{-1}

Background

Urban Ecosyst
DOI 10.1007/s11252-016-0594-5

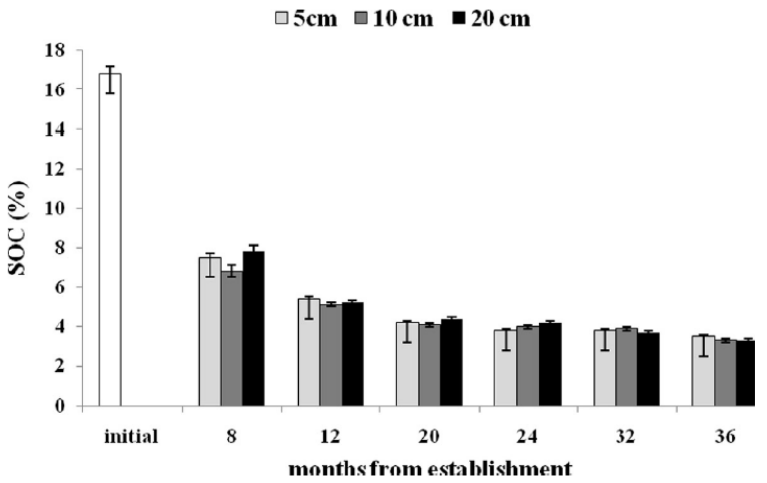
Changes of soil organic carbon stocks and CO_2 emissions at the early stages of urban turf grasses' development

A. S. Shchepeleva[1] · V. I. Vasenev[1,2] · I. M. Mazirov[2] · I. I. Vasenev[2] · I. S. Prokhorov[2] · D. D. Gosse[3]



Seasonal dynamics in 2013-2015 (summer period gave up to up to 60% of annual emissions)

Rapid depletion in C_{org} stocks after the 1st year and stabilization by the 3rd year



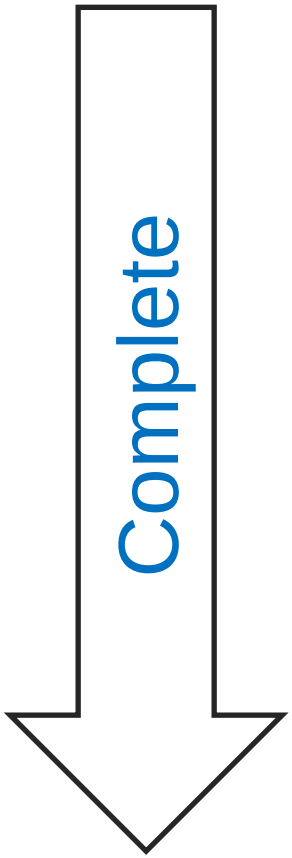
Research questions and tasks

✓Mapping and assessment of SOC stocks in Moscow megapolis

✓Quantifying relationships between microbial (basal respiration), soil properties and meteorological parameters (lab experiment)

✓Analyze dynamics in soil respiration, soil temperature and moisture in situ

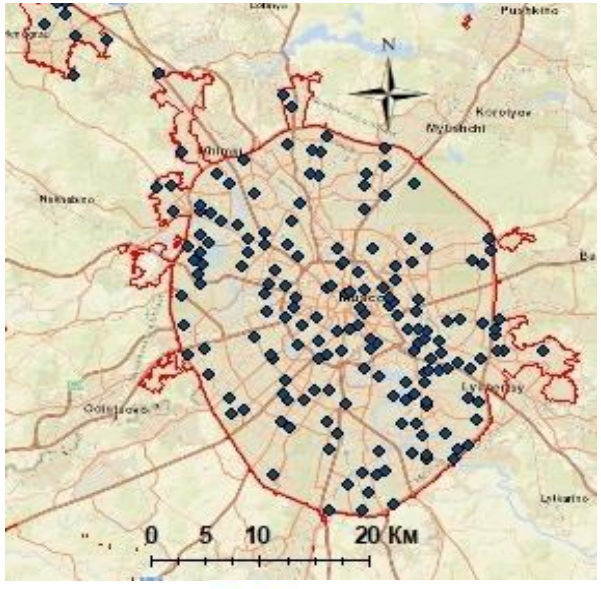
✓Climate monitoring and modeling



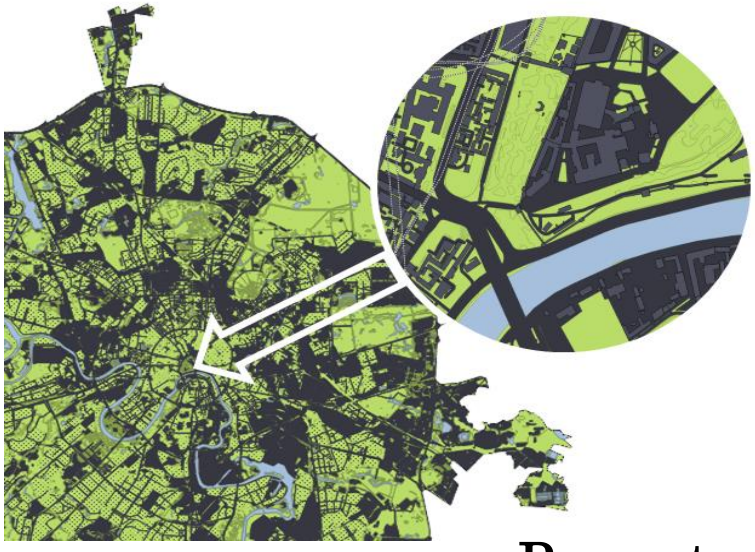
❑ Project the mesoclimatic effect by linking SOC maps to soil temperature and moisture model outcomes

Soil survey and SOC interpolation in Moscow

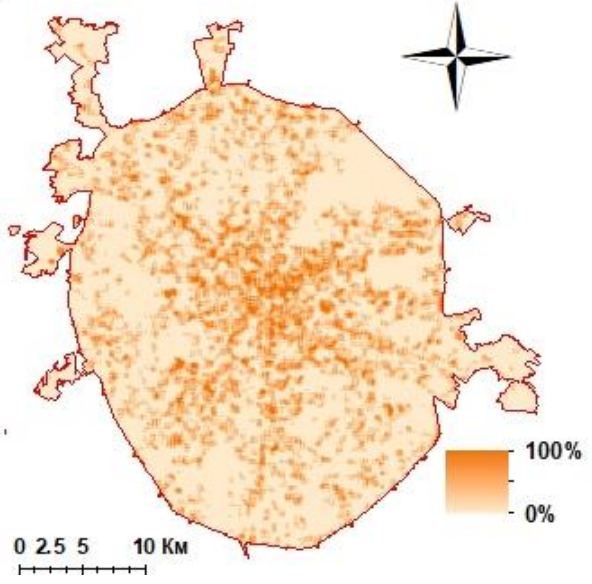
Sampling campaign



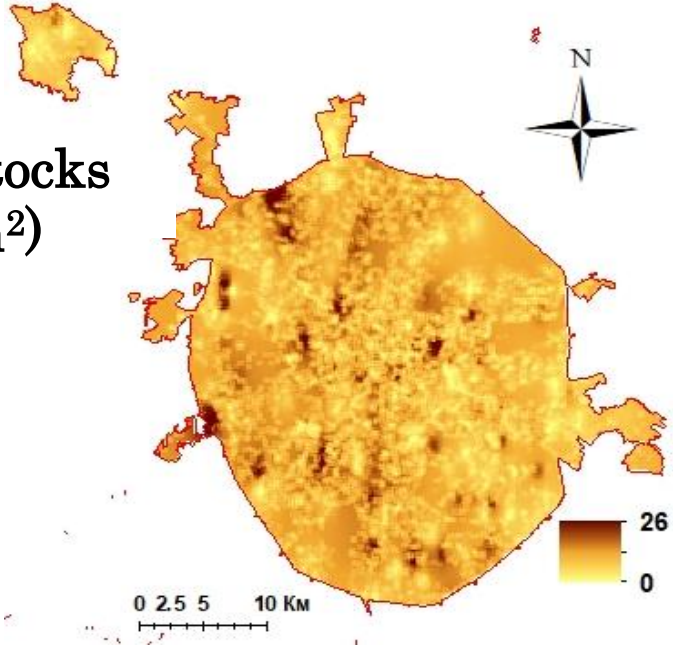
Soil sealing (OSM-based)



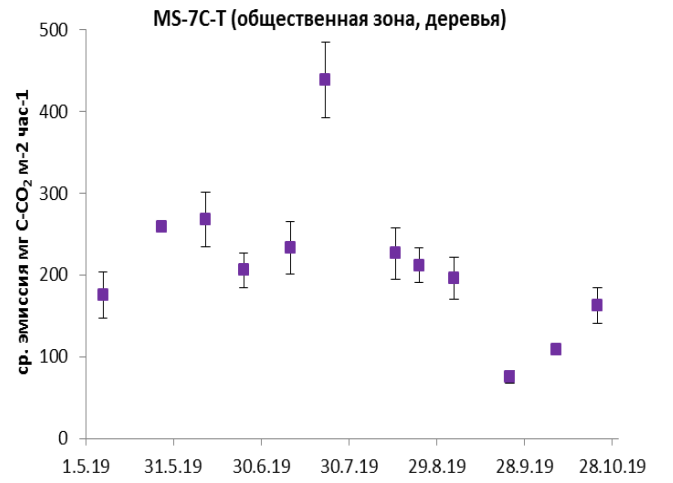
Percentage of sealed soils

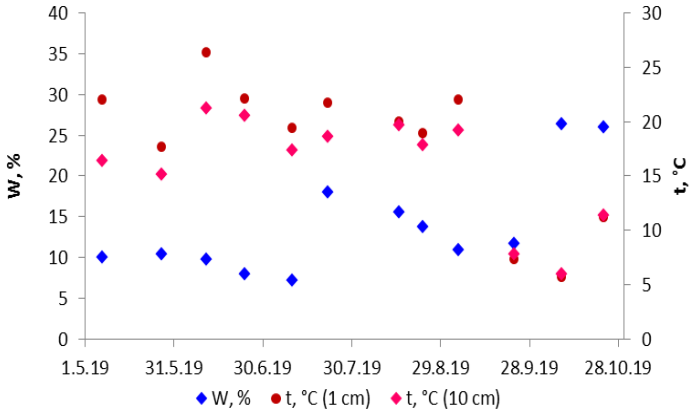


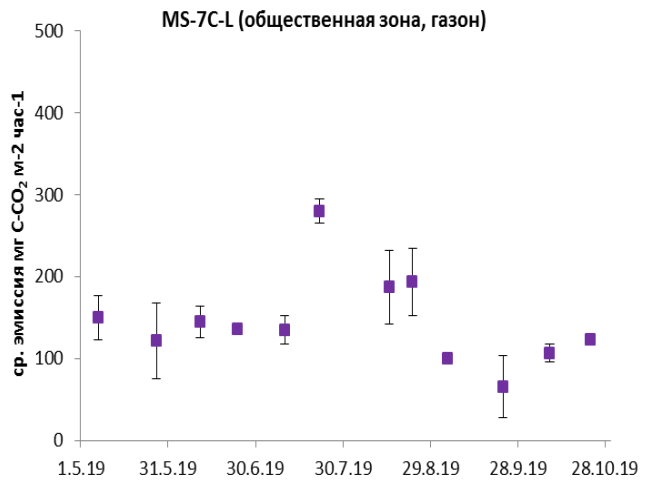
SOC stocks (g m^2)

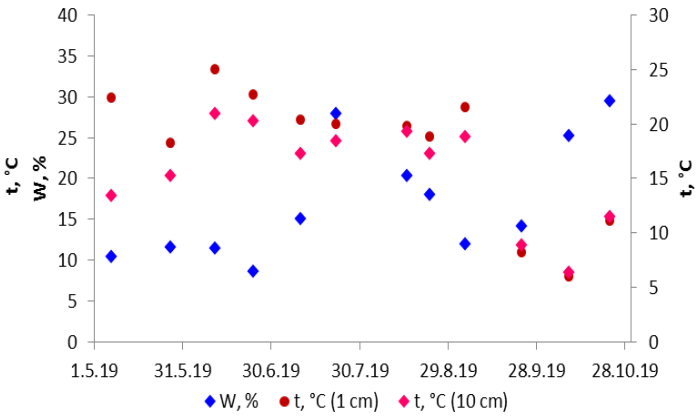


Soil respiration in situ measurements





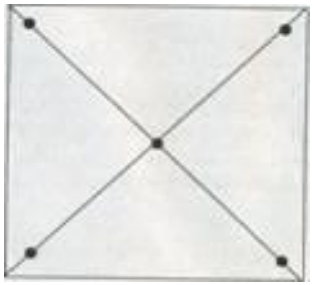




✓Seasonal dynamics driven by soil temperature and moisture

✓Considerable difference in CO_2 emissions between different surfaces (trees, shrubs, lawns) at the local scale

Lab experiment

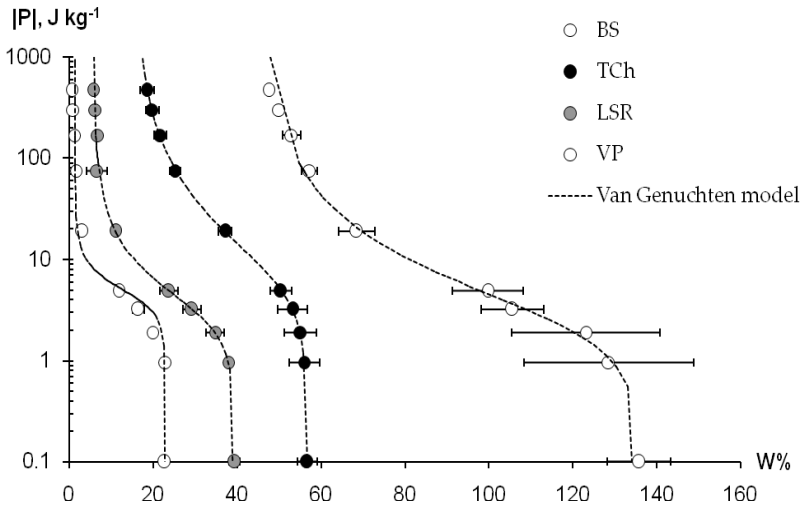


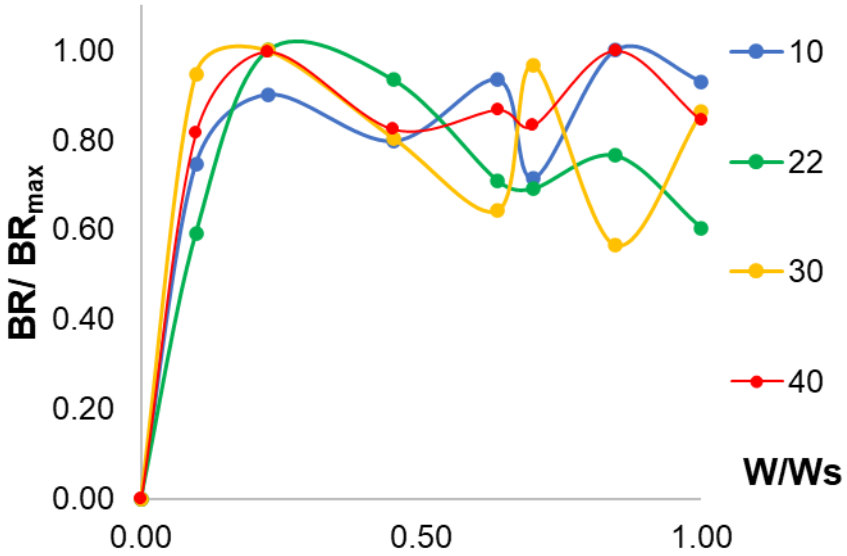
Soil sample
(2 g)

+ H_2O
(0.1 ml / g)

22°C, 24 h

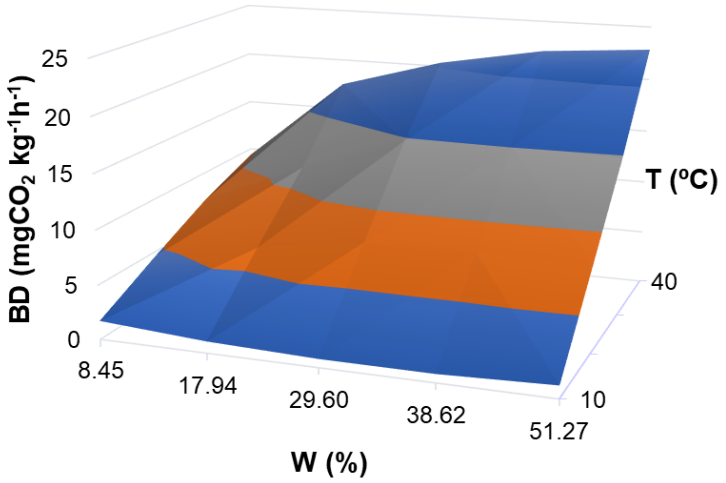
Relationships between BR, soil temperature and moisture





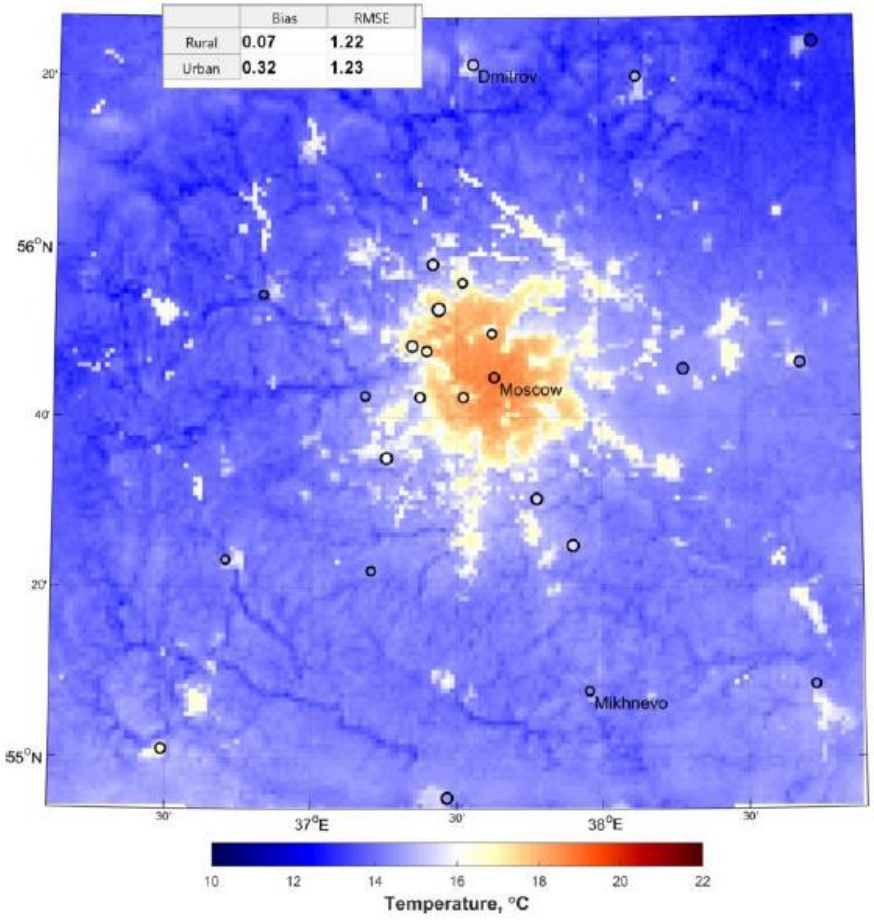
$$BR = 13.1 + 0.54\,T - 0.26\,pH + 0.4\,SOC + 0.01\,W$$

$$R^2_{adj} = 0.52$$

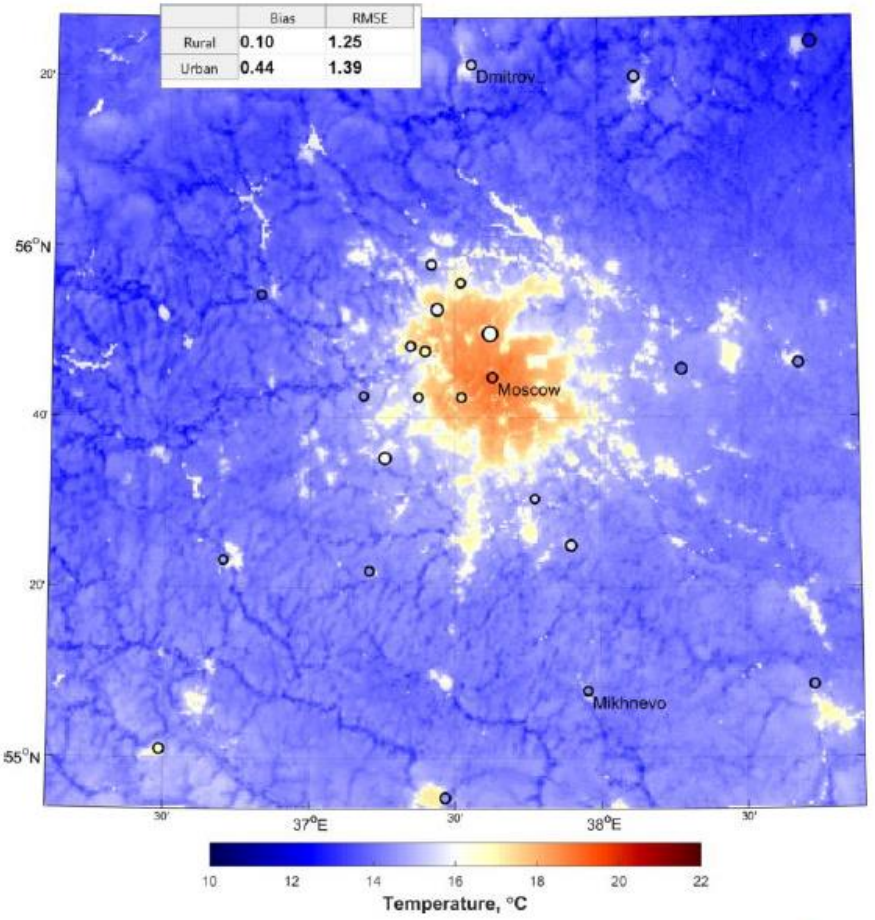


Mesoclimatic modelling

Δx = 1 km, 180x180 grid cells, dt = 10 sec



Δx = 500 m, 400x400 grid cells, dt = 5 sec



Preliminary outcomes and next steps

✓SOC stocks in topsoils (20 cm) of Moscow megapolis were over 8000 and SOCD ranged from 0 to 24 g/m^2

✓ In situ respiration of urban soils ranged from 100 to 500 mg C-CO_2 m^2 h^{-1} and was more sensitive to land cover than to the level of anthropogenic load or functional zoning

✓Basal respiration was significantly correlated to soil temperature, SOC and pH and was not influenced by soil moisture linearly.

✓ Different approaches to model Moscow climate agree on a clear pattern with higher temperatures in the central area due to urban heat island

✓Mesoclimatic maps will be linked to SOC map via the obtained regression equations to project dynamic changes in potential CO_2 emission from urban soils