WP2.

- Task 2.1 Measurement of the physical-chemical properties of urban aerosols

Season and diurnal dynamics of particle mass, black carbon and size-segregated chemical composition

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GENERAL DIRECTION OF AEROSOL RESEARCH

Air mass transportation

Meteorology

Physico-chemical process of origin, transportation, sedimentation, aging

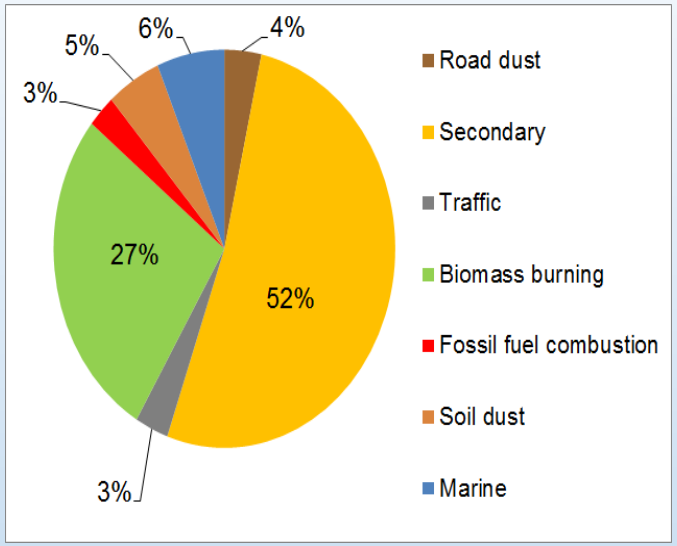
Aerosol pollution, urban emission sources and around

AEROSOL mass COMPOSITION

SAMPLING site

BC
ions
elements
OC, EC
PAH
in PM
size
fractions

Source apportionment



PMF model

Source profiles

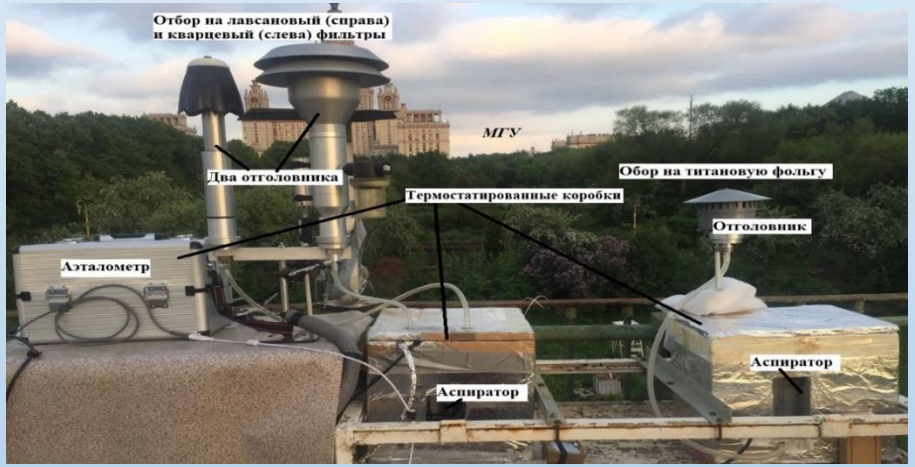
Road dust

soil

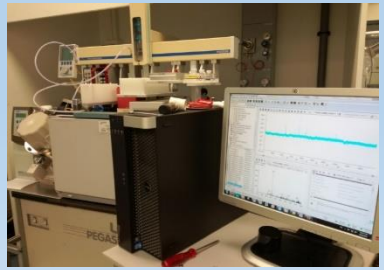
Mobile aerosol complex, Meteorological Observatory of Moscow State University

portable aethalometer
calibrated in «Demokritos»

Two sampling PM10 channels



for analytic chemistry by



GC-TOF-MS

Thermal Optical Reflection

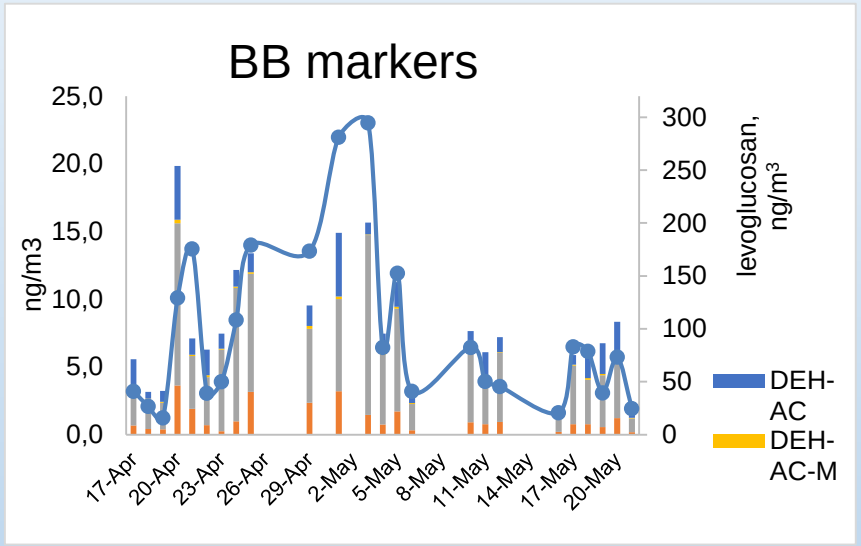
Ion chromatography

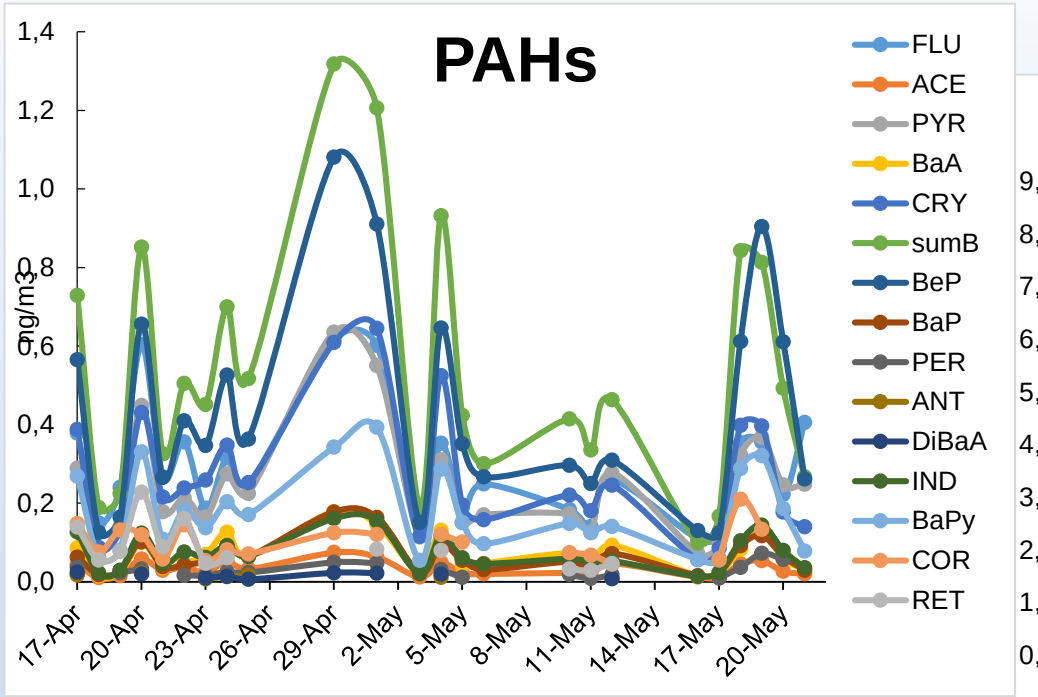
Sampling aerosol campaigns

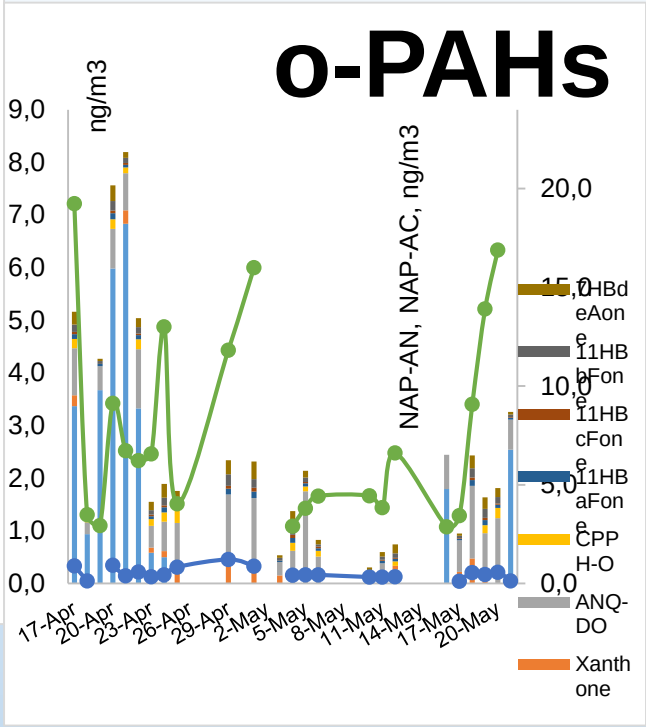
17 April – 21 May 2017
19 April – 23 May 2018
1 April -30 July 2019,
23 sep 2019-18 jan 2020

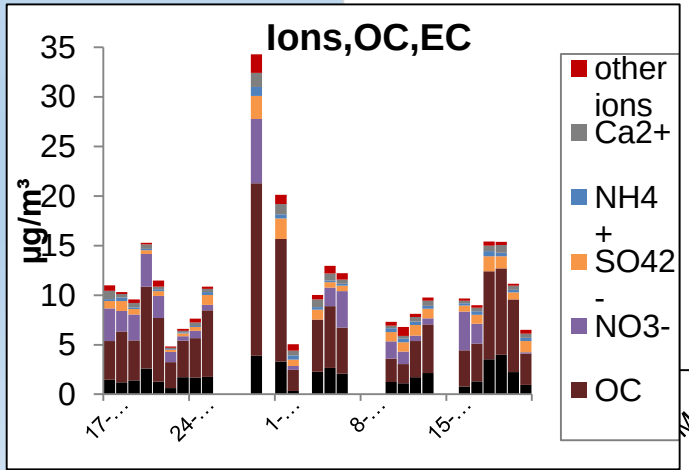
Aerosol Characterization

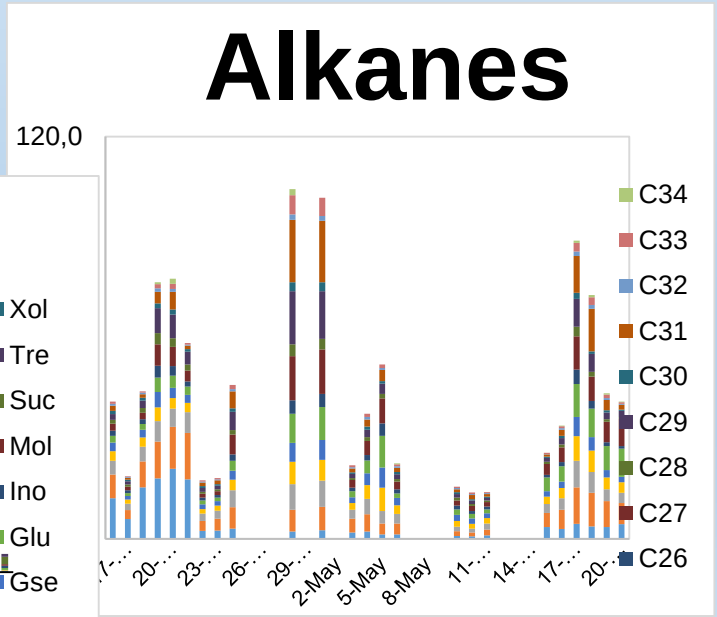
- **Organic and ionic markers**
- 15 PAHs,10 oxy-PAHs,10 hopans
- 15 alkanes, 5 BB markers, Sugars
- Ions **in Spring 2017**

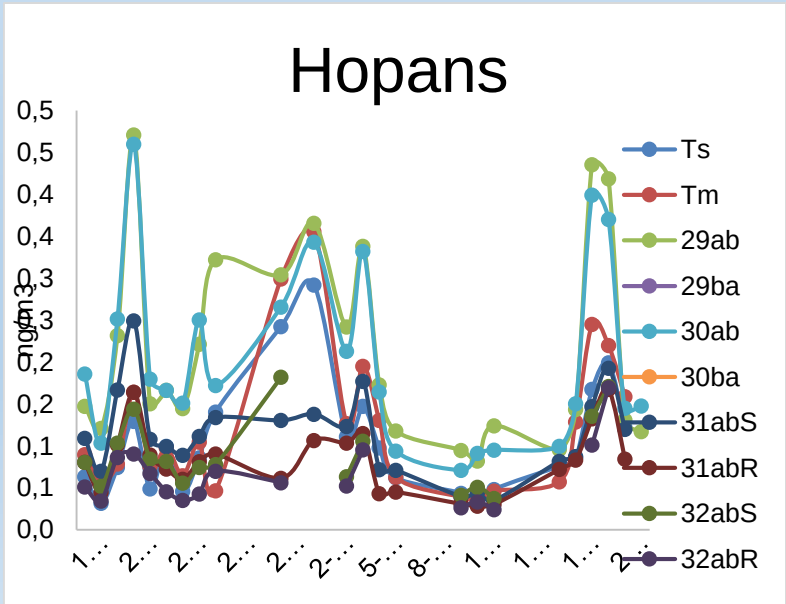










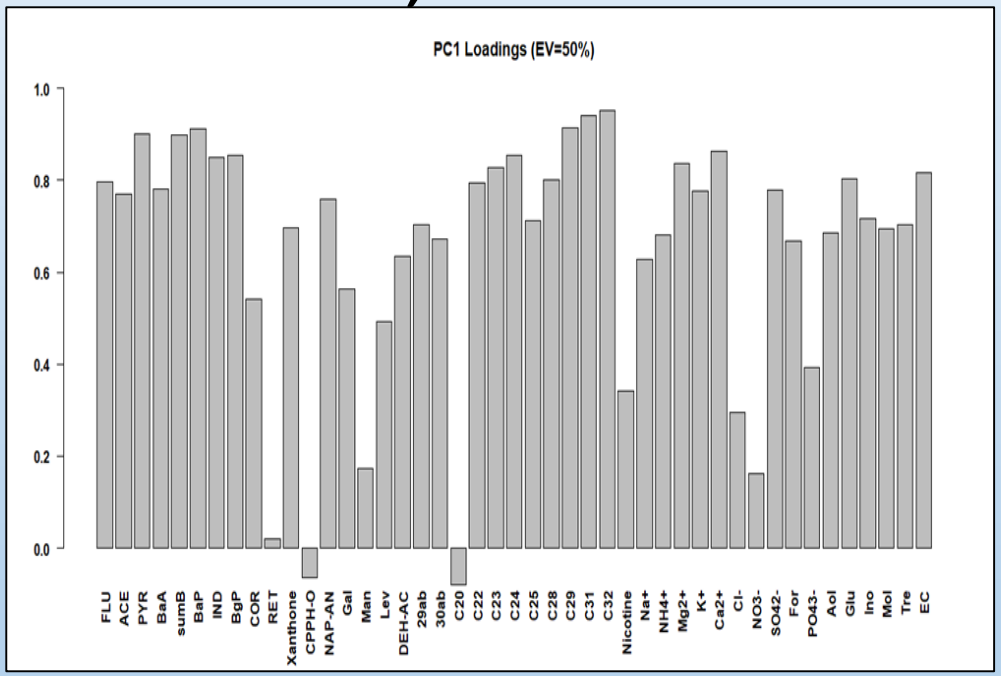


PCA for aerosol composition and source identification, spring 2017

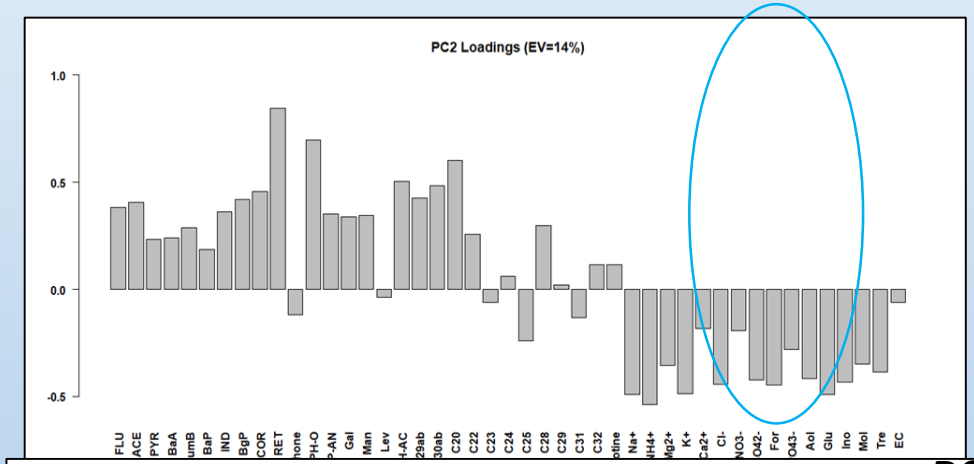
PC1 contains
variables describing multiple combustion sources, including fossil fuel emissions and biomass burning

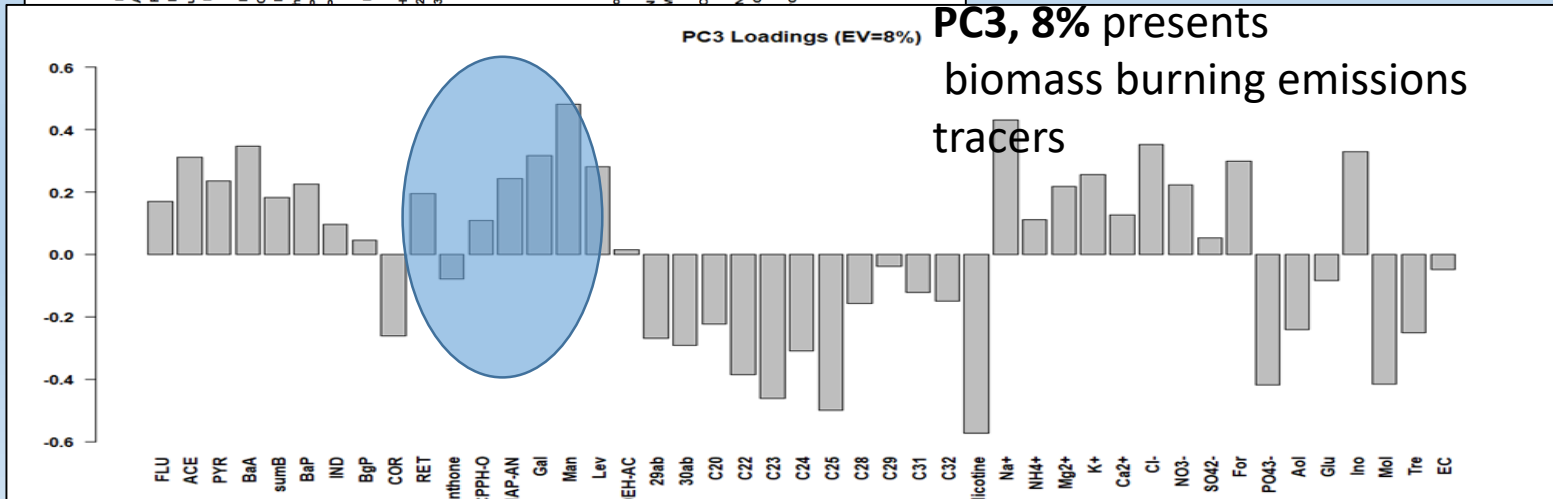
PC2 shows positive loadings on PAHs, o-PAHs, hopans and alkanes.
Negative loadings explained by natural source ions and sugars

PC1, 59%



PC2, 14%

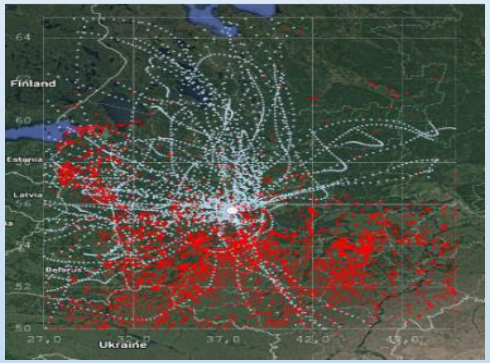


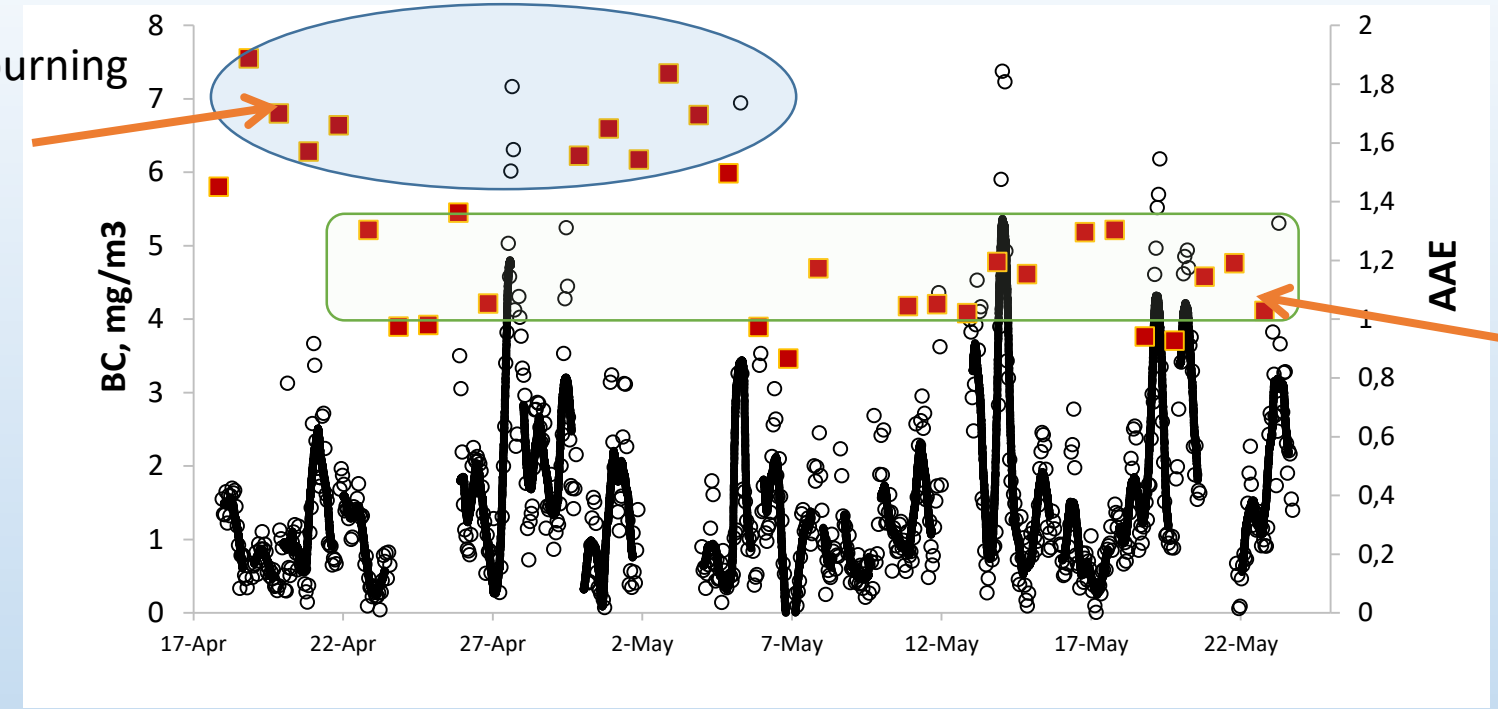


PC3, 8% presents biomass burning emissions tracers

Spring 2017, spectral absorption (AAE) and black carbon concentration

Periods of biomass burning

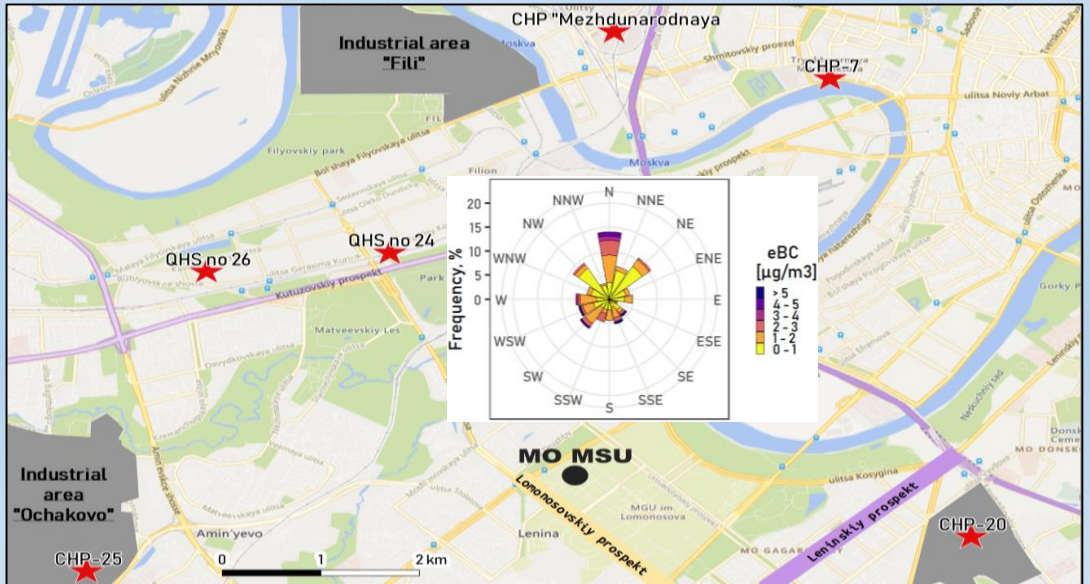




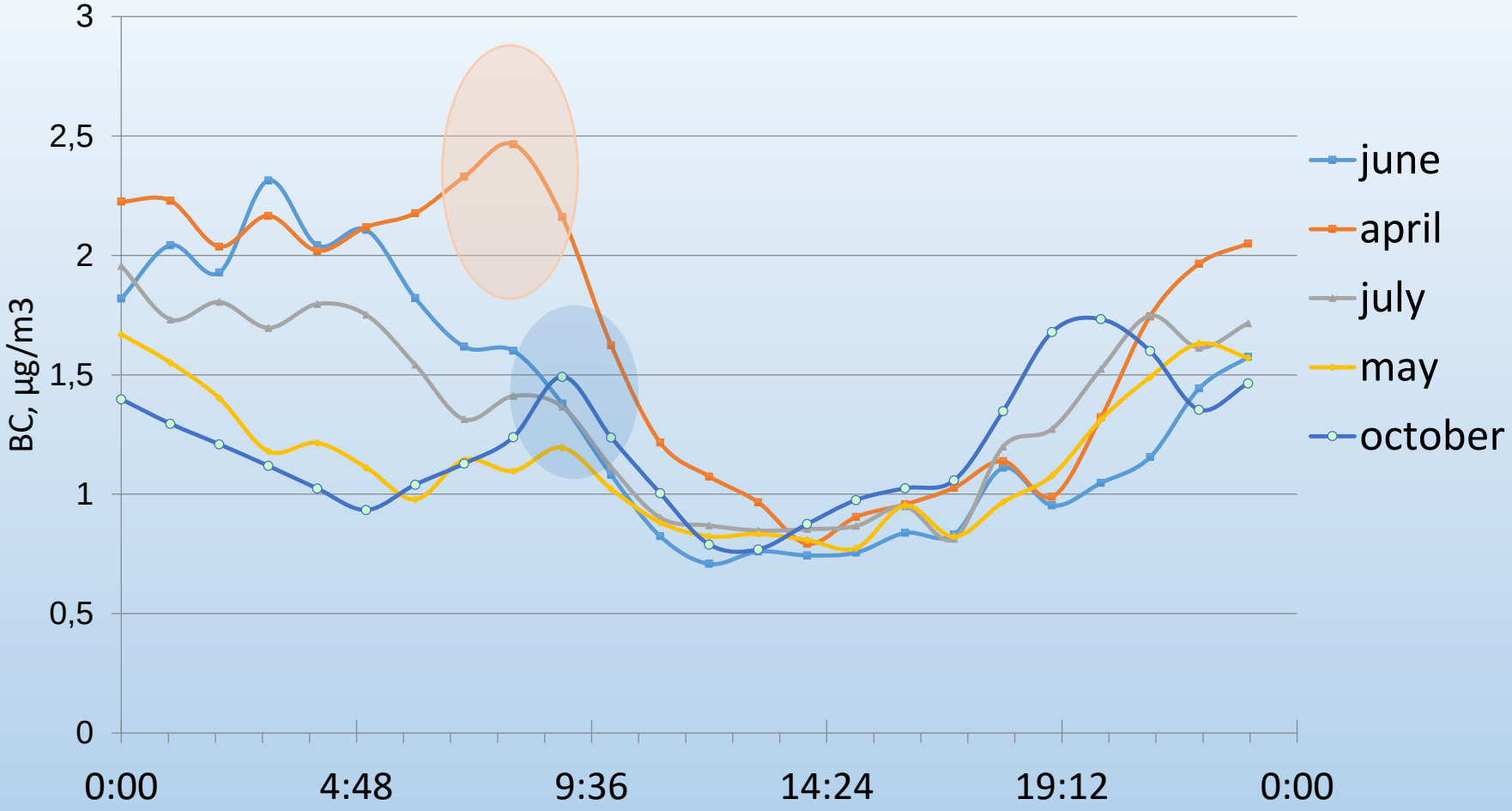
Transport, industry

Black carbon pollution

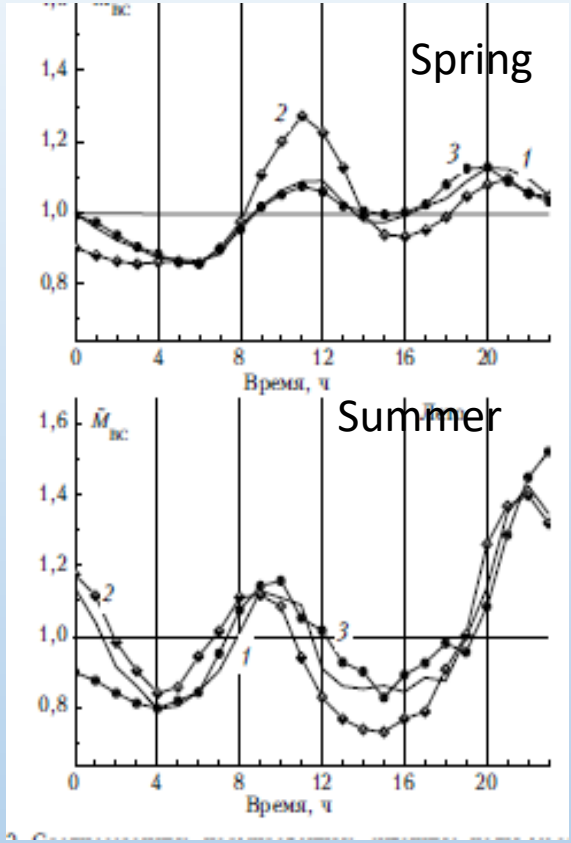
17 April -22 May 2018



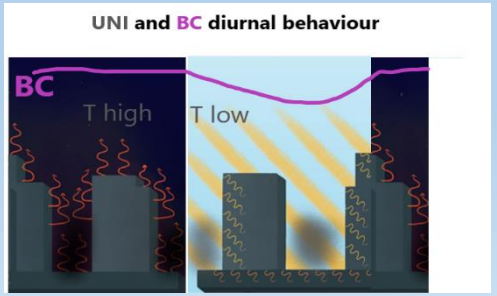
Diurnal variations of hourly BC concentrations, April – July 2019



Tomsk city



Kozlov et al., 2010



Specific features in Moscow megacity:

- morning maximum during months of heating system operating
- high BC nocturnal level ~ relation to UHI

GOALS of WP2

- Quantifying aerosol **day-to-night pollution**
  based on phenomenon of **stable high nocturnal atmospheric boundary layer**
  related to the diurnal variability of **BC and PM2.5 mass, and size - segregated particle number.**

- Establishing the **diurnal variability** of aerosols and its relations to **temporal characteristics of urban heat island** intensity

- Identification of the **source for particular dynamics** of **stable high BC pollution at night time** , including the **type of used fuel and activity** impacted the pollution accumulated in the atmosphere due to intensive emission of combustion sources.

- **Daily chemical dynamics** will be clarifying the intensity and evolution of main pollution sources related to traffic, biomass burning, waster combustion, and long transportation

- Assessing the pollution of urban environments with heavy metals, metalloids, polycyclic aromatic hydrocarbons, water-soluble ions in the atmosphere and depositing from the atmosphere.

Laboratory of Urban Environment with state-of-the-art observational capacity

Atmospheric division

Long-term comprehensive observations will be performed on Aerosol Instrumentation Complex MSU

Aerosol Instrumentation Complex MSU- infrastructure

for measurements of optical and physico-chemical properties of ambient aerosols

Automatic Sampler PNS

LVS sampler

Optical particle counter > 300 nm – 10 µm

Aethalometer AE33

8 stages

Impactor 180 nm – 10 µm Moudi 100NR

Optical and physicochemical properties of aerosols

1. **Physical properties** :

- particle number density and size distribution

TSI Optical particle counter 3330, 300 nm – 10 µm

***objectives**: continuous measurements of particle number in a range of size distribution from **ultrafine nanoparticles up to microparticles**, including the dust from soil, will allow to identify the formation of **new particles and secondary aerosols** in dependence on daytime and season.*

***Need from University of Helsinki**: expert in nanoparticles studies, SMPC installation and work*

2. **Size - segregated chemical composition**:

- bulk composition of PM10 and PM2.5

objectives: comprehensive in-situ 12h day and night sampling. Characterization by analytic chemistry **water-soluble ions**, PAH, and element concentrations, *OC-EC*

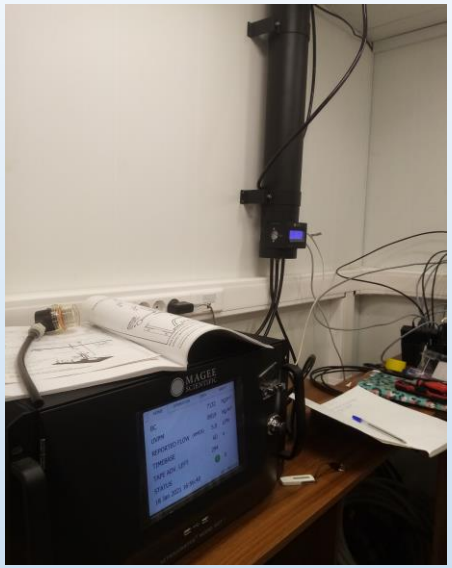
- collecting size-fractionated particle composition in 180 nm to 10 µm aerodynamic diameter range by MOUDI impactor.

***Need from University of Helsinki**: training and analytic work of MSU PhD student/ student*

Results: Assessments of diurnal and season processes of accumulation the pollutants in the atmosphere and precipitation, associated to evolution of main sources of pollution in a megacity.

3. Optical properties:

- continuous diurnal and season optical absorption measurements in the whole solar radiation range of Black carbon and BC components:



BC ff - produced by fossil fuel combustion

BC bb - biomass burning

Two wavenumber aethalometer model*: At first time the absorption coefficient at short wavenumbers will provide the assessment for the impact of biomass and waste burning in comparison with fossil fuel (gas, diesel, gasoline) combustion evaluated at long wavenumbers.*

Objectives:

Observation of diurnal variability of BCff and BC bb in cold and warm seasons on line with PM2.5.

Analyses of phenomenon of stable high BC at night.

Expected results:

- noticeable particularity of BC diurnal profiles and variability in Moscow megacity.
- dominant optical absorption by BCff due to transport/industry emission vs BC bb
- impact of season on BC diurnal and spatial variability and level of pollution BC/PM2.5.
- identification of mechanism of interaction between of stable nocturne BC to UHI intensity at night.