Pikkaajalised atmosfääriuuringud Tartu Ülikoolis

Professor Heikki Junninen

Atmosfääri ja keskkonnateaduste labor

Füüsika instituut

LAES
Laboratory of Atmospheric and Environmental Sciences

Tahkuse and Järvselja SMEAR stations

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are located in rural areas. Tahkuse surrounded by agriculture and Järvselja by managed forest and natural park.

- Trace gases
- Aerosols
- Meteo
- Longterm measurements
- Campaigns

Longterm stations with comprehensive measurements of atmospheric composition

Aerosol science in Estonia is almost 100 years old

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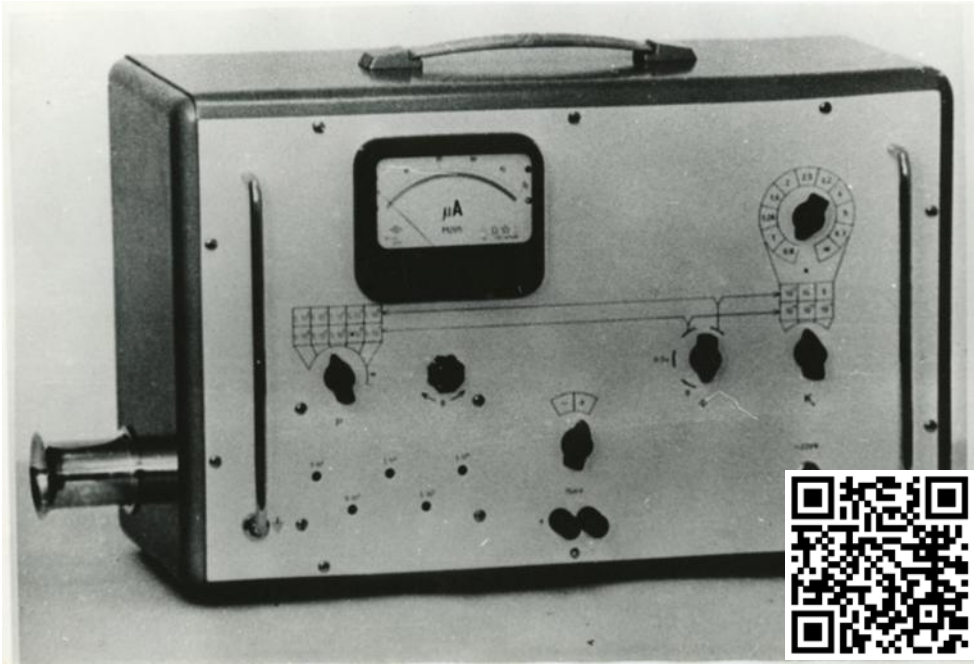
- 1930 Prof. **Johan Vilip** first Gerdien counter to Tartu (ion counter)
- 1937 full year long measuremnts of air ions, master student **Anatoli Mitt**.
- 1950 **Jaan Reinet** starts building air ion instruments
- 1963 **Jaan Salm** First portable ion counter
- 1972 First multichannel ion spectrometer **H. Tammet**
- **1988 starting permanent air ion measurements at Tahkuse station**
- 2022 first time of flight mass spectrometer, 2023 ion-mobility mass spectrometer
- **2024 LAES – Laboratory of Atmospheric and Environmental Sciencies**

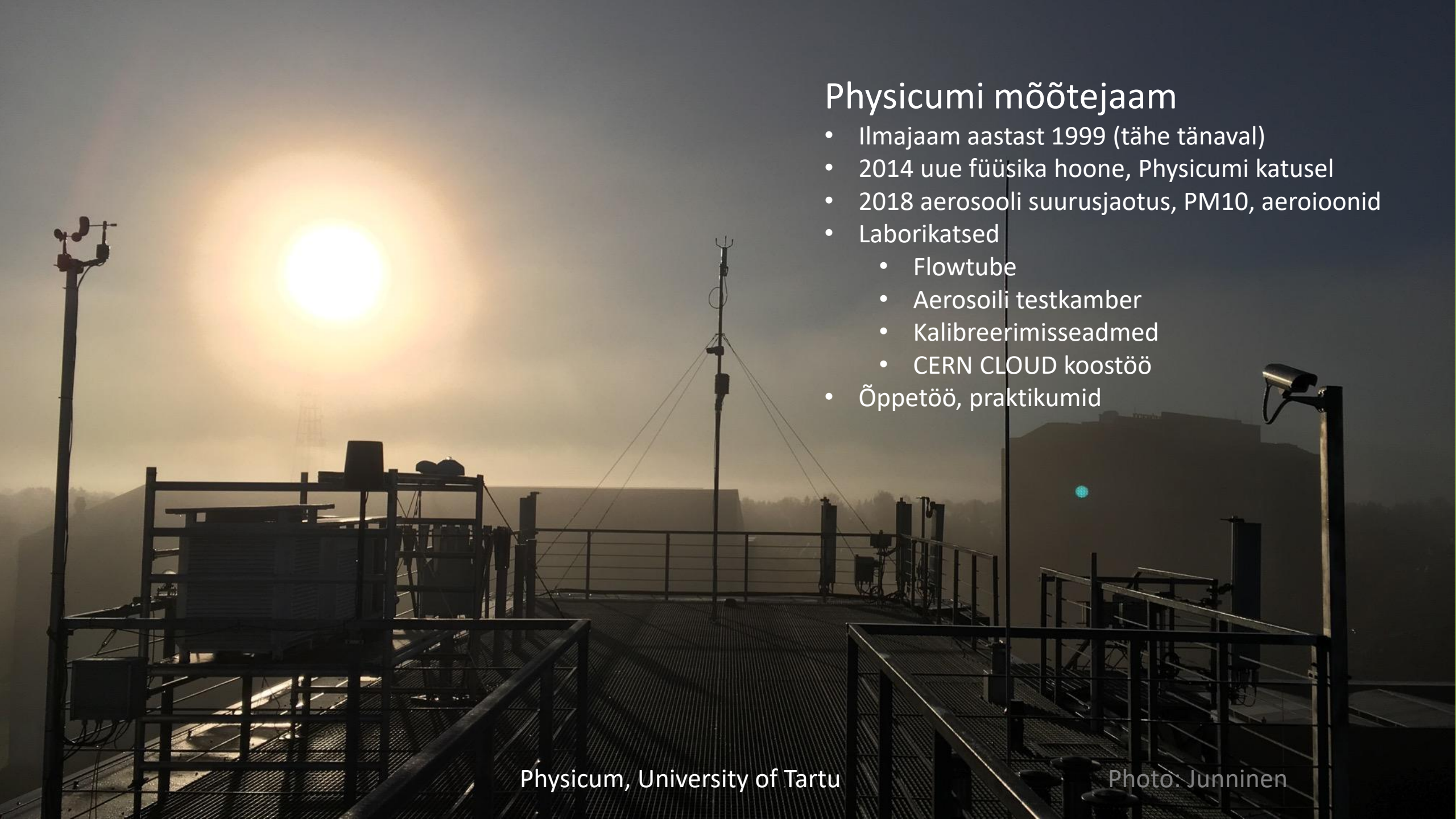


(https://www.muis.ee/museaalview/3354491)

1988

Sisend ja aparatuur aeroioonide suurusjaotuse mõõtmiseks. Tahkuse mõõtejaamas

Fotod. H. Tammet



Physicumi mõõtejaam

- Ilmajaam aastast 1999 (tähe tänaval)
- 2014 uue füüsika hoone, Physicumi katusel
- 2018 aerosooli suurusjaotus, PM10, aeroioonid
- Laborikatsed
  - Flowtube
  - Aerosoili testkamber
  - Kalibreerimisseadmed
  - CERN CLOUD koostöö
- Õppetöö, praktikumid

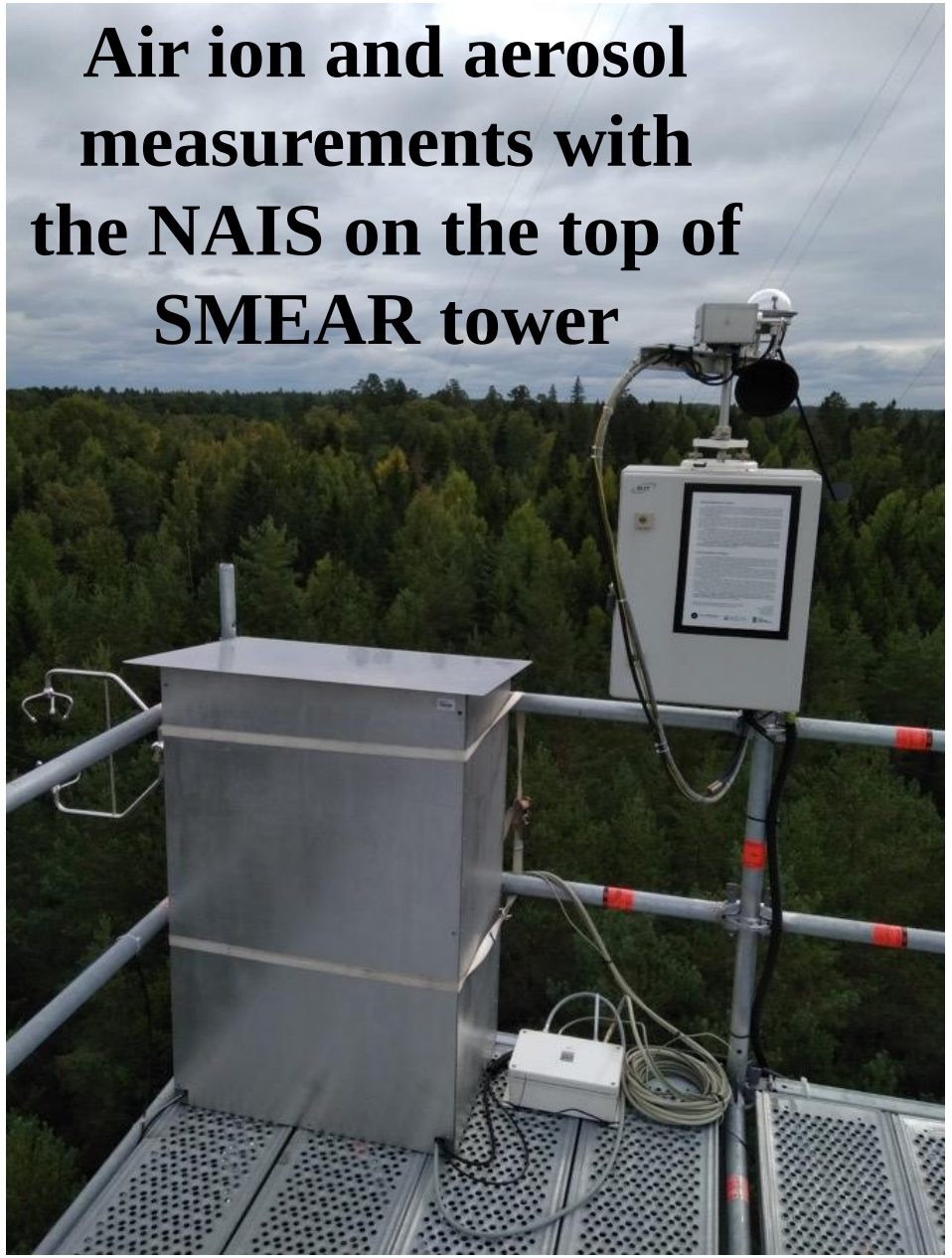
Physicum, University of Tartu

Photo: Junninen

SMEAR Estonia, Järvselja, 2014

New measurement container spring 2018

Measurements from gases to nanometer size particles



Air ion and aerosol measurements with the NAIS on the top of SMEAR tower

Koostöös EMÜ, S. Noe.

Gas profile measurements:

- CO_2
- NO_x
- O_3
- SO_2
- CH_4
- H_2O

Meteorology

- Temperature
- Pressure
- Relative humidity
- Wind

Fluxes

Photo: Heikki Junninen

Esmakordselt maailmas mõõdeti osakeste tekkepuhang Tahkuse mõõtejaamas 1989. Suurusjaotus!

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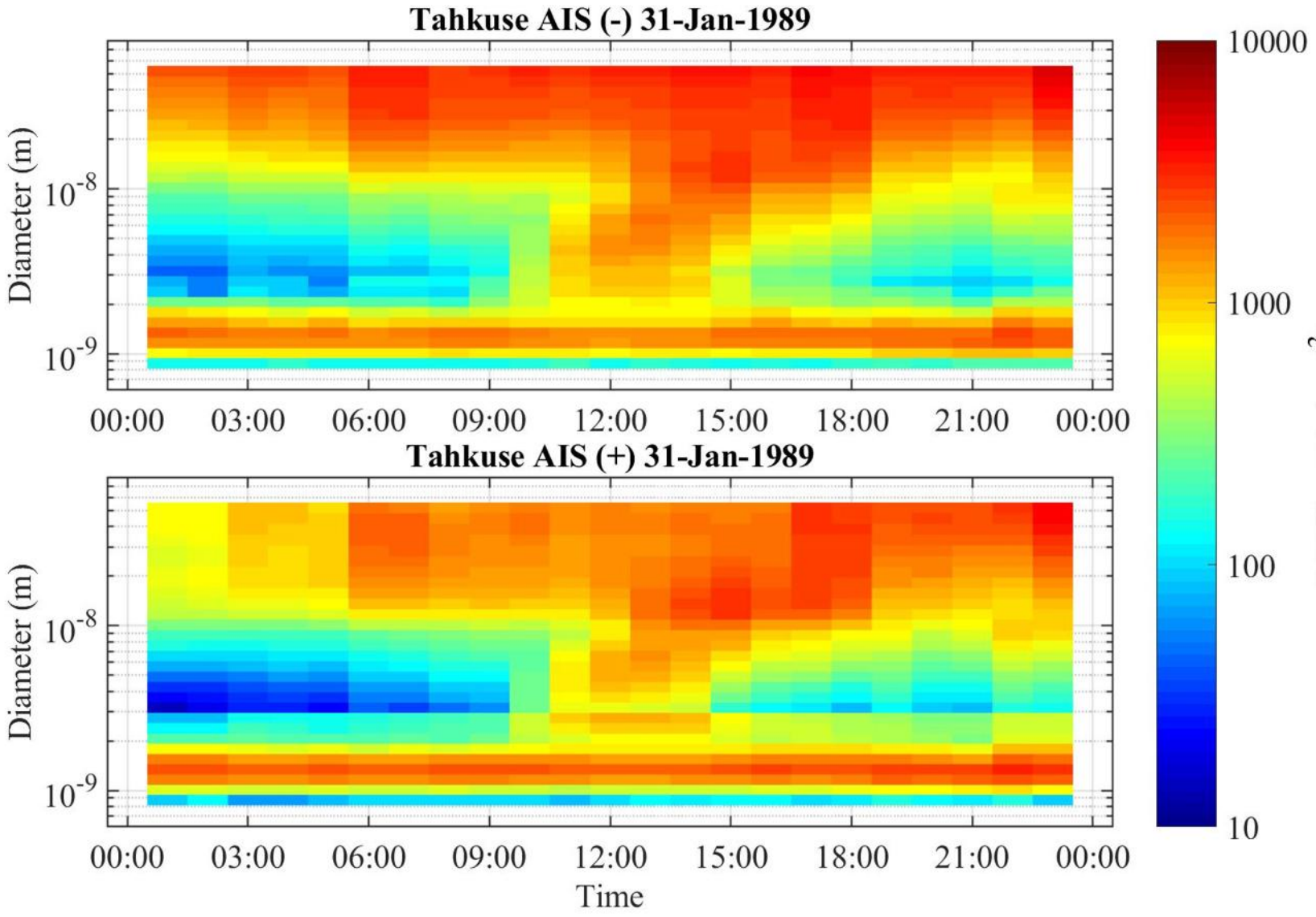
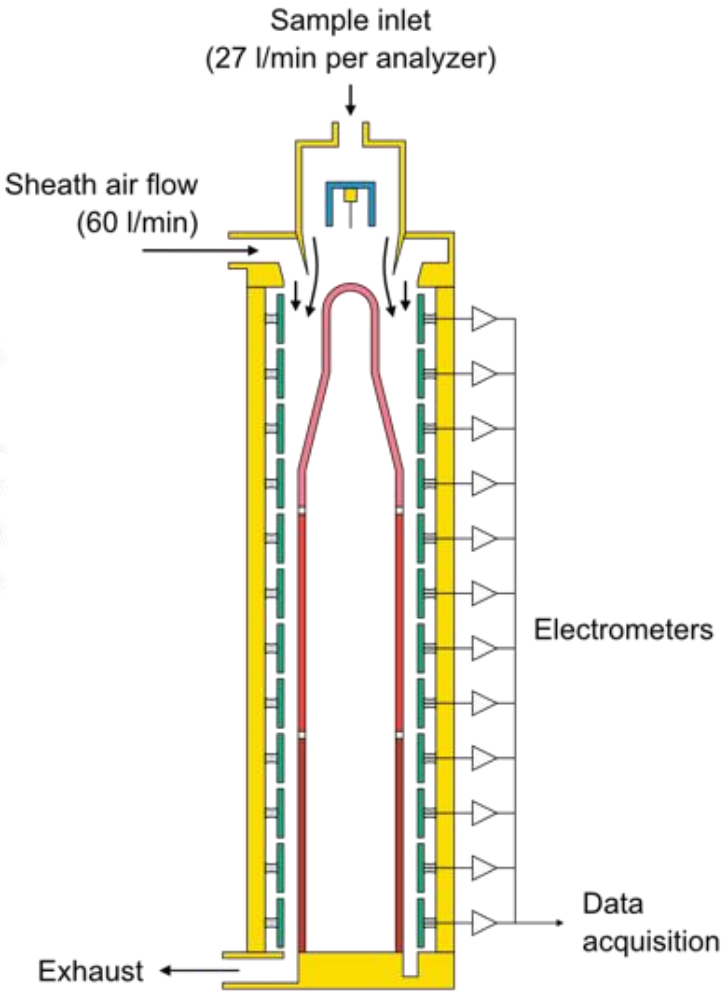


Air ion spectrometer



H. Tammet, E. Tamm, A. Mirme and S. Mirme

Seadmed aerosooli osakeste suuruse mõõtmiseks

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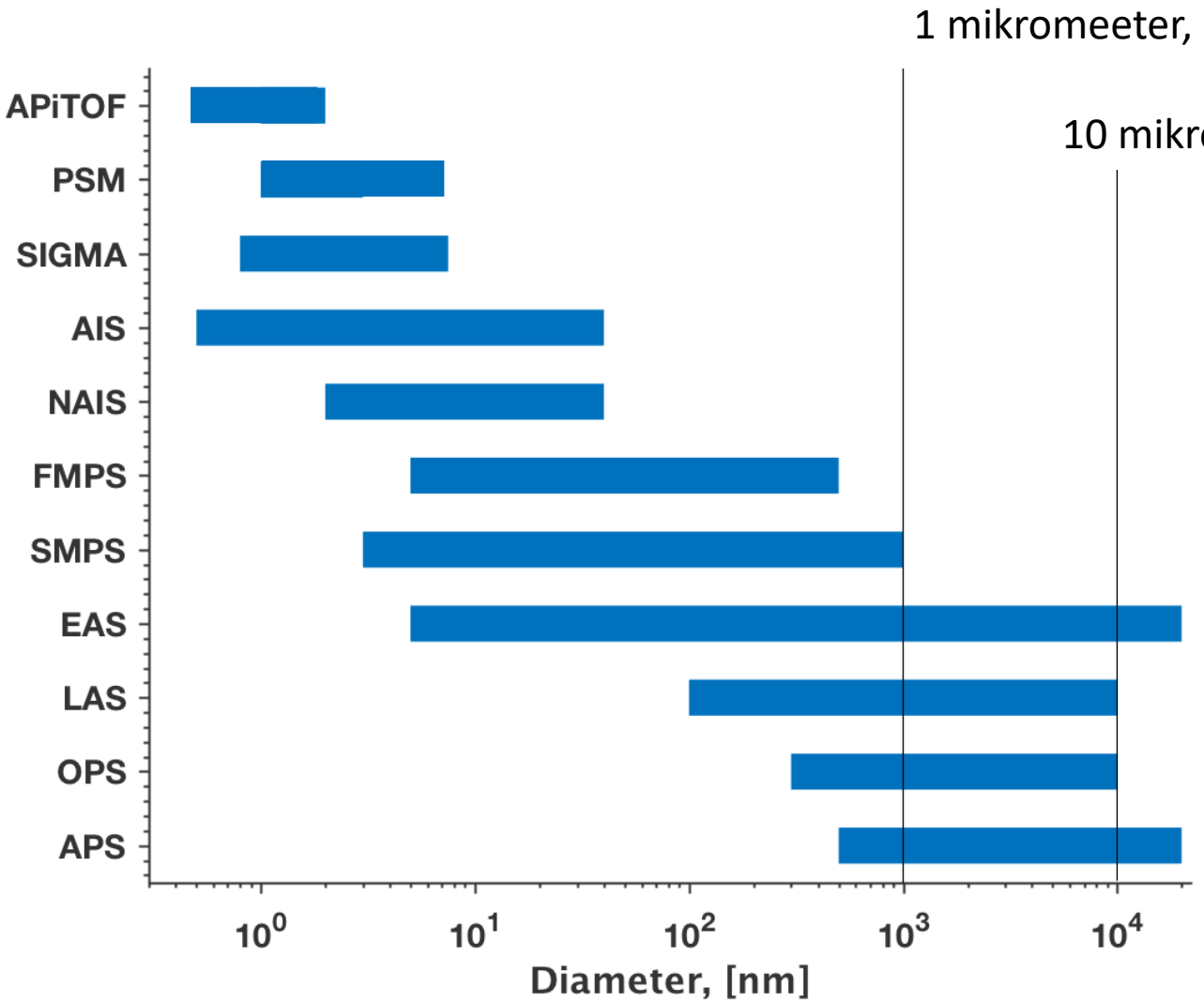
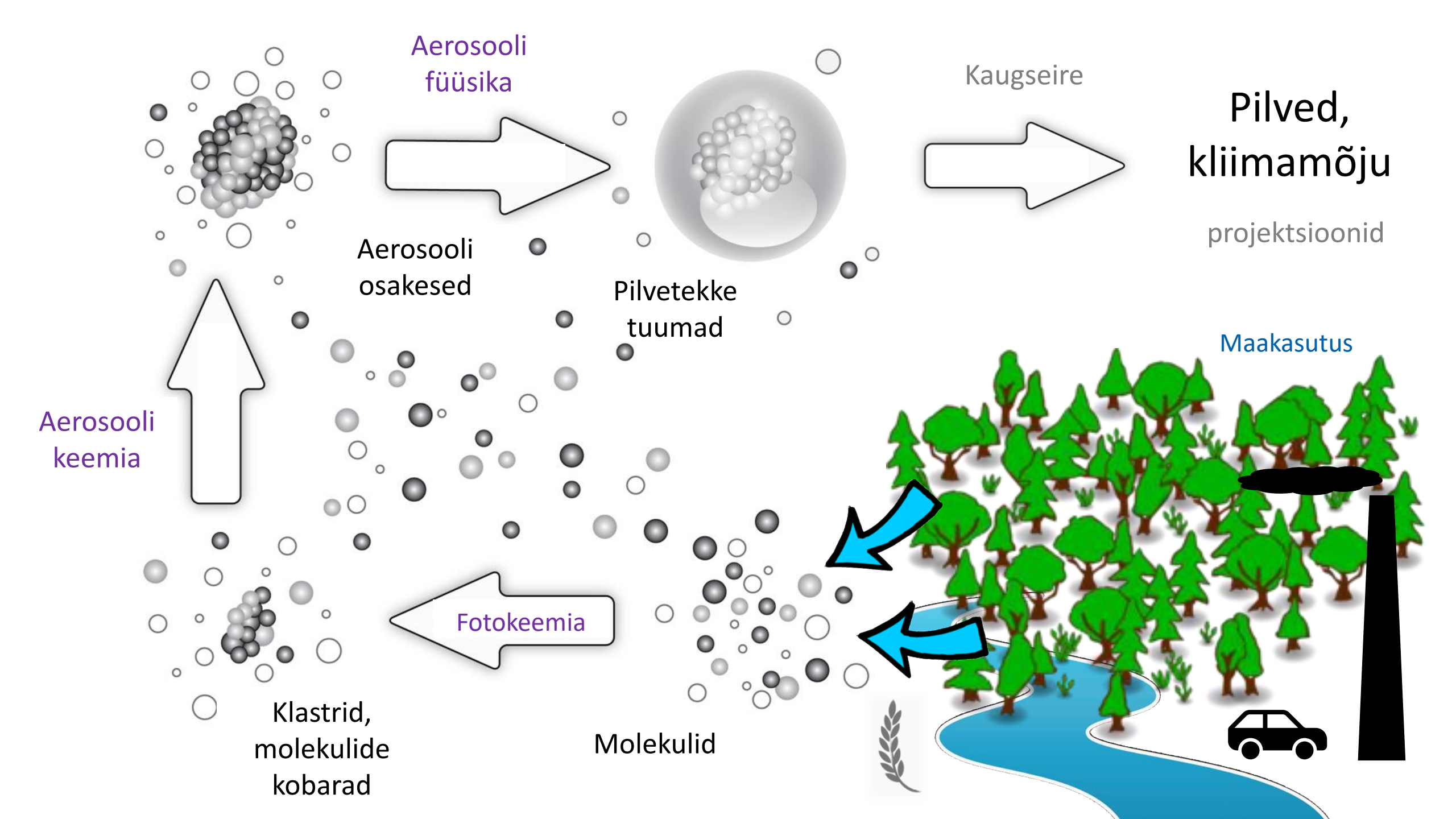


Massispektromeetrid

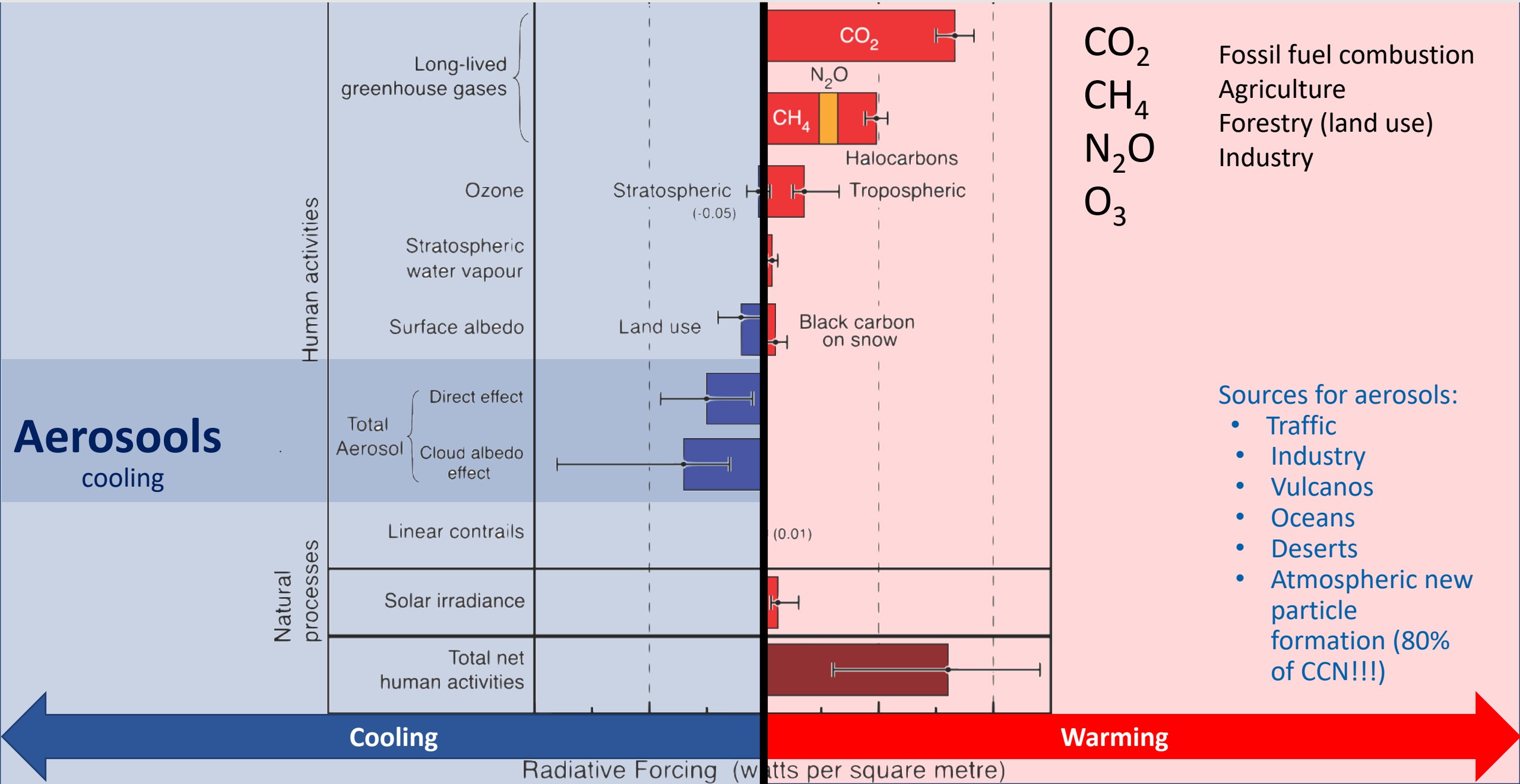
Kondensatsiooni loendurid

Liikuvusanalüsaatorid

Optilised loendurid


Aerosooli füüsika
Kaugseire
Pilved, kliimamõju
projektsioonid
Aerosooli osakesed
Pilvetekke tuumad
Maakasutus
Aerosooli keemia
Fotokeemia
Klastrid, molekulide kobarad
Molekulid

(Anthropogenic) factors for climate change



Aerosools
cooling

CO_2
CH_4
N_2O
O_3

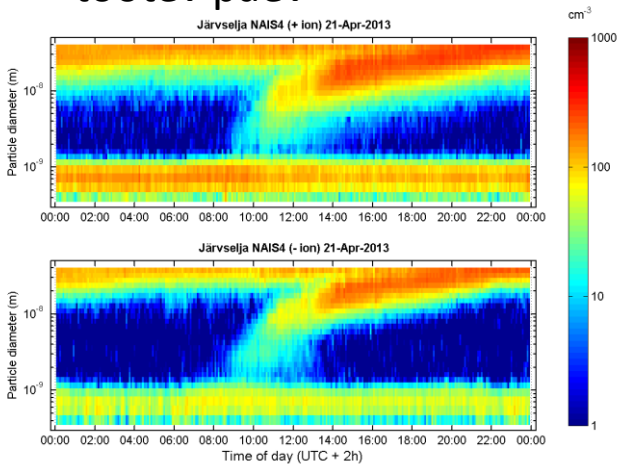
Fossil fuel combustion
Agriculture
Forestry (land use)
Industry

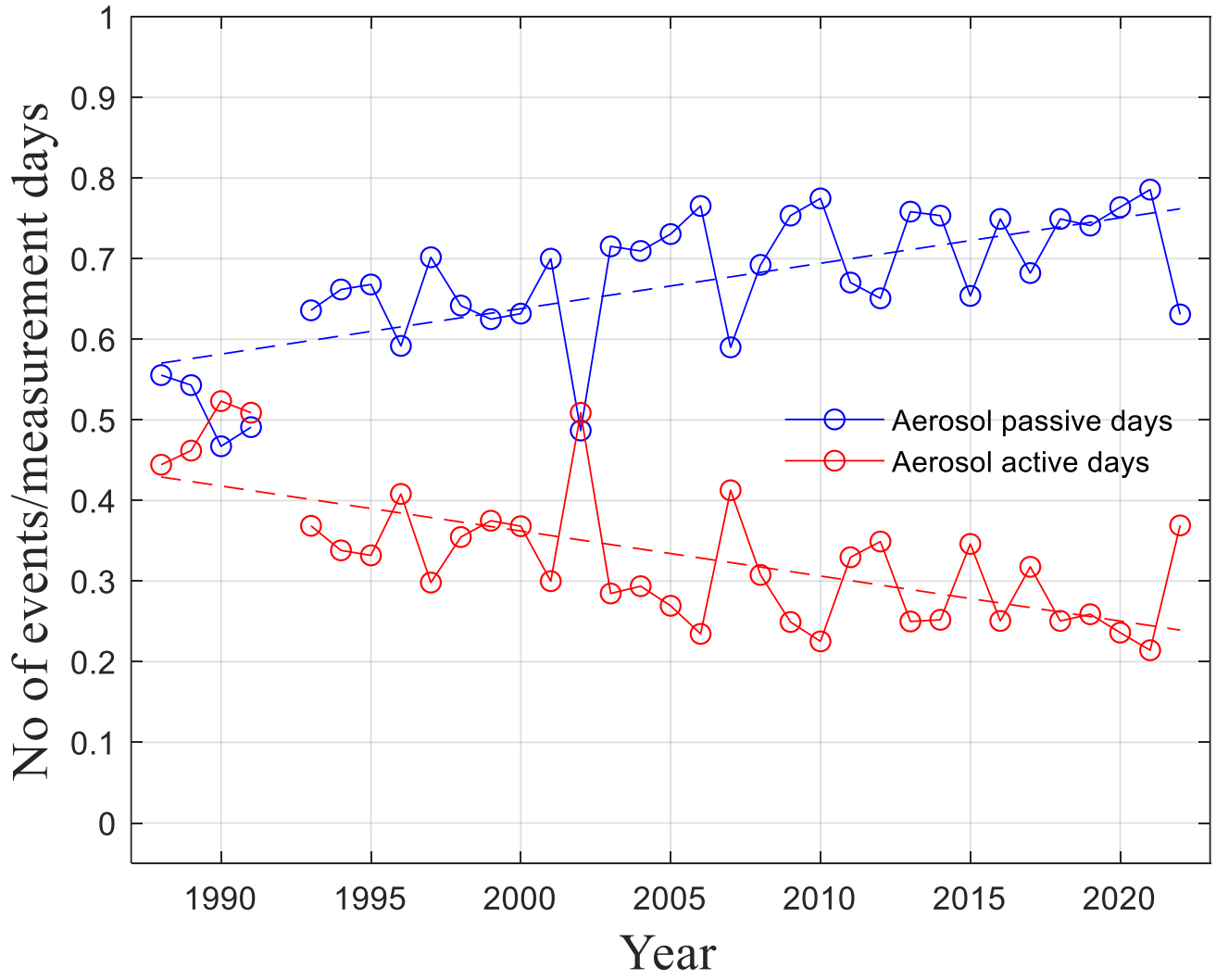
Sources for aerosols:

- Traffic
- Industry
- Vulcanos
- Oceans
- Deserts
- Atmospheric new particle formation (80% of CCN!!!)

Tahkuse,
35 aasta aerosoolide tekkeaktiivsuse kahanemine

Näitena, üks aerosooli tootev päev





Atmosfäär toodab vähem aerosooli osakesi

Aerosol passive days
Sen's slope : 0.0056
alpha: 0.05
p-value: 0.0002
h =1, trend is signficant

Aerosol active days
Sen's slope : -0.0055
alpha: 0.05
p-value: 0.0001
h =1, trend is signficant

Mann-Kendall Tau-b with Sen's Method

Atmosfääri osakestetekke potentsiaal on langemas, Tahkuse mõõtejaam

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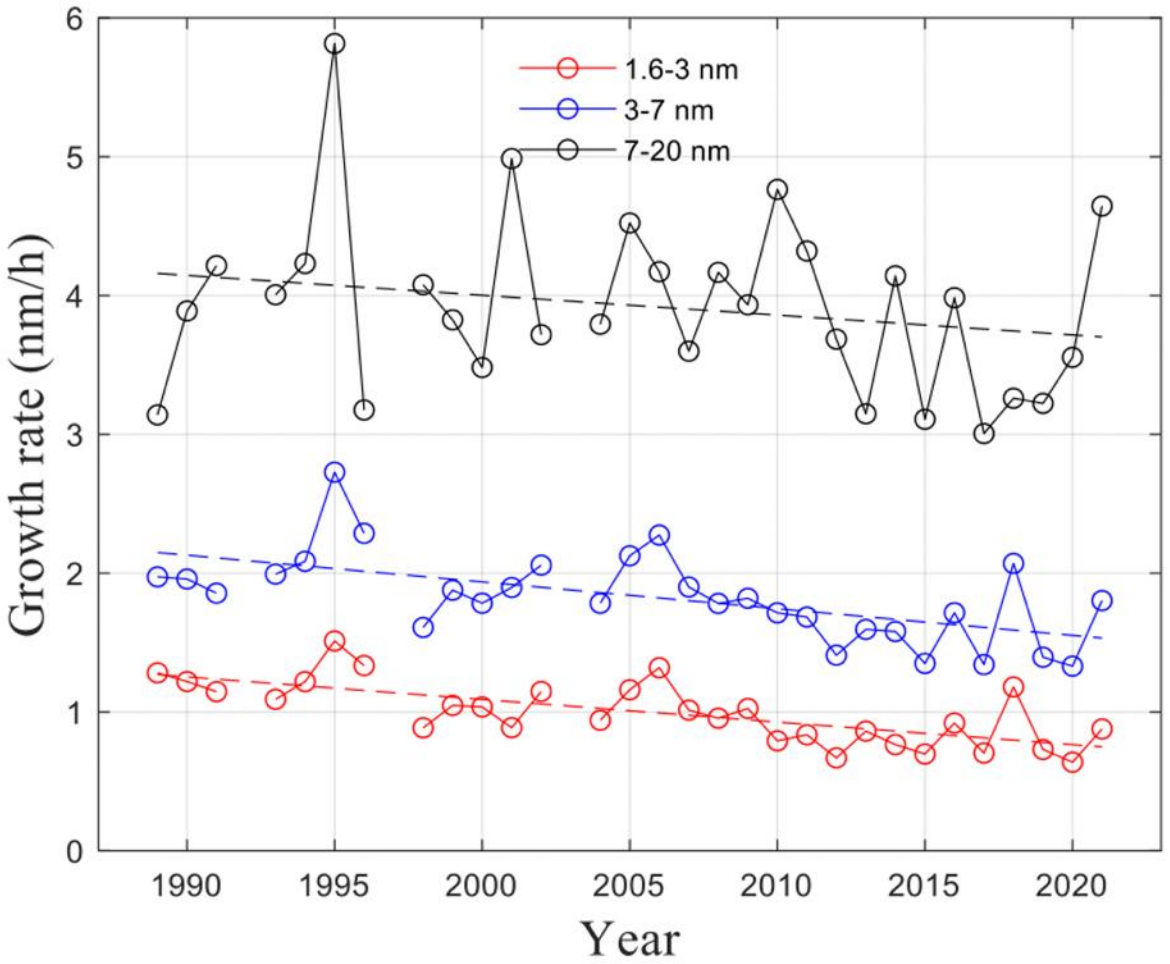
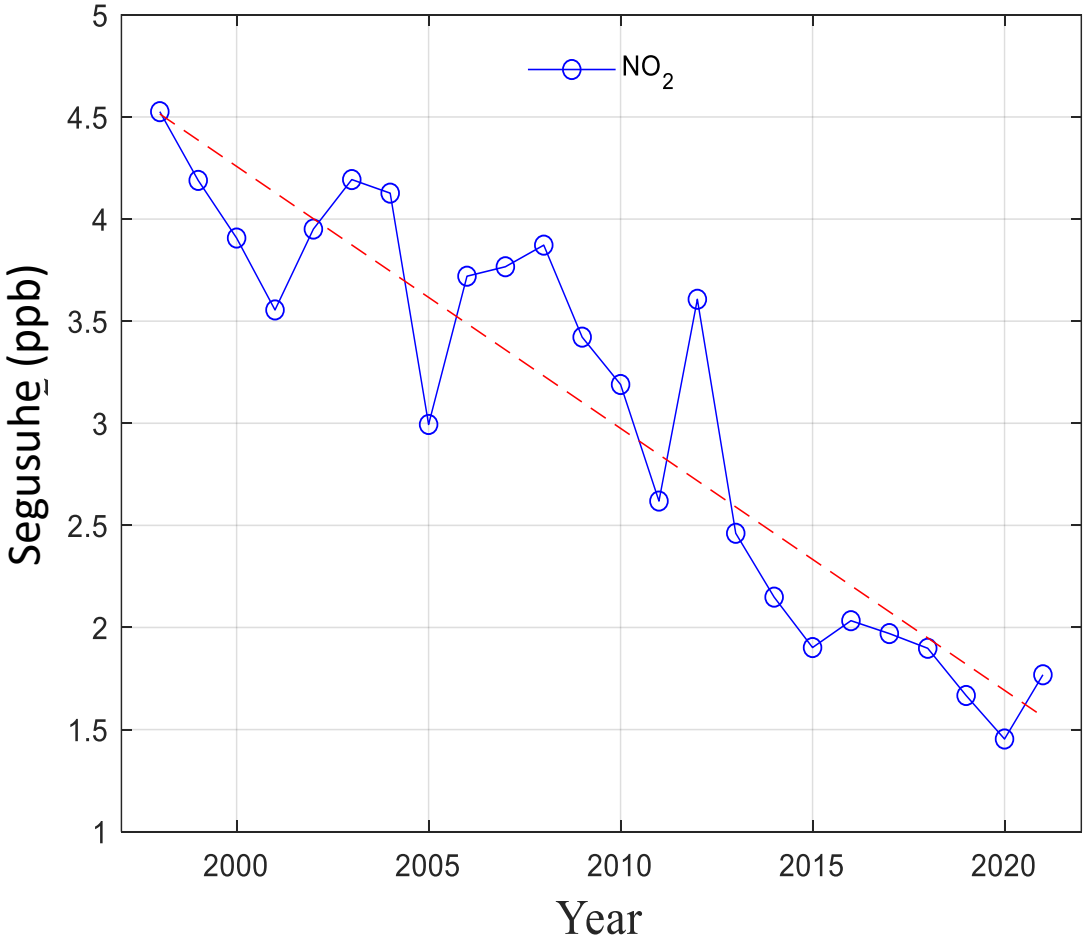
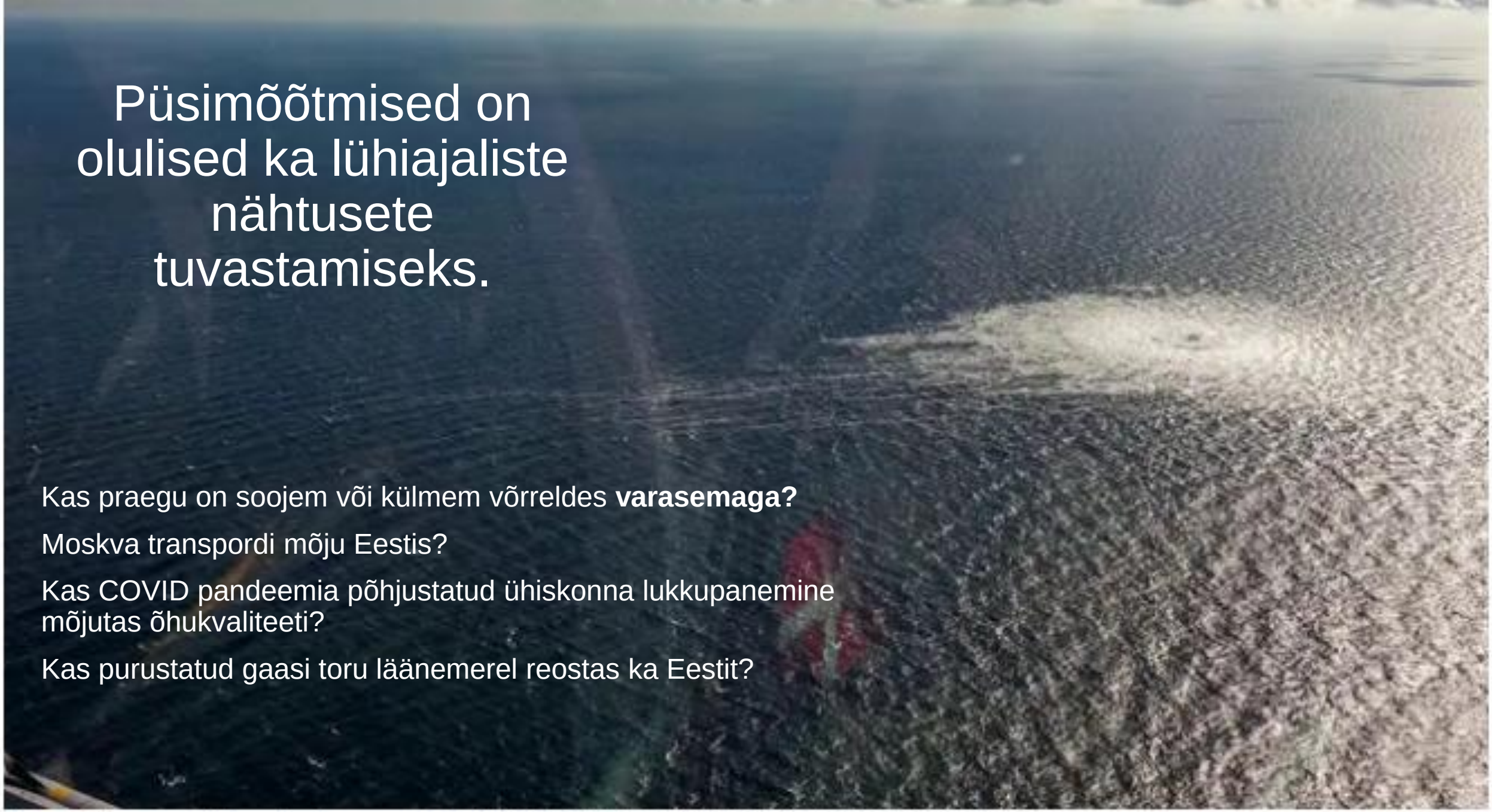


Peamine liiklusest pärinev saaste gaas on NO_2



Püsimõõtmised on olulised ka lühiajaliste nähtusete tuvastamiseks.



Kas praegu on soojem või külmem võrreldes **varasemaga?**

Moskva transpordi mõju Eestis?

Kas COVID pandeemia põhjustatud ühiskonna lukkupanemine mõjutas õhukvaliteeti?

Kas purustatud gaasi toru läänemerel reostas ka Eestit?

Nord Stream 2 leak. Source: SCANPIX/AFP PHOTO/DANISH DEFENCE

Kumulatiivne temperatuur

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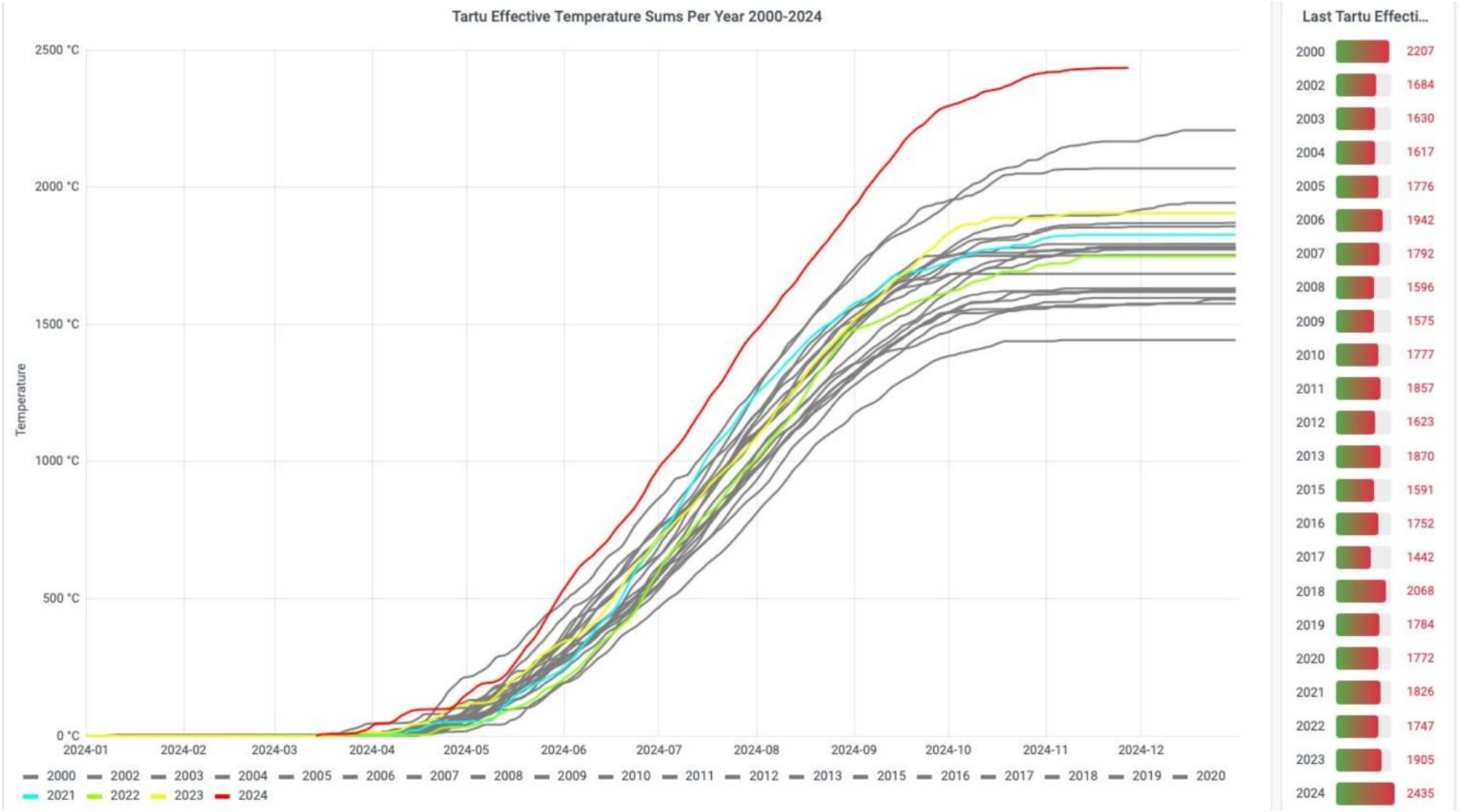
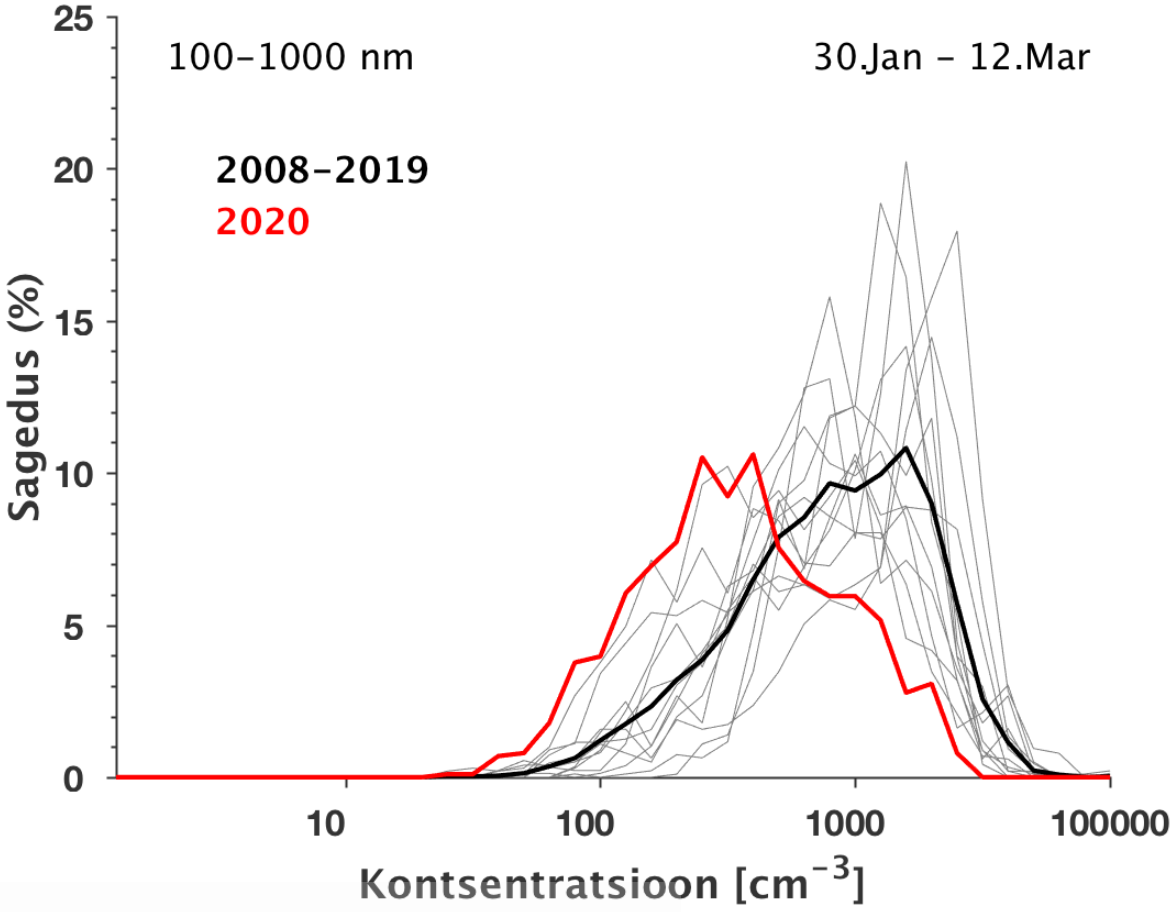
1632

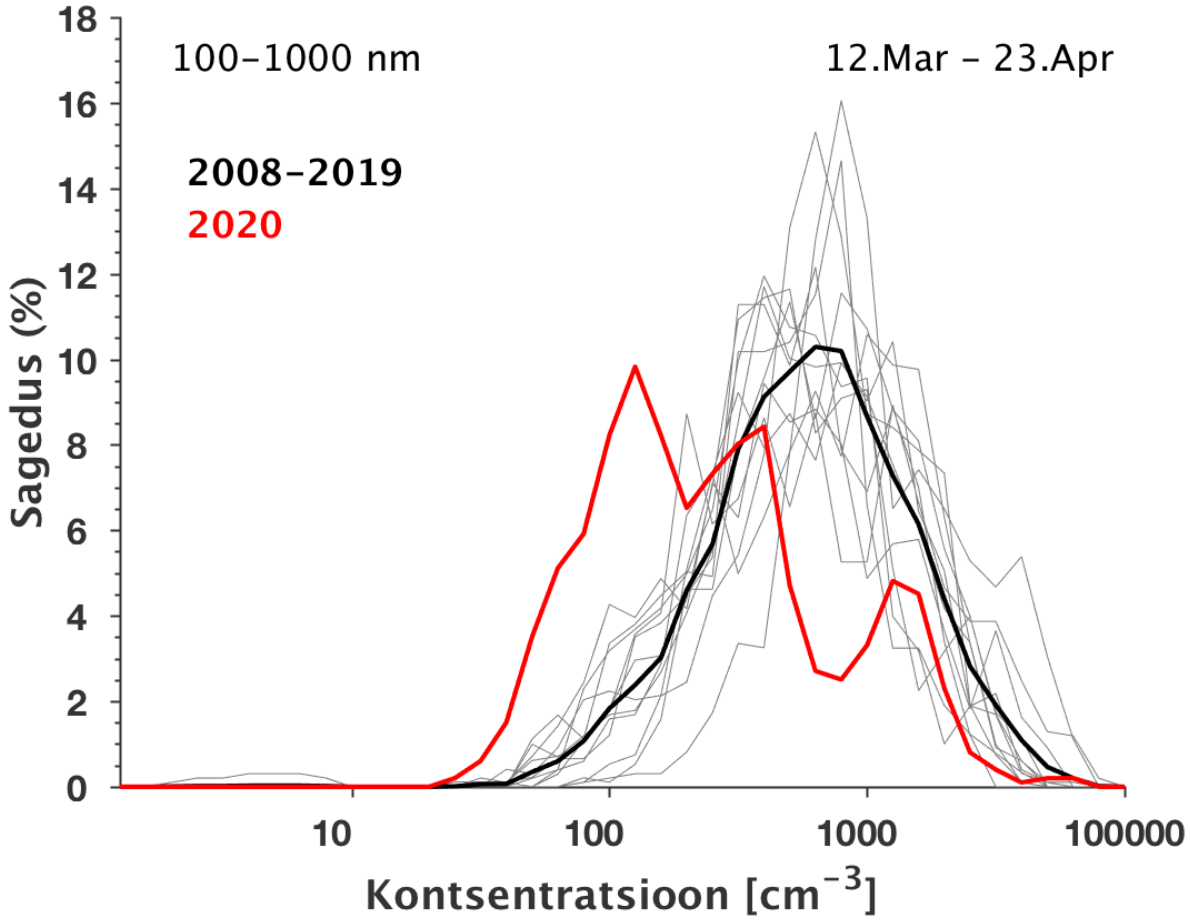


COVID-19 mõjul oli Eestis 13 aasta puhtaima õhuga kevad

Aerosool õhus enne eriolukorda

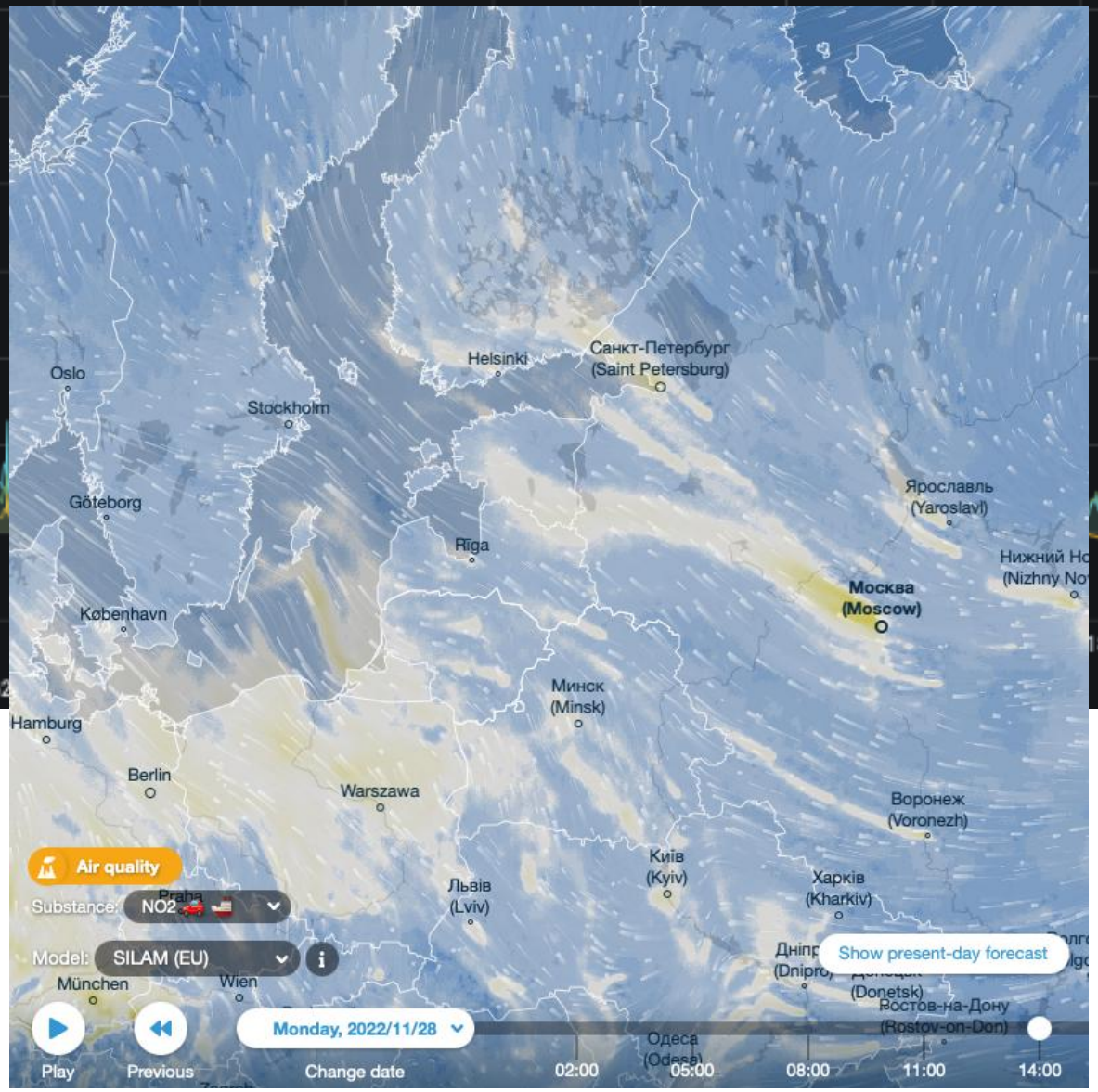


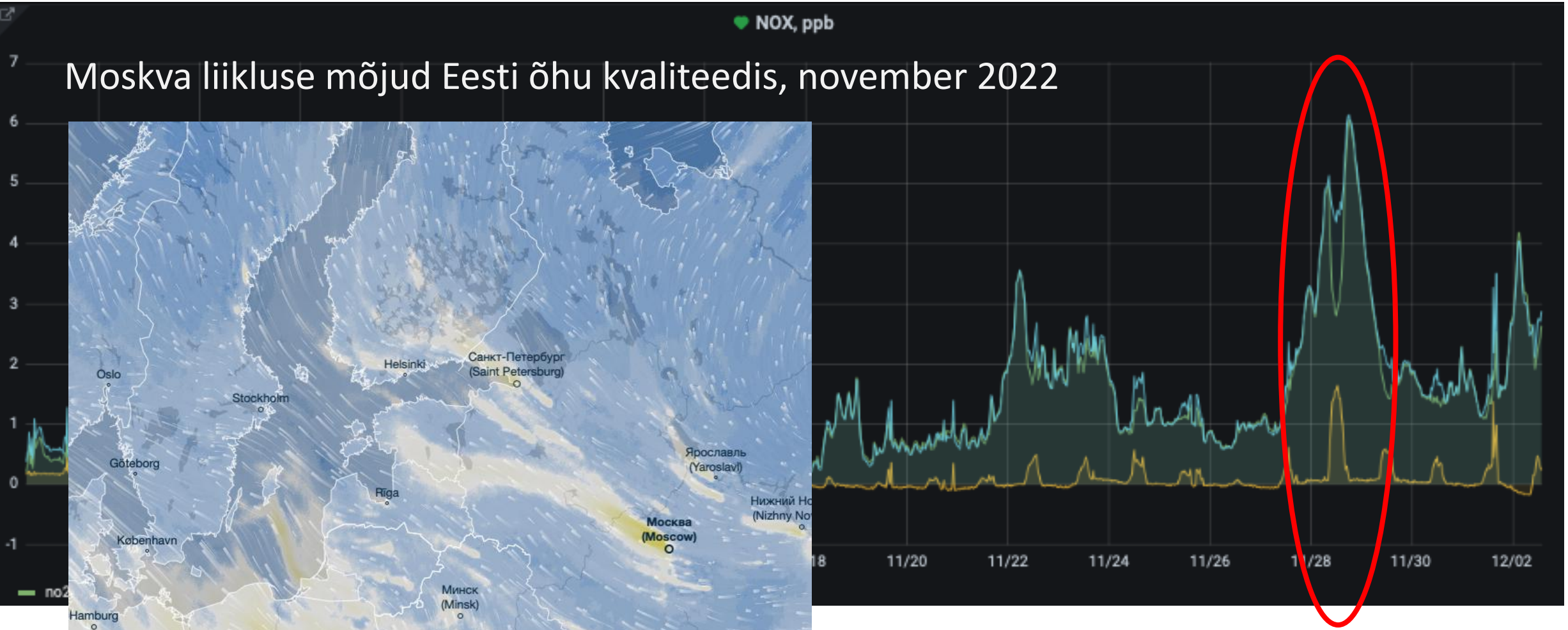
Aerosool õhus eriolukorra ajal

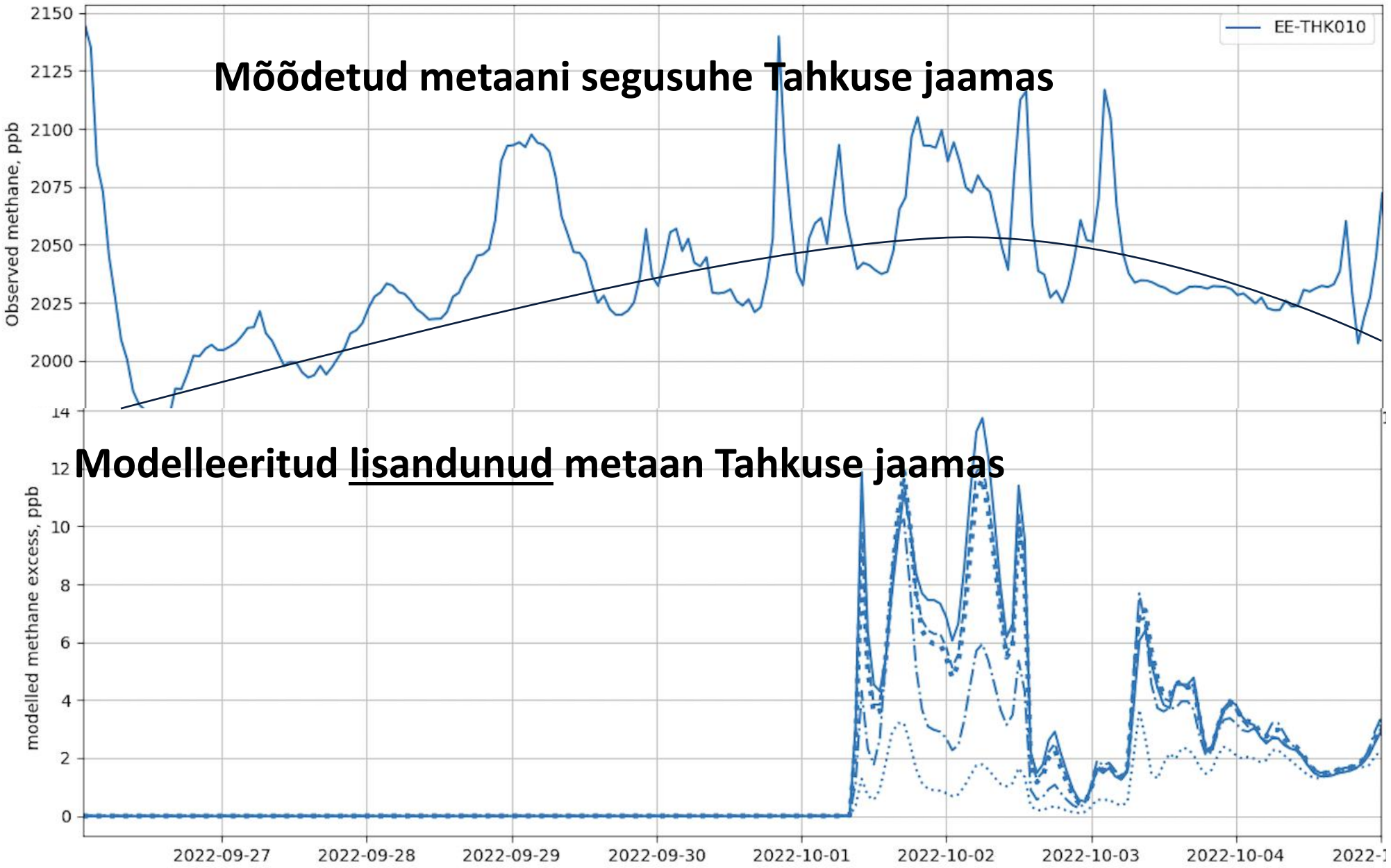


Andmed Tahkuse seirejaamast, Pärnumaalt

Moskva liikluse mõjud Eesti õhu kvaliteedis, november 2022







Kouznetsov, FMI

Pikaajaliste andmete statistiline analüüs.

Aerosooli osakeste nädalased käigud Tahkusel

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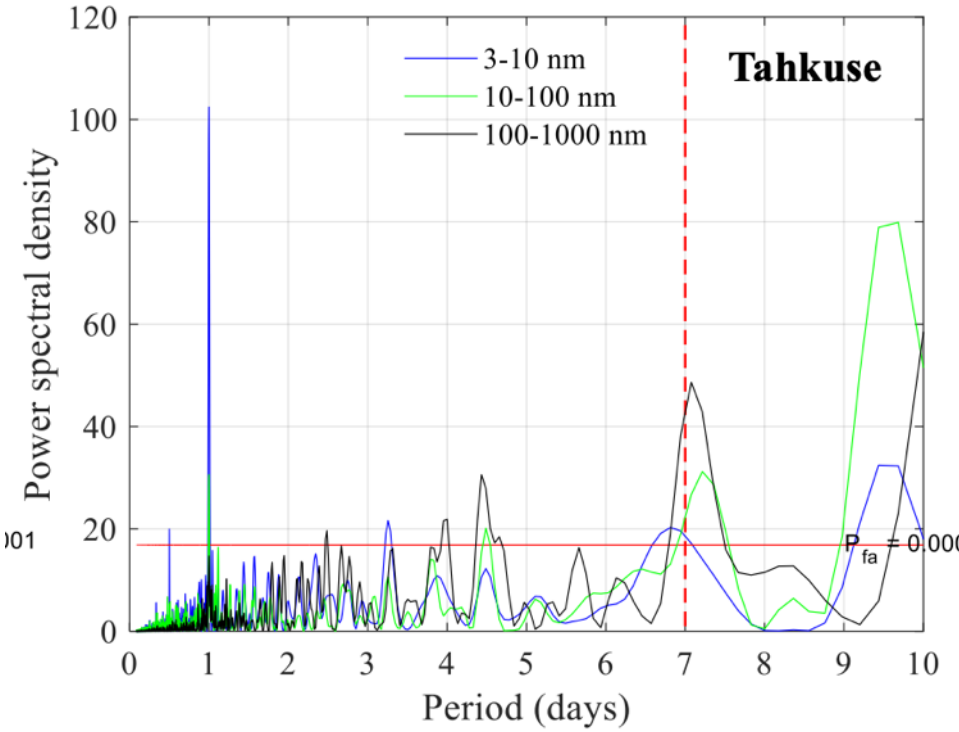
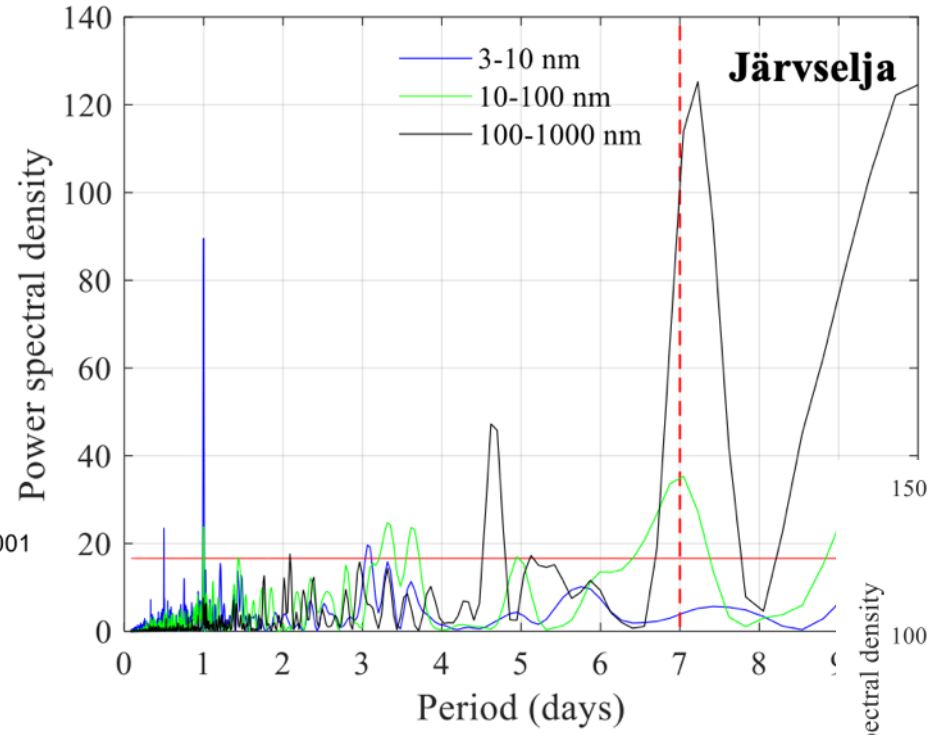
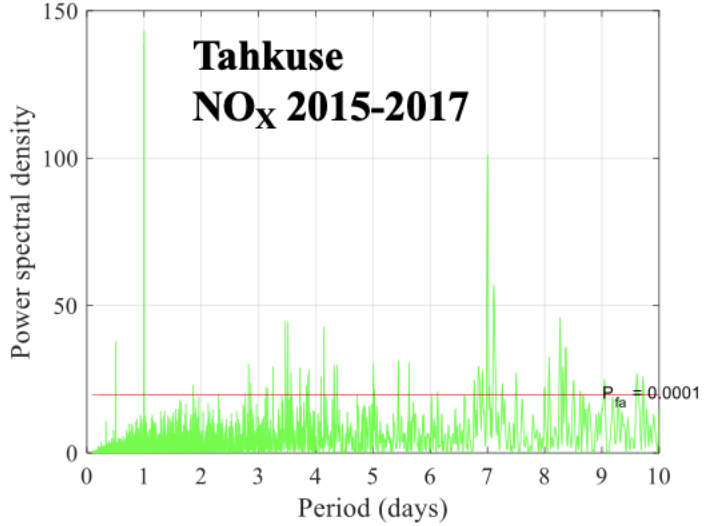
Lomb-Scargle periodograms calculated for the time series of number concentration







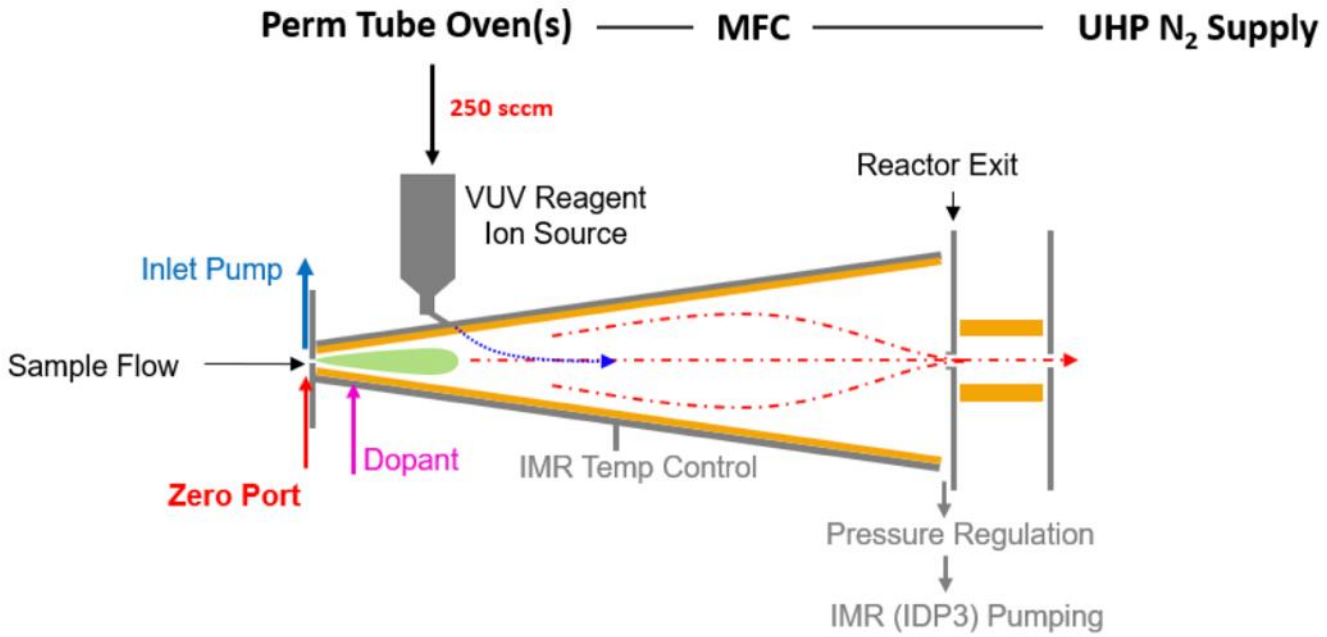
M. Vana

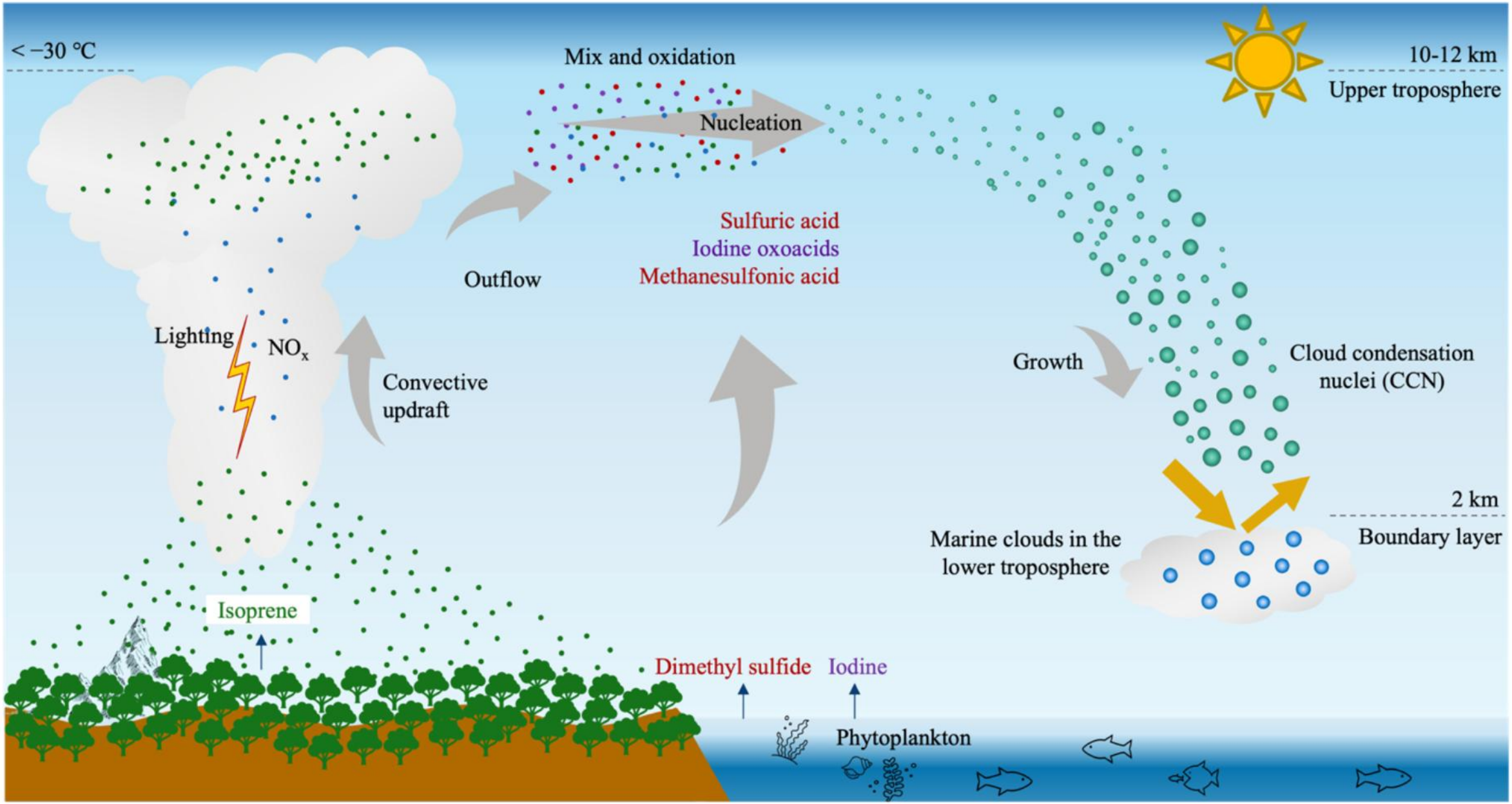
Uued tundlikud massispektromeetrid Järvseljal ja Tartus

PTR-VOCUS (APi-TOF module) and IMS-VOCUS (AIM + PTR)

Charger ions:
Iodite-
Acetone+
Proton+
Benzene+
Nitrate-

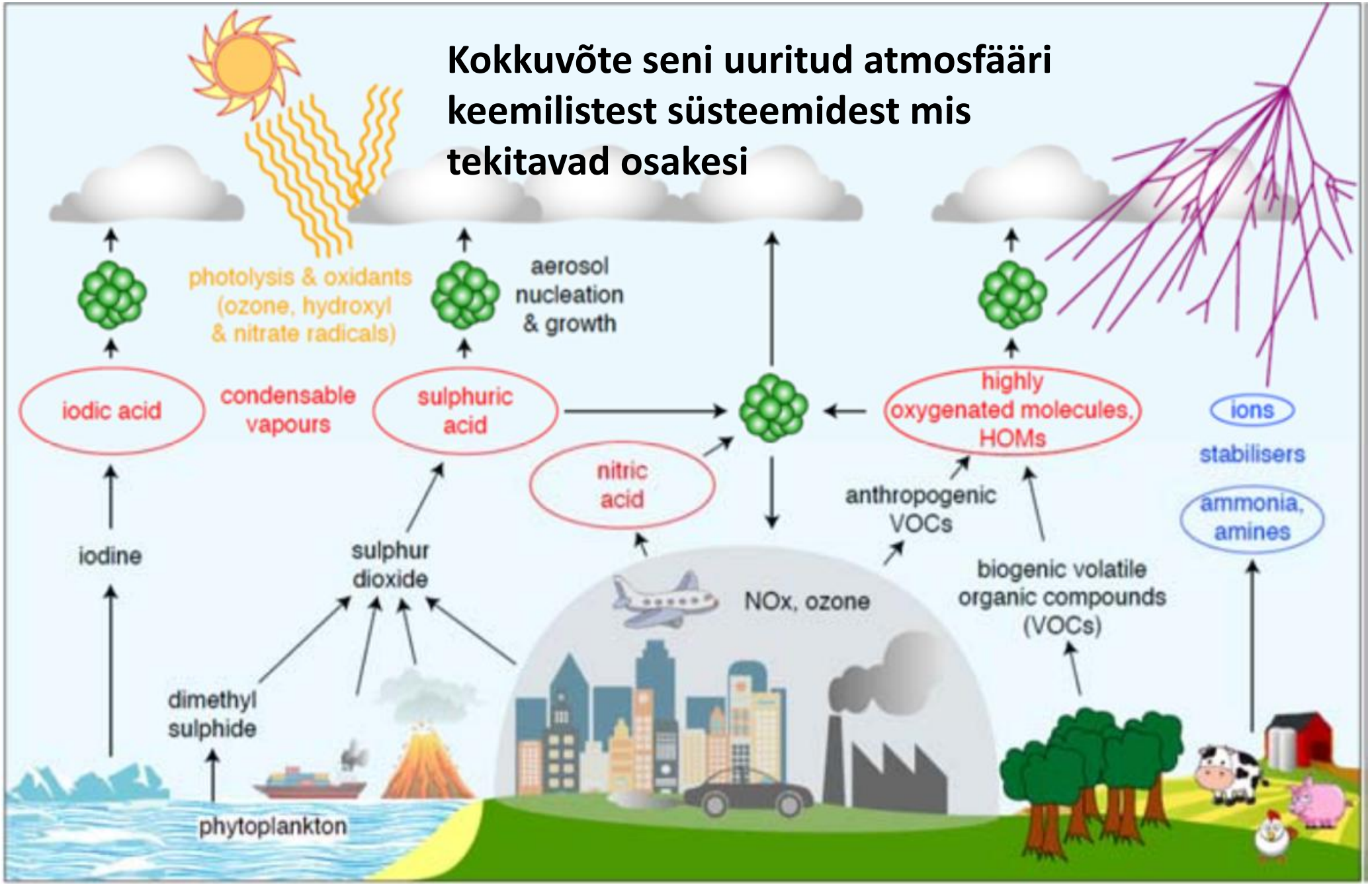
AIM source





Shen, Jiali et al. New particle formation from isoprene under upper-tropospheric conditions. Nature (2024), https://doi.org/10.1038/s41586-024-08196-0

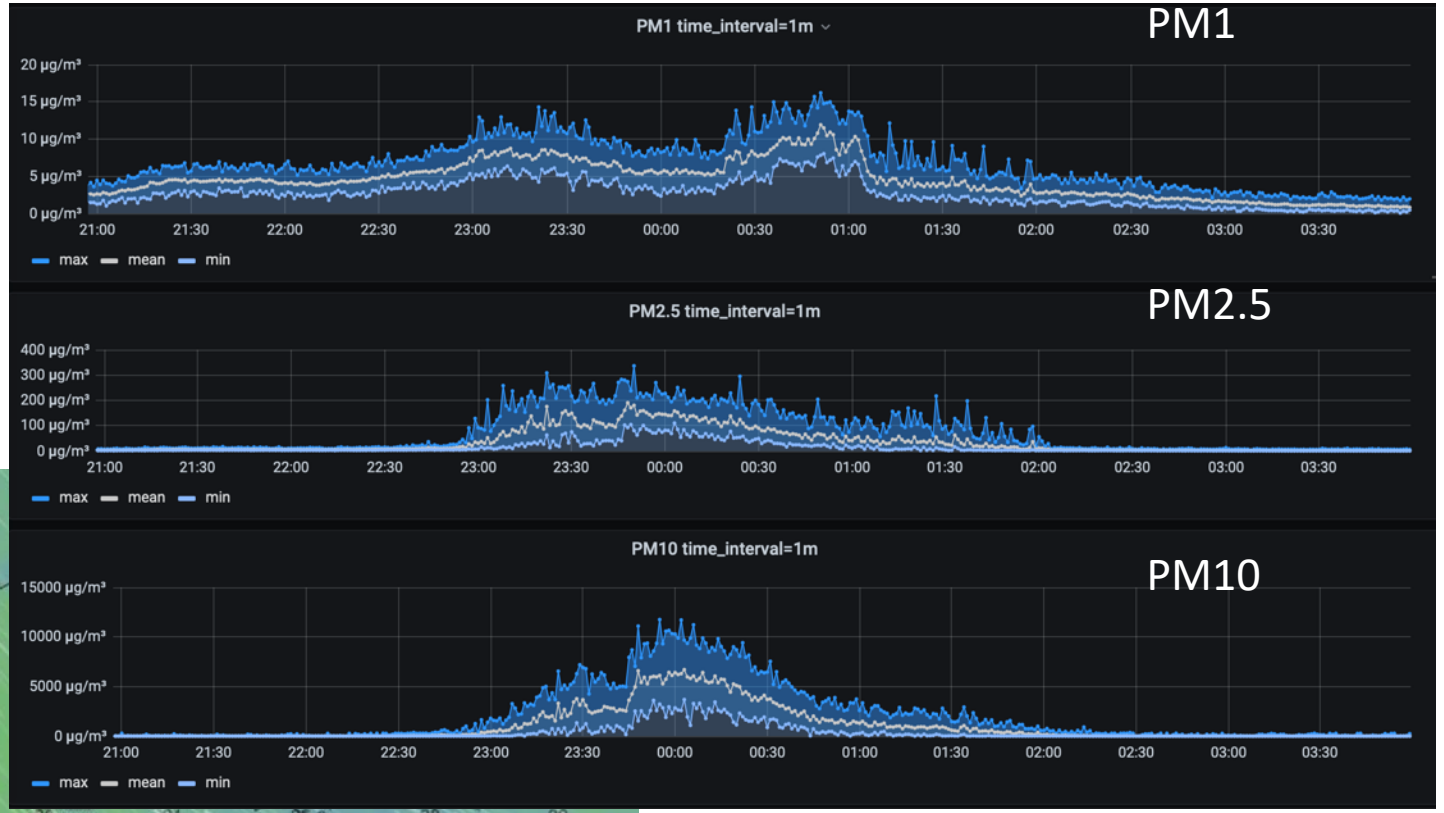
Kokkuvõte seni uuritud atmosfääri keemilistest süsteemidest mis tekitavad osakesi

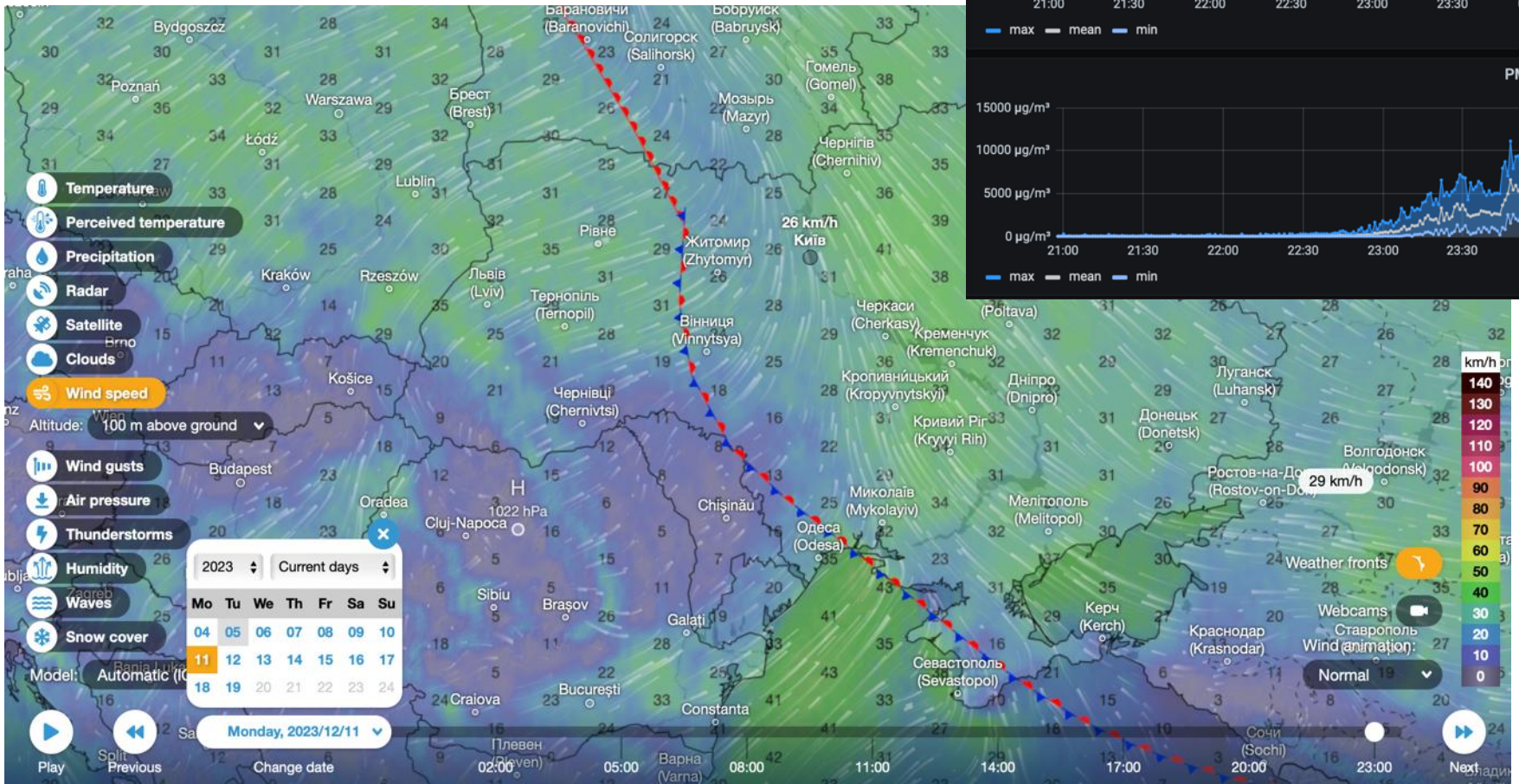


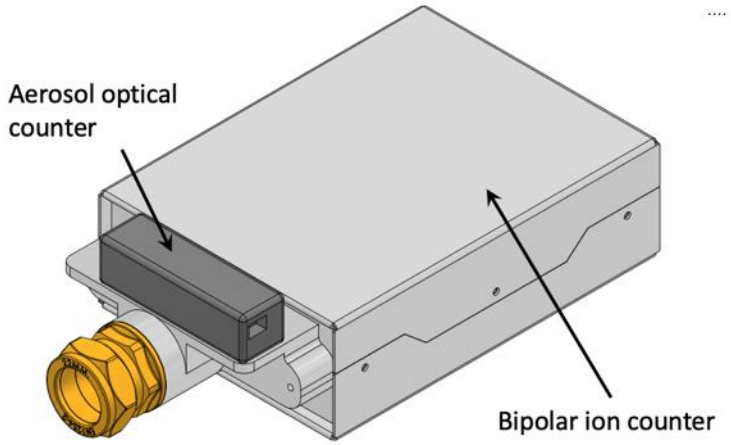
Kirkby et al. (2023) New particle formation in CERN CLOUD experiment. Science

On-going measurements in Kyiv started on September 2023

Many high PM events are associated with air raids downwind Kyiv







Aerosometer

Tuleviku plaanid. 4 identset suurusjaotust mõõtvat seaded Peipsist Läänemereni

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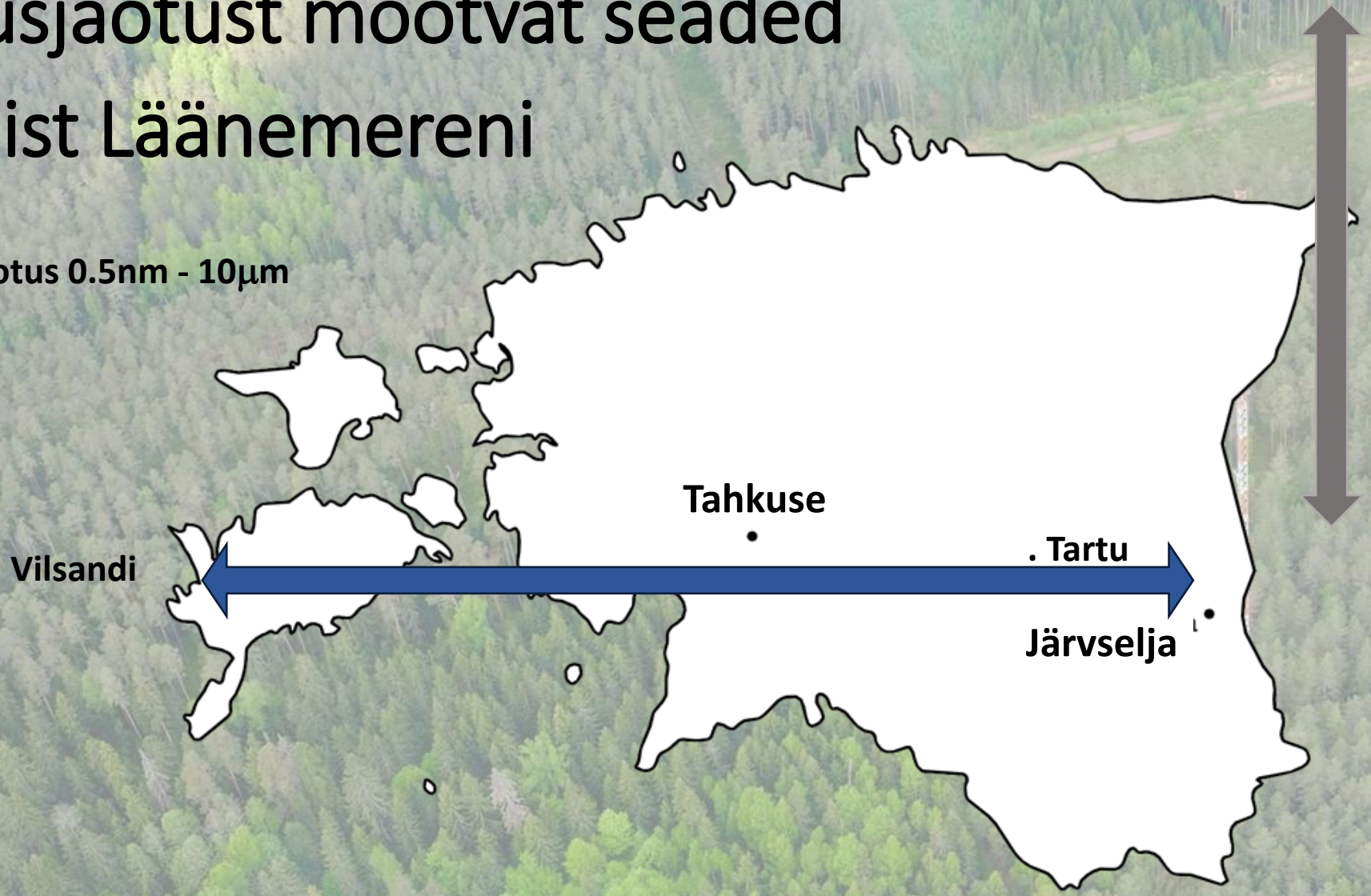
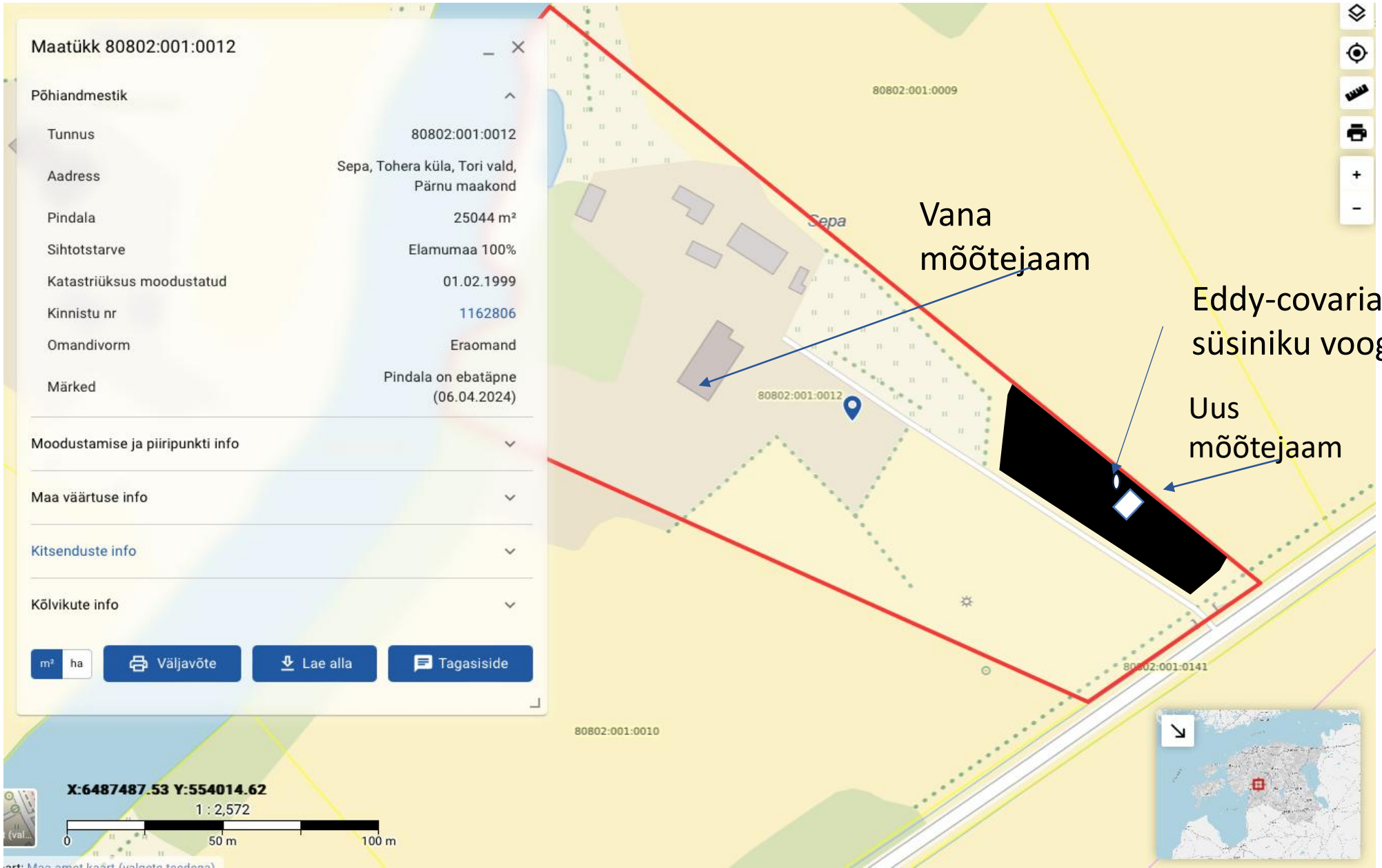
Suurusjaotus 0.5nm - 10µm

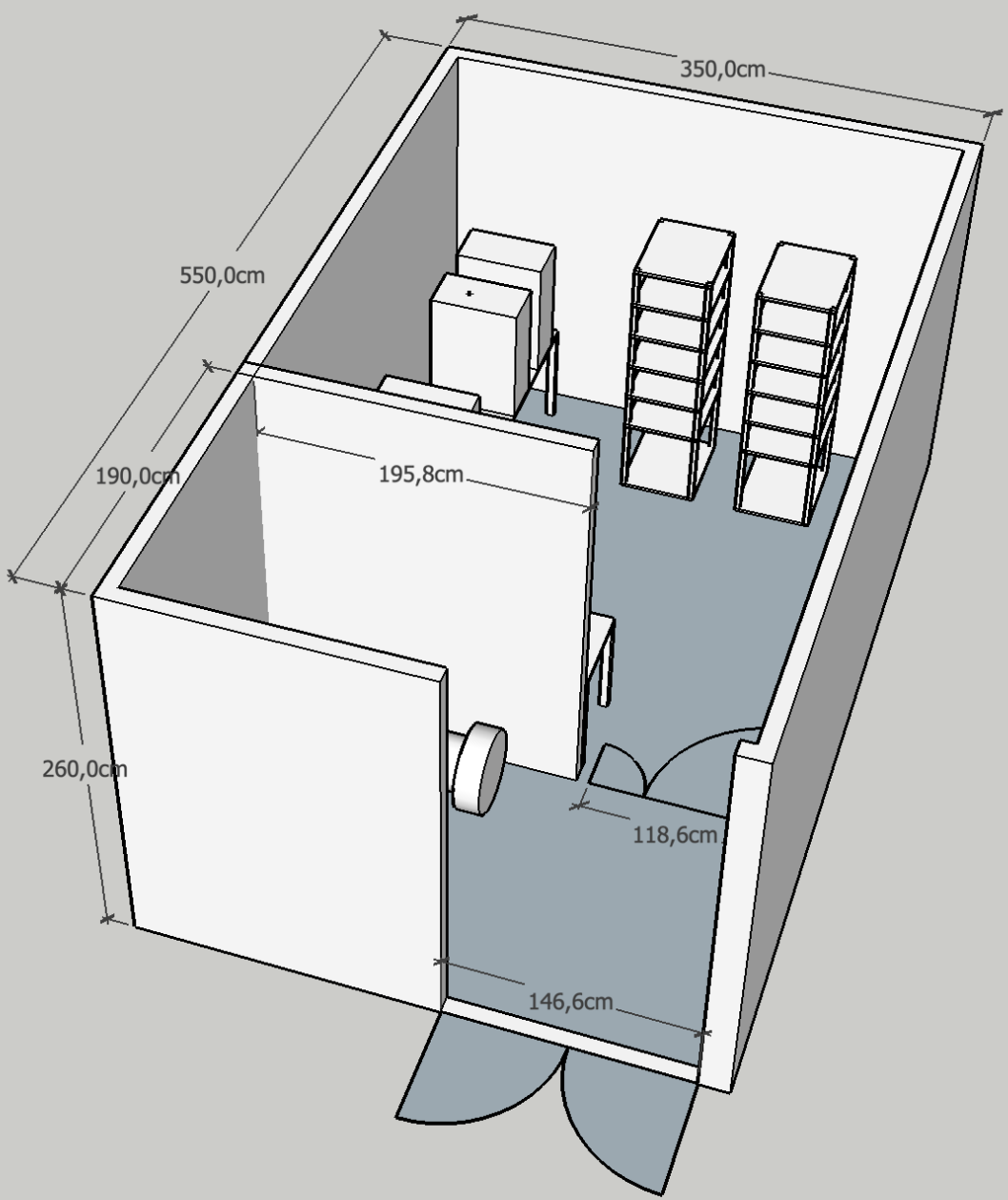


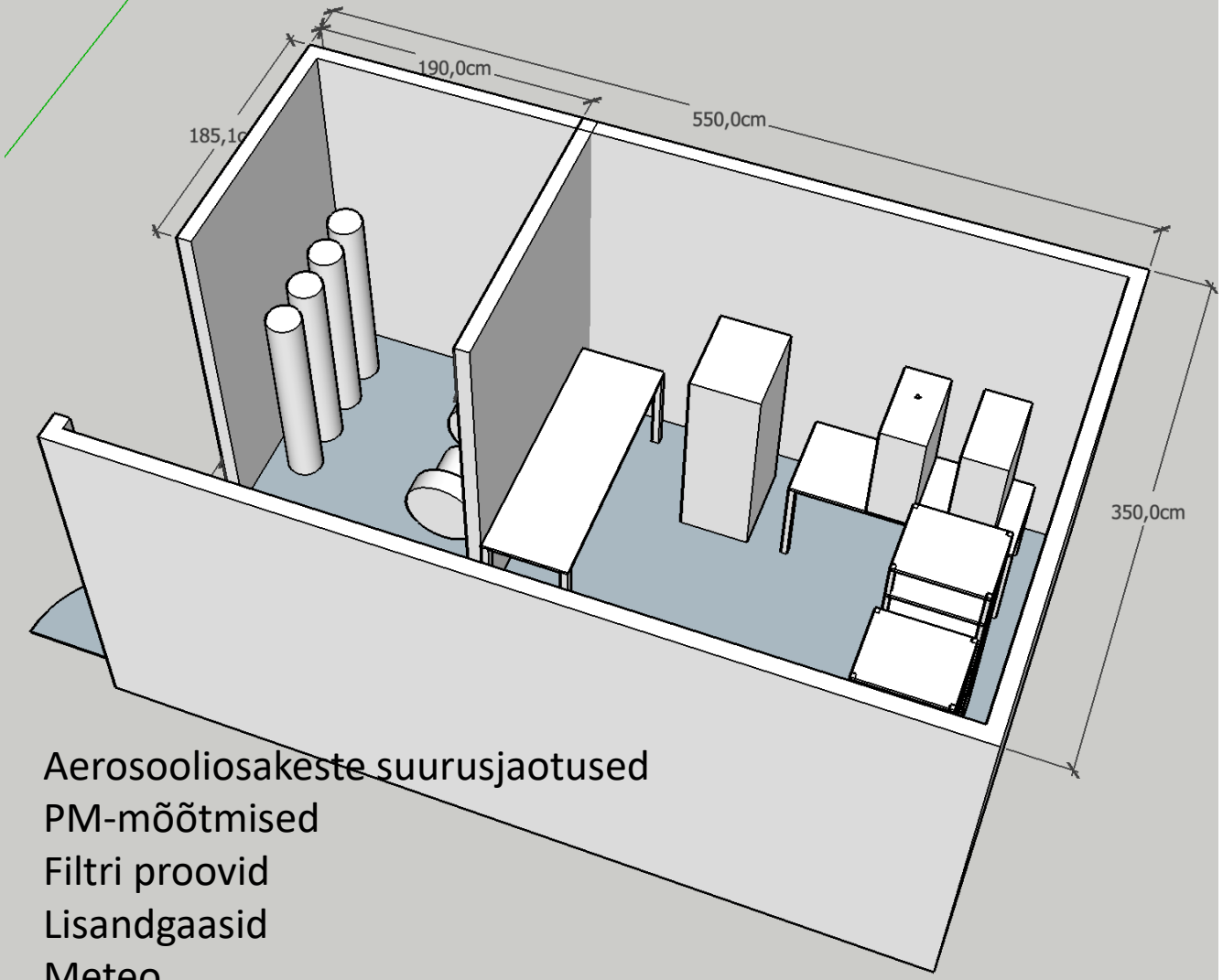
> 1000km võrgustik koos Soome jaamadega

Tahkuse mõõtejaama uuendamine ja kolimine uude asukohta



Tahkuse mõõtepaviljoni plaan





- Aerosooliosakeste suurusjaotused
- PM-mõõtmised
- Filtri proovid
- Lisandgaasid
- Meteo
- Süsiniku voog (rohu- ja põllumaa)

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Kaua mõõdad, kaugele jõuad!

Tänuavaldused:

Atmosfääri ja keskkonnateaduste labor
Kaupo Komsaar, Urmas Hõrrak, Aare Luts, Marko Vana, Sander Mirme, Paap Koemets, Kristo Hõrrak, Helina Lipp, Kalju Tamme, Madis Noppel, Eduard Tamm, Jaan Maasepp

Kliimauuringute keskus
Piia Post, Velle Toll,

Eesti maaülikool
Steffen Noe

Helsingi Ülikool
Markku Kulmala

Projektid: Mobilitas Pluss MOBTT42, ETag grant PRG714, PRG2738, IUT20-11, Keskkonna observatoorium