

SmartSMEAR, boreal forest measurements and database

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Continuous comprehensive observations

Station for Measuring Ecosystem - Atmosphere Relations

SMEAR II

Vegetation

Gas exchange
Transport
Growth
Structure

CO₂

Aerosols

Reactive
gases

Atmosphere

Gas & Aerosol concentrations,
composition, and fluxes
Heat fluxes
BL Meteorology
Irradiance

H₂O

Heat

Soil

Chemical & Physical processes
Water & Element budget
Biological activity

Freshwater

Physical & Biological
processes

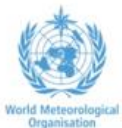
Over **1200** different variables

Flagship site for integration: combines all IPCC components. **Contributes to :**



ICOS

INTEGRATED
CARBON
OBSERVATION
SYSTEM

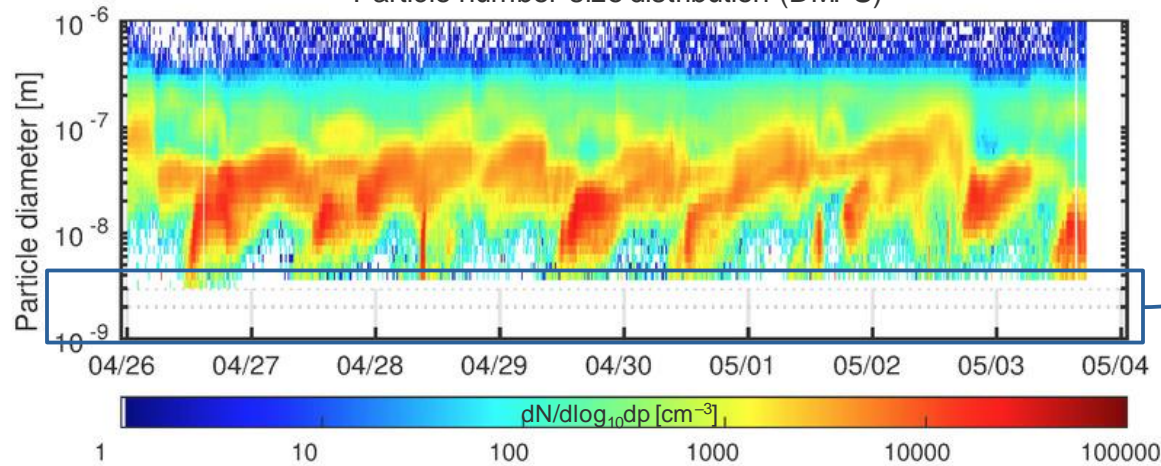


Measurements at Hyytiälä SMEAR II Aerosol

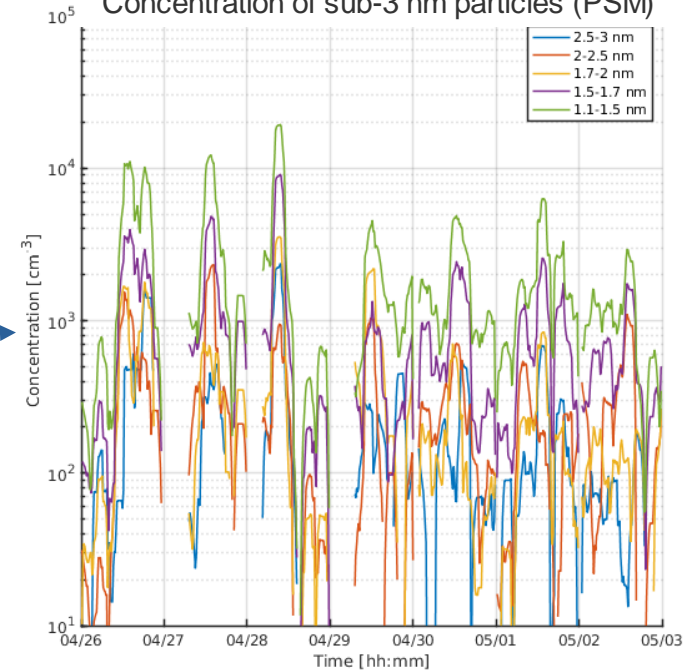
- Particle number size-distributions in several size ranges
 - 3–1000 nm (DMPS, since 1996)
 - 0.8–40 nm (air ions, AIS+NAIS, since 2003)
 - 2 – 40 nm (total particles, NAIS, since 2006)
 - ~1–3 nm (total particles, PSM)
- Atmospheric clusters and their composition
 - mass spectrometers measuring upto ~1000 amu (APi-TOF, from 2009 campaigns; continuous since 2016)
- Particle mass concentration
 - particle mass (PM_{2.5}, PM₁₀), optical properties (scattering, back-scattering, absorption)
 - particle chemical composition (ACSM)
- Particle fluxes

Measurements at Hyytiälä SMEAR II Aerosol

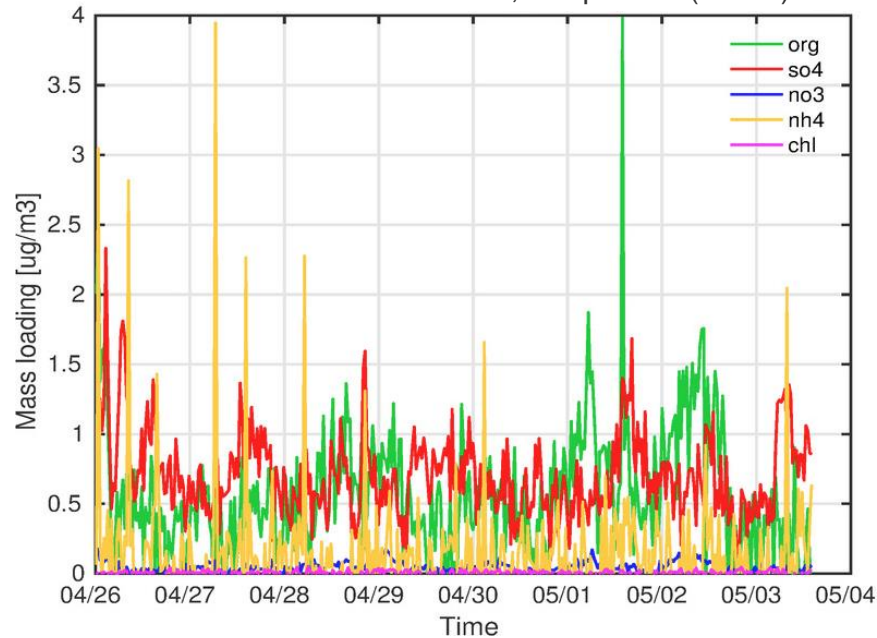
Particle number-size distribution (DMPS)



Concentration of sub-3 nm particles (PSM)



Particle mass concentration, composition (ACSM)



Measurements at Hyytiälä SMEAR II Ecosystem

- Photosynthesis and respiration (CO_2 and H_2O fluxes)
 - ecosystem level (eddy covariance, on top of forest canopy)
 - branch level (shoot chambers)
 - soil respiration and ground vegetation photosynthesis, soil temperature, soil moisture
- Ecosystem level CH_4 fluxes
- Volatile organic compounds (VOC)
 - concentrations (PTR-MS)
 - ecosystem level fluxes (gradient from the mast)
 - emissions from the tree branches (cuvettes)
 - soil VOC emissions (chambers)



Measurements at Hyytiälä SMEAR II

Remote sensing: vertical profiles, cloud properties

- Cloud remote sensing
 - Doppler Cloud Radars (campaigns 2014, continuous from 2016)
 - Doppler Lidar (vertical profile of backscattering)
 - Microwave radiometer
 - Near realtime data available through Cloudnet, <https://cloudnet.fmi.fi/>
- Aerosol optical depth (total column, sun photometer, Aeronet)

Measurements at Hyytiälä SMEAR II

Meteorology, atmospheric trace gases

- Meteorology, solar radiation
 - air temperature, RH, precipitation
 - wind speed/direction; airmass back-trajectories
 - solar radiation: global, UV-B, photosynthetically active (PAR), diffuse and direct radiation
 - boundary layer height
- Inorganic trace gas concentrations
 - SO₂, O₃, NO_x, CO, CH₄, CO₂

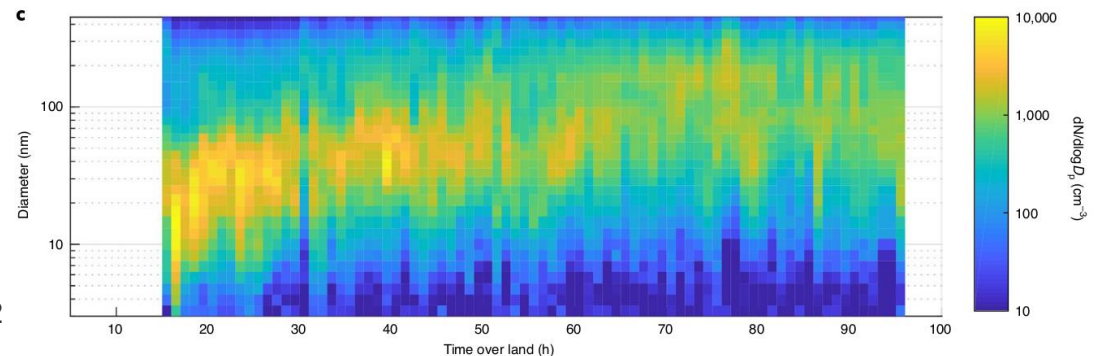
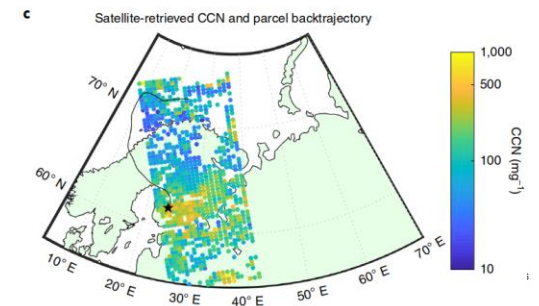
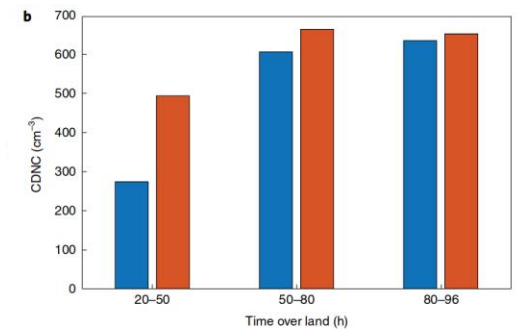
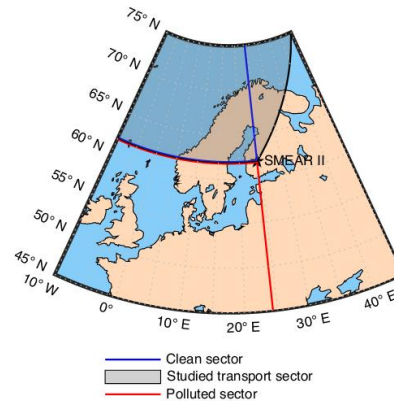


Measurements at Hyytiälä SMEAR II

Connecting local measurements with airmass transport and satellite observations

- Airmass history (back-trajectories) can be used to connect SMEAR data to emission sources, airmass transport patterns, time-over-land, etc.
- Contribution of regional boreal forest emissions on aerosol formation and production of CCN

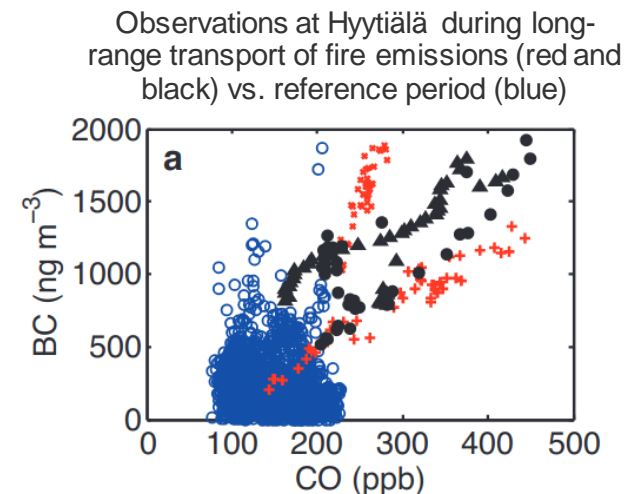
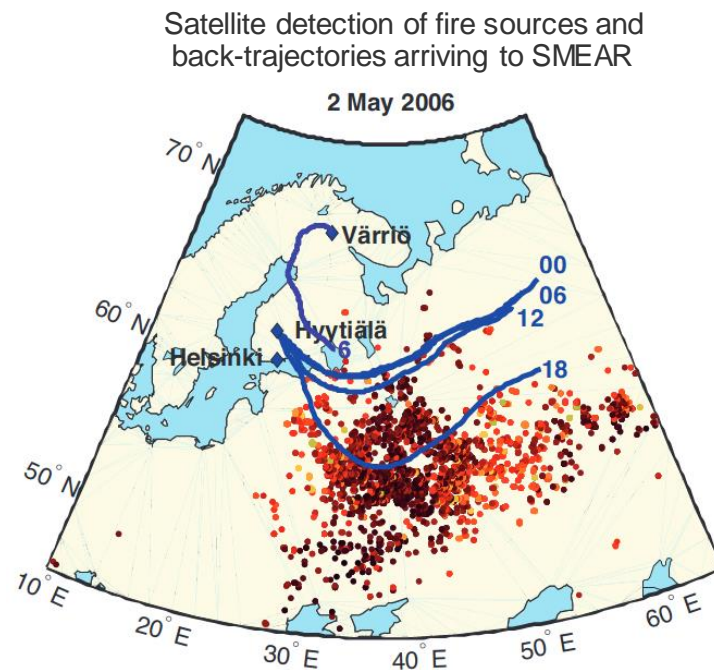
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Measurements at Hyytiälä SMEAR II

Connecting local measurements with airmass transport and satellite observations

- Detecting long-range transport of forest fire emissions

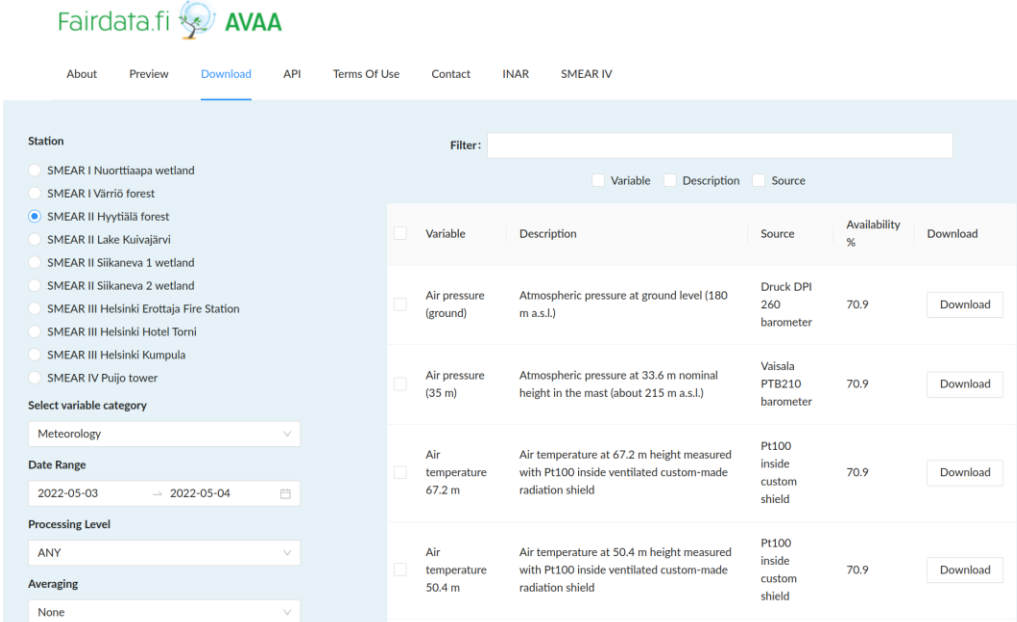


Leino et al., Boreal Env. Res., 2014

Datasets from Hyytiälä SMEAR II

- Most of the data is openly available in SmartSMEAR
 - <https://smear.avaa.csc.fi/>
 - data visualization and download tool for the database of continuous measurements at all SMEAR research stations (graphical user interface to the SMEAR data)
 - API provides access to all variables and metadata
 - data access can be done directly from your analysis tools (Matlab, Python, R)

- Additional datasets available from campaigns through Datacloud (access by request)
 - derived variables
 - analysis results



The screenshot displays the Fairdata.fi AVAA web interface. The top navigation bar includes links for About, Preview, Download (highlighted), API, Terms Of Use, Contact, INAR, and SMEAR IV. The main content area is divided into a left sidebar and a right table.

Left Sidebar:

- Station:** A list of stations with radio buttons. "SMEAR II Hyytiälä forest" is selected.
- Select variable category:** A dropdown menu with "Meteorology" selected.
- Date Range:** A date range selector showing "2022-05-03" to "2022-05-04".
- Processing Level:** A dropdown menu with "ANY" selected.
- Averaging:** A dropdown menu with "None" selected.

Right Table:

Filter: [text input]

Variable Description Source Availability % Download

<input type="checkbox"/>	Air pressure (ground)	Atmospheric pressure at ground level (180 m a.s.l.)	Druck DPI 260 barometer	70.9	Download
<input type="checkbox"/>	Air pressure (35 m)	Atmospheric pressure at 33.6 m nominal height in the mast (about 215 m a.s.l.)	Vaisala PTB210 barometer	70.9	Download
<input type="checkbox"/>	Air temperature 67.2 m	Air temperature at 67.2 m height measured with Pt100 inside ventilated custom-made radiation shield	Pt100 inside custom shield	70.9	Download
<input type="checkbox"/>	Air temperature 50.4 m	Air temperature at 50.4 m height measured with Pt100 inside ventilated custom-made radiation shield	Pt100 inside custom shield	70.9	Download

References

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