

ACTRIS and EUROCHAMP-2020: Long-term Monitoring and Process Studies for a changing Atmosphere: Focus on Biomass Burning

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Introduction and Motivation

ACTRIS

EUROCHAMP-2020

TROPOS Research Station Melpitz

Biomass Burning and SLCFs

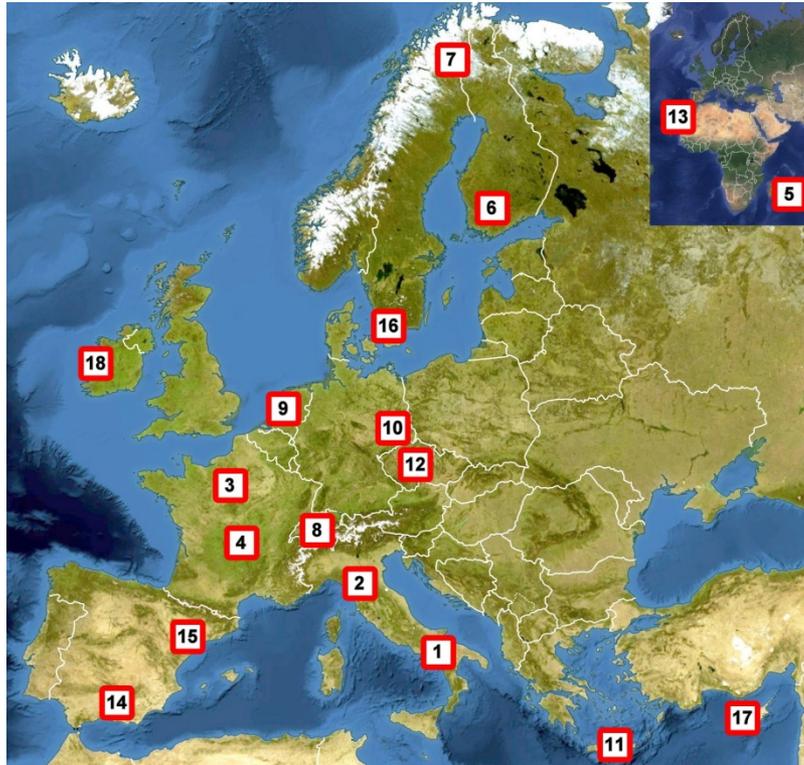
Summary



ACTRIS



ACTRIS 2 network and TROPOS Melpitz research station





Aerosols, Clouds and Trace gases Research Infrastructure

ACTRIS is a distributed pan-European research infrastructure dedicated to high-quality observations of aerosols, clouds and trace gases and the exploration of their interactions.

ACTRIS provides data and services regarding the 4D variability of short-lived atmospheric constituents to analyse, understand and predict the past, current and future evolution of the atmospheric environment.

ACTRIS serves a vast community of users working on observations, experiments, models, satellite data, analysis and predicting systems **and offers access to advanced technological platforms** for exploration of the relevant atmospheric processes in the fields of climate change and air quality.

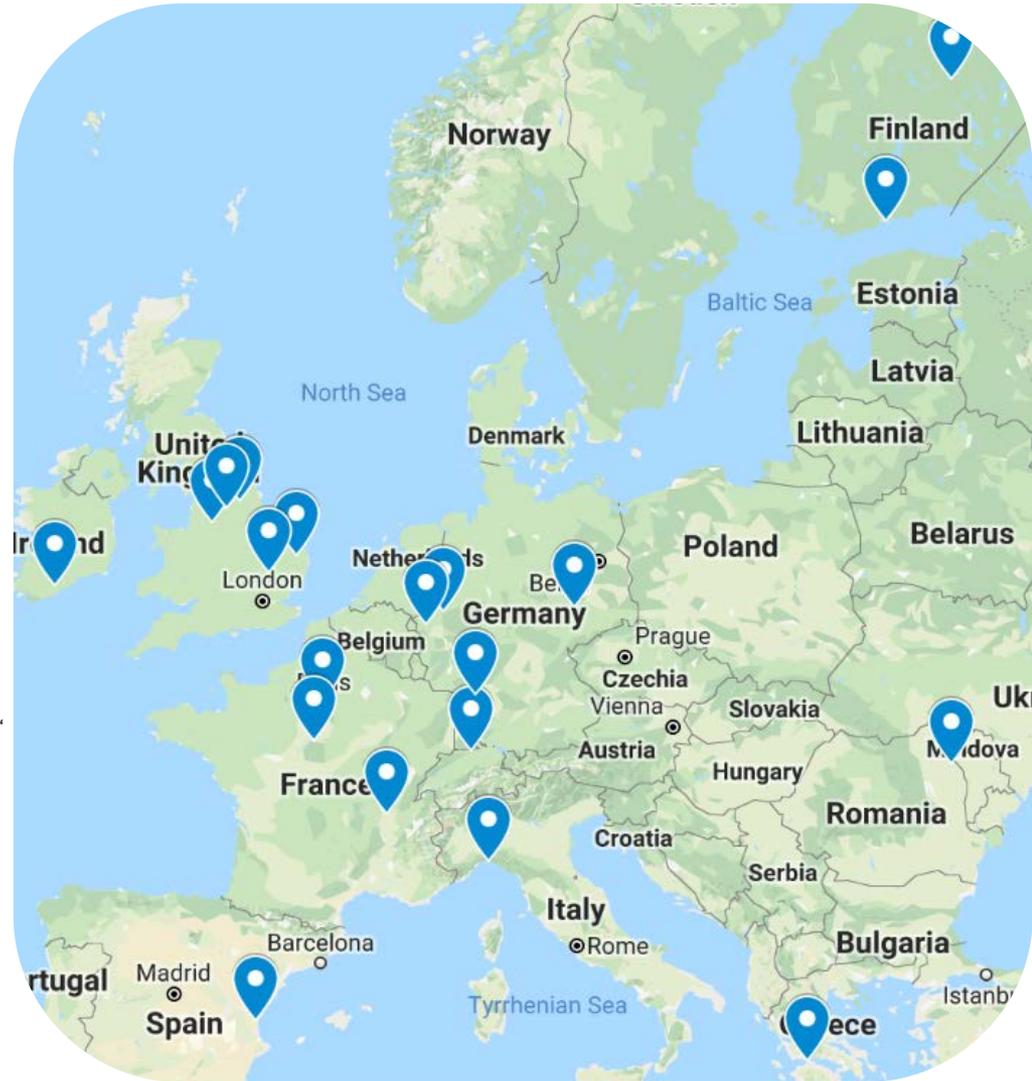
ACTRIS will be implemented as a European Research Infrastructure Consortium (**ERIC**).

EUROCHAMP-2020



The EUROCHAMP-2020 initiative

Since December 2016 and for 4 years:



EUROCHAMP-2020

7TH ENVRIweek – 5-9 November, Riga - Latvia

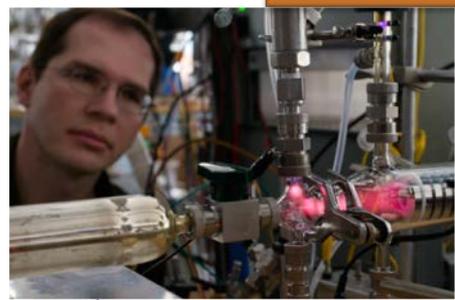
Experimental approaches in atmospheric chemistry

Field observation/campaigns (incl. airborne and satellites)

- Very realistic
- but**
- Complex and hence often difficult to interpret down to mechanisms level



“Tabletop” laboratory experiments



- Very innovative
 - Very efficient for small pieces of mechanism
- but**
- Not so realistic and hence sometimes difficult to scale to atmosphere

Simulation chamber experiments



... are large infrastructures somewhere in between

Understanding chemical transformation
Forecast properties
Quantifying Secondary sources

EUROCHAMP-2020
15th Workshop on Air Quality in Urban and Regional Areas
Lille, France, 4-5 October 2017

Platforms for instrumentation development, calibration, characterization...

FIONA campaign @EUPHORE

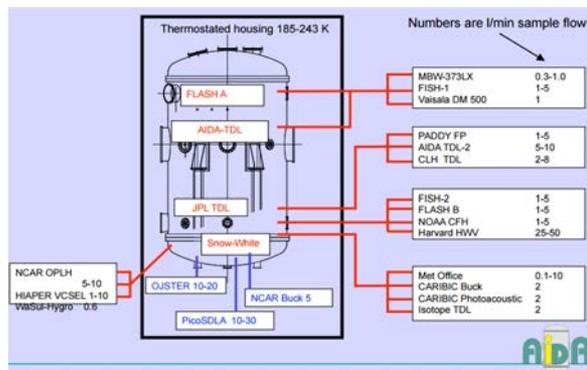
(Formal Intercomparisons of Observations of Nitrous Acid)

46 Participants from 17 Institutions (7 Eurochamp and 10 non-

Eurochamp)

19 instruments of various

concepts



AQUAVIT campaigns 1,2, 3 @AIDA

(Formal intercomparison of atmospheric water measurement)

40 Participants from 14 Institutions

(2 Eurochamp and 12 non-Eurochamp Institutions)

22 instruments of various concepts



MS CHAOS campaign @PSI

(Mass spectrometers for the Chemical Analysis of Organic Substances)

24 participants from 6 Institutions (1 Eurochamp and 5 non-Eurochamp)

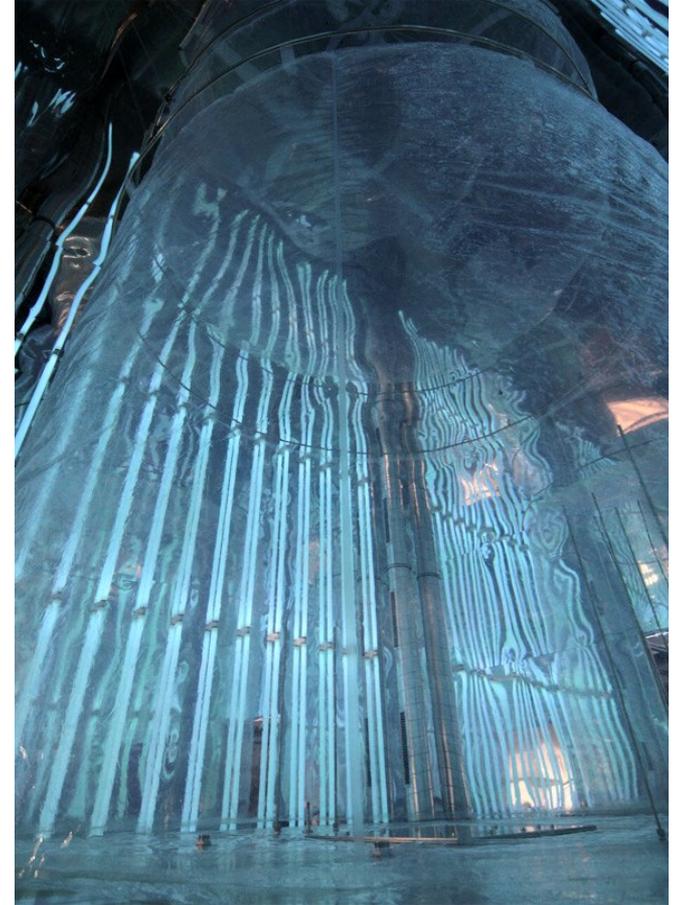
6 Instruments of various concepts



2/ TransNational Access to calibration facilities

~400 days of experiments open to TNA (~0.4 M€)

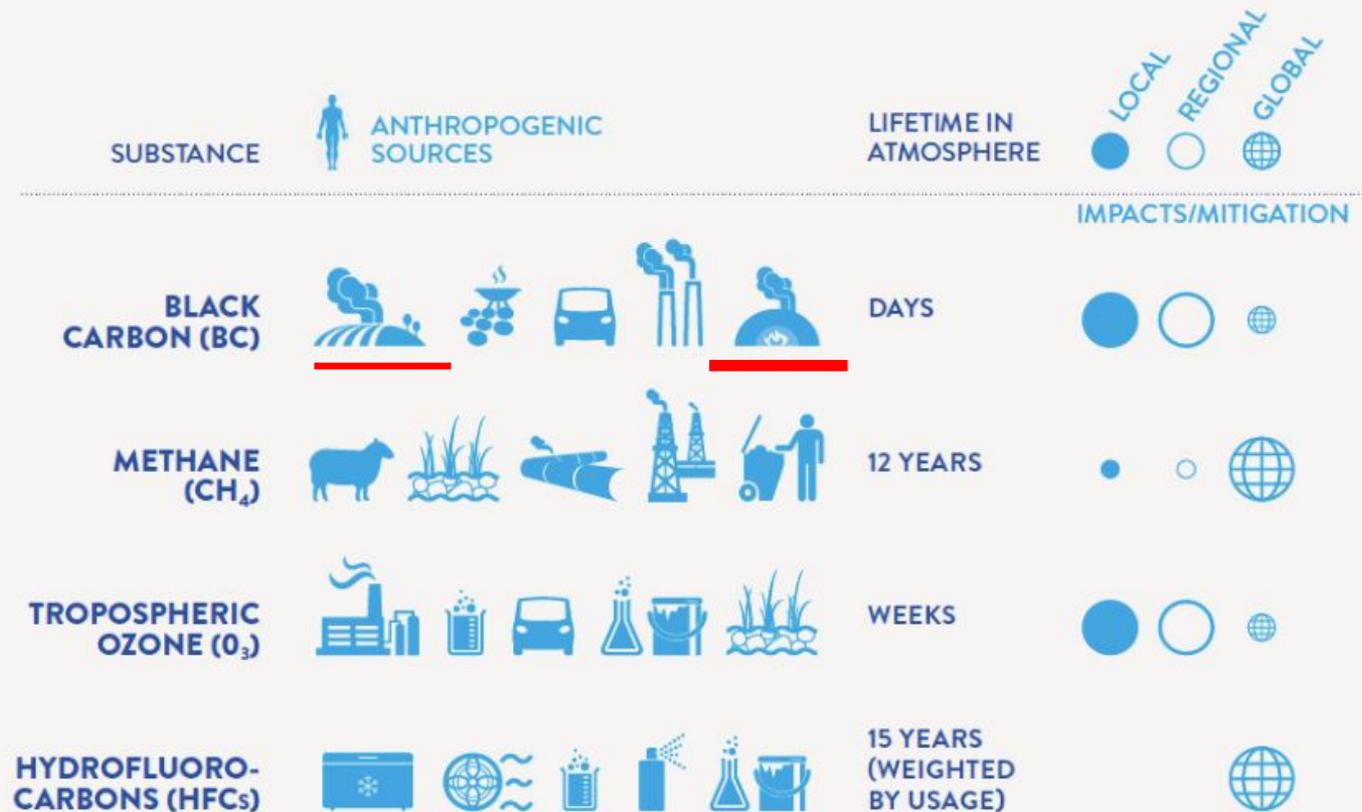
- AIDA Calibration Centre for Cloud Physics (KIT)
- Calibration Centre for Soot Measurements (PSI)
- Organic Tracers and Aerosol Constituents Calibration Centre (TROPOS)
- World Calibration Centre for Aerosol Physics (TROPOS)



Short-lived climate forcers (SLCFs)

SHORT-LIVED CLIMATE POLLUTANTS

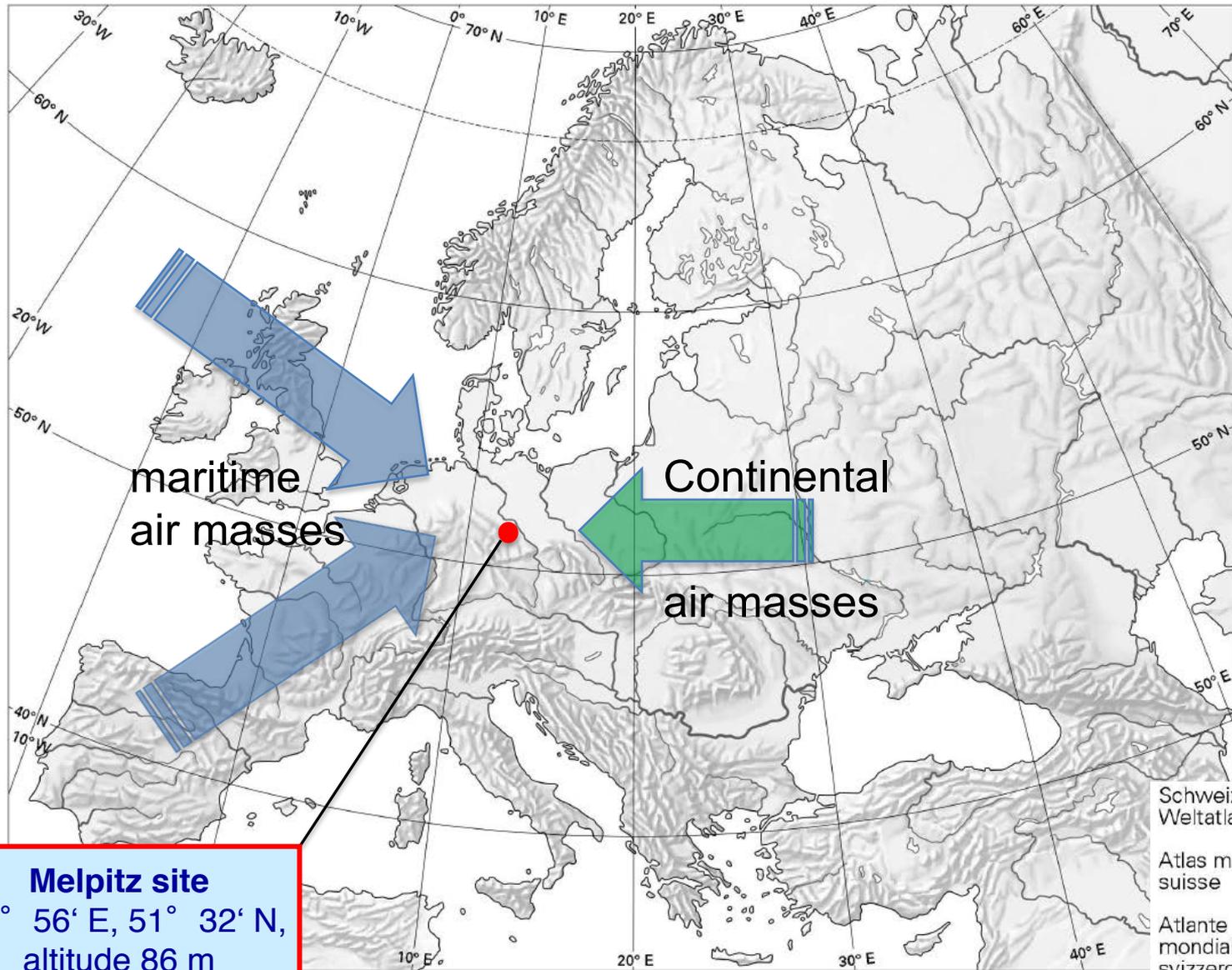
Response to mitigation efforts



TROPOS Research Station Melpitz



Location and integration of the TROPoS research site in Europe



Melpitz site
(12° 56' E, 51° 32' N,
altitude 86 m
above sea level)

EUROPA
EUROPE
EUROPA



LANDESAMT FÜR UMWELT,
LANDWIRTSCHAFT
UND GEOLOGIE



MARGA



Europa fördert Sachsen.



Schweizer
Weltatlas

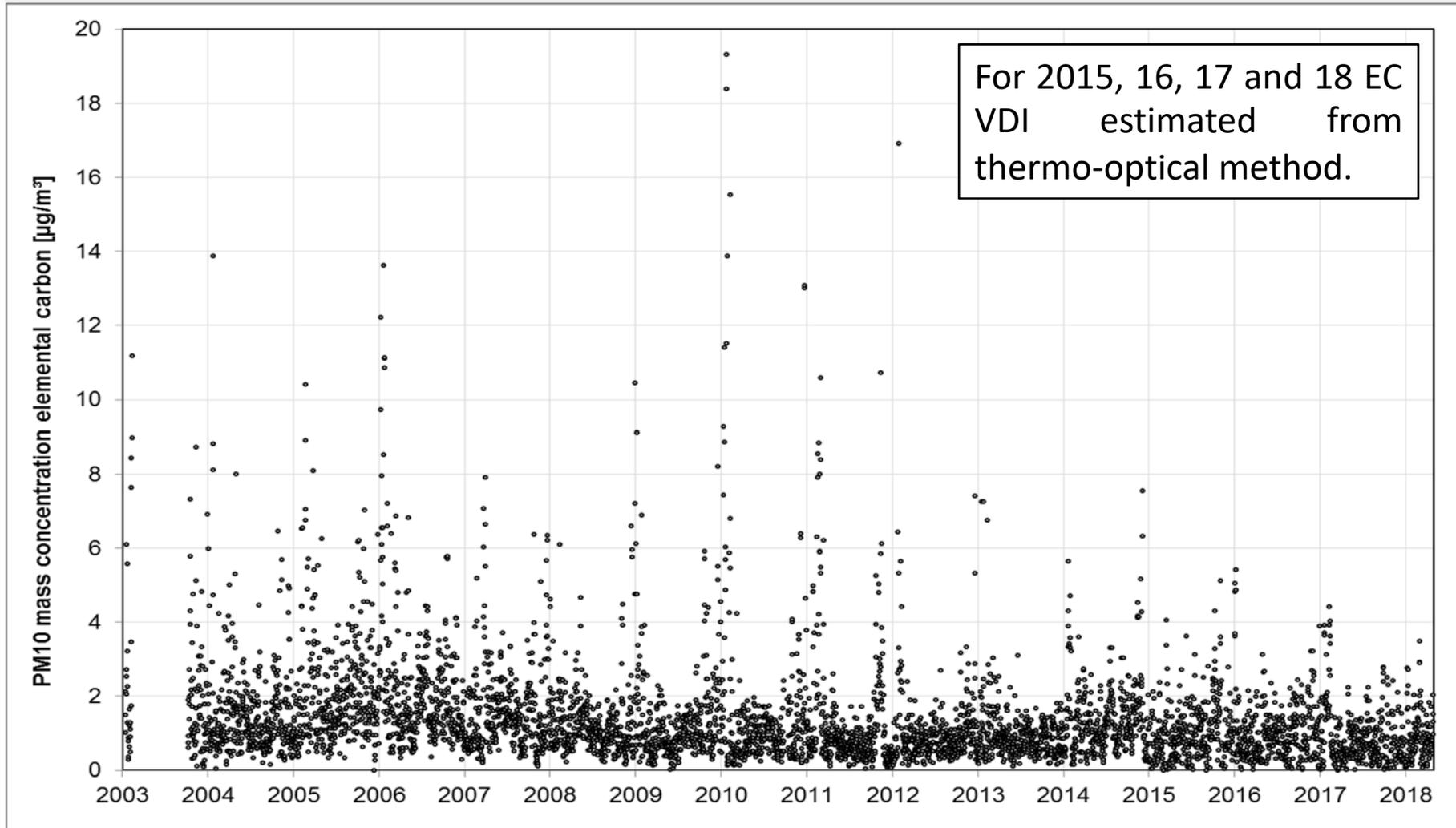
Atlas mondial
suisse

Atlante mondiale
svizzero

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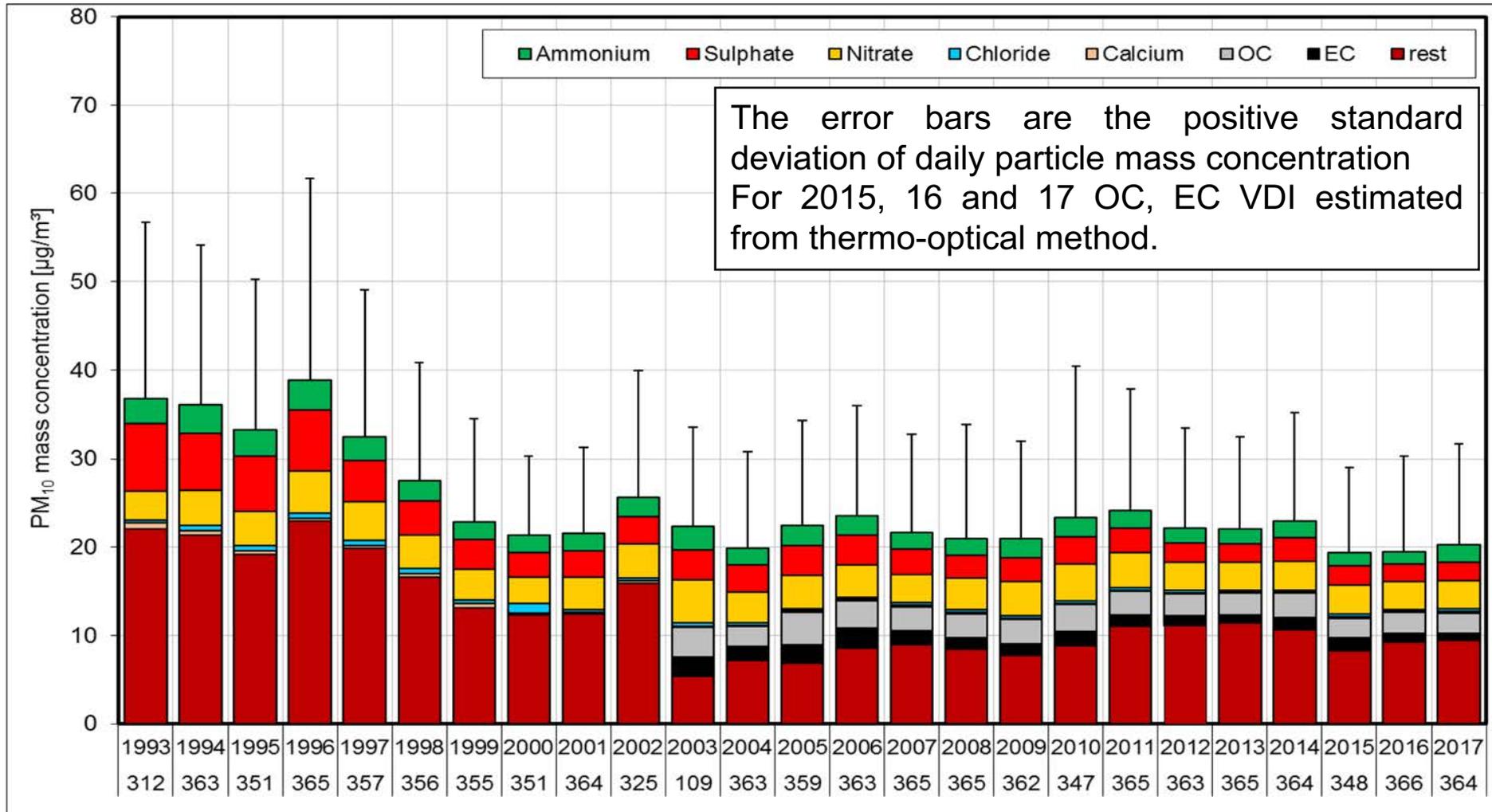
Particle mass concentration elemental carbon PM10 (daily) at TROPOS Melpitz site



The yearly mean EC-concentration PM10 in 2003 was $2.08 \mu\text{g m}^{-3}$, continuous falling trend over 15 years $-0.073 \mu\text{g m}^{-3} \text{a}^{-1}$.

TROPOS

Particle mass concentration PM₁₀ water soluble ions, organic and elemental carbon (yearly means)



HV-filter-sampler at TROPOS Melpitz site, located in German lowlands near Torgau.



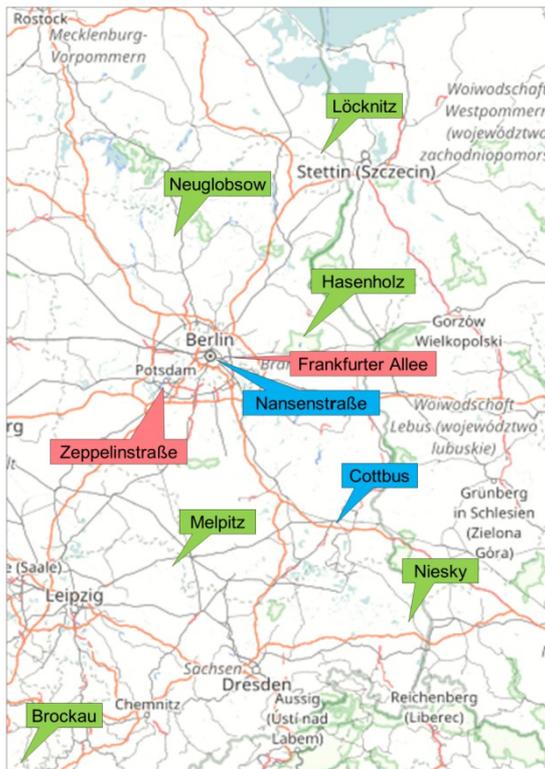
PM Source Contributions Projects





Leipzig Aerosol 2013 - 2015

- summer/winter, 21 samples each
- 4 sites: traffic, traffic/residential, urban and regional background
- 5-stage Berner-type impactor
- chemical composition: ions, oxalate, OC/EC, WSOC, monosaccharides, alkanes, hopanes, PAHs, metals



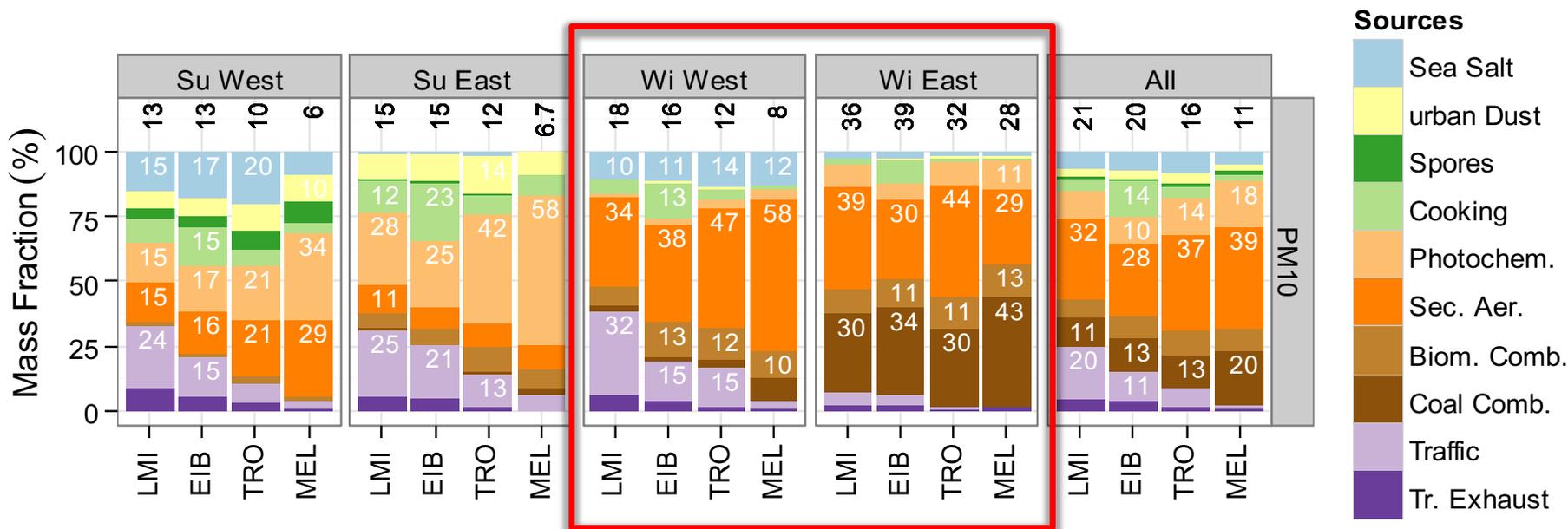
PM-East 2016/17

- Fall/winter, 212 samples per site
- PM10 filters
- 10 sites: 2 traffic, 2 urban, 6 regional background
- chemical composition: ions, + OC/EC, levoglucosan + PAHs for 80 selected days

- PMF for source apportionment
- Lenschow approach + back trajectories for spatial contributions



Source contributions for PM₁₀



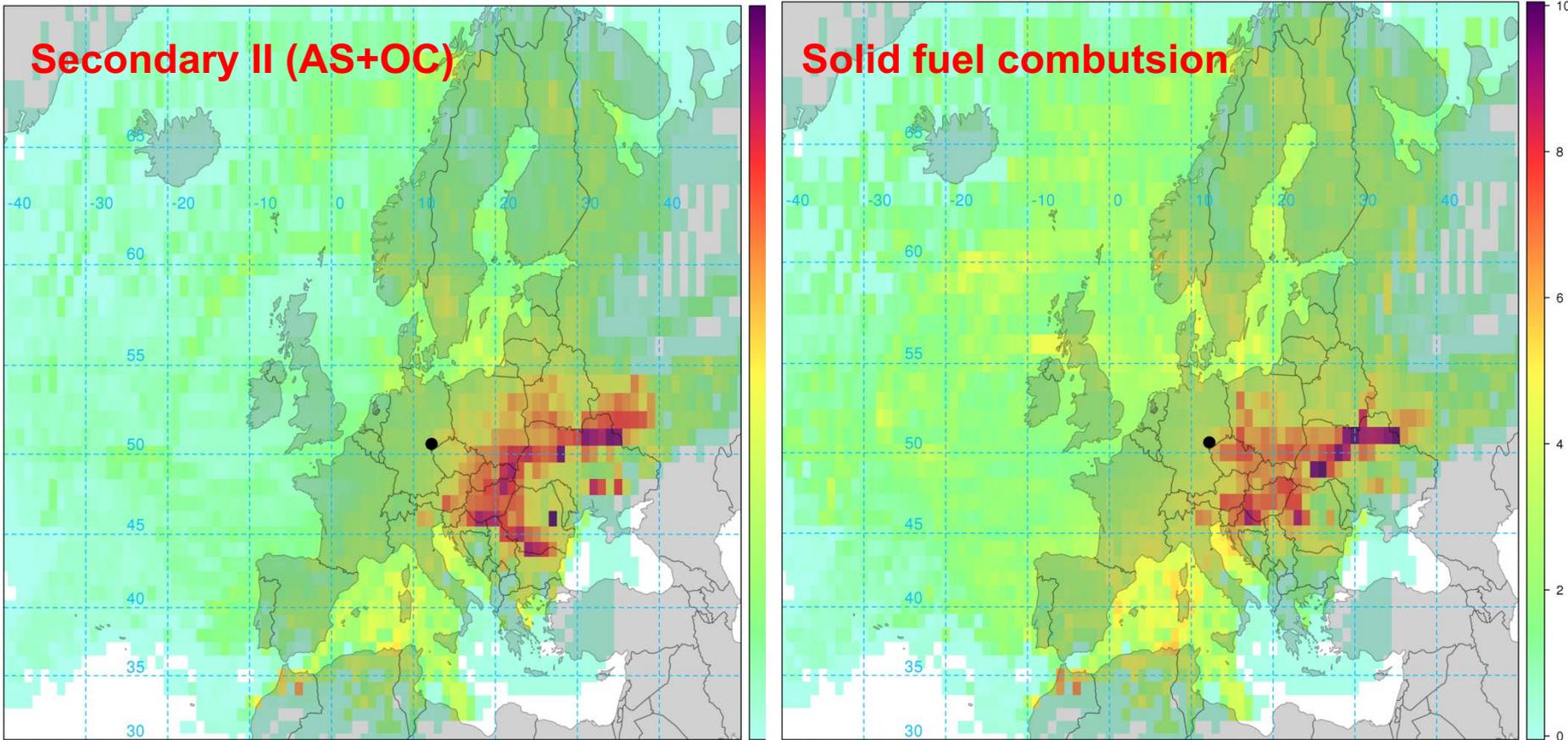
Winter mean contributions to PM₁₀ mass at traffic hotspot:

- 20 % Traffic, dominated by non-exhaust emissions
- 25 % Solid Fuel Combustion, regional
- 45 % Secondary aerosol, regional

large fractions of SLCP brown (BrC) and black carbon (BC) included here

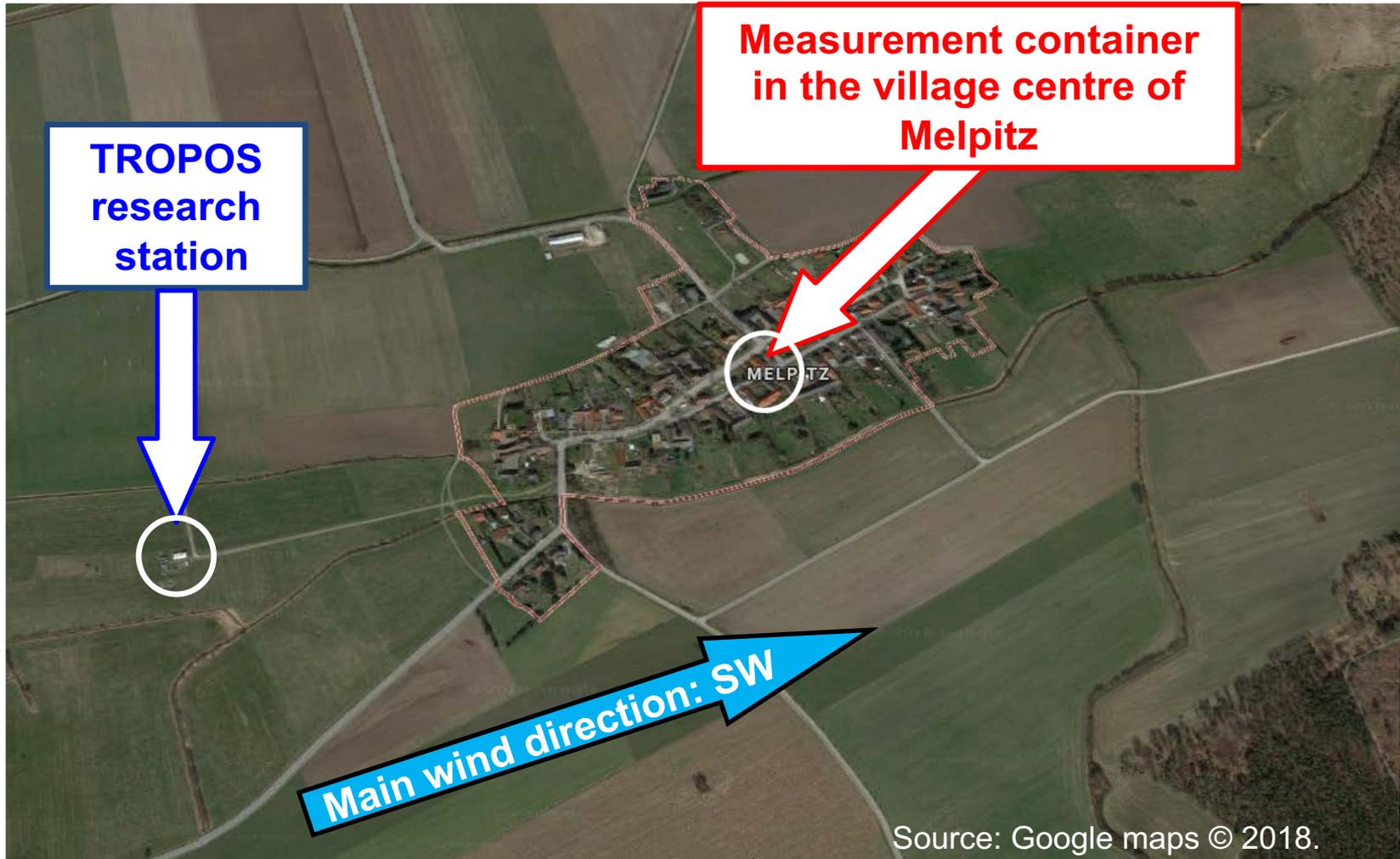
Source areas of PMF source categories

Concentration weighted trajectory plots



- Eastern Europe as main source areas of primary and secondary products of solid fuel combustion

Quantifying the contribution of domestic wood combustion to particulate matter

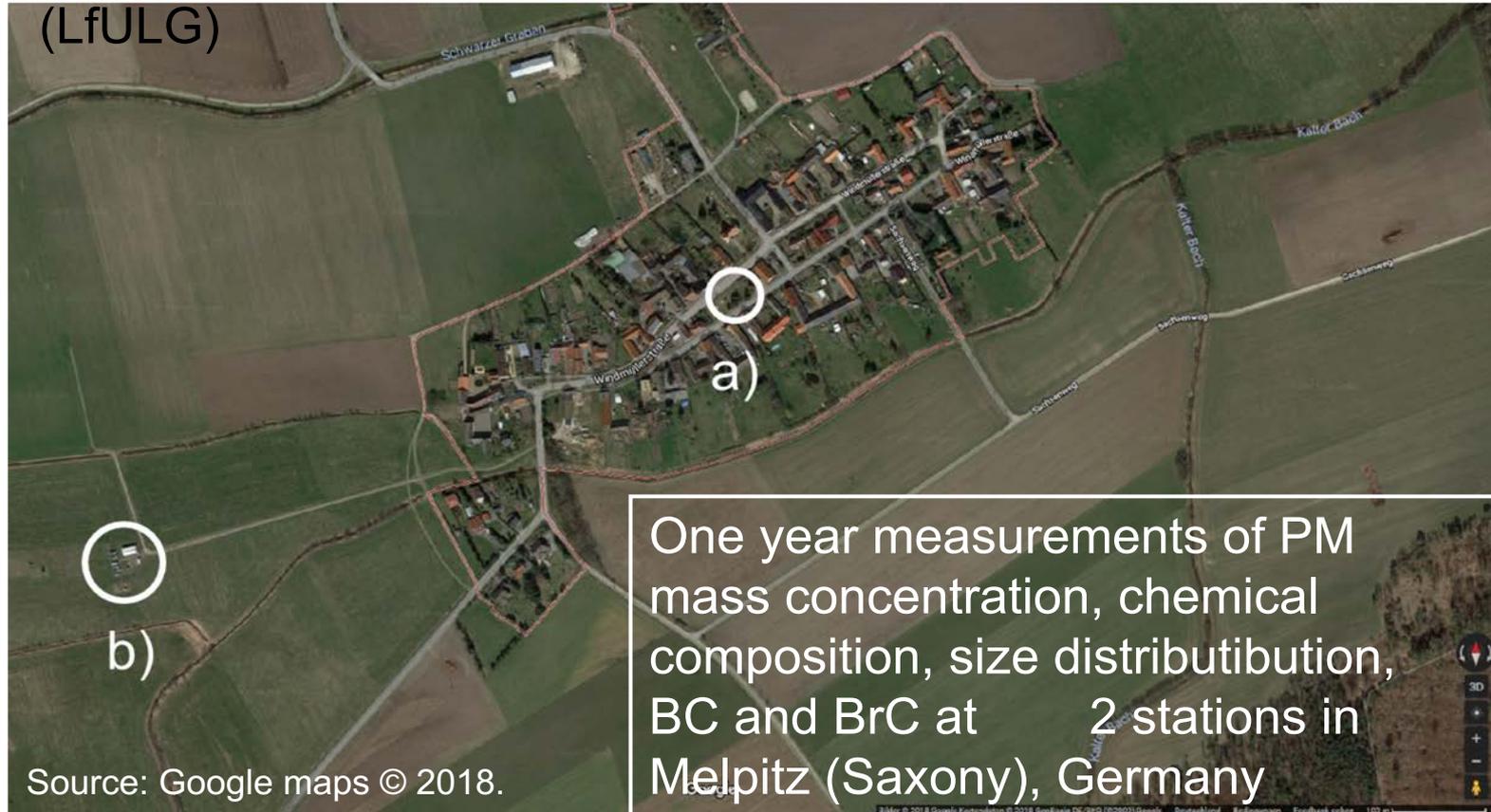


One year measurements of PM mass concentration, chemical composition, size distribution, BC and BrC at 2 stations in Melpitz (Saxony), Germany



Quantifying the contribution of domestic wood combustion to particulate matter

Research and development project of TROPOS together with the Saxon State Office for Environment, Agriculture and Geology (LfULG)

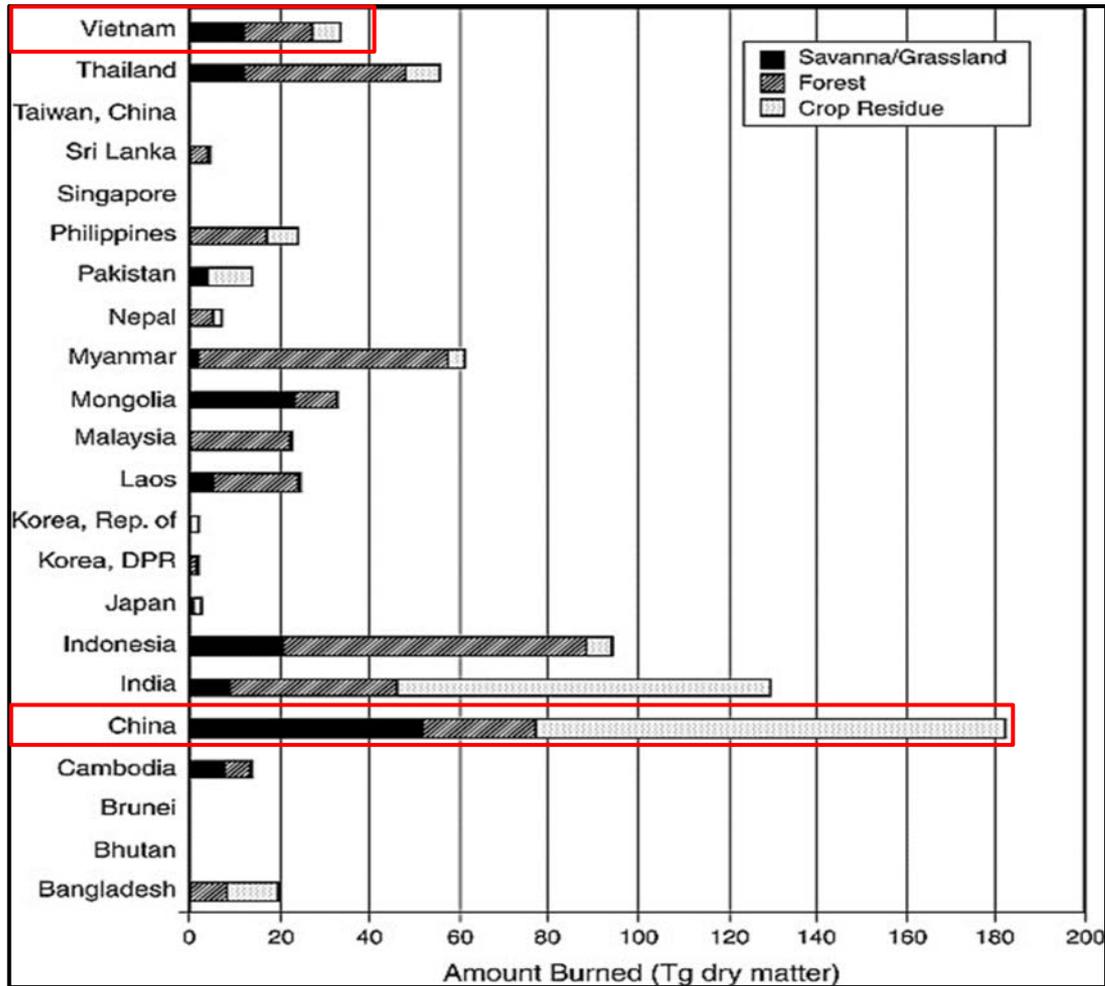


- a) Measuring container in the village centre of Melpitz
- b) TROPOS research site approx. 300m west of a)

Evolution of straw burning smoke in the TROPOS ACD chamber



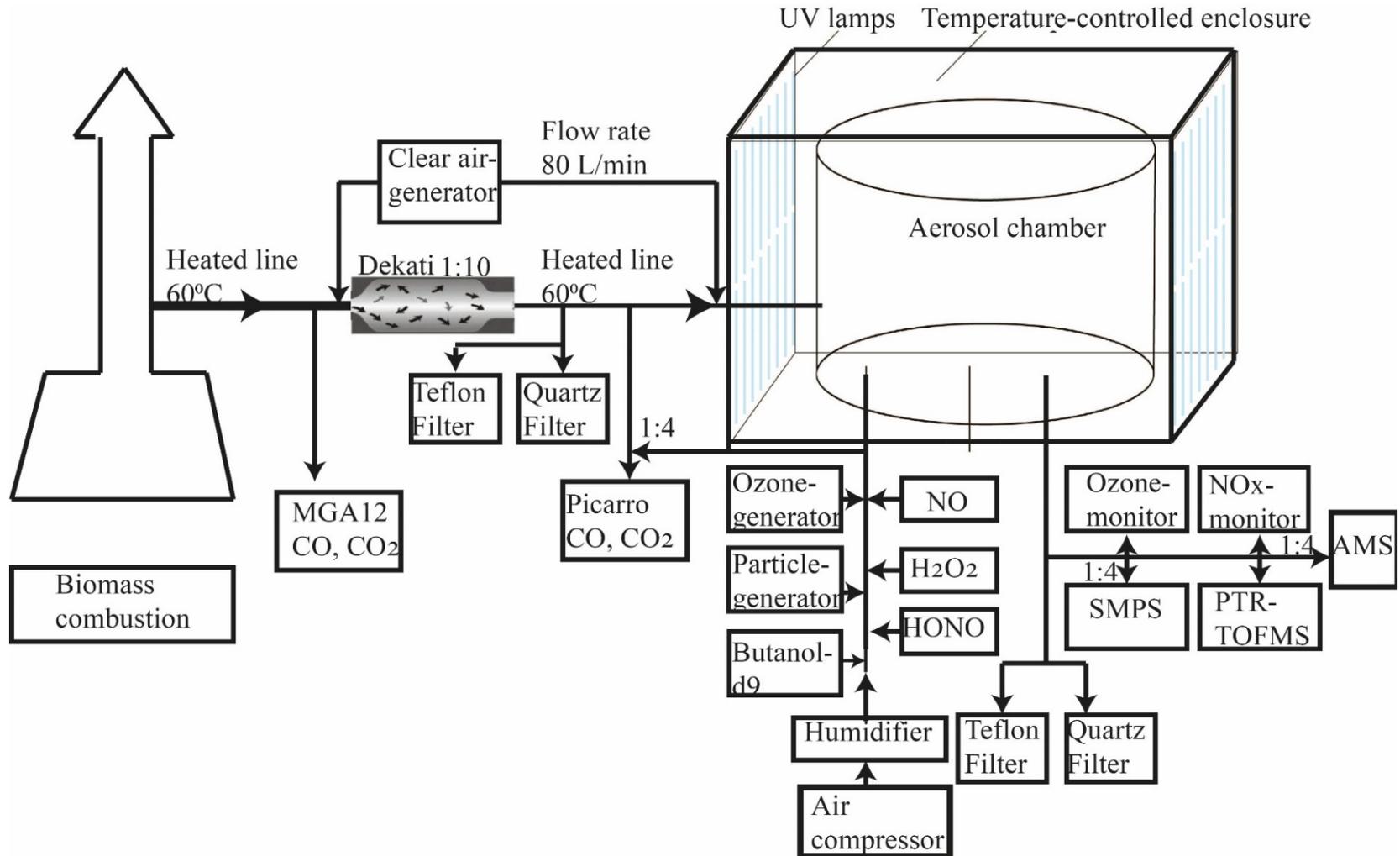
Motivation I: Biomass burning in Asia



Total PM Contribution: China 25%, India 18%, Vietnam 5%, Indonesia 13%



Experimental setup (LBBF)



1. Wheat straw from Germany (400g)



2. Rice straw from Viet Nam (400g)



Chemical Analysis of aerosol samples

Liquid chromatography mass spectrometry

Organic Molecular Markers:

Telfon filter

e.g. Nitrophenol, aromatic compounds

BBSOA,

imidazoles

Trace

elements

Quartz filter

WSOC

Quartz filter

Gas chromatography mass spectrometry

Organic Molecular Markers:

Quartz filter

e.g. PAH, *n*-alkanes, Hopanes....*etc.*

High performance anion exchange chromatography with Pulsed amperometric detection

Organic Molecular Markers:

Quartz filter

e.g. Levoglucosan, mannosan....*etc.*

OC/EC Analyzer

Carbon fractions:

Quartz filter

OC/EC: Organic and elemental carbon

Ion chromatography

Ions, DCA

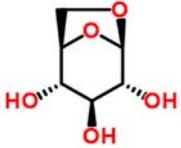
Quartz filter

e.g. Na^+ , K^+ , NH_4^+ , Ca^{++} , Mg^{++} , Cl^- , NO_3^- , SO_4^-

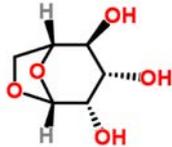


Analysis for toxicology

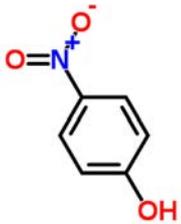
Compounds detected in the particle phase



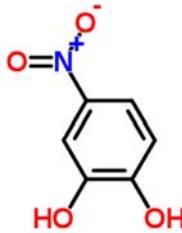
Levoglucosan



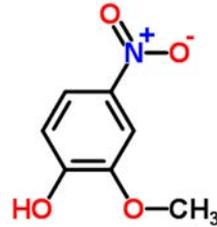
Mannosan



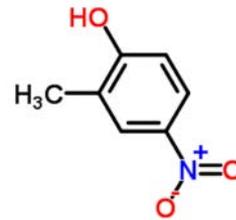
4-Nitrophenol



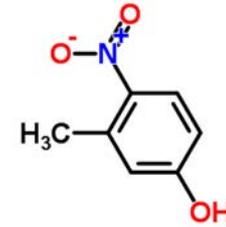
4-Nitrocatechol



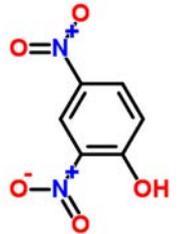
4-Nitroguaiacol



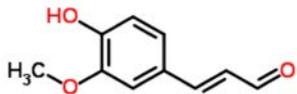
2-Methyl-4-Nitrophenol



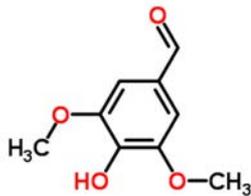
2-Methyl-4-Nitrophenol



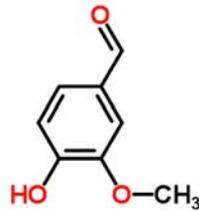
3-Methyl-4-Nitrophenol



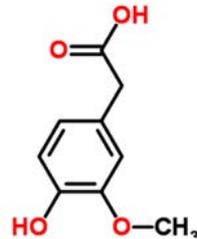
Coniferylaldehyde



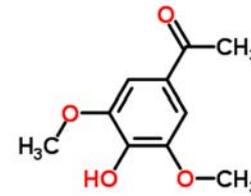
Syringaldehyde



Vanillin



Homovanillic acid



3,5-Dimethoxy-4-hydroxyacetophenone



- **ACTRIS and EUROCHAM-2020 are important European research infrastructure networks to study atmospheric change**
- **TROPOS operates its research station Melpitz. One important research topic is biomass burning, its role in health effects and as a SLCF**
- **Several projects have been done, a new one just starting**
- **Wood burning is a catastrophe for air quality and no good for BC emissions as a SLCF**
- **TROPOS chamber studies allow a molecular understanding of biomass burning emissions and their atmospheric processing**

