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The German Ultrafine Aerosol Network (GUAN) – Experience with routine particle size distribution measurement

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The German Ultrafine Aerosol Network (GUAN): Objectives & characteristics

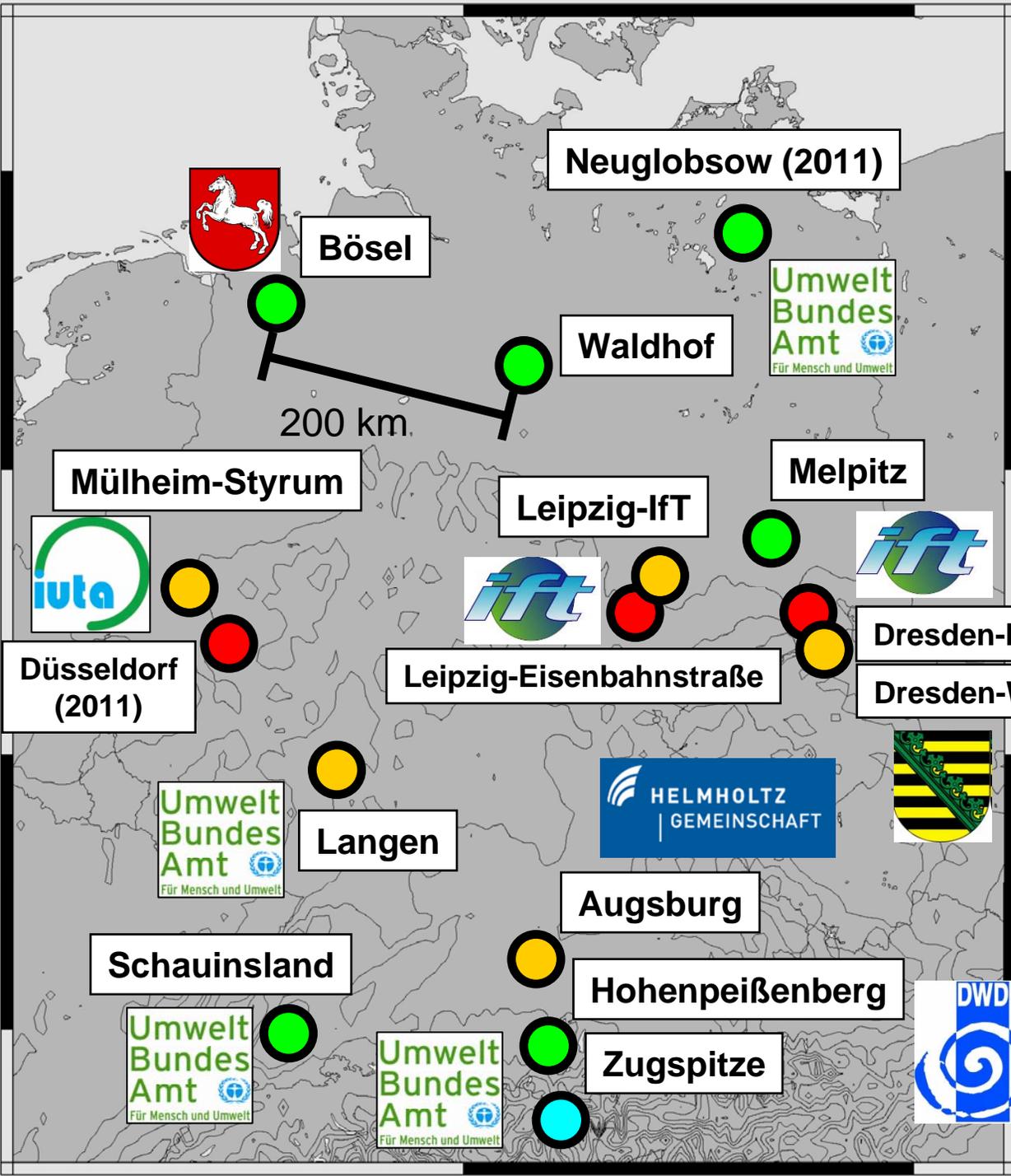
- Collect new experimental data on ultrafine aerosols that are relevant for both, climate and health issues
- Combine previous, scattered efforts into a network
- Use the same technical standards wherever possible (e.g. EUSAAR specifications)
- High level of quality assurance (SMPS round-robin tests)
- Central data processing and joint evaluation



**Sites in the
German Ultrafine
Aerosol
Network (GUAN)**



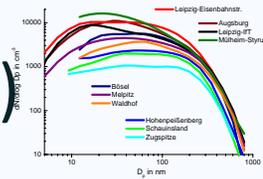
Sites in the German Ultrafine Aerosol Network (GUAN) since 2008



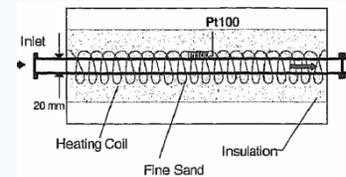
Germany:
population: 80 Mio.
pop. density: 230 km⁻²
FIN: 16 km⁻²
USA: 32 km⁻²
India: 349 km⁻²

Continuous Measurements in GUAN

- **Particle number size distributions (SMPS; TDMPS)**
(standard: 10-800 nm; extended: 3 nm – 10 μm)



- **Non-volatile number size distributions**
(thermodenuder 300°C)



- **Soot mass concentrations (MAAP)**



- **Size-fractionated chemical composition**
Bernier impactors; 7 sites
ca. 40 samples in 2009-2010

Mobility spectrometers in GUAN



SMPS

10 - 900 nm

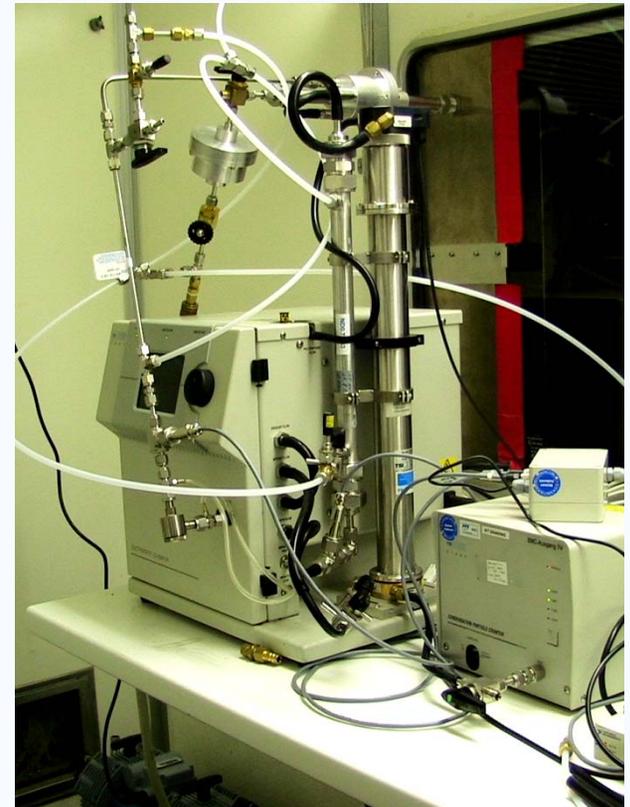


TDMPS

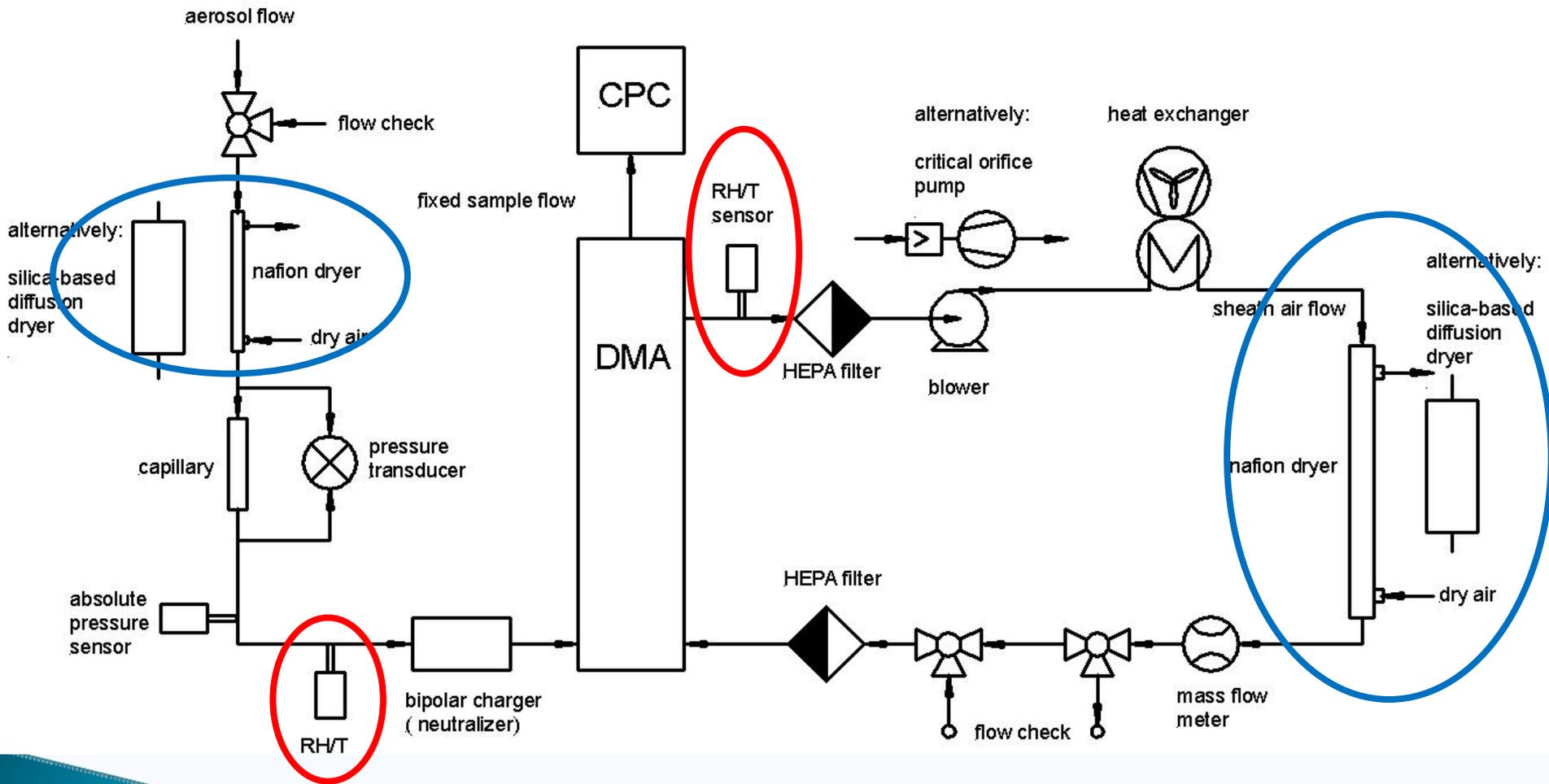
$3 < D_p < 900 \text{ nm}$



**Commercial SMPS
(modified)**

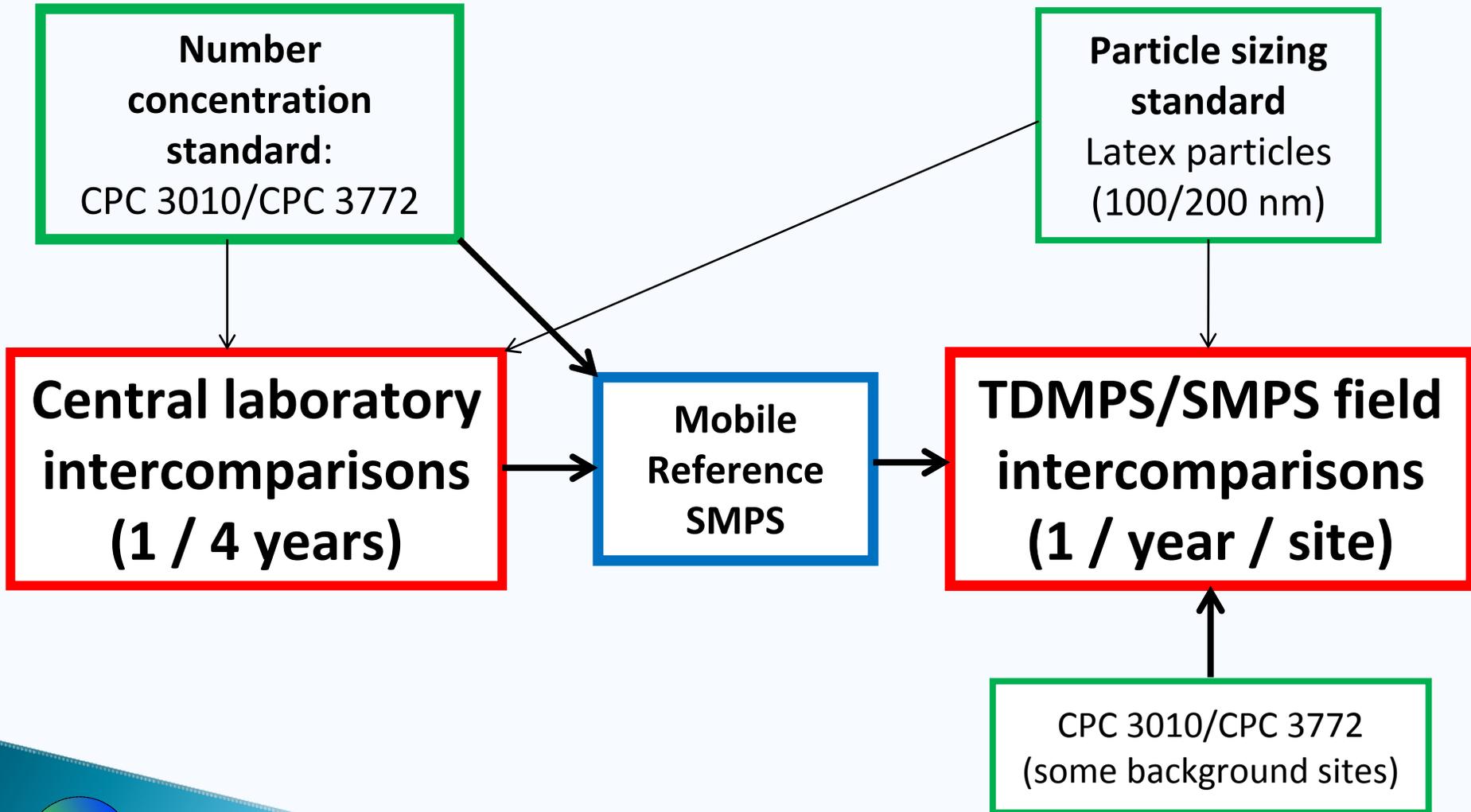


EUSAAR technical standard for mobility spectrometers

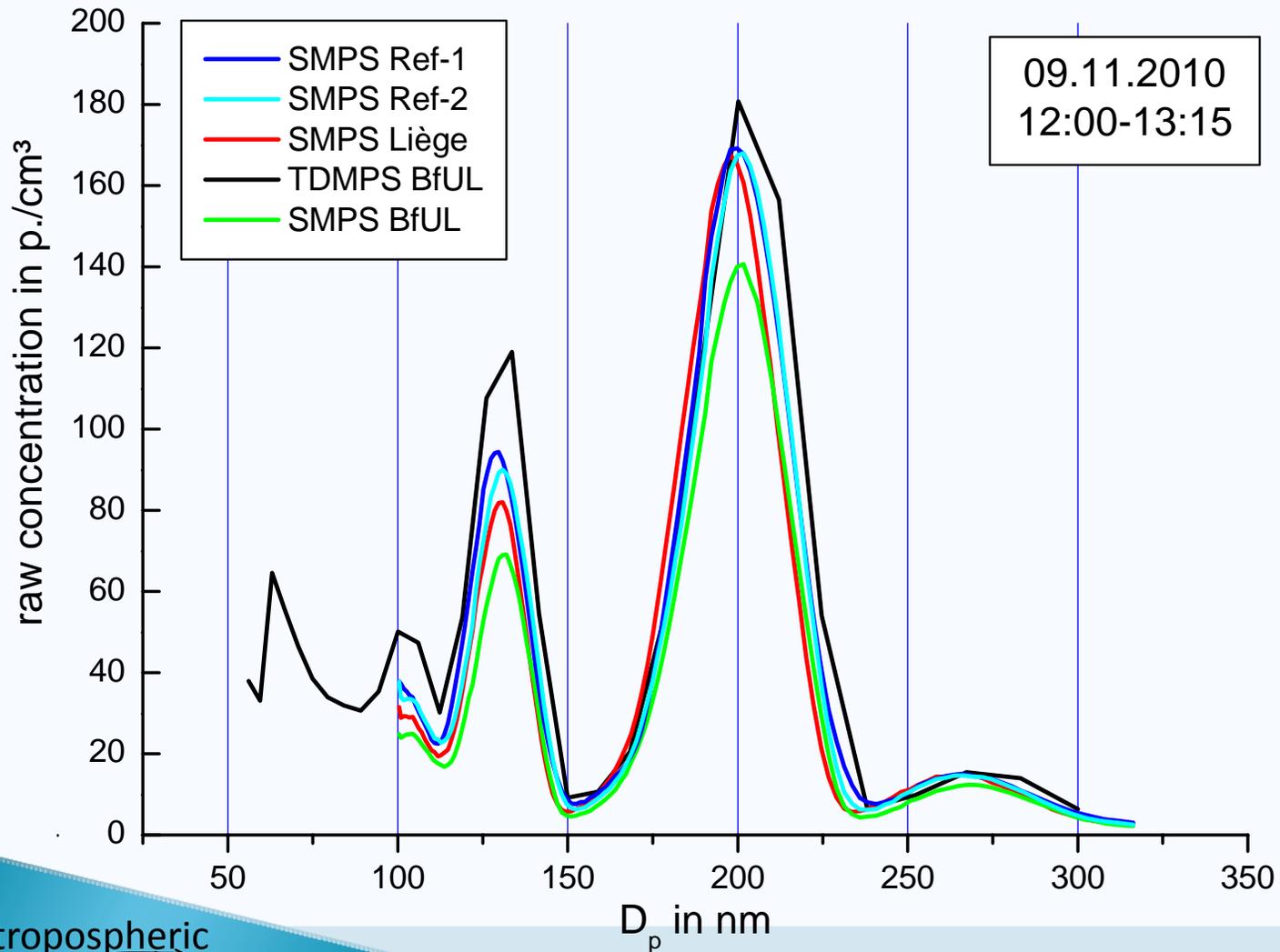


Wiedensohler et al. (2010) Atmospheric Measurement Techniques Discuss.

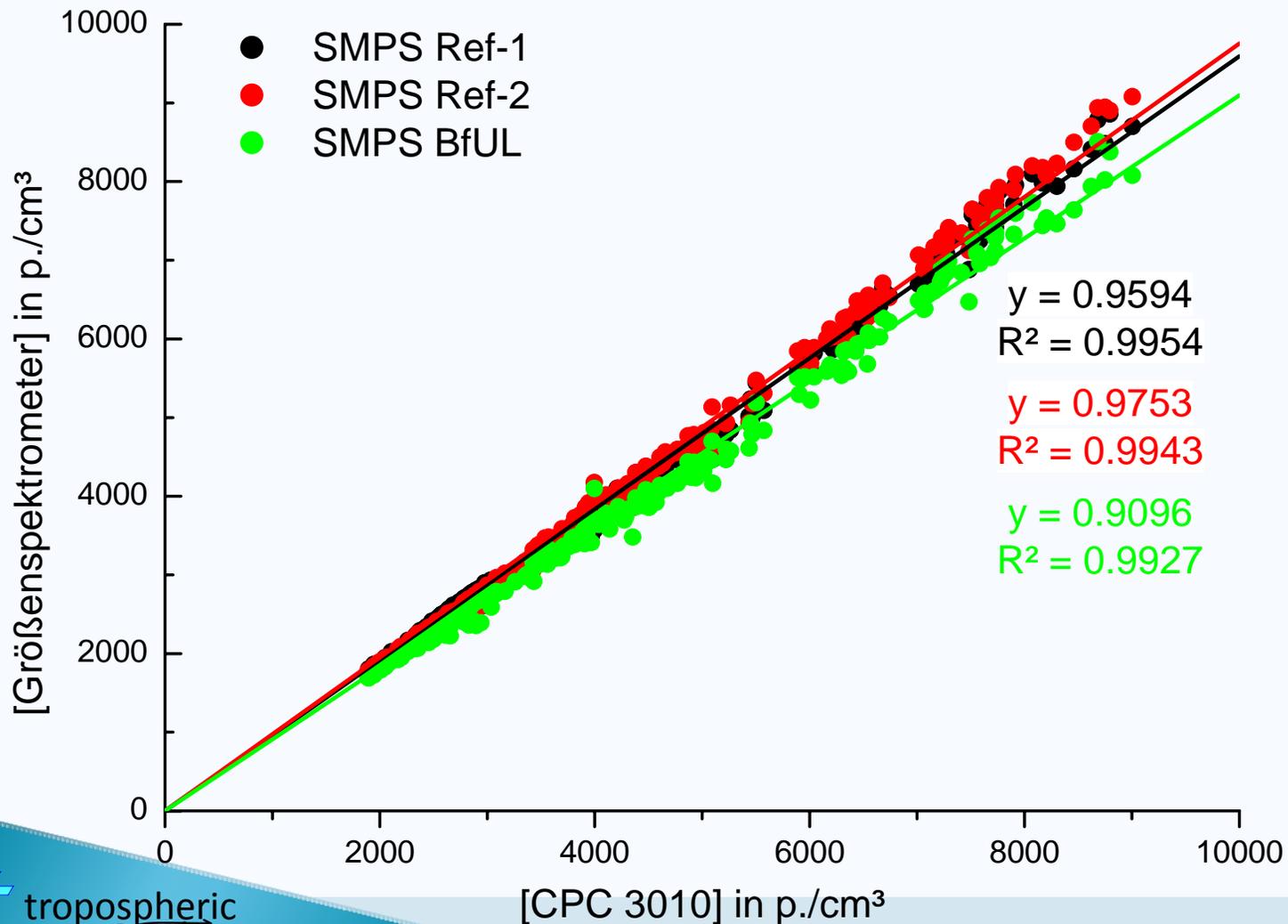
Quality assurance for mobility spectrometers



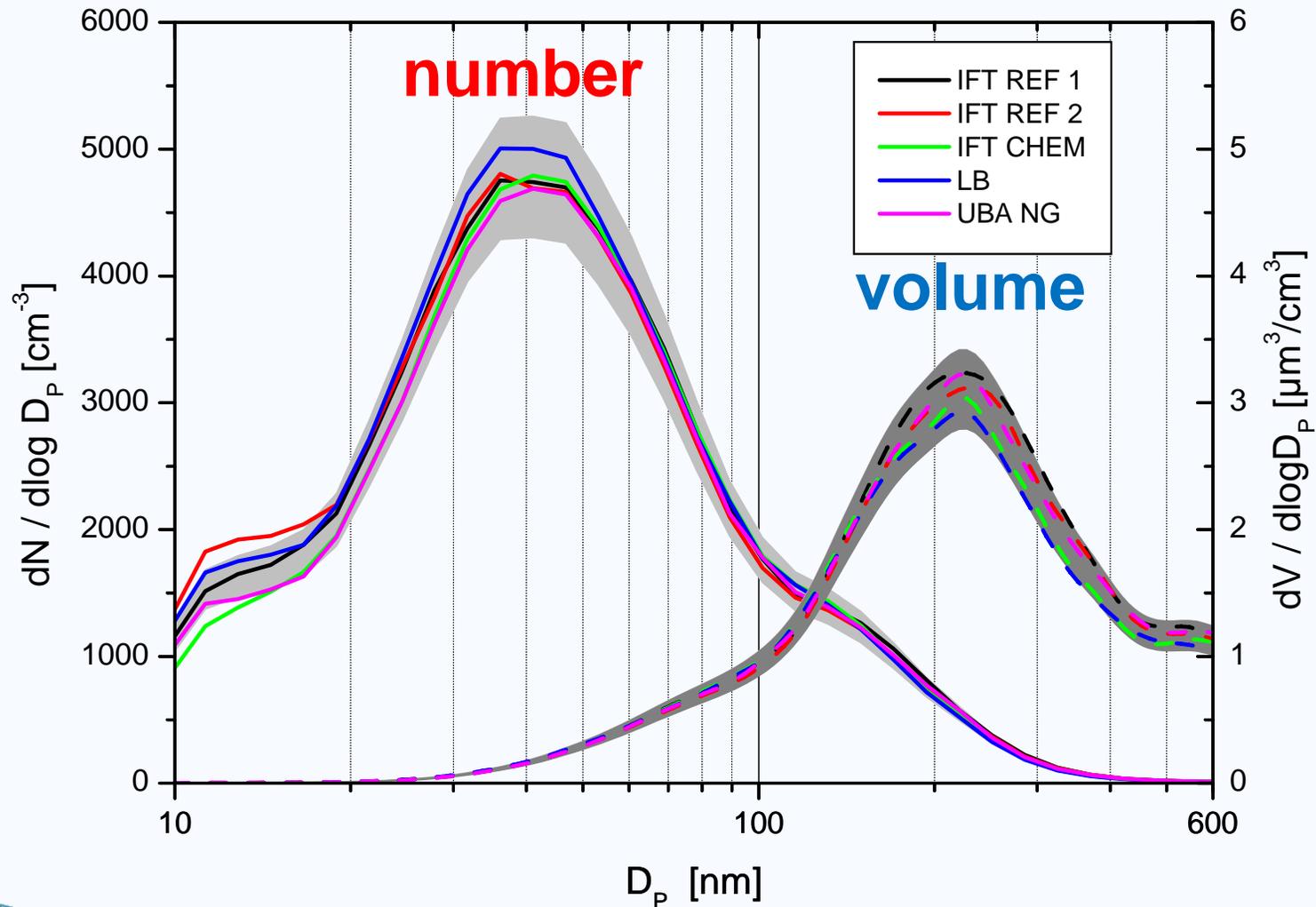
Verification of particle sizing using Latex particles (laboratory)



Reference SMPS-s vs. CPC number concentration standard (laboratory)



Comparability of identical SMPS instruments



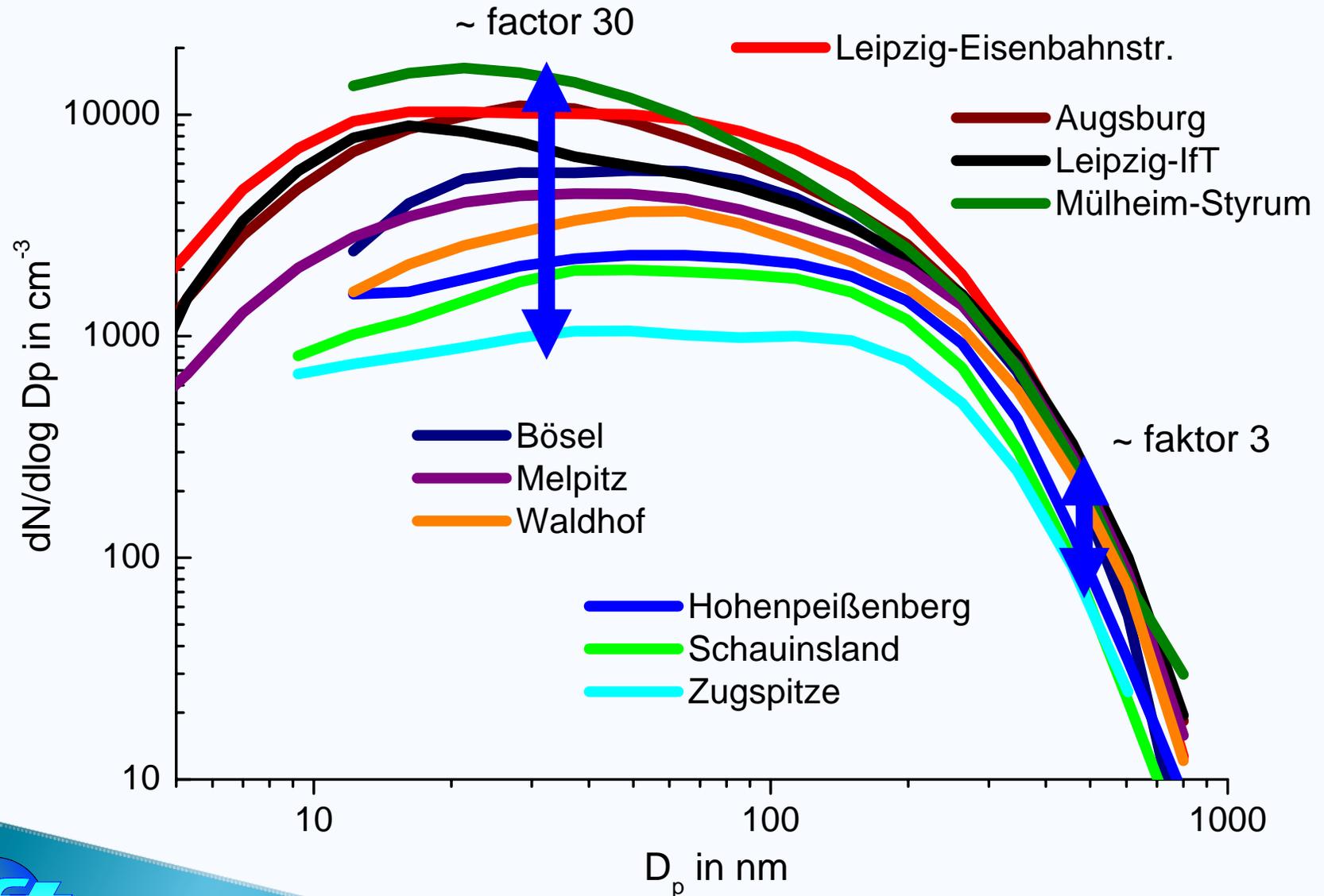
Wiedensohler et al. (2010) Atmospheric Measurement Techniques Discuss.

Estimated uncertainty in field number size distributions

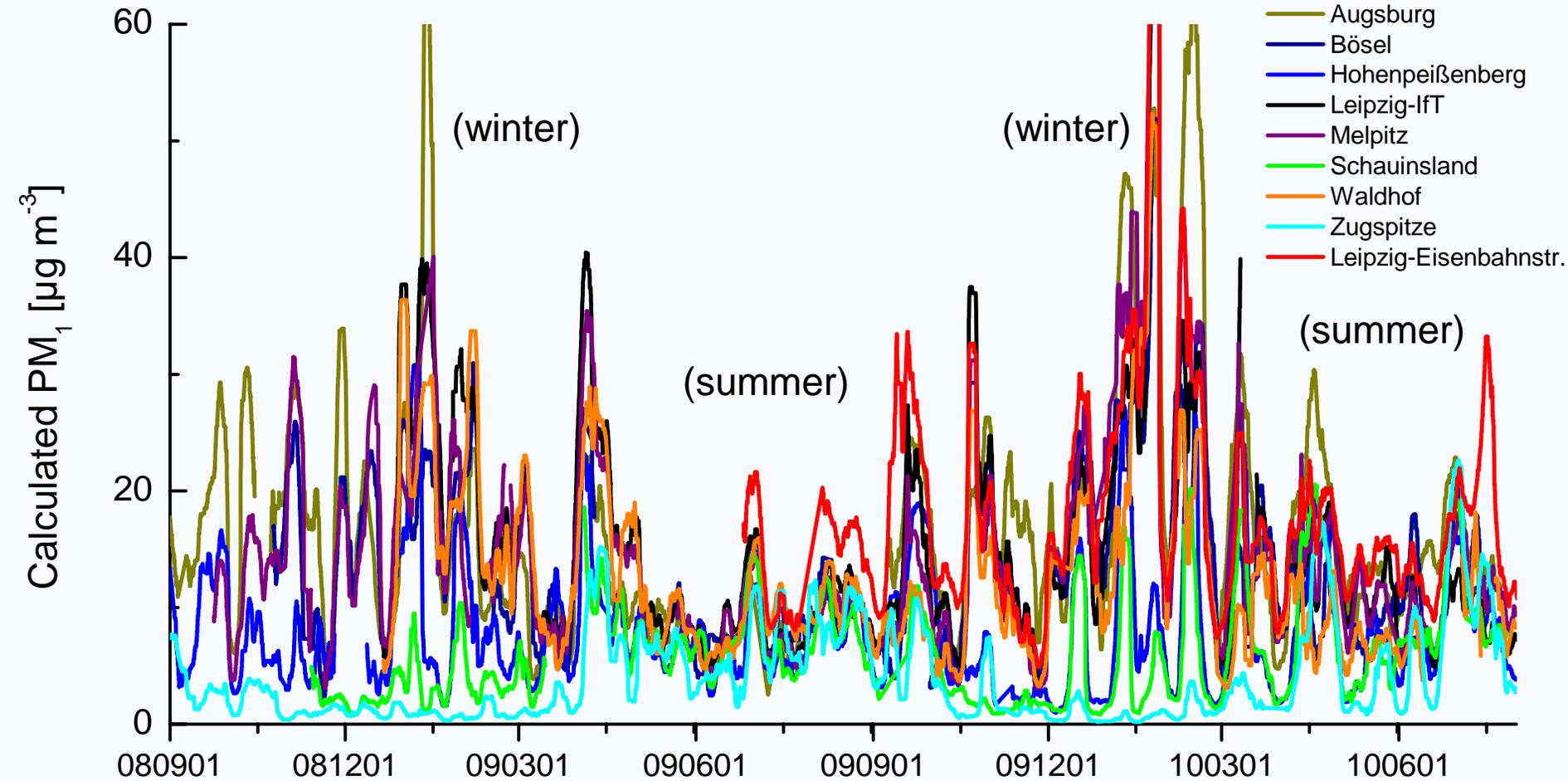
- Particle sizing (20-800 nm):
 - +/- 3 %
- Particle number concentration (20-800 nm)
 - Reference instruments: +/- 5 %
 - Field instruments: +/- 10 %
- Particle number concentration (10-20 nm):
 - +/- 30 %
- Particle volume concentration:
 - +/- 30 %

Exemplary field measurements

Particle number size distributions 2009-2010

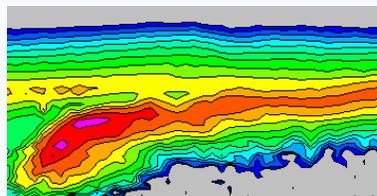
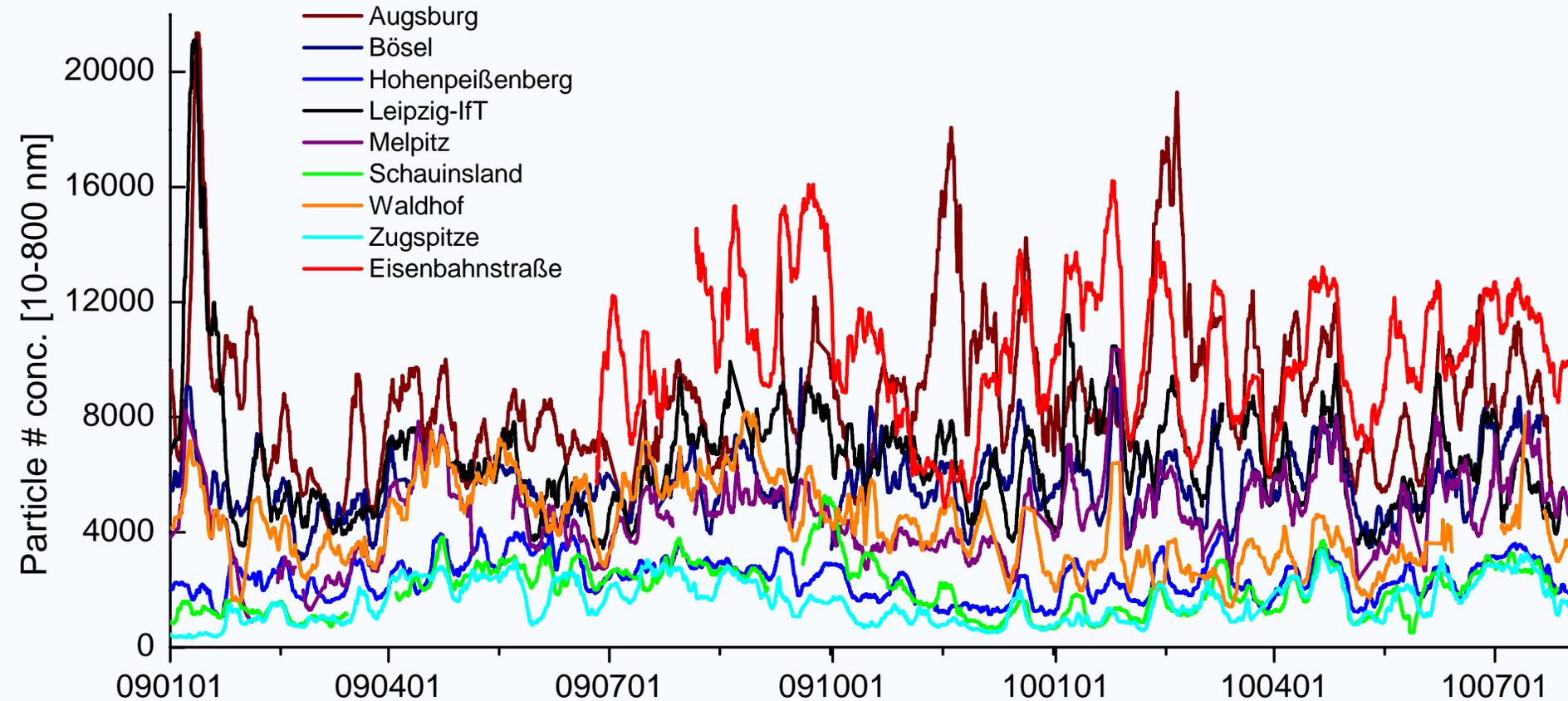


Calculated PM₁ mass concentration (1-week floating average)



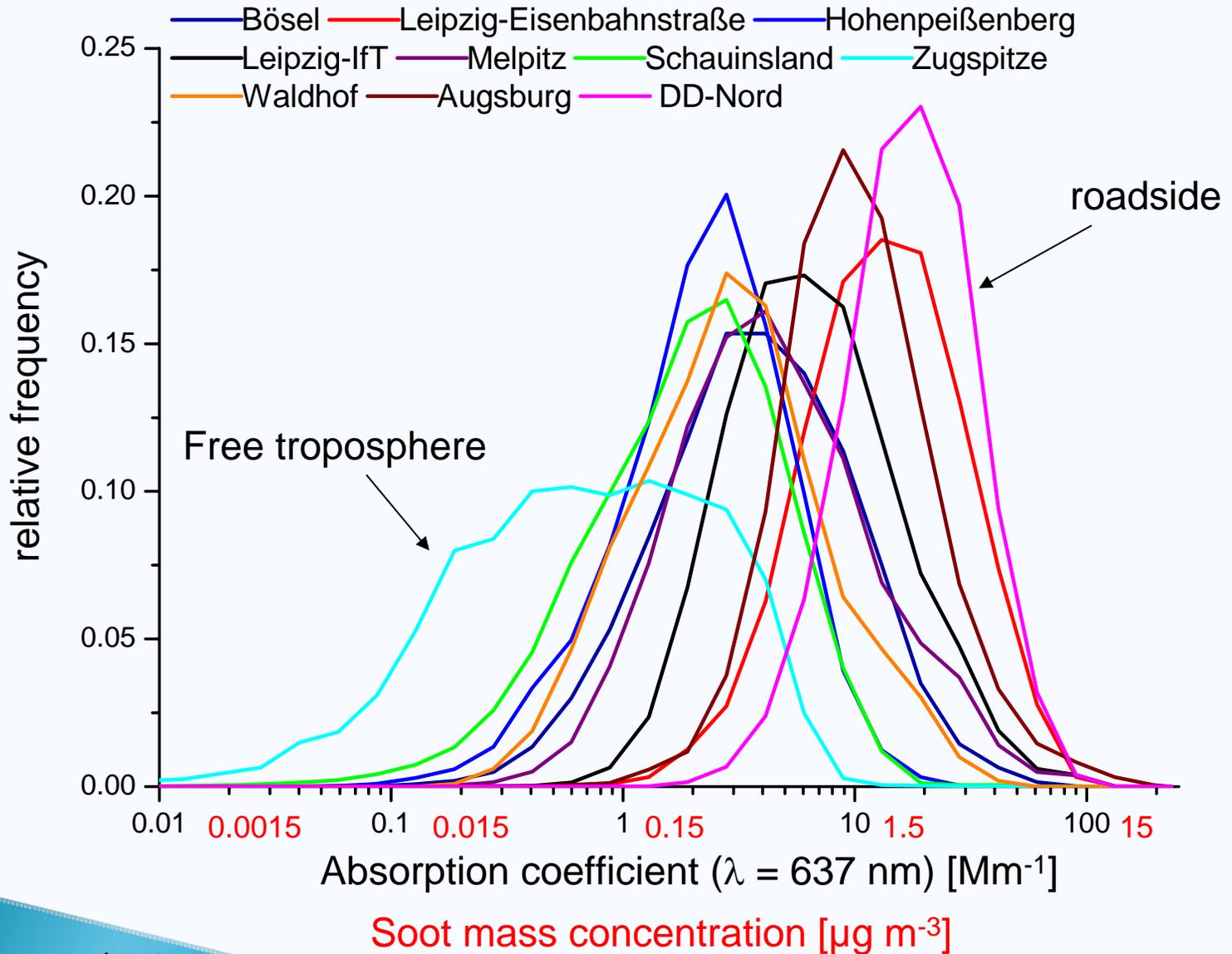
Total particle number (10-800 nm)

(1-week floating average)

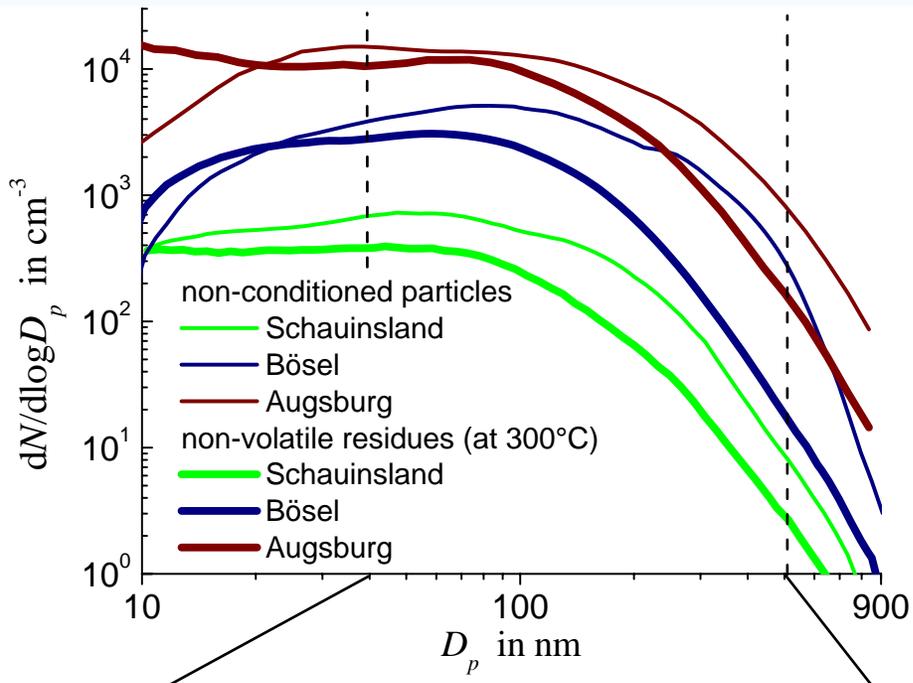


**Secondary new particle formation
not well represented
in this diagram**

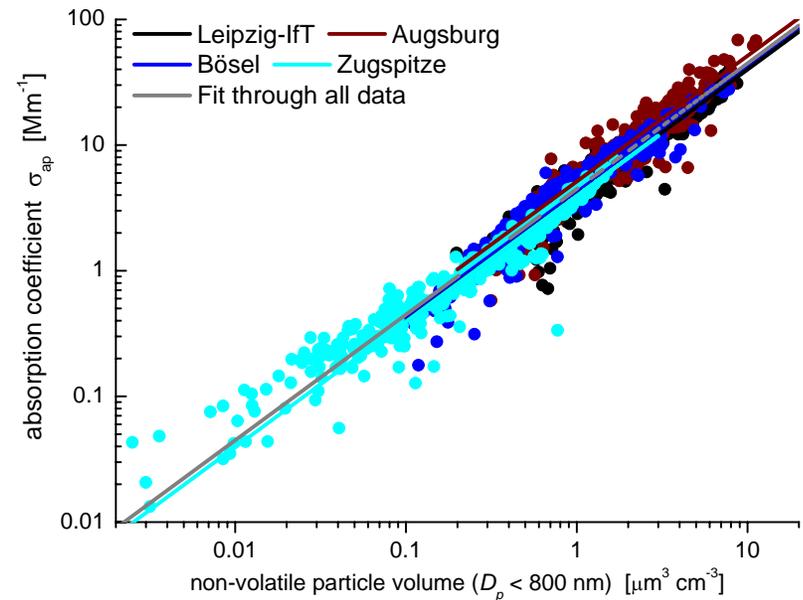
Black carbon (MAAP) 2009-2010



Non-volatile size distributions (at 300°C)



Correlation with BC



Data Applications

In-situ aerosol observation systems

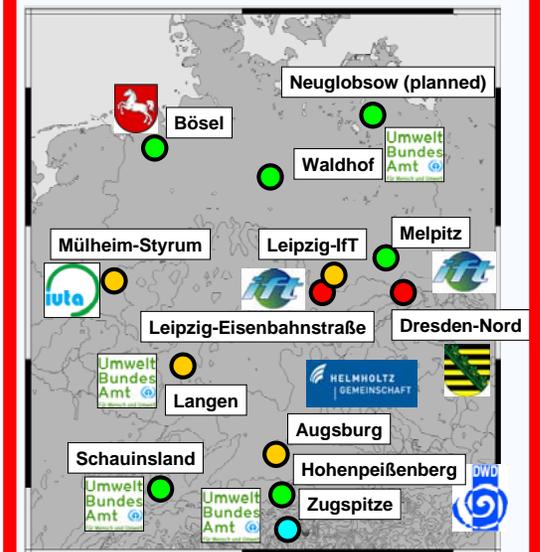


Global Atmosphere Watch (GAW)

EUropean Supersites for Atmospheric Aerosol Research



GUAN



Nations	Stations (Info)	Projects (Info)	Instrument (Info)	Components (Info)	Matrix (Info)
<ul style="list-style-type: none"> Finland France <li style="background-color: #0056b3; color: white;">Germany Greece Hungary Iceland Indonesia 	<ul style="list-style-type: none"> Rodenberg Rottenburg <li style="background-color: #0056b3; color: white;">Schauinsland Schmücke Schneefernerhaus Schorfheide Starnberg 	<ul style="list-style-type: none"> All EMEP <li style="background-color: #0056b3; color: white;">EUSAAR GAW-WDCA EMEP-GAW 	<ul style="list-style-type: none"> All <li style="background-color: #0056b3; color: white;">smps 	<ul style="list-style-type: none"> <li style="background-color: #0056b3; color: white;">All particle_number_size_distribu particle_number_size_distribu pressure temperature 	<ul style="list-style-type: none"> <li style="background-color: #0056b3; color: white;">All aerosol

Available datasets: 190

From To

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[Data policy and restrictions](#)

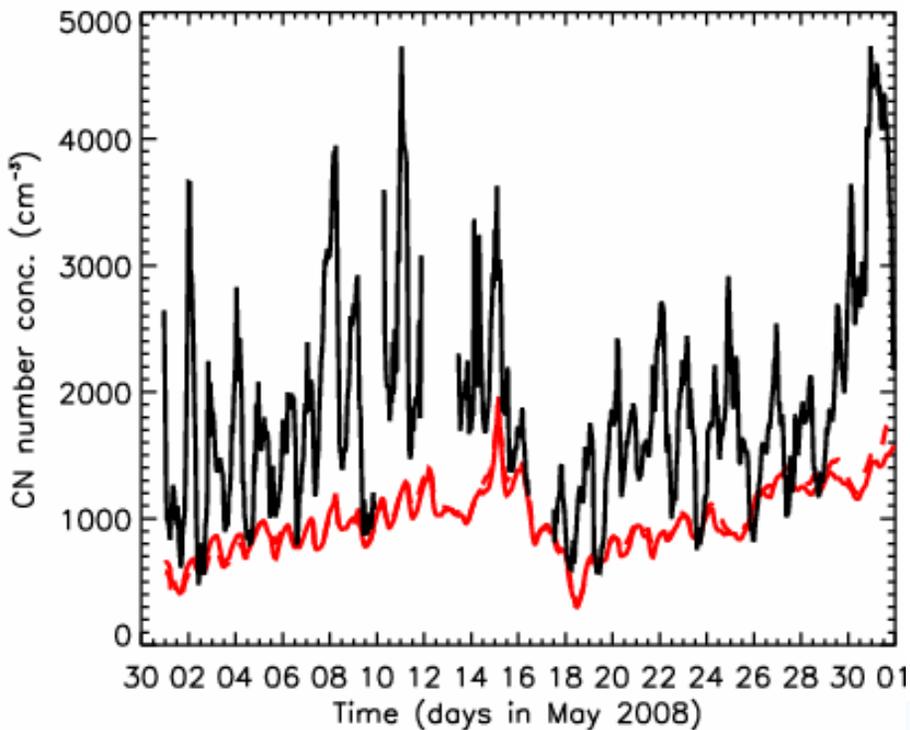
Additional Resources

- [Air mass trajectories](#)
- [Measurement network \(EMEP\)](#)
- [Measurement network \(GAW\)](#)
- [Site descriptions](#)
- [Data submission](#)
- [EMEP/CCC reports](#)
- [Presentations](#)
- [Quality assurance](#)
- [EMEP manual](#)
- [EMEP laboratory intercomparisons](#)
- [TFMM](#)
- [HTAP](#)
- [Measurement programme/strategy \(pdf\)](#)



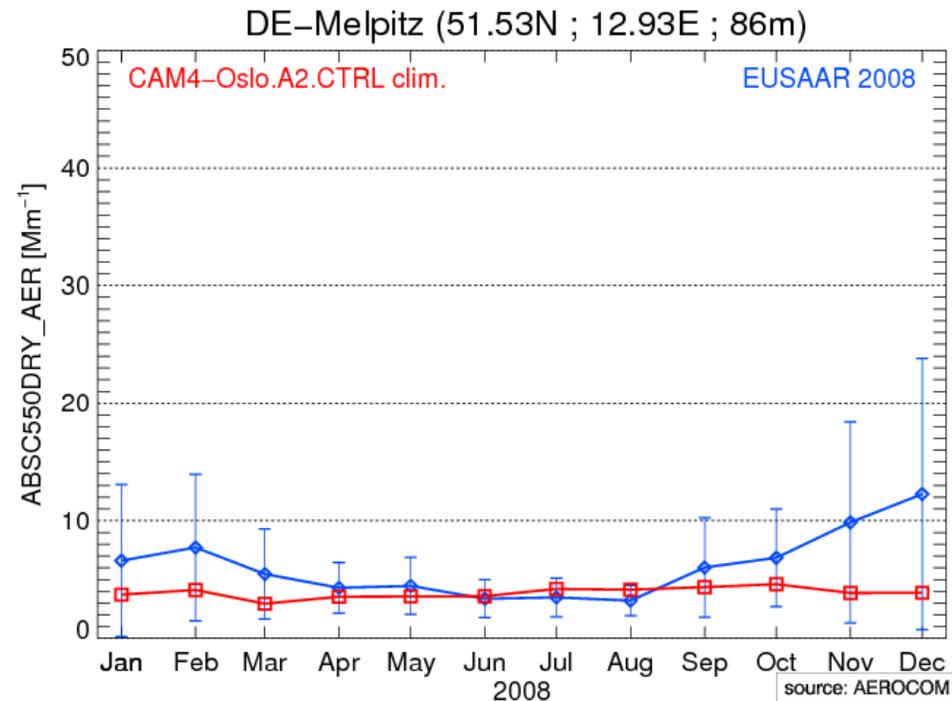
Applications for the data: Global aerosol validation (EUCAARI examples)

GloMap (Leeds):
Particle number Melpitz



Carly Reddington

CAM4 (Oslo):
Absorption coeff. Melpitz



Michael Schulz

Conclusions

- German Ultrafine Aerosol Network (GUAN) is operational with 12 research/monitoring sites
- High efforts for quality assurance
- Particle mass \sim regional / synoptic-scale effects
- Particle number \sim local / regional effects

- Differentiation rural/urban/traffic
- Regional differentiation
- Representativity of single sites can be assessed

Future plans

- Limited expansion of GUAN
- Stabilisation of quality assurance

- Analysis of source regions / source intensities
- Analysis of regional aerosol transport /processing
- Validation of aerosol transport models

- Characterisation of particle exposure
- Use in epidemiological studies

References

- Birmili, W., K. Weinhold, S. Nordmann, A. Wiedensohler, G. Spindler et al.: Atmospheric aerosol measurements in the German Ultrafine Aerosol Network (GUAN): Part 1 - soot and particle number size distributions. *Gefahrst. Reinh. Luft*, **69**(4): 137-145, 2009.
- Nordmann, S., W. Birmili, K. Weinhold, A. Wiedensohler, S. Mertes et al.: Atmospheric aerosol measurements in the German Ultrafine Aerosol Network (GUAN) - Part 2: Comparison of measurements techniques for graphitic, light-absorbing, and elemental carbon, and the non-volatile particle volume under field conditions. *Gefahrst. Reinh. Luft*, **69**(11/12): 469-474, 2009.
- Wiedensohler et al.: Particle mobility size spectrometers: Harmonization of technical standards and data structure to facilitate high quality long-term observations of atmospheric particle number size distributions, *Atmos. Meas. Tech. Discuss.*, 2010, <http://www.atmos-meas-tech-discuss.net/3/5521/2010/>
- Reprints are available on request from the main author (birmili@tropos.de)