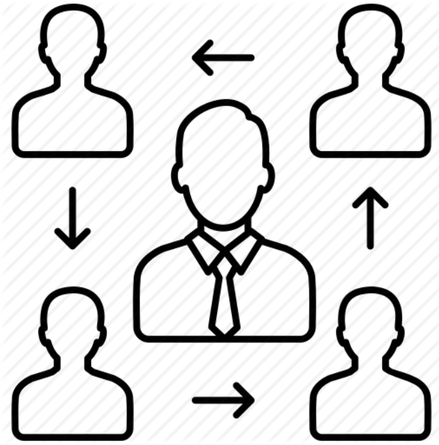
Institute of Chemical Process Fundamentals of the CAS

Department of **Aerosol Chemistry** and **Physics**

Human resources



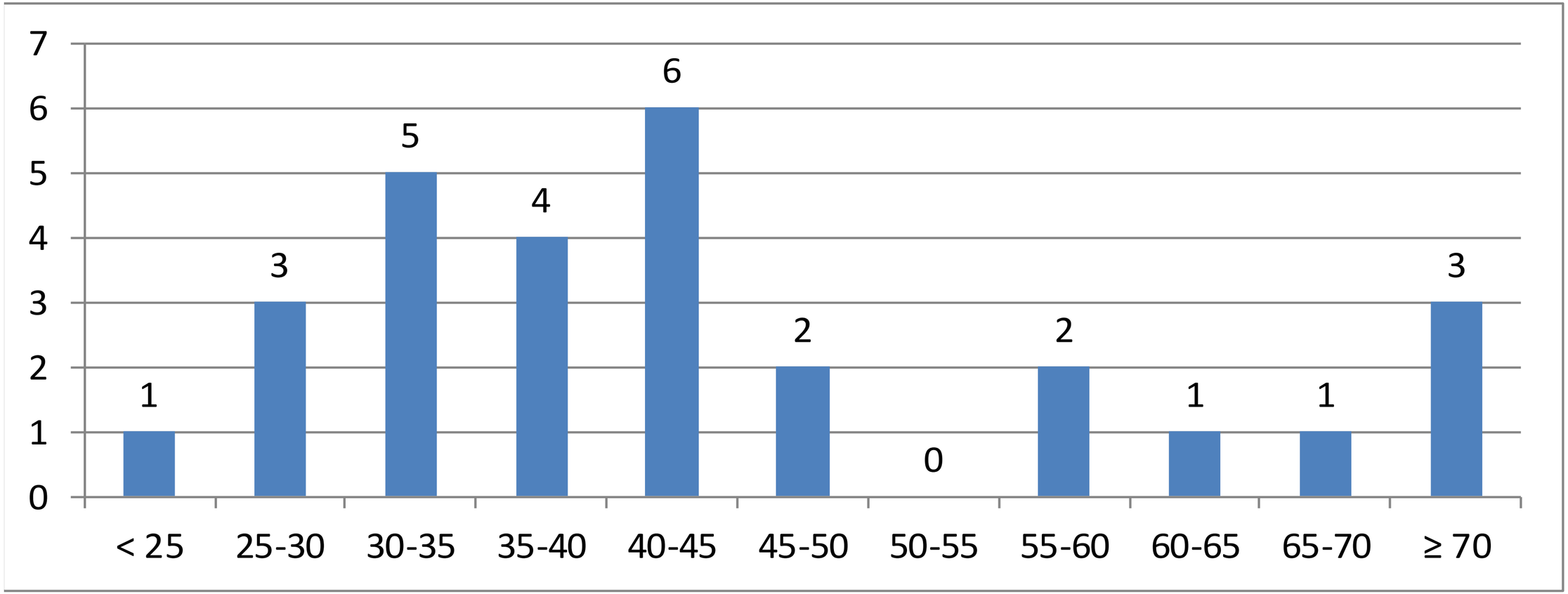
27 people (25 FTE)

- Head of Department - **Vladimír Ždímal**
- Deputy Head of Department - **Jaroslav Schwarz**

- 7 Senior Scientists
  - including 2 Emeritus Researchers
- 7 Scientists
  - including 4 Junior Scientists
- 2 Postdoctoral Fellows
- 6 PhD Students
- 4 Technicians
- 1 Project administrator

Human resources

Age category	< 25	25-30	30-35	35-40	40-45	45-50	50-55	55-60	60-65	65-70	≥ 70
Number of members	1	3	5	4	6	2	0	2	1	1	3



Funding and Projects

5 M EUR total (2 M EUR investments)

Local

- Czech Science Foundation – 7 x
- Ministry of Education, Youth and Sports – 4 x
- Ministry of Environment – 1 x
- Ministry of Culture of the Czech Republic – 2x
- Ministry of the Interior of the Czech Republic – subcotracting – 2 x

International

- ACTRIS FP 7,
- ACTRIS-2 H2020,
- ACTRIS PPP H2020
- COST SimInhale
- COST Collosal
- UFIREG
- HEXACOMM FP 7 People

Focus of the Team

Ambient aerosols, **indoor** aerosols, **laboratory** studies, **thermodynamics**

- Comprehensive characterization of physical and chemical properties of atmospheric aerosol at pan-European scale – ACTRIS ERIC
- New particle formation and transformation
- Chemical composition of aerosols
- Source apportionment of atmospheric aerosol based on receptor modelling
- Aerosol-cloud-interactions
- Indoor and workplace aerosols
- Indoor aerosols and cultural heritage
- Nanoparticle synthesis for inhalation studies
- Size resolved testing of filters and personal protective equipment
- Thermodynamics of Task-Specific Materials (TTSM)

Topic 1: New Particle Formation and Transformation

- Laboratory studies on binary nucleation using Laminar Co-Flow Tube
- Analyses of New Particle Formation events in urban environment – Prague, Vienna, Budapest
- Study on shrinkage events following after a New Particle Formation events

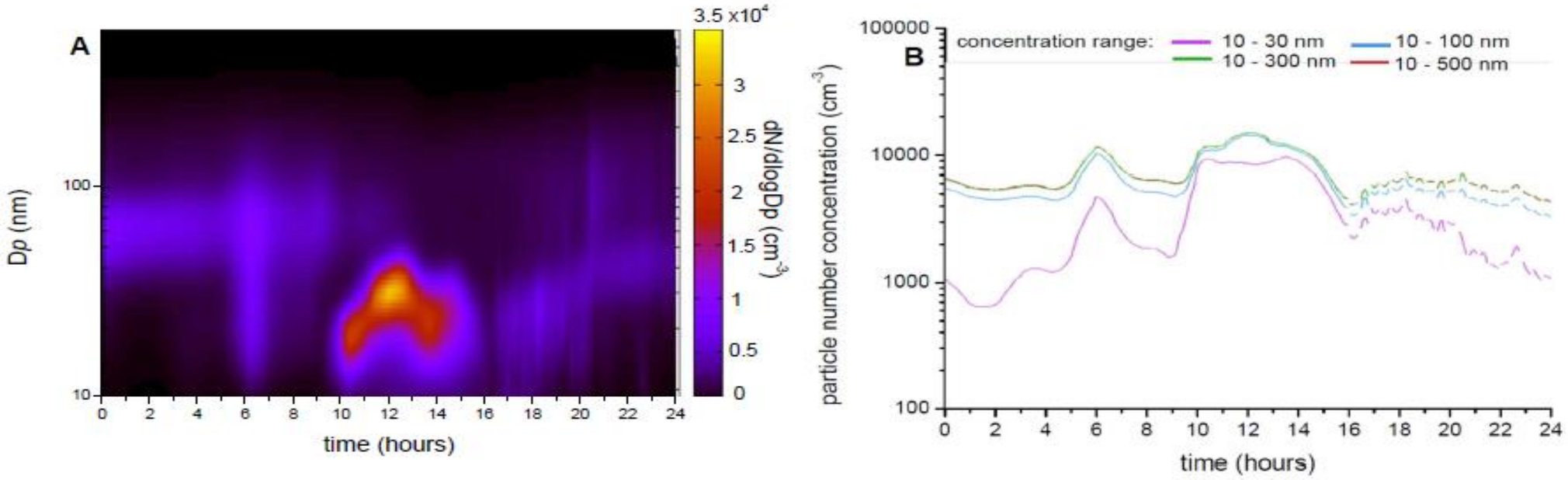


Fig.1. **The evolution of (A) particle size distribution and (B) total number concentrations during one shrinkage event.**
Large fraction of originally condensed volatile and semi-volatile species evaporate from the particulate phase during shrinkage events - following prior new particle formation events.

Skrabalova, L., Zikova, N., Zdimal, V. (2015). Shrinkage of newly formed particles in an urban environment. *Aerosol and Air Quality Research*, 15(4), 1313-1324.

Topic 2: Aerosol Chemical Composition

- Seasonal variations of size-resolved aerosol chemical composition in the CR using off-line methods
- Characterization of chemical composition in high time resolution
- Study on isotopic composition of aerosols at a rural background site in the CR

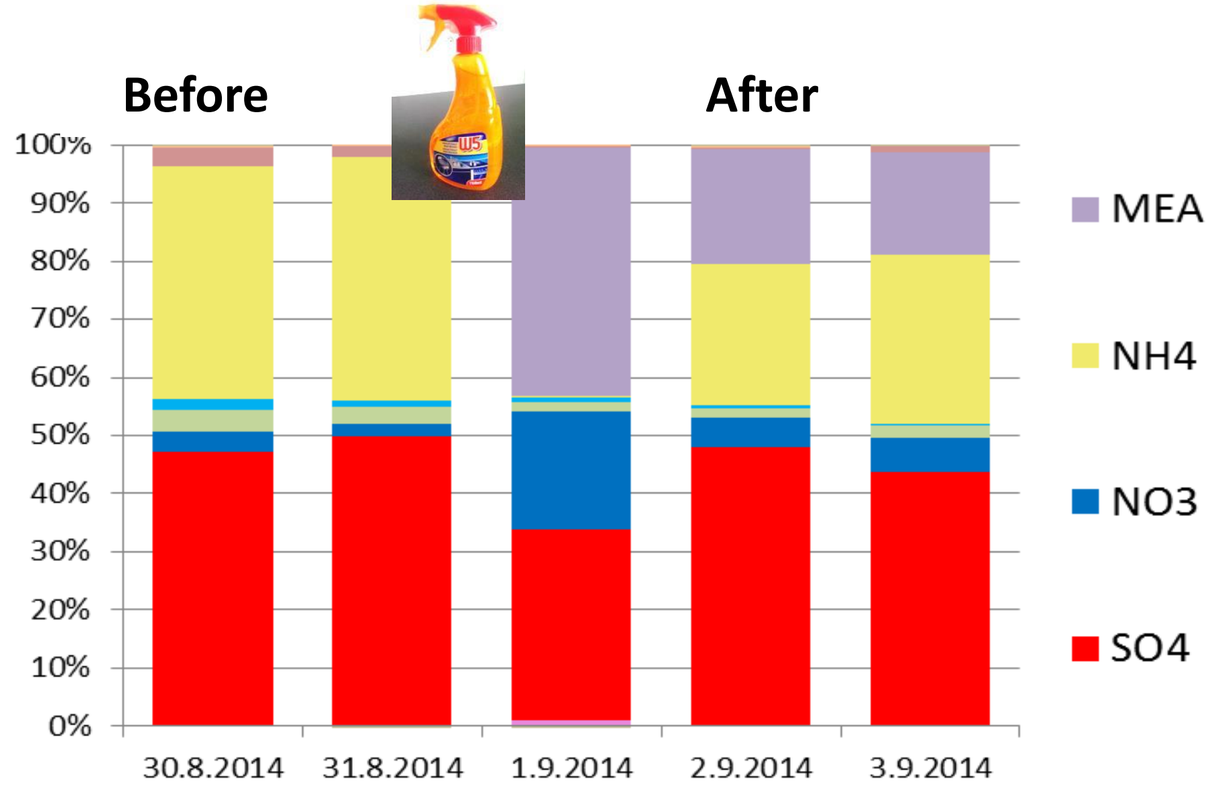


Fig. 2. **Mono-ethanolamine from a kitchen degreaser can alter Indoor aerosol for days**

J. Schwarz, O. Makeš, J. Ondráček, M. Cusack, N. Talbot, P. Vodička, L. Kubelová, V. Ždímal (2017). Single Usage of a Kitchen Degreaser Can Alter Indoor Aerosol Composition for Days. *Environ. Sci. & Technol. 51(11),* 5907-5912.

Topic 3: Source apportionment of atmospheric aerosol based on receptor modelling

- Source apportionment studies based on receptor model applications on size-resolved chemical composition data and particle size distribution data collected in different environments (urban, suburban, rural, industrial) with different integration times (24-h, 2-h, 5-min) during intensive campaigns as well as for long-term period.

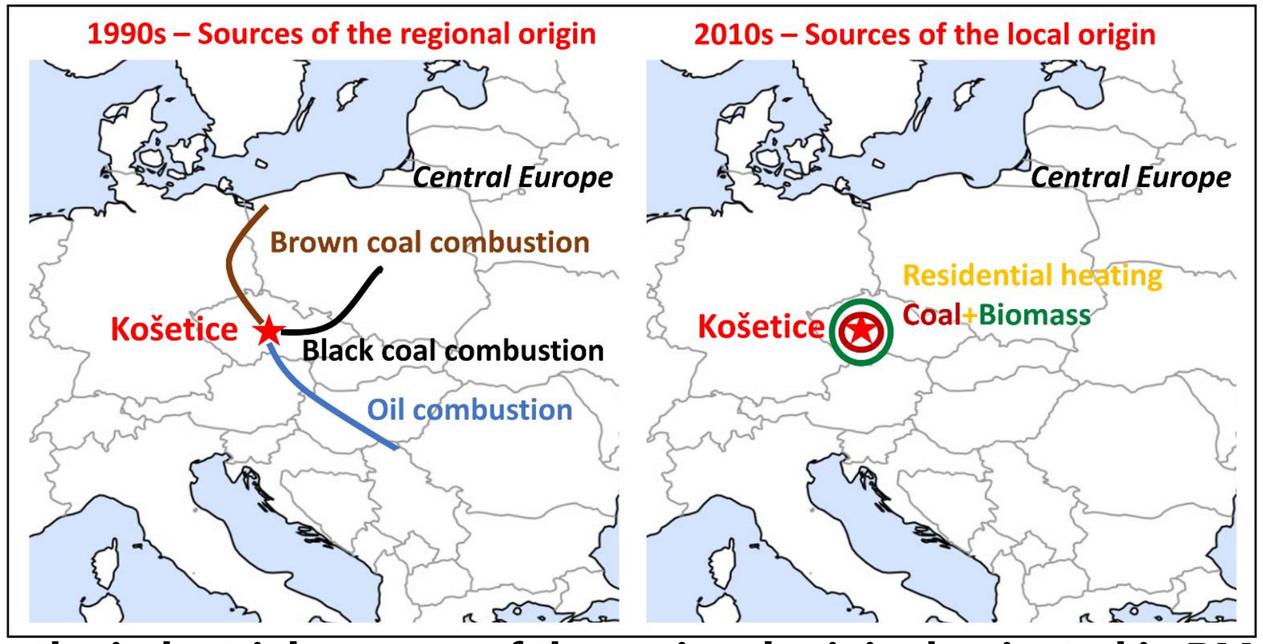


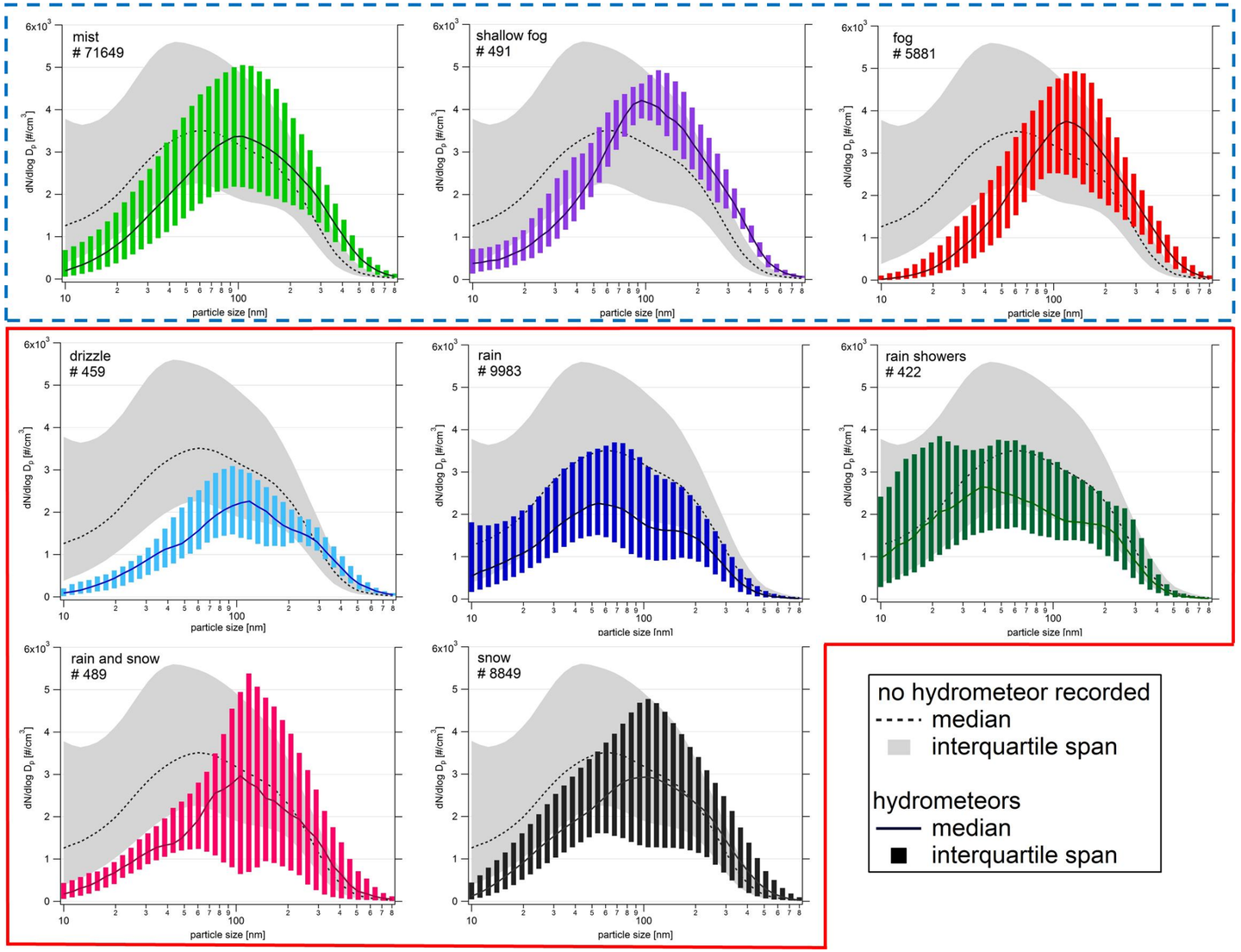
Fig. 3. **In the 90s, the industrial sources of the regional origin dominated in $PM_{2.5}$, however there they were replaced by residential heating in the years 2008/2009.**

P. Pokorná, J. Schwarz, R. Krejci, E. Swietlicki, V. Havránek, V. Ždímal (2018). Comparison of PM2.5 chemical composition and sources at a rural background site in Central Europe between the years 1993/1994/1995 and 2009/2010: Effect of legislative regulations and economic transformation on the air quality. *Environmental Pollution.* 241, 841–851.

Topic 4: Aerosol-cloud-interactions

obscurities

precipitations

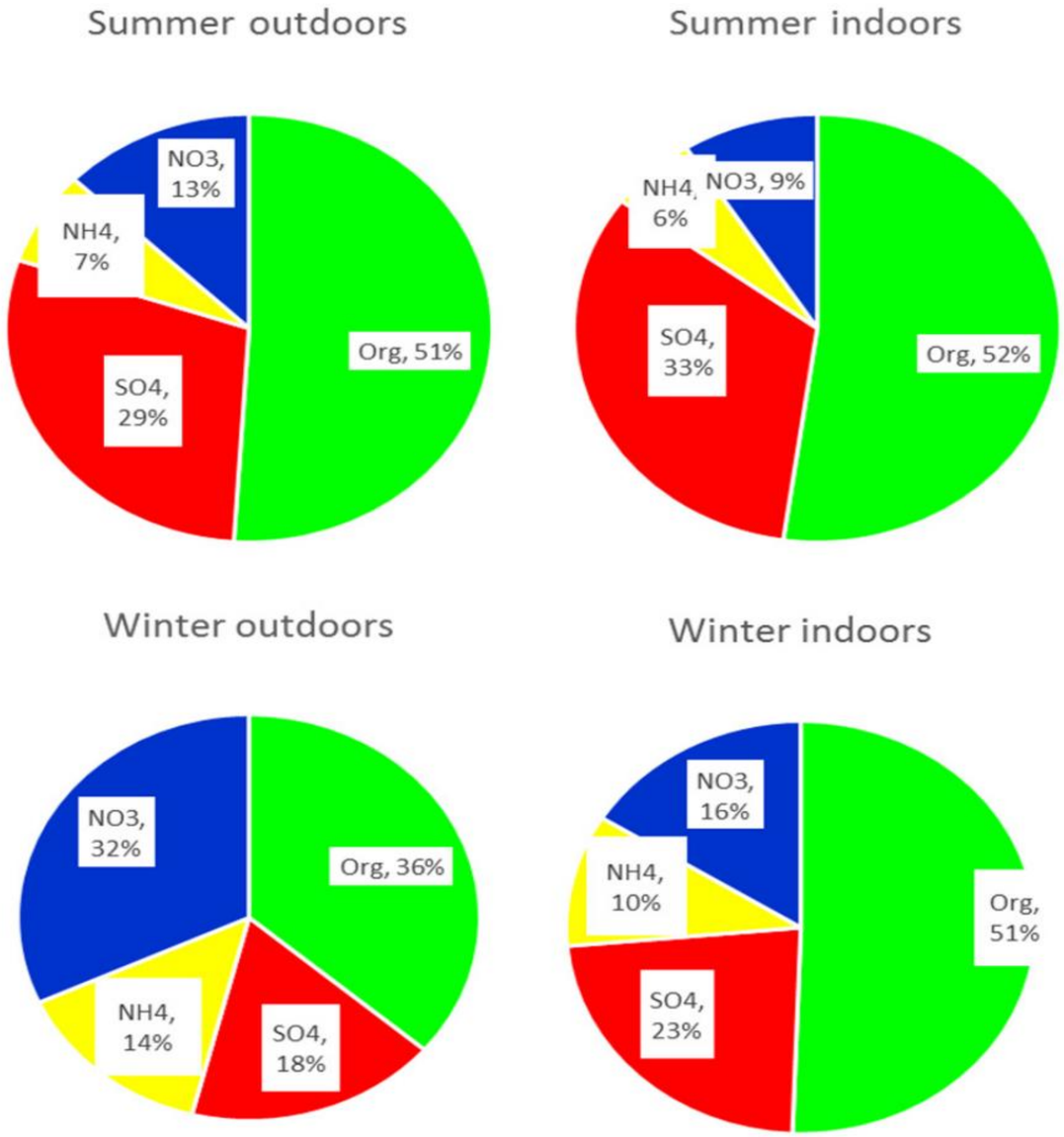


- Study on changes of particle size distribution after interaction of aerosol with different types of hydrometeors, e.g. mist, fog, rain and snow.
- Activation of atmospheric aerosol in fog and low clouds using ground based data.

Fig. 4. **Typical interstitial particle size distributions during individual meteorological phenomena, as compared to the typical particle size distributions recorded without any hydrometeor (grey area). The number (#) is the number of averaged SMPS spectra.**

Zíková, N., Ždímal, V. (2016). Precipitation Scavenging of Aerosol Particles at a Rural Site in the Czech Republic. *Tellus Series B – Chemical and Physical Meteorology.* 68, 27343.

Topic 5: Indoor and workplace aerosols



- Transformations of aerosol particles on their route from outdoor to indoor environment
- Comparison of transport of gases and particles in indoor environment
- Emissions of different indoor sources and their chemical characterization
- Characterization of indoor workplace environments including exposure studies.

Fig. 5. **Seasonal differences in Transformations of Aerosol Particles from an Outdoor to Indoor Environment**

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Talbot, N., Kubelová, L., Makeš, O., Ondráček, J., Cusack, M., Schwarz, J., Vodička, P., Zíková, N., Ždímal, V. (2017). Transformations of aerosol particles from an outdoor to indoor environment. Aerosol Air Qual. Res. 17(3), 653-665.

Topic 6: Indoor aerosols and cultural heritage

- A complex study was performed in libraries, archives, museums, churches, and depositories located in areas with different outdoor air quality.
- Long-term investigation of chemical composition of indoor particulate matter (PM), behaviour of gaseous pollutants, modelling of indoor/outdoor relationship, deposition on indoor surfaces, influence of visitors, and adverse effects of dust deposits.

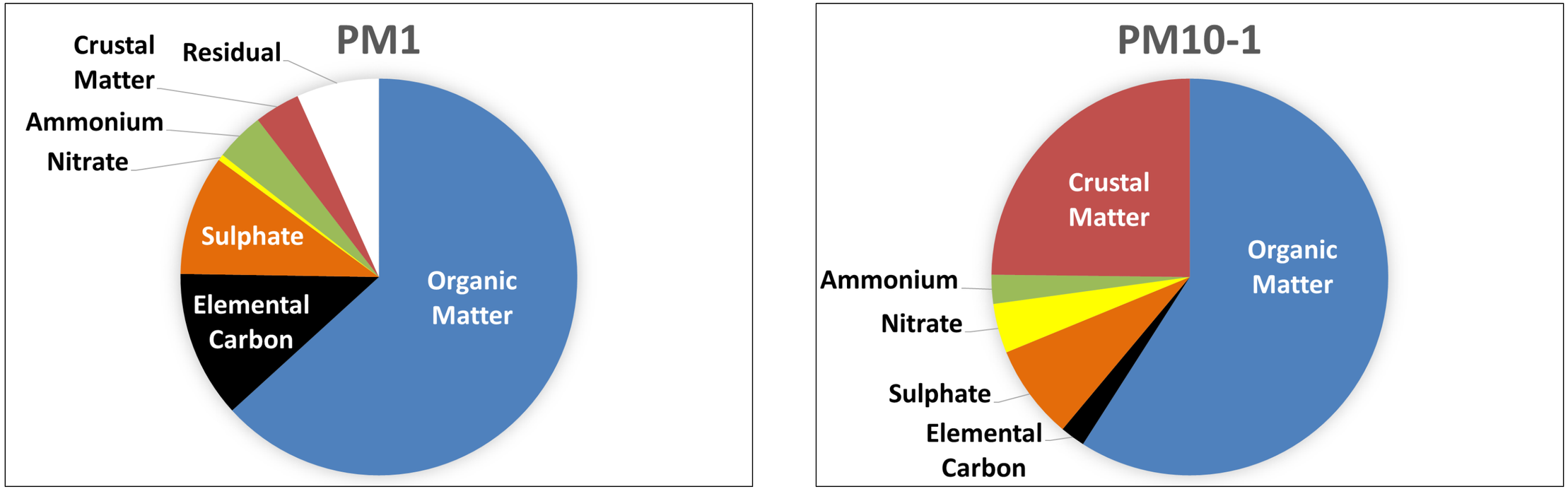
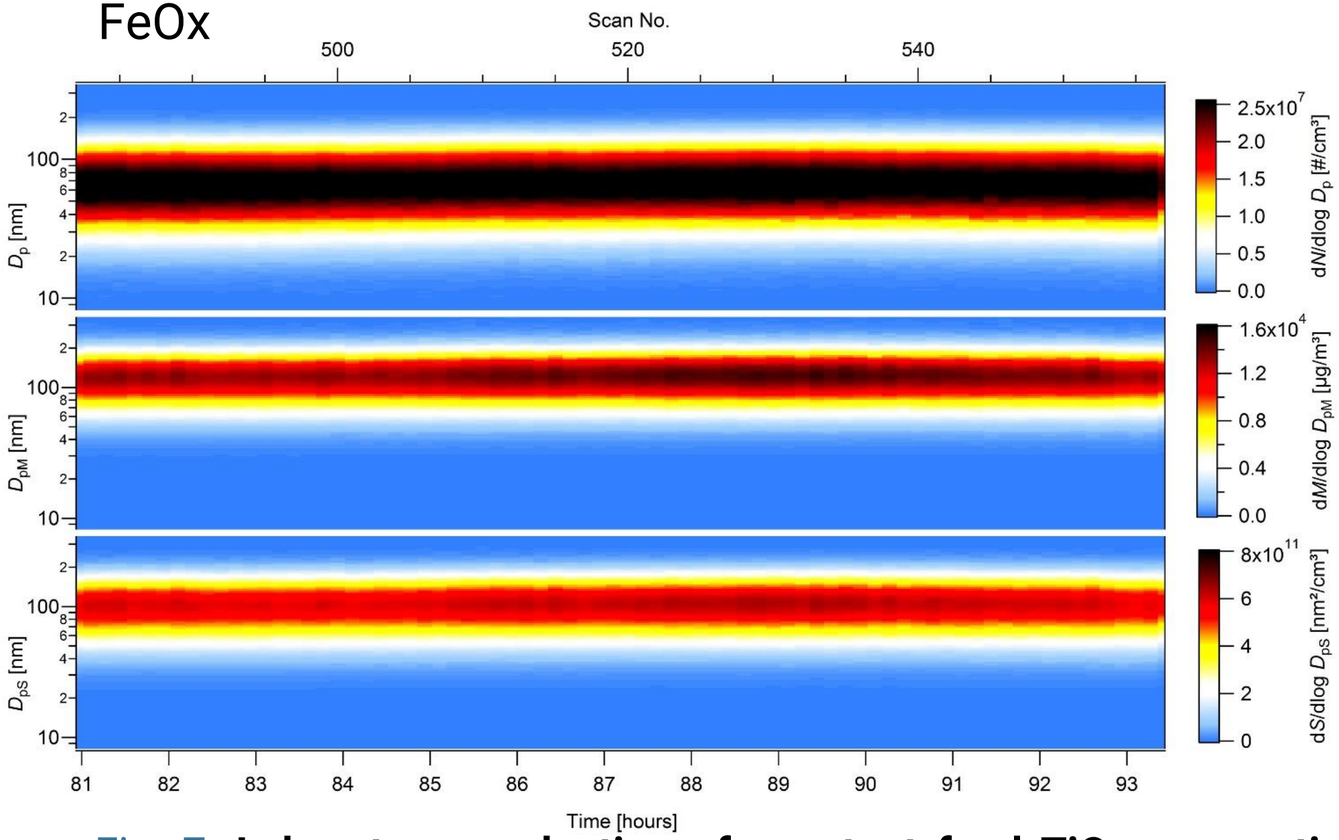


Fig. 6. Average chemical composition of the indoor fine and coarse PM in four archives

L. Mašková, J. Smolík, M. Ďurovič (2017): Characterization of Indoor Air Quality in Different Archives – Possible Implications for Books and Manuscripts. *Building and Environ.* 120, 77-84.

Topic 7: Nanoparticle synthesis for inhalation studies

- Developing of laboratory methods of steady-state generation of nanoparticles aimed to follow-up inhalation studies
- Gas-to-particle conversion, several ways of generation of NPs: PbO, TiO2, ZnO, Cu/Cu2O/CuO, FeOx



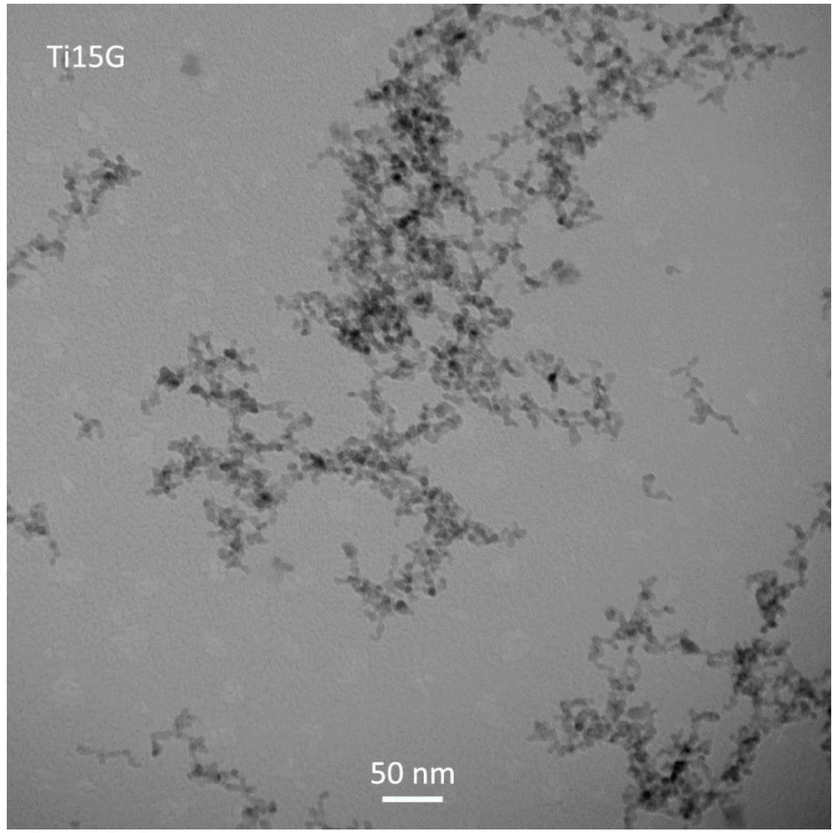


Fig. 7. **Laboratory production of constant feed TiO_2 nanoparticles for follow-up inhalation experiments with laboratory animals at steady state conditions (700 °C, left) and TEM photo of synthesized NPs (right).**

P. Moravec, J. Schwarz, P. Vodička, M. Koštejn (2016) : Study od TiO_2 nanoparticle generation for follow-up inhalation experiments with laboratory animals. *Aerosol Sci. Technol.* 50, 1068-1076.

Topic 8: Size resolved Testing of Filters and Personal Protective Equipment

- Measurements of size-resolved penetration of materials used in aerosol filtration, with focus on facemasks and respirators, determination of MPPS.
- Investigations on size-resolved penetration through facemasks and respirators fixed on a Sheffield head, effects of leaks around the face and in the exhalation valves.

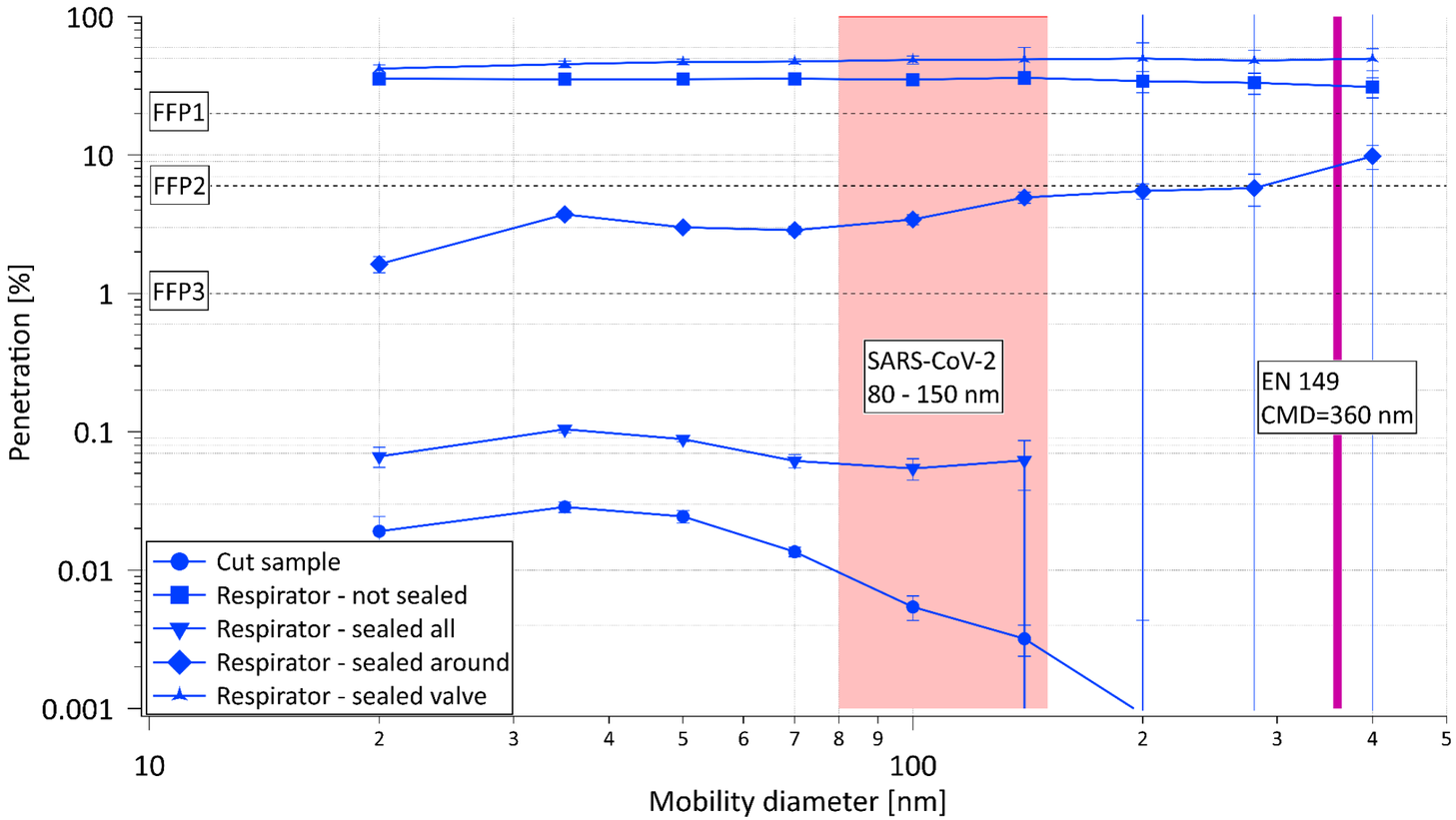


Fig. 8 **Comparison of penetration through respirators under different level of respirator sealing**

N. Serfozo, J. Ondráček, P. Otáhal, M. Lazaridis, V. Ždímal (2017): Manikin-Based Size-Resolved Penetrations of CE-marked Filtering Facepiece Respirators. *Journal of Occupational & Environmental Hygiene.* 14/12. 965–974.

Topic 9: Thermodynamics of Task-Specific Materials

- Structure-property relationships of Ionic liquids - possible use as thermal storage media.
- Experimental determination of vapour pressures, surface tension, and thermal properties of selected terpenes
- Validation of experimentally determined thermophysical properties using mathematical gnostics

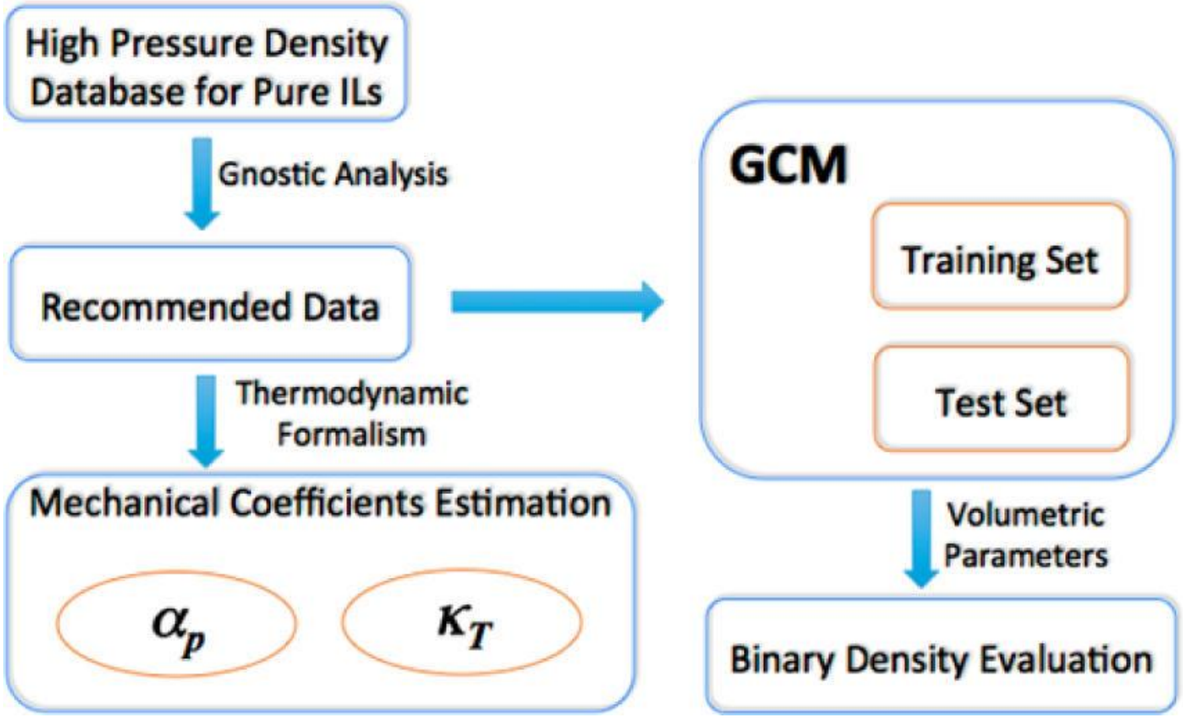


Fig. 9. **Advanced data analysis by means of mathematical gnostics:**

Critical data assessment for optimization of group-contribution method parameters

Zhao, N., Menegolla, H. B., Degirmenci, V., Wagner, Z., Bendová, M., & Jacquemin, J. (2017). Group Contribution Method for Evaluation of Volumetric Properties of Ionic Liquids Using Experimental Data Recommended by Mathematical Gnostics. *Industrial and Engineering Chemistry Research*, *56*(23), 6827–6840.

International cooperation

- ACTRIS consortium:

✓ TROPOS, Leipzig, Germany, Prof. Alfred Wiedensohler

✓ JRC Ispra, Italy, Dr. Jean-Philippe Putaud – OC/EC

✓ CSIC Barcelona, PSI, IMT Lille Douai - Prof. Véronique Riffault - Source Apportionment using ACSM and Aethalometers

- Clarkson University, Potsdam, NY, USA, Prof. Philip K. Hopke – SA based on RM
- DTU, Lyngby, Denmark, Prof. Arsen K. Melikov, NILU, Norway, Dr. K. Torseth, CSIC, Barcelona, Spain, Dr. Marie Cruz Minguillon, University of Birmingham, UK, Prof. Roy Harrison - Indoor aerosols
- Institute of Atmospheric Pollution Research, CNR, Italy –Indoor aerosols and cultural heritage
- University of Parma, Prof. Paolo Colombo, University of Cyprus, Prof. Stavros Kassinos – inhalatory deposition
- Université Francois Rabelais Tours, Dr. Johan Jacquemin - application of ionic liquids

Pedagogical activity

➢ Overview of semestrial lectures, seminars and courses:

- Bachelor – 4 courses, Master – 12 courses, Doctoral - 8

➢ Supervision of theses:

- Bachelor – 5 students, Master – 6 students, Doctoral – 11 students

➢ Topics of doctoral theses:

- Maja Čanji: „Interaction of solute-solvent in mixtures of ionic liquids with molecular solvents.“
- Jana Kozáková: „Sources of the Intermodal Fraction of Atmospheric Aerosol.“
- Lucie Kubelová: „Study on Secondary Aerosol Formation.“
- Otakar Makeš: “Real-Time Studies on Aerosol Volatility”.

Pedagogical activity

➢ Topics of doctoral theses - continuation:

- Ludmila Mašková: “Environment of Different Types of Libraries and Archives”
- Nicholas Talbot: „A detailed study on aerosol particle size distribution in indoor and outdoor environments with attention to ammonium nitrate transformations”.
- Petr Vodička: “Carbonaceous Aerosols at Central European Suburban Site studied in High Time Resolution”.
- Lenka Škrabalová: „Nucleation of Sulphuric Acid and Water. Laboratory and Atmospheric Observations".
- Jan Rotrekl: „Structure of ionic liquids and their mixtures with molecular solvents".
- Karolina Machanová: „Phase equilibria and thermodynamic properties of mixtures containing ionic liquids".

Participation of team members in activities of scientific community

Karel Aim

- Member (vice-chairman until June 2019) of the Board of Governors of the Joint Research Centre of the European Commission
- Member of the permanent International Steering Committee of the European Symposia on Applied Thermodynamics (28th ESAT 2015 in Athens, 29th ESAT 2017 in Bucharest, 30th ESAT 2018 in Prague)
- Member of the EFCE Working Party on Thermodynamics and Transport Properties

Magdalena Bendová

- Associate Editor of the Journal of Solution Chemistry
- Member of the Editorial Board of the Journal of Chemical Thermodynamics
- Member of the IUPAC Analytical Division Subcommittee on Solubility and Equilibrium Data
- Member of the EFCE Working Party on Fluid Separations
- Member of the Board of Directors, European Society of Ionic Matter

Participation of team members in activities of scientific community

Petra Pokorná

- Co-coordinator, national expert (2016 – 2018) in EUSDR PA6 TFAQ – EU Strategy for the Danube region, Priority area 6, Task Force for Air Quality,
- National expert in FAIRMODE – Forum for air quality modelling in Europe, WG3 Source apportionment

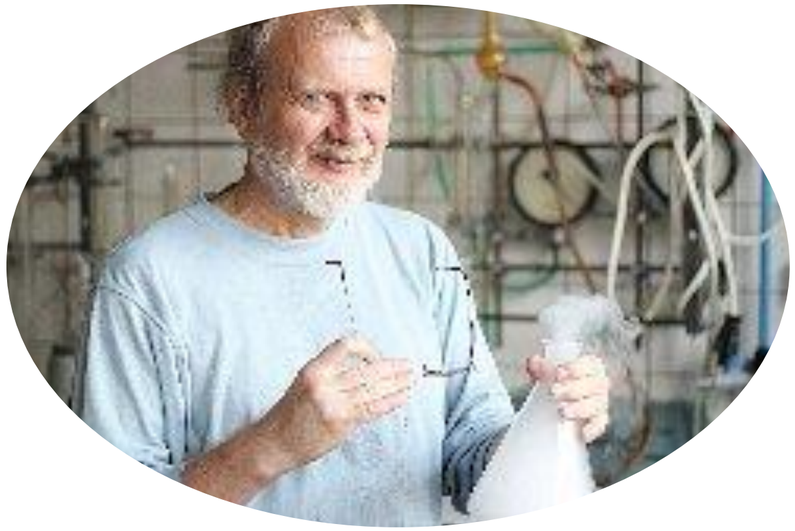
Vladimír Ždímal

- Chairman of the Czech Aerosol Society
- Member of the Board of European Aerosol Assembly (EAA),
- Panelist (3 terms) of Czech Science Foundation panel 209 on Earth Sciences
- Member of the Committee on Nucleation and Atmospheric Aerosols

Participation of team members in activities of scientific community

Jiří Smolík

- Member of the Editorial board of the Heritage Science,
- Member of the Editorial board of the Aerosol and Air Quality Research



Zdeněk Wagner

- Member of IUPAC Analytical Division Subcommittee on Solubility and Equilibrium Data

Participation in large collaborations

DACP participates in ACTRIS, going to be ERIC

(Aerosols, Clouds, and Trace gases Research InfraStructure)

DACP is part of ACTRIS-CZ consortium with:

- Czech Hydrometeorological Institute
- Centre RECETOX of Masaryk University
- Global Change Research Institute

DACP provides services within ACTRIS:

- operates National Facility – Prague-Suchdol – Aerosol In Situ
- takes care of Aerosol In Situ at a National Facility NAOK –provides logistic support to 2 other National Facilities – Usti n/L and Lom
- will become part of Central facility – Centre for Aerosols In Situ

ACTRIS space

Provision of 83 atmospheric variables in the natural atmosphere
Provision of 24 atmospheric data products
Provision of Simulation Chamber Experiment data

Cloud in-situ (15 Variables)
Cloud Remote Sensing (25 Variables)

Aerosol in-situ (12 Variables)
Aerosol remote sensing (16 Variables)

Trace Gases in Situ (5 Variables)
Trace gases Remote Sensing (10 Variables)

ACTRIS controls the whole processing chain from production to dissemination

A common aim in ACTRIS : *high service and data quality*

ACTRIS CZ – Topical Centres

Prague Aerosol Calibration Centre (PACC)

Centre for Aerosol in Situ Measurements ICPF

- calibration of aerosol instrumentation according to ACTRIS standards (MPSS, CPC, APSS)
- training of users for operation of aerosol instrumentation
- workshops for ACTRIS internal and external users

Open access of users on national and international level

ACTRIS Servises

National Facilities

Topical Centres

Physical Access
Research Services
Instrument calibration
Industry Services
Training services

Data Centre

Virtual Access
ACTRIS data products
ACTRIS VRE with tools and computing

Instrument calibration

NF aerosol, cloud and trace gas variables




Activity plan for the period of 2020-2024

- Prague Aerosol Calibration Centre (PACC) – ACTRIS ERIC – CAIS
- Atmospheric Aerosols:
  - Vertical profiles and Fluxes
  - Particle Size Distributions
  - Size resolved Chemical Composition
  - Source Apportionment / Receptor Modelling
  - Aerosol-Cloud-Interactions
  - Optical properties.
- Indoor and workplace aerosols - aerosol exposure in the working environment, transformations of aerosol particles indoors
- Indoor aerosols and cultural heritage - advanced techniques for restoration of library and archival collections
- Thermodynamics of Task-Specific Materials (TTSM) - thermophysical properties of materials used in thermal energy storage, physico-chemical properties of compounds and mixtures relevant to atmospheric research

Thank you for your attention !

Department of Aerosols Chemistry and Physics