Structure

aeroHEALTH divides its interdisciplinary research in one project management work package and four interlinked scientific work packages. The joint management is conducted by the Scientific Steering Board consisting of four leading scientists and four early career scientists.

Scientific Steering Board

Spokesperson of aeroHEALTH
Prof. Dr. Ralf Zimmermann (HMGU/University of Rostock)

Poject manager of aeroHEALTH
Dr. Hendryk Czech (HMGU/University of Rostock)

The scientific steering board is comprised of one principle investigator and one early career scientist per participating research group. The members are leading the work packages:

Work Package I – AeroMAN: Project Management
Prof. Dr. Ralf Zimmermann and Dr. Hendryk Czech (HMGU)

Work Package II – AeroAGE: Aerosol Transformation and Aging
Prof. Dr. Astrid Kiendler-Scharr and Dr. Thorsten Hohaus (FZJ)

Work Package III – AeroEXCA: Aerosol Exposure and Characterisation
Prof. Dr. Ralf Zimmermann and Dr. Hendryk Czech (HMGU)

Work Package IV – AeroTOX: Aerosol in vitro and in vivo Toxicology
Prof. Dr. Yinon Rudich and Dr. Michal Pardo (WIS)

Work Package V – AeroDAT: Aerosol Data Integration & Analysis
Prof. Dr. Fabian Theis and Dr. Nikola Müller (HMGU)

Education

In addition to excellent science, the aeroHEALTH Programme is devoted to support young scientists on all education and career levels. The education programme has two main branches. First, the careers of four excellent early career scientists at the partner institutes are fostered by the aeroHEALTH Early Career Scientist Programme (ECP). Secondly, very early career scientist on the MSc, PhD and postdoc levels are supported by the aeroHEALTH Young Scientist Training Program (YTP).

Finally, a student programme (SP) offers scientific education and interdisciplinary research experiences to undergraduates. The aeroHEALTH Helmholtz International Laboratory Programme includes lectures and seminars, regular workshops and summer schools, interlaboratory exchange, mentoring, and joint measurement campaigns.

Complimentary Joint Infrastructure and Building a Long-term Research Programme

The consortium possesses outstanding and complementary abilities by simulation of realistic and long-term atmospheric aging, comprehensive physico-chemical and biological aerosol analysis, state-of-the-art in vivo and in vitro toxicology, and a multidisciplinary approach in data analyses.

In aeroHEALTH, HMGU brings forward the expertise and infrastructure from the HICE initiative for aerosol characterization and toxicology based on air-liquid-interface cell exposures, extended by “Big Data” analytical competence.

FZJ enters the consortium with their unique infrastructure for simulation of atmospheric aging and physical characterisation approaches.

WIS contributes by in vivo toxicological expertise, aerobiology and further complimentary aerosol characterisation approaches. To achieve realistic exposure scenarios, aeroHEALTH bridges the gap between laboratory simulation and ambient aerosols.

Building a long term cooperation

aeroHEALTH strives for building long-term cooperation between the partners beyond the funding currently allocated by the Helmholtz Association and the Weizmann Institute of Science. It is the firm intention of the partners to jointly develop into a permanent common infrastructure (including an “aeroHEALTH mobilLAB”), and to attract further international researchers.

HMGU supports the sustainability of the network by funding of a representative of the HMGU at the WIS. Dr. Daniela Gat (Daniela.gat@helmholtz-munchen.de) is working in the scientific programme and facilitating links between the data science programs of HMGU and WIS.

Contact and Further Information

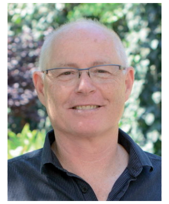
aeroHEALTH Helmholtz International Laboratory: www.aeroHEALTH.eu

The aeroHEALTH steering board members

Prof. Dr. Ralf Zimmermann
Spokesperson of the aeroHEALTH
Helmholtz International Laboratory

Helmholtz Zentrum München
Comprehensive Molecular Analytics (CMA)
Chair of Analytical Chemistry,
Institute of Chemistry, University of Rostock
Gmunder Str. 37, 81379 München
Email: ralf.zimmermann@helmholtz-muenchen.de
Email: ralf.zimmermann@uni-rostock.de
Phone: +49 (0)89 3187 4544

Prof. Dr. Astrid Kiendler-Scharr
Forschungszentrum Jülich GmbH
Institute of Energy and Climate Research
IEK-8: Troposphere
Wilhelm-Johnen-Straße, 52425 Jülich
Email: a.kiendler-scharr@fz-juelich.de
Phone: +49 (0)2461 61-4185



Prof. Dr. Yinon Rudich
Weizmann Institute of Science
Department of Earth and Planetary Sciences
Faculty of Chemistry
234 Herzl Street, POB 26, Rehovot 7610001 Israel
Email: yinon.rudich@weizmann.ac.il
Phone: +972-8-934-4237

Prof. Dr. Fabian Theis
Helmholtz Zentrum München
Institute of Computational Biology
Ingolstädter Landstr. 1, 85764 Neuherberg
Email: fabian.theis@helmholtz-muenchen.de
Phone: +49 (0)89 3187-4030

Dr. Hendryk Czech
Project Manager of the aeroHEALTH
Helmholtz International Laboratory

Helmholtz Zentrum München
Comprehensive Molecular Analytics (CMA)
Chair of Analytical Chemistry, Institute of Chemistry,
University of Rostock
Dr.-Lorenz Weg 2, 18059 Rostock
Email: hendryk.czech@uni-rostock.de
Email: hendryk.czech@helmholtz-muenchen.de
Phone: +49 (0)381 498 6533

Dr. Thorsten Hohaus
Forschungszentrum Jülich GmbH
Institute of Energy and Climate Research
Group Stable Isotopes in Aerosols
Wilhelm-Johnen-Straße, 52425 Jülich
Email: t.hohaus@fz-juelich.de
Phone: +49 (0)2461 61-2563

Dr. Nikola Müller
Helmholtz Zentrum München
Institute of Computational Biology
Ingolstädter Landstr. 1, 85764 Neuherberg
Email: nikola.muller@helmholtz-muenchen.de
Phone: +49 (0)89 3187-1174

Dr. Michal Pardo
Weizmann Institute of Science
Department of Earth and Planetary Sciences
Faculty of Chemistry
234 Herzl Street, POB 26, Rehovot 7610001 Israel
Email: michal.levin@weizmann.ac.il
Phone: +972-8-934-4235

Published by
Helmholtz Zentrum München
Deutsches Forschungszentrum für Gesundheit und Umwelt (GmbH)
Ingolstädter Landstraße 1
D-85764 Neuherberg, Germany
www.helmholtz-muenchen.de

Layout: Nadine Gibler Informationsdesign

aeroHEALTH
HELMHOLTZ
International Lab

aeroHEALTH
a Helmholtz International Laboratory

HelmholtzZentrum münchen
German Research Center for Environmental Health
JÜLICH
Forschungszentrum
מכון ויצמן למדע
WEIZMANN INSTITUTE OF SCIENCE

About aeroHEALTH

The German-Israeli Helmholtz International Laboratory aero-HEALTH strives to understand the biological and health effects induced by atmospheric aerosols, combining information on primary emissions as well as secondary and ambient aerosols. Atmospheric processing of biogenic and anthropogenic emissions (“aging”) under realistic conditions is simulated on short and long time scales to connect laboratory observations with the observed health impacts from field experiments.

The Helmholtz International Lab aeroHEALTH is a cooperation of:

- **Helmholtz Zentrum München, Germany**
  HMGU, www.helmholtz-muenchen.de
  Leading PIs: Prof. Dr. Ralf Zimmermann, Prof. Dr. Fabian Theis
- **Forschungszentrum Jülich, Germany** FZJ, www.fz-juelich.de
  Leading PI: Prof. Dr. Astrid Kiendler-Scharr
- **Weizmann Institute of Science, Israel**
  WIS, www.weizmann.ac.il, Leading PI: Prof. Dr. Yinon Rudich

aeroHEALTH is funded for 5 years (extendable to 8 years) by the Helmholtz Association in Germany (www.helmholtz.de/en) and the Weizmann Institute of Science, beginning on April 1st 2019, and utilises the Helmholtz network and strengthens the strategic partnership to the WIS.

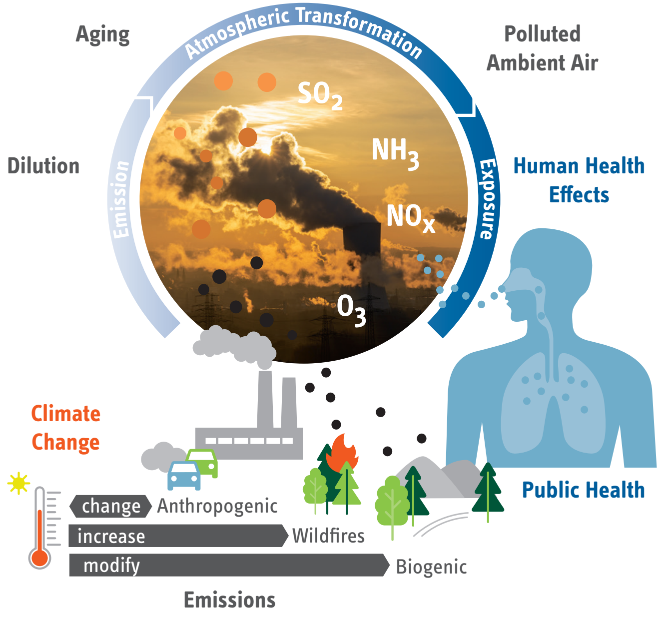
The aeroHEALTH concept and infrastructure bases partly on the Virtual Helmholtz Institute of Complex Molecular Systems in Environmental Health - Aerosol and Health (HICE; now in basic funding at HMGU). While HICE targets on primary anthropogenic emissions, aeroHEALTH extends this approach to secondary and ambient aerosols.

Aerosol emissions undergo rapid conversion by complex multi-phase- and photochemistry, which alter the physico-chemical properties. Thus, understanding their toxicological potential is the challenging key topic of aeroHEALTH. The research benefits from the expertise in various disciplines, including analytical chemistry, physics, biochemistry, biology, medicine, engineering, statistics and informatics.

Research Goals

The World Health Organisation (WHO) states particulate matter (PM) air pollution to be the largest environmental health risk in Europe, causing a substantial disease burden. It’s estimated that in 2014 more than 90% of the world population lived in places where WHO air quality guidelines were not met. Although the association between several combustion aerosols and health effects is well established, the effect of atmospheric aging on aerosol toxicity has been sparsely investigated. This knowledge gap is addressed by the research of aeroHEALTH:

- Elucidation of the molecular mechanisms and relevant agents in secondary and ambient aerosols relevant for the observed adverse health effects
- Identification of biomarkers for exposure and health effects
- Evaluation of the relative toxicological potential of secondary aerosols generated under different realistic atmospheric conditions
- Combination of the toxicological potentials of primary aerosls and secondary aerosols at different aging scenarios



Overview on the aeroHEALTH research topic: Between emission and exposure, ambient aerosols are transformed by complex photochemistry and multiphase interactions in the atmosphere, affecting their toxicity in an yet unknown way. aeroHEALTH elucidates the composition and health effects of the polluted ambient air.

Partners

aeroHEALTH is represented by its spokesperson Prof. Dr. Ralf Zimmermann (Helmholtz Zentrum München and University of Rostock) and is comprised of four funded working groups from the three partner institutions:

- **Comprehensive Molecular Analytics (CMA)**
  Helmholtz Zentrum München (HMGU), DE
- **Institute of Computational Biology (ICB)**
  Helmholtz Zentrum München (HMGU), DE
- **Institute of Energy and Climate Research: Troposphere (IEK-8)**
  Forschungszentrum Jülich (FZJ), DE
- **Earth and Planetary Science**
  Weizmann Institute of Science (WIS), IL

Further associated partners are supporting aeroHEALTH research activities:

- **Analytical Chemistry**
  University of Rostock (UR), DE
- **Department of Environmental Science**
  University of Eastern Finland (UEF), FI

aeroHEALTH is open to adopt further associated partners for scientific synergies.

Hypotheses

aeroHEALTH work is organised to address these research questions:

- Does atmospheric photochemical aging of aerosols and the associated increase and change in the organic aerosol fraction alter aerosol-induced health effects?
- Do health effects of aged anthropogenic and aged natural combustion aerosols (wildfires) depend on the specific chemical composition of the aerosol emission source?
- Are health effects of aged biogenic aerosols different from aged anthropogenic aerosols and do they depend on the aging process?
- How does the interaction of biogenic and anthropogenic constituents of primary and secondary origin influence the biological and health effects during aging?
- Does the oxidation of aerosols increase or decrease the toxicity, depending on the chemical composition of the aerosol and the duration/intensity of photochemical or night-time aging?
- What is the role of transported bacteria, fungi and viruses as well as microbial debris in inducing adverse health effects?

The synergistic expertise of the partners is complemented with cutting edge infrastructures for the simulation of atmospheric aging, including extreme endpoints, aerosol analytics, exposure approaches, in vitro and in vivo model systems. World-class biological services are provided by the infrastructure to investigate the biological outcomes. Finally, incorporation of new “Big Data” and Artificial Intelligence methods will be developed to elucidate the connection between environmental exposure and health effects.

Approach

A comprehensive chemical and physical characterisation of the exposome is performed by state-of-the-art online methods. This includes aerosol/single-particle mass spectrometry for particle analysis and photoionisation mass spectrometry for the determination of reactive gases.

Off-line methods for deep molecular investigations comprise multidimensional chromatography and ultra-high resolution MS techniques.

The methods are further developed to realise

- Exposure monitoring in real-time by online dose analysis and cell status diagnosis
- Targeted and untargeted analyses of primary and secondary aerosol constituents by statistical methods and advanced scripting from bulk properties to the single particle level
- Detailed analyses of organic particle constituents on a single particle level
- Obtaining genetic information about the atmospheric microbiome and transport of pathogens and functional genes.

Special emphasis is put on the generation of secondary aerosols, which will be performed in photochemical reactors and flow tubes with complementary projections of atmospheric aging on short and long timescales. This includes the atmosphere simulation chamber SAPHIR, a continuously stirred tank reactor (SAPHIR++) and the oxidation flow reactors potential aerosol mass (PAM) as well as photochemical emission aging flow tube reactor (PEAR).

Key objectives of aerosol aging are:

- Simulation of atmospheric day- and nighttime chemical aging of aerosols under NO_X, SO_2, and NH_3 conditions typical for the representative concentration pathways (RCP)
- Developing and applying integral metrics for the quantification of aerosol chemical age
- Developing experimental procedures to quantify represen-tativeness of chemical aging in experiments using simulation chamber and flow reactor approaches

Innovative, mobile air-liquid interface (ALI) cell exposure technology allows the controlled and differentiated exposure of realistic biological systems (human lung cell tissue models, including simple and highly differentiated cultures) in laboratory experiments.

These experiments will include:

- Refinement of cell exposure schemes to get more realistic conditions and sufficient sensitivity to address very diluted aged (chamber) and ambient aerosols
- Enhancing exposure efficiency for particles and developing methods for dose determination
- Optimizing exposure of human epithelial lung cell and other tissue (liver, fat) cultures
- Development of co-cultures of lung epithelial cells with e.g. macrophages, fibroblasts, hepatocytes or organoids, differentiated 3D cell cultures and disease-oriented tissue models for ALI exposures to represent the lung
- Development and application of in vivo models for validating the in vitro cell line/tissue model results and for investigating systemic effects of exposure.

Data from comprehensive analyses of biological samples, including transcriptomics, proteomics, metabolomics, and secretomics, are integrated by a multi-omics approach and linked to aerosol physico-chemical properties by advanced bioinformatics and AI techniques.