# CHASE

## Unravelling Particle **Ch**emistry in Dronning Maud Land: from **a**tmosphere to **s**urfac**e**

DURATION
**1/01/2017 - 15/04/2021**

BUDGET
**599 018 €**

PROJECT DESCRIPTION

**Context**

Atmospheric composition change is a main driver of present and near-future climate change with airborne particles playing a major role therein. But the aerosol fluxes and sources in Antarctica and its closely associated Southern Ocean are poorly constrained, in particular the particle chemistry. Antarctica is considered the best preserved region on Earth from anthropogenic emissions. However, the impact of anthropogenic airborne particles and pollutants could be significantly larger than expected. Furthermore, a detailed understanding of present-day atmospheric transport pathways of particles and of volatile organic compounds (VOC) from source to deposition in Antarctica remains essential to document biogeochemical cycles and the relative importance of natural and anthropogenic compounds, which are not well constrained at the moment. This information is relevant to interpret climatic data extracted from ice cores and the transport and deposition of not only mineral nutrients, but also and essentially of organic micro-pollutants in polar regions. CHASE will provide detailed physical-chemical analyses of both atmospheric and surface snow particles as well as of VOCs and thoroughly investigates their atmospheric transport pathways. Samples will be taken both near the Belgian research station Princess Elisabeth (active sampling with pumps, passive samplers and surface snow samples) and on a transect to the coast as well as near the coast (only passive samplers and surface snow samples).

**General objectives and underlying research questions**

The objectives of CHASE are:

- CHASE will build up a unique database of organic and inorganic composition of both atmospheric and surface snow particles as well as of VOCs in Dronning Maud Land, East Antarctica.
- CHASE will assess comprehensively source regions, atmospheric transport pathways, seasonal variations and relative importance of trace elements, micronutrients and atmospheric pollutants and of natural and anthropogenic compounds in Dronning Maud Land, East Antarctica.
- CHASE will improve the understanding how the Antarctic atmospheric composition is influenced by lower latitudes.

Main research questions are:

- What is the organic chemical composition of atmospheric particles during austral summer in the vicinity of Princess Elisabeth station?
- How abundant are volatile organic compounds and persistent organic micropollutants during austral summer and winter?
- What is the size-resolved inorganic chemical composition of atmospheric particles, in the vicinity of PE station and near the coast?
- What is the size-resolved inorganic chemical composition of particles in surface snow samples, during austral summer and both in the vicinity of PE station and near the coast?
- What is the isotopic composition of the material?
- How much of the total Fe found in the particles is soluble and bioavailable to marine phytoplankton?
- What are the possible source regions for the chemical tracer compounds found?
- What is the relative importance of natural versus anthropogenic compounds?
- What are the atmospheric transport pathways and how are they related to the larger-scale atmospheric circulation in and around Antarctica

**Methodology**

The starting point consists of the particle and air sampling followed by a thorough physical-chemical analysis with state-of-the art and innovative analytical instruments. Sampling of atmospheric particles for organic composition analyses will be done by active High-Volume sampling on quartz fibre filters in the first place and by exploring the possibilities of passive sampling, using e.g., polyurethane foam plugs (PUF). Molecular chemical analyses will be carried out by liquid or gas chromatography coupled to high resolution mass spectrometry (HRMS).

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Also, the occurrence and concentration levels of atmospheric VOCs will be investigated by means of both active and passive sampling followed by TD-GC-MS analysis. The determination of the inorganic composition of AP will be done by both passive and active sampling.

In addition, surface snow will be collected for inorganic particle composition analysis. Single particle morphological and chemical analyses will be done by automated-FEG-SEM-EDS analyses and both geochemical and isotopic analyses by HR-ICP-MS and MC-ICP-MS, respectively. Isotope Ratio Mass Spectrometry (IRMS) will determine the stable isotopic signature (C, N) of the different types of organic material recovered. Air mass tracing will be carried out by dispersion analysis of atmospheric transport, using the atmospheric dispersion model FLEXPART.

**Nature of the interdisciplinary**

The Royal Meteorological Institute of Belgium (RMI) brings in its expertise on atmospheric composition modelling, validation of satellite observations, aerosol studies, atmospheric dispersion modelling and carrying out research campaigns to Princess Elisabeth station.
The EnVOC research group of Ghent University focuses since more than 30 years on the occurrence, fate and behaviour of organic micropollutants in the environment, with particular attention to the compartments particulate matter, air and water. It has built up considerable expertise in the sampling, sample preparation and analysis of VOCs, PM, and emerging organic micropollutants, using state-of-the art analytical instruments.
The research unit of Prof. Nadine Matielli of Université Libre de Bruxelles (Laboratoire G-Time) hosts state-of-art analytical facilities, which are almost unique in Belgium (HR-MC-ICP-MS-Nu instrument, necessary for isotopic analyses of radiogenic isotopes like Pb, Nd and of heavy stable isotops like Zn). At Vrije Universiteit Brussel, Belgium, Philippe Claeys heads the interdisciplinary research unit Earth System Sciences and within it he heads the research unit *Analytical, Environmental and Geo – Chemistry*. The groups of Prof. Matielli and of Prof. Claeys have built a shared analytical platform, facilitating the access to the HR-ICP-MS required for the trace element analyses.
Further expertise and in-kind contributions will come from Profs. Karine Deboudt and Pascal Flament from the Laboratory of Physics and Chemistry of the Atmosphere, Université du Littoral – Côte d'Opale, Dunkerque, France ( aerosol characterisation by applying single-particle analysis; SEM-EDX), Prof. Reto Gieré, Department of Earth and Environmental Science, University of Pennsylvania, USA (translating the SEM-EDX chemical data into mineralogical data) and from Dr. Volker Dietze, German Meteorological Service, Germany (passive sampler equipment and related expertise).

**Potential impact of the research on science, society and/or on decision-making**

**CHASE outcomes will include:**

- Comprehensive database available via the project website;
- Peer-reviewed publications;
- Publication to the scientific community on respective conferences and workshops
- An international scientific workshop on Antarctic particle chemistry;
- Relevant contribution to the Global Atmosphere Watch programme of WMO and to pending research questions formulated by the Scientific Committee on Antarctic research (SCAR);
- Communication with policy via the Scientific Committee on Antarctic Research (SCAR);
- Lectures at universities, schools and outreach activities for the general public.

**Description of finished products of research (model, scenario, report, workshop, publication, etc…) at short and medium term**

The CHASE project can build upon the experience from former and running BELSPO projects (BelAtmos, Aerocloud) and upon first results of passive sampling of atmospheric dust particles near Princess Elisabeth research station and their chemical analysis during the ongoing PhD thesis work of A. Vanderstraeten (ULB).

**CONTACT INFORMATION**

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**LINKS**

The CHASE website is in preparation
Alexander Mangold is maintaining a blog on RMI's projects and activities at Princess Elisabeth station:
belatmos.blogspot.be

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