CLIMB

How do aerosol-CLoud Interactions influence the surface Mass Balance in East Antarctica?

DURATION
15/12/2019 - 15/03/2022

BUDGET
376 450 €

PROJECT DESCRIPTION

The water cycle, cloud microphysics and cloud-aerosol-interactions are recognized as key elements of the Antarctic climate system. Clouds and aerosols play a significant role in the radiative energy budget and aerosols impact cloud microphysics because they are cloud condensation and ice nuclei. In addition, clouds are an important part of the hydrological cycle serving as the agent linking water vapour transport into Antarctica with precipitation. Because precipitation is the only source term in the surface mass balance (SMB) of the Antarctic ice sheet, it is one of the key factors affecting sea level. However, current knowledge on the interaction between clouds, precipitation and aerosol in the Antarctic is still limited, both from direct observations and from regional climate models.

At the Belgian Antarctic research station Princess Elisabeth (PES), an observatory for aerosol, cloud and precipitation properties exists (Gorodetskaya et al., 2015, Herenz et al., 2019). The synergy of the data sets has been exploited in first case studies on the effect of aerosols on cloud and precipitation processes with an improved aerosol-cloud-precipitation parameterisation of the regional climate model (RCM) COSMO-CLM^2 (Souverijns et al., 2019). First results show a strong sensitivity of cloud microphysics to the number of ice nucleating particles (INP), and to a less degree to the number of cloud condensation nuclei (CCN). CLIMB proposes to do systematic measurements of INP at PES, combined with meteorological, aerosol and cloud microphysics observations – both made at PES and at the typical precipitating cloud level and improving the aerosol-cloud-precipitation parameterisation in a regional climate model for East Antarctica.

The objectives of CLIMB are:

- CLIMB will deliver a unique data set of in-cloud meteorological, aerosol and cloud characteristics, combined with simultaneous boundary layer and ground-based remote sensing measurements;
- The CLIMB data set will enable a detailed mapping of air mass origins and thus the transport mechanisms into East Antarctica, relevant for the surface mass balance ;
- CLIMB will generate an improved COSMO-CLM² regional climate model (member of POLAR-CORDEX) for Antarctica;
- CLIMB will improve the understanding of the climatological effect of INP and on clouds, precipitation, radiation and the surface mass balance in East Antarctica.

Main research questions are:

- What are the meteorological, aerosol and cloud characteristics at different altitude levels near PES?
- Which volatile organic compounds (VOCs) are present at cloud-level?
- What are the air mass origins?
- What is the abundance of INP near PES?
- What are the results of the improved parameterisation for the surface mass balance?

The CLIMB project will comprise to do measurements of meteorological, aerosol, cloud and precipitation characteristics directly at the cloud level, at a mountain top, with small-sized instrumentation, including:

- A vertically resolved, continuous (year-round) profile of temperature, relative humidity and pressure for three heights: at PES (1390 m asl), on the Utsteinen nunatak summit (around 1600 m asl) and in the Vikinghogda mountains (around 2600 m asl).
- Measurements of precipitation type, intensity and droplet/crystal size by a disdrometer. One will be placed in the mountain and one at PES.
- In-cloud measurements of aerosol particle number size distribution;
- An automated sampling system for VOCs; year-round sampling might be possible.

CLIMB

In addition, at PES (1390 m asl) there will be:

- The operational aerosol-cloud-precipitation observatory (see www.aerocloud.be);
- INP filter sampling;
- Active sampling of airborne particles for organic chemistry and for VOCs.

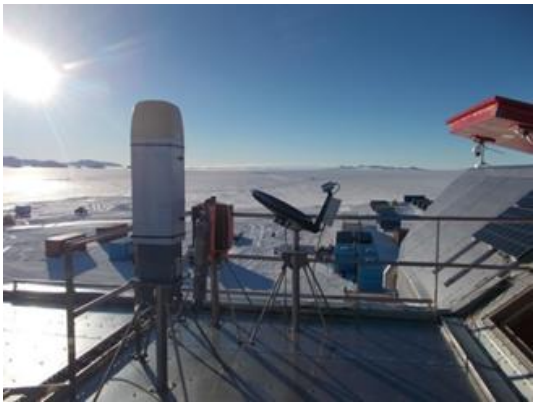
CLIMB combines the specific expertise of two federal research institutes, two Belgian universities and of an international partner with long-standing expertise on cloud formation. It aims at supporting the potential of the Belgian Federal Scientific Institutions, improve cooperation within the Belgian scientific community and strengthen collaboration within the European and international community involved in regional climate modeling, atmospheric chemistry and physics, and chemical analysis.

In order to obtain reliable estimates of the future Antarctic climate and SMB including sea level rise, a large number of high-quality climate model simulations needs to be considered. Providing this information at a regional level is the goal of the COordinated Regional climate Downscaling Experiment (CORDEX). During meetings of the POLAR-CORDEX group, the importance of Antarctic RCMs was highlighted several times for ensemble studies of important climate variables. The addition and improvement of this model will allow a more reliable estimation of the SMB over Antarctica.

The connection between scientific research on Antarctica and policy is largely managed by the Scientific Committee on Antarctic Research (SCAR). Belgium is Full Member of SCAR, represented by the Belgian National Committee on Antarctic Research (BNCAR), in which Alexander Mangold, Nicole van Lipzig and Michel Van Roozendael are members.

CLIMB outcomes will include:

- A comprehensive database available via the project website;
- Peer-reviewed publications;
- An improved aerosol-cloud interaction parameterization for the COSMO-CLM² model for Antarctica;
- Publications to the scientific community on respective conferences and workshops
- Relevant contributions to the Global Atmosphere Watch program of WMO and to pending research questions formulated by the Scientific Committee on Antarctic research (SCAR);
- Lectures at universities, schools and outreach activities for the general public.



CONTACT INFORMATION

Coordinator

Alexander Mangold
Royal Meteorological Institute of Belgium (RMI)
Scientific Service Observations
alexander.mangold@meteo.be

Partners

Nicole van Lipzig
Katholieke Universiteit Leuven (KU Leuven)
Department of Earth and Environmental Sciences
nicole.vanlipzig@kuleuven.be

Michel Van Roozendael
Royal Belgian Institute for Space Aeronomy
Atmospheric Composition: Reactive Gases
michel.vanroozendael@aeronomie.be

Christophe Walgraeve
Universiteit Gent (UGent)
Department of green chemistrry and technology
Faculty of Bioscience Engineering, Research Group EnVOC
Christophe.Walgraeve@UGent.be

LINKS

www.aerocloud.be
chase.meteo.be

A CLIMB website is in preparation