CLARA2

CLouds And Radiation in the Arctic and Antarctica

Principal investigator

Giandomenico Pace
giandomenico.pace@enea.it

ENEA

Areas of contribution

Polar atmospheric processes
Observations

Summary

The project CLouds And Radiation in the Arctic and Antarctica (CLARA2) aims at investigating the optical and physical properties of clouds and at determining their effects on the surface and atmospheric radiative budget. Special emphasis will be dedicated to the determination of the atmospheric vertical structure and to the role of liquid clouds.

Two intensive field campaigns will be carried out:
The first campaign will be based at the Thule High Arctic Atmospheric Observatory (THAAO, 76.5°N, 68.8°W) in north-western Greenland. This campaign will take place between February and April 2020 and will contribute to the third Special Observing Period of the Arctic YOPP through the characterization of the atmospheric conditions and the cloud properties. Automatic measurements will also be carried out during a full annual cycle.

The second campaign will be carried out in Antarctica at the M. Zucchelli Station (MZS; 74.7°S, 164.1°E) at Terra Nova Bay during the summer season (November 2020 — February 2021). A preliminary analysis of the data acquired during the YOPP activities of the SOP-SH at MZS (austral summer 2018 – 2019; data from other projects) will be carried out with the aim of deriving information on cloud effects and optimizing the observational strategy of the CLARA2 Antarctic campaign. These measurements will be provided by the Italian Antarctic Meteo-Climatological Observatory.
CLARA2 observations will be carried out by ground based active and passive remote sensing instruments operating in the visible, infrared, and microwave spectral regions; as well as by meteorological sensors, and radiosondes. The overall set of instruments will provide a comprehensive data set of atmospheric and cloud parameters.

**Description**

The purpose of the CLouds And Radiation in the Arctic and Antarctica (CLARA2) project is to improve our understanding of the impact of clouds on the radiative budget in polar regions, at the ground, and in the atmosphere. The proposing groups aim at increasing the number of polar stations capable of observing cloud properties in relation to the radiative fluxes.

In order to reach this goal, the Arctic THAAO observatory and the Antarctic M. Zucchelli Station (MZS) present interesting similarities in terms of geographical position and observing capabilities. Both are coastal observatories relatively close to the ice caps and both will use the same suite of instruments.

The impact of clouds, with emphasis on liquid-bearing clouds, on the shortwave (SW) and longwave (LW) radiative budgets will be assessed in terms of cloud radiative forcing and heating rate at the surface and at the top of the atmosphere. Essential to this goal is the measurement of all the relevant variables influencing the SW and LW radiative fluxes in clear sky conditions and the detection of physical and optical cloud properties.

The activities of the project CLARA2 will be organized in 3 work packages:

WP1 is devoted to the preparation and the realization of two measurement campaigns: the first at Thule Air Base (76.5°N, 68.8°W) during February and March 2020, matching the planned third YOPP Special Observing Period (SOP-NH3), and the second at the M. Zucchelli Station (MZS, 74.7°S, 164.1°E) from November 2020 to February 2021.

During both campaigns, continuous observations will be carried out with a set of robust ground-based remote sensing instruments. The main instrument is a microwave profiler (MWPRO) providing temperature and humidity profiles in the troposphere, as well as liquid water path (LWP) and integrated water vapour (IWV) measurements. Together with the MWPRO, the following instruments will carry out continuous observations: a zenith narrow field of view (FOV) hyperspectral radiometer, a ceilometer, a net radiometer, a pyranometer, a pyrgeometer, a pyrometer, and a sky imager. Additionally, ground measurements of meteorological parameters and daily launches of radiosondes will be performed. At MZS, the latter is provided by the Italian Antarctic Meteo-Climatological Observatory. At Thule instead a radio sounding program will be activated specifically for the intensive 2020 campaign which will actively contribute to the YOPP Arctic Special Observing Period.

WP2 will be dedicated to the development of algorithms to improve the estimation of LWP accuracy and calculate the cloud optical thickness from zenith radiance measurements.

WP3 will be dedicated to the analysis of the data sets focusing on:
- the determination of the atmospheric and cloud properties from ground-based measurements;
- the estimation of the radiative forcing of clouds at the ground;
- the calculation of cloud radiative forcing and heating rate at the surface, at the TOA and in the atmosphere with a detailed radiative transfer model.

The main contribution of the project CLARA2 to the SOP-NH3 activities is to improve the Arctic observing
system, providing additional high quality observations.

A database with the measurements carried out at the THAAO observatory will be realized including:
daily radiosonde launches; hourly temperature profiles, LWP and IWV measurements by means of a microwave
profiler; meteorological parameters at the ground; measurements of SW and LW irradiance (pyranometer and
pyrgeometer); IR sky brightness temperature (pyrometer); zenith radiance measurements (hyperspectral
radiometer); cloud base altitude (ceilometer).

**Timeline**

2019-06-03 - 2021-06-02

**Regional emphasis**

Northern hemisphere: Yes

Southern hemisphere: No

**Further specification**

The proposed activity will contribute to the third Arctic SOPs in winter 2020.
In the frame of the project CLARA2, a preliminary analysis of the data acquired during the YOPP activities of
the SOP-SH at MZS (summer 2018 – 2019; data from other projects) will be carried out with the aim of
deriving information on cloud effects and optimizing the observational strategy of the CLARA2 Antarctic
campaign.

**Key project deliverables**

- realization of an atmospheric parameters database for Arctic researches in the frame of the Year Of Polar
  Prediction (see Description).

- assessment of the cloud properties derived from ground-based observations in terms of cloud cover and
  vertical distribution, cloud phase, cloud optical thickness, liquid water path, integrated water vapour, effective
  radius of droplets, cloud base effective emissivity.

**Data management**

Data will be primary archived at the facilities for storage of scientific data provided by groups involved in the
Access to the data will be provided via a dedicated project web page and/or the information system PANGAEA. The Thule High Arctic Atmospheric Observatory website (http://www.thuleatmos-it.it/) is hosted by the ENEA group using institutional facility.

The PANGAEA information system was already contacted for the provision of the data collected during the activity of the OASIS-YOPP project of the first Arctic SOP in February – March 2018. We discussed the data format with Amelie Driemel, successfully testing the data format. We have agreed to submit the data of the microwave profiler (IWV) and temperature profiler after the campaign. We are confident that also data from the YOPP SOP-NH3 campaign could be successfully submitted to PANGAEA with the same modality.

**Is data provided to WMO Global Telecommunication System**

Yes

**Real-time provision**

The proposing groups are willing to provide real time surface meteorological parameters and radiosounding profiles. At this aim, we will contact the Italian WMO representative Colonel Silvio Cau to activate the procedure to submit data in real time using the GTS.

**Other information**

The research groups involved in the project are:
- Laboratory for Observations and Analyses of Earth and Climate, ENEA;
- Microwave Atmospheric Remote Sensing Group, INGV;
- Atmospheric Physics Group, Physics Dep. “Sapienza” University of Rome;
- National Research Council of Italy, Institute of Methodologies for the Environmental Analysis, CNR-IMAA.

**Timelines**

<table>
<thead>
<tr>
<th>Location</th>
<th>Latitude</th>
<th>Longitude</th>
<th>Start date</th>
<th>End date</th>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thule High Arctic Atmospheric Observatory, THAAO</td>
<td>76.5° N</td>
<td>68.8°W</td>
<td>2020-02-01</td>
<td>2020-03-31</td>
<td>Campaign</td>
</tr>
</tbody>
</table>