DACAPO-PESO

Dynamics, Aerosol, Cloud and Precipitation Observations in the Pristine Environment of the Southern Ocean

https://dacapo.tropos.de

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Areas of contribution

Modelling and forecasting

Polar-lower latitude linkages

Observations

Summary

The project Dynamics, Aerosol, Cloud and Precipitation Observations in the Pristine Environment of the Southern Ocean (DACAPO-PESO) is motivated by the need to provide an explanation for the observed evidence of strong regional contrasts in heterogeneous ice formation. Various studies report that heterogeneous ice formation at temperatures between -40 and 0°C is more efficient in the northern hemisphere than in the southern hemisphere. This conclusion was also supported by lidar observations of stratiform clouds in the northern midlatitudes (Leipzig, Germany, 51°C) and the southern midlatitudes (Punta Arenas, Chile, 52° S), conducted by Leibniz Institute for Tropospheric Research (TROPOS), Leipzig, Germany. Meanwhile, the mobile ground-based supersite LACROS of TROPOS is operated to provide observations with co-located lidar, cloud radar, precipitation-profiling radar, Doppler lidar, microwave radiometer, sun photometer, precipitation disdrometer, a radiation balance station, an all-sky cloud camera and irregular launches of radiosondes. These observations allow to derive aerosol-cloud-dynamics-precipitation interaction in much higher detail than with lidar alone. In Europe LACROS has collected multi-year datasets of these observations for the continental site of Leipzig, Germany, and the strongly mineral-dust-burden subtropical region of Cyprus. In a next step, LACROS will be deployed in Punta Arenas, Chile, which is the southernmost point of continental land mass of the southern hemisphere showing a mitlatitudinal to subpolar climate. Contrasting the LACROS observations
from Leipzig, Cyprus, and Punta Arenas, which are based on the same instrumentation, will allow to infer the
reasons for the regional observed differences in heterogeneous ice formation efficiency.

**Description**

Clouds and aerosols still cause a high degree of uncertainty in numerical weather prediction models and climate
simulations in general and especially over the southern ocean. A lack of understanding on the level of cloud
processes is considered to be the major reason for this uncertainty as microphysical processes are not
parametrized correctly. One key process is heterogeneous ice formation. The presence of aerosol particles acting
as cloud condensation nuclei (CCN) and ice nucleating particles (INP) determines the efficiency of ice
formation. The DACAPO-PESO project is intended to improve understanding of aerosol-cloud interactions by
contrast the polluted northern and the pristine (i.e. absence of terrestrial and anthropogenic aerosol particles)
southern hemisphere.

The core of DACAPO-PESO is a one-year deployment of the LACROS instrument suite to Punta Arenas, Chile
(53.1°S, 71°W) starting in November 2018. The location of Punta Arenas was selected for two reasons. On the
one hand, the westerly flow is undisturbed by landmasses for over 8000 km. Hence, terrestrial or anthropogenic
aerosols are mostly absent in the free troposphere and clouds are formed by a low baseline of CCN and INP. On
the other hand, Patagonia is the southernmost source for soil dust. Once mobilized, long-range transport over the
southern ocean and even towards Antarctica is feasible and can be investigated well at the location of DACAPO-
PESO.

The investigation of aerosol cloud interaction requires different key aspects to be addressed. Firstly, the aerosol
conditions from the bulk properties down to microphysical properties are characterized using sophisticated lidar
instruments together with advanced retrieval techniques. From these aerosol observations, the amount of
available CCN and INP can be inferred, providing the link to cloud formation. The second topic covers cloud
processes from the formation of droplets and ice crystals to precipitation reaching the ground. The cloud
observation will be primarily covered by cloud and precipitation radars. The retrieved profiles of cloud and
aerosol properties can then be used for comparison with model simulations and for radiative closure studies.

LACROS consist of a MIRA-35 35-GHz cloud radar, a 24 GHz precipitation profiling radar, a PollyXT
multiwavelength polarization Raman lidar, a Doppler lidar, a 14-channel microwave radiometer, a sun
photometer, a precipitation disdrometer and a Baseline Surface Radiation Network (BSRN) compatible
radiation station. If funding becomes available, a 94 GHz cloud radar will be also deployed. The continuous
measurements are processed with the synergistic Cloudnet retrieval and data will be available near-realtime.
Products of this Cloudnet setup are profiles of macro- and microphysical cloud and aerosol properties, humidity,
horizontal wind as well as integrated parameters (precipitation rate, aerosol optical depth, integrated water
vapor).

Additionally to the deployment of LACROS, DACAPO-PESO will support operation of the Universidad de
Magallanes own SAVERNet lidar until November 2019. By then, a 3-year dataset of continuous lidar
observations will be available for long-term studies.
Timeline

Regional emphasis
Northern hemisphere: Yes
Southern hemisphere: Yes

Further specification
DACAP-PESO is only one experiment in a series of observations performed with the same set of ground-based remote sensing observations. Datasets available for inter-comparison are available for the heavily aerosol-burden site of Limassol, Cyprus (34°N,30°E), Leipzig, Germany (51°N,12°E), and the region of Spitzbergen (30°N, ~12°E). In addition, developments for the LACROS instrument suite are in general compatible to Cloudnet (http://devcloudnet.fmi.fi/), allowing to extend studies to large number of sites of Cloudnet collaborators (approx. 10) of which some are located in the Arctic.

Key project deliverables
- dynamic and thermodynamic parameters of the troposphere
- profiles of cloud and aerosol properties
- radiation observations

Data management
The data will be available near realtime at lacros.tropos.de and published in the ACTRIS database (http://actris.nilu.no/)

Is data provided to WMO Global Telecommunication System
No

Real-time provision
Provision of Cloudnet data products (cloud microphysical properties, cloud and atmospheric dynamics, aerosol properties) within 24 hours after observations.