DACAPO-PESO: Towards the first long-term ground-based remote-sensing dataset of aerosols and clouds in the southern hemispheric mid-latitudes

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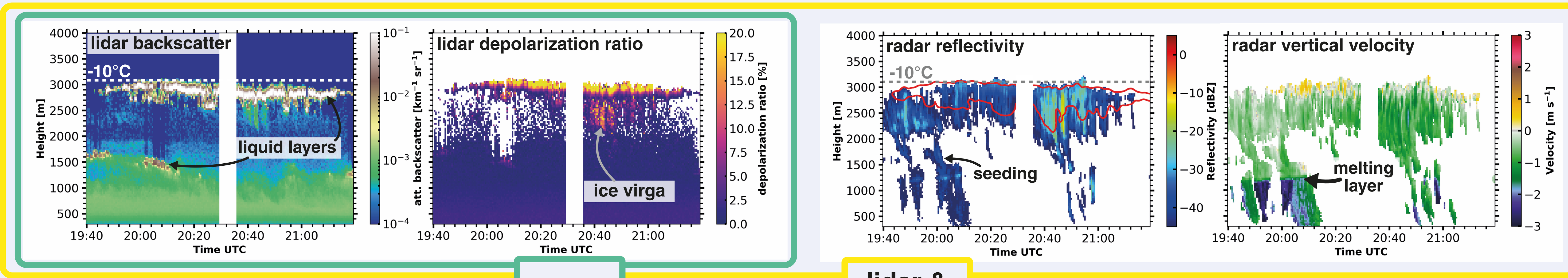
DACAPO PESO – Dynamics, Aerosol, Cloud and Precipitation Observations in the Pristine Environment of the Southern Ocean

TROPOS – Leibniz Institute for Tropospheric Research

Observing cloud microphysics under ambient conditions

Measurement example

- Limassol, Cyprus (34.6 N, 33.0 E)
- 30 Apr 2017
- Observed with LACROS facility (see below)
- Current deployment: Cyprus Clouds, Aerosols and Rain Experiment (CyCARE)



Global studies of heterogeneous ice formation

- Long-term lidar-based cloud datasets exist for various sites.
- Method: classify layered clouds as liquid or ice containing (based on highly depolarizing ice particles) and sort them by cloud-top temperature (derived from weather prediction models)
- Statistics for each site are shown in Fig. 1 .

The efficiency of liquid-dependent freezing processes varies strongly around the globe [1].

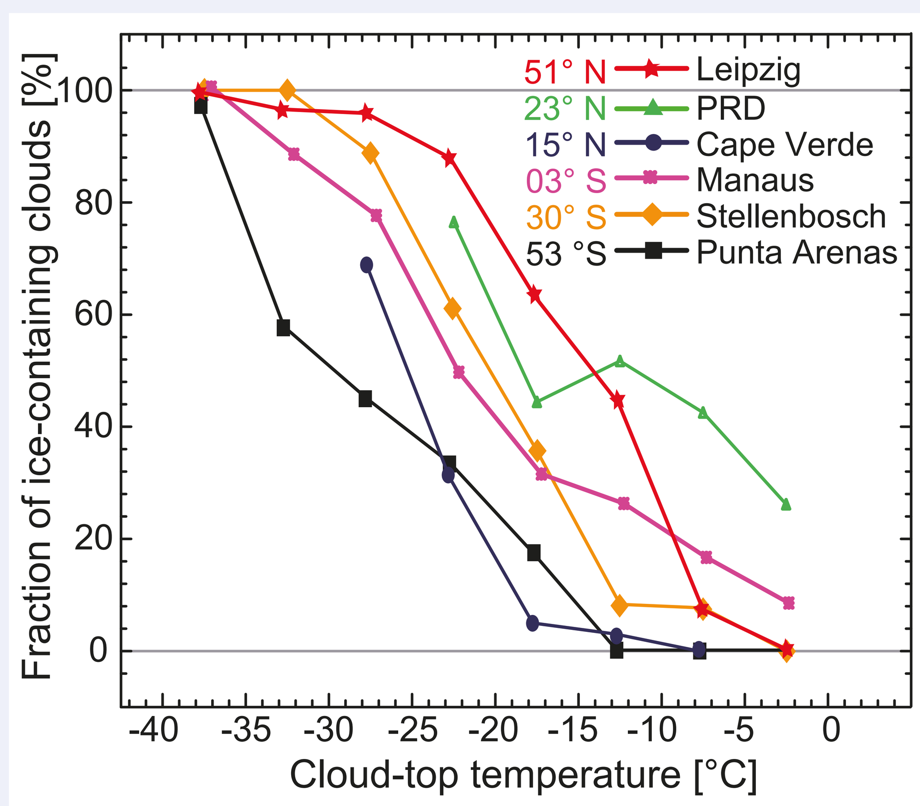


Fig. 1: Fraction of ice-containing clouds as a function of cloud-top temperature for different sites. [1]

Synergistic observations

- 35 GHz cloud radar improves the capability to observe clouds and precipitation due to higher sensitivity to large hydrometeors
- Combined observations are more sensitive to low amounts of ice water (Fig. 2)
- Long term datasets allow statistics on ice production of super-cooled liquid layers (Fig. 3).

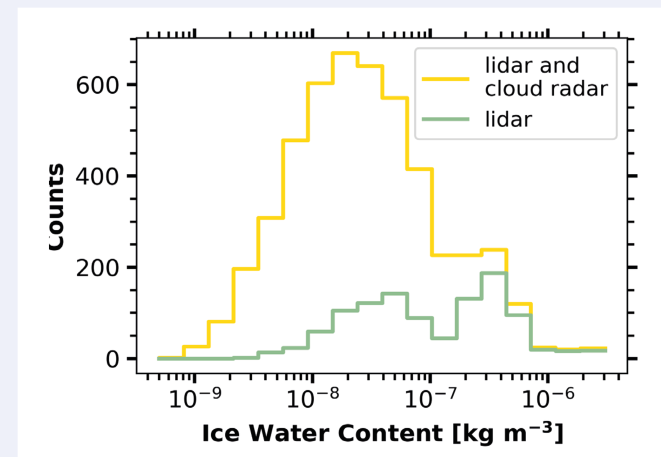


Fig. 2: Histogram of ice water contents (case above) as detectable by lidar alone vs. lidar and cloud radar.

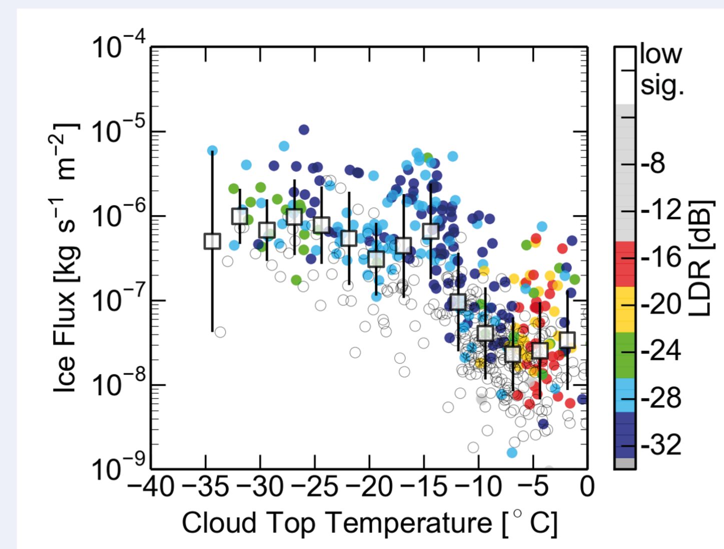


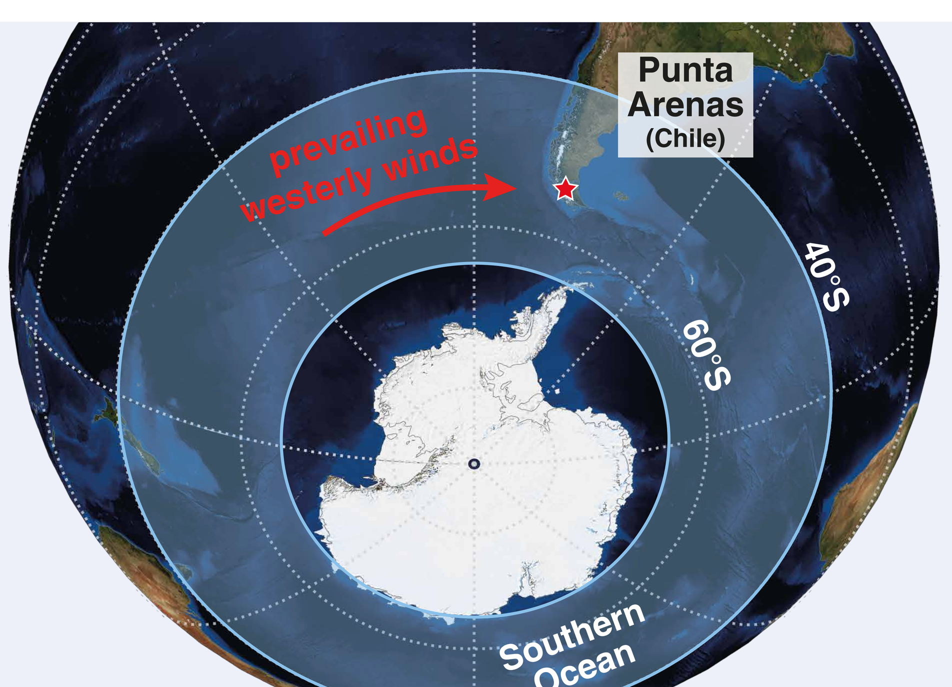
Fig. 3: Ice mass flux produced by layered mixed-phase clouds as a function of cloud-top temperature as observed at Leipzig between 2011-2015 [2].

Synergistic multi-sensor observations are necessary to cover the full lifecycle of clouds.

DACAPO-PESO campaign

Observe cloud microphysics in pristine environments

- Unique conditions over the Southern Ocean
- Absence of landmasses causes a clean marine aerosol condition with very low number concentrations [3].
- Only few cloud condensation nuclei and ice nucleating particles are available for cloud formation.
- Observations show high cloud fraction with large amounts of super-cooled liquid water at cloud top [4,5].
- Climate simulations suffer from a strong radiation bias over the Southern Ocean [6] which is most likely caused by a poor representation of clouds [7].



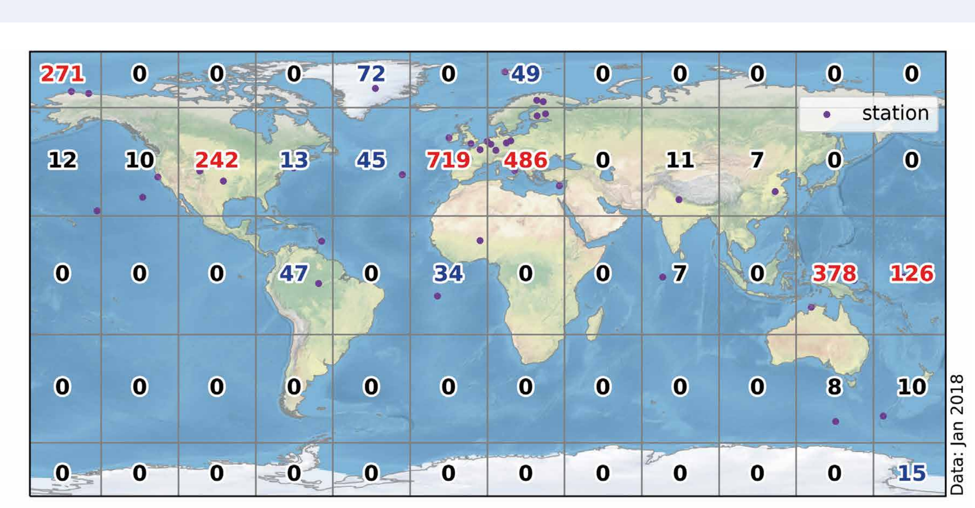


Fig. 4: Stations with collocated ground-based aerosol and cloud profiling observations. Numbers indicate the temporal length of the datasets in months per gridbox.

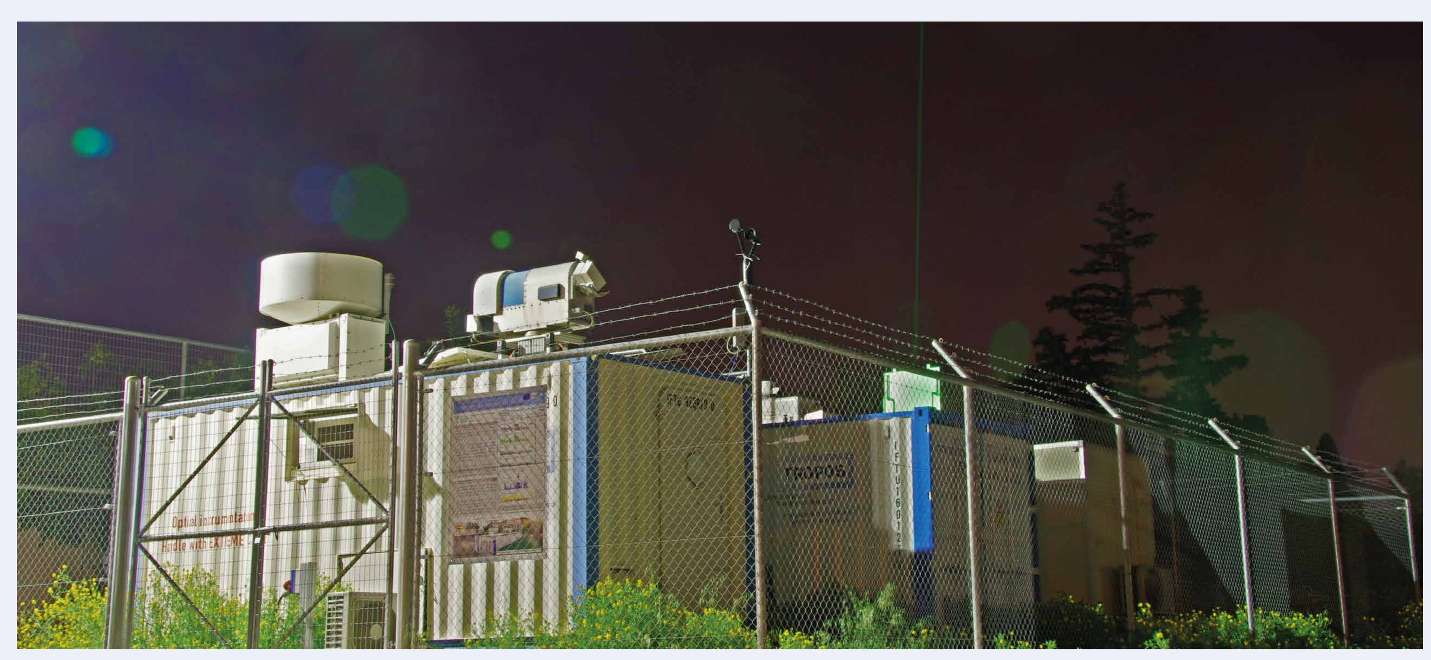
Goals

- Contrast microphysics and, specifically, ice production in southern-hemispheric and northern-hemispheric super-cooled stratiform cloud layers.
- Profiling of aerosol conditions in the southern-hemispheric mid-latitudes

Deployment of the LACROS facility

- One-year measurement campaign at Punta Arenas, Chile (53.1 S) within the project „Dynamics, Aerosol, Cloud and Precipitation Observations in the Pristine Environment of the Southern Ocean" (DACAPO-PESO).
- Collaboration with the Universidad de Magallanes
- Measurements starting November 2018
- Lack of ground-based remote-sensing observations of aerosols and clouds in the southern mid-latitudes (Fig. 4).

The LACROS facility



- The Leipzig Aerosol and Cloud Remote Observations System (LACROS) is a suite of state-of-the-art active and passive remote sensing instruments.
  Key components are:
  - 35 GHz cloud radar
  - Polly^{XT} Raman and depolarization lidar
  - Doppler lidar
  - microwave radiometer
  - sun photometer
  - disdrometer
  - radiation station, all-sky camera
- Added during DACAPO-PESO:
  - 94 GHz cloud radar (provided by LIM)
  - 24 GHz micro rain radar
- Near real-time data processing and microphysical retrievals with the Cloudnet algorithm [8]
- Multi-year dataset already available for Leipzig, Germany (continental Europe)
- Similar dataset from the strongly dust-burden eastern Mediterranean currently under investigation at Limassol, Cyprus

Further Information

Current quicklooks:

LACROS.RSD.TROPOS.DE

Upcoming campaign:

DACAPO.TROPOS.DE

References

[1] Kanitz, T., et al. (2011), Contrasting the impact of aerosols at northern and southern midlatitudes on heterogeneous ice formation, GRL, 38
[2] Bühl, J., et al. (2016). Measuring ice- and liquid-water properties in mixed-phase cloud layers at the Leipzig Cloudnet station, ACP, 16(16)
[3] Minikin, A., et al. (2003). Aircraft observations of the upper tropospheric fine particle aerosol in the Northern and Southern Hemispheres at midlatitudes: UT fine particle aerosol at midlatitudes. GRL, 30(10)
[4] Haynes, J. M., et al. (2011). Major Characteristics of Southern Ocean Cloud Regimes and Their Effects on the Energy Budget. J.Clim, 24(19)
[5] Huang, Y., et al. (2015). A-Train Observations of Maritime Midlatitude Storm-Track Cloud Systems: Comparing the Southern Ocean against the North Atlantic. J.Clim, 28(5)
[6] Trenberth, K. E., et al. (2010). Simulation of Present-Day and Twenty-First-Century Energy Budgets of the Southern Oceans. J.Clim, 23(2)
[7] Bodas-Salcedo, A., et al. (2014). Origins of the Solar Radiation Biases over the Southern Ocean in CFMIP2 Models. J.Clim, 27(1)
[8] Illingworth, A. J., et al. (2007). Cloudnet: Continuous Evaluation of Cloud Profiles in Seven Operational Models Using Ground-Based Observations. BAMS, 88(6)