Synoptic Development during the ACLOUD/PASCAL Field Campaign near Svalbard in Spring 2017

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Research Question

- In the sparsely observed Arctic (Fig. 1), is the Arctic amplification dominating the synoptic situation?

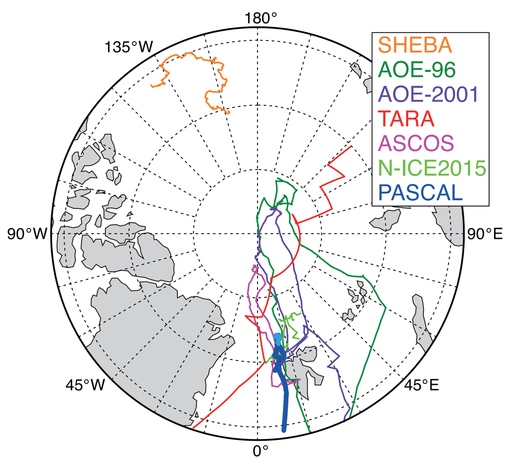

Fig. 1: Tracks of PASCAL's *RV Polarstern*[i] and previous ship-based Arctic field campaigns[ii,iii,iv].

Objectives

- ACLOUD (Fig. 2 top) aimed to improve the understanding of what role clouds play in the rapidly changing Arctic climate.
- PASCAL (Fig. 2 bottom) aimed to improve the understanding of the Arctic energy budget and its interaction with clouds and aerosols.

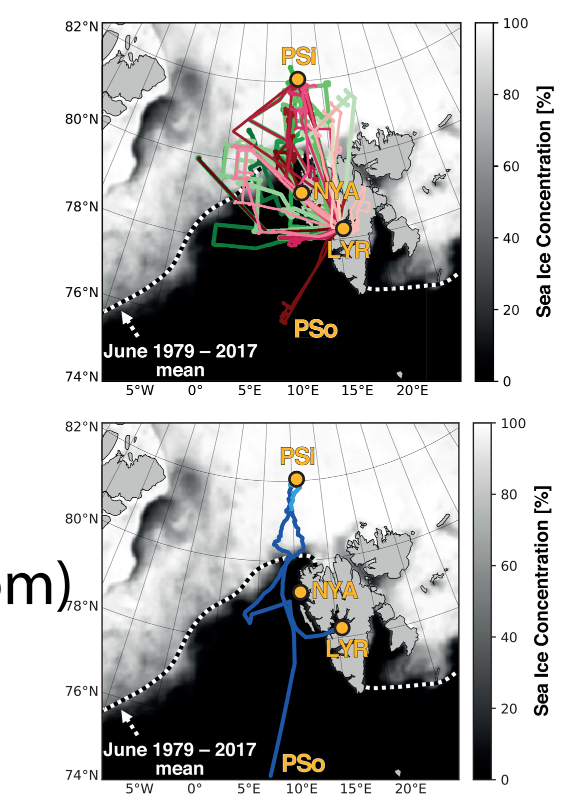

Fig. 2: [Top] Tracks of ACLOUD's *Polar 5* and *Polar 6* flights, with later dates in brighter colors[v]. [Bottom] Tracks of PASCAL's *RV Polarstern* ocean-crossing (PSo) and ice-attached (PSi) position[v]. LYR = Longyearbyen, NYA = Ny-Ålesund.

Data

Time period:

- May 23 – June 26, 2017.

Data sets:

- Near-surface meteorological and radiosonde data from Ny-Ålesund (AWIPEV[vi,vii]) and *RV Polarstern*[viii] (Figs. 2 and 3).
- Atmospheric temperature, humidity, and circulation data from the European Re-Analysis Interim[ix] (ERA-I; Figs. 4, 5 and 6).
- Cloud data from the Infrared Atmospheric Sounding Interferometer[x] (IASI; Fig. 7).
- Sea ice and snow data from more satellite products[xi,xii,xiii] in manuscript[i].

Conclusions

- Short-term variability in atmospheric circulation dominated over the long-term forcing of the Arctic amplification during the campaign.
- Three key periods during the campaign:
  1. The cold period (CP; May 23–29, 2017), characterized by cold and dry Arctic air from the north associated with widely covering low-level clouds.
  2. The warm period (WP; May 30 – June 12, 2017), characterized by warm and moist maritime air from the south and east associated with less covering and mainly mid-level clouds.
  3. The normal period (NP; June 13–26, 2017), characterized by close-to-average temperate and moist air from a mixture of regions associated with a mix of earlier cloud conditions.

Time Series Variability

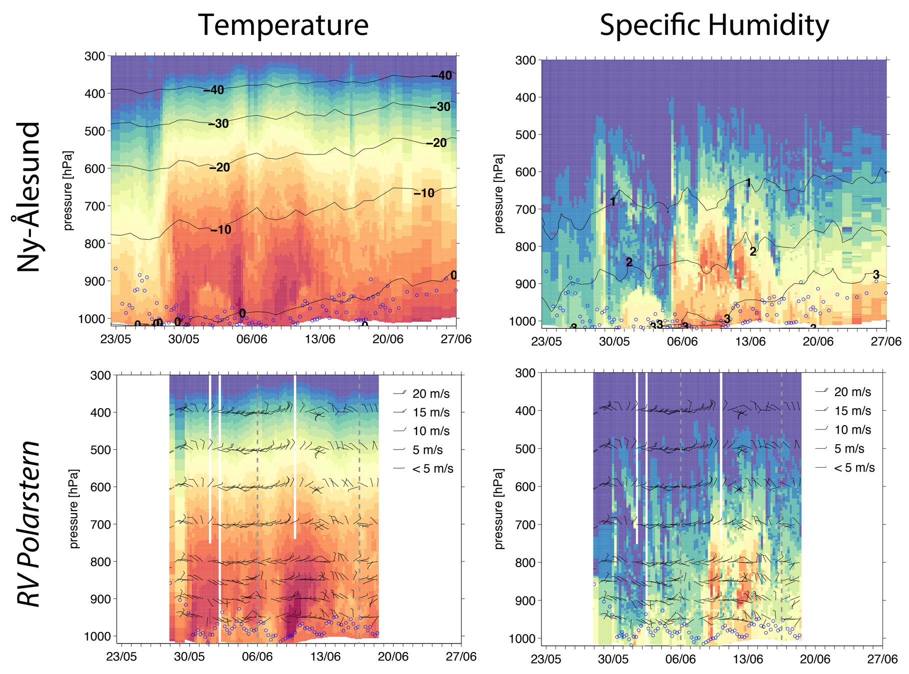

Fig. 3: Vertical profiles of [left] temperature and [right] specific humidity measured at [top] Ny-Ålesund and [bottom] *RV Polarstern*. ○ = atmospheric boundary layer (ABL) height, [top] √ = 1993–2016 mean, [bottom] ↵ = wind speed and direction.

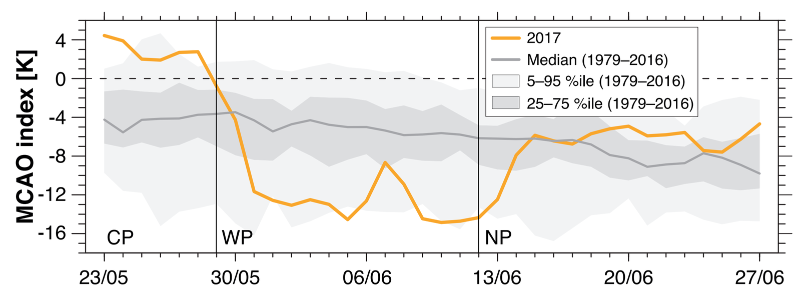

Fig. 4: Marine cold air outbreak (MCAO) index[vi] = $\theta_{SKT} - \theta_{850hPa}$[xiv] for the central ACLOUD/PASCAL region. | and | separate the three key periods the cold period (CP), the warm period (WP), and the normal period (NP).

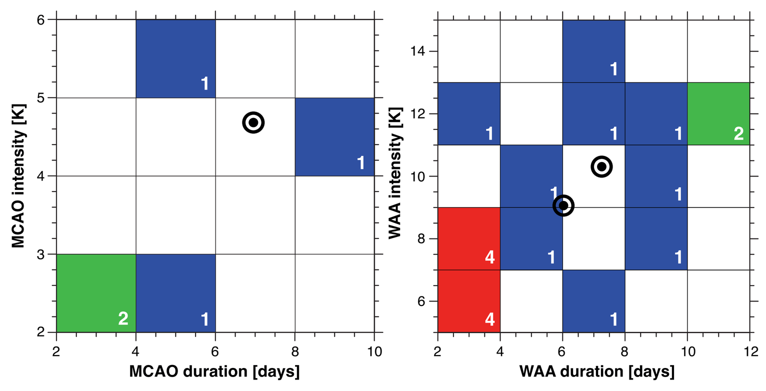

Fig. 5: [Left] Marine cold air outbreak (MCAO) and [right] warm air advection (WAA) durations and intensities for the central ACLOUD/PASCAL region over [colored boxes] 1998–2016 and [bull's-eyes] 2017.

- Cold and dry air with thick ABL (Fig. 3), during the first week, including an anomalous MCAO (Figs. 4 and 5) ➔ CP.
- Warm and moist air with thin ABL (Fig. 3) during the next two weeks, including two moderate warm air advections (Figs. 4 and 5) ➔ WP.
- Close-to-average air the remaining two weeks (Figs. 3 and 4) ➔ NP.

Key Period Characteristics

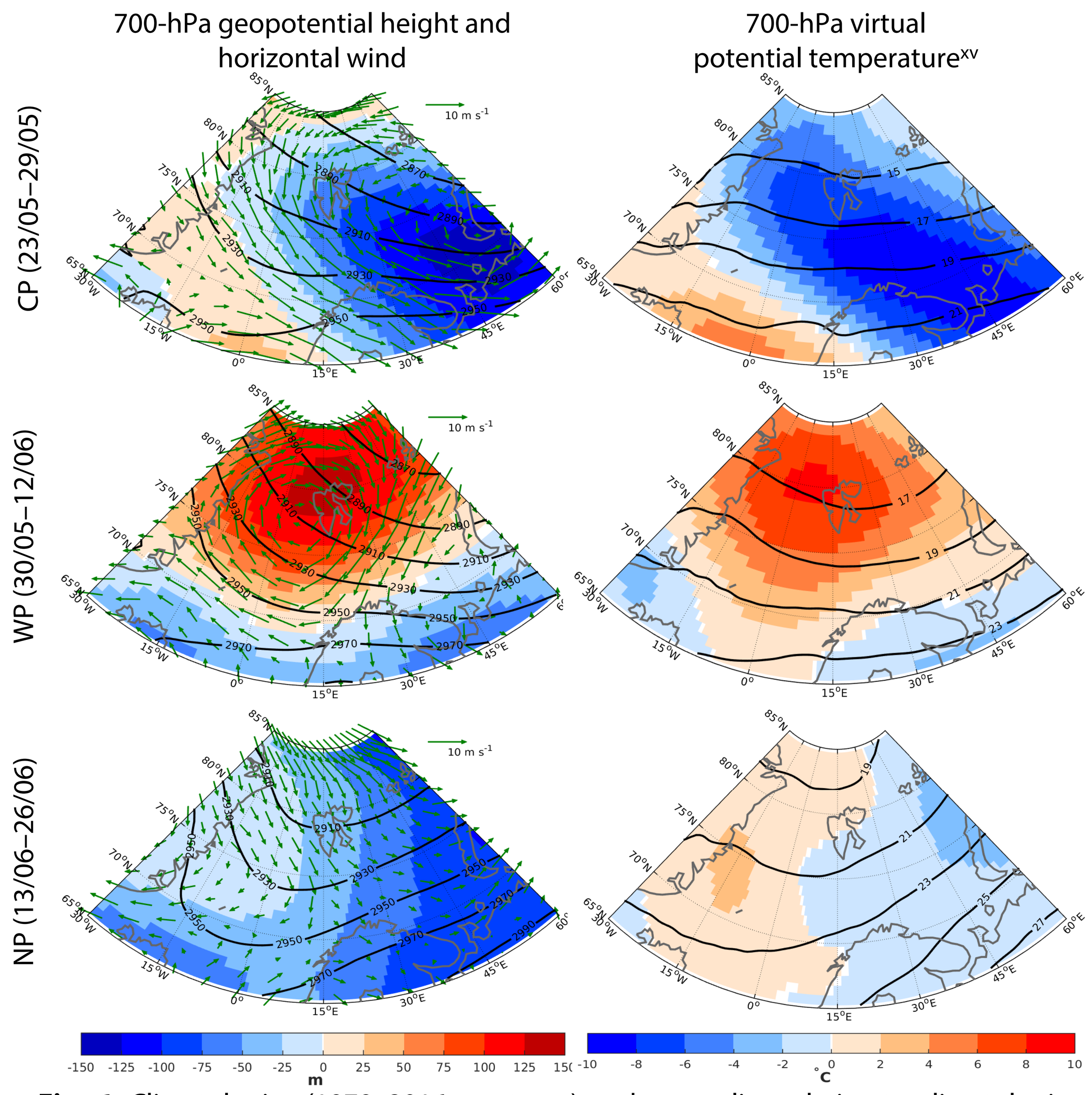

Fig. 6: Climatologies (1979–2016; contours) and anomalies relative to climatologies (2017 minus 1979–2016; shading) of 700-hPa [left] geopotential height with median wind (vectors) and [right] virtual potential temperature for key periods [top] CP, [middle] WP, and [bottom] NP.

- Cold period (CP):
  - Cyclonic circulation (Fig. 6 left).
  - Cold and dry Arctic air (Fig. 6 right).
  - Highest cloud coverage (Fig. 7).
- Warm period (WP):
  - Anticyclonic circulation (Fig. 6 left).
  - Warm and moist maritime air (Fig. 6 right).
  - Lowest cloud coverage (Fig. 7).
- Normal period (NP):
  - Zonal divide (Fig. 6 left).
  - Mixed, average air (Fig. 6 right).
  - Medium cloud coverage (Fig. 7).

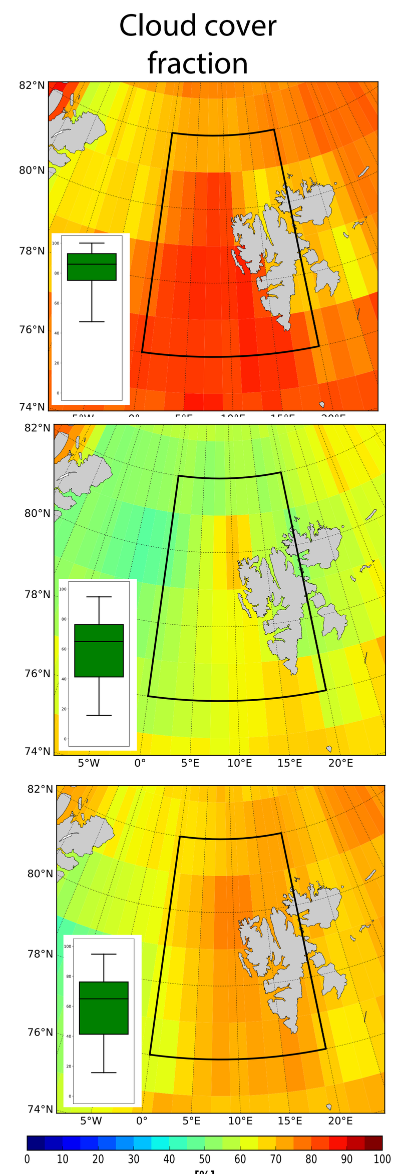

Fig. 7: Average cloud cover fractions for key periods [top] CP, [middle] WP, and [bottom] NP.

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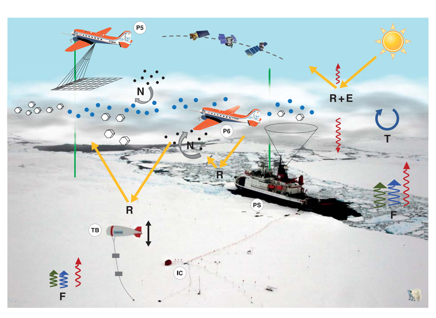

Fig. A: Set-up of the ACLOUD/PASCAL campaign. From [v].

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