Characterization of the cloud conditions at Ny-Ålesund using sensor synergy and representativeness across Arctic sites (Project: E02)

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1. Abstract

Clouds are a crucial component of the hydrological cycle and alter the energy budget in the system Earth atmosphere and thus affecting the global climate. Arctic clouds usually occur at low altitudes and often contain a mixture of tiny liquid drops and relatively large ice particles. The amount of ice and liquid water in clouds has a strong impact on radiative properties of clouds. Therefore, an accurate phase partitioning is important for the characterization of net effect of clouds on the Arctic climate. We present a statistics on clouds that derived from the synergy of ground-based remote sensing measurements at Ny-Ålesund.

2. Radiosonde statistics

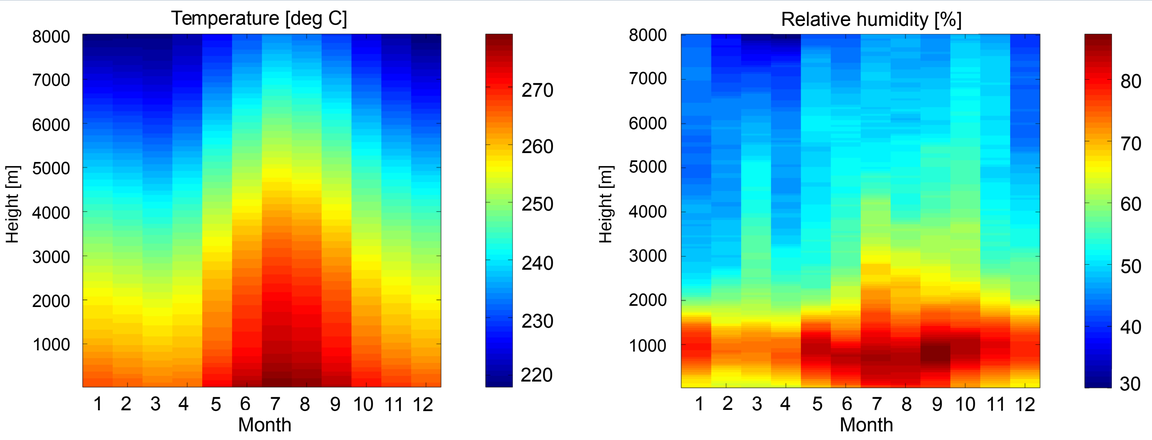

***Fig. 1**: Annual cycle of tropospheric temperature (left) and relative humidity (right) at Ny-Ålesund from radiosonde observations from 2006 to 2017 based on [1].*

3. Ground-based instrumentation for cloud study

***Fig. 2**: 94 GHz Cloud Radar*

- since June 2016
- active instrument
- sensitive to large particles (ice)
- vertical structure of clouds

***Fig. 3**: Ceilometer CL51*

- active optical sensor
- small particles with high concentration
- strong attenuation by liquid water

***Fig. 4**: Microwave radiometer*

- passive instrument
- profiles of temperature and humidity
- integrated amount of liquid water and water vapor in the column

4. Synergistic cloud observations

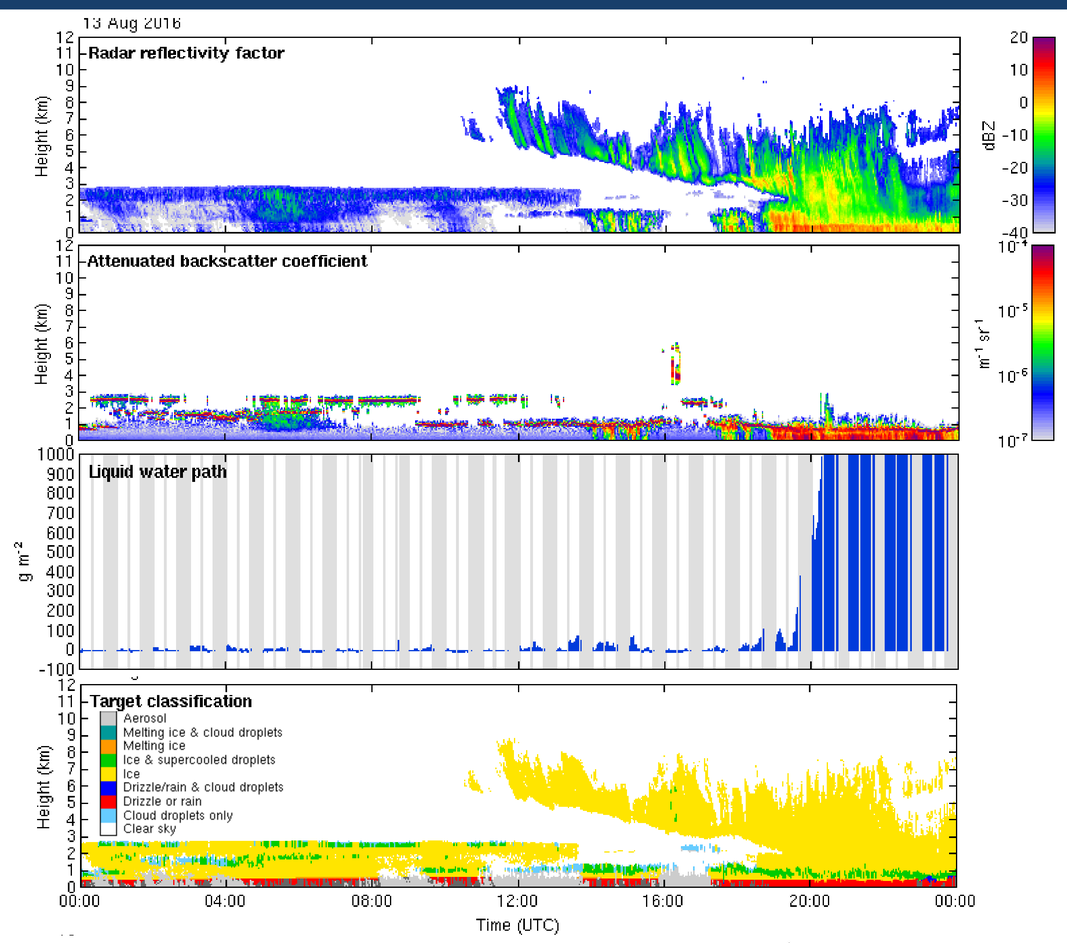

***Fig. 5**: Example of Cloudnet classification product at Ny-Ålesund, 13 Aug 2016.*

- CLOUDNET [2] provides a target categorization and cloud microphysical products based on the synergy of ground-based remote sensing measurements.
- Operational since 10 June 2016

5. Statistics on clouds at Ny-Ålesund

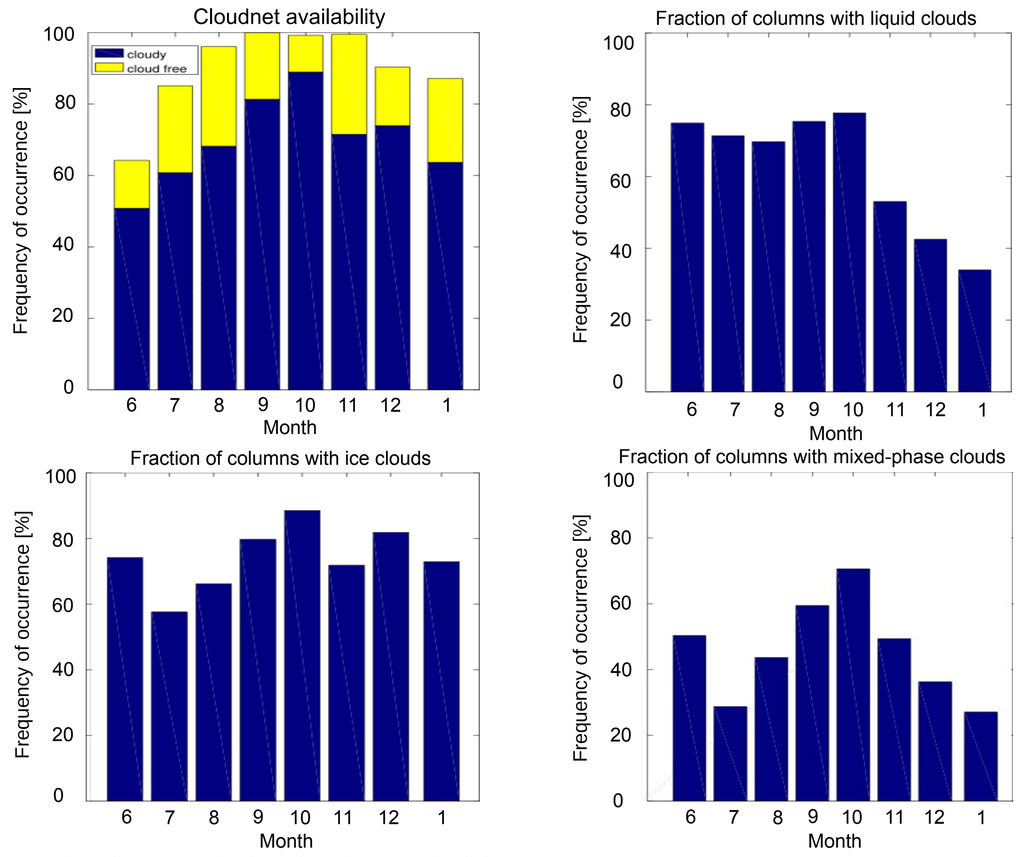

***Fig. 6**: Cloudnet statistics for the period from 10.06.2016 to 31.01.2017.*

- Significant difference in ice and mixed-phase cloud occurrence between July and October (30 and 40 %, respectively)

6. A closer look on clouds in July and October

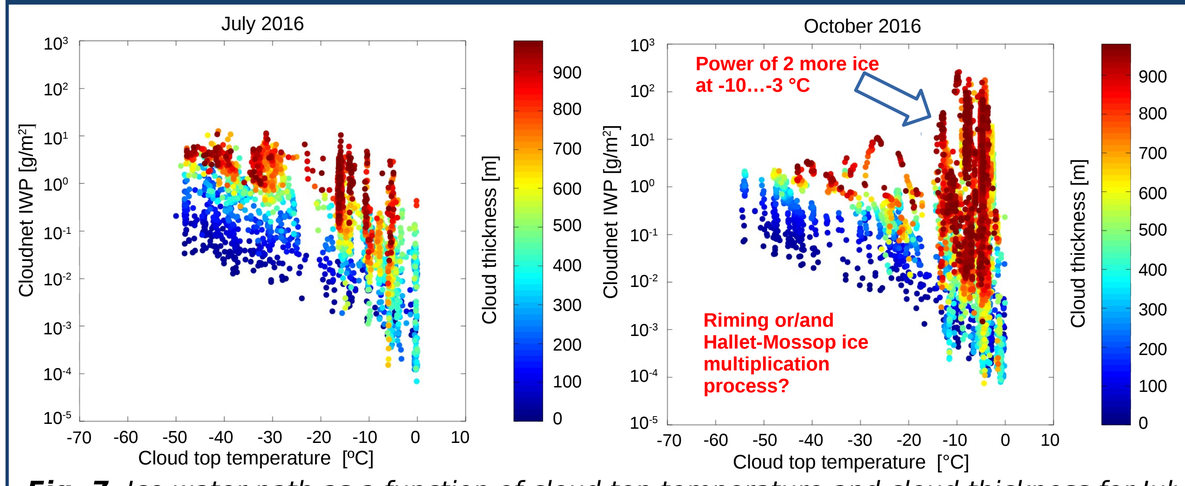

***Fig. 7**: Ice water path as a function of cloud top temperature and cloud thickness for July (left) and for October (right). Cloud top temperature is taken from Global Data Assimilation System.*

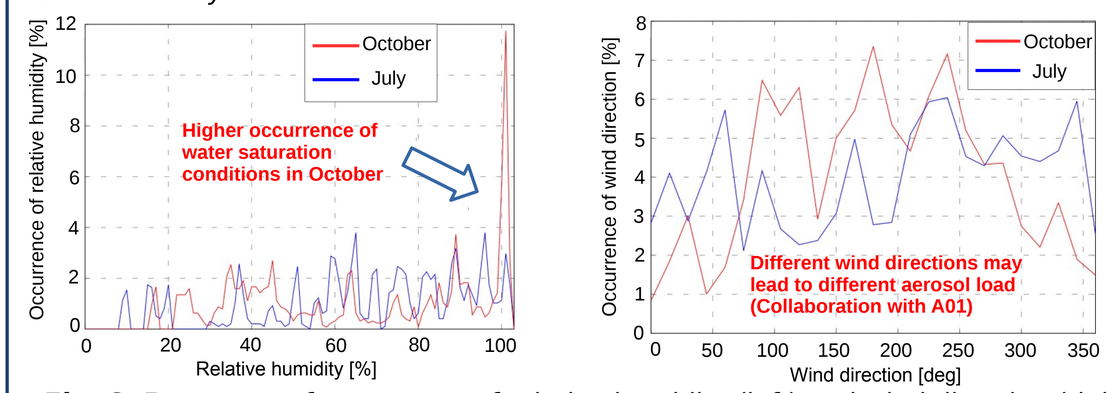

***Fig. 8**: Frequency of occurrence of relative humidity (left) and wind direction (right) for temperature -7 °C for October and July at Ny-Ålesund from radiosonde observations from 2006 to 2017.*

7. Summary and Outlook

- Preliminary analysis of cloud occurrence and phase of clouds at Ny-Ålesund
- Evidence of enhanced ice production was found in October 2016
- Higher occurrence of water saturation conditions in temperature range from -10 to -3 °C
- Next step is comparison with other Arctic sites (Barrow, Summit, Eureka)
- In-situ observations during the measurement campaign are in high demand

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This work was supported by the German Research Foundation (Deutsche Forschungsgemeinschaft) within the Transregional Collaborative Research Center (TR 172) "Arctic Amplification: Climate Relevant Atmospheric and Surface Processes, and Feedback Mechanisms (AC)³".
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References:

1. *M. Maturilli, M. Kayser, 2016: Arctic warming, moisture increase and circulation changes observed in the Ny-Ålesund homogenized radiosonde record, Theoretical and Applied Climatology, DOI 10.1007/s00704-016-1864-0.*
2. *A. Illingworth, R. Hogan, E. O'Connor, and D. Bouniol, Cloudnet, 200: Bulletin of the American Meteorological Society, 88(6), 883 (2007).*