Investigating mixed phase clouds using a synergy of ground based remote sensing measurements

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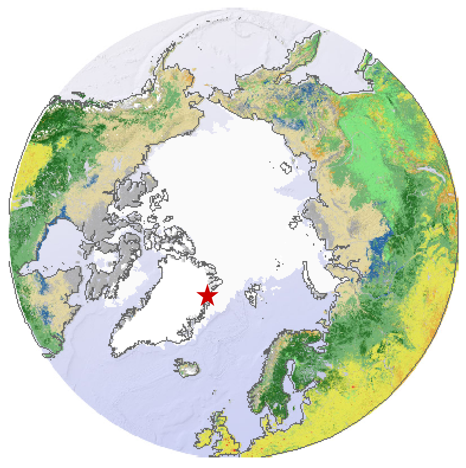
Arctic Amplification & Clouds

Arctic Amplification: Climate Relevant Atmospheric and Surface Processes and Feedback Mechanisms (AC)[3]



- German collaborative research project to investigate the key processes contributing to Arctic Amplification
- Comprehensive cloud observations carried out at AWIPEV station in Ny Ålesund

Mixed phase clouds at Ny Ålesund

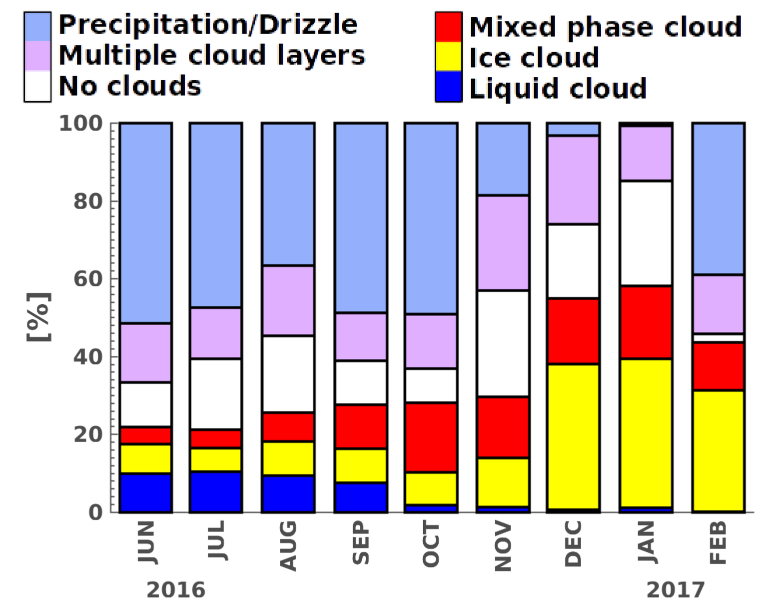


Fig 1. Occurrence of different type of clouds, using CLOUDNET[1] classification product for 10th June 2016 – 6th Feb 2017.

Mixed Phase Clouds: Case Study

Mixed phase cloud on the Nov 23th 2016

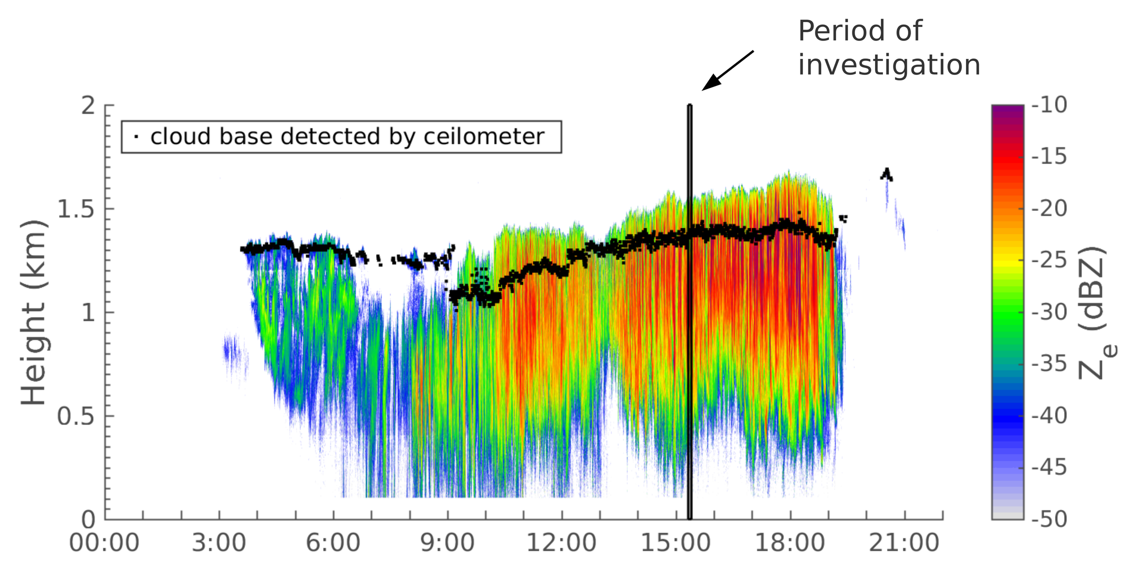


Fig 2. Radar reflectivity and cloud base detected by ceilometer.

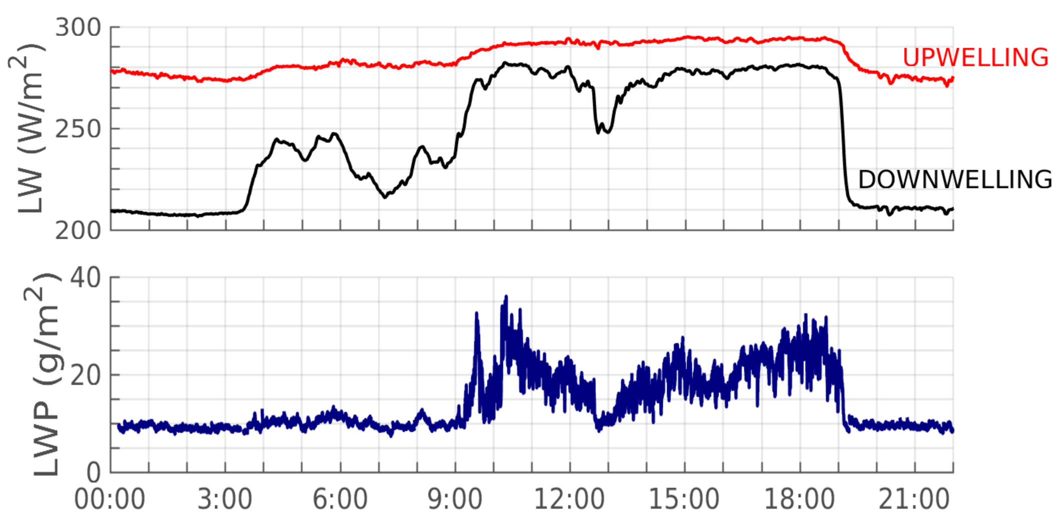


Fig 3. Long-wave surface radiation measurements (upper panel); liquid water path retrieved from the radar's 89 GHz passive channel[2] (lower panel).

- Very low amount of liquid in the cloud is causing a significant radiative impact
- The variability of vertical wind is changing during the day

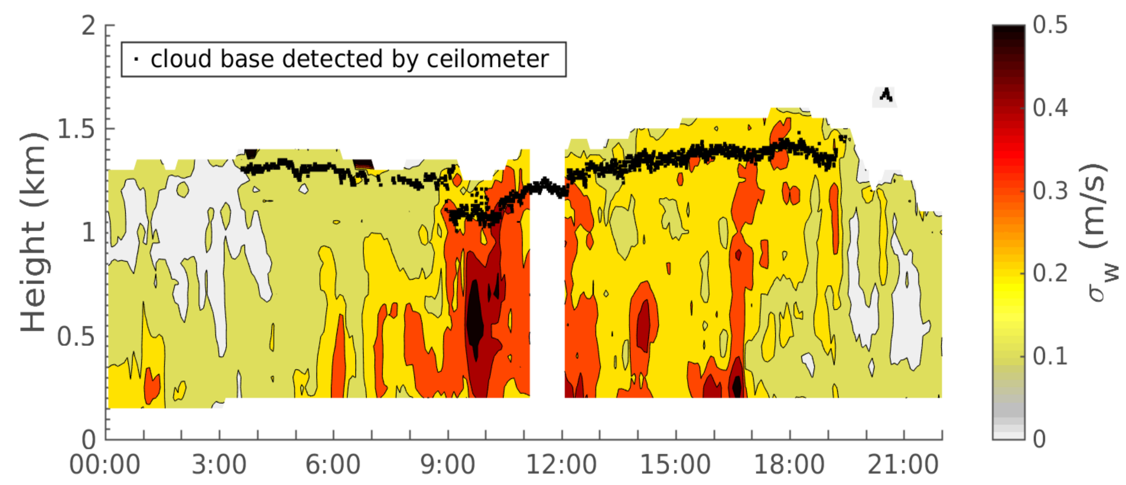
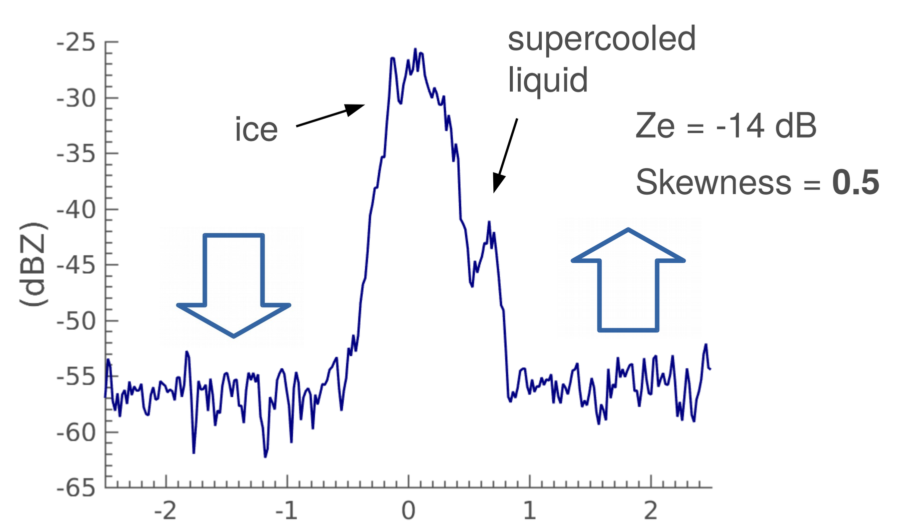
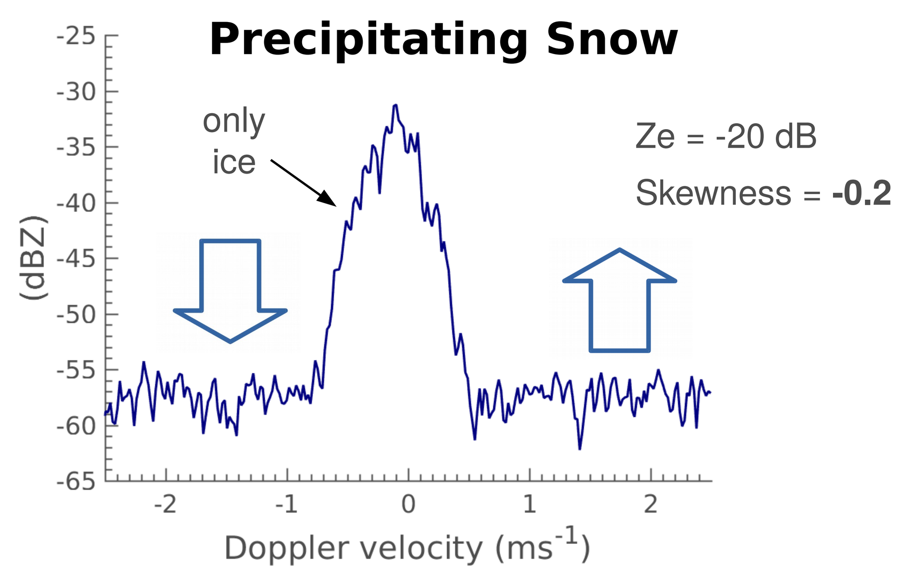


Fig 4. Standard deviation of vertical wind retrieved from wind lidar scans[3].

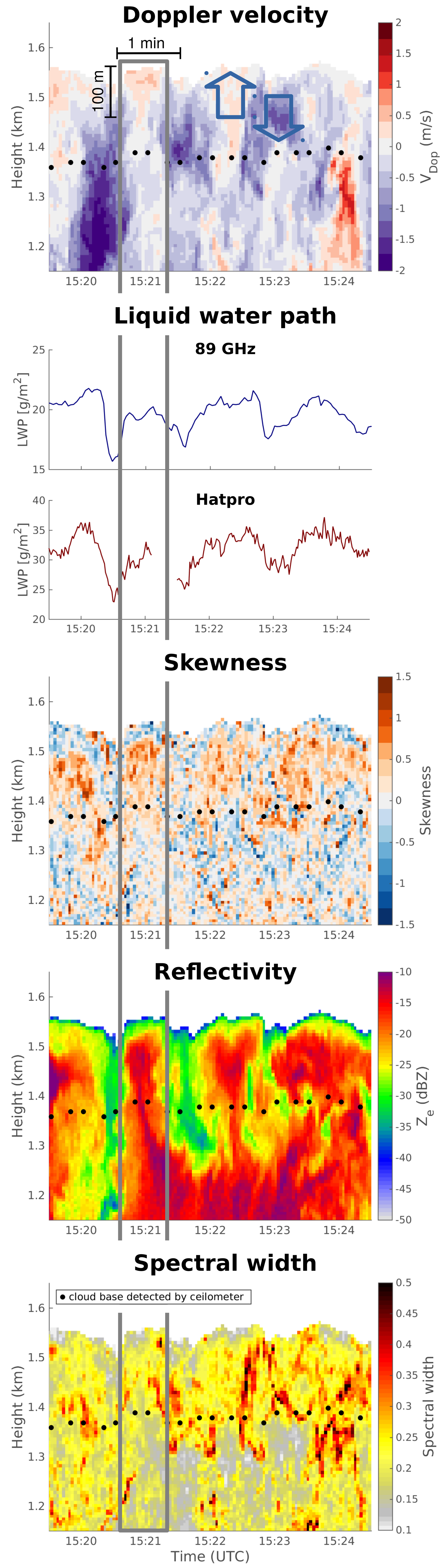
Radar Doppler Spectra





- Ze is dominated by ice ($Ze \sim D^6$)
- Mean Doppler velocity $V_{Dop} = V_{Terminal} + V_{Air}$ → since $V_{Terminal}$ is always down (negative), a positive V_{Dop} is caused by upwind
- Super-cooled droplets are floating with the air ($V_{Terminal} \approx 0$ m/s) → ice particles separate from super-cooled liquid in the Doppler spectra (if low turbulence) → if both super-cooled liquid and ice present, spectra become positively skewed

Small scale variability



Doppler velocity dominated by vertical air motion driven by cloud top cooling

Liquid water path (super-cooled) seems to be modulated by up- and downdrafts

Positive skewness often indicates presence of secondary liquid peak (see explanations in the middle).

Reflectivity stronger (weaker) in updraft (downdraft) regions due to stronger (weaker) ice growth.

Spectral width enhanced in liquid top layer but rather complex structure.

Fig 5. Cloud top structures revealed by different radar moments.

References

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2- Küchler et al. (2017), A W-band radar-radiometer system for accurate and continuous monitoring of clouds and precipitation, J. Atmos. Ocean. Tech., under review
3- Schween et al. (2014). Mixing-layer height retrieval with ceilometer and Doppler lidar: from case studies to long-term assessment. Atmos. Meas. Tech., 7(11), 3685-3704.

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