Simulations of Arctic Mixed-Phase Clouds: Impact of surface heterogeneities

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Conclusion

- Simulations of different VERDI campaign flights
- Model is sensitive to initialization profiles, LWC agree with value from Klingebiel et al., 2015
- Liquid water content is higher in cloud with an open lead at the surface

Motivation

The Arctic is a highly sensitive region to changes in climate. Shallow and persistent mixed-phase layer clouds play an important role in the surface energy budget in this region. Different surfaces may change cloud evolution and properties.

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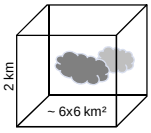
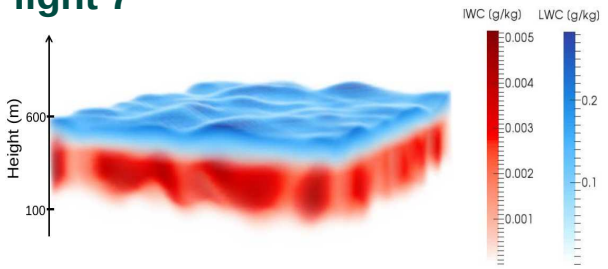
COSMO model setup

- Idealized simulations, 64 x 64 grid points
- Initialization profiles from VERDI measurements
- Δt: 2 s, Δx: 100 m
- Vertical levels: 133
- 2 moment scheme (Seifert and Beheng, 2006)
- 3D turbulence scheme
- Activated droplet number: 100 #/cm³ (Klingebiel et al., 2015)



Simulations over ice

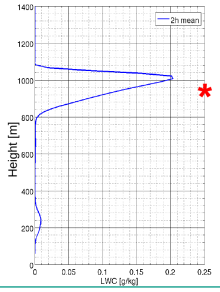
Flight 7



Mixed-phase low level cloud during VERDI campaign.

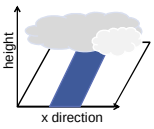
Flight 11

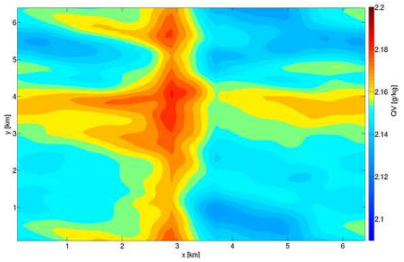
Comparison of liquid water content (LWC) with Klingebiel et al., 2015:
* LWC = 0.25 g/kg



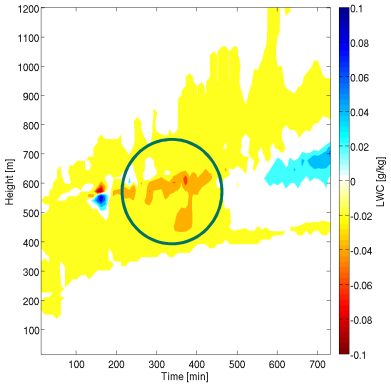
Simulations over ice/open lead

Flight 7





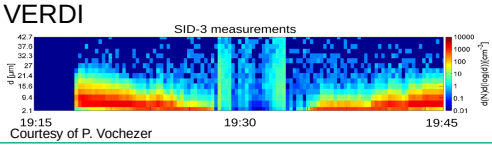
Horizontal cross section of specific humidity (QV) at 15m above surface. Open lead has a width of 8 grid points and is located in the middle of the x direction.



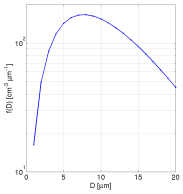
LWC over ice surface minus LWC over ice/open lead. LWC is ~10 % higher than without open lead.

Outlook

- Detailed analysis of turbulence
- Surface heterogeneity experiments, e.g. vary ice surface temperature
- Bimodal droplet size distribution at cloud top was detected during VERDI
  - Investigate cloud top structure and droplet diameter



Courtesy of P. Vochezer



Flight 7, droplet distribution at 541m

References

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Seifert, A. and K. D. Beheng, 2006: A two-moment cloud microphysics parameterization for mixed-phase clouds. part 1: Model description. Meteorol. Atmos. Phys., 92 (1-2), 45-66

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