Radiative Closure Studies Over the Arctic During Polarstern Expedition PS106

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1. Introduction

Motivation

- Earth radiation balance is dominated by clouds.
- In the Arctic these effects are closely linked with the ice albedo feedback.

Objectives

- The aim is to evaluate radiative closure, cloud radiative effect (CRE) at the bottom of the atmosphere (BOA) and cloud radiative heating rate forcing (CRHF) of selected cases of liquid, ice and mixed-phase single clouds running the 1D Rapid Radiative Transfer Model (RRTMG)

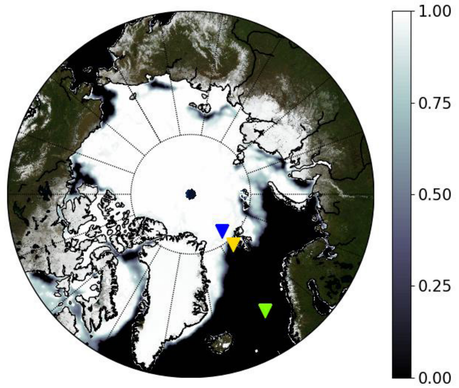

Fig 1. Sea Ice Fraction [NOAA_NSIDC]. Triangles indicate POLASTERN location for May 28th (green), 31st (yellow) and June 10th (Blue)

2. Instrumentation and Methods

Measurements

- The present results are based on remote sensing observations and radiative flux measurements performed onboard the research vessel POLASTERN during PS106 expedition (May 25th – July 21st. 2017).
- Liquid water content, liquid effective radius [1], ice water content [2], ice effective radius [3], and macro physical cloud properties were retrieved from Cloudnet [4] processed based on Lidar Polly XT, microwave radiometer HATPRO, Mira cloud radar 35GHz and Disdroeter.

Model

- Additionally forecast profiles of temperature were used as inputs to run the 1D RRTMG.

3. Results

Liquid Cloud – June 10th, 2017

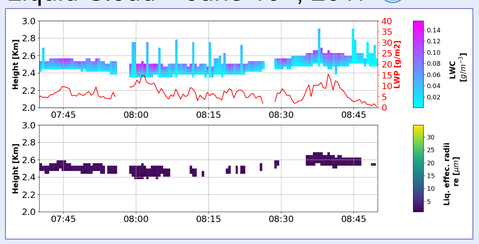

Fig 2. Microphysical properties of liquid cloud. Top in LWP(in red) LWC, bottom liquid effective radius

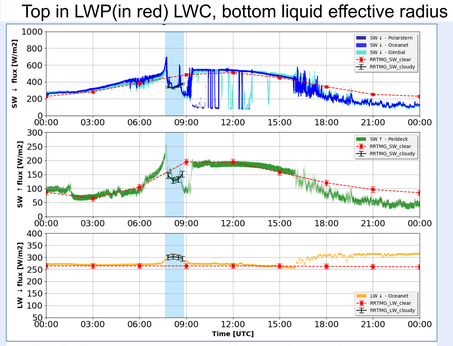

Fig 3. Radiative closure of broadband downward (top), upward (middle) SW and downward (bottom) LW radiative flux

Fig 4. Sky view of liquid cloud at 07:59:46 [UTC]

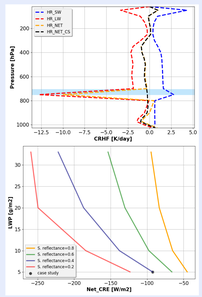

Fig 5 . CRHF (top) and dependence of CRE on LWP at BOA at 8:45 [UTC] (bottom)

Ice Cloud – May 31st, 2017

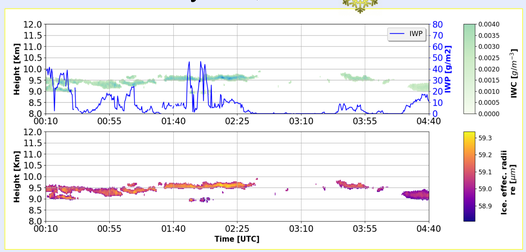

Fig 6. Microphysic properties of ice cloud. Top in IWP(in blue) LWC, bottom ice effective radius

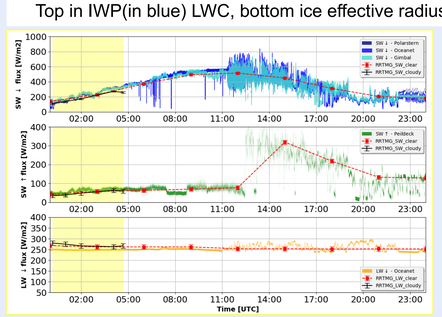

Fig 7. Radiative closure of broadband downward (top), upward (middle) SW and downward (bottom) LW radiative flux

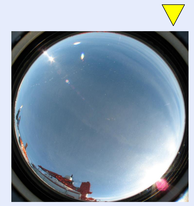

Fig 8. Sky view of liquid cloud at 02:08:06 [UTC]

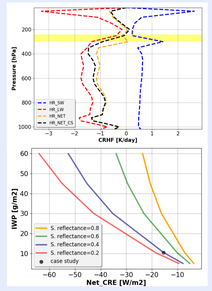

Fig 9 . CRHF (top) and dependence of CRE on LWP at BOA at 8:45 [UTC] (bottom)

Mixed-phase cloud – May 28th,

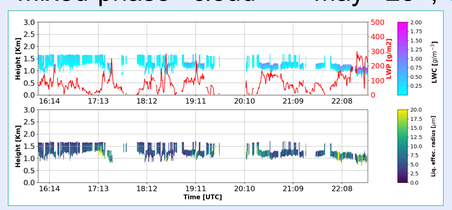

Fig 10. Liquid microphysical properties of mixed-phase cloud. Top in LWP(in red) LWC, bottom effective radius

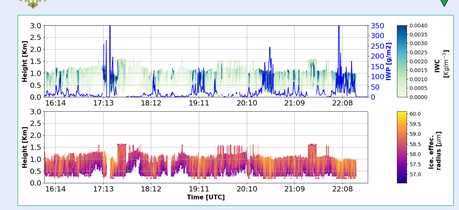

Fig 11. Ice microphysical properties of mixed-phase cloud.Top in IWP(in blue) LWC, bottom effective radius

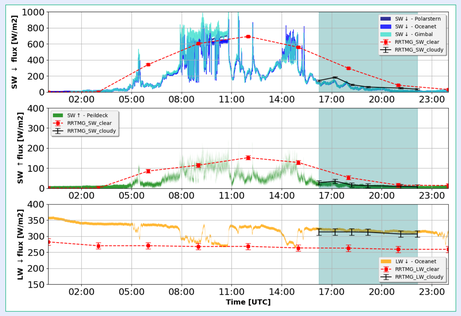

Fig 12. Radiative closure of broadband downward (top), upward (middle) SW and downward (bottom) LW radiative flux

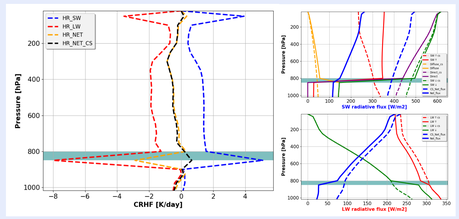

Fig 13 . CRHF (left) and profiles of broadband radiative fluxes SW (right top) and LW (right bottom) at 16:14 [UTC]

4. Conclusions and Outlook

- The simulations for liquid clouds showed a very good agreement with the observations of upward, downward SW and downward LW radiative flux having the highest cooling CRE at the BOA of -92,5 [W/m2] and the highest influence of heating rates of -10 K/day in the cloud layer.
- The simulations of ice and mixed-phase clouds have relative good agreement with the observations. However the variance might be due to the ice effective radius retrieval [3] since it was computed neglecting the number, shape and size distribution of ice particles. Future simulations will be made considering a more suitable retrieval for the entire cruise.

5. References

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[2] Hogan, R., et al., 2006: The retrieval of ice water content from radar reflectivity factor and temperature and its use in evaluating a mesoscale model. J. Appl. Meteor. Climatol., 45, 301–317, doi:10.1175/JAM2340.1

[3] McFarquhar., G. M., et al., 2003: SCM simulations of tropical ice clouds using observationally based parameterizations of microphysics. J. Climate, 16, 1643–1664, https:// doi.org/10.1175/1520-0442(2003)016,1643:SSOTIC.2.0.CO;2

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