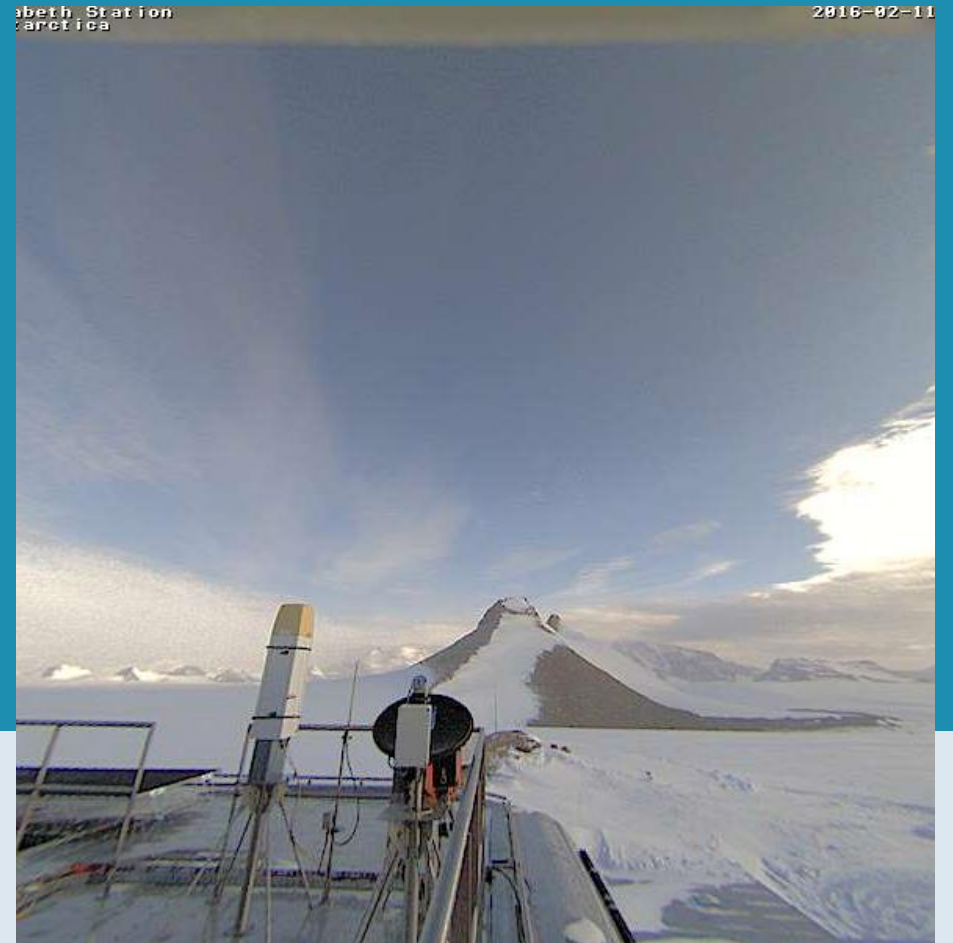
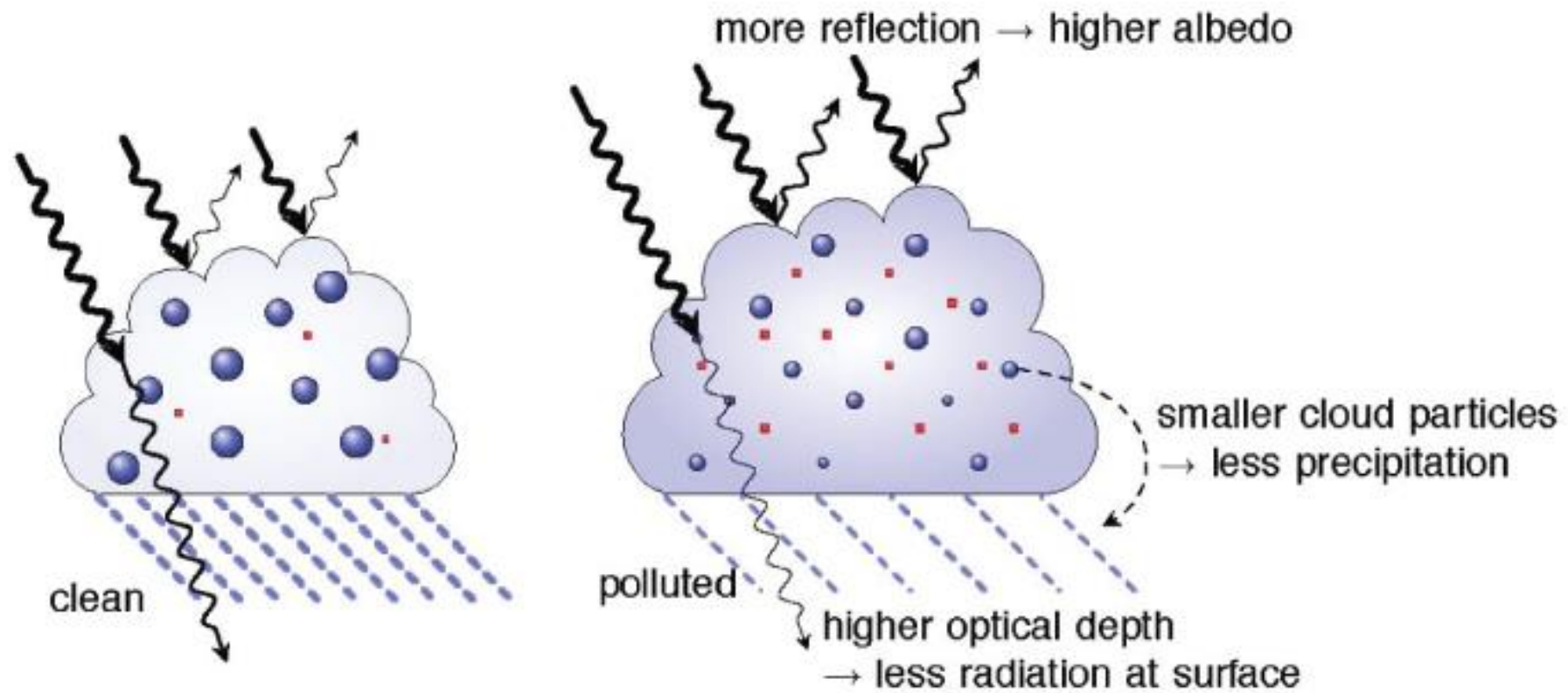


# Cloud-Aerosol Interactions over Dronning Maud Land in COSMO-CLM<sup>2</sup>

**Florian Sauerland**, Niels Souverijns, Alexander Mangold, Heike Wex, Nicole van Lipzig



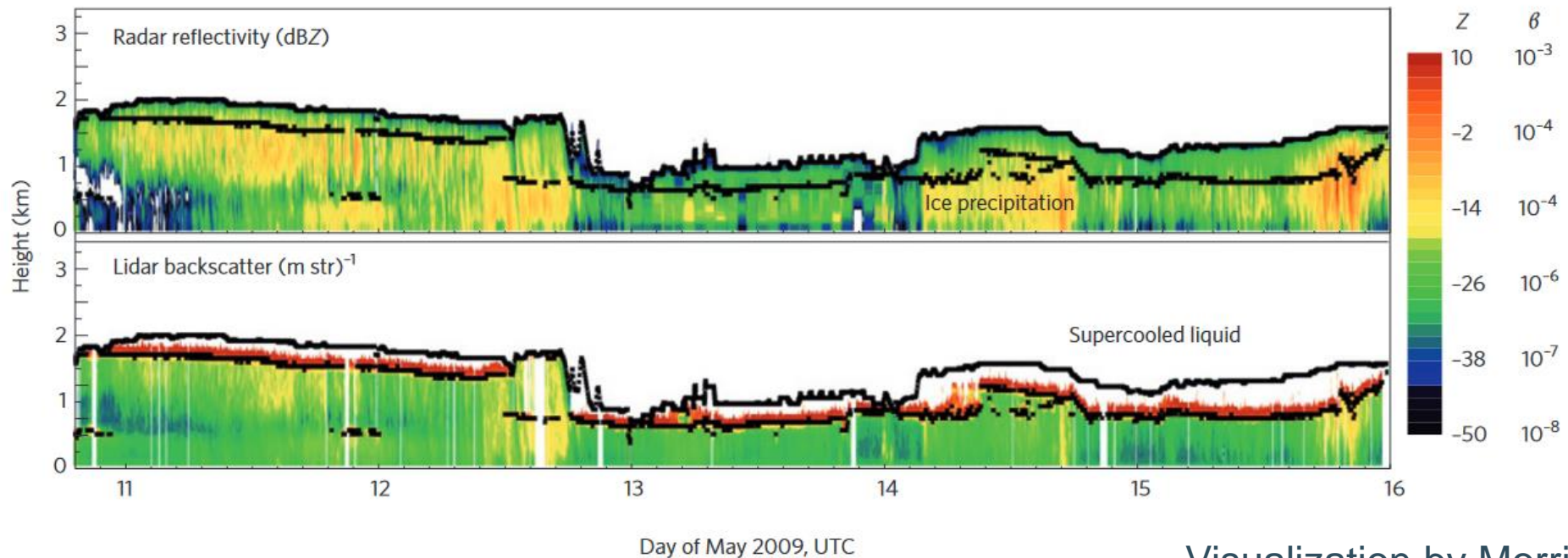
# Motivation



Graphic: IPCC 4th assessment report

# Mixed-phase clouds

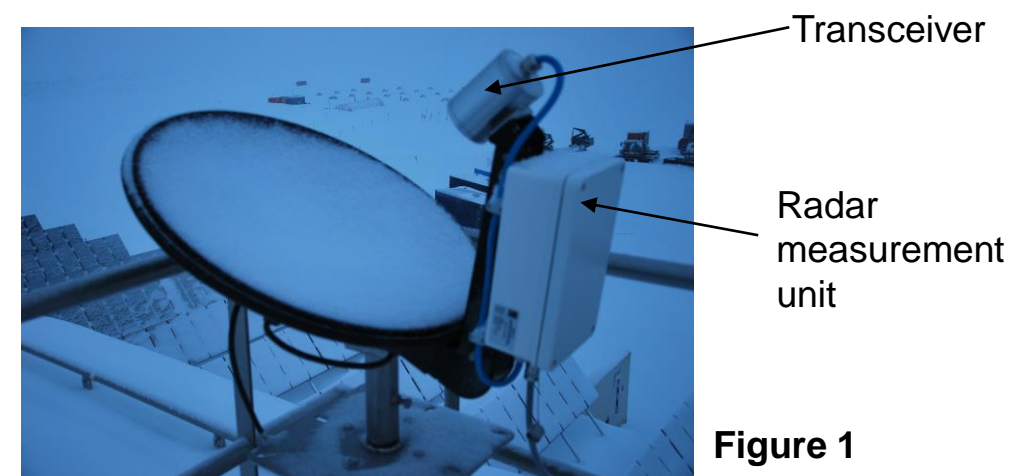
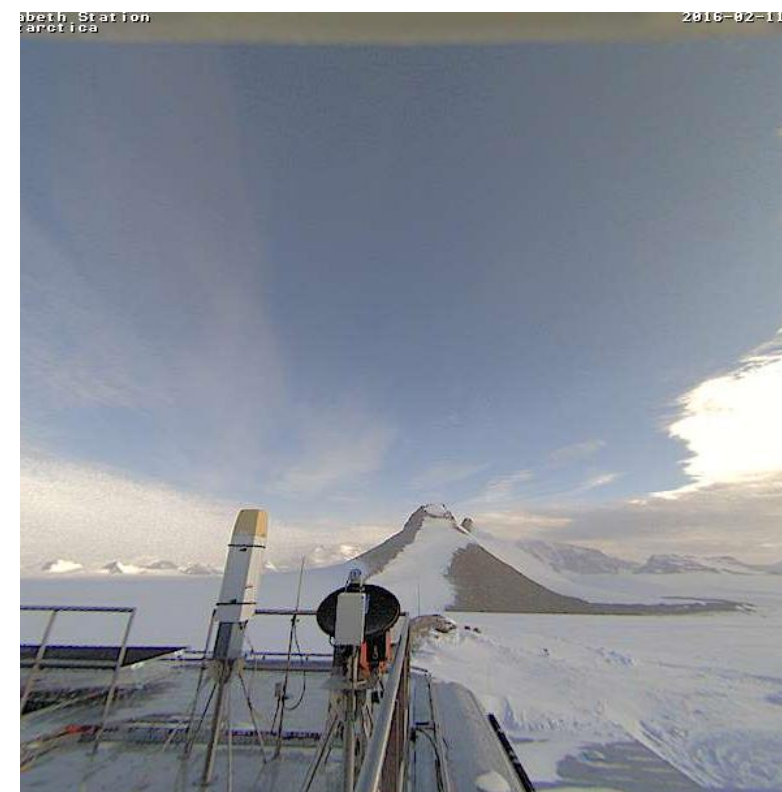
1. Cloud of supercooled water starts freezing
2. The created ice crystals grow faster than the remaining cloud droplets
3. The heavy ice crystals fallout



Visualization by Morrison et al., 2012

# What we're doing

- Cloud observatory at PEA (Gorodetskaya et al., 2015):
  - Micro Rain Radar and Ceilometer
  - Air Chemistry Laboratory
- Standard aerosol parametrizations focus on other regions
- How does this affect COSMO-CLM<sup>2</sup>?



# Model Setup



- COSMO-CLM<sup>2</sup>
  - COSMO version 5.00
  - OASIS version 3
  - CLM from CESM version 1.2.0

## Modifications:

- Aerosol module (Possner et al., 2017)
- Two-moment cloud scheme (Seifert and Beheng, 2006)

# Model Setup

- $0.025^\circ \times 0.025^\circ$  resolution
- 392 x 392 grid size in large domain
  - small domain: 192 x 175
- centered at PEA
- 40 vertical layers
- 20s temporal resolution
- forced by ERA-5 (3hr)
- 2 test cases à 2 weeks

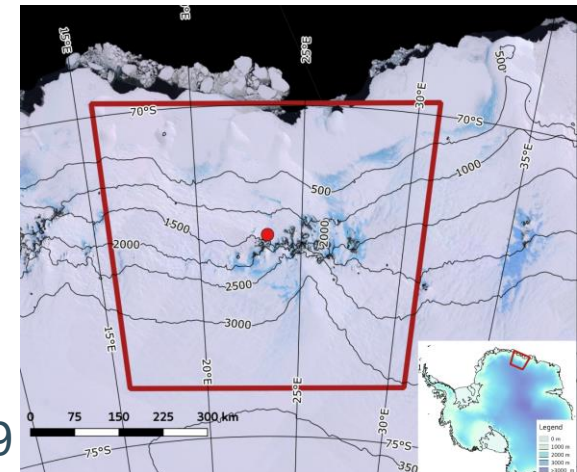
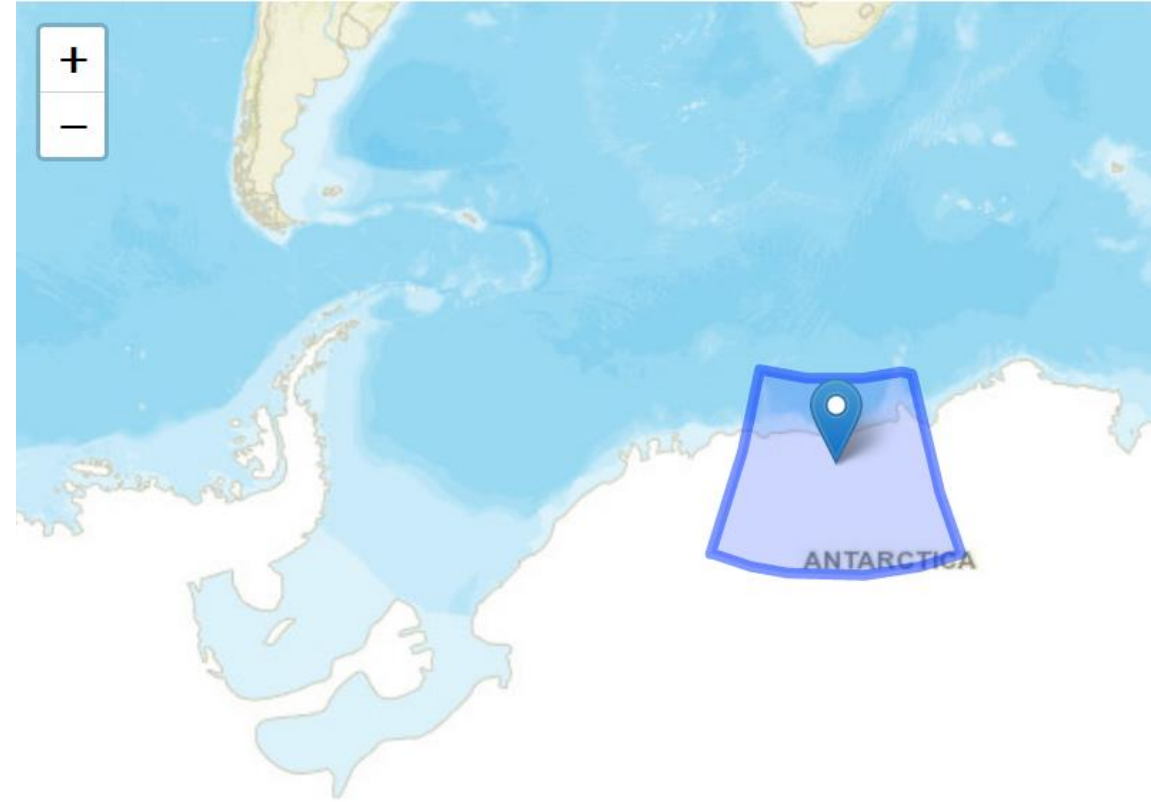
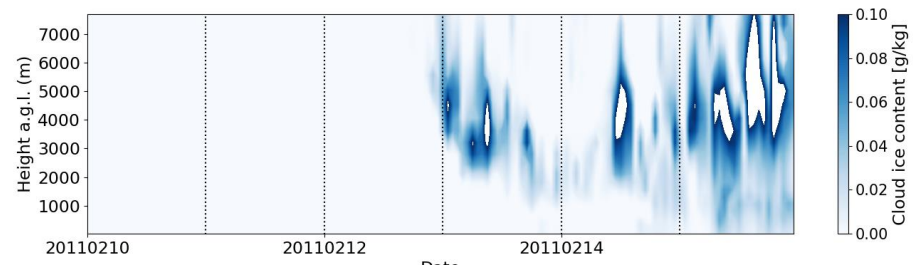
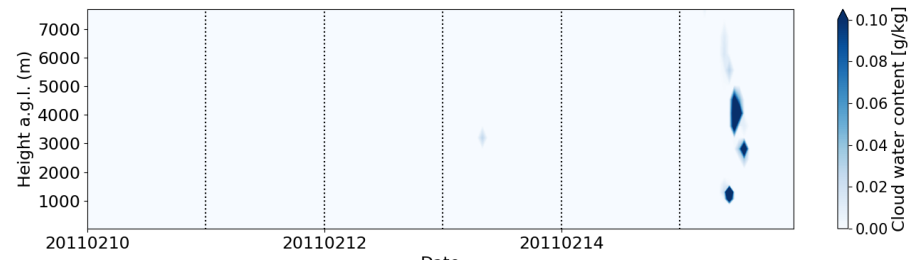


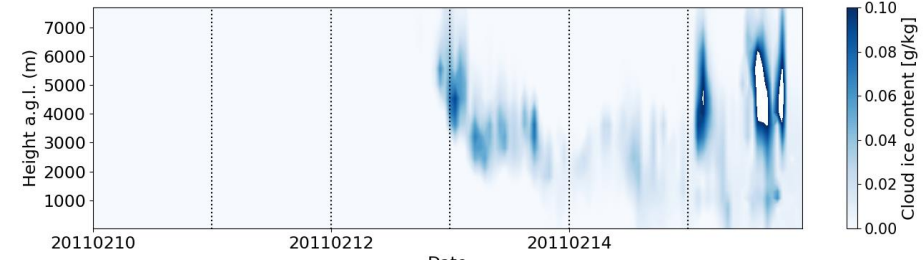
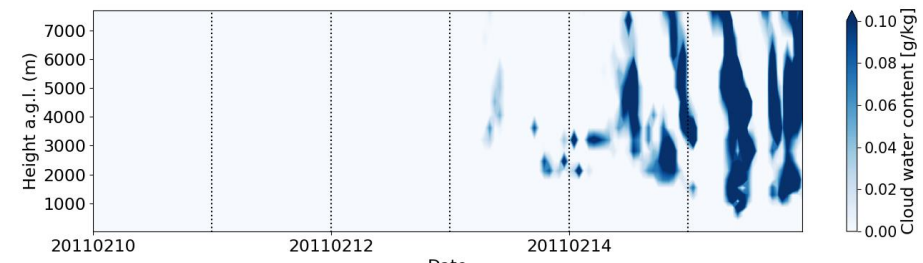
Image: Souverijns et al., 2019

# Liquid Water vs Ice Content

## High INP content



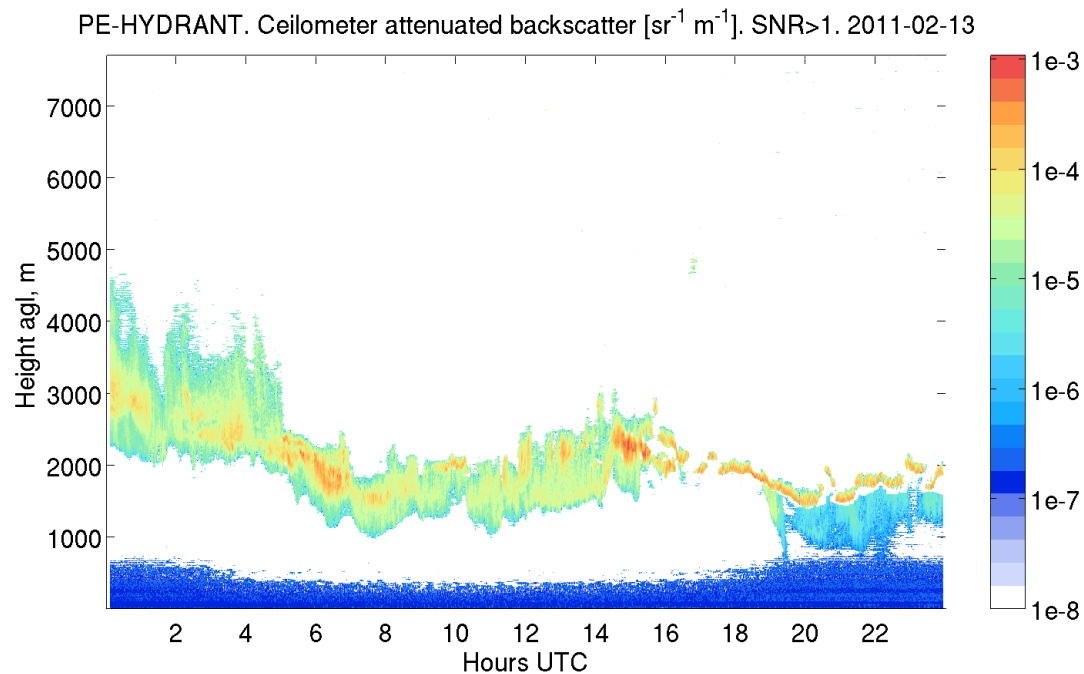
## Low INP Content



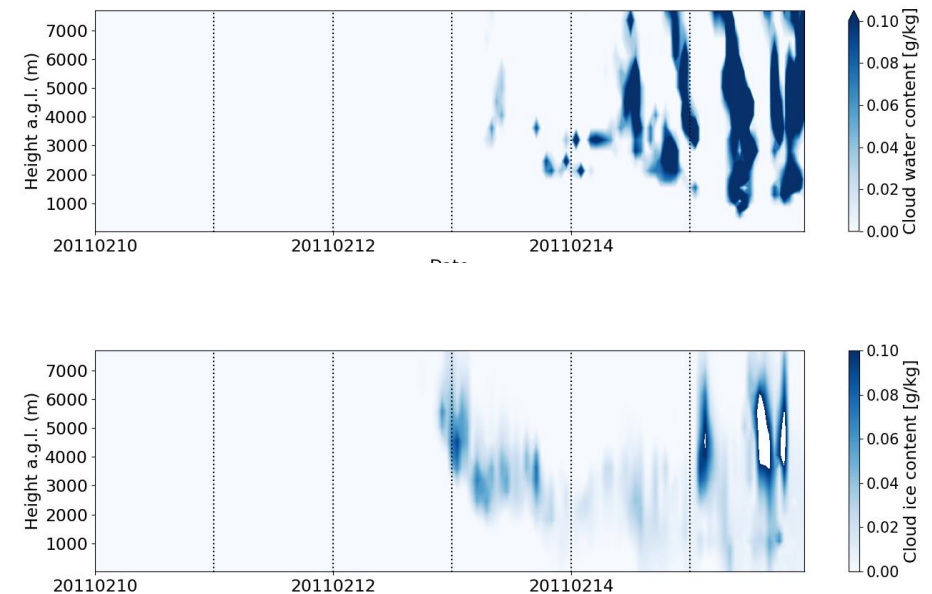
Test case 2011; large domain, forced by ERA-5

# Comparison with on-site measurements

## Ceilometer measurements



## Low INP Content

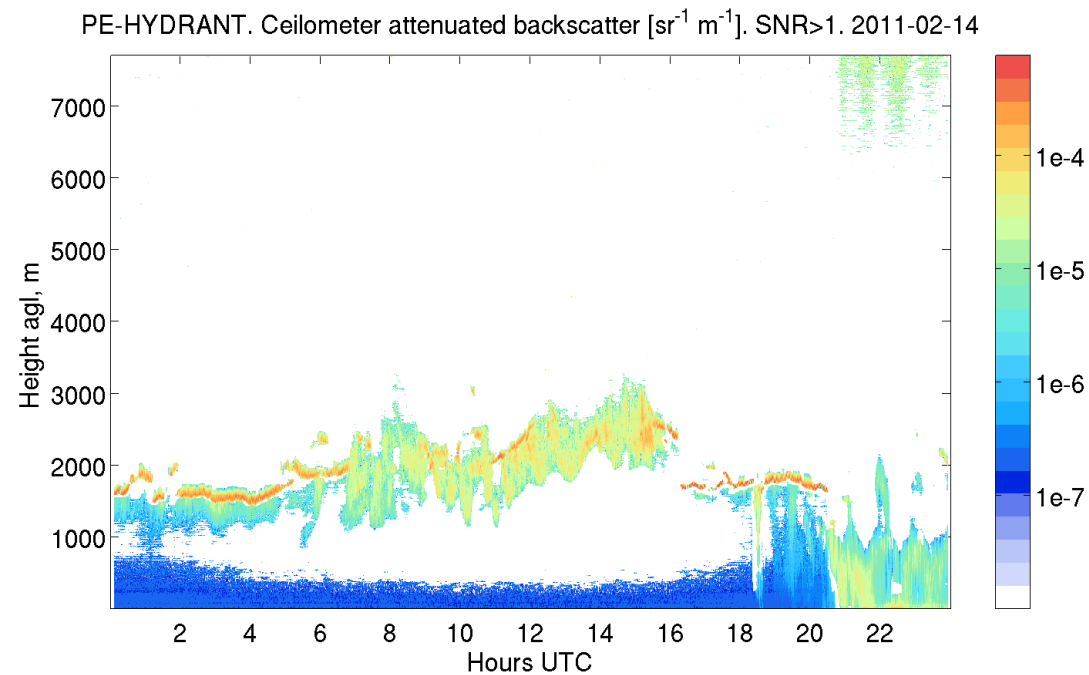


Test case 2011; large domain, forced by ERA-5

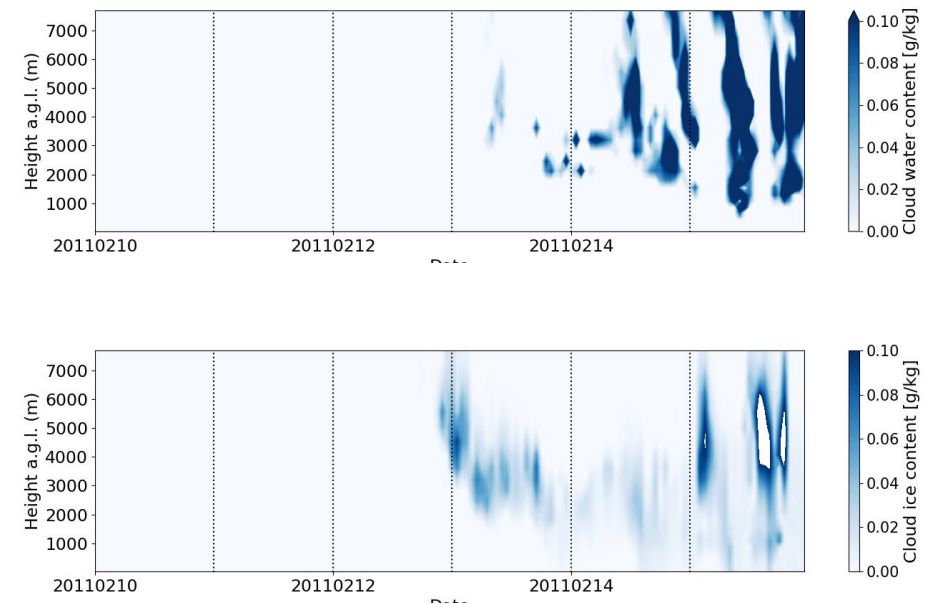


# Comparison with on-site measurements

## Ceilometer measurements



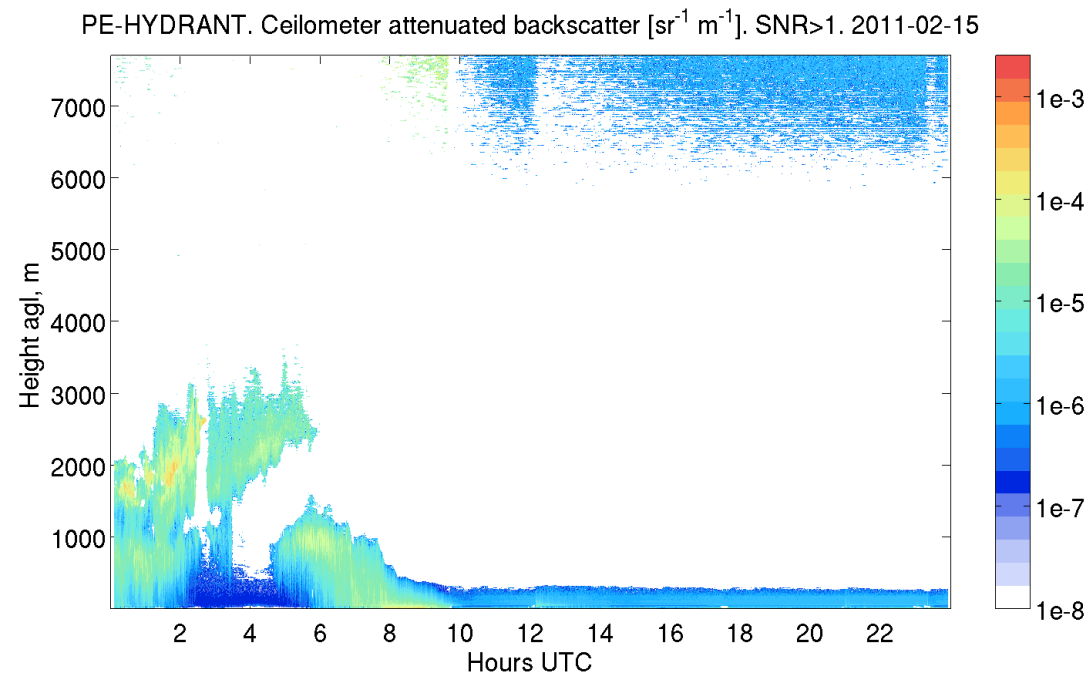
## Low INP Content



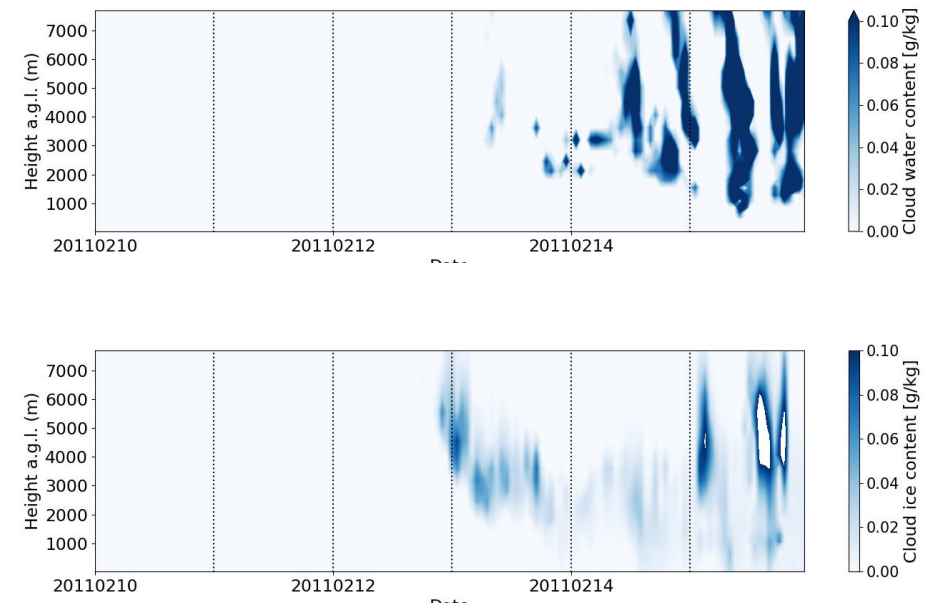
Test case 2011; large domain, forced by ERA-5

# Comparison with on-site measurements

## Ceilometer measurements



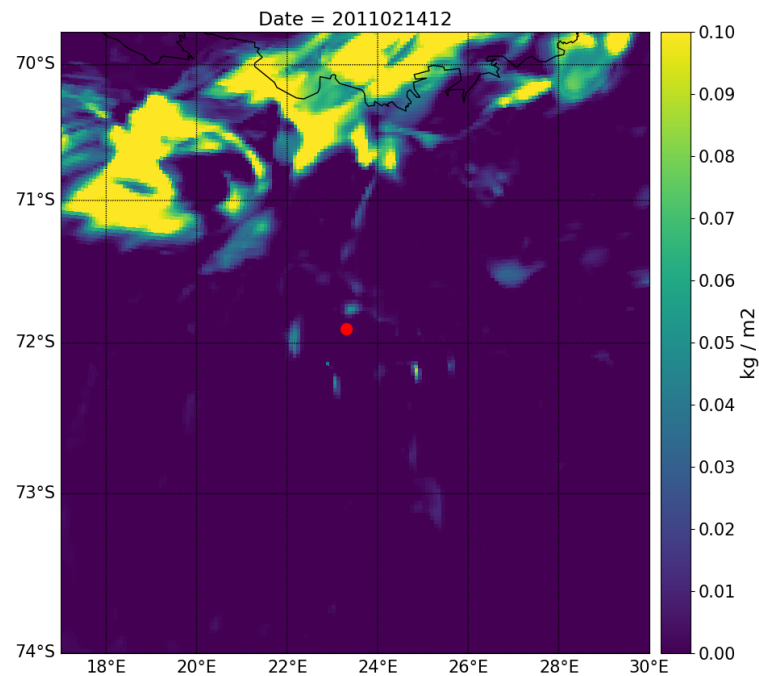
## Low INP Content



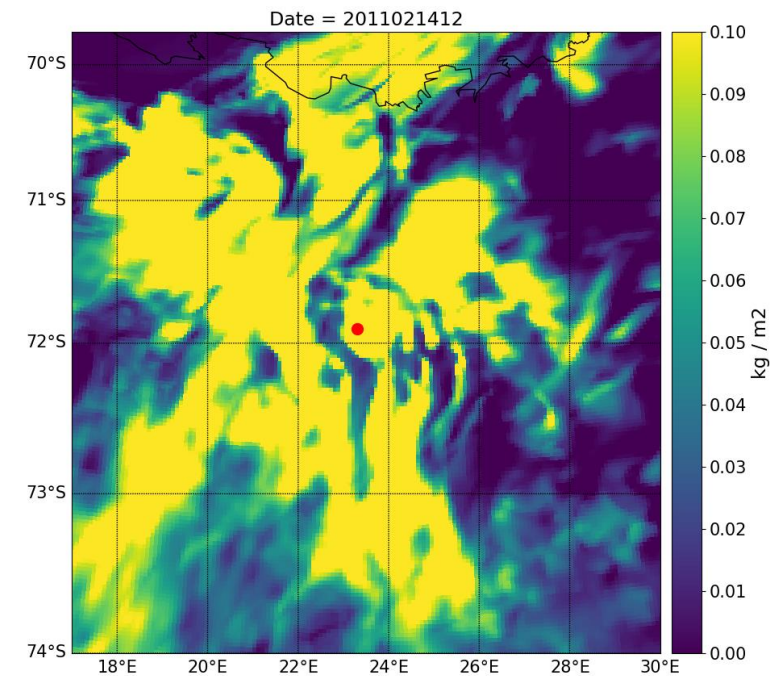
Test case 2011; large domain, forced by ERA-5

# Cloud maps (liquid water)

2011-02-14; high INP



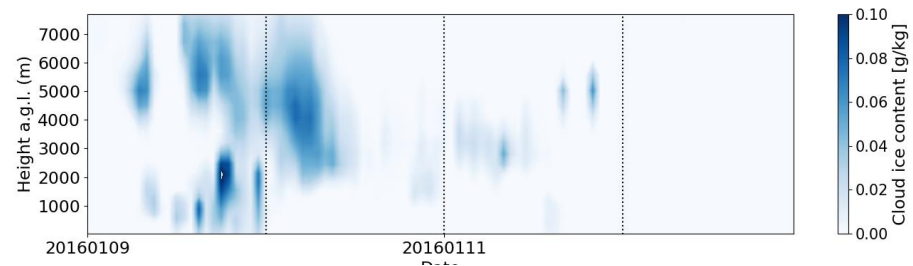
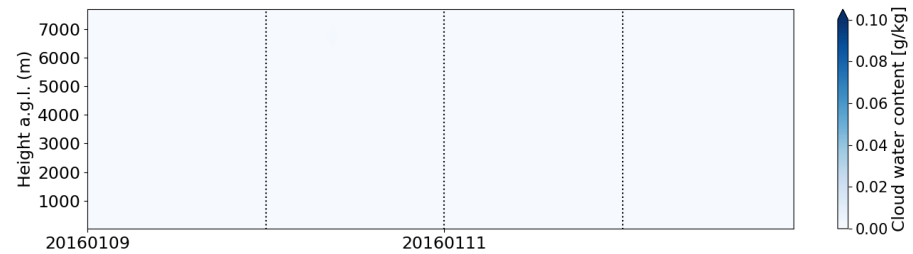
2011-02-14; low INP



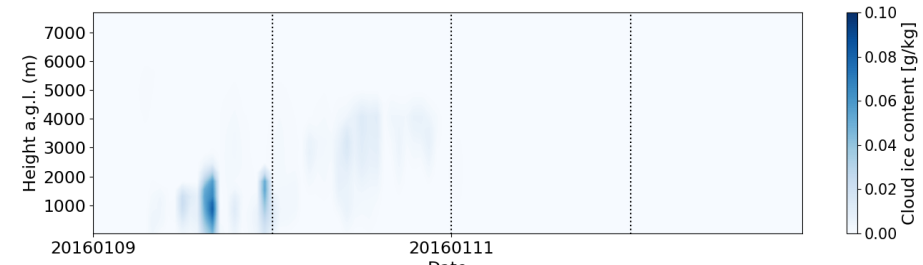
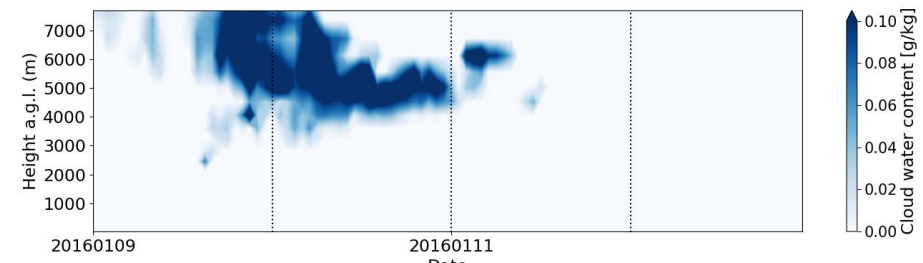
Test case 2011; large domain, forced by ERA-5. Only cutout of small domain shown

# Second Test case: Liquid Water vs Ice Content

## High INP content



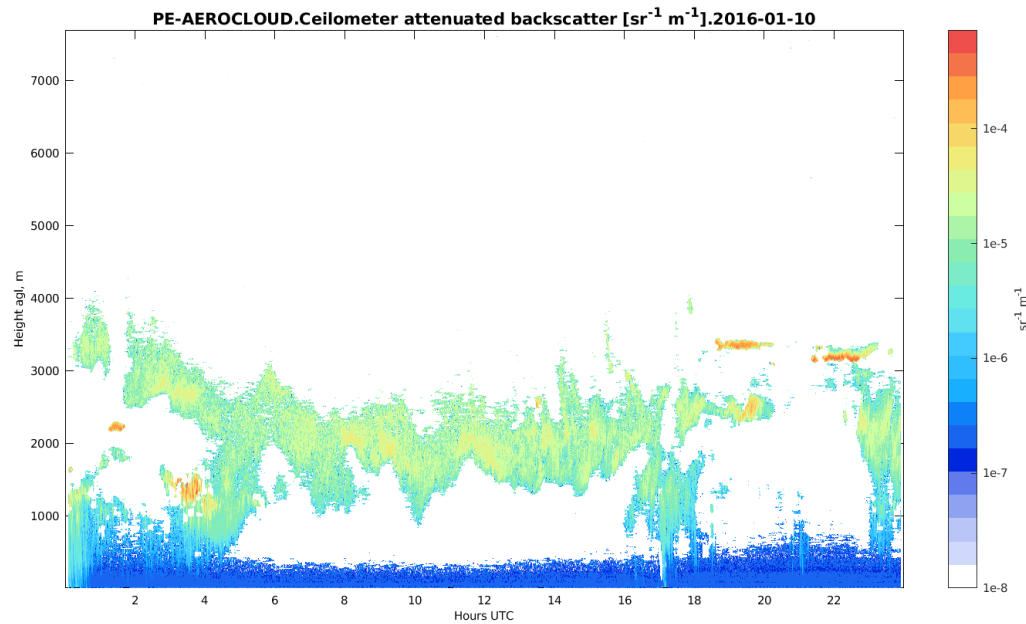
## Low INP Content



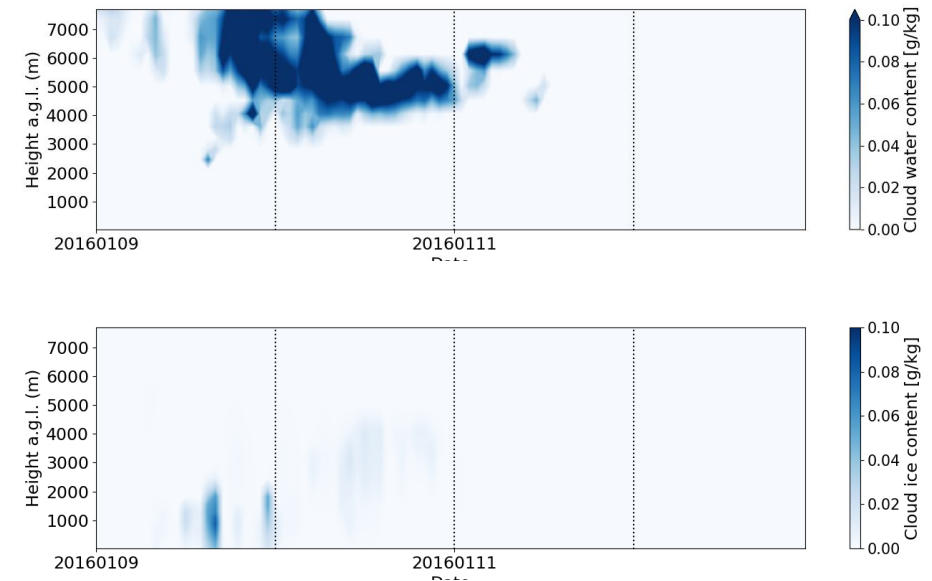
Test case 2016; large domain, forced by ERA-5

# Comparison with on-site measurements

## Ceilometer measurements



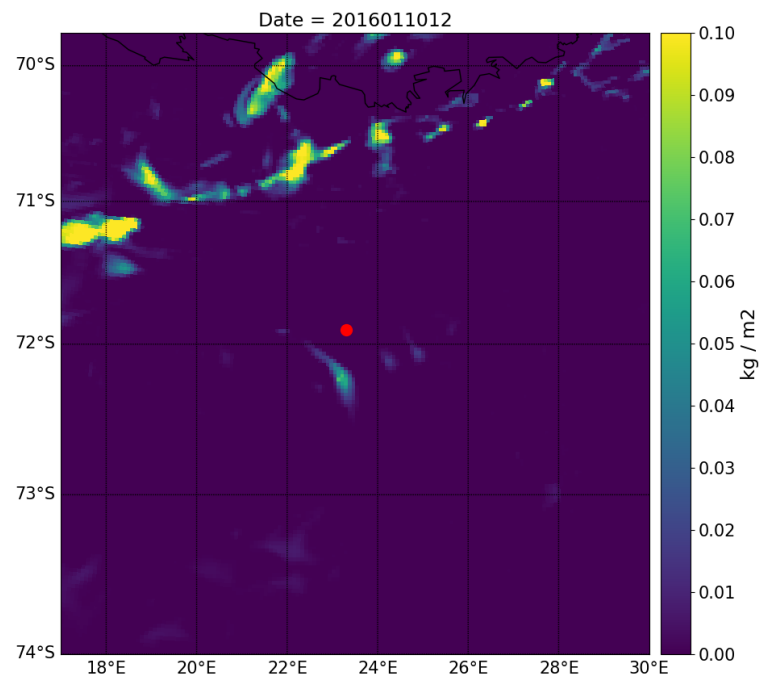
## Low INP Content



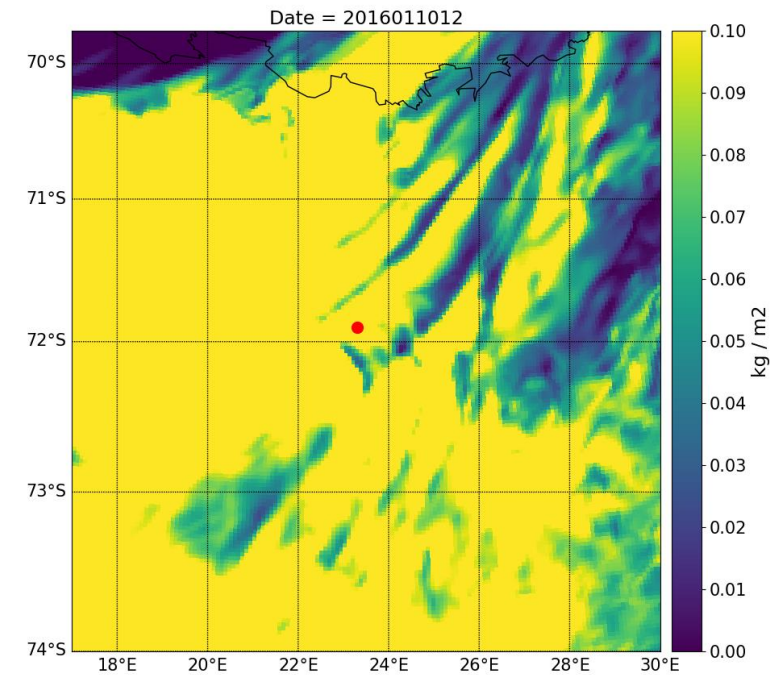
Test case 2016; large domain, forced by ERA-5

# Cloud maps (liquid water)

2016-01-10; high INP



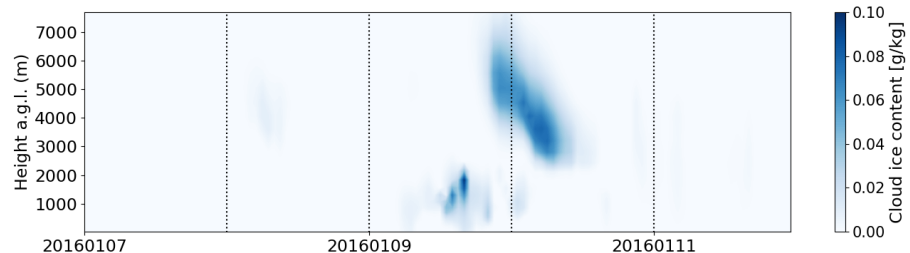
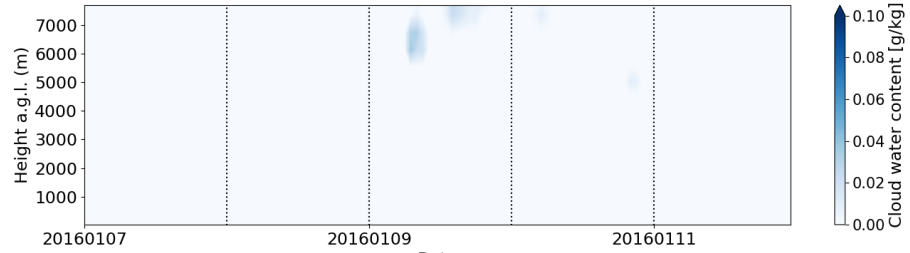
2016-01-10; low INP



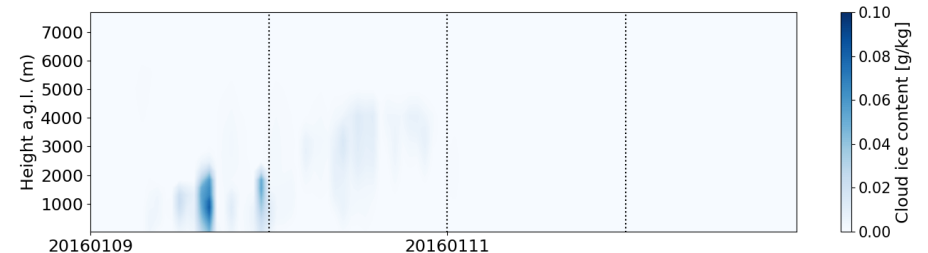
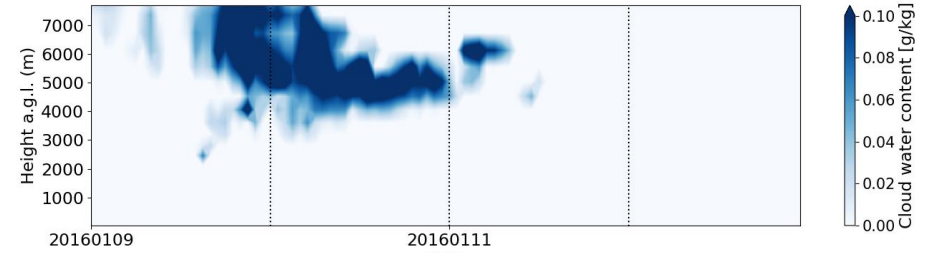
Test case 2016; large domain, forced by ERA-5. Only cutout of small domain shown

# Small domain vs. large domain

## Small domain, low INP

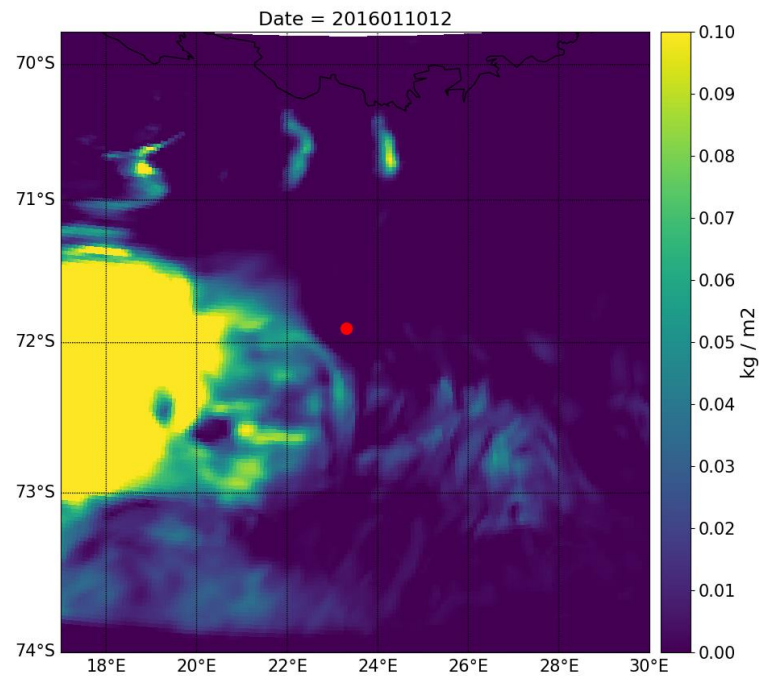


## Large domain, low INP

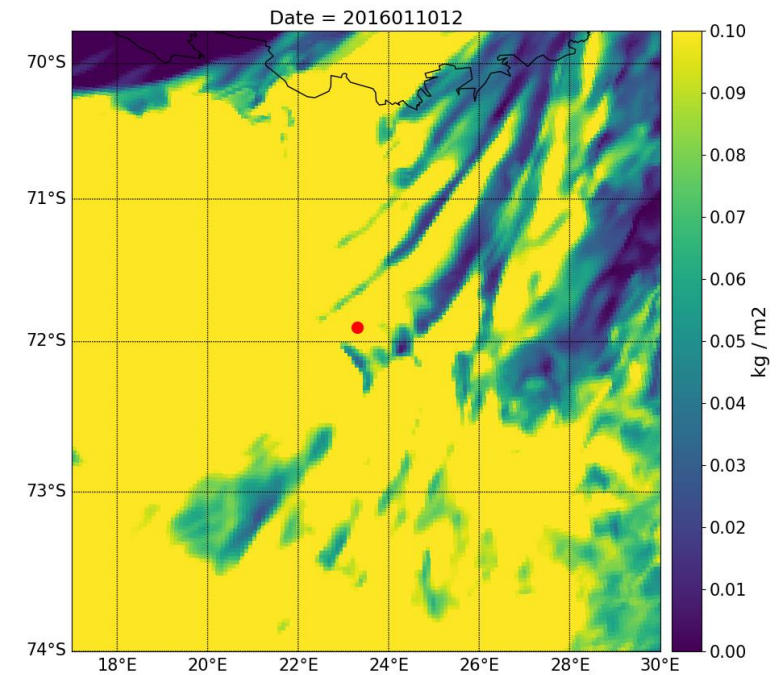


# Small domain vs. large domain

2016-01-10, Small domain, low INP



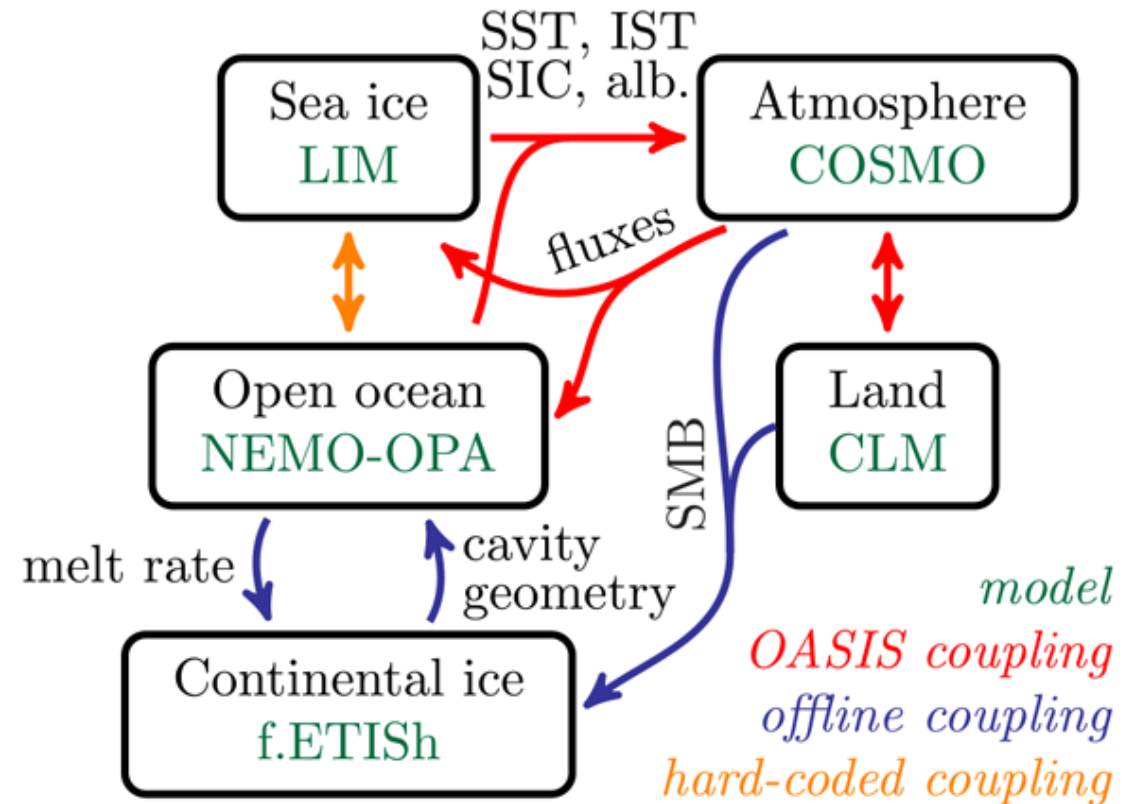
2016-01-10, Large domain, low INP





# Conclusions, Future plans

- Low INP numbers have reasonable results
- Can be forced by ERA-5 directly, requires larger domain size
- Decide on a domain size
- If possible, increase simulation length
- Analyze radiative effects
- PARASO model (long-term)



Graphic source: Pelletier et al., 2022

# References

- Gorodetskaya, I. V., Kneifel, S., Maahn, M., Van Tricht, K., Thiery, W., Schween, J. H., ... & Van Lipzig, N. P. M. (2015). Cloud and precipitation properties from ground-based remote-sensing instruments in East Antarctica. *The Cryosphere*, 9(1), 285-304.
- Seifert, A., & Beheng, K. D. (2006). A two-moment cloud microphysics parameterization for mixed-phase clouds. Part 1: Model description. *Meteorology and atmospheric physics*, 92(1), 45-66.
- Possner, A., Ekman, A. M., & Lohmann, U. (2017). Cloud response and feedback processes in stratiform mixed-phase clouds perturbed by ship exhaust. *Geophysical Research Letters*, 44(4), 1964-1972.
- Souverijns, N. (2019). Precipitation and clouds over Antarctica from an observational and modelling perspective.
- Morrison, H., de Boer, G., Feingold, G. *et al.* Resilience of persistent Arctic mixed-phase clouds. *Nature Geosci* 5, 11–17 (2012).
- Pelletier, C., Fichefet, T., Goosse, H., Haubner, K., Helsen, S., Huot, P. V., ... & Zipf, L. (2021). PARASO, a circum-Antarctic fully-coupled ice-sheet-ocean-sea-ice-atmosphere-land model involving f. ETISH1. 7, NEMO3. 6, LIM3. 6, COSMO5. 0 and CLM4. 5. *Geoscientific Model Development Discussions*, 2021, 1-59.

# End