Simulating and evaluating a weak cold-air outbreak observed during ACLOUD

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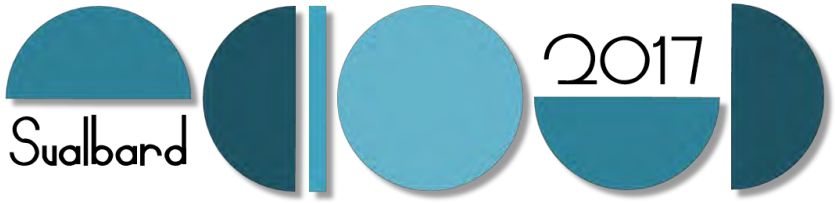
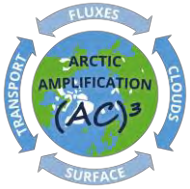




The **ACLOUD** field campaign took place in May – June 2017 in the Fram Strait

Wendisch et al. (BAMS, 2019) doi:10.1175/BAMS-D-18-0072.1

P5 and P6 aircraft stationed at Longyearbyen, Svalbard

Research Flight **RF05** (25 May 2017): Weak cold air outbreak in Fram Strait

P5 instrumentation: MiRAC, Lidar, dropsondes, noseboom sensors (100Hz), …
P6 instrumentation: USHAS, Nevzorov probe, noseboom sensors (100Hz), …

Research question: Can we reproduce the observed cloud streets in a high-resolution simulation that is (partially) based on P5 measurements?

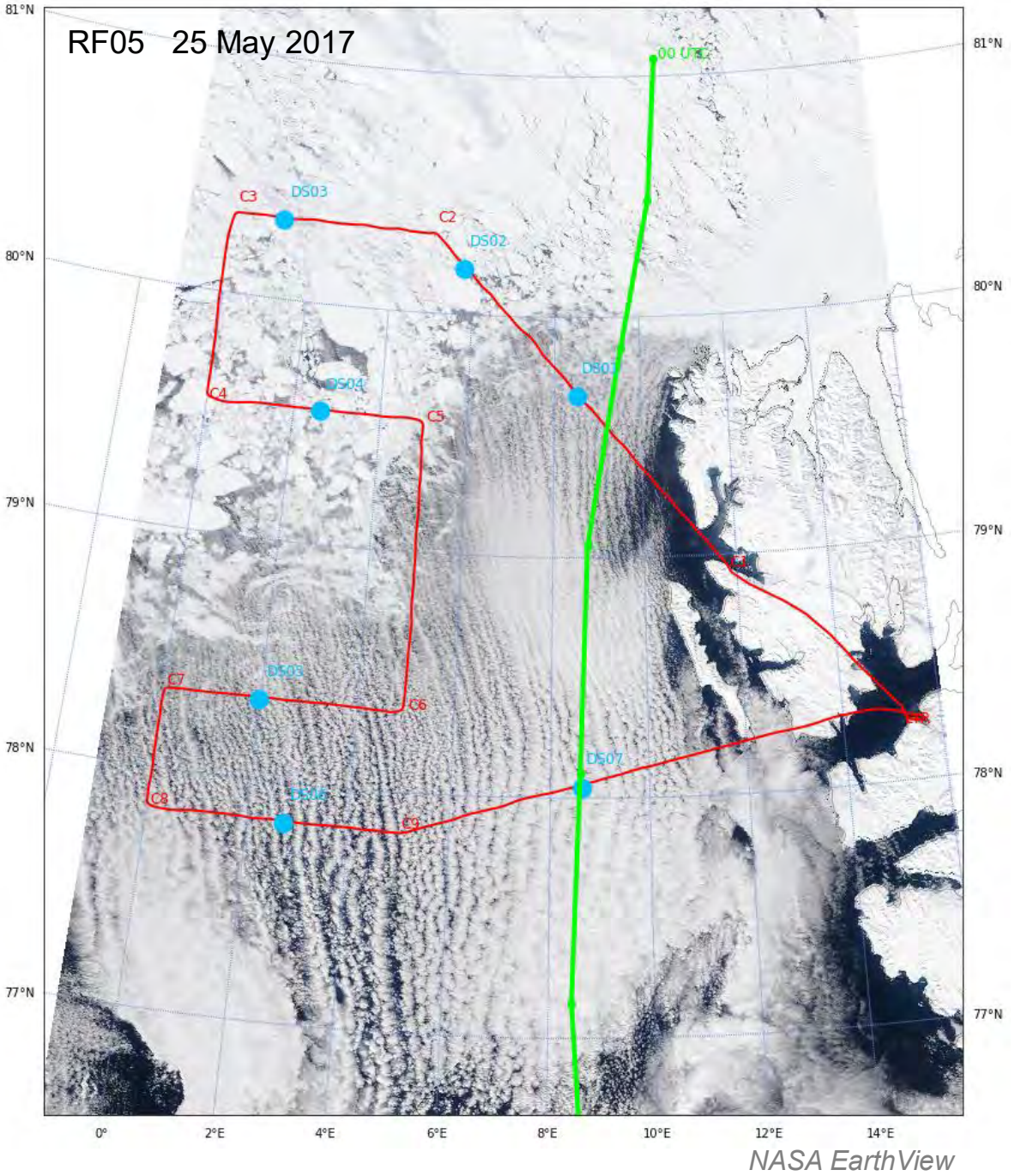
MODIS

Reflectance, true color

Red: P5 flight path including waypoints

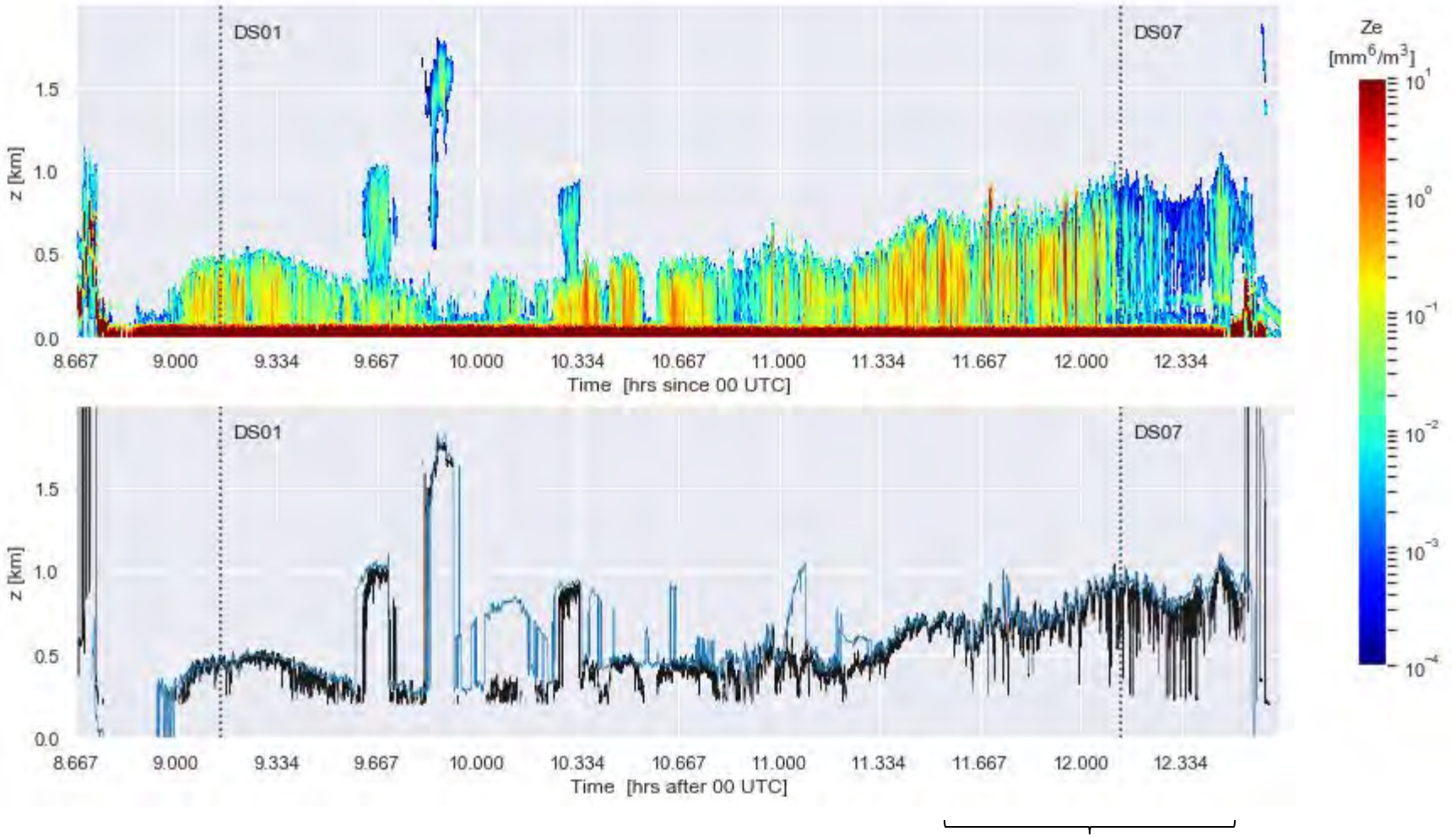
Blue dots: Dropsondes

Green line: 950 hPa back & forward trajectory connecting with DS07



NASA EarthView

MiRAC and Lidar data



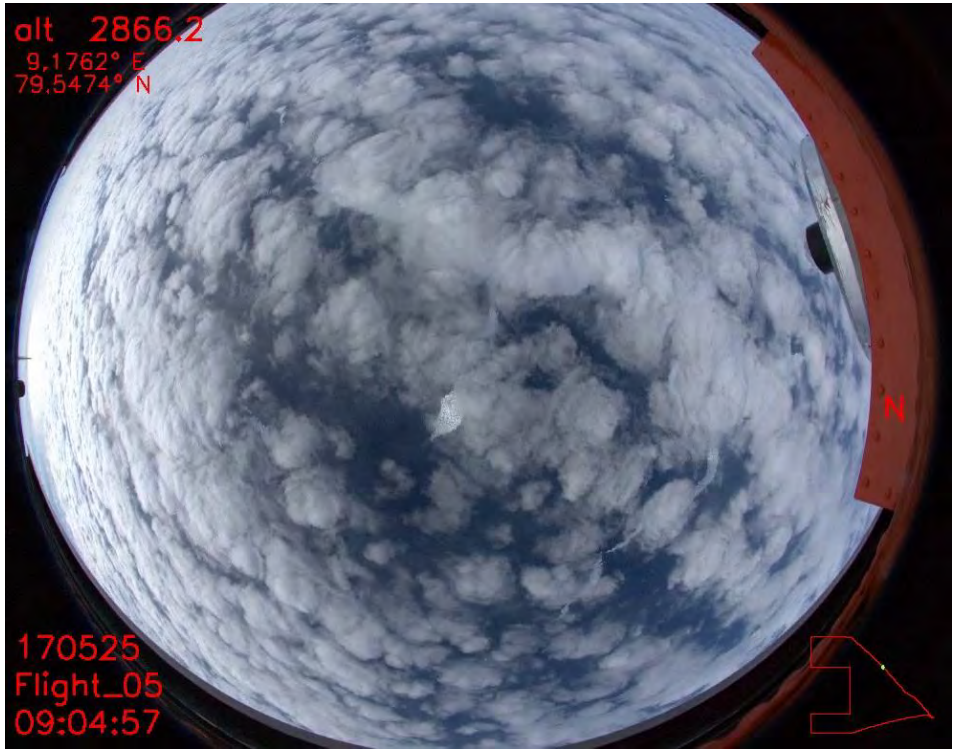
Black: Mirac

Blue: Lidar

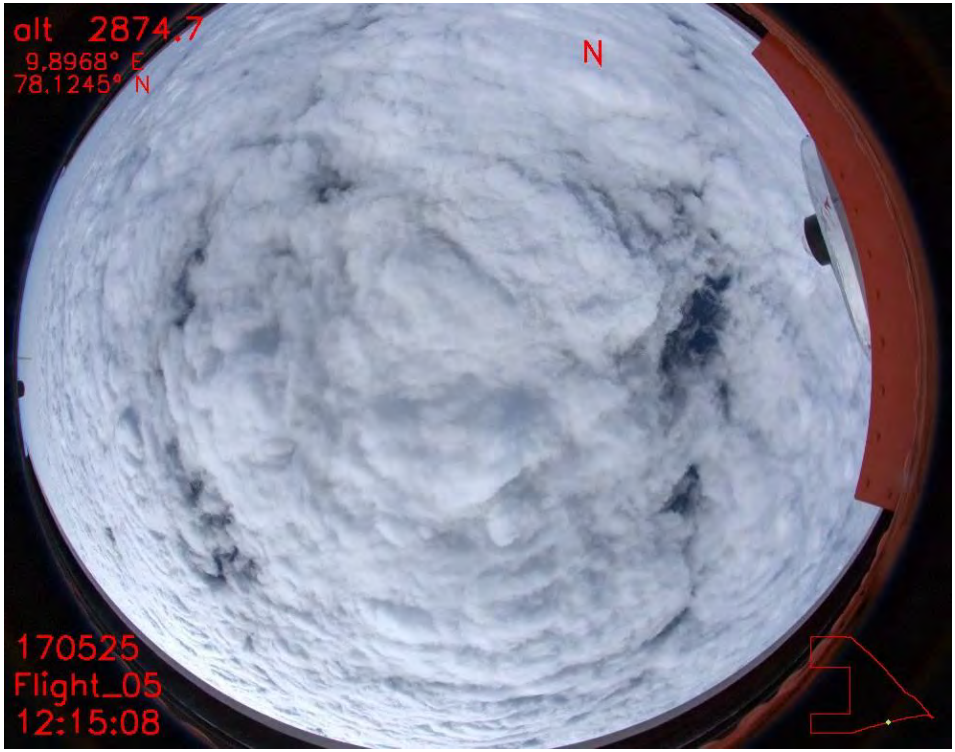
Cloud streets in last flight leg

Canon fisheye camera

DS01



DS07



Experiment configuration

ICON model

- Icosahedral Non-hydrostatic model (Zängl et al., 2014)
- Available simulation modes: Global, NWP, LES (used in this study)
- Double moment mixed phase microphysics (Seifert Beheng)

Four domains at increasing spatial resolution:

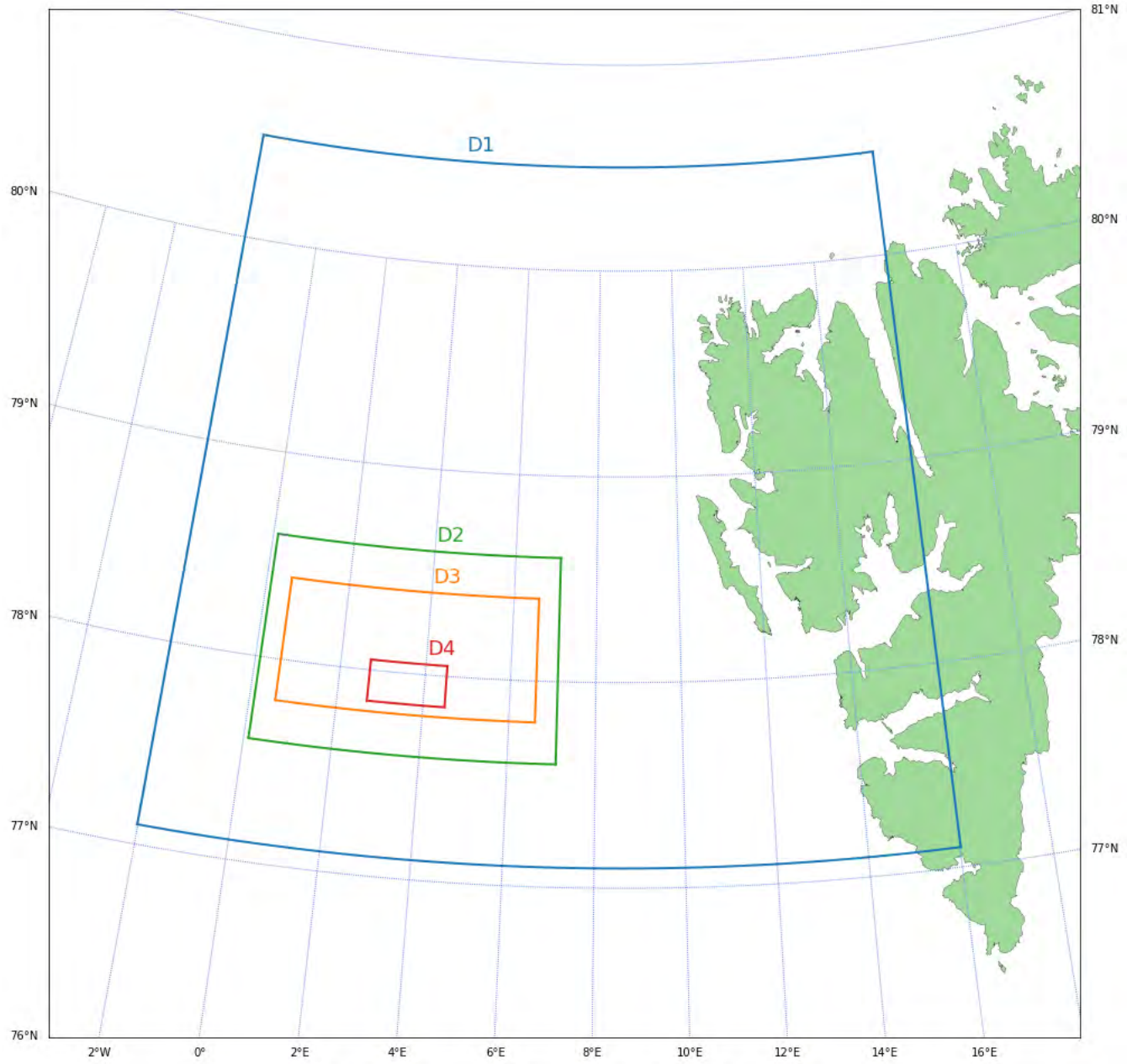
- D1: regional, 600m
- D2: sub-regional, 300m
- D3: local, 150m
- D4: cloud street scale, 75m

4x one-way nesting:

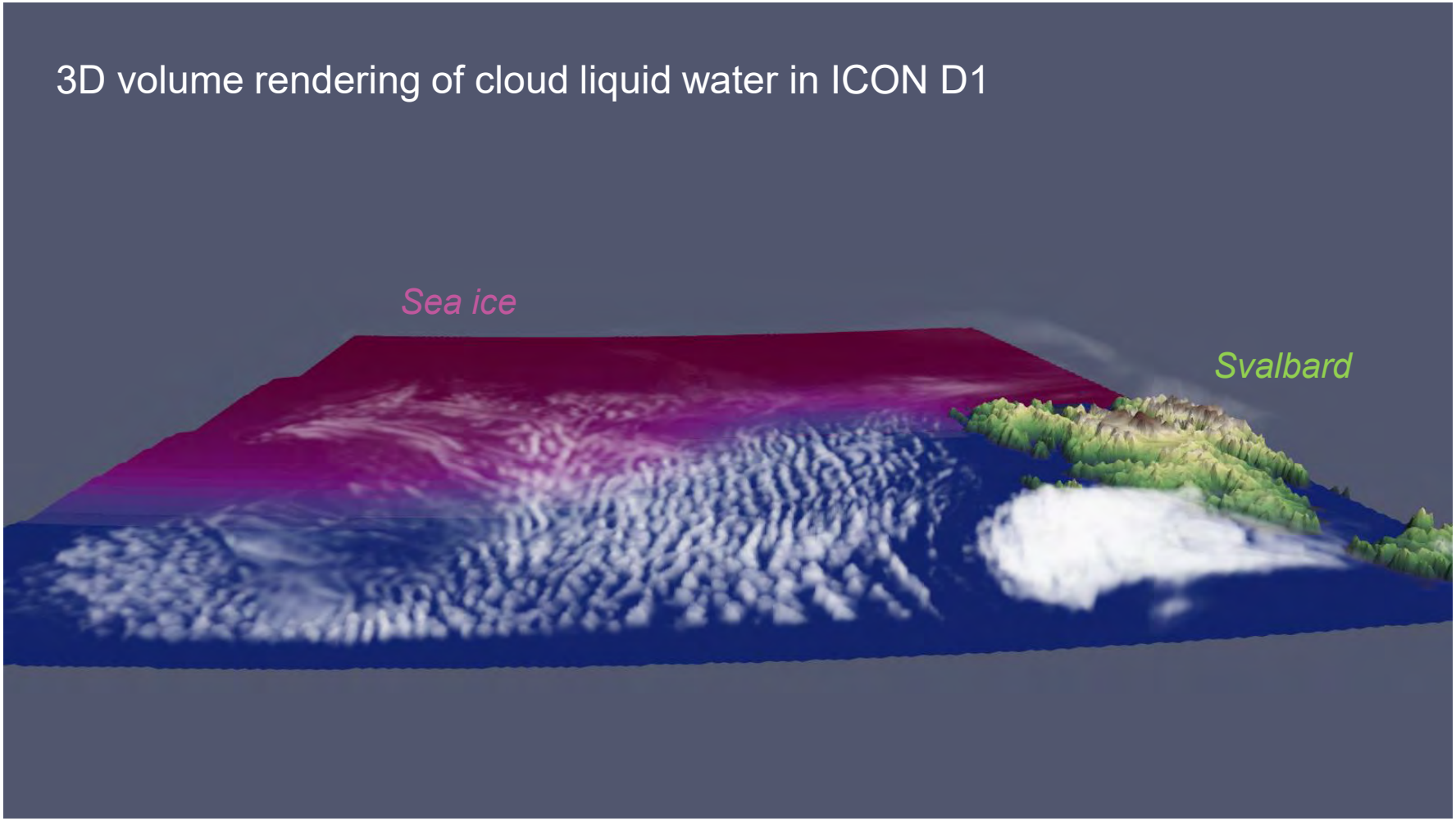
- ECMWF IFS data drives the outer domain D1
- ICON D1 drives D2, D2 drives D3, D3 drives D4

Time-dependent forcing, corrected for biases over the sea ice

Domains



Results


3D volume rendering of cloud liquid water in ICON D1
Sea ice
Svalbard

Forcing adjustments

IFS (like most GCMs) suffers from a “too warm, too deep” bias over the sea ice

This bias flows directly into the nested ICON simulations

Adjustments needed in the initial and boundary conditions over the sea ice (D4):

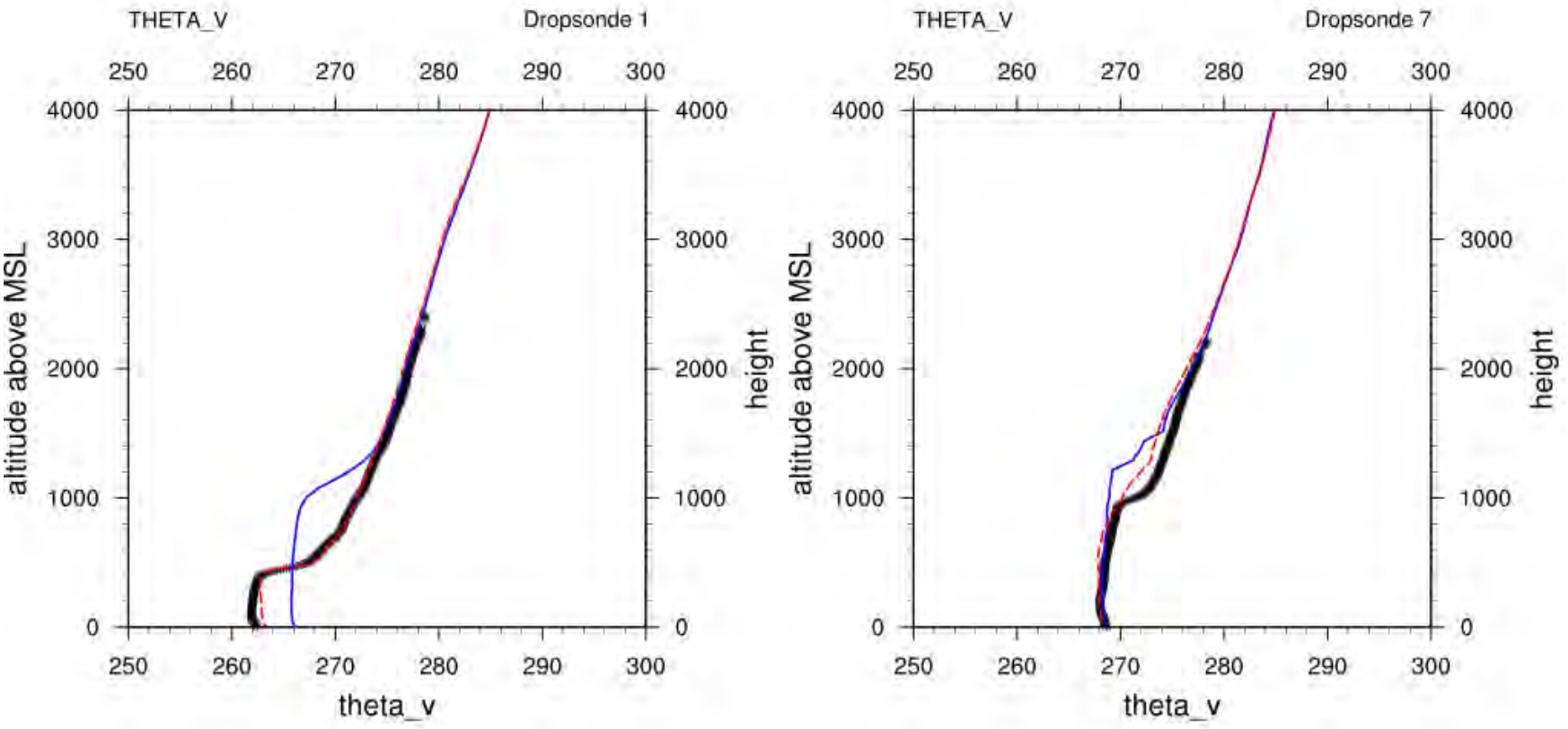
- Inversion is lowered by 500m
- Mixed layer temperature is adjusted by -1K

These values are obtained from a phase-space analysis with small-domain Lagrangian LES simulations along the trajectory intersecting with DS07

Neggers et al. (JAMES, 2019) doi:0.1029/2019MS001671

Dropsondes 01 (near ice edge) and 07 (target area) are used for calibration

Evaluation against dropsondes

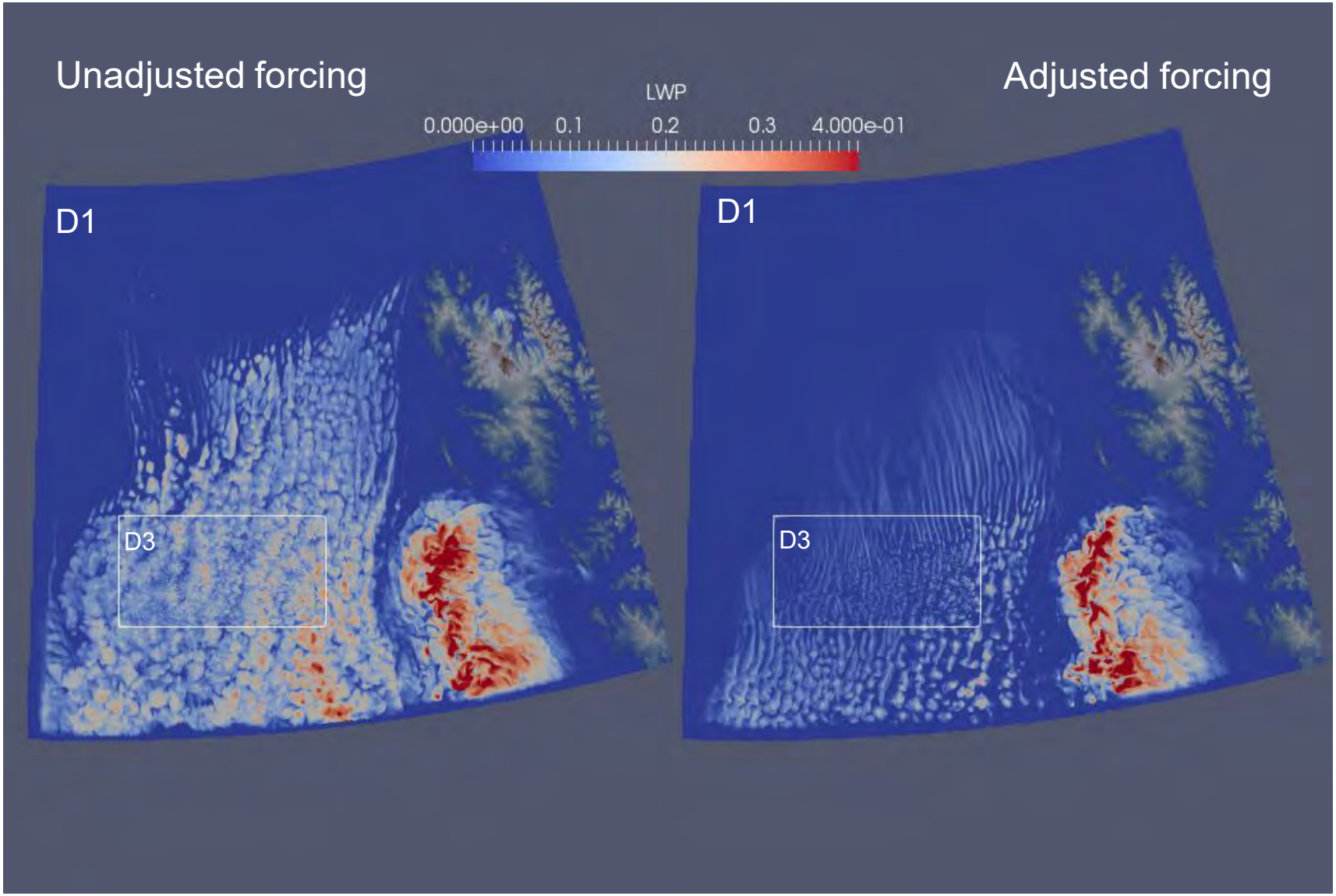


Blue: Unadjusted

Red: Adjusted

Black: Dropsonde data

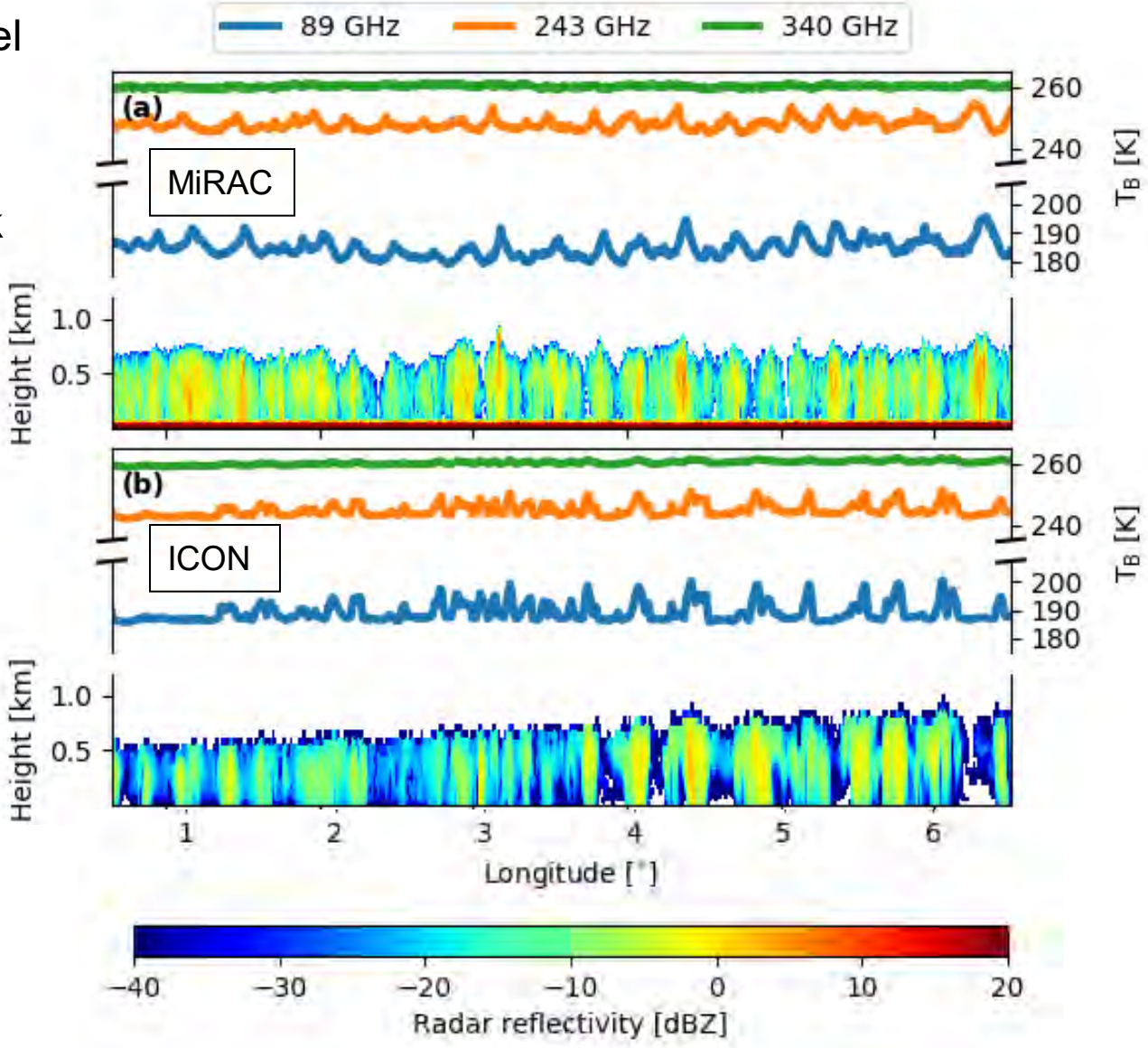
Impacts on cloud streets



Evaluation against MiRAC

PAMTRA forward model

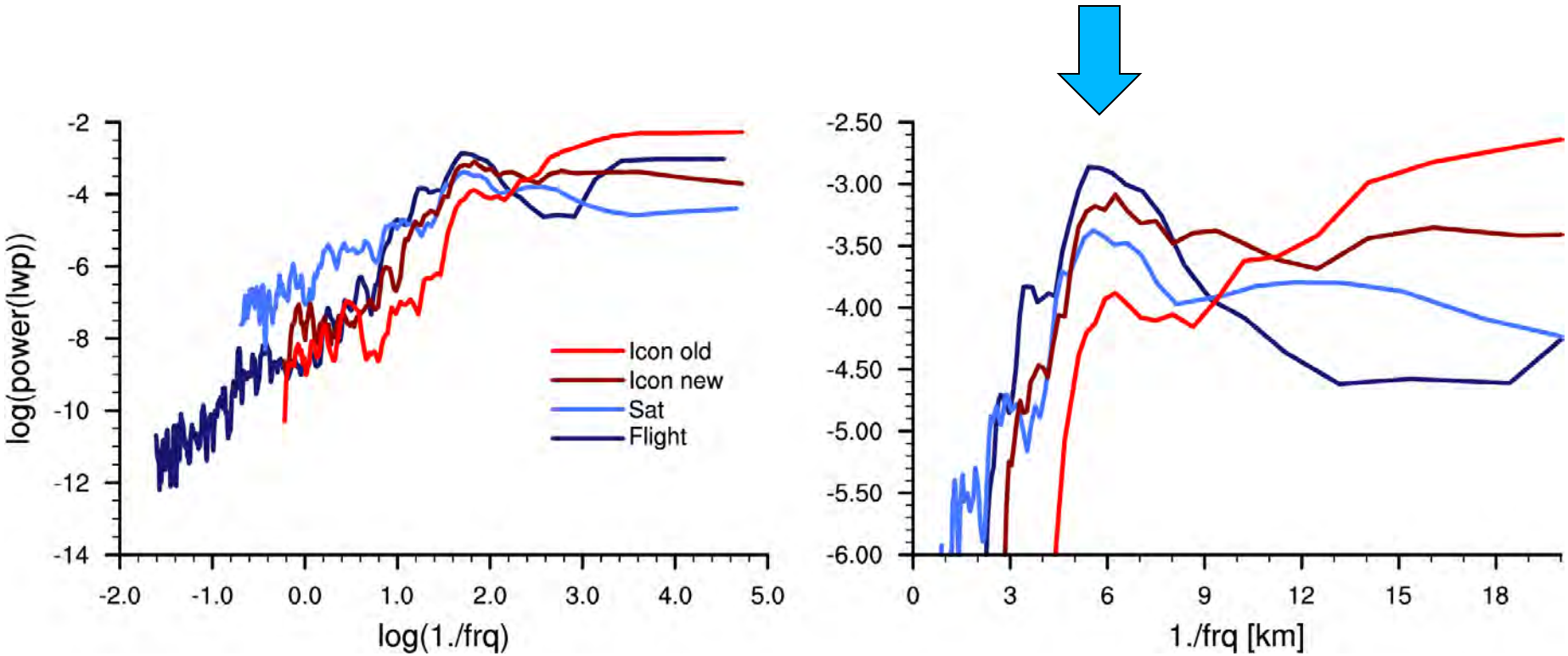
Applied to model data
along virtual flight track



Mech et al., submitted to GMD,
doi:10.5194/gmd-2019-356

Spectral evaluation of cloud streets

Power spectra based data along the last flight leg



Sat: MODIS reflectance (250m)

Conclusions

We configured a nested simulation with ICON-LEM of an observed CAO

Adjustments of the forcings were necessary to obtain realistic cloud streets

A forward model and a spectral analysis were useful for confronting simulated cloud macrophysics with observations

Outlook

To do's:

- Finish evaluation of D3 and D4 simulations
- Interpret impacts of resolution on the cloud macrophysical structure
- Introduce heterogeneity in the sea ice?

Paper in preparation about the case configuration & evaluation

Outlook: configure ICON-LEM for COMBLE cases