Airborne Validation of Cloud Spatial Properties from the ATLID Instrument on EarthCARE

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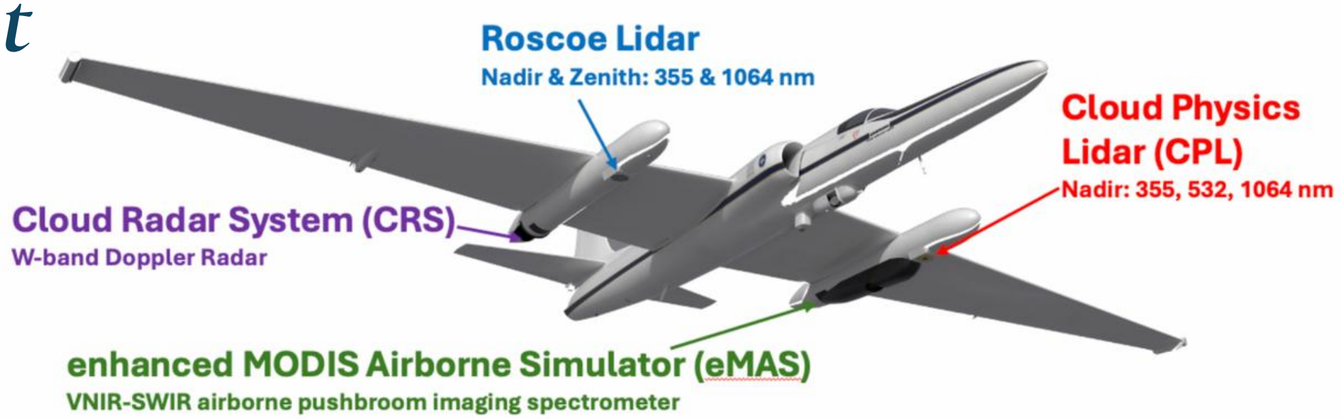
The GSFC Lidar Observation and Validation Experiment (GLOVE) field campaign



Campaign's details:

- **When:** 27 Jan to 28 Feb, 2025.
- **Where:** Edwards Air Force Base, **California**.
- **Objectives:** (1) validate new ICESAT-2 atmospheric products and (2) **validate EarthCARE lidar,** radar, and spectrometer products.
- The campaign used NASA's ER-2 aircraft that flew at 20 km, equipped with **two lidars, a radar, and a spectrometer.**

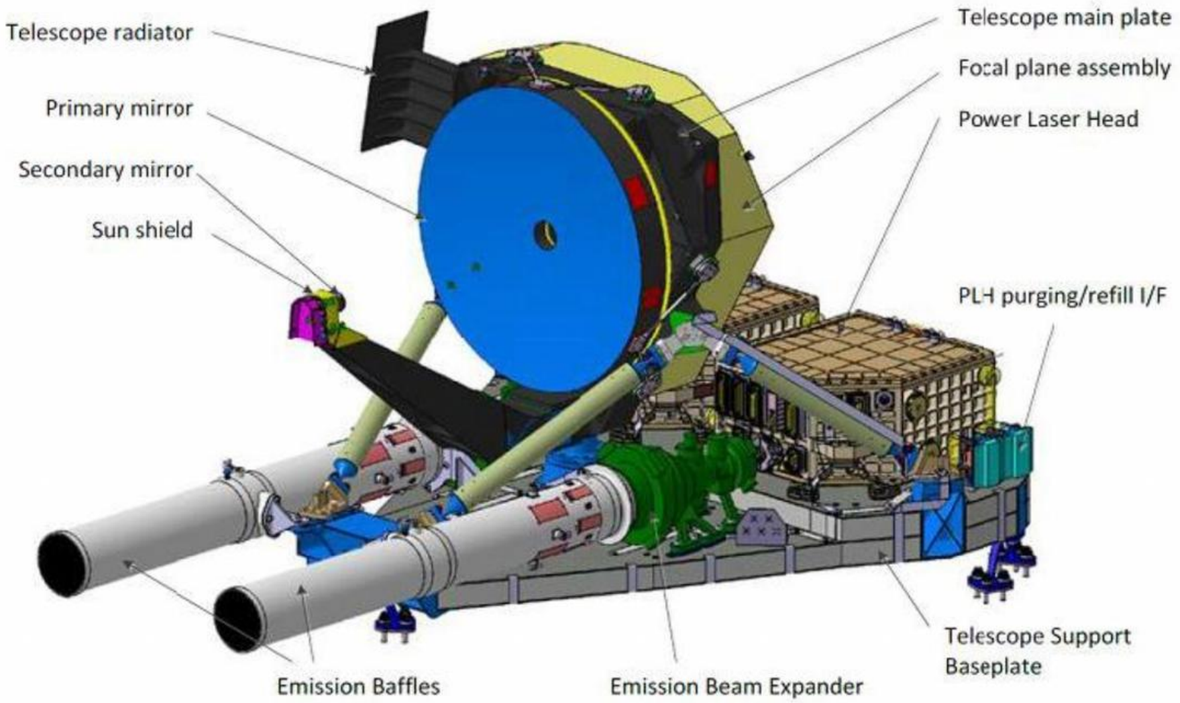
Our goal with this investigation

Validate the cloud geometrical properties (cloud top and base heights) retrieved by the ATLID instrument:

Datasets:

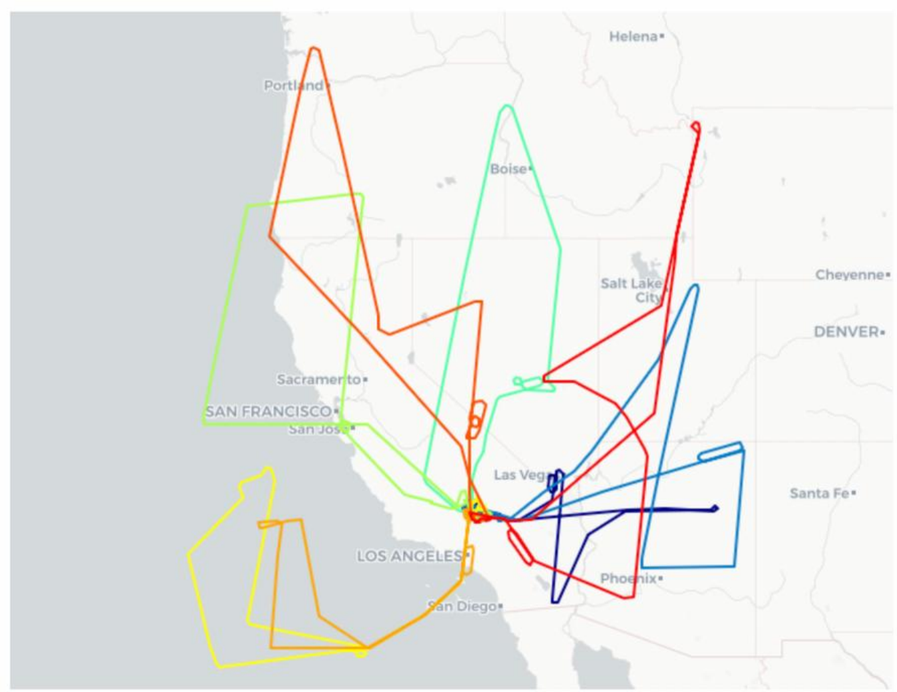
- **EarthCARE:** A-TC product with baseline BA, classification variable.
- **GLOVE:** CPL level 2 feature mask, profile product.

We computed cloud tops and bases directly from this product.



Methodology

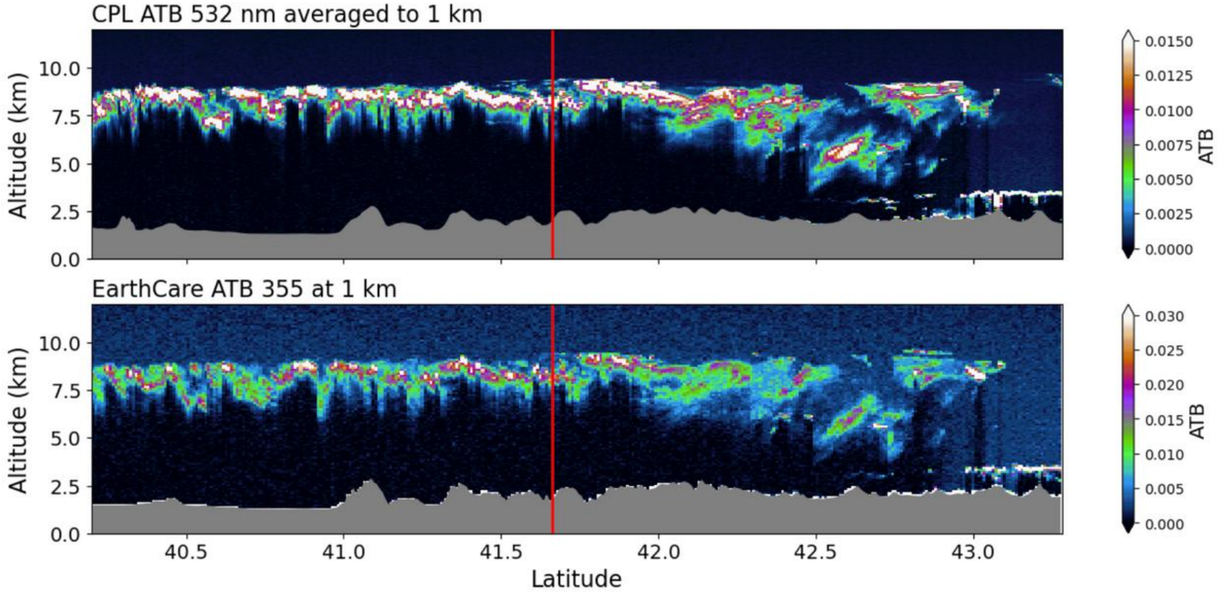
Glove conducted 8 flights (daytime only) with a total of **six EarthCARE underflight segments**. We divided the cloud cases between **homogeneous and heterogeneous clouds**

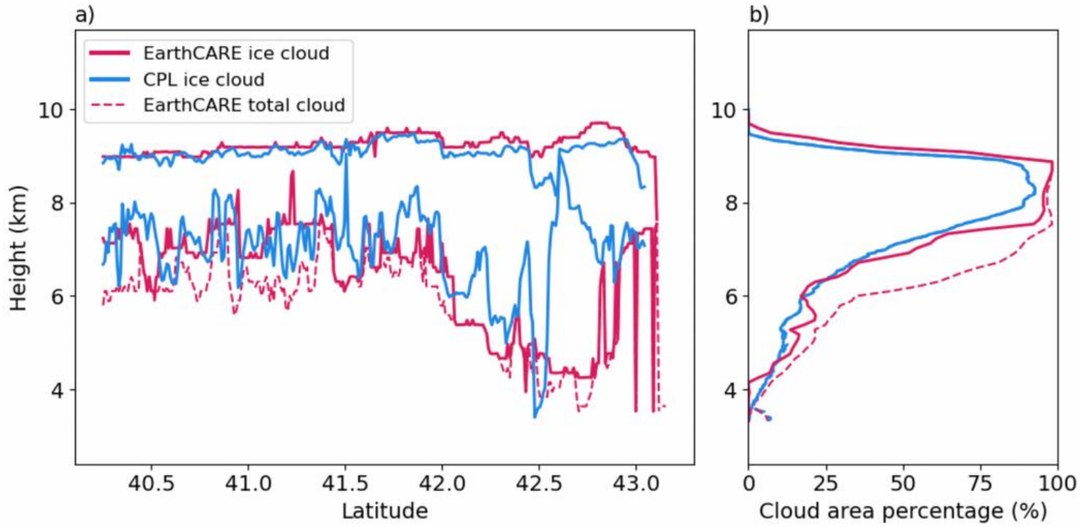


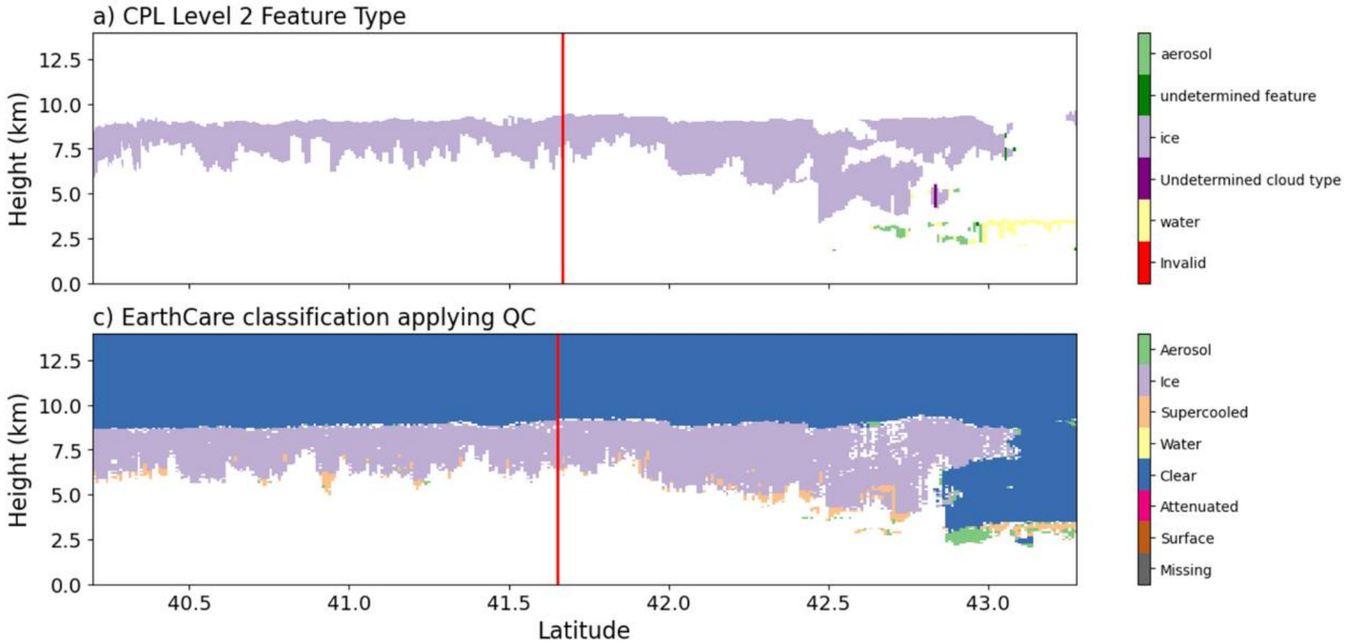
We selected 9 cloud cases,
6 homogeneous and 3 heterogeneous.

Date	Homo	Hetero	Phase
2/4/2025	X		Ice
2/7/2025		X	Ice
2/10/2025		X	Ice
2/12/2025	X		Warm
2/12/2025	X		Supercooled
2/19/2025	X		Warm
2/19/2025	X		Ice
2/19/2025		X	Ice
2/20/2025	X		Ice

Case study homogeneous cloud: February 20

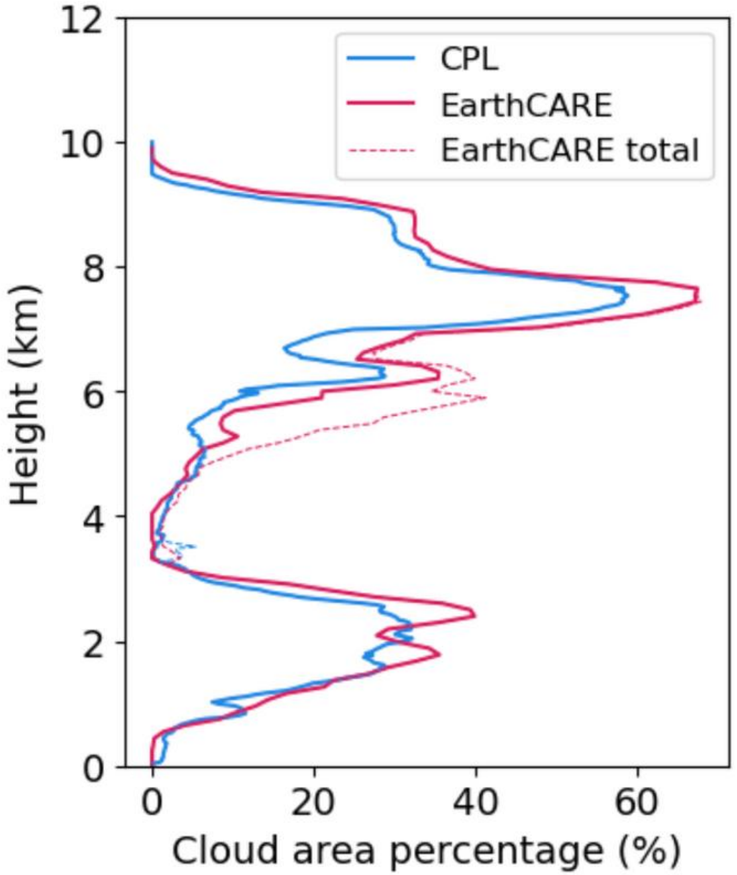


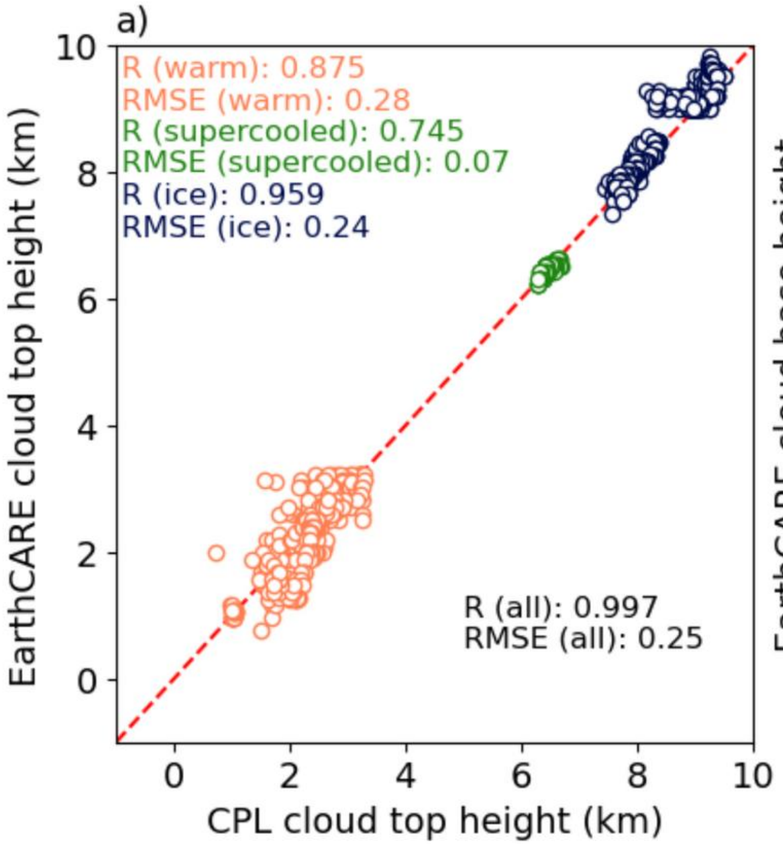


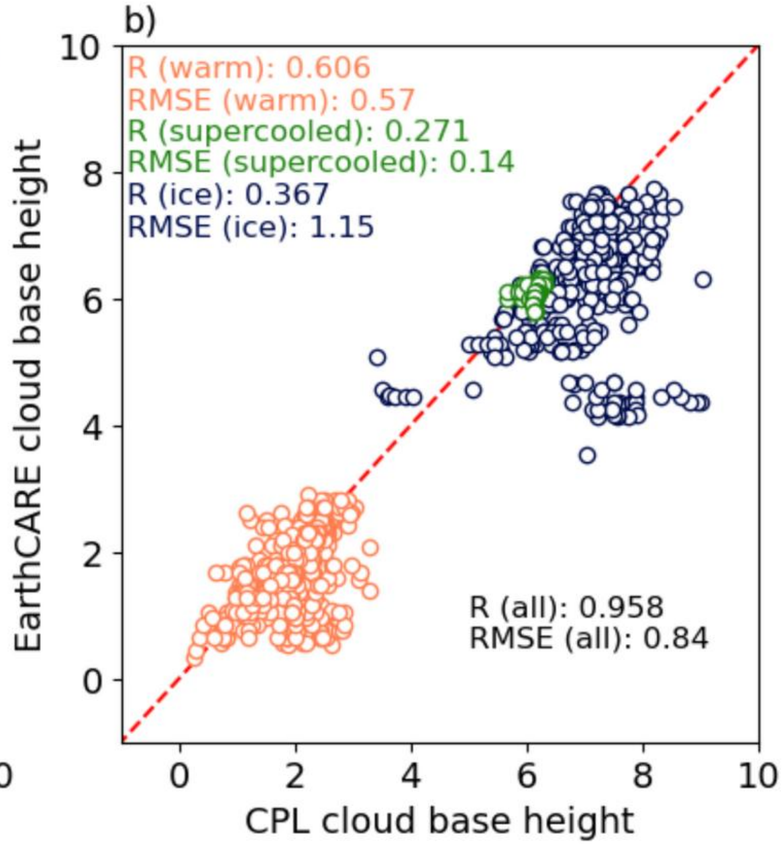


- The smoothing process in the EarthCARE processing fill the gap between clouds
- The total cloudy area observed by EarthCARE is bigger tan CPL.

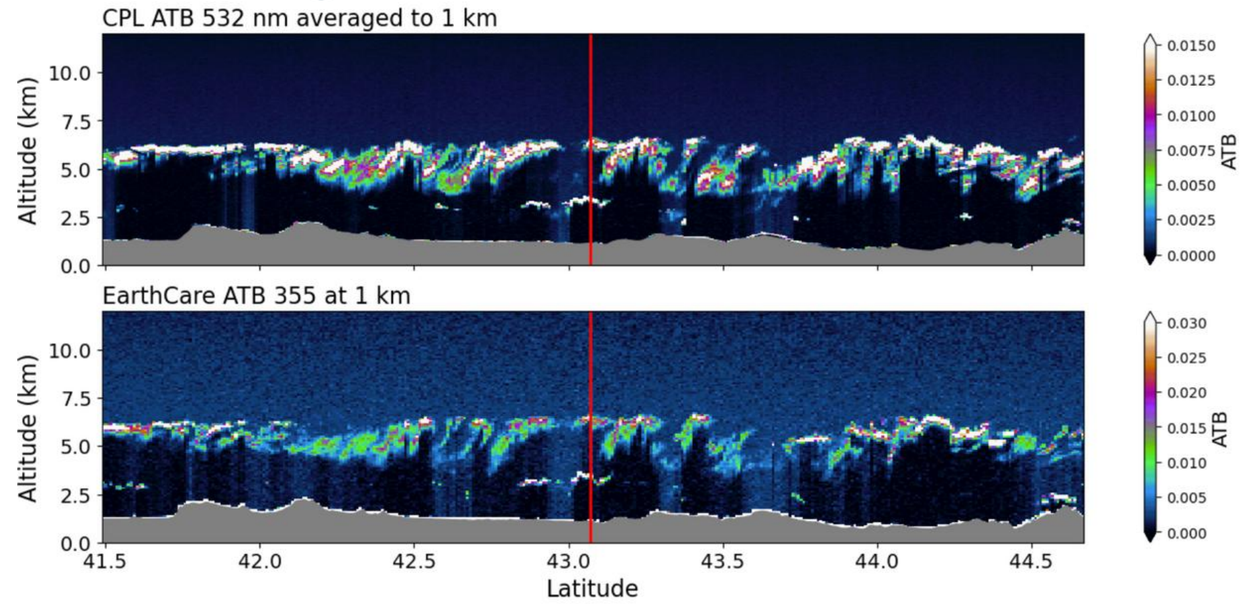
Overall homogeneous clouds show a good agreement

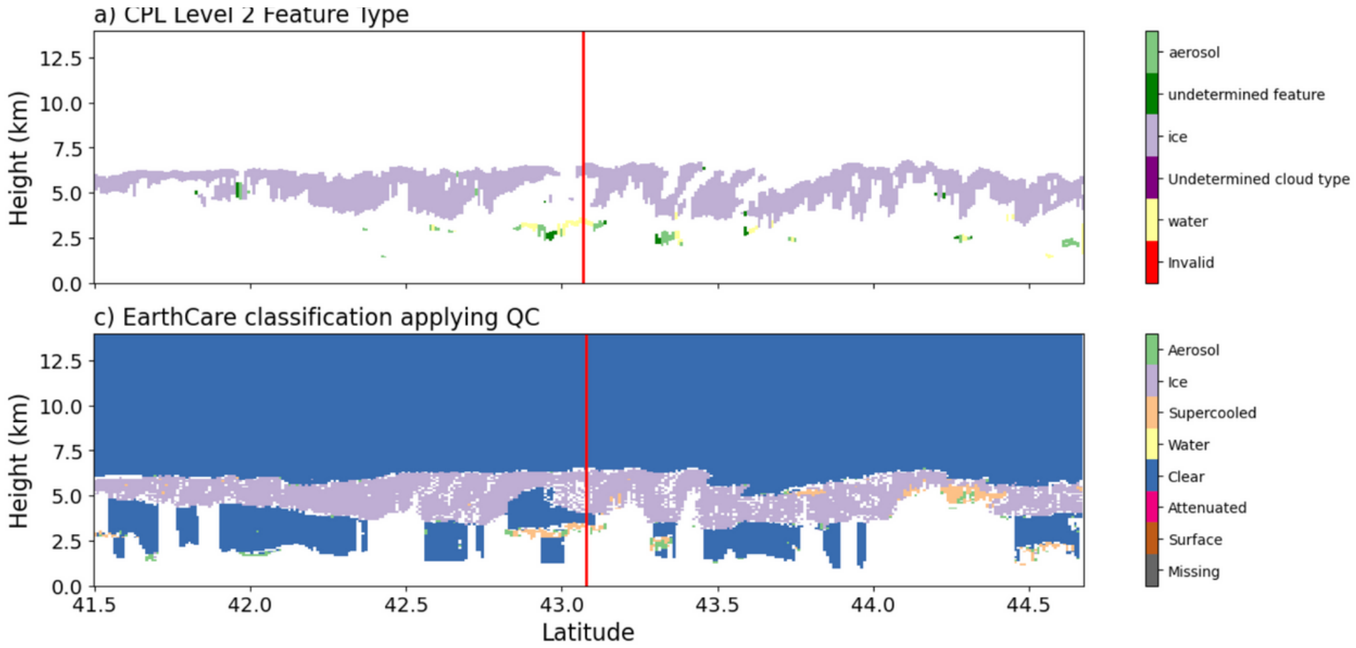


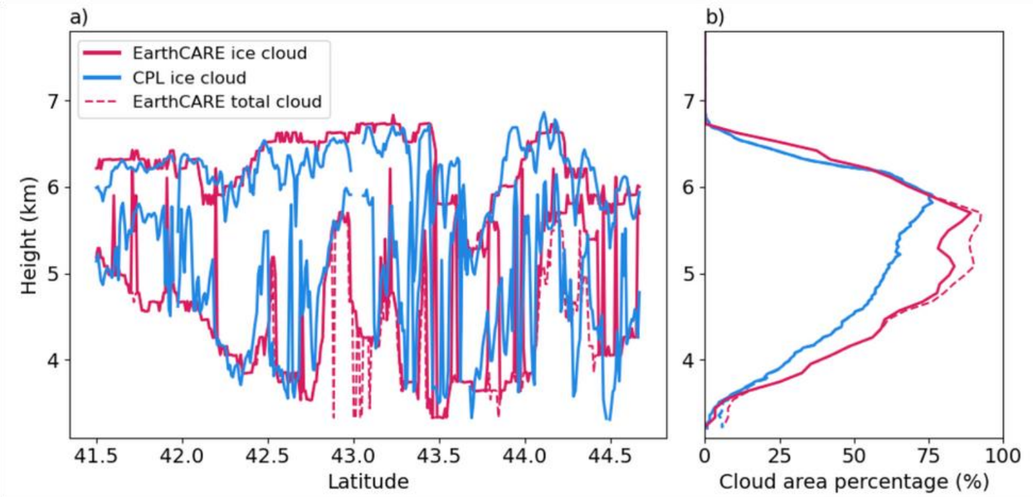




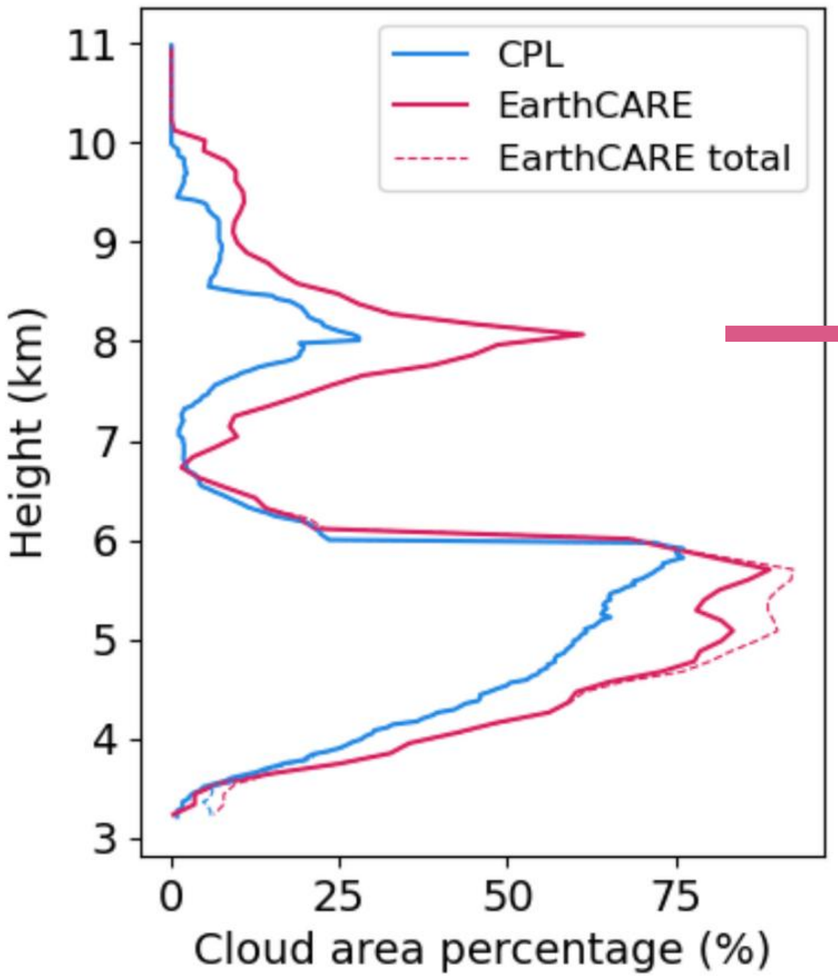
Heterogeneous Clouds: February 7th







- The smoothing process in the EarthCARE processing expand the cloud signal.
- EarthCARE show lower bases: posible multiple scattering

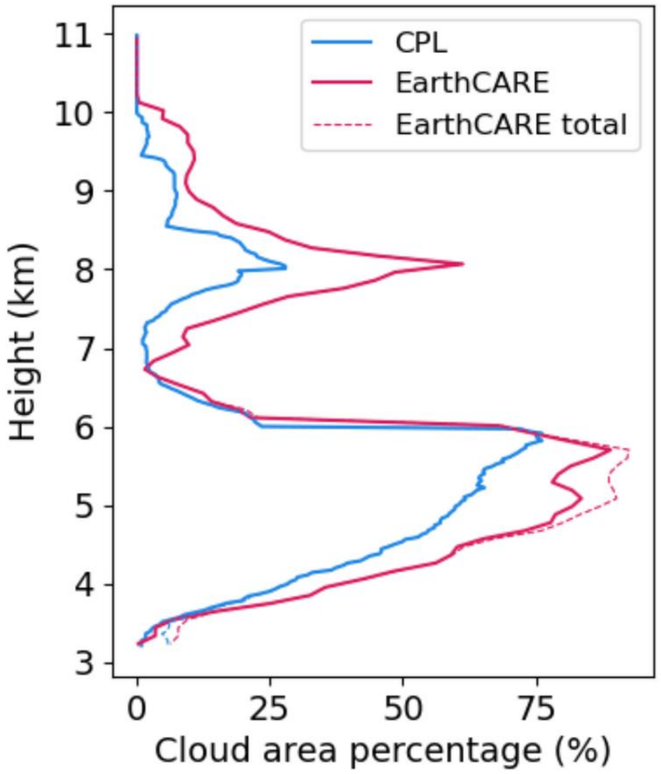


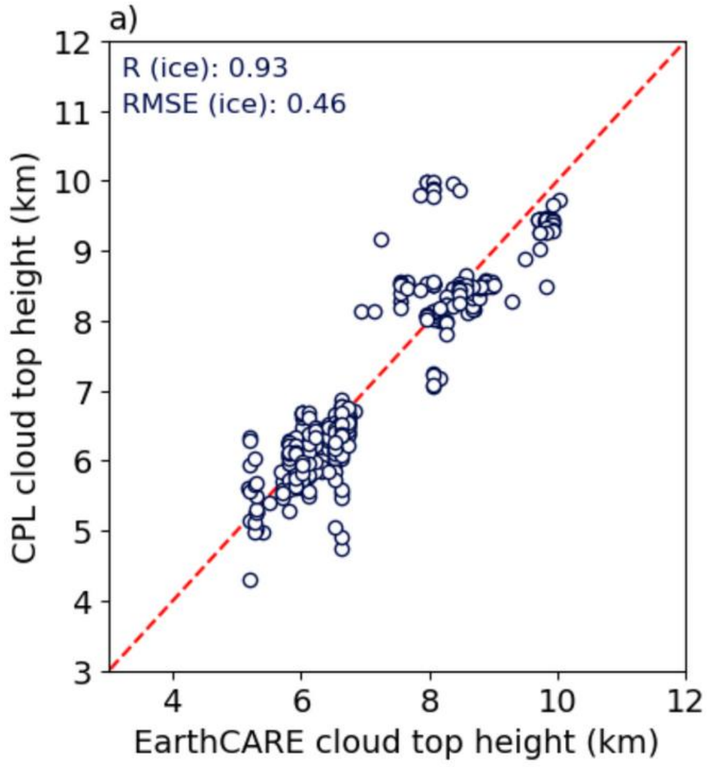
20 to 30% more cloud area for heterogeneous clouds showed by EarthCare

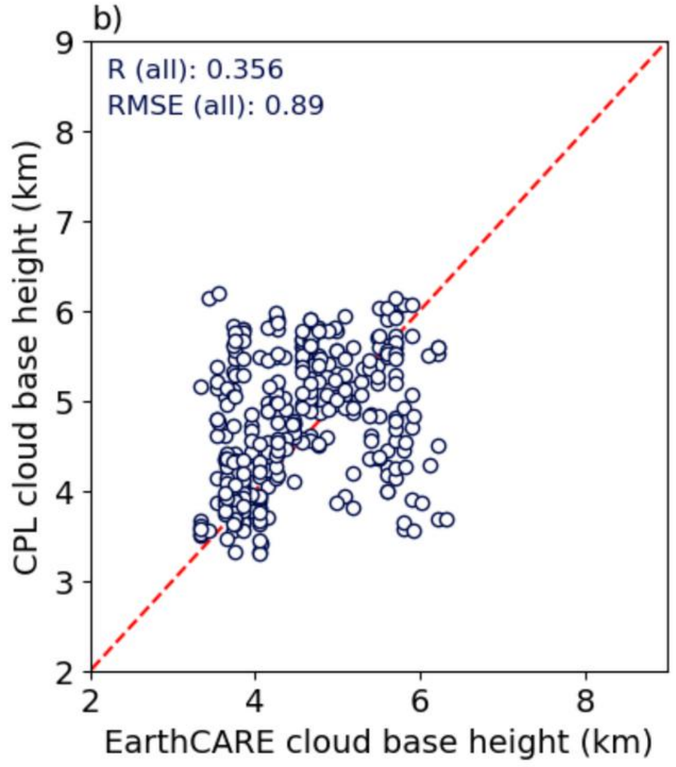
February 19 + February 10
(smoothing process for weak signals)

February 7
(multiple scattering)

20 to 30% more cloud area percentage for heterogeneous clouds showed by EarthCARE







Summary

- For homogeneous clouds, ATLID and aircraft observations showed excellent agreement. Correlations for cloud tops exceeded 0.7 for all individual cloud features and reached 0.99 when all clouds were combined
- For heterogeneous clouds, ATLID showed a weaker performance, with cloud area overestimated by 20–30%. The main sources of error were multiple scattering and ATLID's smoothing process to increase the signal-to-noise ratio (SNR).

Future Work:

Compute EarthCARE extinction thresholds that improve the identification of cloud features.

Thank you

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