Comparison Between Arctic and Antarctic Cloud Morphology, Thermodynamic Phase, and Inversion Coupling Properties

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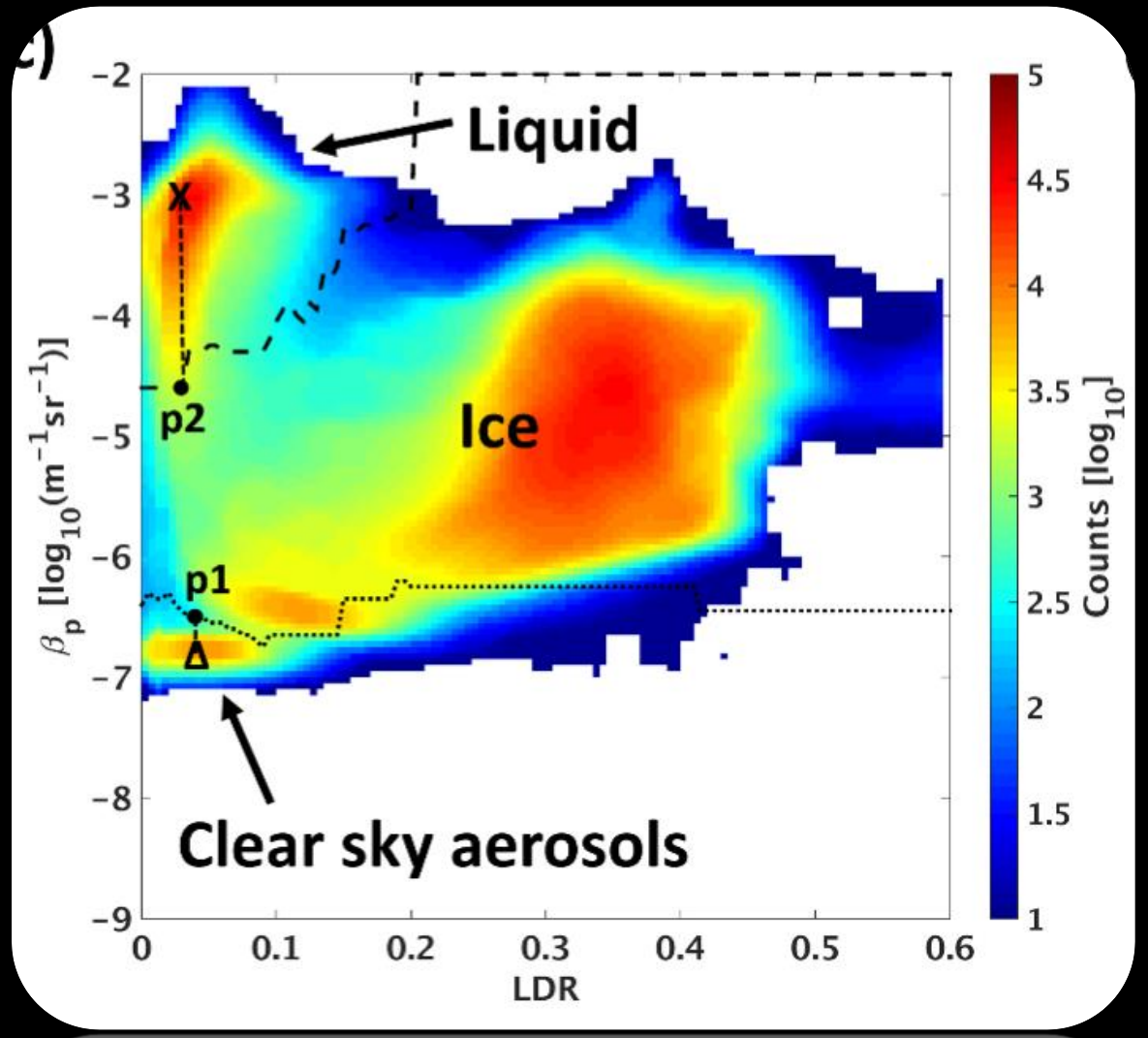
Background

- Polar clouds impact the surface and atmospheric energy balance.
- Studies performed in the Arctic show distinct cloud properties.
- Are these properties the same over Antarctica?
- Comparison between annual data from Barrow (2015) and McMurdo (2016, as part of the ARM AWARE campaign) is presented.

Methodology

- Utilization of (mainly) the Ka-band ARM zenith radar (KAZR) and the high-spectral resolution lidar (HSRL) data, together with sounding, microwave radiometer (MWR), and ceilometer data.
- Generate a KAZR cloud mask (unknown phase) using the moderate sensitivity (MD) and general (GE) modes.
- Generate a HSRL cloud mask which includes water phase classification based on median-filtered monthly linear depolarization ratio (LDR) vs. particulate backscatter cross-section (β_p) histograms.
- Complementary analysis steps (gridding, filtering, etc.).



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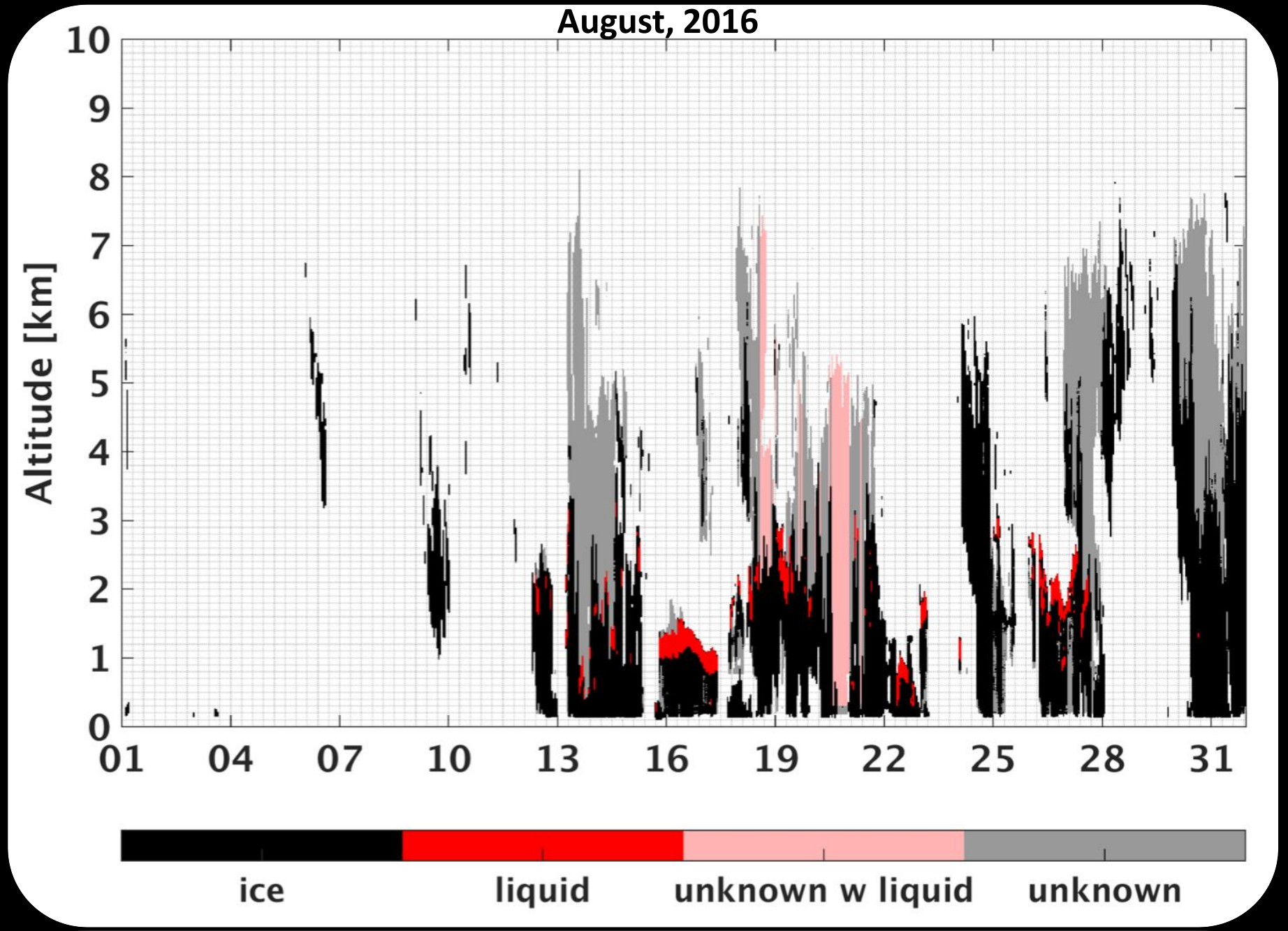
Resolved cloud mask



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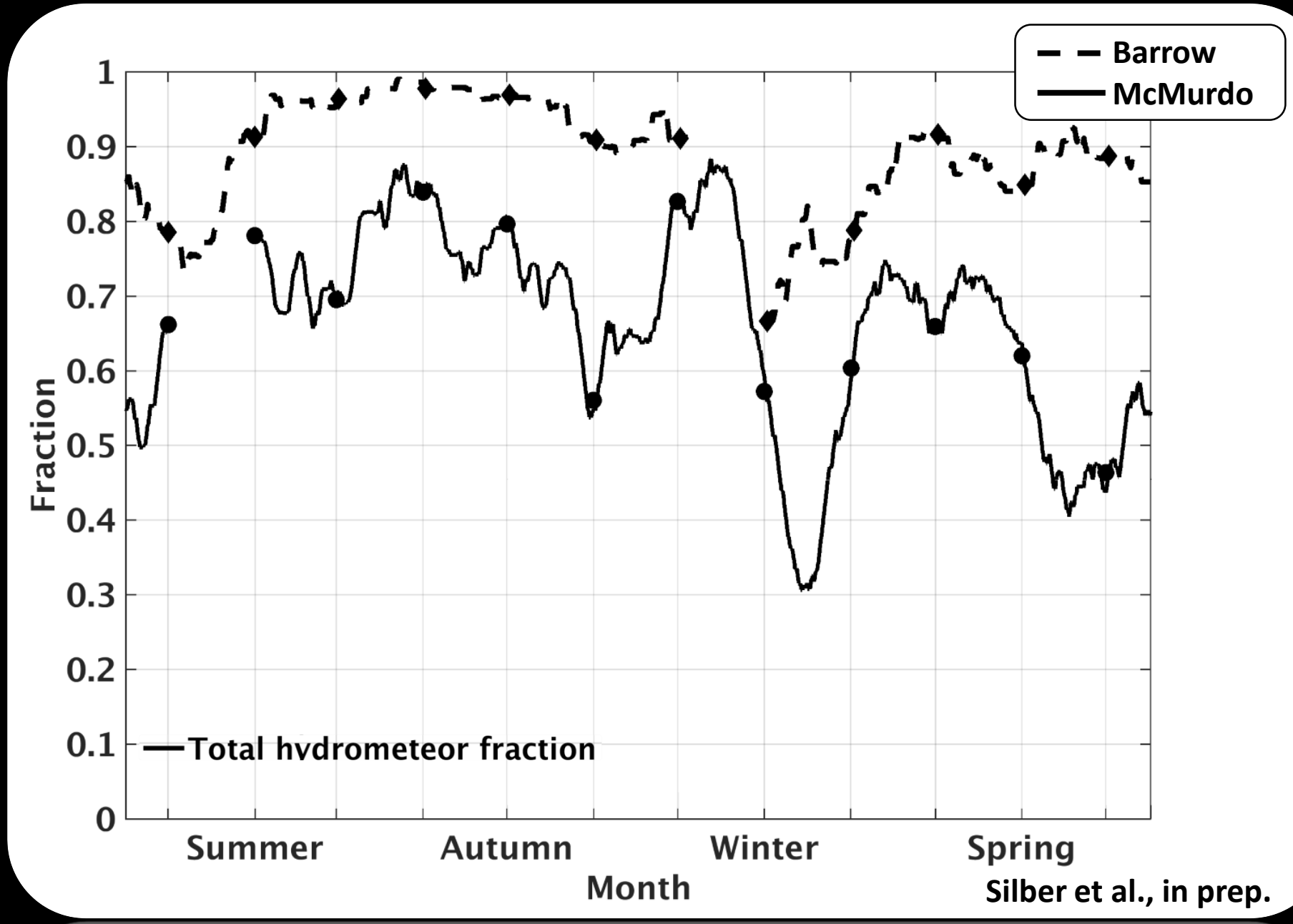
30-day running mean occurrence fractions

- The annual hydrometeor occurrence fraction at Barrow is less variable, but ~20% higher relative to McMurdo.



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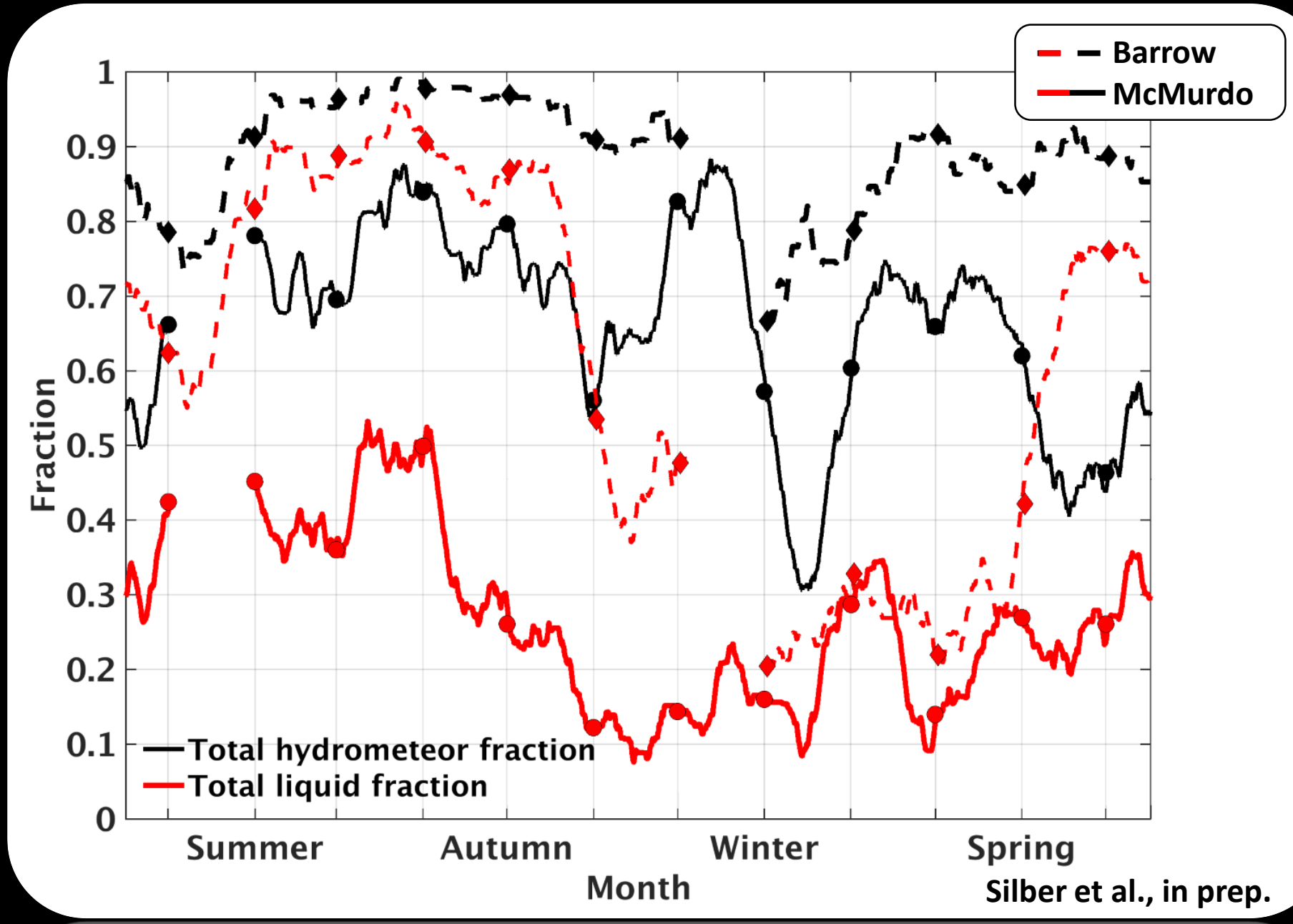
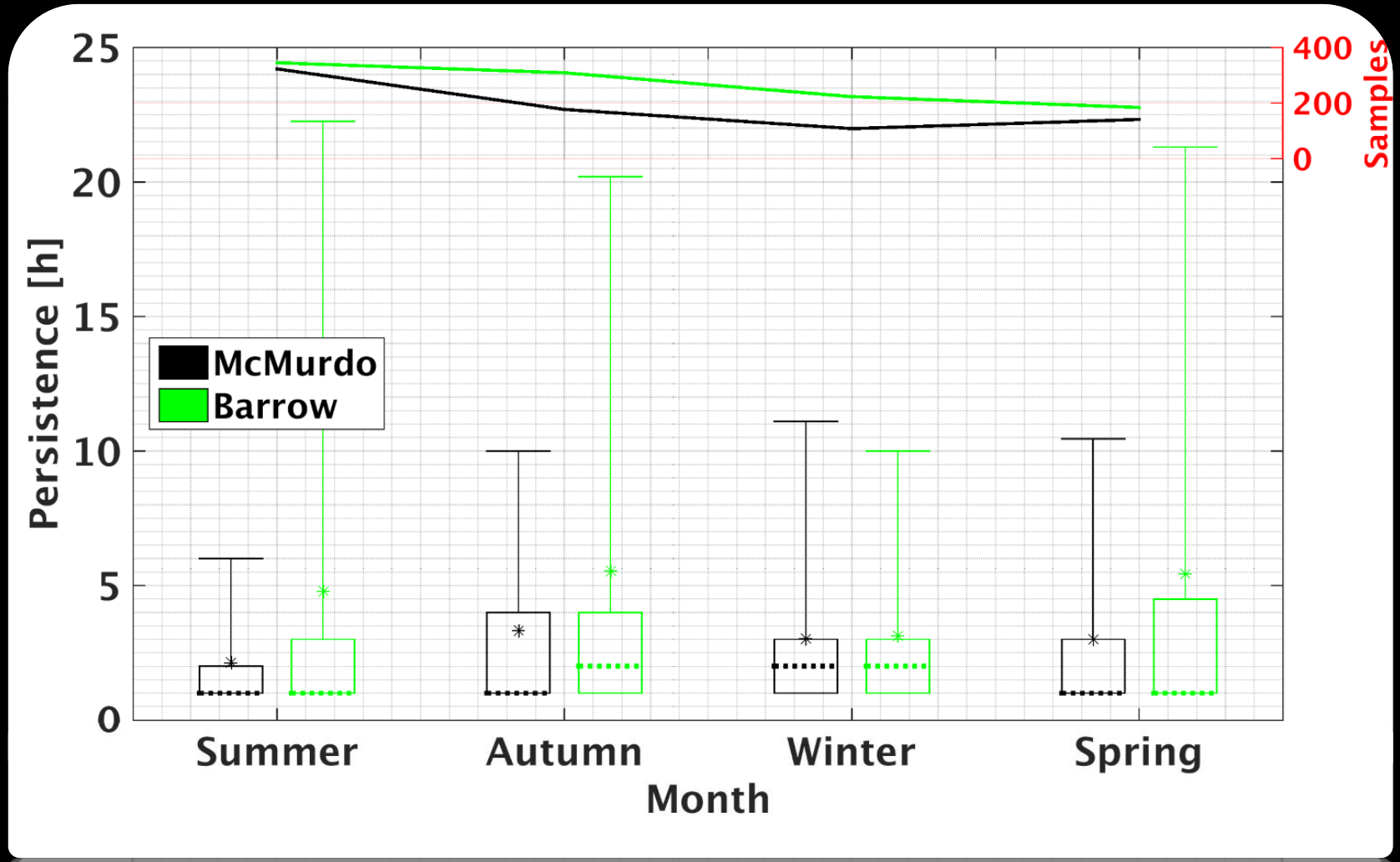
30-day running mean occurrence fractions

- The annual hydrometeor occurrence fraction at Barrow is less variable, but ~20% higher relative to McMurdo.
- The annual liquid occurrence fraction is more variable and ~31% higher at Barrow relative to McMurdo.



Liquid-bearing cloud layer persistence

- Different seasonal patterns.
- On an annual scale, liquid-cloud layers are significantly more persistent at Barrow than McMurdo.



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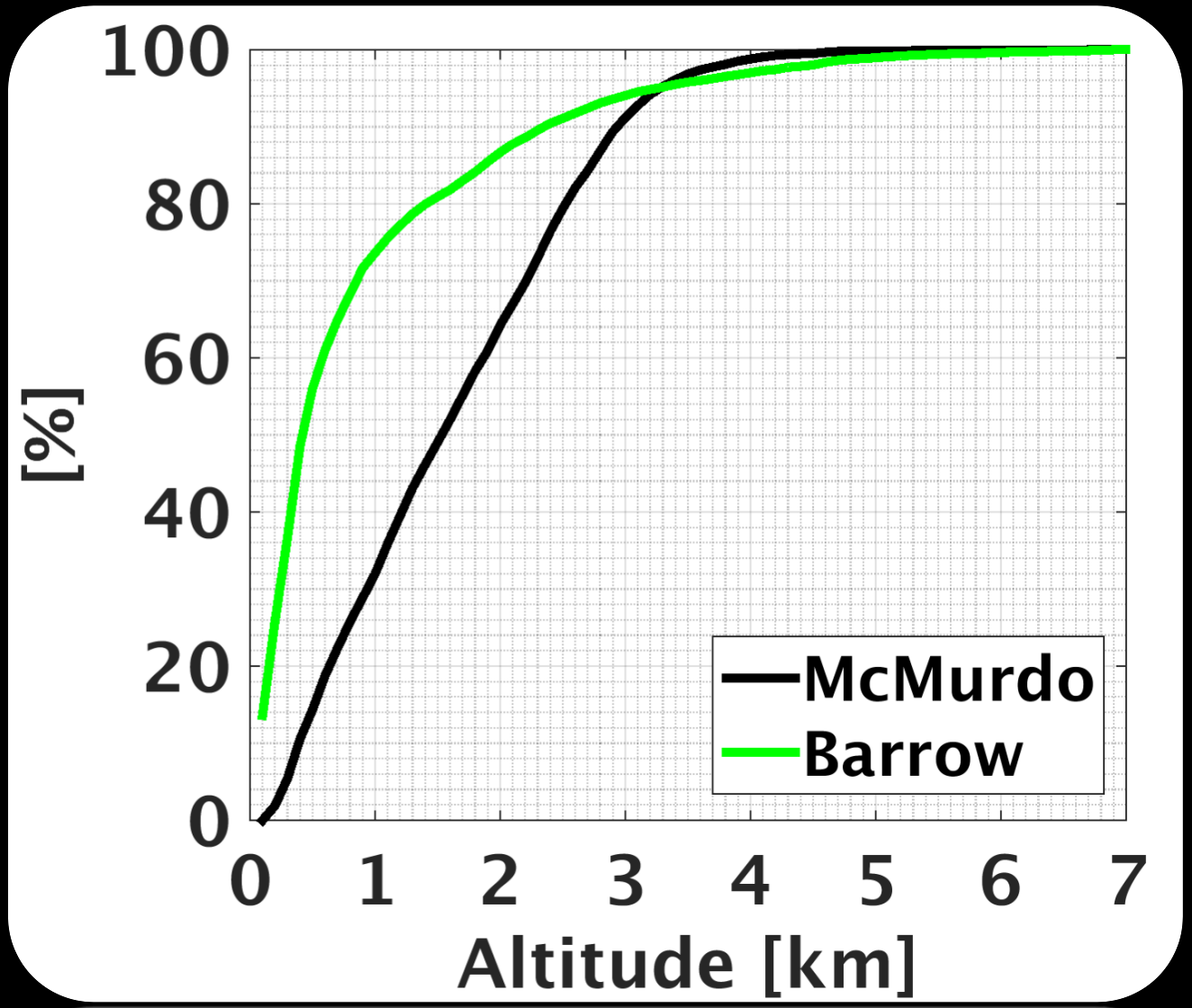
lowest liquid-bearing cloud layer base height CDF

- The lowest liquid-bearing cloud layer base is evenly distributed up to ~3 km at McMurdo.
- Liquid-bearing cloud layers are concentrated near the surface at Barrow.
- Liquid-bearing cloud layers are detected at higher altitude over Barrow (due to typically higher temperatures in the atmospheric profile).



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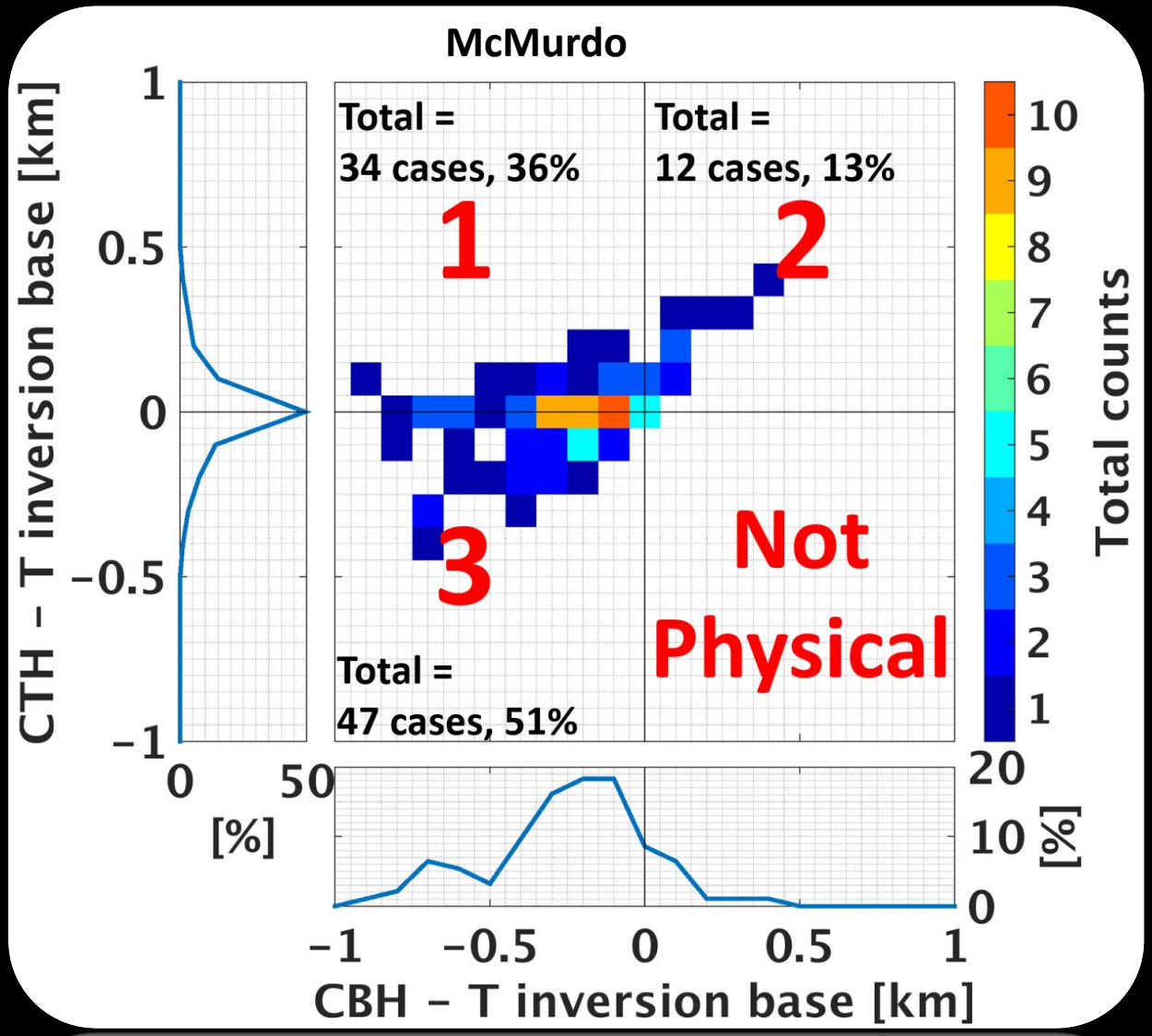
Cloud boundaries relative to temperature inversion base



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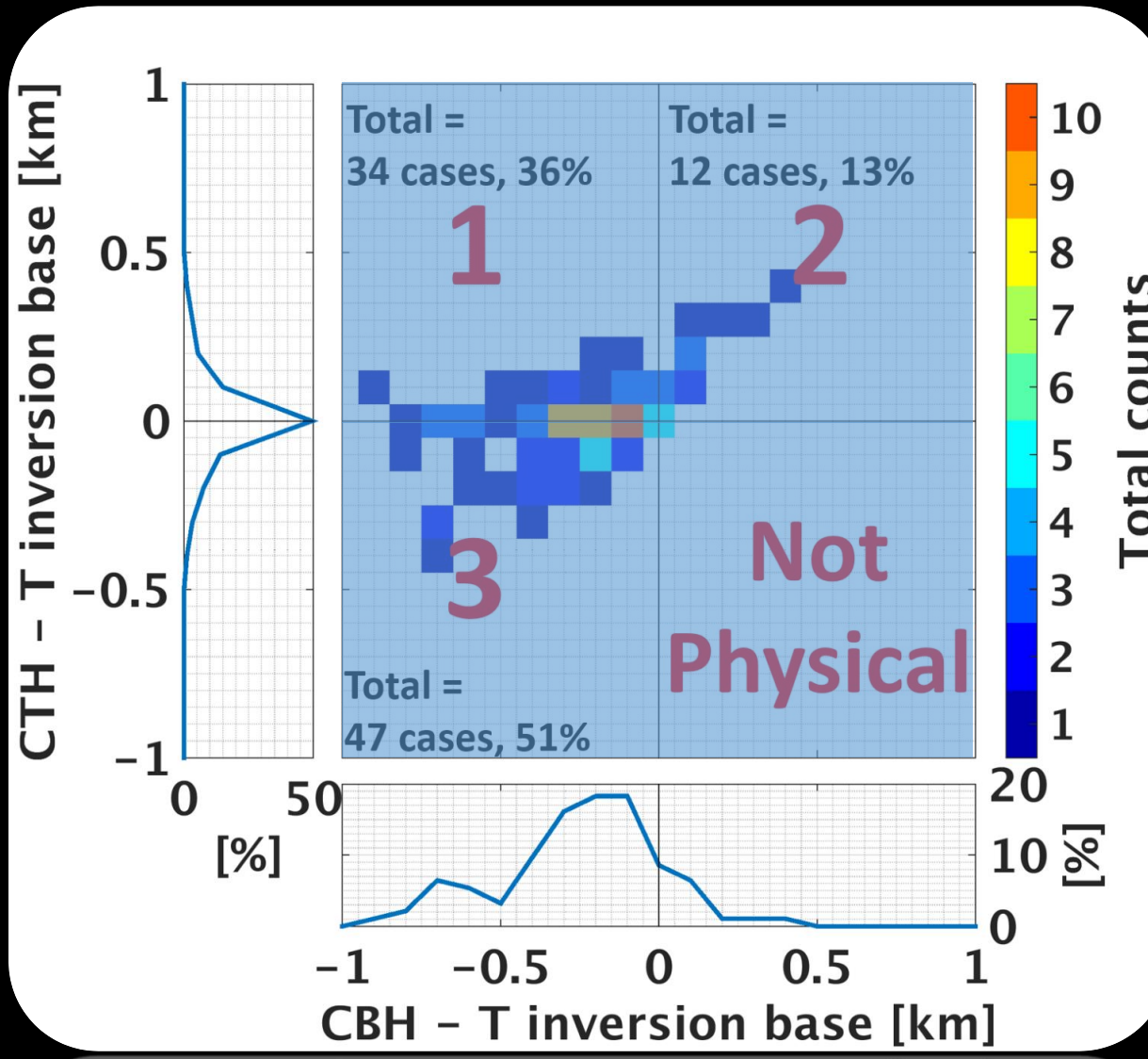

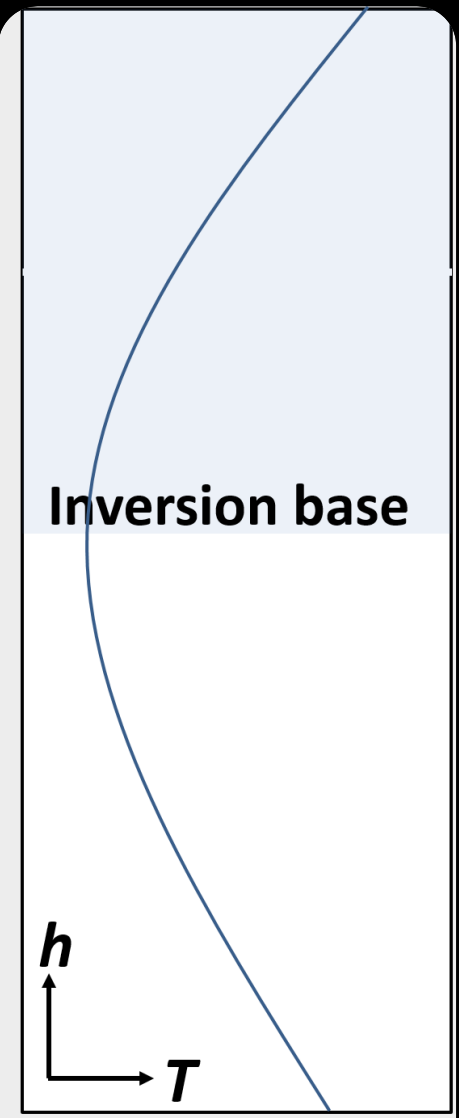

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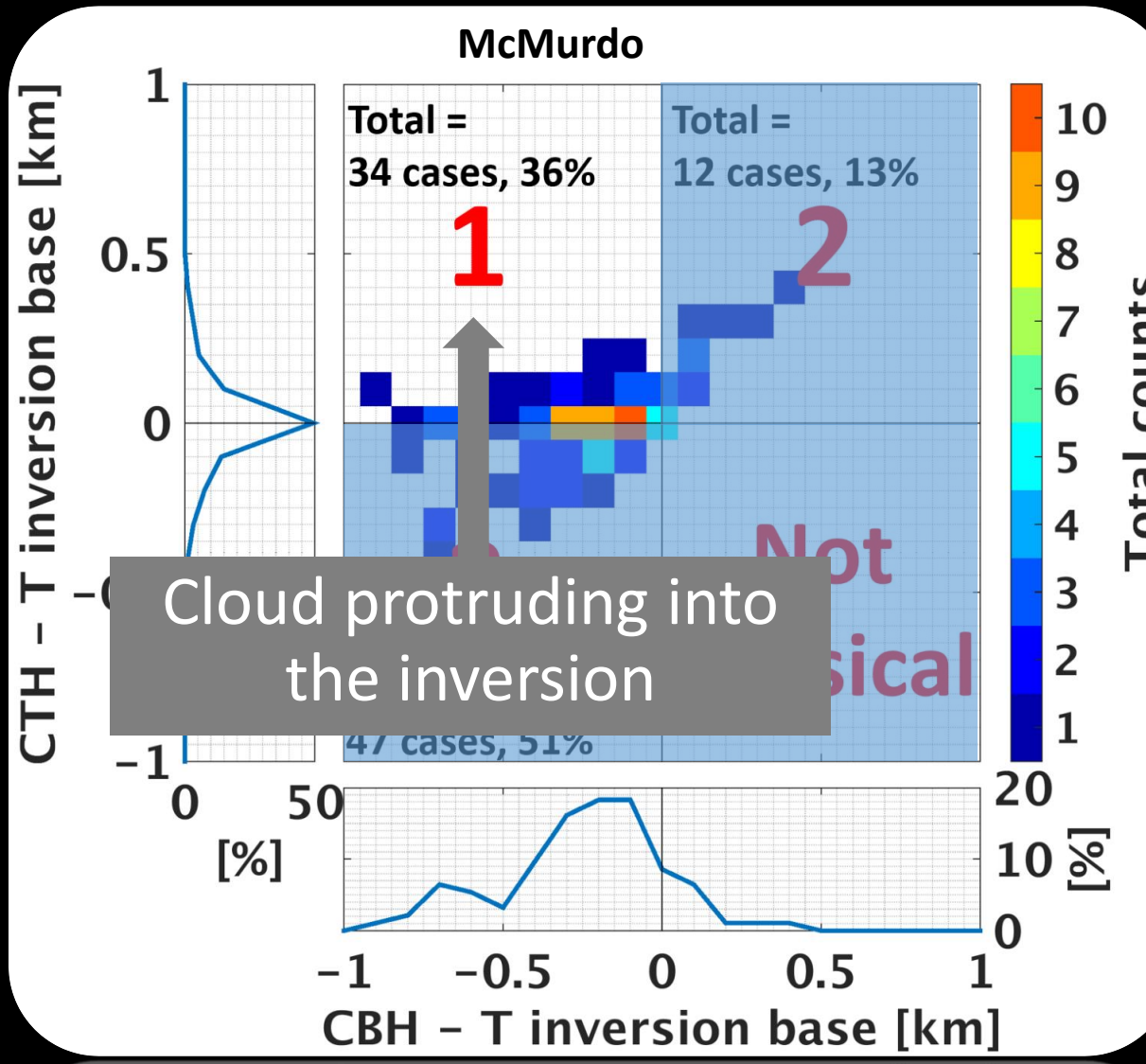
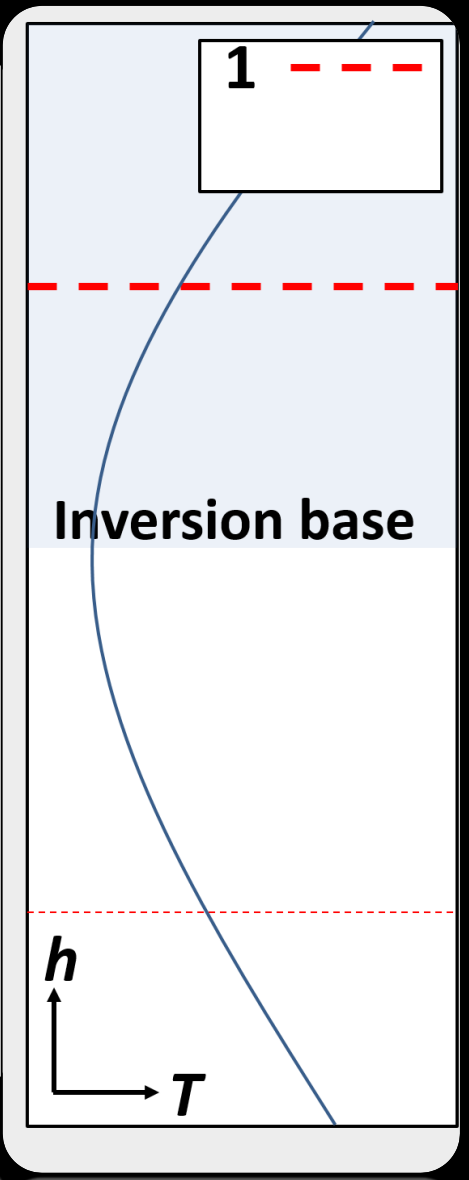
Cloud boundaries relative to temperature inversion base

- Cloud are concentrated around the inversion base.





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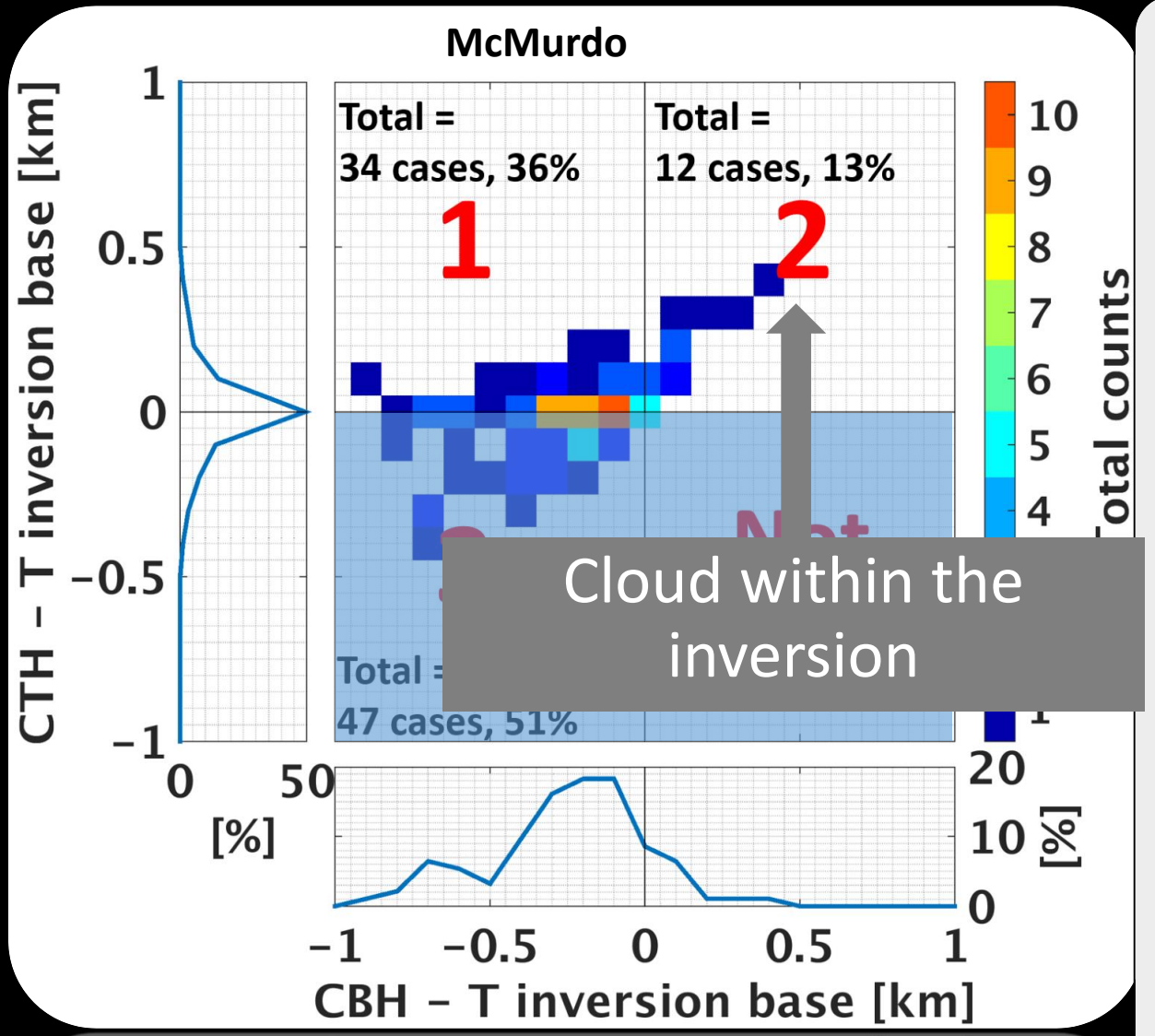
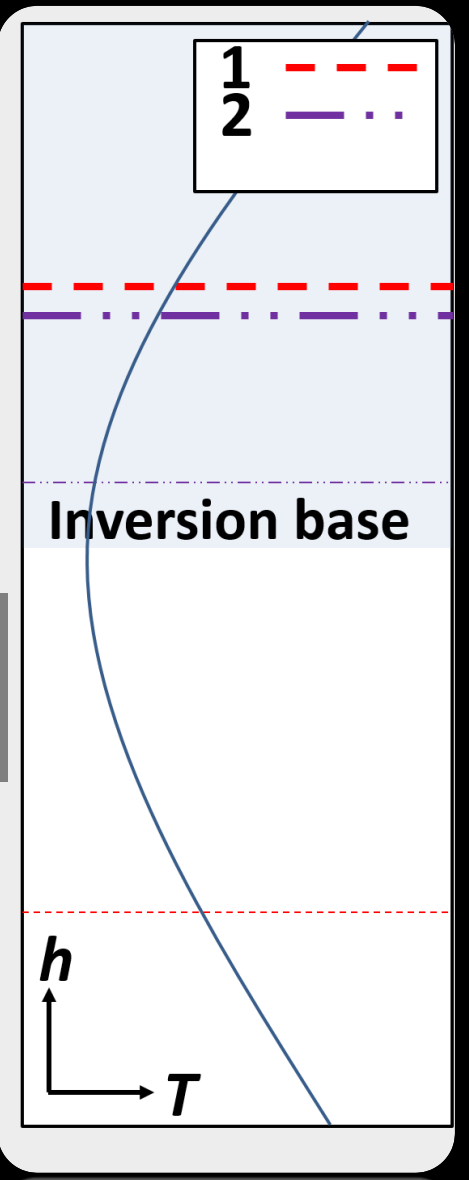
Cloud boundaries relative to temperature inversion base

- Several cases of clouds within the inversion.





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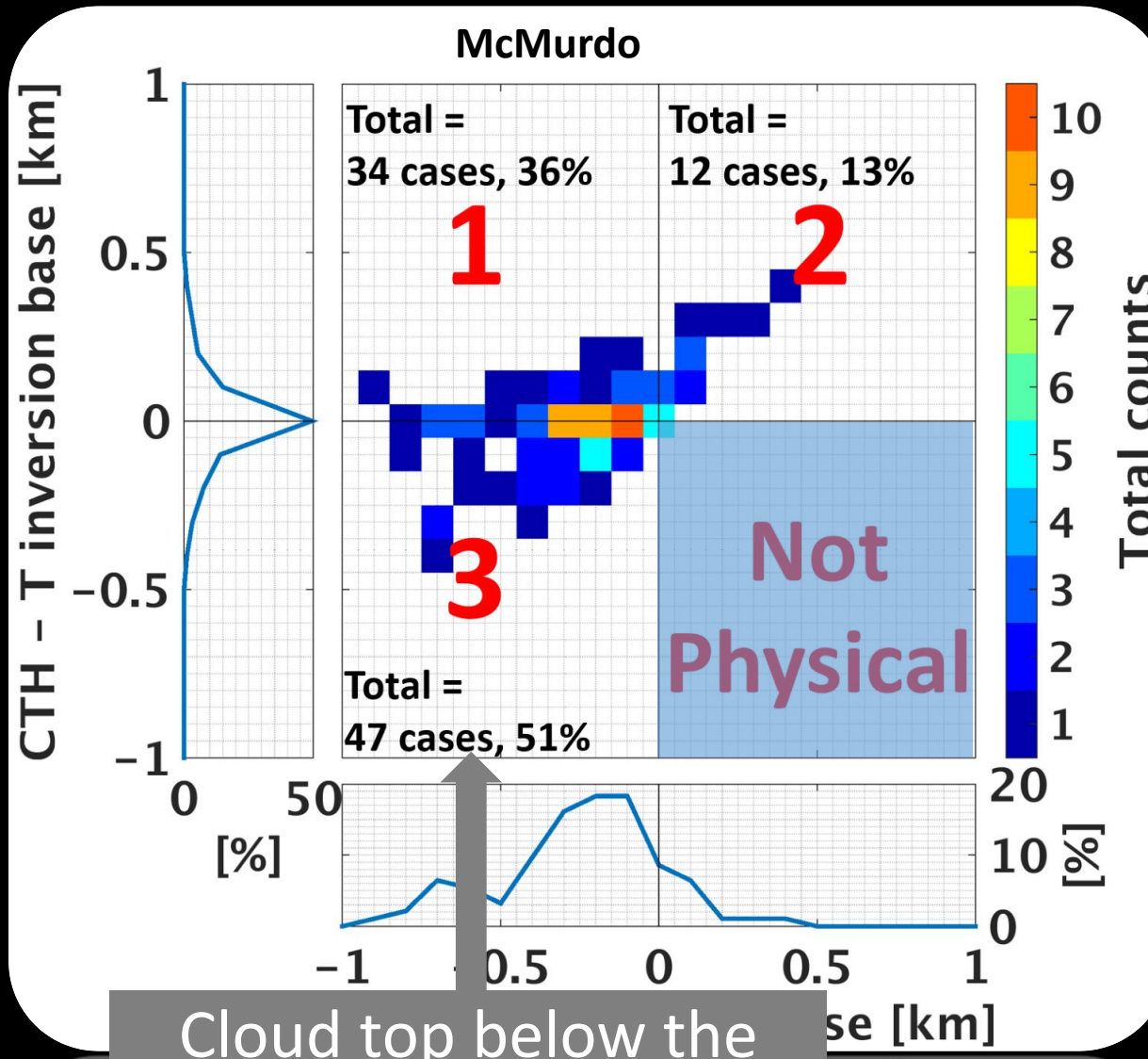
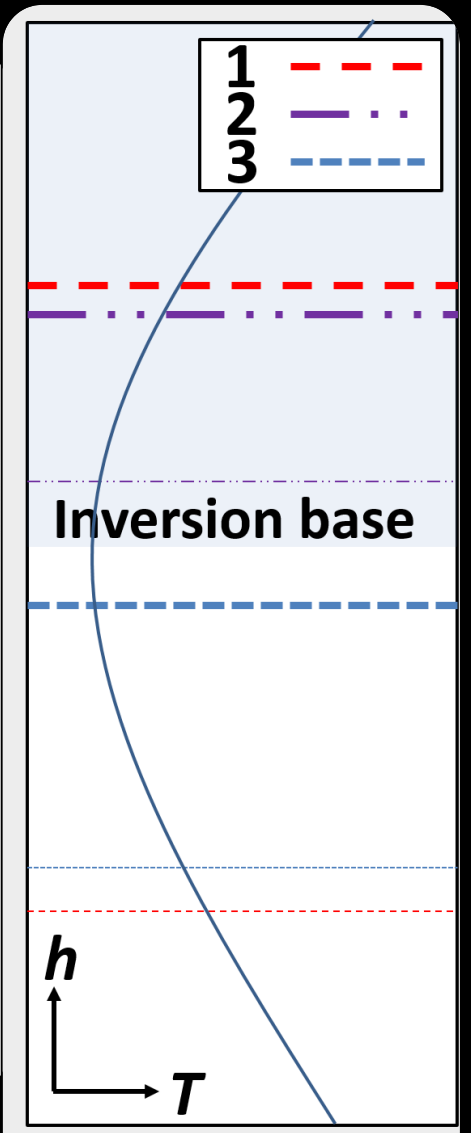
Cloud boundaries relative to temperature inversion base

- The counts of cloud tops below the detected inversion base suggests that very weak temperature inversions are formed at (often very tenuous) cloud tops, and hence, not detected in this analysis



Cloud top below the inversion base



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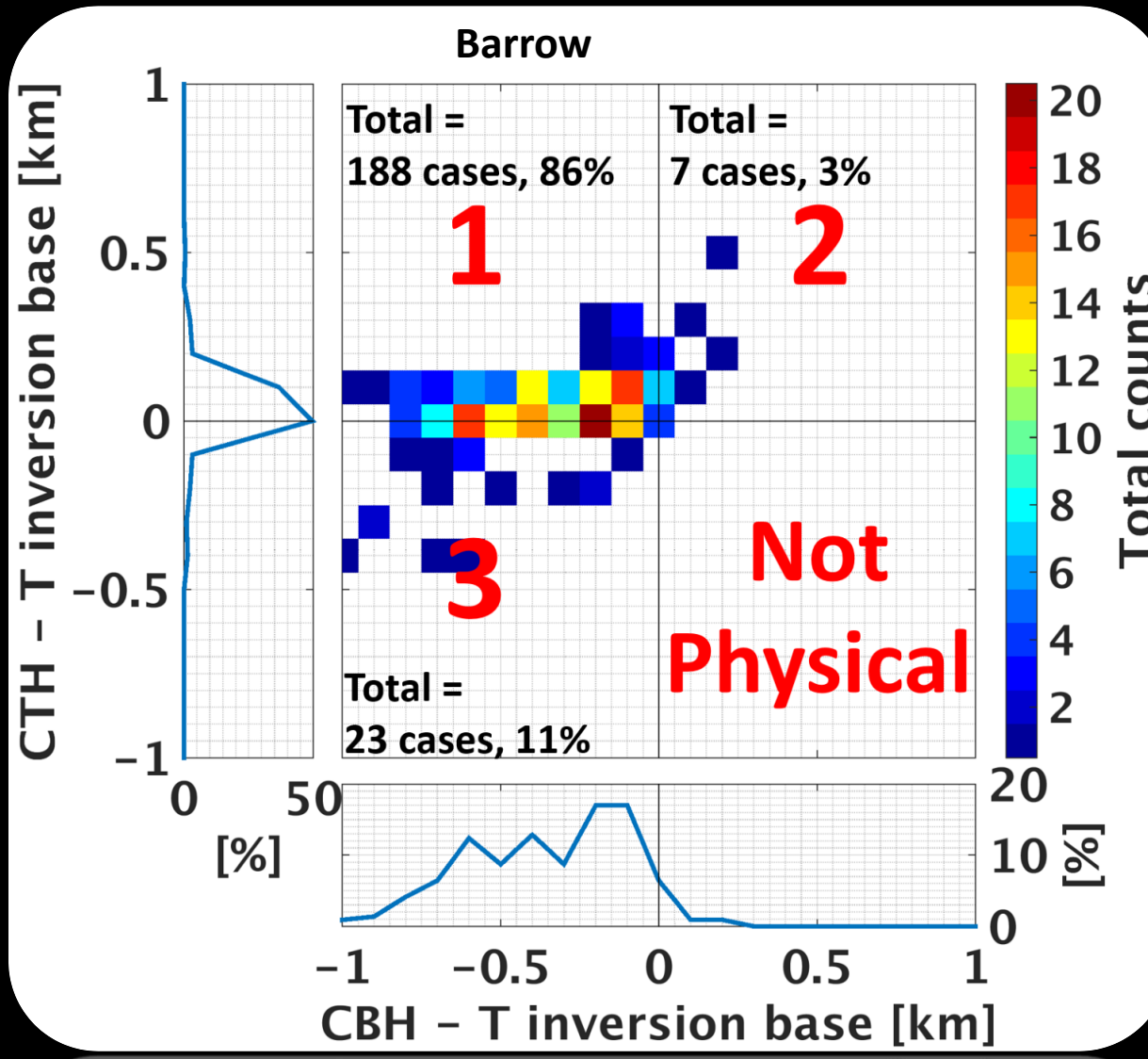
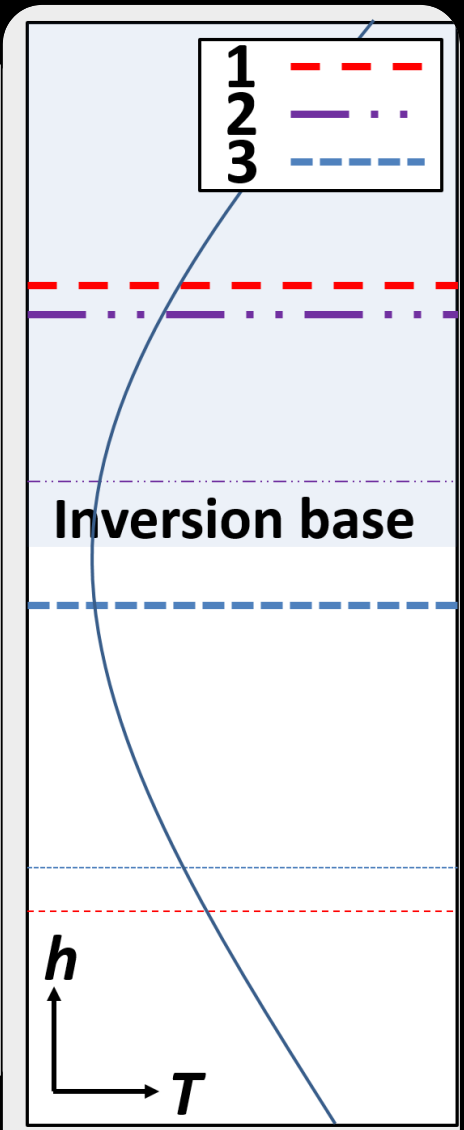
Cloud boundaries relative to temperature inversion base

- Clouds at Barrow protrude deeper into the inversion relative to McMurdo.





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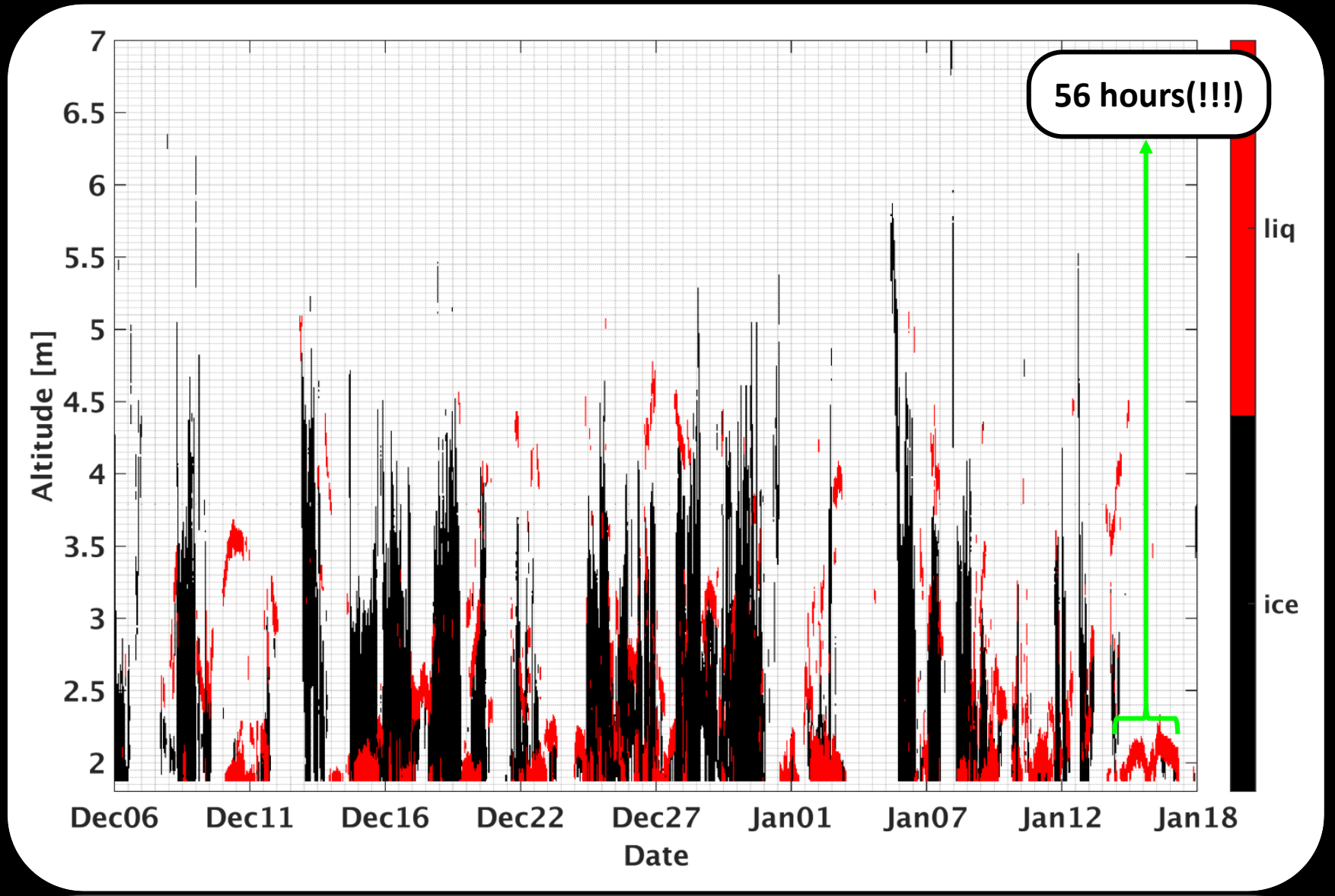
How well does McMurdo represent Antarctica?

We might receive a clue from the West Antarctica Ice Sheet (WAIS)…

McMurdo most persistent liquid-bearing cloud layer – 56 hours.

Liquid cloud occurrence fraction - ~64% relative to ~45% at McMurdo during the same time of year…



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Summary

- Unprecedented cloud and liquid-bearing layer properties extracted from multiple-instrument measurements as part of the ARM AWARE campaign were presented and compared with data gathered at Barrow, Alaska.
- Clouds at McMurdo are less prevalent and persistent relative to Arctic clouds, but typically have a higher liquid-cloud base height.
- Cloud and temperature/moisture inversion configuration near cloud top is often similar to the common structure observed in the Arctic.

References

Silber, I., Verlinde, J., Eloranta, E. W., and Cadeddu, M. (2018). Antarctic cloud macrophysical, thermodynamic phase, and atmospheric inversion coupling properties at McMurdo Station. Part I: Principal data processing and climatology, *J. Geophys. Res.: Atmospheres*, doi:10.1029/2017JD027840.

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