



# ESA-JAXA Pre-Launch EarthCARE Science and Validation Workshop

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## Representativity of air- and spaceborne radar-lidar measurements

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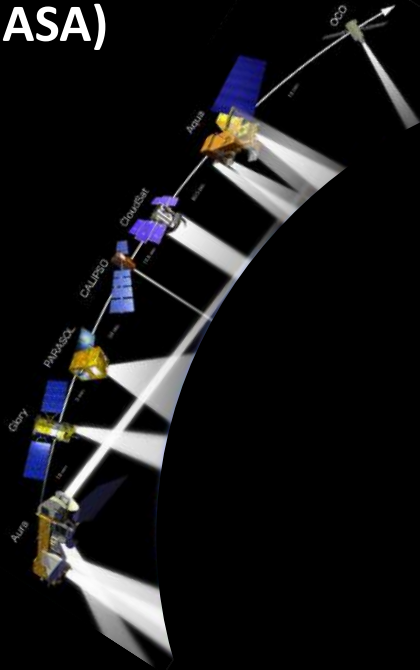
*2) LATMOS/IPSL/UVSQ/CNRS, Guyancourt, France*



# The challenge – a seamless transition

CalVal between A-Train and EarthCARE

A-Train  
(NASA)



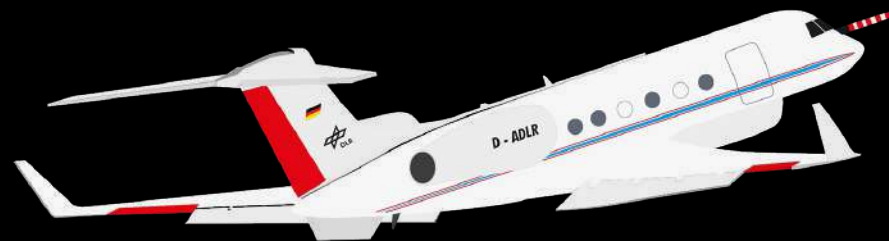
EarthCARE  
(ESA/JAXA)



**1a) Influence of different platforms?**

**1b) Influence of different algorithms?**

**2) Representativity of airborne validation campaigns?**



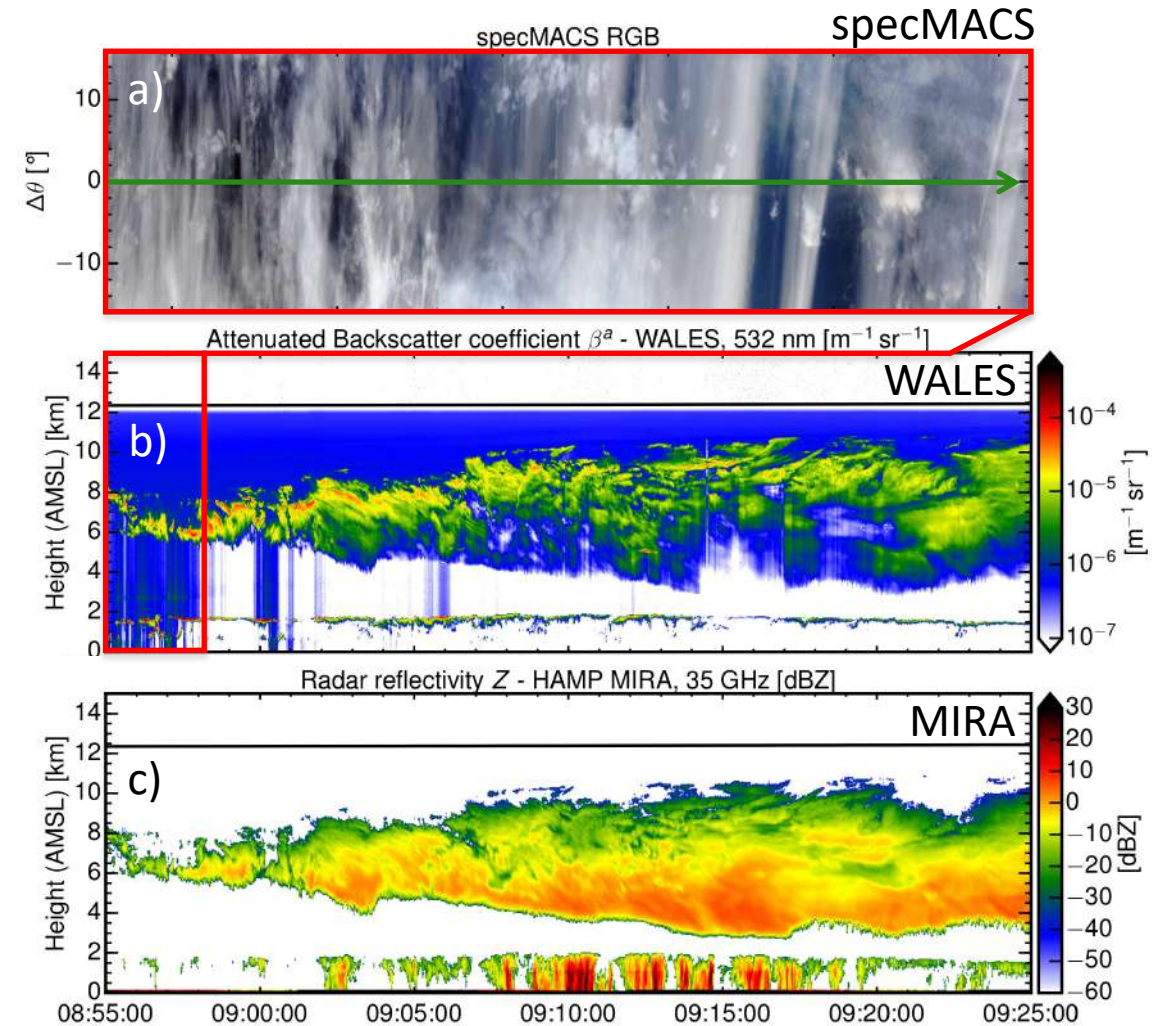
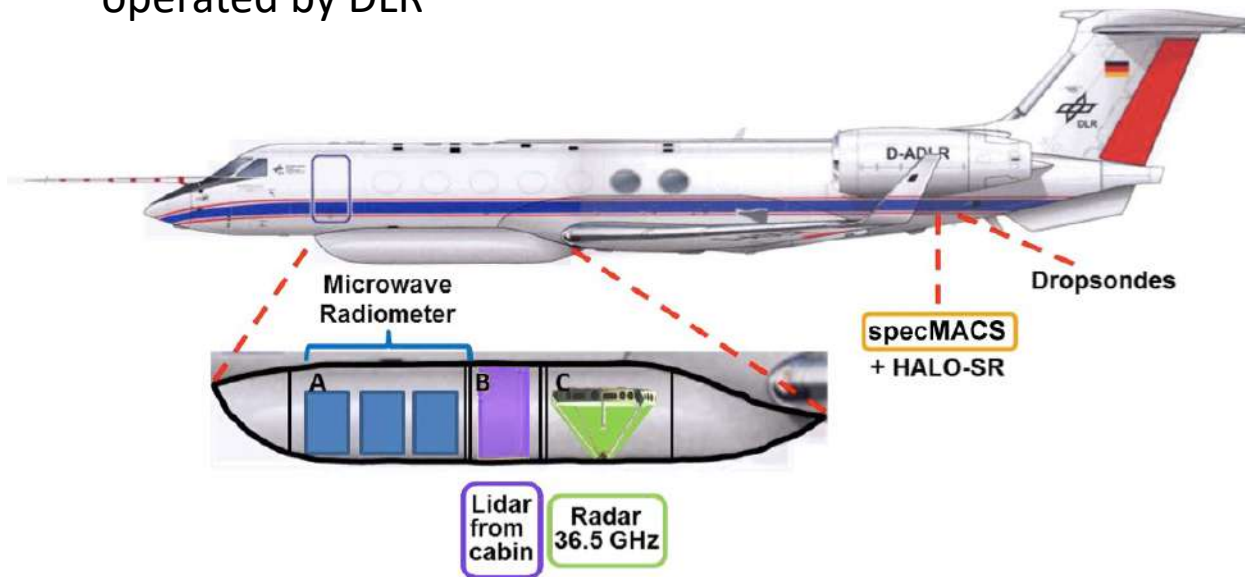
Bridging the gap via **underflights** and **statistical sampling**

# The airborne platform – HALO Remote Sensing Payload

An airborne testbed to anticipate EarthCARE



- G550, max. alt 16 km / max. range: 8000 km
- In operation since 2012
- operated by DLR



## Scientific Instruments

HSRL-Lidar (WALES, 532 nm – Wirth et al. 2009)

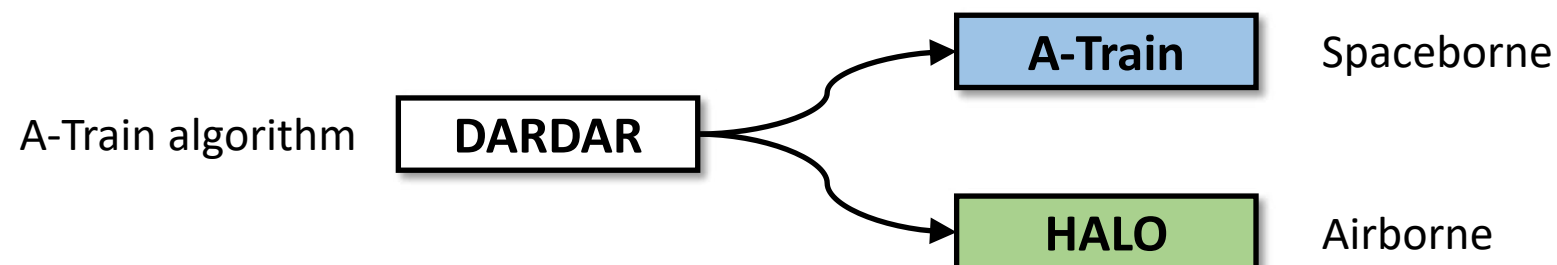
Cloud-Profiling Radar (MIRA, 35 GHz – Ewald et al. 2019)

Hyper-Spektral Imager (specMACS – Ewald et al. 2016)

Microwave Radiometer (HAMP – Mech et al. 2014)

## The influence of different platforms

*Underflights of the A-Train (NASA) with HALO (DLR)*



# Influence of different platforms – airborne vs spaceborne

Underflights of the A-Train (NASA) with HALO (DLR)



## A-Train

CALIOP (532 nm)  
CloudSat (94 GHz)

## HALO

WALES (532 nm)  
MIRA (35 GHz)

## NARVAL campaigns

2013 - 2016

Base: Iceland / Barbados

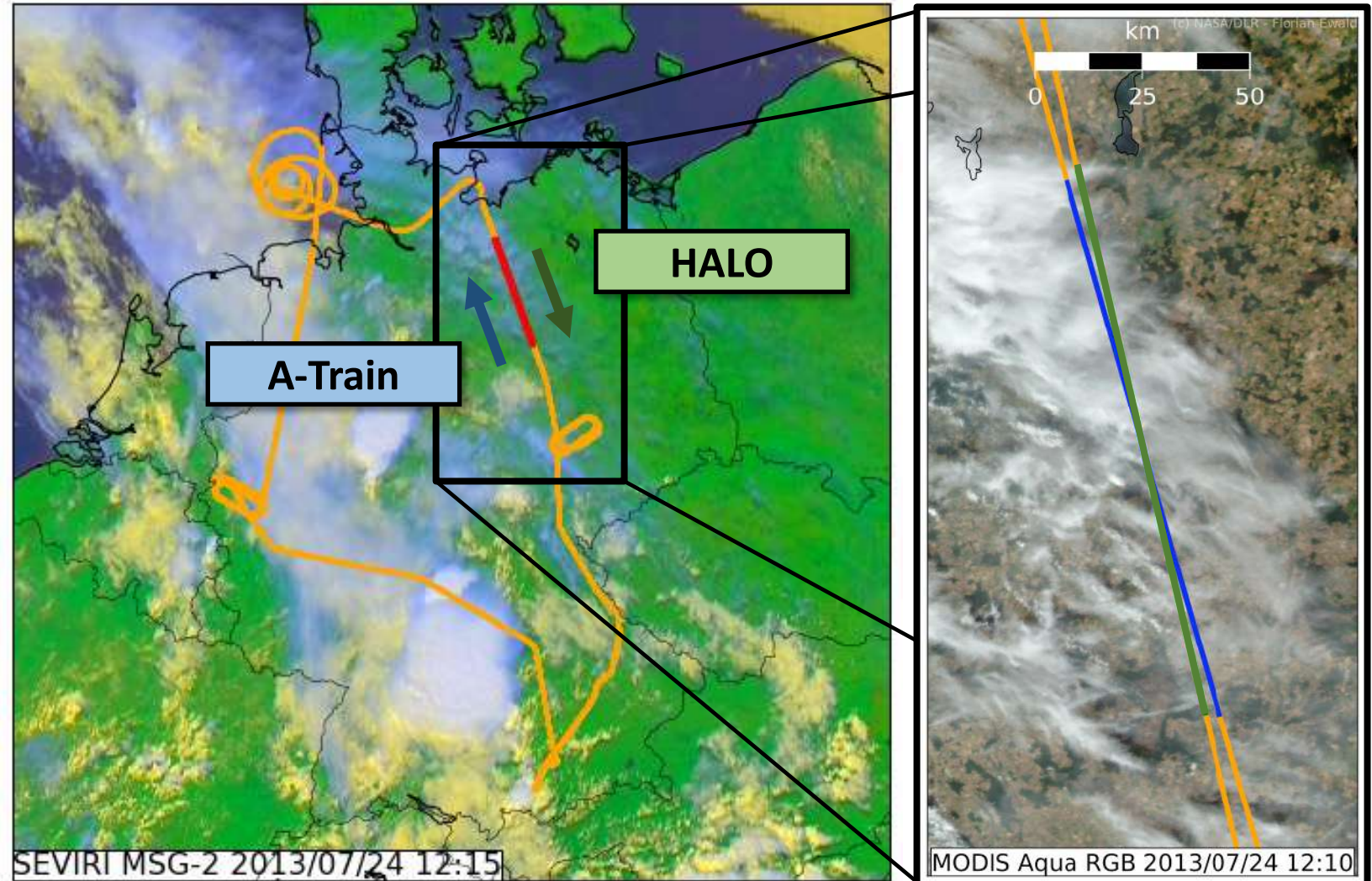
Area: Full atlantic

Aim: Ice / marine clouds

17x A-Train underpasses

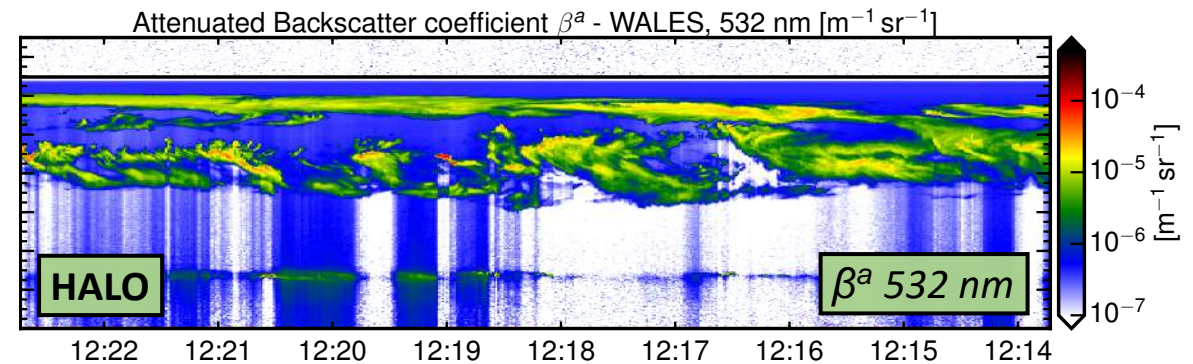
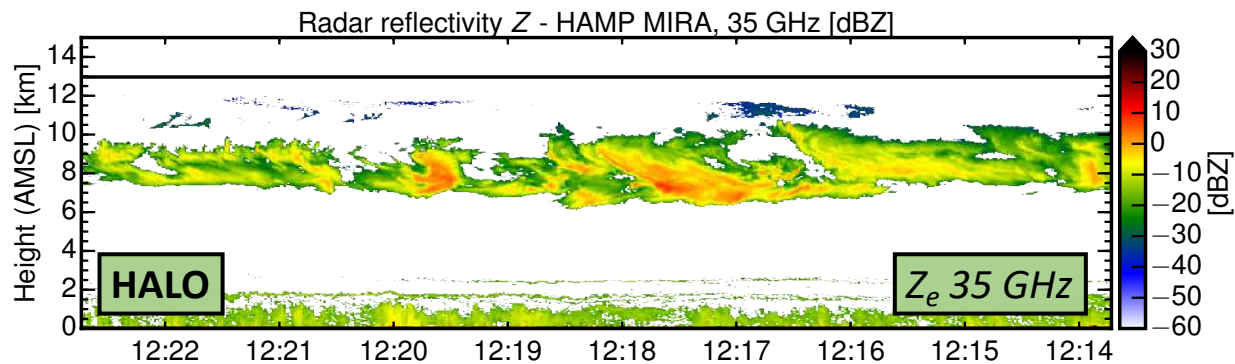
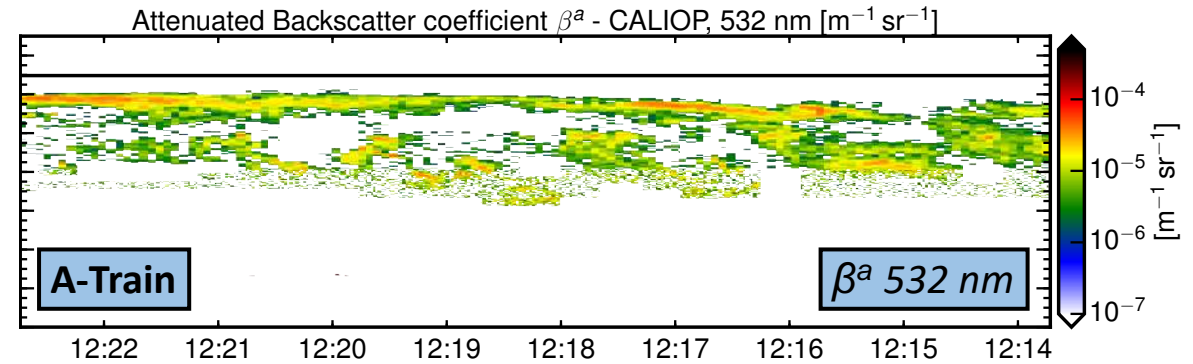
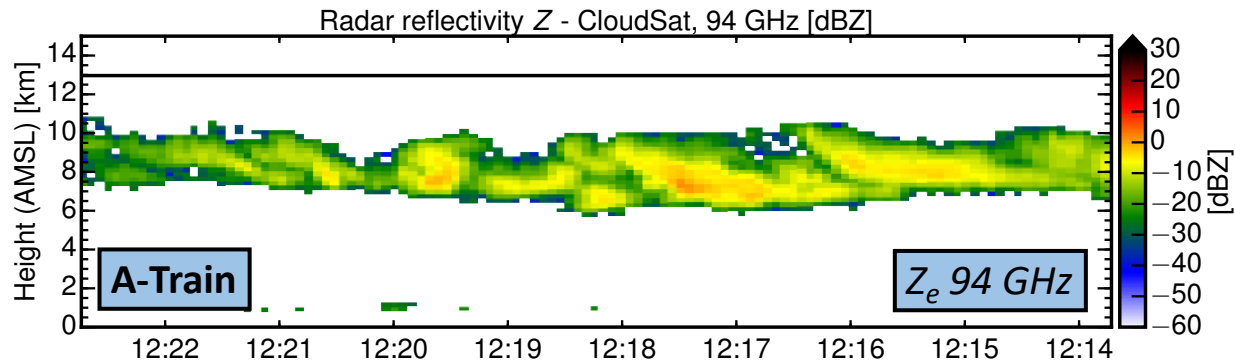
**Demo Flight 2 →**

(2013/07/24)



# Influence of different platforms – measurements

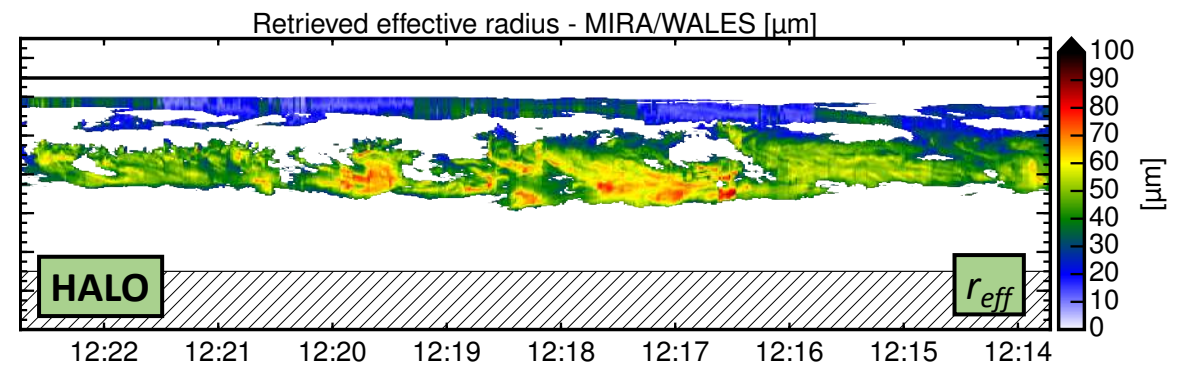
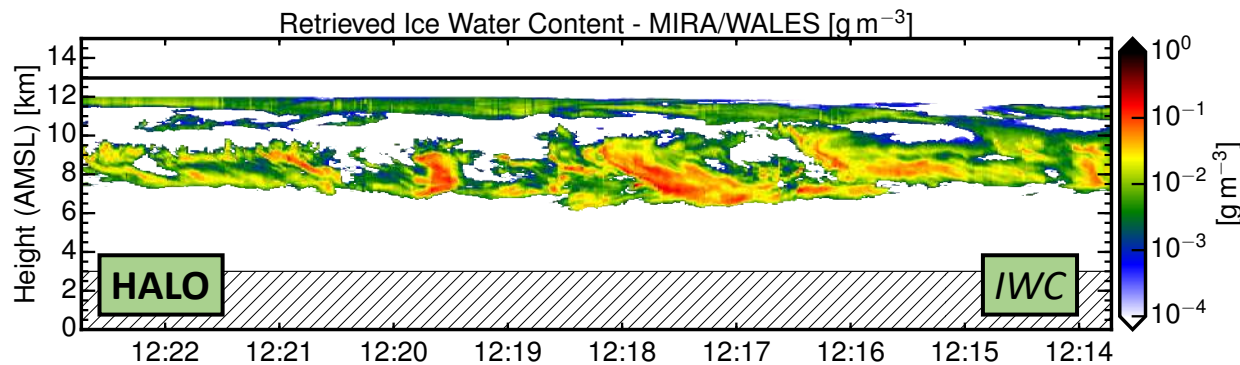
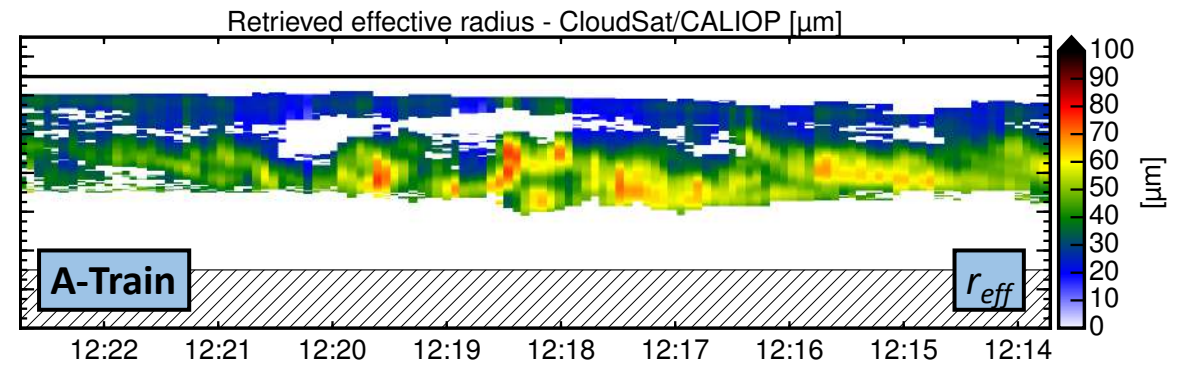
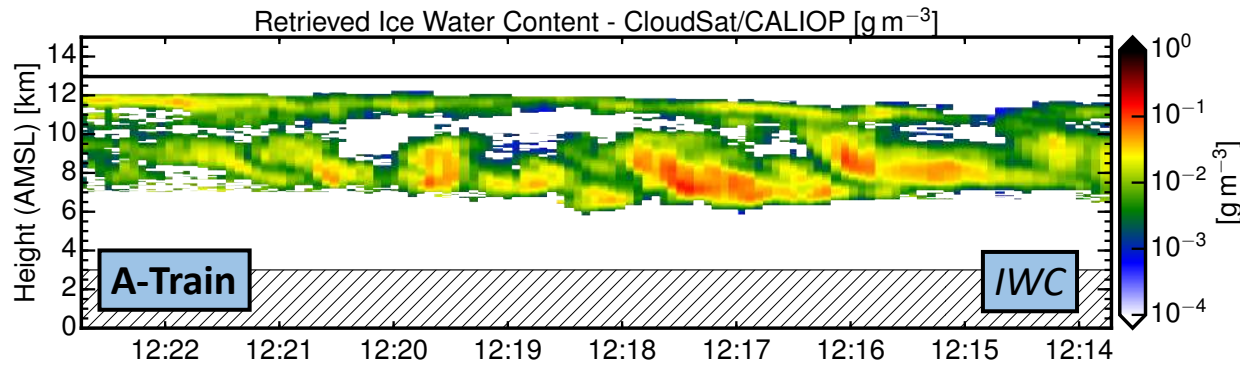
Underflights of the A-Train (NASA) with HALO (DLR)



→ **Observation:** *similar sensitivity for ice clouds but coarser spatial resolution and more noise in spaceborne measurements*

# Influence of different platforms – ice cloud retrievals

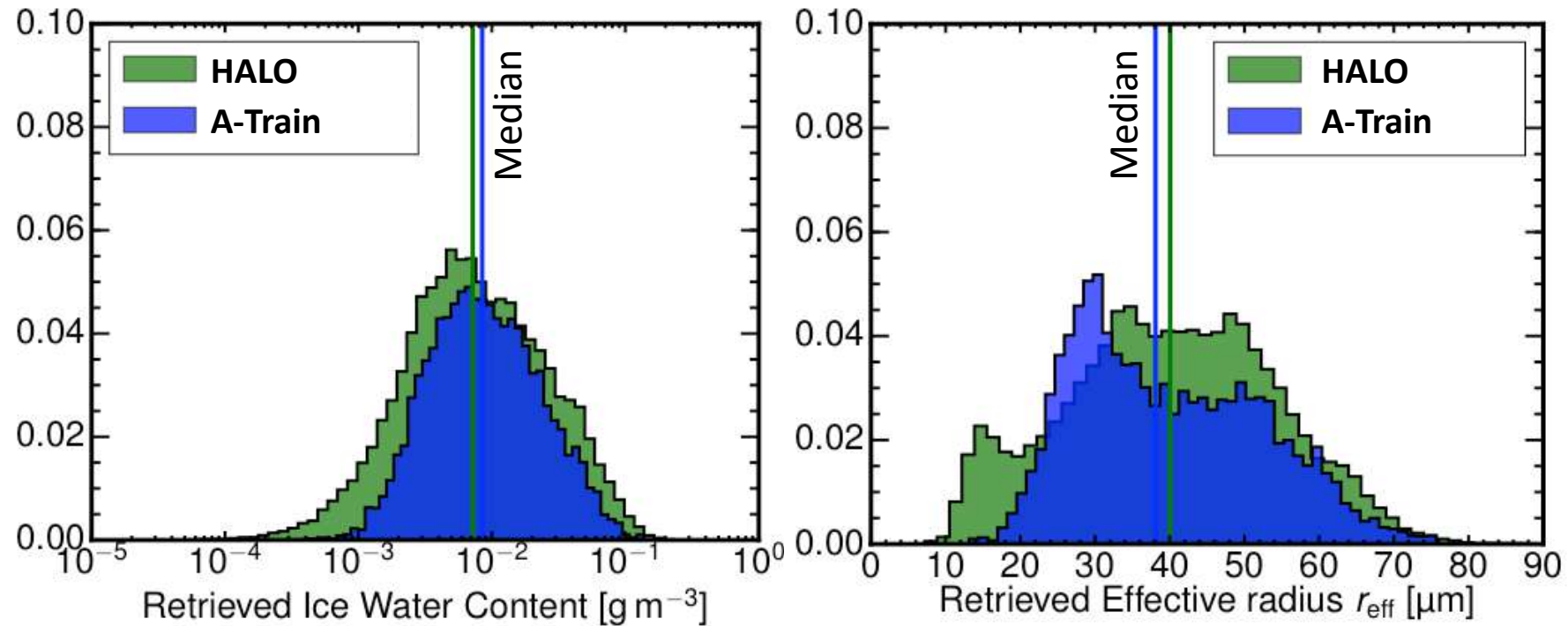
## Underflights of the A-Train (NASA) with HALO (DLR)



→ **Observation:** similar retrieved values between platforms while the spaceborne data is missing the fine-scale structures of cloud microphysics

# Influence of different platforms – ice cloud retrievals

Underflights of the A-Train (NASA) with HALO (DLR)

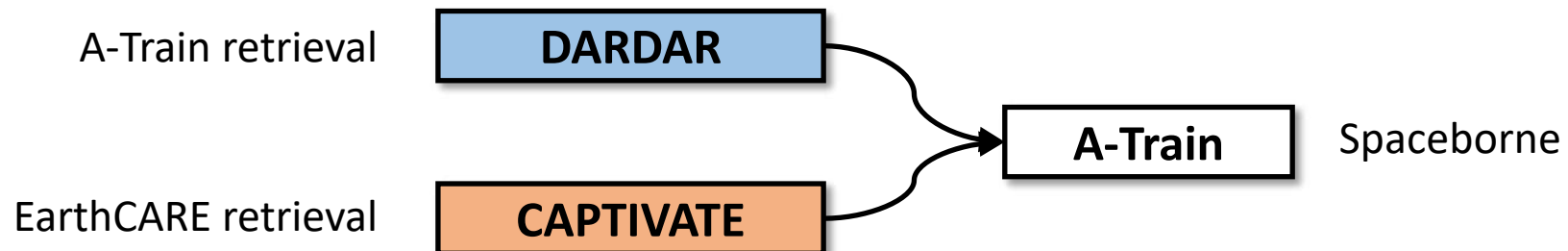


- **Ice water content:** +10% larger with narrower distribution for A-Train
  - **Effective radius:** -5% smaller with slightly narrower distribution for A-Train
- **Conclusion:** slightly lower sensitivity and coarser spatial resolution of spaceborne instruments leads to more narrow distributions of cloud properties



## The influence of different algorithms

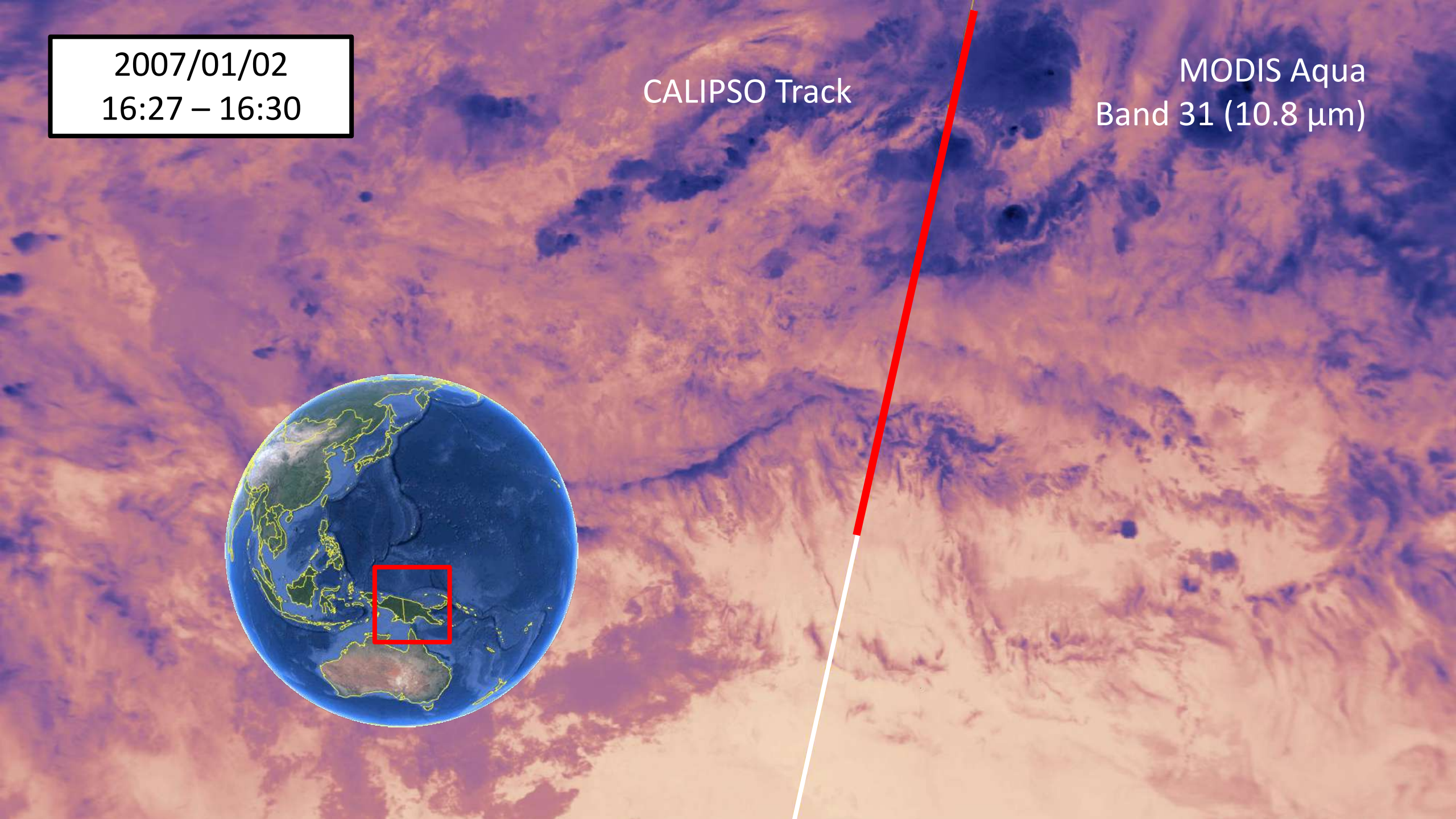
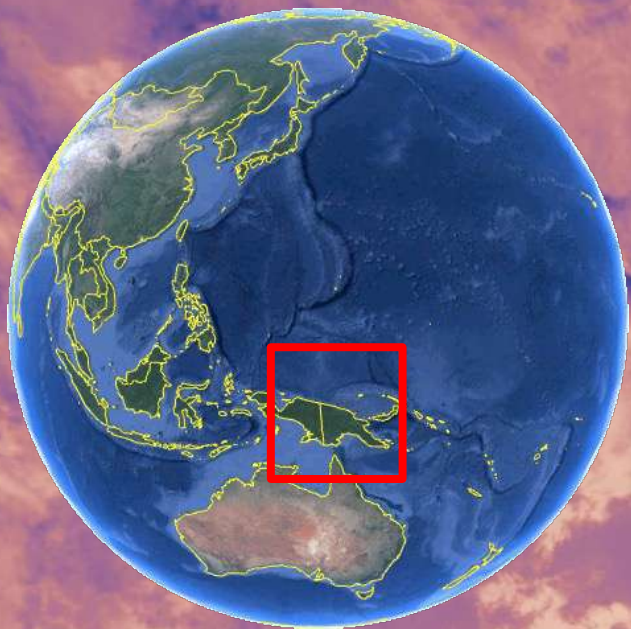
*DARDAR and CAPTIVATE on the same A-Train granule*



2007/01/02  
16:27 – 16:30

CALIPSO Track

MODIS Aqua  
Band 31 (10.8  $\mu\text{m}$ )

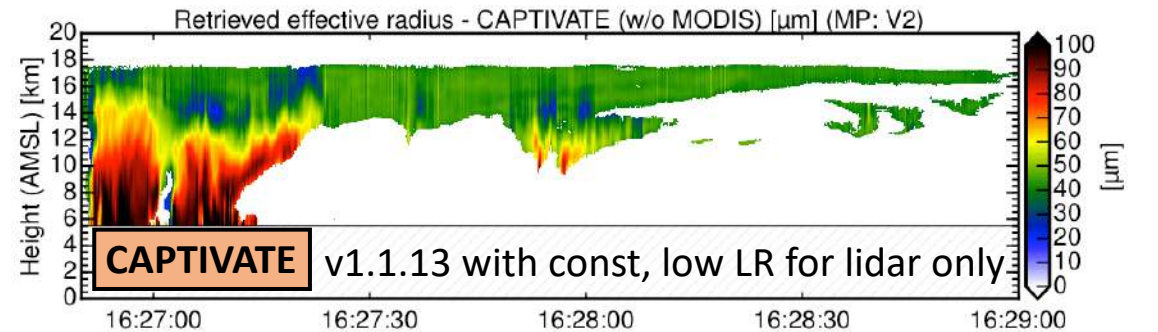
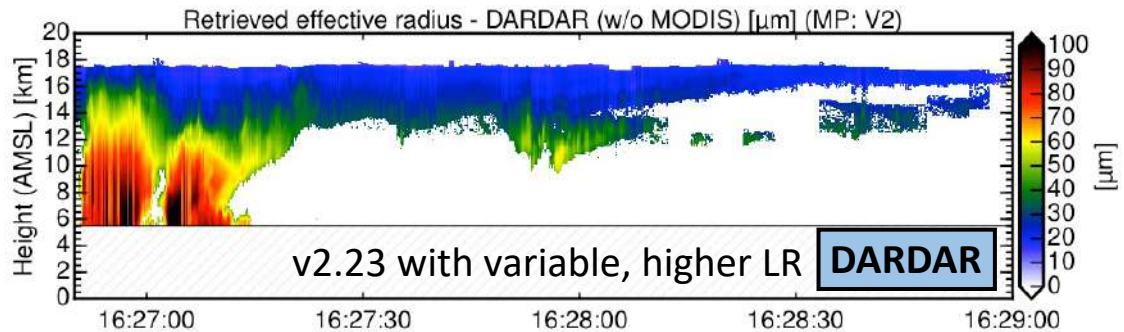
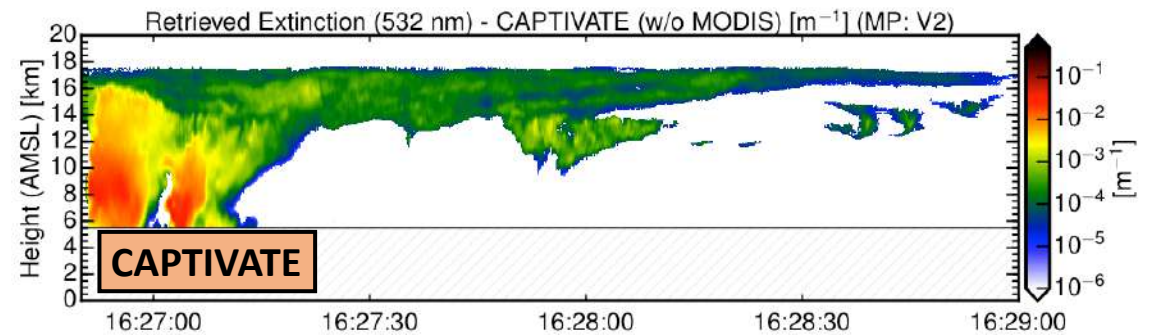
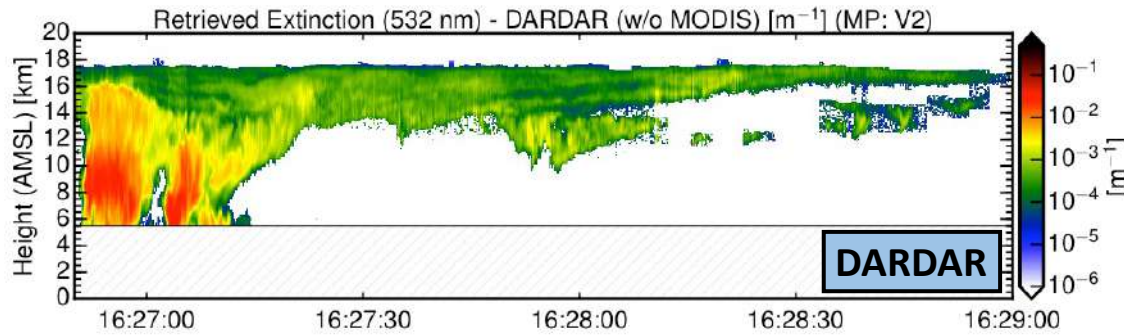
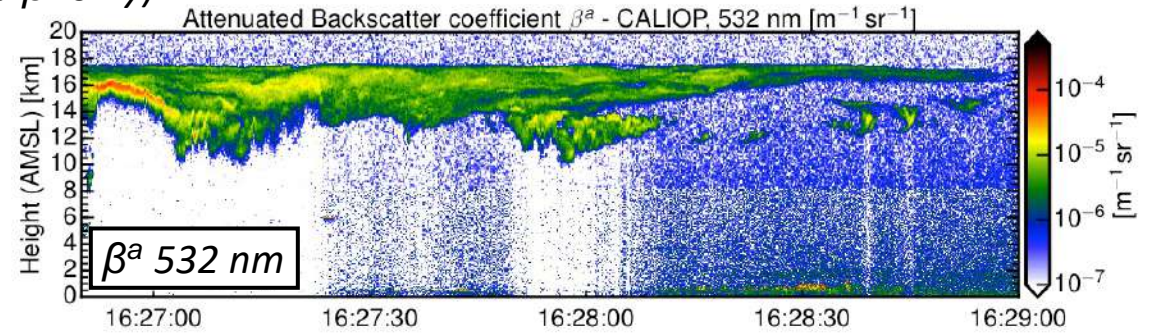
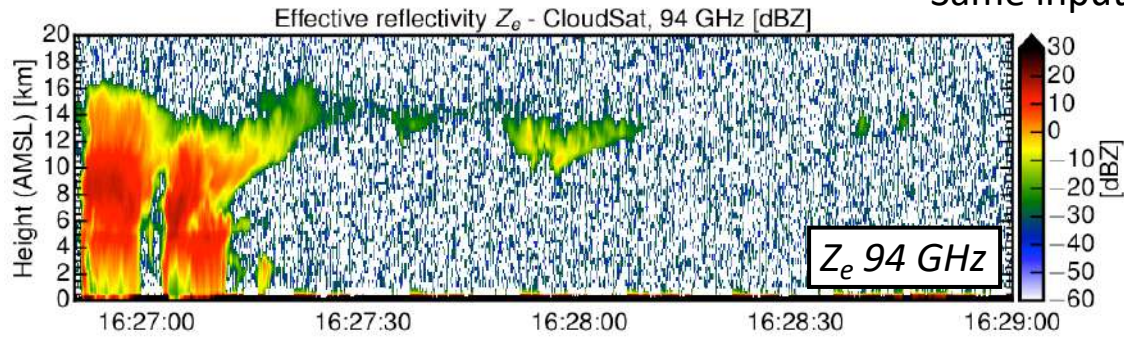


# Influence of different retrievals – measurements /retrieval

## DARDAR and CAPTIVATE on the same A-Train granule



Same input ( $Z_e$  and  $\beta^a$  only)

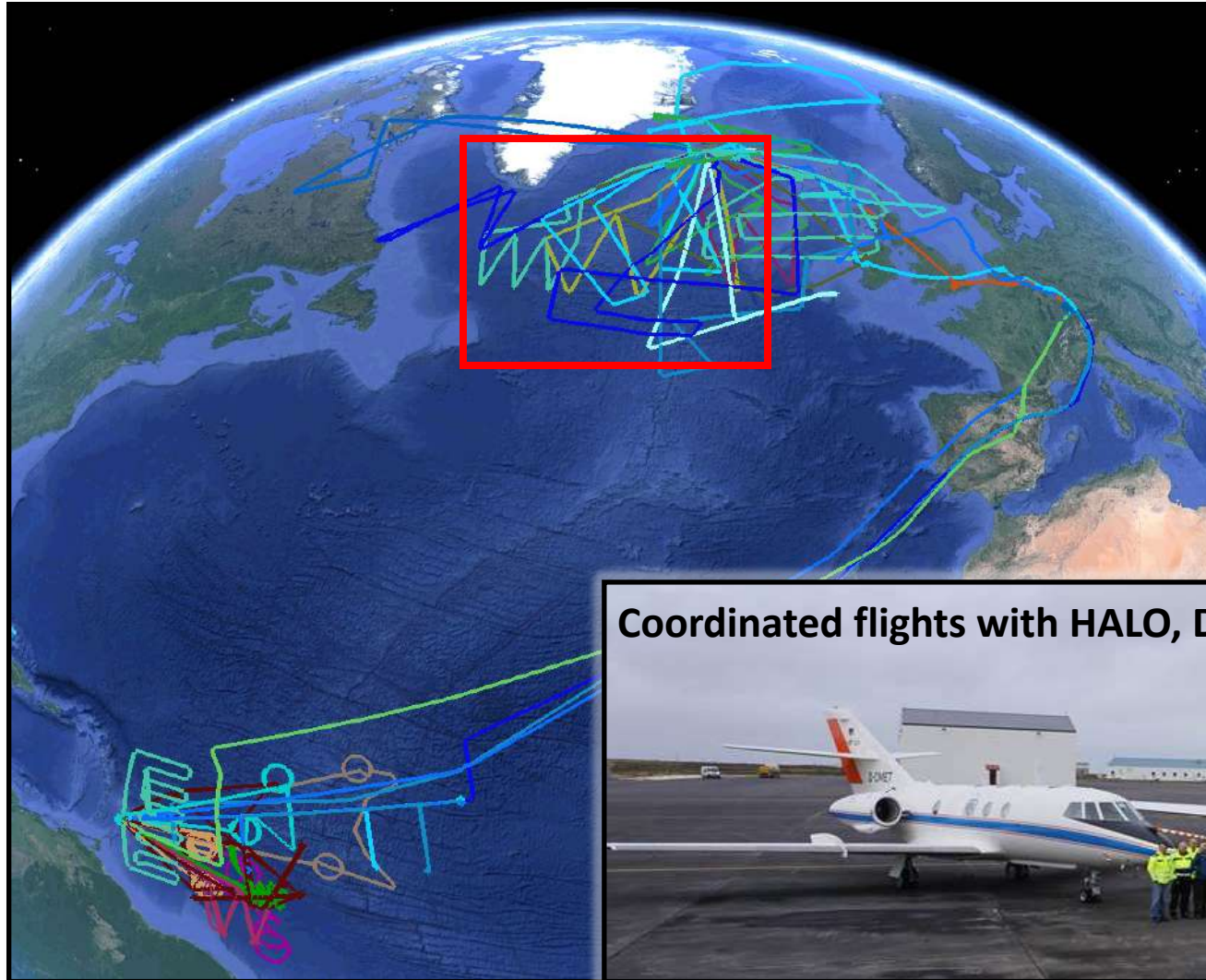


## **Representativity of validation campaigns**

*Can we validate EarthCARE using airborne measurement campaigns?*

# Representativity of validation campaigns – Overview

All DLR airborne measurements during NARVAL-I / -II and NAWDEX



## Tropical North-Atlantic

- NARVAL-I: 10 – 20 Dec 2013 (dry season)
- NARVAL-II: 8 – 29 Aug 2016 (wet season)

## Extra-tropical North-Atlantic

- NARVAL-I: 7 – 22 Jan 2014
- **NAWDEX**: 15 Sep – 18 Oct 2016
  
- ~310 flight hours
- **17 coordinated A-Train underpass**
- 6 coordinated HALO – FF20 legs (NAWDEX)

Coordinated flights with HALO, DLR Falcon, SAFIRE Falcon (+ A-Train) during NAWDEX

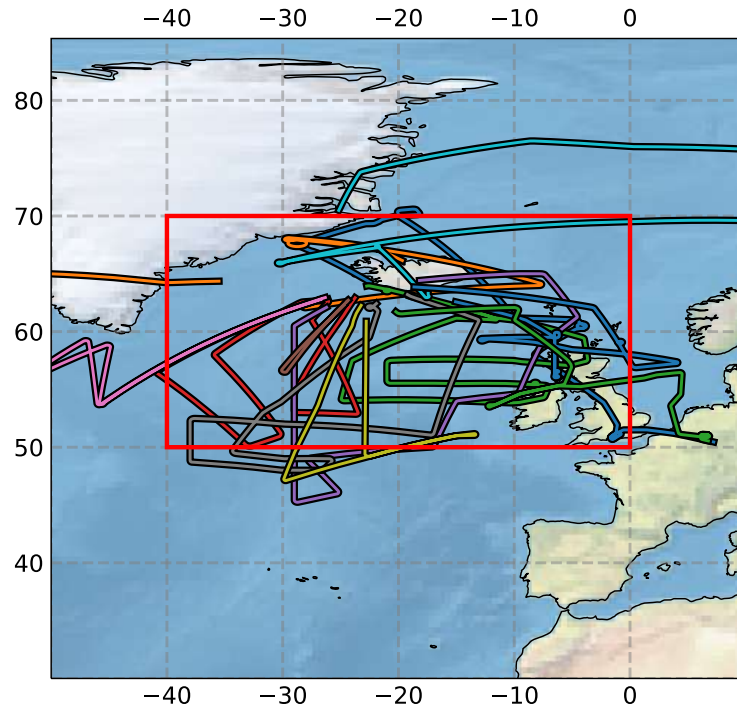


# Representativity of validation campaigns – NAWDEX

Was the NAWDEX airborne campaign representative in comparison with A-Train?

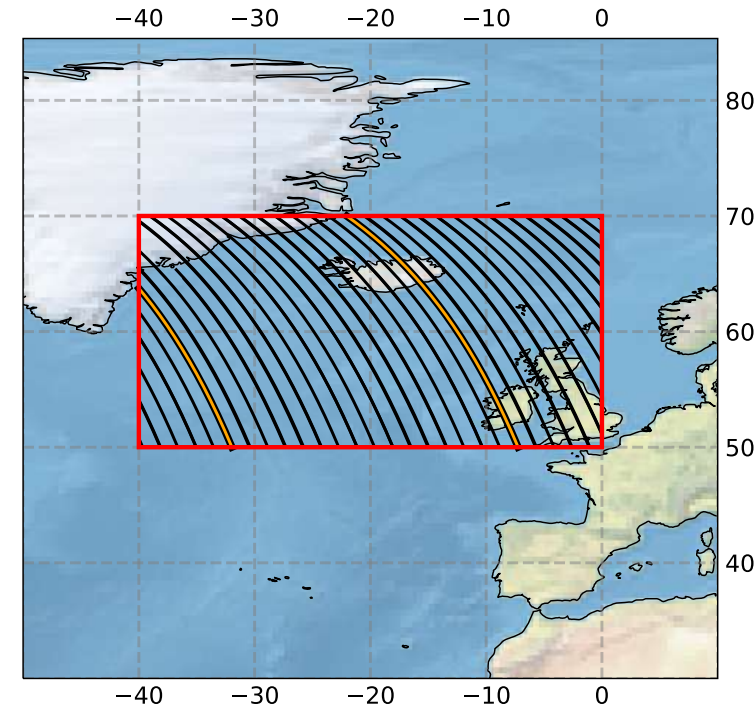


NAWDEX campaign (HALO) 16.09. – 16.10.2016



13 HALO Flights  
(0.5 x per day, 80h, 60.000 km)

DARDAR dataset (A-Train)



61 A-Train Overpasses (noon)  
(2 x per day, 4h, 100.000 km)

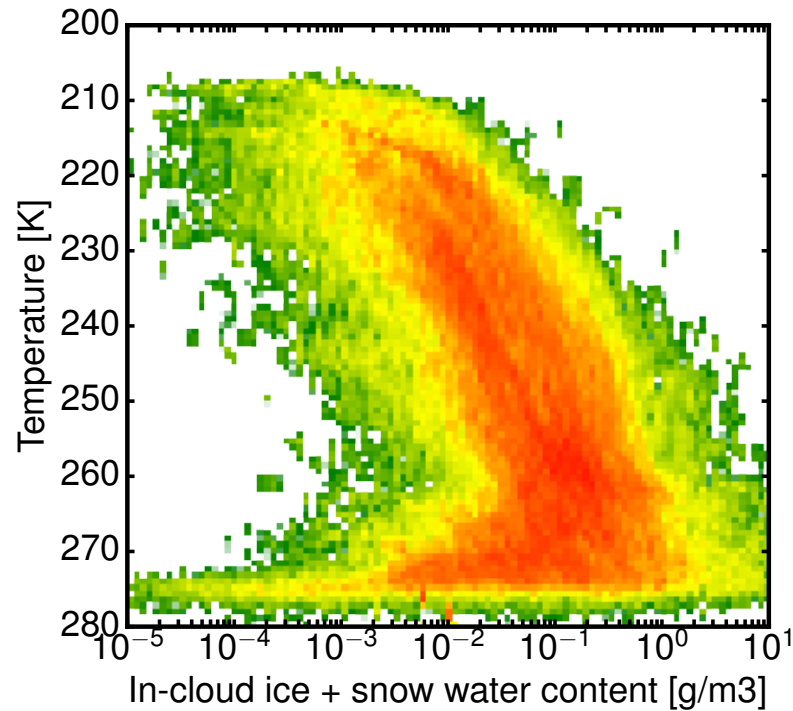
→ **Approach:** Comparison of ERA5 ice cloud statistics along HALO flight path with ERA5 ice cloud statistics of full domain

# NAWDEX campaign – Representativity of HALO flights

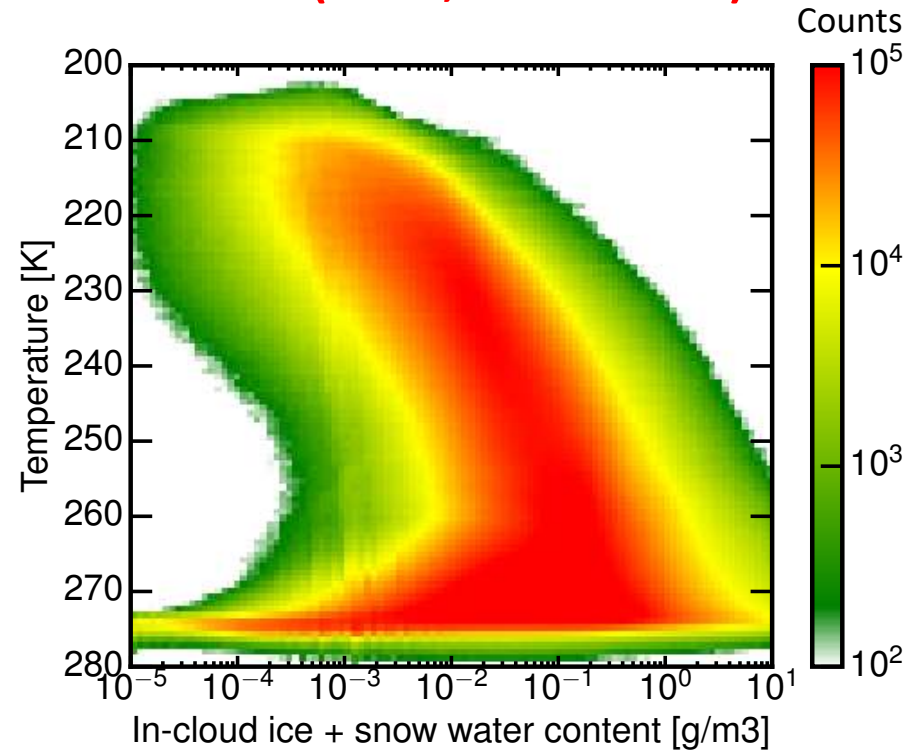
ERA5 IWC statistics along HALO flight path compared to full domain



ERA5 (TIWC, HALO Track)



ERA5 (TIWC, Full domain)



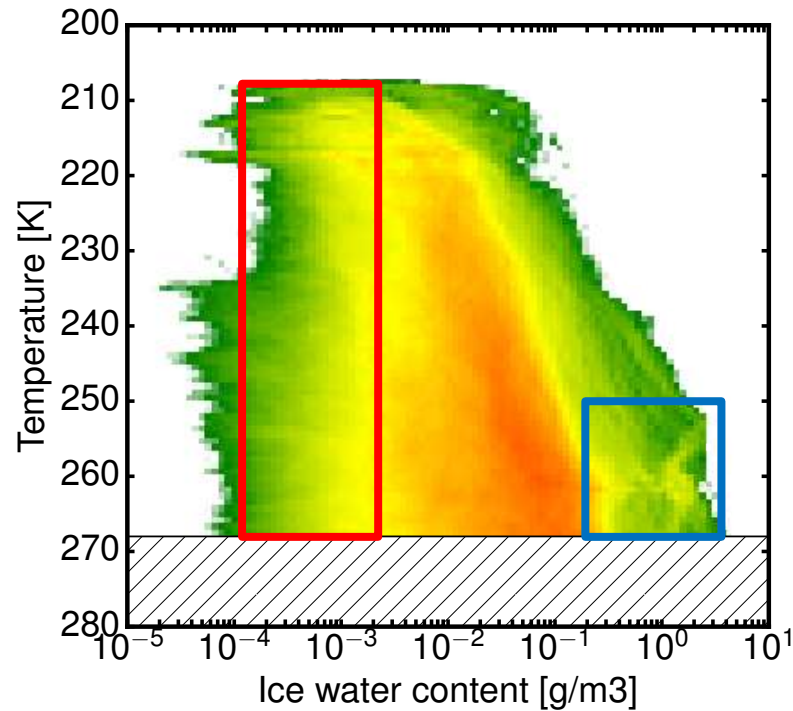
- *Shape and relative frequency of IWC-T profile along the HALO flight path matches with the IWC-T profile for the full model domain*
  - **Conclusion:** *NAWDEX flights were representative for ice clouds!*

# NAWDEX campaign – Comparison between platforms

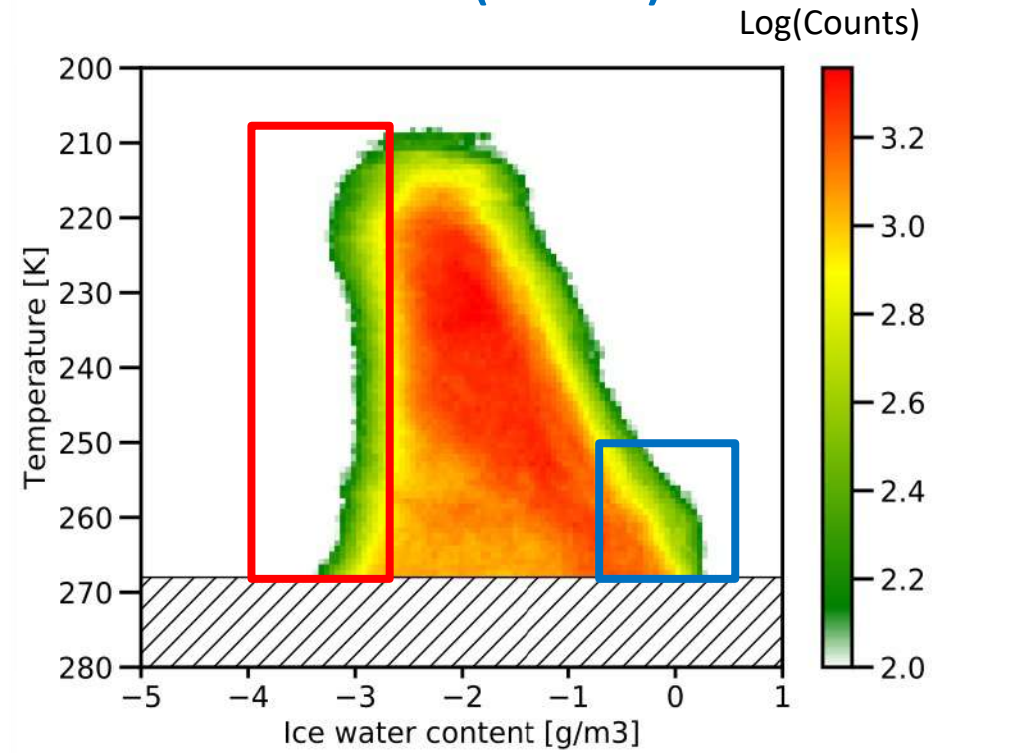
Comparison of IWC statistics between HALO and A-Train



VarCloud (HALO)



DARDAR (A-Train)



- **With ERA5:** Slightly different profile shape, with missing low IWC values in ERA5
- **With A-Train:** Overall agreement of profile shape, but **missing sensitivity for thin clouds** and **slight higher IWCs at higher temperatures** from A-Train



# Summary – Representativity of radar-lidar products

... and bridging the gap between A-Train and EarthCARE via airborne campaigns



## 1) How well do airborne and spaceborne retrieval results agree?

→ “Similar mean retrieval results, with **narrower distributions of retrieved ice water content and particle sizes** from A-Train”

## 2) How well do the retrievals DARDAR and CAPTIVATE agree?

→ “Without HSRL, Doppler and solar radiances, **very similar results for thick ice clouds, with larger differences in  $r_{eff}$  for thin cirrus.**”

## 3) How representative were airborne campaigns w.r.t ice cloud statistics?

→ “**No significant sampling bias detected** in IWC-T statistics while **sensitivity and resolution have their impact** on ice cloud statistics”

