Evaluating ATLID's L2 cloud products (A-TC, A-CTH) with airborne observations during PERCUSION

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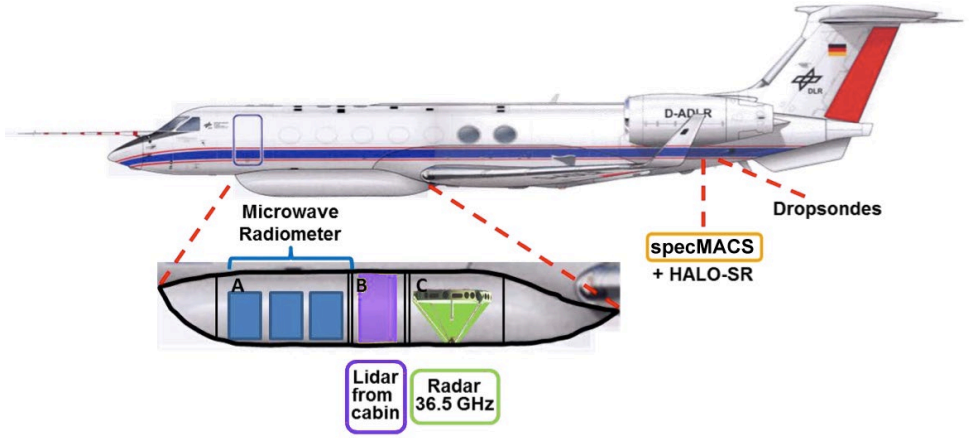
HALO campaign PERCUSION for EarthCARE validation

Persistent EaRthCare Underflight Studies of the ITCZ and Organized convectioN

(see presentation by Silke Gross Wednesday, 11:45LT)



EarthCARE-like payload on HALO

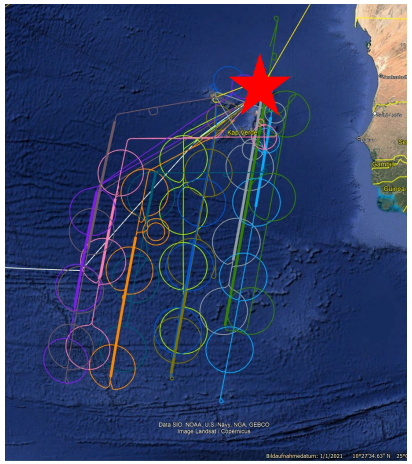
HSRL-Lidar (WALES[1], 532 nm)

Cloud Doppler Radar (MIRA[2], 35 GHz)

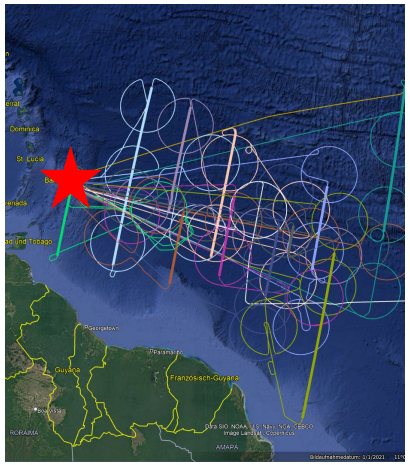
Hyper-Spektral Imager (specMACS[3])

Thermal Infrared Imager (VELOX[4])

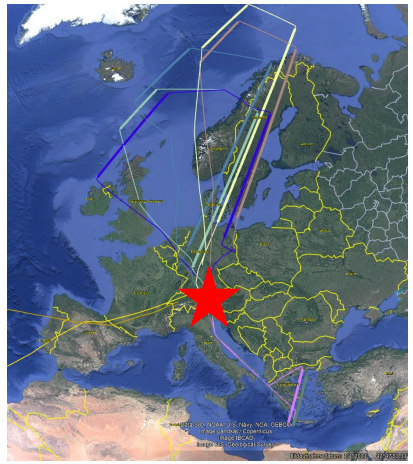
Cap Verde



Barbados



Germany



- Strategy: EarthCARE legs: Underpass ± at least 15 min
- Three sites
- Focus on the tropics

[1]Wirth et al. 2009; [2]Ewald et al. 2019; [3]Ewald et al. 2016, [4]Schäfer et al. 2014

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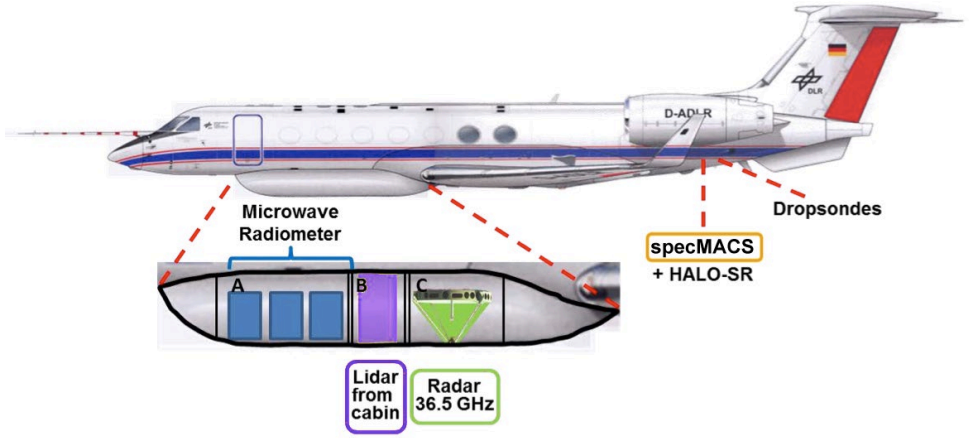
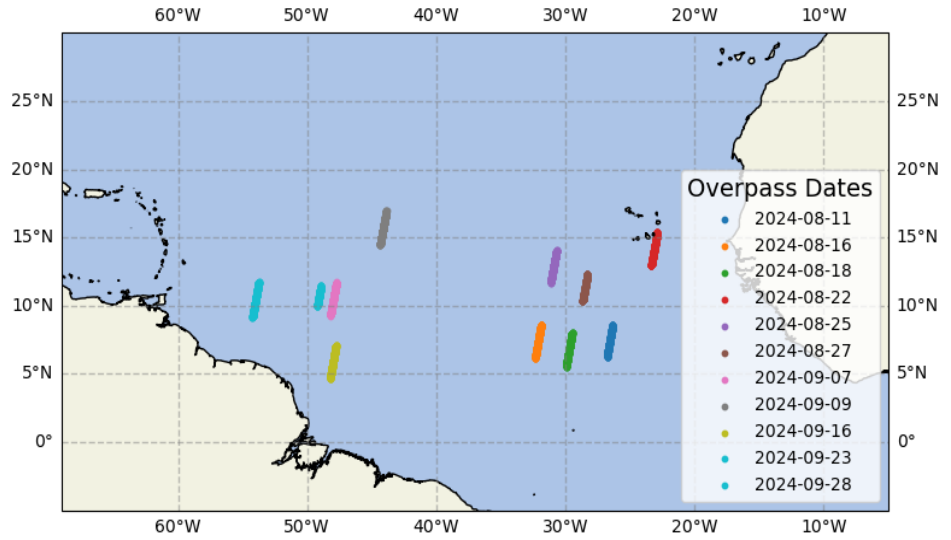


EarthCARE-like payload on HALO

HSRL-Lidar (WALES[1], 532 nm)

11 research flights in the tropics

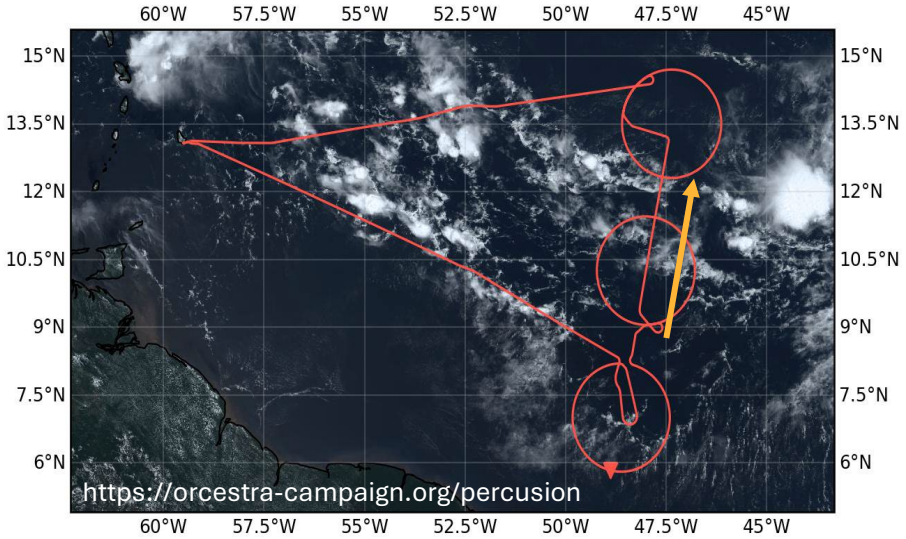


- Data analysis: underpass ±10 min
- ~2900 km flight track (1/3 clouds detected)
- Backscatter ratio (BSR) data set observed with HSRL WALES

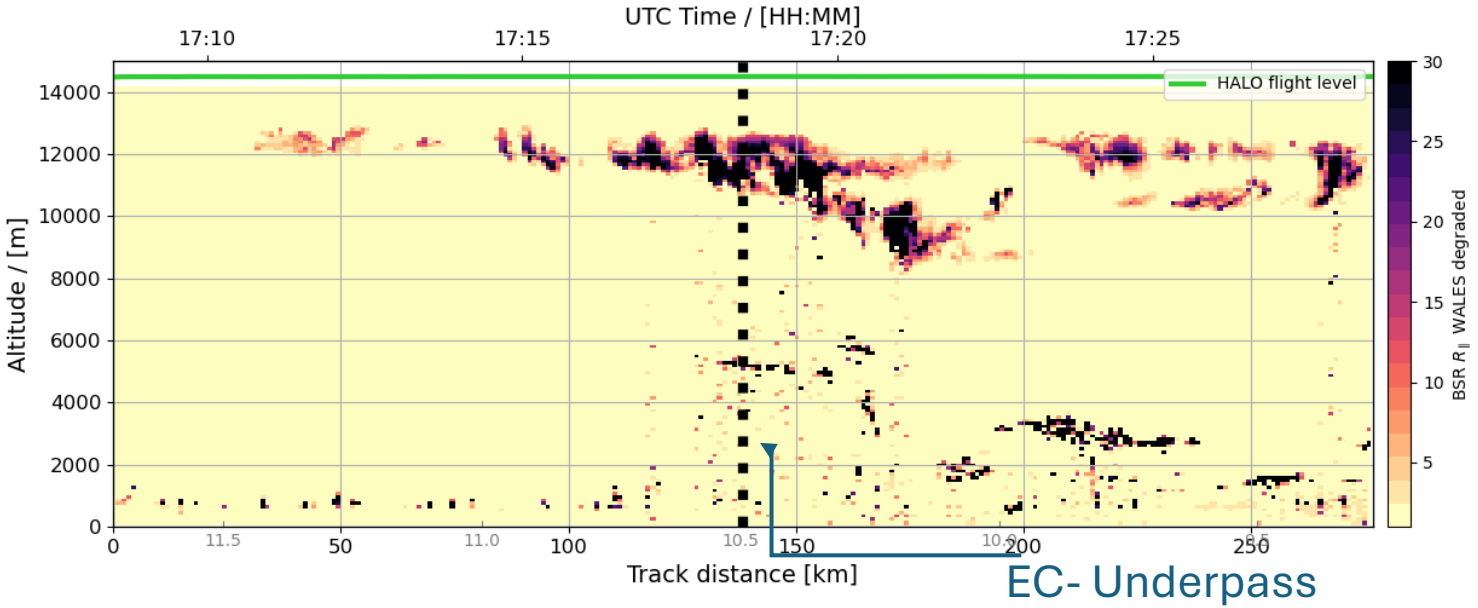
[1]Wirth et al. 2009; [2]Ewald et al. 2019; [3]Ewald et al. 2016, [4]Schäfer et al. 2014

Case study: HALO flight on 7 Sept. 2024

Flight track and GOES image



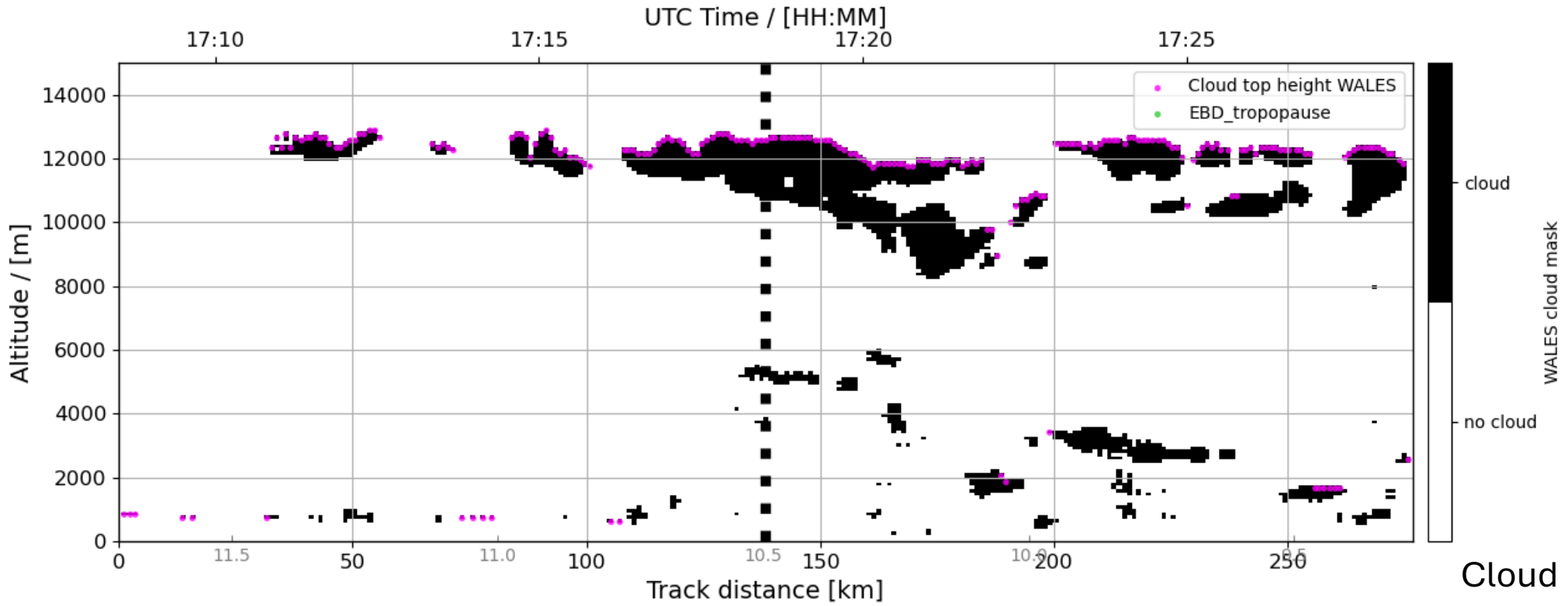
WALES backscatter ratio (BSR) degraded to A-TC grid



- Along EarthCARE track → Clouds at multiple altitudes (high altitude cirrus, boundary layer, mid-level)
- Occasion for validation of different ATLID L2 cloud products
  - Can ATLID correctly capture the cloud distribution? →cloud masks **(A-TC)**
  - How precise is the ATLID-derived cloud top altitude? →cloud top altitude **(A-CTH)**

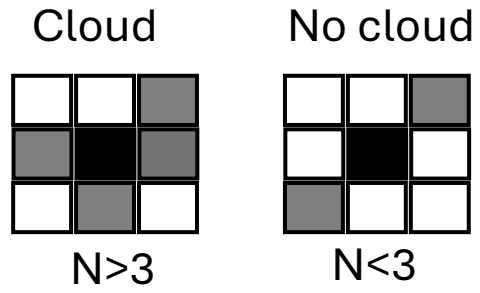
Case study: HALO flight on 7 Sept. 2024

WALES cloud mask



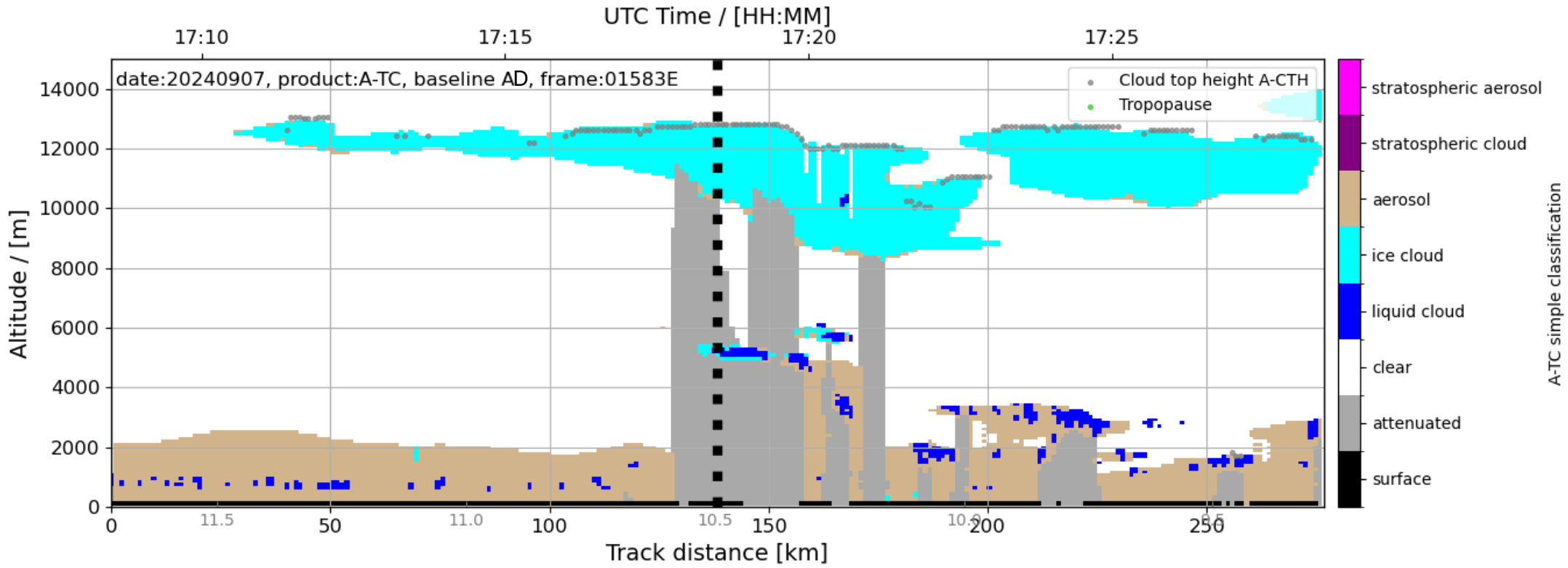
Implementation

- Simplified approach: Threshold-based detection (cloud = BSR > 4) for 3x3 image filter
- Cloud top height determination from the top



Case study: Target classification (A-TC)

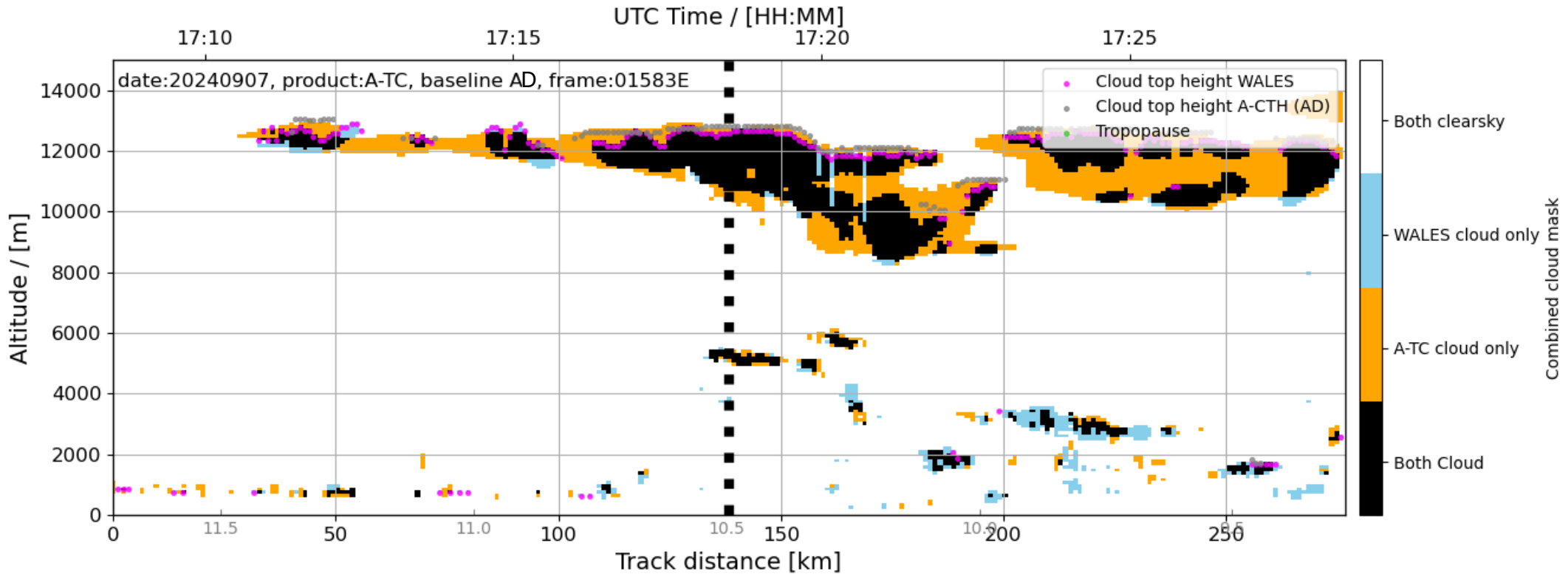
A-TC “simple classification” and A-CTH cloud top altitude



- First glance: ice and liquid cloud mask resemble all features observed by WALES
- Aerosol mask shows a continuous layer in the lowermost 2 km, sometimes aerosol pixels at cloud edges

Case study: Combined cloud mask and top altitudes

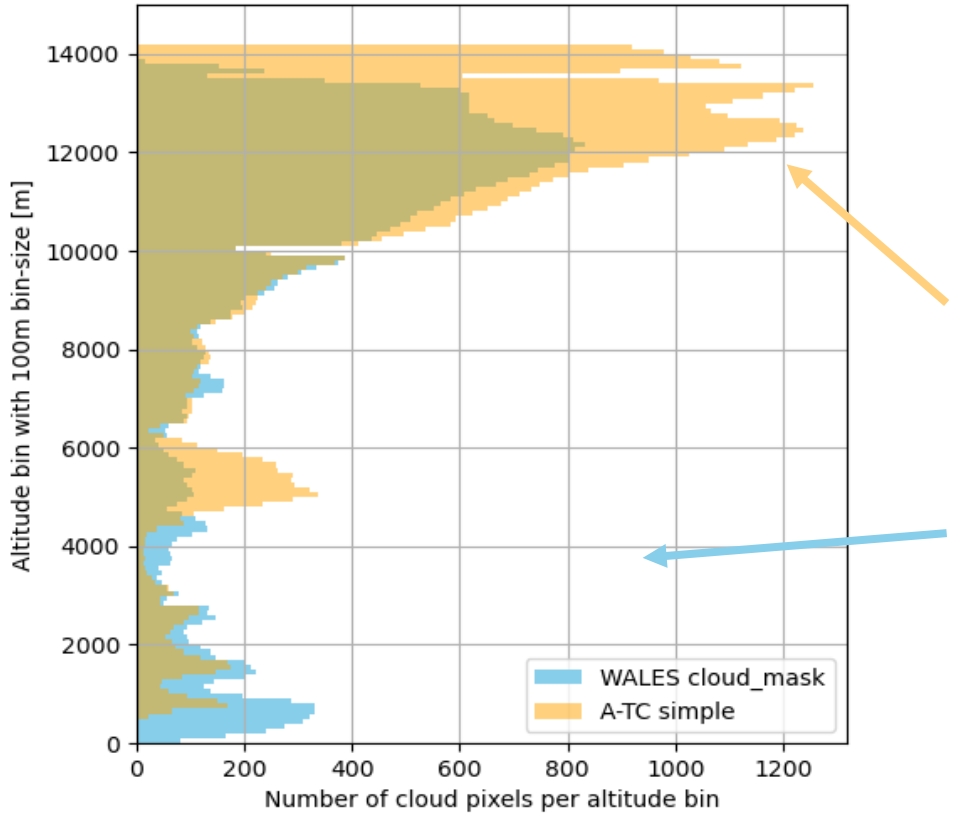
Combined cloud mask of A-CTH and WALES



- Overall good agreement, but clouds in A-TC (liquid+ice) appear to be vertically thicker and less patchy
- Lower agreement for small-scale low-level clouds
- A-CTH cloud top height seems to be slightly higher compared to WALES cloud tops

Statistical assessment (A-TC)

Vertical distribution of cloud pixels (A-TC “simple” vs. WALES) for 11 research flights

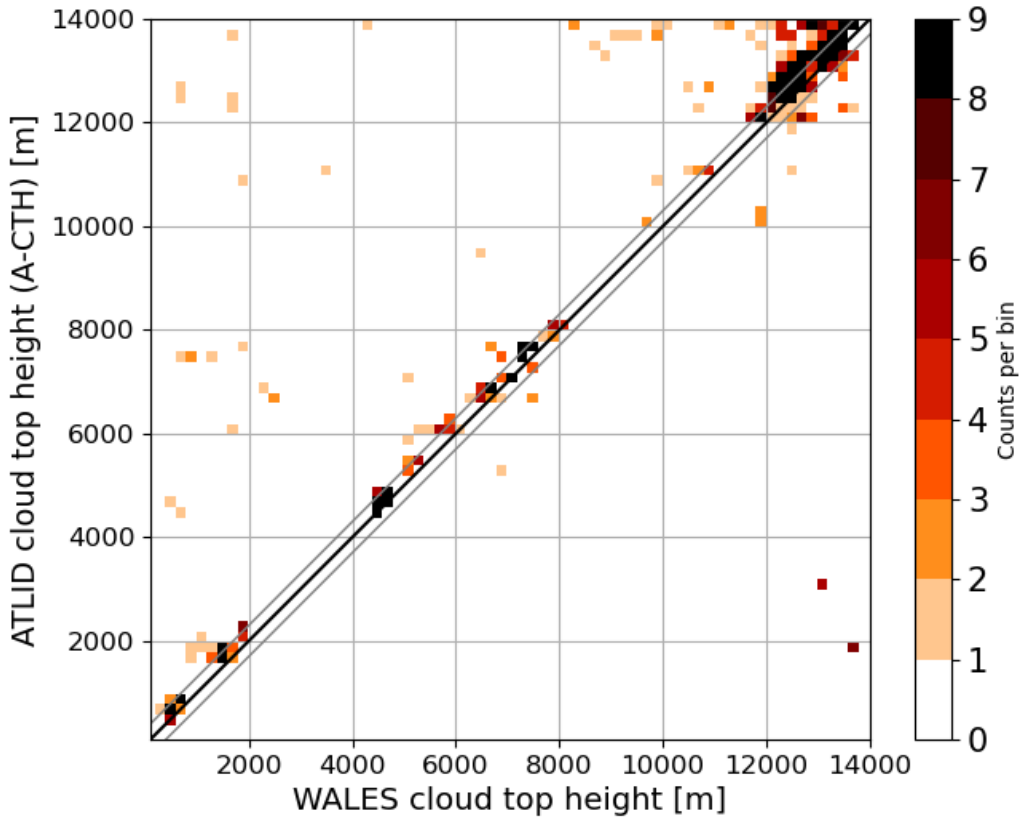


Maxima at similar altitudes in WALES and A-TC mask associated with cirrus (8-12 km), mid-level clouds (3-6 km), boundary layer (1-3 km)

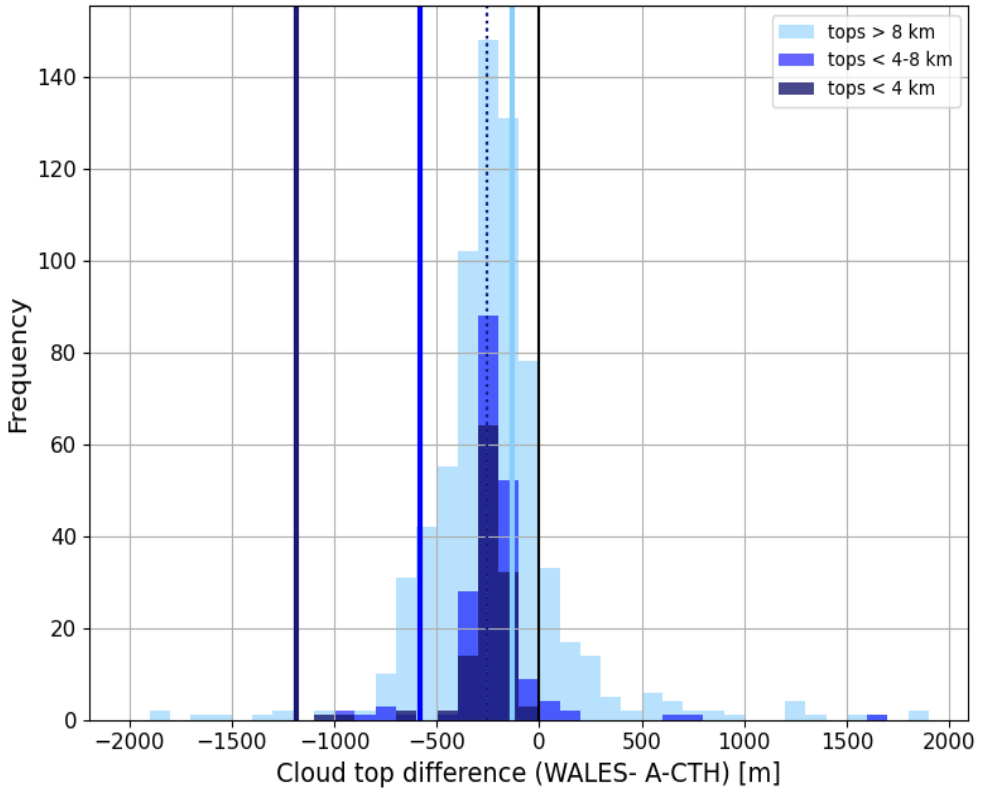
- Overestimation of high altitude clouds in A-TC simple classification (ice+liquid clouds)
- Indication of a slight underestimation of A-TC cloud pixels below 4 km altitude

Statistical assessment (A-CTH)

Bin-averaged correlation of cloud tops



Histogram of cloud top differences



- Good agreement of A-CTH cloud top altitudes compared to WALES (66% within ± 300 m)
- Cases with strong deviations (likely related spatial/temporal mismatch → relevant near cloud edges, sensitivity, ….)

Summary and conclusion

Evaluation of ATLID cloud products with PERCUSION data

- 11 underflights (tropics) covering different clouds scenes
- WALES BSR → cloud mask/ top altitudes determination → comparison with A-TC and A-CTH

Assessing A-TC simple classification

- High agreement between A-TC (liquid+ice) cloud and WALES BSR cloud mask
- Overestimation of high-altitude clouds (because too thick, too horizontally wide-spread)

Assessing A-CTH product

- Accuracy requirements (300 m) are met for the majority (66 %) of the data
- Indication of a overestimation of A-CTH cloud tops

Outlook

- Origin of the deviations between A-CTH/A-TC and WALES? (e.g., sensitivity, mismatch, Level 1 data, cloud mask detection)
- Inclusion of mid- and high-latitude PERCUSION and ASCCI flights