



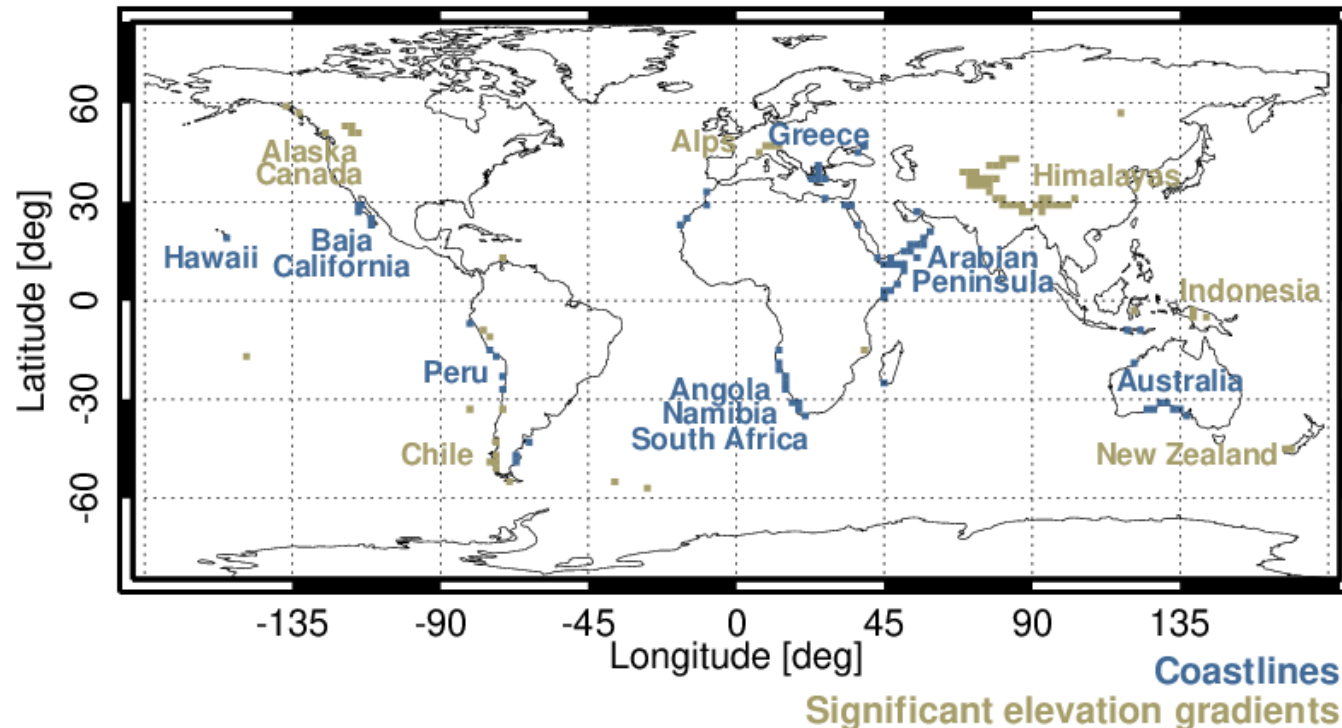
# ATLID and CPR geolocation and co-registration

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McGill University*

1<sup>st</sup> ESA-JAXA EarthCARE In-Orbit Validation Workshop  
14 – 17 January 2025 | VIRTUAL EVENT

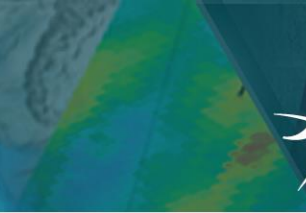


The geolocation assessment has been performed over regions with **significant elevation gradients** and **coastlines**, using the instruments' surface detections



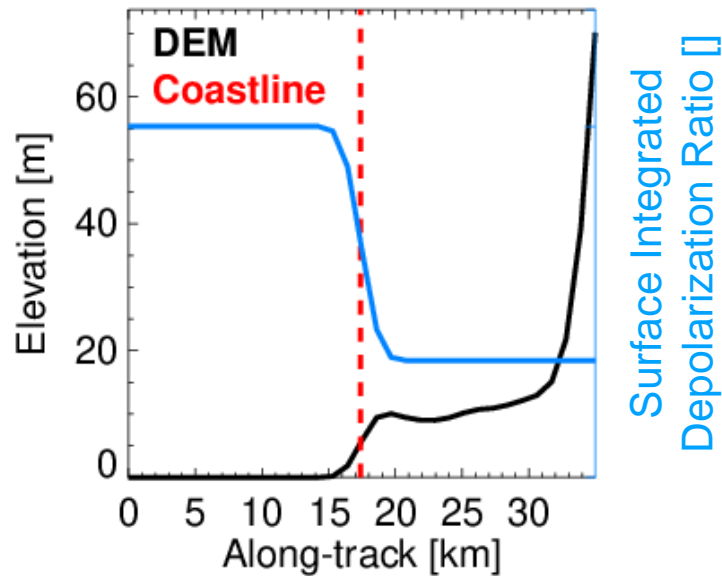
The ATLID and CPR instruments are currently accurately geolocated and co-registered with pointing errors below 100m — five times better than the specified requirements





## Coastlines

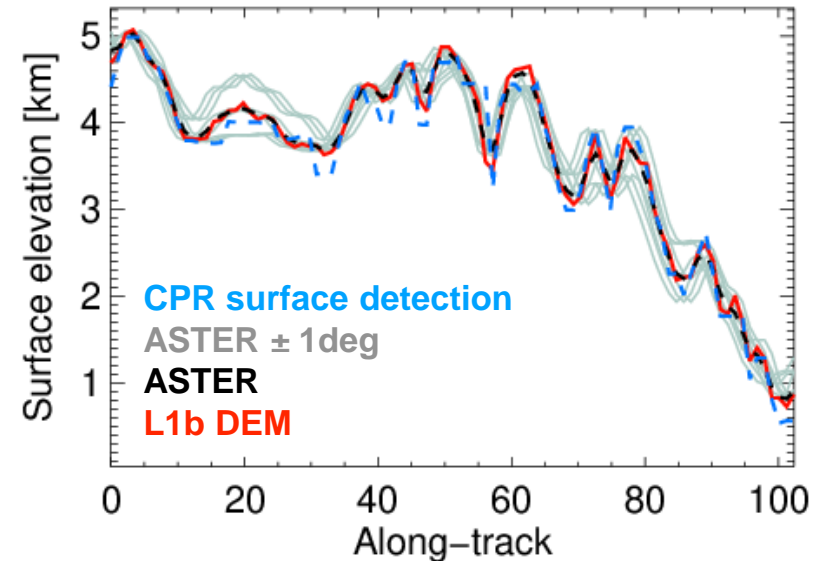
Identify the land/water transition using the surface signal and compare to a reference map



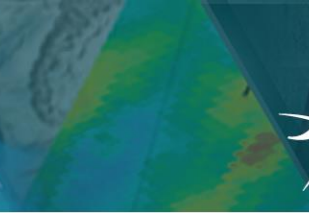
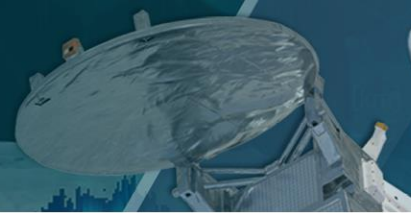
The coastline signature is modelled using a cubic fit.  
The inflection point is considered to be the actual location of the coastline

## Significant elevation gradients

Compare the CPR and ATLID surface detection height to a reference DEM



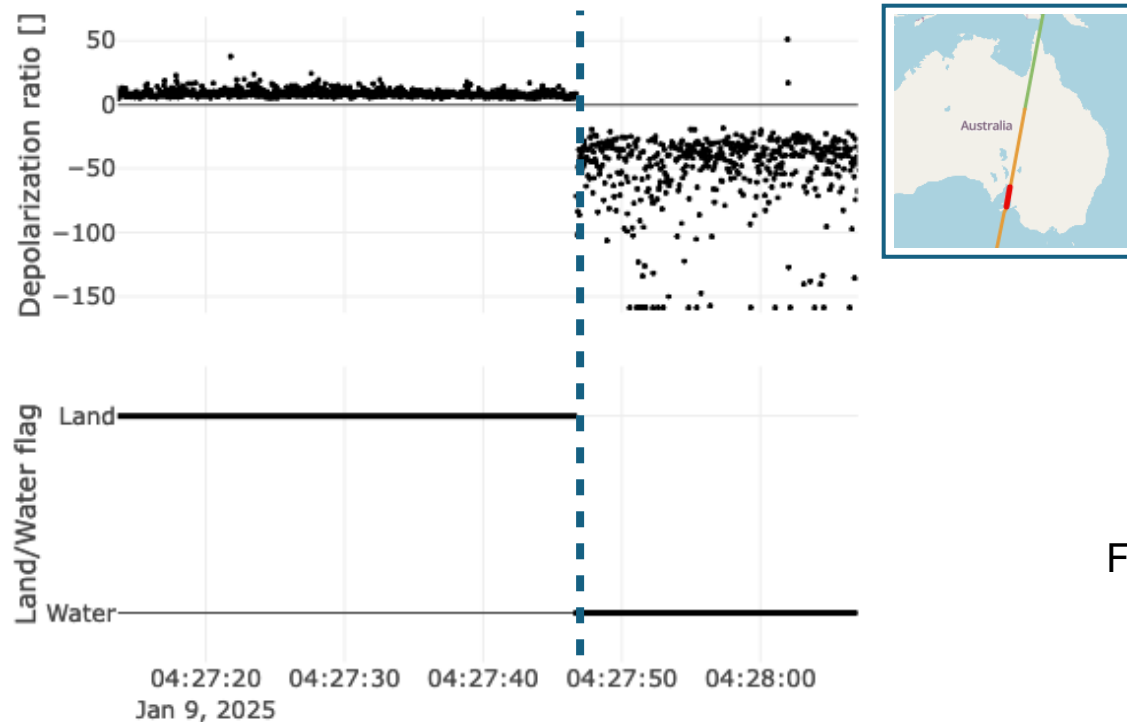
Artificial pointing errors are deliberately introduced in the along- and cross-track directions and the final geolocation error is found by the maximum correlation



## Coastlines

Identify the land/water transition using the surface signal and compare to a reference map

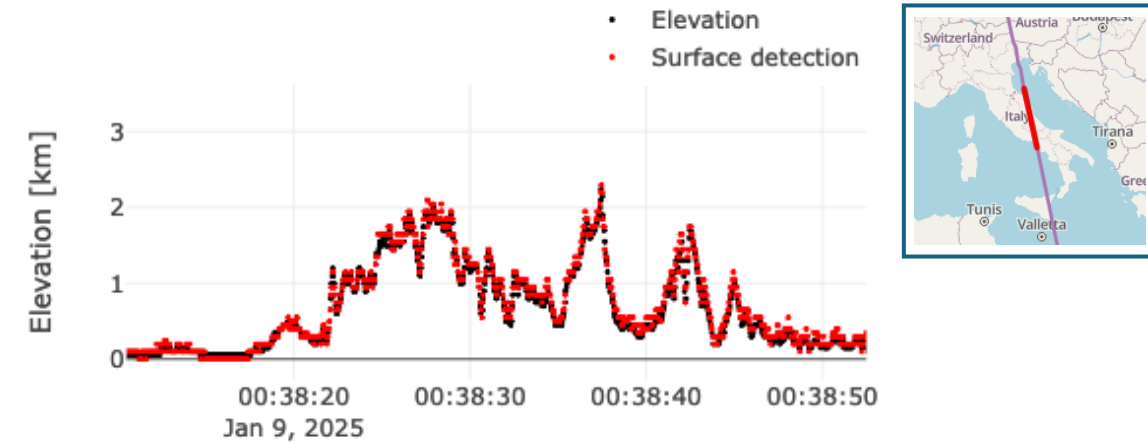
\_EXAC\_ATL\_FM\_\_2A\_20250109T042438Z\_20250109T084534Z\_03504F



## Significant elevation gradients

Compare the CPR and ATLID surface detection height to a reference DEM

\_EXAC\_ATL\_FM\_\_2A\_20250109T003320Z\_20250109T010642Z\_03502B



For more info:

**An improved geolocation methodology for spaceborne radar and lidar systems**

Bernat Puigdomènech Treserras and Pavlos Kollias

doi: 10.5194/amt-17-6301-2024

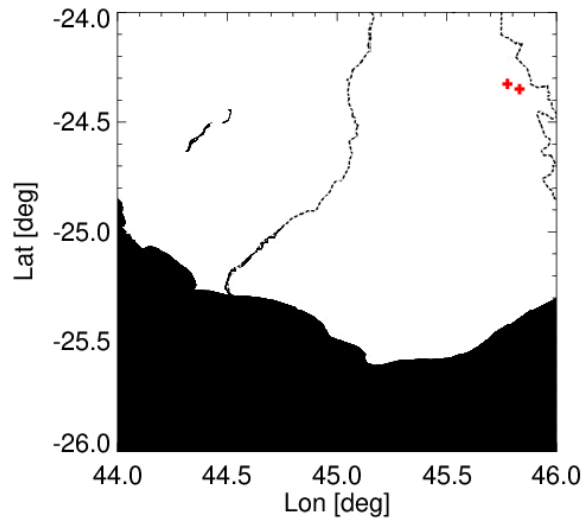


# EarthCARE CPR Geolocation

## Coastlines

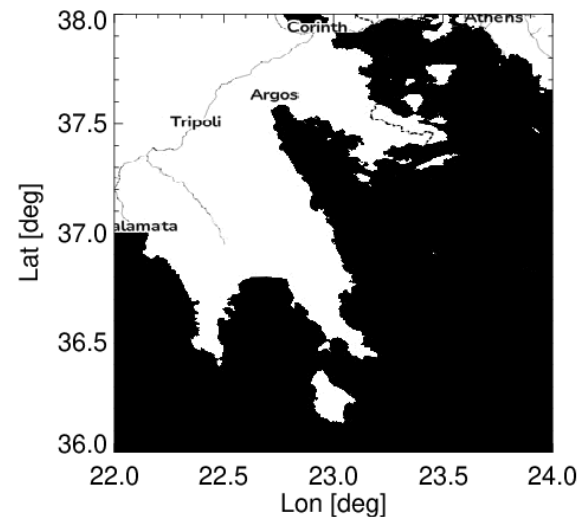
The absolute geolocation is determined by minimizing the error between a collection of coastline detections and the reference map

### Madagascar



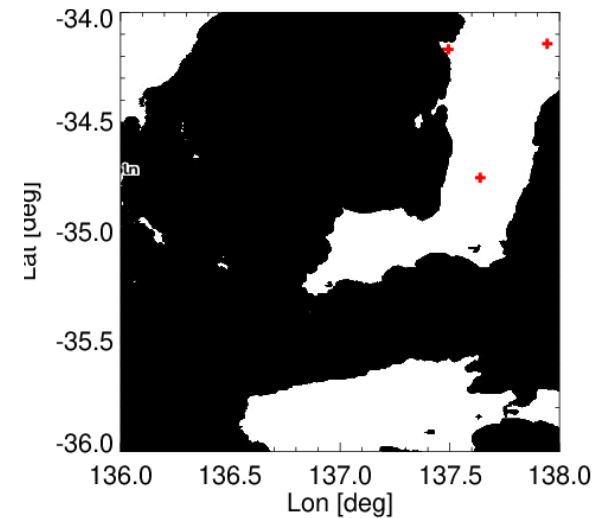
**N detections: 6**  
**Orbit tilt: -10° (N-W)**  
**Iteration: 1**  
**Cross-track offset: +6.403° ~ +79111m**  
**Along-track offset: +10.297° ~ +128085i**

### Greece



**N detections: 15**  
**Orbit tilt: -13° (N-W)**  
**Iteration: 1**  
**Cross-track offset: +5.067° ~ +62516m**  
**Along-track offset: +10.324° ~ +128421m**

### South Australia



**N detections: 20**  
**Orbit tilt: -10° (N-W)**  
**Iteration: 1**  
**Cross-track offset: +5.761° ~ +71121m**  
**Along-track offset: +10.093° ~ +125492m**

The coastline technique is less reliable;

One or few crossing detections per overpass based on  $\sigma_0$  measurements with an along-track resolution of 500m

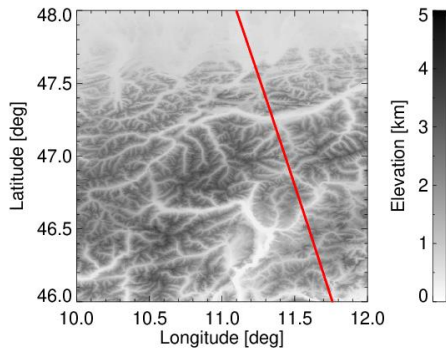
The significant gradients provide many reliable surface detections per overpass with a higher sampling resolution of 100m in height



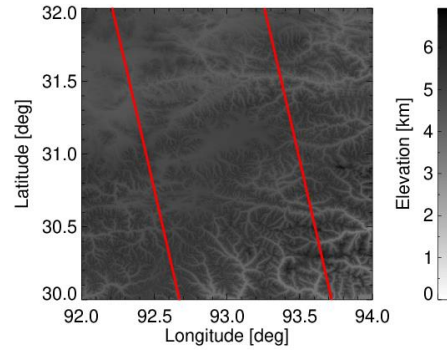
# EarthCARE CPR Geolocation

## Significant elevation gradients

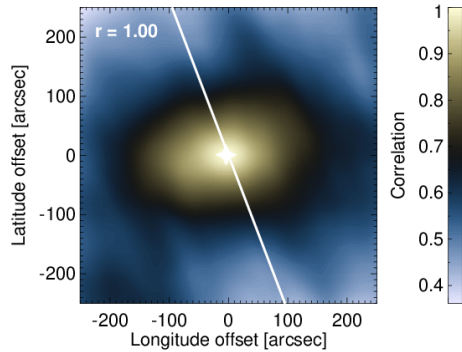
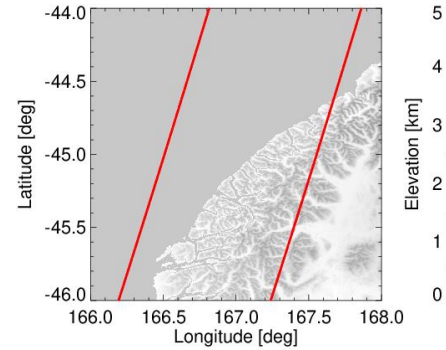
### Austrian Alps



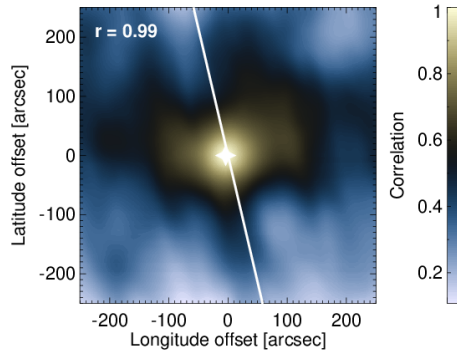
### Central Tibet



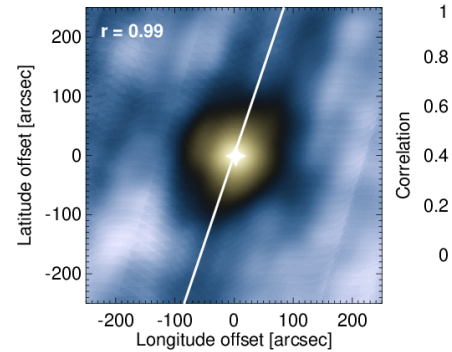
### New Zealand



**N overpasses: 1**  
**N detections: 439**  
**Orbit phase: ASC**  
 Cross-track offset:  $-0.013^\circ \sim -89m$   
 Along-track offset:  $+0.001^\circ \sim +8m$



**N overpasses: 2**  
**N detections: 869**  
**Orbit phase: ASC**  
 Cross-track offset:  $-0.015^\circ \sim -104m$   
 Along-track offset:  $-0.003^\circ \sim -20m$

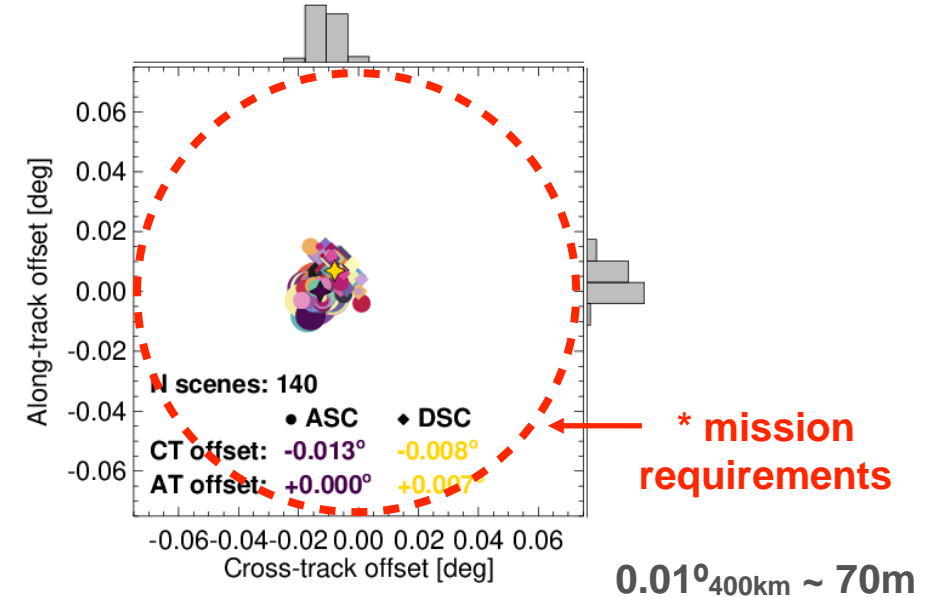


**N overpasses: 2**  
**N detections: 315**  
**Orbit phase: DSC**  
 Cross-track offset:  $-0.008^\circ \sim -56m$   
 Along-track offset:  $+0.007^\circ \sim +45m$

Starting from baseline AD, the EarthCARE CPR demonstrates excellent geolocation

## Combined statistics

Dec 2024



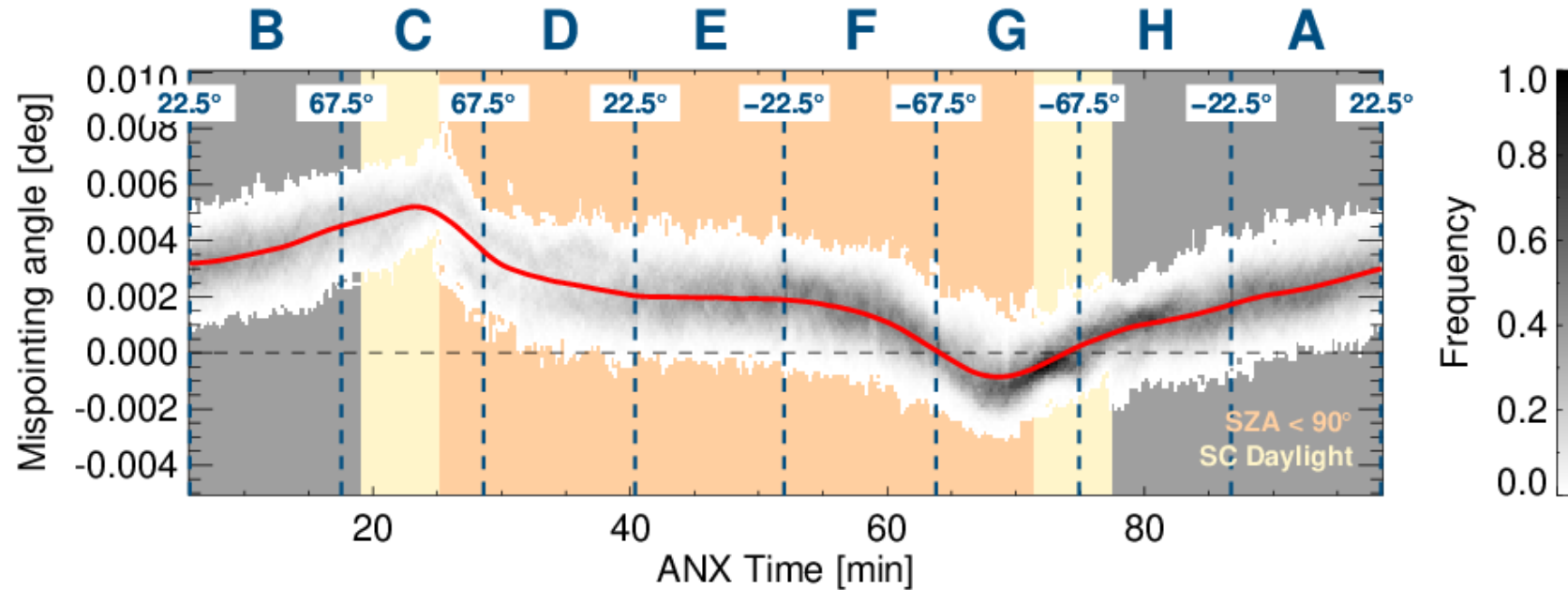


## EarthCARE CPR antenna mispointing

Derived from clear-sky surface Doppler measurements over the sea surface (free of ice) and snow-covered land

Mispointing trends influenced by solar illumination cycles and thermoelastic distortions on the antenna

**Satellite line-of-sight velocity contamination**  
 $0.01^\circ (7.6\text{km/s}) \rightarrow 1.32\text{m/s}$



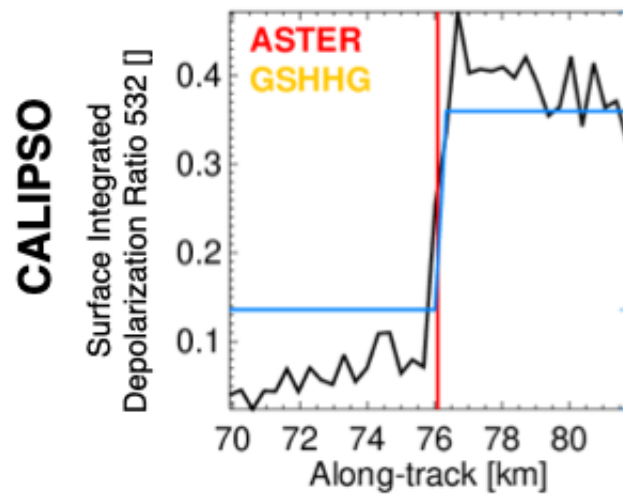
...more information in the “Findings on Level 1 product from ESA Level 2A algorithm verification” presentation

# EarthCARE ATLID Geolocation

## Coastlines

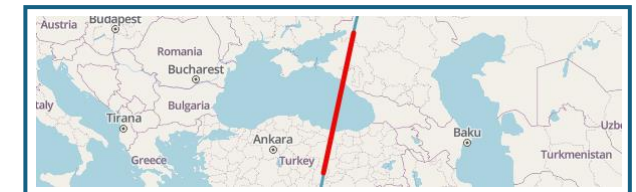
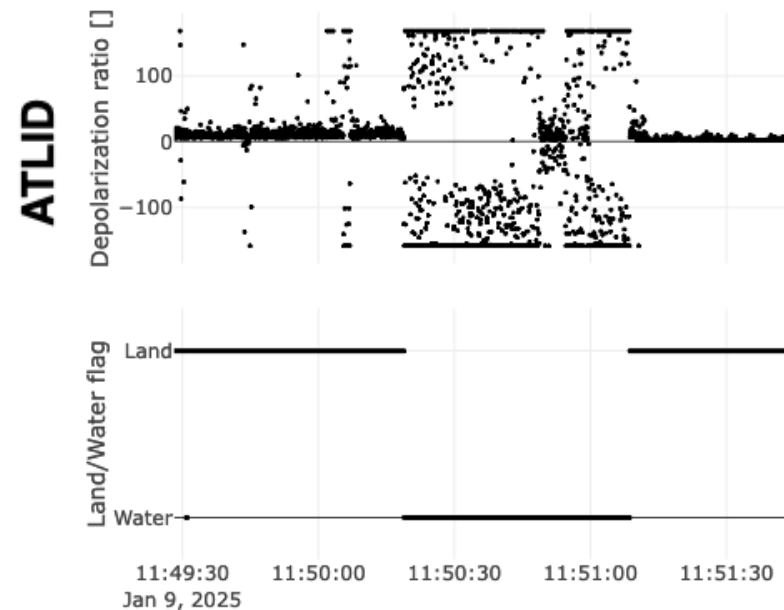
The ATLID geolocation could not be assessed using coastlines. The surface depolarization ratio is not stable enough

### Expectations



### Reality

\_EXAC\_ATL\_FM\_2A\_20250109T114401Z\_20250109T133155Z\_03509D





# EarthCARE ATLID Geolocation

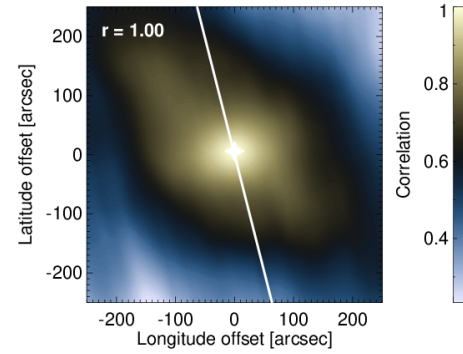
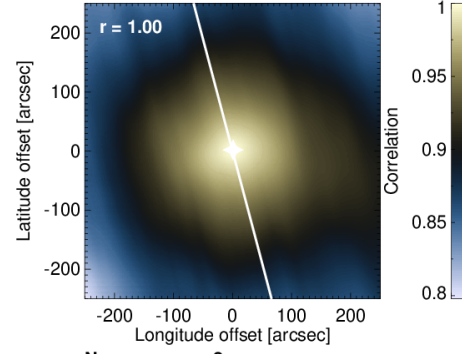
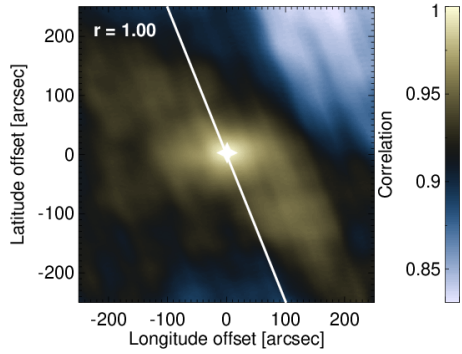
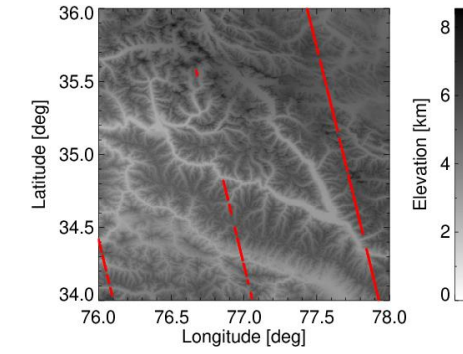
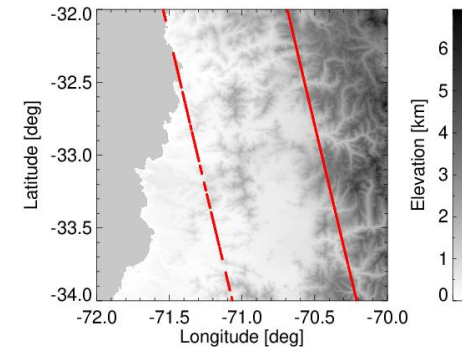
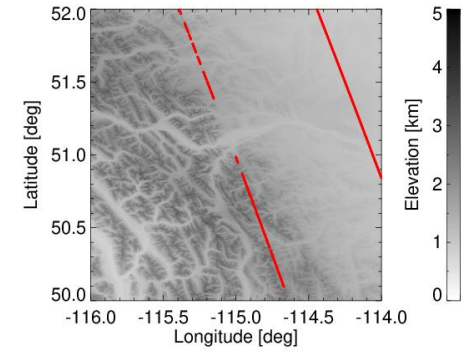
Significant elevation gradients

Very good geolocation since first observations

## Canada

## Central Chile

## Northern India



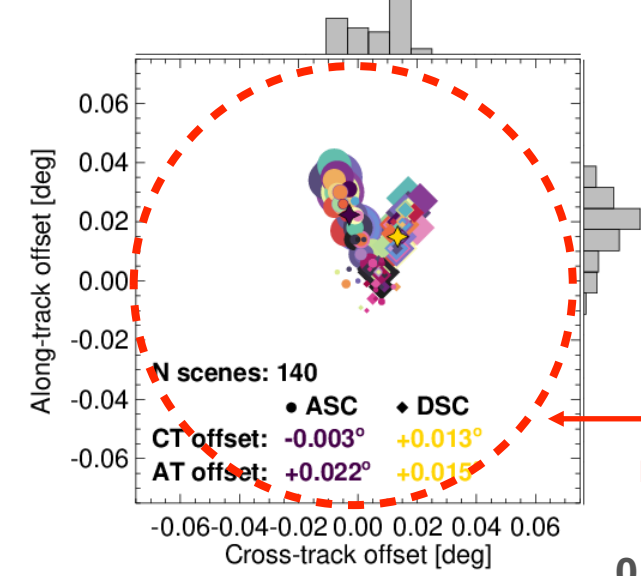
**N overpasses: 17**  
**N detections: 950**  
**Orbit phase: ASC**  
**Cross-track offset: -0.001° ~ -5m**  
**Along-track offset: +0.014° ~ +94m**

**N overpasses: 2**  
**N detections: 1588**  
**Orbit phase: ASC**  
**Cross-track offset: +0.002° ~ +12m**  
**Along-track offset: +0.009° ~ +65m**

**N overpasses: 40**  
**N detections: 954**  
**Orbit phase: ASC**  
**Cross-track offset: -0.005° ~ -37m**  
**Along-track offset: +0.026° ~ +181m**

## Combined statistics

Dec 2024



**N scenes: 140**  
**• ASC** **◆ DSC**  
**CT offset: -0.003°** **+0.013°**  
**AT offset: +0.022°** **+0.015°**

**\* mission requirements**

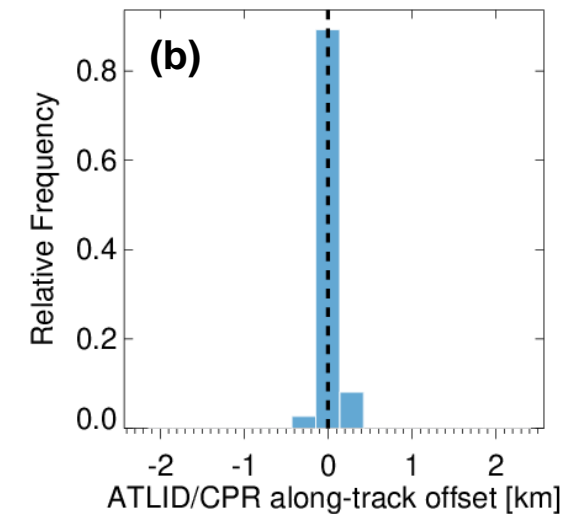
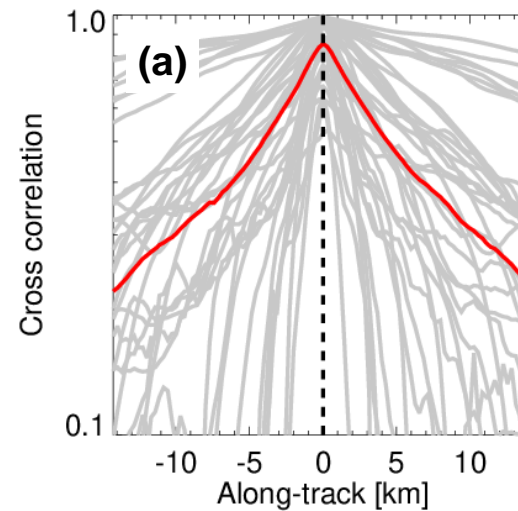
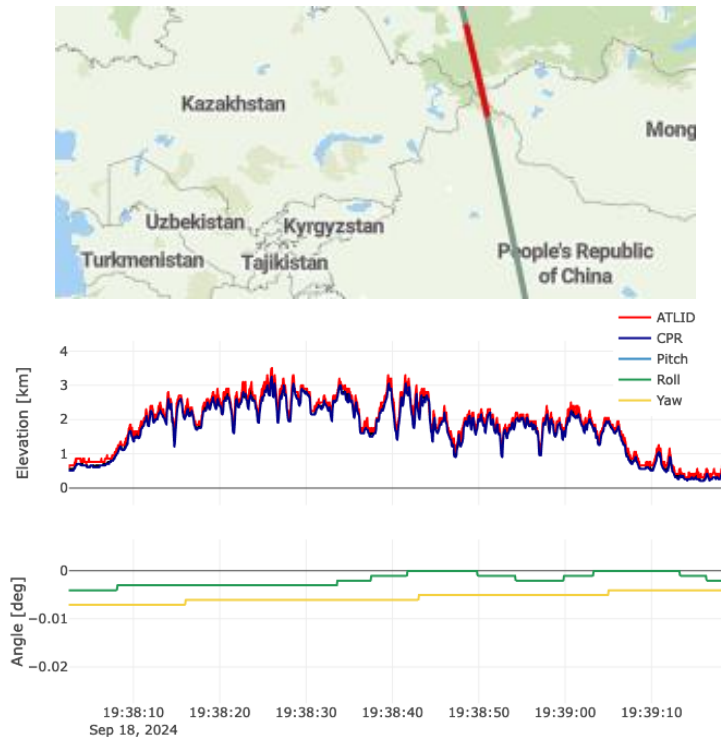
0.01°<sub>400km</sub> ~ 70m



# EarthCARE CPR and ATLID Co-Registration

Compare the **surface height detection** of both instruments in the along-track direction, considering the differences between their pointing angles that translate into time differences of about 3s

ECA\_JXAD\_CPR\_NOM\_1B\_20240918T193126Z\_20240918T215801Z\_01756B



(a) cross-correlation of CPR and ATLID surface height detections (grey lines) for the 70 significant elevation selected scenes, with the red line depicting the average.  
 (b) histogram of the maximum CPR and ATLID cross-correlation lags at the ATLID's along-track resolution (285m)