# EarthCARE geolocation accuracy assessment for passive instruments (MSI, BBR): proof of concept

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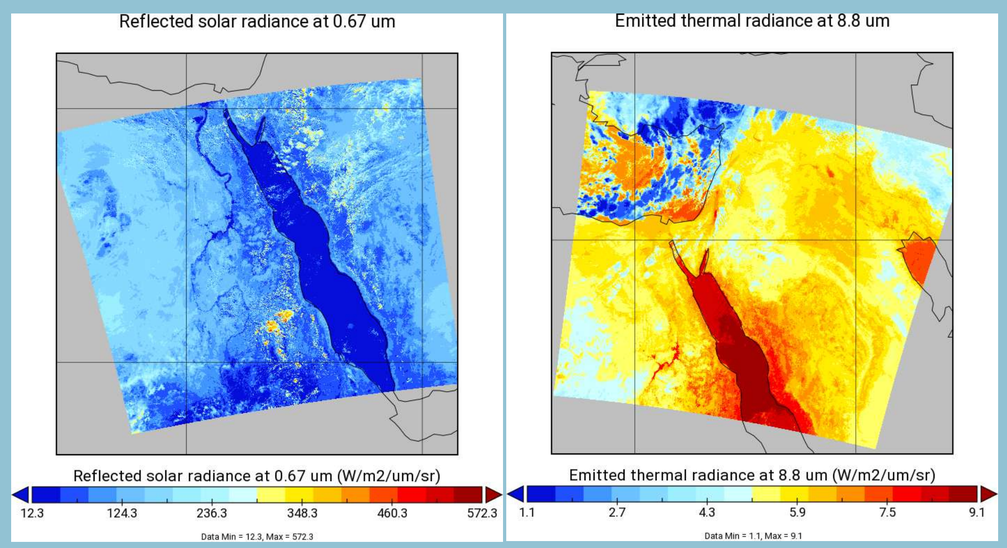
## Abstract

Geolocation is essential to all EarthCARE L1 and L2 data products. The EarthCARE spacecraft Attitude Determination System (ADS) is expected to provide high quality information on the satellite location and pointing. This information must be evaluated, though, to determine its absolute accuracy, and to uncover unknown error sources, if any. In addition to the absolute geolocation, co-registration of the instruments is especially important for the interpretation of the information provided by each sensor and for the development of synergistic algorithms.

This study aims to be an assessment of the geolocation accuracy of the passive instruments on board the EarthCARE platform (the multi-spectral imager MSI, and the broadband radiometer BBR). Both absolute and relative geolocation accuracy will be assessed.

The approach that will be used during commissioning is demonstrated on a test dataset, obtained by collecting radiances from the Moderate Resolution Imaging Spectroradiometer (MODIS) instrument. A coastline detection algorithm is applied to the reflected solar radiances, and compared to databases of known coastline locations. Furthermore, relative co-registration between the reflected solar radiances and emitted thermal radiances is demonstrated for the test dataset.

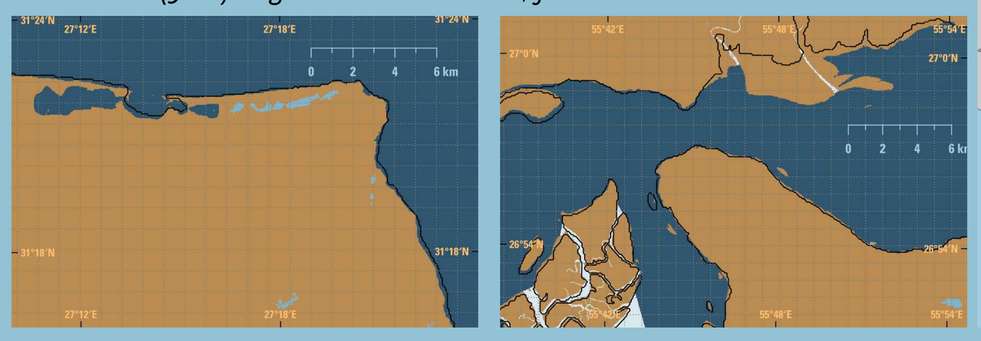
## Data




**Radiance data: MODIS (Moderate Resolution Imaging Spectroradiometer)**
*Mock-up dataset compiled from Aqua data, for all selected scenes (see below) for the year 2019.*
*Products used: MYD021KM (1km radiances), MYD03 (geolocation), MYD35_L2 (cloud mask)*

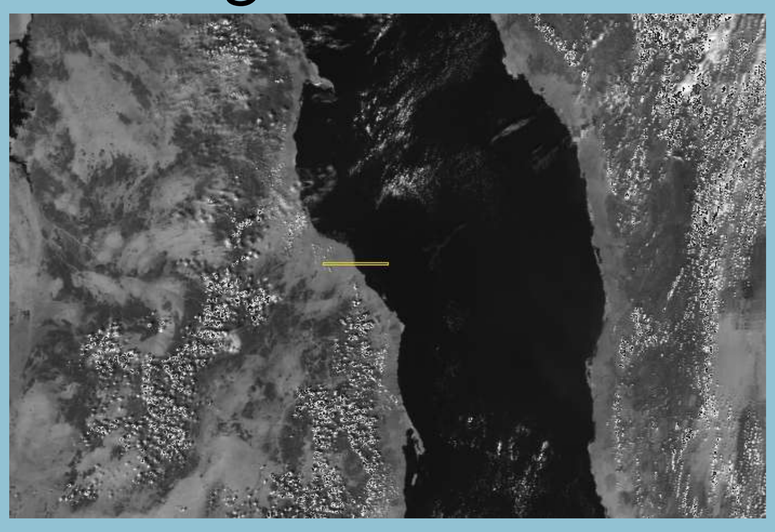
| Channel (nominal MSI wavel.) | MODIS | MSI |
|---|---|---|
| Visible (0.67 µm) | 620 – 670 nm (250m, **1000m**) | 660 – 680 nm (500m) |
| Near-infrared (0.865 µm) | 841 – 876 nm (250m, **1000m**) | 855 – 875 nm (500m) |
| Short-wave infrared 1 (1.65 µm) | 1628 – 1652 nm (500m, **1000m**) | 1625 – 1675 nm (500m) |
| Short-wave infrared 2 (2.21 µm) | 2105 – 2155 nm (500m, **1000m**) | 2160 – 2260 nm (500m) |
| Thermal infrared 1 (8.8 µm) | 8.400 – 8.700 µm (1000m) | 8.35 – 9.25 µm (500m) |
| Thermal infrared 2 (10.8 µm) | 10.780 – 11.280 µm (1000m) | 10.35 – 11.25 µm (500m) |
| Thermal infrared 3 (12.0 µm) | 11.770 – 12.270 µm (1000m) | 11.55 – 12.45 µm (500m) |

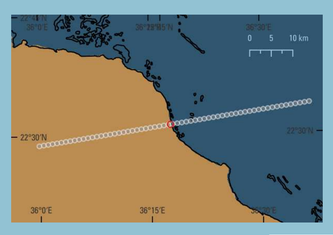
**Digital Elevation Model (DEM): Copernicus GLO-30**
*1-arcsecond (30m) Digital Elevation Model, from the TanDEM-X mission*

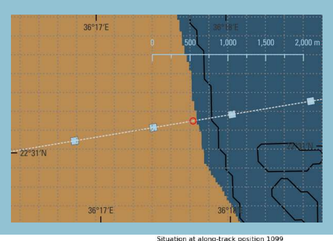


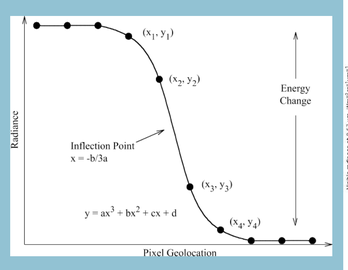

**Vector shoreline dataset: GSHHG**
*Wessel & Smith (1996), version 2.3.7, June 2017, but suffers from inaccuracies (see comparison with DEM to the left)*

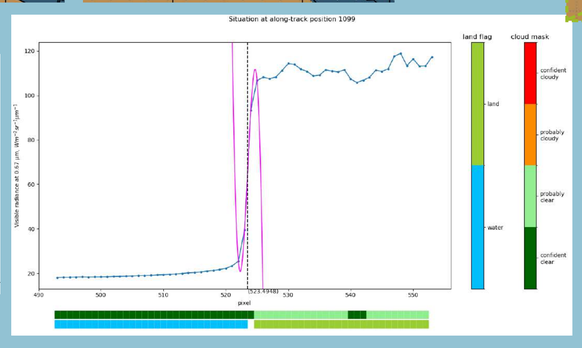

## Absolute geolocation assessment



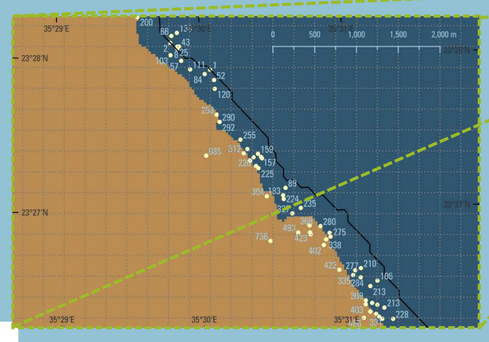


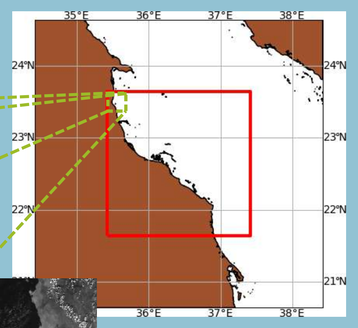



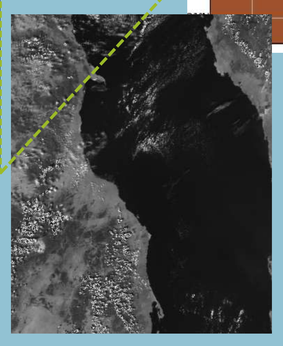




## Results (Red Sea 2019)

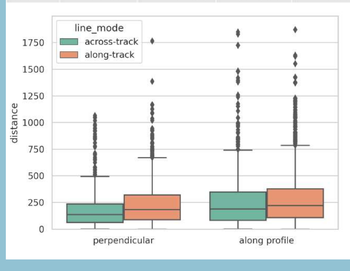


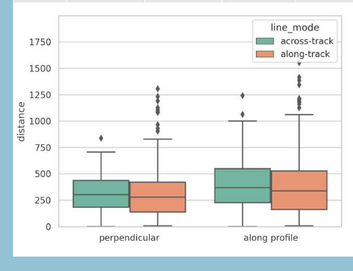
### visible (0.67µm)

| | sensor elevation angle, ° | solar elevation angle, ° | distance (perp.), m | distance (along profile), m |
|---|---|---|---|---|
| count | 3473 | 3473 | 3473 | 3473 |
| mean | 78.90 | 48.32 | 217.56 | 267.98 |
| std | 5.51 | 9.59 | 180.51 | 227.79 |
| min | 71.28 | 38.39 | 0.02 | 0.02 |
| 25% | 73.56 | 40.45 | 83.30 | 102.81 |
| 50% | 78.46 | 44.32 | 173.84 | 219.37 |
| 75% | 81.49 | 53.05 | 311.07 | 375.91 |
| max | 89.97 | 70.53 | 1766.02 | 2301.54 |

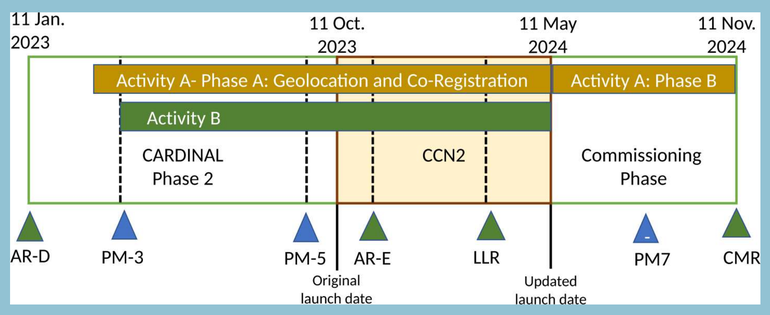



### thermal infrared (8.8µm)

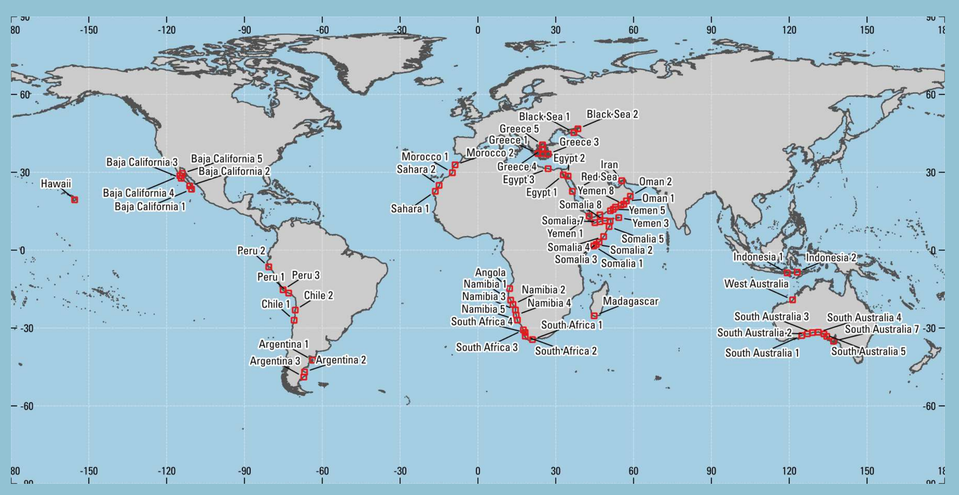
| | sensor elevation angle, ° | solar elevation angle, ° | distance (perp.), m | distance (along profile), m |
|---|---|---|---|---|
| count | 370 | 370 | 370 | 370 |
| mean | 76.87 | 34.11 | 317.36 | 396.78 |
| std | 4.00 | 54.62 | 243.90 | 341.16 |
| min | 69.64 | -67.16 | 0.54 | 0.55 |
| 25% | 72.75 | 58.08 | 143.86 | 167.20 |
| 50% | 76.11 | 64.94 | 285.49 | 343.87 |
| 75% | 80.85 | 65.26 | 430.47 | 532.96 |
| max | 88.60 | 70.50 | 2016.69 | 3786.49 |




## Timeline




## Scenes




## Status

– Compiling mock-up dataset: complete (2.5 TB)
– Absolute geolocation assessment: in progress (algorithm complete but now applying to scenes)
– Relative co-registration assessment: in development (optimization approach)

## References & acknowledgments

*Geolocation and Co-Registration verification*, CARDINAL Technical Note 6.A1 version 0.0.1 (draft), Bernat Puigdomènech Treserras and Edward Baudrez, 7 September 2023

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