VALIDATION OF ENVISAT ASAR GEOCODED PRODUCTS

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ABSTRACT

Geometric accuracy is a very important quality aspect of each remote sensing product, especially for use in combination with geographic information systems. This paper describes the approaches and techniques for validation of geometric parameters and the results in the commissioning phase of ENVISAT. Specially the Geocoded Image Mode (IMG) and the Medium resolution Image Mode (IMM) were tested

The paper describes the results of the DLR activities in the ESA ASAR calibration group. They are related to the results of the team member Joanneum Research (Graz) and Remote Sensing Lab (Zürich).

1 INTRODUCTION

The PF-ASAR processor produces for the different modes of the ASAR sensor a large variety of products in different levels. The highest standard processing level 1b supported by ESA are ellipsoid geocoded products. They are important data sets for the value adding industry. Therefore it is necessary to deliver accurate numbers of product parameter specially for the geocoding to guarantee their quality.

Geocoding is the process of the reduction of internal geometric distortion fixing external absolute location. To fulfil this exact relationship a very detailed calibration and validation is required.

During the commissioning phase of ENVISAT various products were tested. At the beginning of the project it was planned to investigate the geometric quality in test sites covering the whole globe with the different geodetic systems. Due to the late availability of real ASAR products only the Flevopolder test site were available.

The result of each test was reported to ESA and the cal-val team if necessary an upgrade of the SAR processor was initiated.

During the commissiong phase more than 60 products were analysed. Errors which where detected in former releases of the processor are not listed in this paper. Only results of products from the latest PF-ASAR version 3.03 are shown in this paper.

2 TEST PROCEDURE

A large variety of products have to checked and in each of them different parameters should be investigated. Following tests are carried for ENVISAT ASAR data:

- Product format verification
- Localisation accuracy
- Geocoding parameters
- Radiometric resampling effects
- Consistency of the products
- Temporal consistency
- Interchannel co registration of AP-mode

3 LOCATION ACCURACY USING GCP AND ADJUSTMENT

The geometric location accuracy of Envisat products was determined by using control points (GCP). The ground coordinates of such points can be made available either by means of corner reflectors as specifically established for this purpose, or by means of co-ordinate measurements made in a reference map. The image co-ordinates in either case have to be measured interactively. As input, the following information are used:

Sensor model,
Control information,
Corner reflectors,
Control points,
Reference maps.

The test site Flevopolder has a very flat terrain. Therefore topographic will not effect the validation with GCP's. In one data take from ENVSAT of 84 control points were measured. Topographic maps 1:50 000 from Netherlands were used. The measurement was done in the national Dutch geodetic reference system. (Bessel 1842, Ammersfoort, stereographic projection). As input data the single look complex product IMS 337_01894_0017.N1 was available. The measurement was done in the slant range geometry to avoid any systematic effects.

Figure 1 shows the distribution of the GCP's.

Figure 1: Ground Control Point distribution at Flevopolder test site

The first run of the adjustment computes for each GCP a misloaction. The operator has to delete points with unexpected high residual. High residuals in the first run are an indicator for wrong measurements or not clear defined points.

Table 1 presents the location accuracy of the IMS product after the adjustment. From 84 measured points 74 could be used. The units are the pixelsize of the mulitlook (5) IMS product.

Ground control points: 74	X[pxl]	Y[pxl]	XY[pxl]
Rms	4.61	1.09	4.74
Mean	-0.00	0.00	3.83
Std	4.61	1.09	2.79
Min	-10.92	-2.12	0.20
Max	11.26	2.43	11.32

These accuracies fit the specifications of the IMS product and are in the same dimension as other approaches inside of the Cal-Val team achieved.

4 LOCATION ACCURACY OF IMG PRODUCTS WITH REFERENCE DATA

The Image Mode Ellipsoid Geocoded Image (IMG) product is stand-alone Image Mode Geocoded SAR image generated in either HH or VV polarisation, using the Range/Doppler algorithm with the best available instrument corrections. It is the highest product level of ESA Processing and Archiving Centers (PAC).

To control the geometric misloaction reference data can be a very useful source. One very well calibrated SAR product is the geocoded amplitude of SRTM. These products guarantee a geometric misloaction of only 4 m. These numbers are more accurate than GCP measurements in topographic maps. They are not influenced by the accuracy of topographic maps and errors in the interactive GCP measurement.

During the Shuttle Radar Topographic Mission (SRTM) the area of Flevopolder was covered by two X-band radar images. The accuracy increased in the crossing over areas, where the Flevopolder test site is located.

The geodetic reference of SRTM products is identical to IMG products of ENVSAT, UTM and WGS84. Therefore no effects caused by additional resampling and non well-defined projection.

Figure 2: SRTM reference image

Using GCPs only the accuracy of selected point can be measured, areas or special geometric features with a well known shape such as lines or circles can not be integrated into the quality analysis.

An overlay of the IMG product and the SRTM product shows very fast and accurate any misloaction or resampling effects of the products. The following example is combination of two IMG products, orbit 3547 (green), orbit 3633 (blue) and SRTM (red).

The same approach is used to control the coregistration in the alternate polarisation mode of geocoded images. The final used products have no displacement between the two channel. This confirmes the results of former tests during the commissionig phase and different approaches inside the calval team.

Figure 3: Overlay of ENVISAT and SRTM data

To get an exact mislocation the original resolution of 12.5m should be used. Geometric objects as shown in the next example gives perfect information regarding the location accuracy.

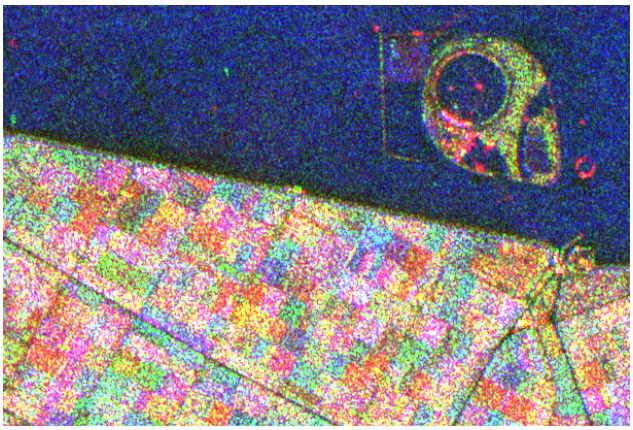

Figure 4: Enlargement of geometric validation feature

Overlays of streets and linear features are identical in the used images. Mislocations are not visible, assumed the objects are flat. In case of object heights relative to the used reference height for the SAR processing, differences are visible. But they are caused by the different incidence angle of ENVISAT and SRTM and their different radar bands. The bridge (Fig. 5) is a very good example. The bridge appears in green and in red. The red “shadow” is caused by the very flat incidence angle or the X-band SRTM data.

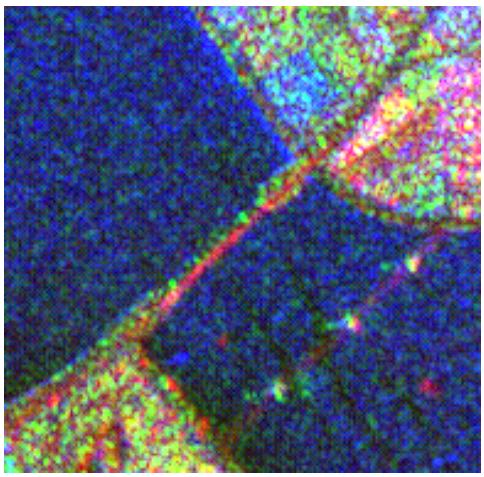

Figure 5: Height mislocation " ENVISAT-SRTM"

5 TEMPORAL PRODUCT CONSISTENCY

The PF-ASAR and the other involved processing modules are optimised from time to time. Also the SAR–system and the satellite are not fixed systems. Therefore the products have to be verified during the mission. At the end of the calibration phase a comparison of PF-ASAR ellipsoid geocoded products was carried out.

The product 3311 was tested and the location accuracy regarding former datasets computed. The processing was done in the same way as for the reference data. A not acceptable geometric mislocation could be demonstrated. It appears only in azimuth direction, in range the product is ok.

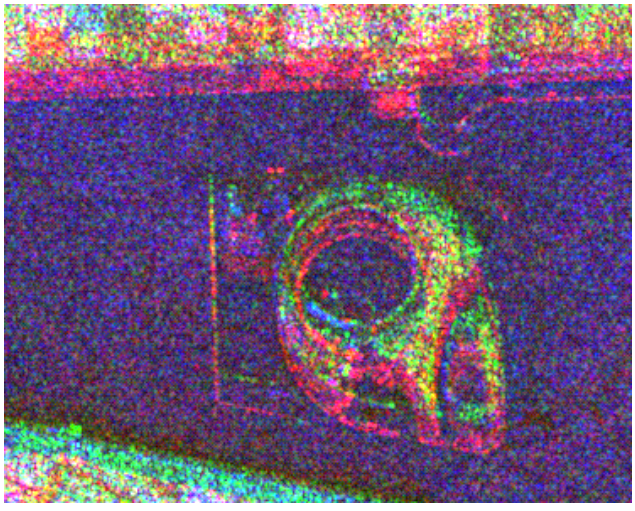

Figure 6: Temporal inconsistency

This bad product could be a result of manoeuvres for the satellite as some colleagues from ESA-mission management reported.

6 QUALITY OF IMM PRODUCTS

PF-ASAR has the capability to generate medium resolution images called IMM. They are image products with a resolution of 150 m. They are processed to ground range geometry without an integration of a Digital Elevation Model (DEM) the geometric quality was checked in a test site in southern Germany. The test was carried with GCP's measured in digital topographic maps.

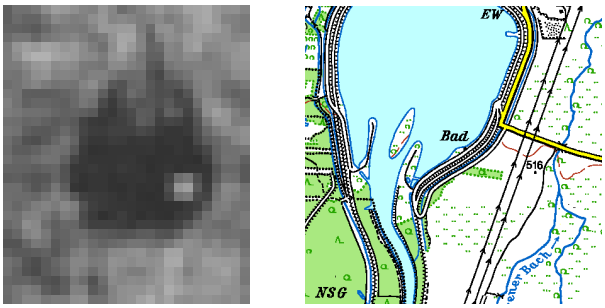

Figure 7: GCP in IMM and topographic map

The absolute coordinates of the GCP are:
48.308/10.960 (image) 48.258 / 10.931 (map)

The difference of 0.05^{O} in northing and 0.02^{O} in easting full fill the specification of the IMM products.

7 CONCLUSIONS

The validation of ENVISAT especially of the image mode was strongly effected by the minimum number of well-processed SAR data. Additionally the late availability of DORIS orbit information influenced the validation process. Only with DORIS resituated orbits the geometric quality of IMG can be achieved.

Results of the validation:

+ Single IMG fulfil the requirements
+ Product formats are ok
+ No radiometric artefacts from processor
+ EnviView software can handle all producttypes
+ Location of IMM is good as expected
+ Exact co registration of APG polarisations
- Temporal consistency not guaranteed
- Check in only ONE test area
- No check in hilly terrain

8 REFERENCES

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