INTERFEROMETRIC PROCESSING OF ENVISAT-1 /ASAR IMAGE MODE AND ALTERNATING POLARISATION MODE FOR APPLICATION IN LAND COVER AND CROP MAPPING.

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ABSTRACT

The paper describes the progress and the preliminary results of the "interferometric part" of the project entitled "Synergetic use of ASAR and SPOT data for land cover mapping and crop monitoring" carried out in the framework of ESA's ENVISAT AO Projects (ID:783). The main data sources for this research are ENVISAT / ASAR detected products (both Image Mode and Alternating Polarization Mode - Geocoded). The acquisition dates and imaging parameters were programmed regarding ASAR flight schedule and instrument availability. Some of the images were demanded in two options: as geocoded detected products and as single look complex data. Long time interval between the acquisitions (temporal interferometric decorrelation) and unpredictable baselines at the moment of image ordering made the data set not optimal for interferometric processing. The interferometric set is undergoing the processing using BEST, DORIS and EV_InSAR Atlantis software packages. Two pairs of ASA_IMS images were processed to coherence maps but the ASA_APS data is still under processing - testing several processing options and variants.

1. INTRODUCTION

The main data sources for this research are ASAR detected products: Image Mode and Alt.Pol Mode. Different polarimetric configurations for Alt.Pol Mode as far as for Image Mode are exploited jointly with a few different imaging angles. Additionally single look complex ASAR products both for Image Mode and Alt. Pol Mode are processed for coherence map generation to create an additional source of potential useful information like in well known case of ERS-1/2 tandem and 35-days repeat pass interferometry. The acquisition dates and imaging parameters were programmed for the test site Malbork located in the North of Poland during 2003 growing season regarding ASAR **flight schedule and instrument availability**. The interferometric pairs are chosen **amongst the available** sets of ASAR data previously acquired for detected product generation. Simultaneously to ASAR acquisition the field observation over test site were performed: visual examination and measurements of some bio-metric parameters of crops. On the other hand the series of 5 optical SPOT images were acquired during the period April-August 2003 for facilitating ASAR images interpretation and understanding. Both sensors are exploited jointly for examining the complementarity and synergism of them. The interferometric set is undergoing the processing using BEST, DORIS and EV_InSAR software packages. Long time interval between the acquisitions (temporal interferometric decorrelation) and unpredictable baselines at the moment of image ordering made the data set not optimal for interferometric processing. The authors had an earlier experience in interferometric processing of ERS-1/2 SLC image series (Image Mode) but this work is a newly gained experience with single look complex data registered in Alternating Polarization Mode.

2. MATERIALS AND METHODS

2.1 Test area.

The test area Malbork is located in the northern Poland near Gdansk agglomeration in the Vistula river delta. This is an agricultural region where dominate the cereals, rape seed and sugar beet as a main crops. The terrain is flat on the west side (delta) and with moderate, postglacial relief on the east side (+/- 20 m high differences). The main advantage of

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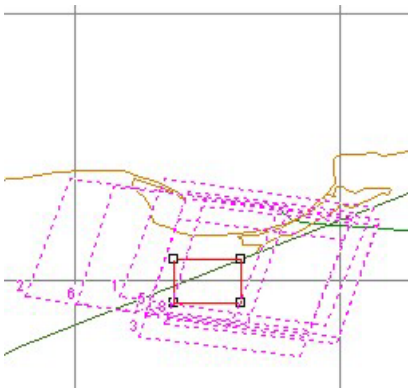
this area for testing RS technologies are large parcels of agricultural crops.



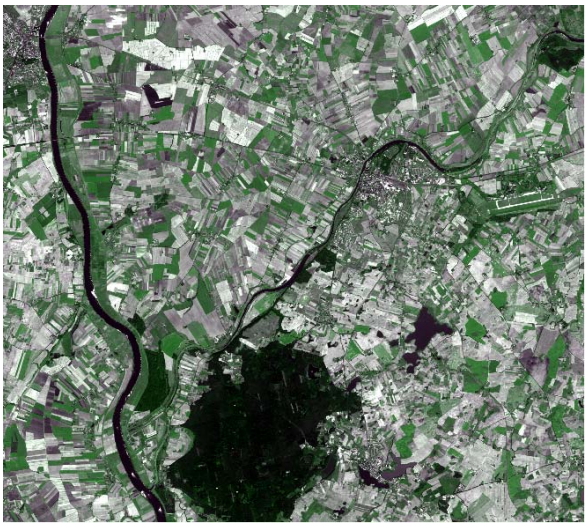


Fig.1 a,b. Test area Malbork:
a) ENVISAT / ASAR frames with AOI boundaries.
b) SPOT 5 color composition (SPOT Data / Program ISIS @CNES 2003, distributed by Spotimage S.A)

2.2. ASAR_IMS and ASAR_APS data sets.

A series of ASAR Image Mode (ASA_IMG) and ASAR Alternating Polarization Mode (ASA_APG) products was programmed and ordered for their use in land cover and crop mapping. From this data set the backscattering coefficients could be calculated for the parcels of several crops for investigating of backscattered signal changes in the time due to crop state and crop developing stage changing. This part of the project will not be presented in this paper. For the several dates of ASAR acquisitions, chosen amongst all dates for which registrations were programmed and detected products were generated, also single look complex images were ordered. The details of the interferometric data set are shown in the tab.1.

Tab.1. Interferometric images taken over test area Malbork.

Date yy-mm-dd	Swath	Orbit	Track		Product Type / Level	Product Acronym	Polarisation	Status on 31.12.2003
03-04-09	IS 3	5787	3 222		Alt. Pol. SLC	ASA_APS_1P	VV/HH	Delivered
03-04-12	IS 2	5830	2 265		Image Mode SLC	ASA_IMS_1P	HH	Delivered
03-04-25	IS 4	6016	4 451		Alt. Pol. SLC	ASA_APS_1P	VV/VH	Not yet delivered
03-05-01	IS 2	6102	2 036		Alt. Pol. SLC	ASA_APS_1P	HH/HV	Delivered
03-05-11	IS 4	6245	4 179		Image Mode SLC	ASA_IMS_1P	VV	Delivered
03-06-05	IS 2	6603	2 036		Alt. Pol. SLC	ASA_APS_1P	HH/HV	Delivered
03-06-15	IS 4	6746	4 179		Image Mode SLC	ASA_IMS_1P	VV	Delivered
03-07-04	IS 4	7018	4 451		Alt. Pol. SLC	ASA_APS_1P	VV/VH	Delivered
03-07-10	IS 2	7104	2 036		Alt. Pol. SLC	ASA_APS_1P	HH/HV	Delivered
03-07-26	IS 2	7333	2 265		Image Mode SLC	ASA_IMS_1P	HH	Delivered
03-08-11	IS 3	7562	3 494		Alt. Pol. SLC	ASA_APS_1P	VV/HH	Delivered

Both the IMS and APS data was processed using BEST software (Beta version 3.0) made available free by ESA / ESRIN for the ENVISAT data users. The IMS data was processed also using EV-InSAR, commercially available software of Atlantis Scientific. At the moment of this data processing the option of Alt_Pol_Envisat was not yet

supported by EV-InSAR. The interferometric processing of Alt_Pol_Envisat data is possible with the freely available Doris software package developed by the Delft Institute for Earth-Oriented Space Research (DEOS), Delft University of Technology [ref.1]. Actually the available APS data are under processing with DORIS.

As is seen in the tab. 1 the ASAR registrations are of IS2 and IS4 swaths in majority and only two scenes are taken from IS3 swath. All the interferometric pairs (and one triplet) can be established as follows:

- 12_April 26_July IS2 IM HH time interval 104 days
- 11_May 15_June IS4 IM VV time interval 35 days
- 25_April 04_July IS4 Alt.Pol. VV/VH time interval 70 days
- 01_May 5_June 10_July IS2 Alt.Pol. HH/HV time intervals 35 days

All the registrations are separated by "long time" temporal baselines, at least 35 days or much more, and at the moment of acquisitions' programming the geometric baselines were also not known. Some of the acquisitions in Alt. Pol Mode can be regarded as "zero baseline interferometric pairs between different polarizations" (see Hajnsek et al. in the [ref.4]). Tab.2 shows the parameters of interferometric processing for the pairs of Master and Slave images used for coherence map generation.

Tab.2. Main interferometric parameters of processed pairs.

No. of pair	Image Type	Swath / Polarization	Master Date	Slave Date	Time interval (days)	Main interferometric Parameters
1	ASA_IMS	IS2 / HH	12.04.2003	26.07.2003	104	Baseline perp. = 820 m [BEST] Baseline parall. = 246 m [BEST] --- Baseline perp. = 819 m [EV_InSAR] Baseline parall. = 239 m [EV_InSAR] Bias Calculation Results: Range – 29 pixels, Azimuth – 434 Spatial Overlap: 97 % Range Spectral Overlap: 23% (less than supposed min. 50 %)
2	ASA_APS	IS2 / HV_HV HH_HH	01.05.2003	05.06.2003	35	Baseline perp. = 2084 m [BEST] Baseline parall. = 645m [BEST]
3	ASA_APS	IS2 / HV_HV HH_HH	05.06.2003	10.07.2003	35	Baseline perp. = 120.6 m [Doris] Baseline parall. = 59.3 m [Doris] Range – 8 pixels, Azimuth 32
4	ASA_IMS	IS4 / VV	11.05.2003	15.06.2003	35	Baseline perp. = 873 m [BEST] Baseline parall. = 607m [BEST] --- Baseline perp. = 870 m [EV_InSAR] Baseline parall. = 581 m [EV_InSAR] Bias Calculation Results: Range – 74 pixels, Azimuth – 1645 Spatial Overlap: 93 % Range Spectral Overlap: 53.3% (slightly better than supposed min. 50 %)

During the processing of IMS data using EV_InSAR package 144 points were automatically "pointed" for precise images' corregistration. Also automatic procedure was chosen for Range and Azimuth Bias calculation. During the stage of corregistration analysis all tie points located on water bodies and other points with low quality (high row or column residuals or low coherence not exceeding the threshold of 0.1) were eliminated. During processing using BEST the number of points 100 or 200 was tested, coherence threshold 0.2 , polynomial degree 1 or 1.5 , interpolation window 512 x 512 and interpolation method Sinc or Constant shift (as suggested in BEST User Manual for the pairs with high geometric bias). APS data processing with Doris was performed in the same way like with IMS data except the data reading stage which needs to dump MDS1 and MDS2 channels into separate raw data files. To perform this the "envisat_dump_data" program developed by ESA within BEAM package have been used. BEAM package is freely available software distributed under GPL license.

3. PRELIMINARY RESULTS

At the moment of publication only two pairs can be regarded as fully processed:
- IMS_IS4_VV from 11.05 and 15.06.2003
- IMS_IS2_HH from 12.04 and 26.07.2003.

This two pairs composed of ASA_IMS images were processed to coherence maps in slant range geometry. In both cases the interferometric coherence is poor. The reasons are of long time interval between acquisitions but also very long baselines. In the case of the first pair (IMS_IS4_VV from 11.05 and 15.06.2003) we can distinguish easily urban areas and railways as the places of higher coherence. See fig.1. The rest of the terrain is characterized by a very low coherence regardless its origin. On the other images of coherence it is possible to distinguish, often with difficulties, some strong scatterers in the urban areas or along the river banks.

The ASA_APS data are currently under processing testing several processing options and variants and the results are not presented in this paper.

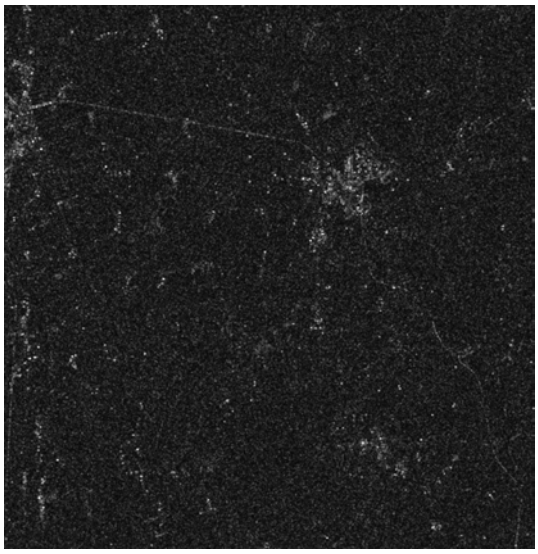


Fig.1. Coherence image from IMS_IS4_VV pais acquired on 11.05 and 15.06.2003.

An attempt was made to generate also the polarimetric coherences between the co-pol or cross-pol channels of the same registration. The processing of a “zero baseline” pairs shows no coherence. The half-pixel shift between MDS1 and MDS2 datasets in range direction reduced a spectral overlap which was probably the main source of decorrelation.

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4. REFERENCES

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