ENVISAT and ERS-1/2 CARD4L SAR NRB PROJECT

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S. Pinori (presenter)

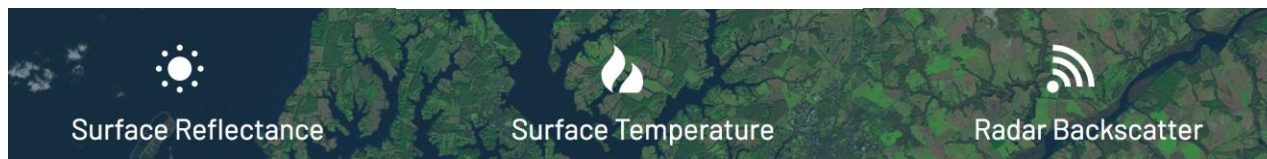IDEAS-QA4EO Reprocessing Coordinator

CEOS CARD4L

- CEOS: **Analysis Ready Data** (ARD - https://ceos.org/ard/) are satellite data that have been processed to a minimum set of requirements and organized into a form that allows:

  - **Immediate analysis with a minimum of additional user effort** and

  - **Interoperability both through time and with other datasets**.

ESA Contribution

Surface Reflectance — Surface Temperature — Radar Backscatter

Sentinel-2   Sentinel-3   Sentinel-1
Proba-V   (A)ATSR   (A)SAR
MERIS

#	Item	Threshold (Minimum) Requirements	Target (Desired) Requirements
1.1	Traceability	Not required.	Data must be traceable to SI reference standard. Note 1. Relationship to 3.4. Traceability requires an estimate of measurement uncertainty. Note 2: Information on traceability should be available in the metadata as a single DOI landing page.
1.2	Metadata Machine Readability	Metadata is provided in a structure that enables a computer algorithm to be used to consistently and automatically identify and extract each component part for further use.	As threshold, but metadata is formatted in accordance with CARD4L NRB Metadata Specifications, v.5.5, or a community endorsed standard that facilitates machine-readability, such as ISO 19115-2
1.3	Product type	CARD4L product type name and (if required by the data provider) Copyright.	As threshold.
1.4	Document Identifier	Reference to CARD4L-Normalised Radar Backscatter document as URL or DOI.	As threshold.

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SAR ARD Definition Approach

Sentinel-2

Sentinel-1 Next Generation

ROSE-L

Sentinel-1

BIOMASS

ENVISAT

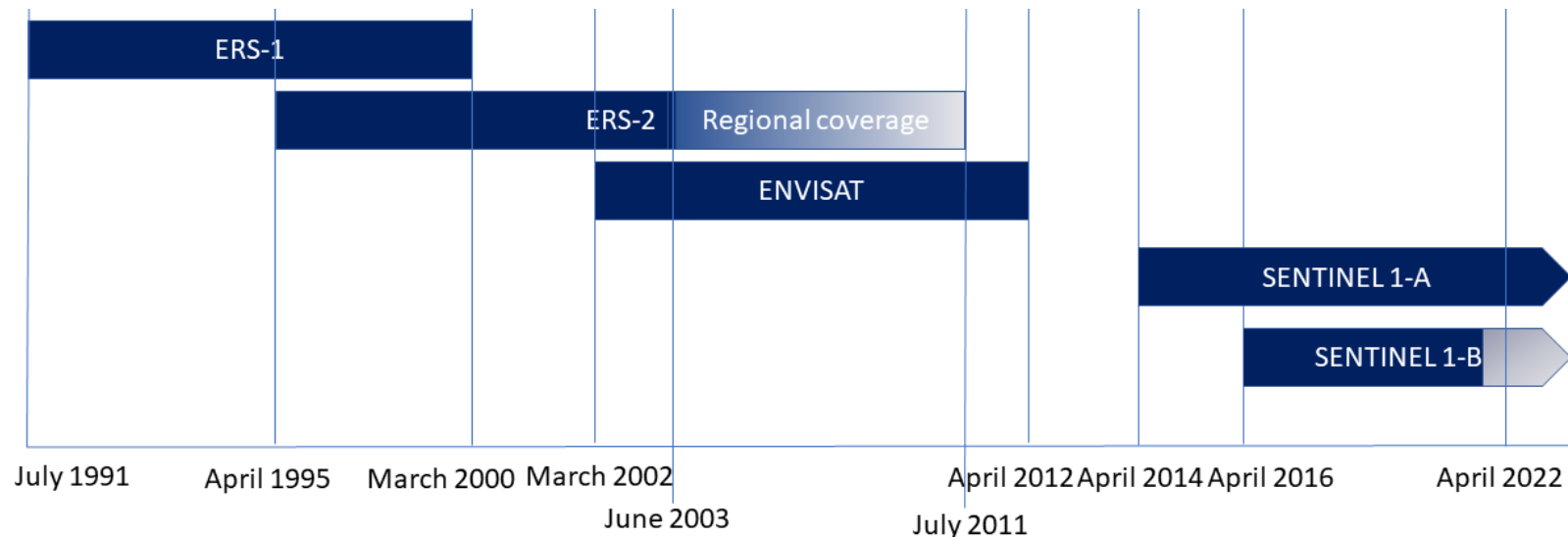ERS-1/2
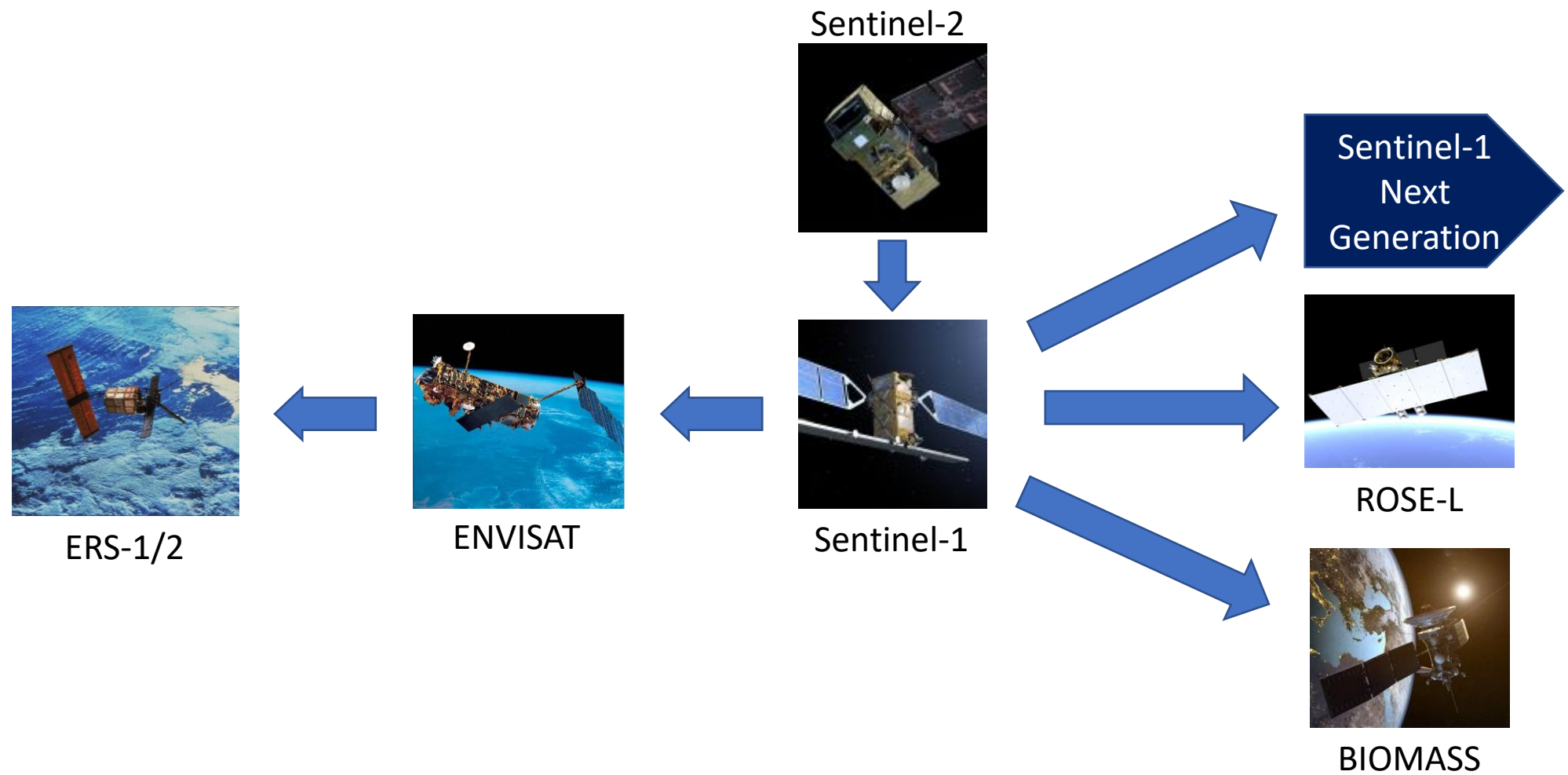
CEOS ARD – SAR NRB Products
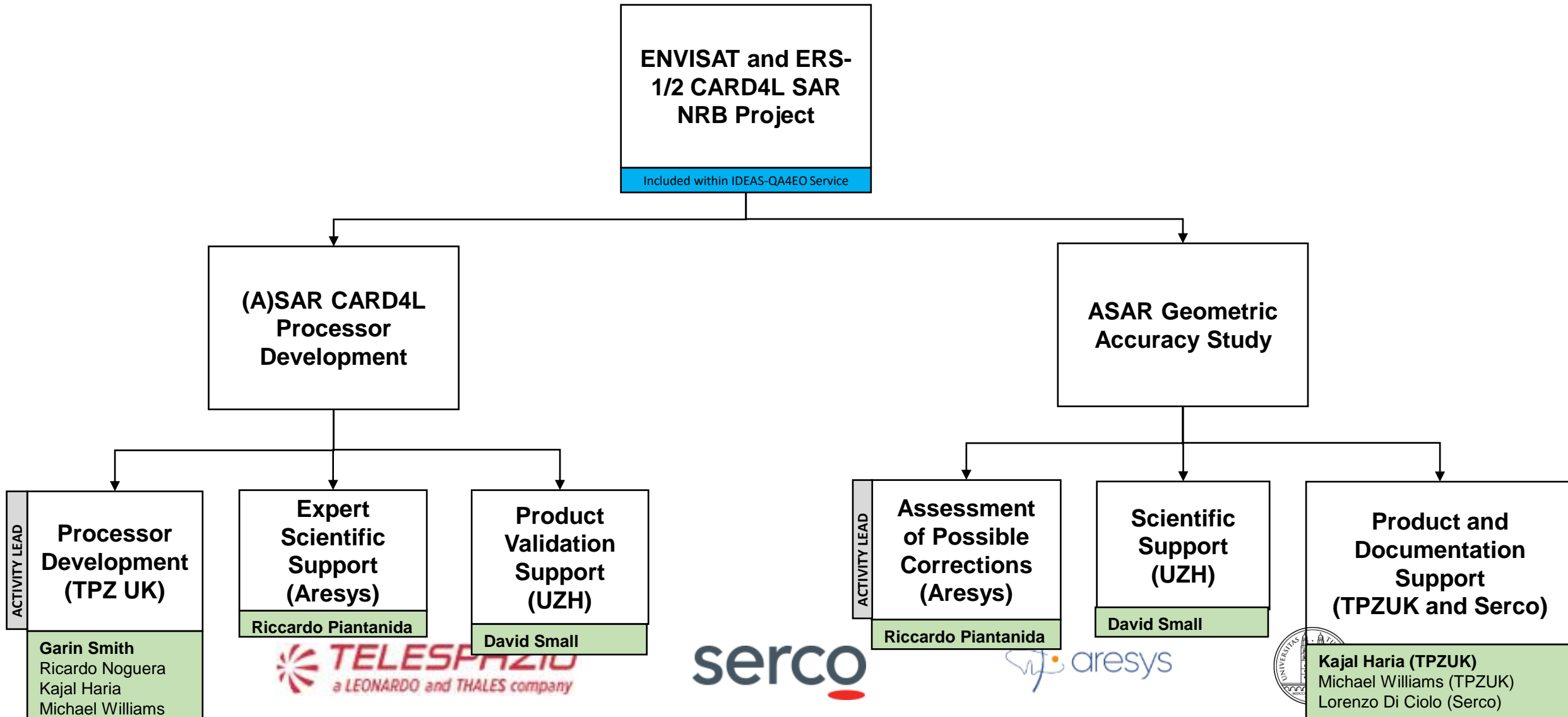
- These projects will allow:

  - *Interoperability* ➜ Same gridinding / tiling system, and DEM than Sentinel-2 (MGRS)

  - *Immediate analysis* ➜ Products calibrated with RTC, denoised, projected over Copernicus DEM, geolocated

  - *Cloud-computing compliant* ➜ Cloud-Optimised GeoTIFF, VRT, XML and STAC

  - *Open science compliant* ➜ Open source processor (prototype and operational)

IDEAS-QA4EO (A)SAR CARD4L Project

- Over the last 3 years, IDEAS-QA4EO SAR Team has been involved in the assessment of CARD4L specification for historic ERS-1/2 SAR and ENVISAT ASAR data.
  - ✓ To understand the possibility of generating ARD data for these missions.
- From the start of 2021, a more dedicated progress has taken place.
  - ✓ In close coordination with the Sentinel-1 ARD work via the support of Clément Albinet, ESA
- This led to the conception of ENVISAT and ERS-1/2 CARD4L NRB Project

(A)SAR CARD4L Project Set-up and Team

IDEAS-QA4EO

ENVISAT and ERS-1/2 CARD4L SAR NRB Project

Included within IDEAS-QA4EO Service

(A)SAR CARD4L Processor Development

ASAR Geometric Accuracy Study

ACTIVITY LEAD

Processor Development (TPZ UK)

Garin Smith
Ricardo Noguera
Kajal Haria
Michael Williams

Expert Scientific Support (Aresys)

Riccardo Piantanida

Product Validation Support (UZH)

David Small

ACTIVITY LEAD

Assessment of Possible Corrections (Aresys)

Riccardo Piantanida

Scientific Support (UZH)

David Small

Product and Documentation Support (TPZUK and Serco)

Kajal Haria (TPZUK)
Michael Williams (TPZUK)
Lorenzo Di Ciolo (Serco)

TELESPAZIO a LEONARDO and THALES company

serco

aresys

ASAR Geometric Accuracy Study

- The CARD4L specification v5.5 has a Target (Desired) requirement for geometric accuracy

  Output product sub-sample accuracy should be less than or equal to 0.1-pixel radial root mean square error (rRMSE).

- For historic missions only geometric accuracy "threshold" (Minimum) requirement can be met

- Study will aim to close the gap as much as possible -> *To deliver the highest resolution ARD products that is practically possible.*

- Study will focus on ENVISAT ASAR products
  - Will also include recommendations for ERS-1/2 based on findings.

- Outcome -> *A set of recommendations with a description of identified algorithms.*

| #	Item	Threshold (Minimum) Requirements	Target (Desired) Requirements
4.3	Geometric Accuracy	An estimate of the absolute localisation error is provided as bias and standard deviation, provided in slant range/azimuth, or Northing/Easting. *Note 1: Can be obtained from corner reflector measurements or mission calibration/ validation results.* *Note 2: Accurate geolocation is a prerequisite to radar processing to correct for terrain. To enable interoperability between radar sensors, absolute accuracy is required.*	Output product sub-sample accuracy should be less than or equal to 0.1-pixel radial root mean square error (rRMSE). Provide documentation of estimate of absolute localisation error as DOI or URL.

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ASAR Geometric Accuracy Study – Calibration Sites

- Bali transponder: available between 2006 and 2008
- Netherlands transponders: different locations according to mission period
- Canada transponders: 4 sites. Resolute transponder with many acquisitions but only available between 2004 and 2007
- CR in Neustrelitz: only 3 acquisitions
- CR is Switzerland: only for a limited time span (TBC with UZH)

SITE NAME	LATITUDE	LONGITUDE
	decimal deg	decimal deg
NL - ASAR Transponders		
Edam	52.524552	5.049332
Zwolle	52.551796	6.006086
Aalsmeer	52.199801	4.818415
Swifterbant	52.55497	5.668955
RADARSAT Transponders		
Ottawa	45.294665	-75.757550
Resolute	74.746398	-95.001370
Fredericton	45.870278	-66.539444
Saskatchewan	53.216470	-105.679290
Ground Stations		
Kiruna	67.854752	20.963405
Neustrelitz	53.328787	13.069388
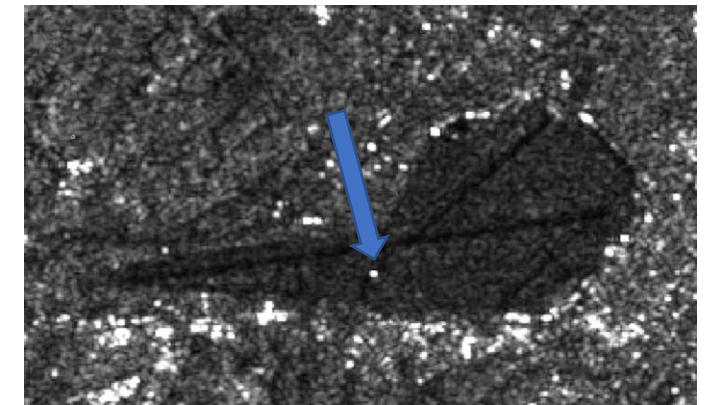
20030908_093201_Orbit7963: Dübendorf corner reflectance

ASAR Geometric Accuracy Study – Next Steps

- To **retrieve the ASAR products to be used for the geolocation assessment** (transponder and corner reflectance) and perform a preliminary analysis to get the current accuracy (i.e., no post-processing corrections are applied).

- Simultaneously, UZH to provide Aresys a **presentation detailing the required post processing corrections** to be applied to the ASAR data including information on calibration sites and literature references, mains are:

  - **the "bistatic" azimuth bias**, i.e., a shift along azimuth direction caused by the processing assumption that the satellite echo transmit and receive positions are identical;
  - **the intermittent range bias**, i.e., a shift along range direction strictly related to the adopted processing chain (Range-Doppler or SPECAN);
  - **the atmospheric path delay**, i.e., a shift along range direction caused by the specific atmospheric conditions at the time of acquisition;
  All these corrections have already been identified and studied in literature (see Guide to ASAR Geocoding, 2008, and Small et al., 2011)

- Aresys to **develop the post-processing algorithm corrections** and **assess the improvements** of the geolocation accuracy

(A)SAR CARD4L Processor Development

- Develop the ARD processor for ERS-1/2 SAR and ENVISAT ASAR Imaging mode products
  - Focus on **L1 Precision (PRI) for IM and AP** and **L1 Medium Resolution (MR) for WS**

- Planning:
  - **Estimated duration:** 9 months (T0 – 06/01/2022)
  - **Platform:** Open Source SNAP toolbox capabilities
  - **Output format:** GeoTIFF Optimised Cloud (GOC)
  - **Essential inputs**:
    - Close coordination with S-1 ARD team for specification, architecture and development software

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(A)SAR CARD4L Processor Development – Current Status

- Break down of requirements completed and tested by script

- Note that script is still being developed to test some requirements

REQ	Sentinel-1			ERS		
	Status	No. Done	No. Sub tests	Status	No. Done	No. Sub tests
1.2	Done	1	1	Done	1	1
1.3	Done	1	1	Done	1	1
1.4	Done	1	1	Done	1	1
1.5	In progress	0	2	In progress	0	2
1.6.1	Done	1	1	Done	1	1
1.6.2	Done	2	2	Done	2	2
1.6.3	Done	2	2	Done	2	2
1.6.4	Done	5	5	Done	5	5
1.6.5	Done	5	5	Done	5	5
1.6.6	Done	7	7	Done	7	7
1.6.7	Done	7	7	In progress	2	7
1.6.9	To do	0	1	To do	0	1
1.7.1	In progress	5	6	To do	0	6
1.7.2	To do	0	1	To do	0	1
1.7.3	Done	2	2	To do	0	2
1.7.4	In progress	1	5	To do	0	5
1.7.5	Done	1	1	To do	0	1
1.7.6	Done	1	1	To do	0	1
1.7.7	Done	4	4	To do	0	4
1.7.8	Done	1	1	To do	0	1
1.7.9	Done	1	1	To do	0	1
1.7.10	Done	1	1	To do	0	1
2.1	Done	1	1	Done	1	1
2.5	In progress	4	5	To do	0	5
3.3	In progress	1	2	To do	0	2
4.2	Done	2	2	To do	0	2

	Requirements	Percentage Done (%)		Requirements	Percentage Done (%)
Done	19	73	Done	10	38
In progress	5	19	In progress	2	8
To do	2	8	To do	14	54
total	26	100 %	total	26	100 %

Total No. Done	57	Total No. Done	28
Total sub tests	68	Total sub tests	68
% of total tests completed	84	% of total tests completed	41

(A)SAR CARD4L Processor Development – Current Status

- Development Status
  - 33 Threshold requirements in total
  - 10 Requirements implemented and tested for ERS

- Design Approach/Re-use
  - Where possible utilising common code for our development
    Github https://github.com/SAR-ARD/pyroSAR
  - Where needed new code has been developed
    Github https://github.com/SAR-ARD/ERS_NRB

- Testing approach
  - Using an automated test script to assess GOC format compliance for above requirements

THANK YOU!