

### SAR Processing on Demand Service for CryoSat-2 at ESA G-POD

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**European Space Agency** 

# **Presentation Outline**



- ESA G-POD System Introduction
- CryoSat-2 SAR Processing Service walkthrough and options
- Service Evolutions
- Conclusions

## **G-POD Distributed Environment**



The **ESA Grid Processing on Demand** system is a <u>generic GRID</u>-based operational computating environment where specific <u>data-handling Earth-Observation services</u> can be seamlessly plugged into system. One of the goal of G-POD is to provide users with a <u>fast computational facility without the need to handle bulky data</u>.

The G-POD system hosts high-speed connectivity, distributed processing resources and large volumes of data to provide scientific and industrial partners with a shared data processing platform fostering the development, validation and operations of new Earth Observation applications.

In particular, the G-POD environment consists of:

- Over **350** CPU in about 70 Working Nodes
- Over **330** TB of local on-line Storage plus 180 TB of EO data accessed directly from the PACs.
- Access to Cloud processing and data resources on demand (from Interoute and other providers)
- Internal dedicated 1 Gbit LAN at ESRIN and at UK-PAC archives
- 1 Gbps external connection
- Software Resources on-line: IDL, Matlab, BEAT, BEAM, BEST, CQFD, NEST, BRAT, Gamma
- System: GRID Globus on Linux

Actually, G-POD has more than **300TB** of EO data locally stored. EO Data available to G-POD services come either from ESA and from not-ESA mission.





### **G-POD Web Portal**



The **G-POD web portal** is a flexible, secure, <u>generic</u> and distributed web platform where the user can easily <u>manage all own tasks</u>. From the creation of a new task to the output publication, passing by the data selection and the job monitoring, the user goes trough a <u>friendly and intuitive</u> user interface accessible from everywhere.

More info on the G-POD Web Portal are available here: <u>http://wiki.services.eoportal.org/tiki-index.php?page=GPOD+User+Manual#Annex</u>



JPEG TIFF PING PNG:10 PNG:20

## CryoSat-2 Processor Prototype



The service is based on the SAR Processor Prototype that has been developed entirely by EOP-SER Altimetry Team (Salvatore Dinardo, Bruno Lucas, Jerome Benveniste) for <u>CryoSat-2 validation purposes and preparation to Sentinel-3 mission</u>, with the following system features:

- SAR/SARin L1b Processor Prototype (Standard Delay-Doppler Processing)
- SAR/SARin L2 Retracker Prototype (with SAMOSA Analytical Model and LEVMAR Least Square Estimator)
- Input: CRYOSAT SAR/SARIN FBR DATA
- Output L1b → Radar Echogram
- Output L2 → SSH, SLA (W/O SSB), SWH, sigma0, wind speed



# GPOD CryoSat SAR Processing Service esa

The ESA G-POD Service, SARvatore (SAR Versatile Altimetric Toolkit for Ocean Research & Exploitation) for CryoSat-2 is an Earth-Observation application that provides the capability to process remotely and on demand CryoSat-2 SAR data, from L1a (FBR) data products until SAR Level-2 geophysical data products.

SAR vatore for CryoSat-2 NameSARvatore for CryoSat-2 ClassificationD



Service DescriptionSARvatore (SAR Versatile Altimetric Toolkit for Ocean Research and Exploitation) for CryoSat-2 is a Software Processor Prototype developed in ESA/ESRIN to experiment with SAR processing from L1a (FBR) to L2 using the SAMOSA model. It can be used over open ocean or coastal zone, as well as more difficult targets such as rivers and lakes. This toolkit is made available to the user community as EO G-POD Service and features an handy graphic user interface. The toolkit takes in input Cryosat-2 SAR FBR data products and produces in output geophysical L2 products in standard netcdf format. This output can be manipulated and visualized with BRAT (ESA Basic Altimetry Radar ToolBox).



The service works over any kind of surfaces but it has been so far optimized for ocean studies.



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## GPOD CryoSat-2 Processor Service esa

ESRIN EOP-SER ALT team compiled the processor's source code into a 64-bit <u>Linux</u> binary and delivered to ESA G-POD team the executable codes, the input archive (SAR FBR) and satellite footprints (ASCII tracks).

Now, the toolkit has been fully integrated in the GPOD System for gridded and on demand computation.

The objectives of the service integration in GPOD are:

- to experiment <u>in-house research</u> themes that will be further exploited in the ESAfunded R&D projects
- to provide expert users with consolidated SAR geo-products to get acquainted with the novelties and specifities of SAR Altimetry

The toolkit has been validated extensively over the German Bight in open sea



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### Cryosat-2 SAR Mode



### Currently SAR mode (green) is available in CryoSat-2.

Geographical Mask 3.6 (Since 06 October 2014)



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## Service Registration and Access



- The service is open, free of charge and accessible on line from everywhere.
- In order to be granted the access to the service, you need to have an EO-SSO (Earth Observation Single Sign-On) credentials (for EO-SSO registration, go at <u>https://earth.esa.int/web/guest/general-registration</u>) and afterwards, you need to submit an e-mail to G-POD team (write to eo-gpod@esa.int), requesting the activation of the SARvatore service for your EO-SSO user account
- After a registration to EO SSO, user can freely access at the on line service at:

### https://gpod.eo.esa.int/services/CRYOSAT\_SAR/

The service is listed under the Marine Theme or you can find through the search bar as well.

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ESA Earth Observation Users' Single Sign On Login

EO-SSO ID:	Salvatore.Dinardo	
Password:		
Max idle time:	half a day	
Max session time:	Until browser close	
	Login	Reset



# CryoSat-2 DATA Catalogue in G-POD esa

The current GPOD service works only in SAR Mode (no SARIN or LRM mode).

So far, in the service catalogue, we have stored ~**100 thousands** of SAR passes over the all globe for the years 2010, 2011, 2013 and part of 2014 and 2012. This amount to **16 TB** of CryoSat-2 FBR data archived into G-POD storage.

Data obtained from EOP-SER (historical) and CS2 ftp servers (current).



Partial historical archive (<2012/05) were gratefully provided by NOAA/RADS and ESTEC

# The Service Graphical User Interface esa

Once get to the service page, the first action to operate is to select **the zone of interest** and **the time of interest** for the required run.

Regarding the selection of the area of interest, the user can simply **draw a rectangle** in the world map, after clicking on the rectangle icon on the tool bar. Instead, for more precise geo-selection, the user can type directly the geo-coordinates of the area of interest using the <u>geographical boxes</u>.

Regarding the <u>time of interest</u>, the user may set the start date and the stop date in the calendar bar. By default, the start date is the time of CryoSat-2 launch time and the stop date is set at 2 months prior to the current date.

The GUI embeds all the standard buttons for image browsing as panning, zoom-in zoom-out, centering, undo, redo, reset, etc.



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CRYOSAT SIRAL F&R-SAR mode product (SIR1S/ V Query Received new 50 entries (0.709 sec)

# DATA SELECTION

esa

Once operated the time and geo selection, clicking on the "QUERY" button, the service lists all the CryoSat-2 passes matching the time and space requirements. The CryoSat-2 SAR tracks, crossing the area of interest, are then shown on the world map in overlay.

The graphical interface lists at maximum 100 passes for page and informs users of the total number of found passes.

The user can decide which passes to select clicking on the passes, select all, or delete some specific passes from the list.

1- DATA SELECTION 2- PROGRESSING STATUS 3- RESULTS VISUALIZATION Schedule (Time-driven scheduler) Schedule (Data-driven scheduler) Save in Workspace Process it! 180.0 90.00 -180. -90.0 AOI -- T Select Date start date stop date 2010-04-08T00: 2014-08-02T11 2000 km 2000 mi 181.15, -88.16 CRYOSAT SIRAL FBR-SAR mode product [SIR15/ 🔻 Query Received new 100 entries (4.285 sec) File Name Start

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Unselect All Delete Query Results from 1 to 100 out of 80006 (4.285 sec) | <u>next page</u>

Showing 1 to 100 of 100 entries

SARvatore for CrvoSat-2

# LIST OF PROCESSING OPTIONS



The last step, before to submit the task, is to set the list of processing options.

- Indeed, the processor prototype is versatile in the sense that the users can customize and adapt the processing, according their specific requirements, setting a list of configurable options.
- In the G-POD interface, user can enter easily this list of processing options via a series of drop-down menu. The configurable options are divided according to the processing level they refer to (L1b and L2).

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CS_OFFL_SIR1SAR_FR_20140202T063959_20140202T064108_B	001 <u>2</u> 014-02-02T06:39:59.00	0Z 2014-02-02T06:41:08.000Z	
CS_OFFL_SIR1SAR_FR_20140202T064125_20140202T064137_B	001 2014-02-02T06:41:25.00	0Z 2014-02-02T06:41:37.000Z	
CS_OFFL_SIR1SAR_FR_20140202T183952_20140202T184139_B	001 2014-02-02T18:39:52.00	0Z 2014-02-02T18:41:39.000Z	
CS_OFFL_SIR1SAR_FR_20140203T054931_20140203T054950_B	001 2014-02-03T05:49:31.00	0Z 2014-02-03T05:49:50.000Z	
CS_OFFL_SIR1SAR_FR_20140203T072726_20140203T072912_B	001 2014-02-03T07:27:26.00	0Z 2014-02-03T07:29:12.000Z	
CS_OFFL_SIR1SAR_FR_20140203T073157_20140203T073332_B	001 2014-02-03T07:31:57.00	10Z 2014-02-03T07:33:32.000Z	
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# L1B Option – Hamming Window



Option Name	Option Value	Option Description
	- Apply only in coastal zone	
Hamming weighting Window	- Yes, apply it	User can decide here whether to apply a Hamming weighting window on the SAR burst data, do not apply it, or to apply it only for, surface location in coastal area (more infect
	- No. do not apply it	REF1)

Default option: Apply only in coastal zone Coastal Zone recommended: Apply only in coastal zone Open Ocean recommended: No. do not apply it

# Weighting Function in coastal zone esa

To suppress parabolic artifacts on the radargram to the quasi- specular coastal waters, => application of Weighting Function (Hamming) in Doppler Domain to Delay-Doppler Spectrum before the Beam Forming



Effect of the application of Weighting Function to eliminate parabolic artifacts on radargram (echo stack)



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### L1B Option – Exact Beam-Forming

Exact Beam-Forming exact Beam-Forming or an approximated Beam-Forming (more info at REF1)
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\* In the **approximate beam** steering, all the Doppler Beams will be steered by the same angle.

This approximation can be considered acceptable on gentle undulating surfaces.

\* For effect of the application of the Beam Formation, the Doppler Beams are angularly Equispaced.

The exact beam forming needs to be applied in case of highly variable topographic surfaces (land).

REF1, section 4.4

**Default option:** Approximated **Coastal Zone recommended:** Approximated **Open Ocean recommended:** Approximated

# **FFT Zero-Padding**



FFT Zero-Padding	- Yes, apply Zero-Padding - No, don't apply Zero- Padding	User can decide here whether to operate the Zero-Padding prior to the range FFT ( <b>section 4.8 in REF1</b> ). Zero-Padding is indicated for coastal zone and sea-ice analysis
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Default option: Yes, apply Zero-Padding Coastal Zone recommended: Yes, apply Zero-Padding Open Ocean recommended: User pref

# ZERO-PADDING =>DOUBLE SAMPLING



# L1B Options – Window Size



Radar Receiving Window Size	128 Range Bins 256 Range Bins	User can select here the size of the radar receiving window: 128 range bins (standard) or 256 range bins (extended). Extended window is indicated for coastal zone analysis
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### Default option: 128 Range Bins Coastal Zone recommended:256 Range Bins Open Ocean recommended: 128 Range Bins





# L2 Options – Retracking Surfaces esa

Option Name	Option Value	Option Description
Restrict the re-tracking on specific surfaces	<ul> <li>Process all</li> <li>Process only open sea points</li> <li>Process only water points</li> </ul>	User can decide here whether to process the whole pass, only points in open sea or only water points (points in open sea, costal zone and inland water)

Default option: Process only water points Coastal Zone recommended: Process only water points Open Ocean recommended: Process only open sea points

# L2 Options – SAMOSA version esa

SAMOSA Model GenerationUse SAMOSA 2<br/>- Use SAMOSA 3User can decide here which SAMOSA<br/>generation model to use in the processing<br/>(SAMOSA 2 or SAMOSA 3).- Use SAMOSA 3- Use SAMOSA 3The SAMOSA 2 or SAMOSA 3).- Use SAMOSA 3- Use SAMOSA 3- Use SAMOSA 2 or SAMOSA 3).- Use SAMOSA 3- Use SAMOSA 2 or SAMOSA 3).- Use SAMOSA 3- Use SAMOSA 3<td

Default option: - Use SAMOSA 2 Coastal Zone recommended: - Use SAMOSA 2 Open Ocean recommended: - Use SAMOSA 2

### TASK SUBMISSION



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Once user has operated the selection of the processing options, in order to submit the task to G-POD Computing Elements, the user has to click on the "PROCESS IT" button.



# TASK VIEWER/WORKSPACE



- After submission of job, users will be directed to the workspace page where they can check in real time the status of the run and can be notified on the run status. The color code is:
- **Orange**  $\rightarrow$  run under processing
- **Green**  $\rightarrow$  run completed
- **Red**  $\rightarrow$  run failed
- Further, clicking on the task, the user can have more info on the processing task as:
- Task Id
- Processing Id
- Grid Working Node Id
- Task Progress (data retrieving, data processing, data publishing)
- Task Creation Time

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### **Output Package Publishing**



- In case of successful run completion (green status), the portal will provide user a http link from where to download the output package on own local drive.
- The user can order to post the package directly on own personal ftp server once that he communicated to the web platform his ftp server credentials (through my "publish servers" sub-menu).

This is the recommended option in case of processing of large amount of data.



### **Output Package Content**

esa

The output package consists of :

- Pass Ground-Track in KML format
- Radar Echogram Picture in PNG format
- L2 data product in NETcdf format with all the scientific results. The netCDF format is self-explanatory with all the data field significance described in the attributes

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Doppler_Hange_Shift_20Hz	15 716835.04
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Ins_Rng_Com_20Hz	10 216025.92
Range_Unc_20Hz	20 71683632
SSH_Unc_20Hz	21 716636.72
SSH_20H2	22 716836.94
MS5_20Hz	24 716037.52
SLA_20Hz	25 716837.75
SWH_20Hz	27 716839.32
Pout 20Hz	20 716030.55





### **NETcdf Product IN BRAT**



The NETcdf product follows the CF (Climate&Forecast) 1.6 Convention and can be opened with any standard NETcdf tools (ncdump, HDFview, etc)

Anyhow, the recommended option is to ingest the NETcdf product in BRAT Toolbox in order to exploit all the BRAT functionalities to browse and visualize the output content



# **Next Service Evolutions**



- Attachment of SAR Waveforms in the netCDF files
- Attachment of STACK Data in the netCDF files
- Support for CryoSat-2 SARIN Data
- Enhancement of the retracking in coastal zone and inland water

# **CONTACTS & REFERENCES:**



For any question, bugs and support, please contact us at:

### altimetry.info@esa.int

□ For G-POD platform specific questions please contact:

### eo-gpod@esa.int

Service Manual available at: <u>http://wiki.services.eoportal.org/tiki-index.php?page=GPOD+CryoSat-2+SARvatore+Software+Prototype+User+Manual</u>
 Service available at:

### https://gpod.eo.esa.int/services/CRYOSAT\_SAR/

- REF1: Guidelines for the SAR (Delay-Doppler) L1b Processing, ESA, 2013
- REF2: SAR Altimeter Backscattered Waveform Model (SAMOSA Model Paper), IEEE-TGARSS



### THANK YOU !

### Further inquiries @:

Altimetry.Info@esa.int

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