

SAR Processing on Demand Service for CryoSat-2 and Sentinel-3 at ESA GPOD

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European Space Agency

Presentation Outline

- ESA-ESRIN GPOD System Introduction
- CryoSat-2 SAR Processing Service walk-through and options
- Service Evolution towards Sentinel-3
- Conclusions

G-POD Distributed Environment

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

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

In particular, the GPOD environment consists of:

1. Over **350** CPU in about 70 Working Nodes
2. Over **330** TB of local on-line Storage
3. Access to external Cloud processing and data resources on demand
4. Internal dedicated **1 Gbit** LAN at ESA-ESRIN
5. **1 Gbps** external connection
6. Software Resources on-line: IDL, Matlab, BEAT, BEAM, BRAT...



GPOD Web Portal

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

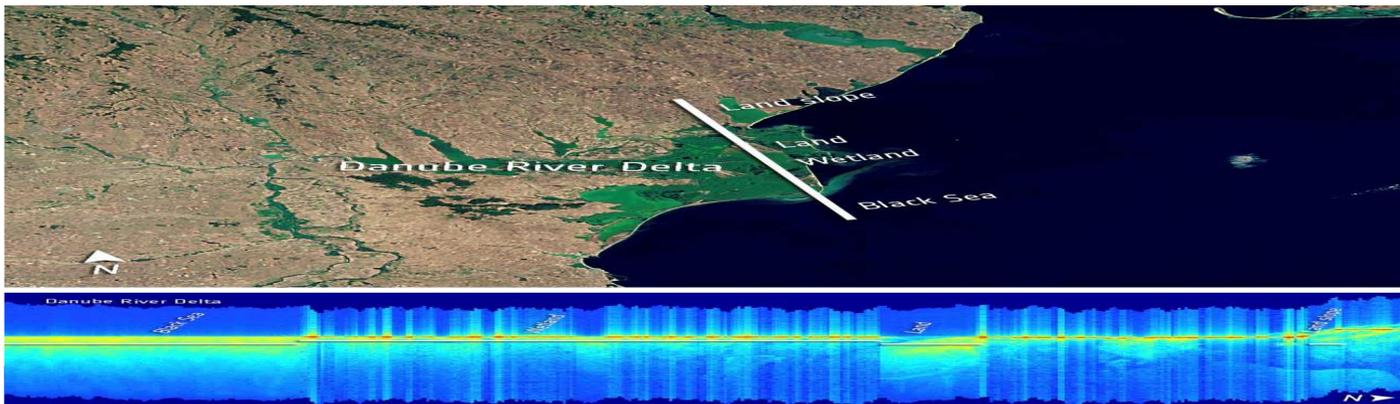
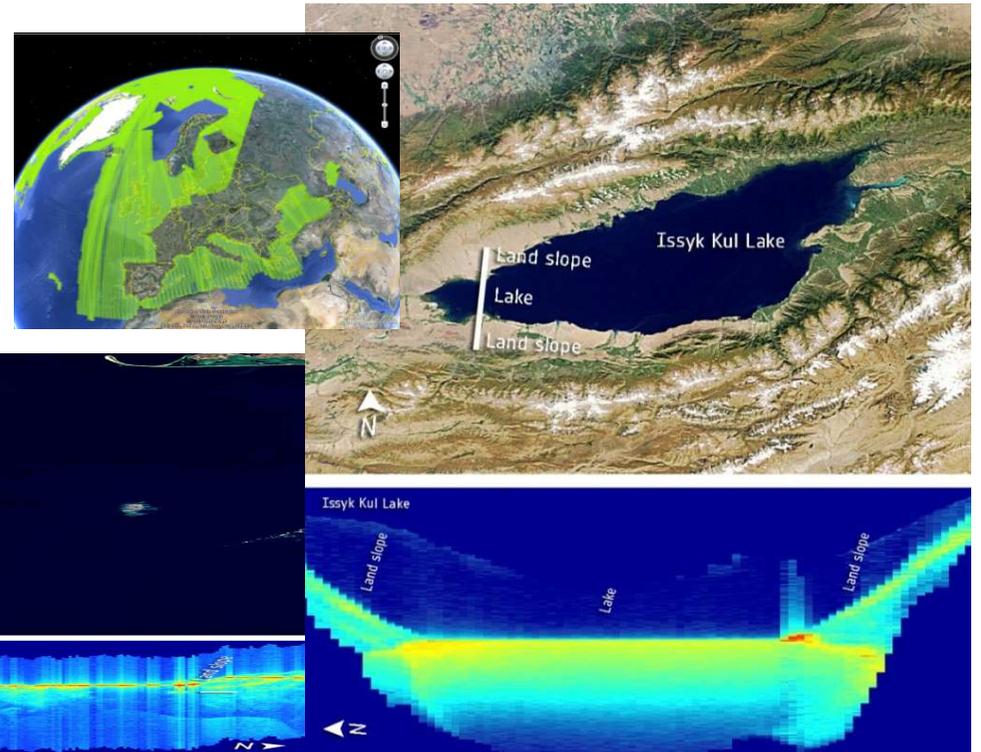
More info on the G-POD Web Portal are available here:
<http://wiki.services.eoportal.org/tiki-index.php?page=GPOD+User+Manual>



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, Jérôme Benveniste) for CryoSat-2 validation purposes and preparation to Sentinel-3 mission, with the following system features:

- SAR/SARin L1b Processor Prototype (Standard Delay-Doppler Processing)
- SAR/SARin L2 Retracker Prototype (with SAMOSA Model and LEVMAR Least Square Estimator)
- Input: CRYOSAT SAR/SARin FBR DATA
- Output L1b → Radar Echogram
- Output L2 → SSH, SLA,



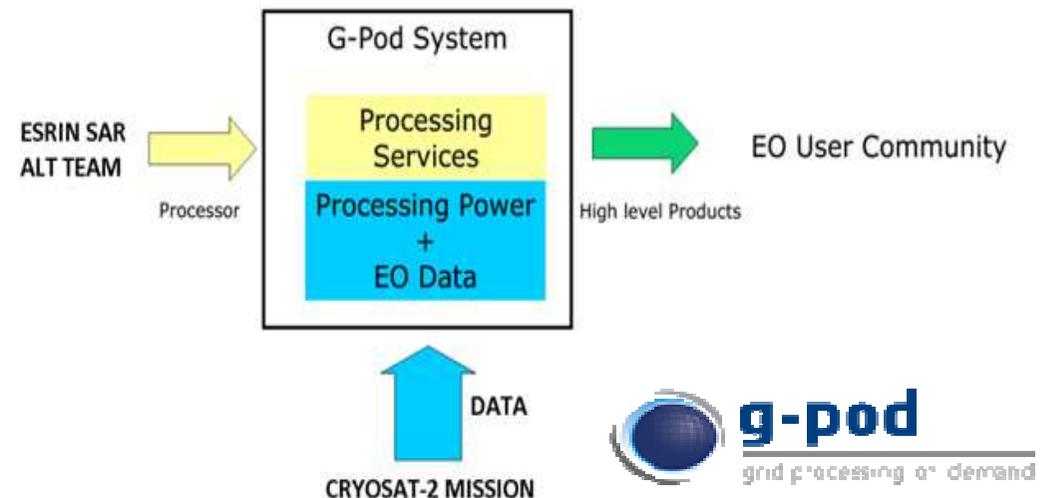
GPOD CryoSat SAR Processing Service

The ESA GPOD 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.

The service **works over any kind of surfaces** (ocean, ice, inland water and land).



The screenshot shows the service page for SARvatore for CryoSat-2. It includes a title, a classification of 'D', a 4-star rating, and a detailed service description. The description states that SARvatore 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 zones, as well as more difficult targets like rivers and lakes. The toolkit is available to the user community as an EO G-POD Service and features a handy graphic user interface. It takes input CryoSat-2 SAR FBR data products and produces output geophysical L2 products in standard netcdf format, which can be manipulated and visualized with BRAT (ESA Basic Altimetry Radar ToolBox).



GPOD CryoSat-2 Processor Service

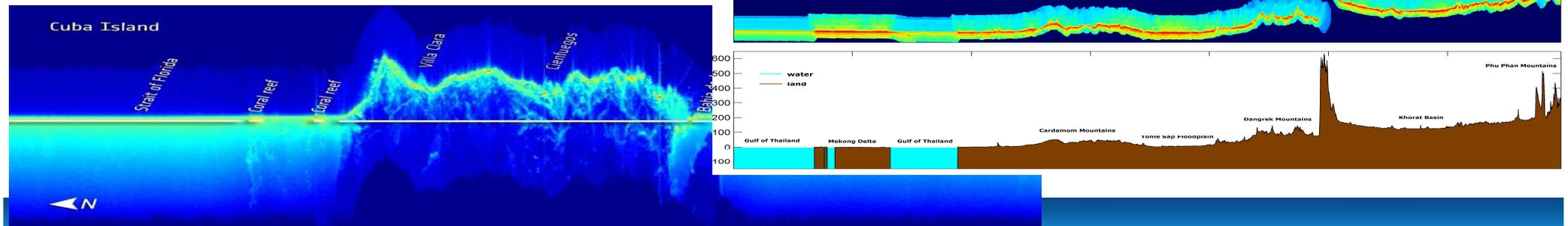
ESRIN EOP-SER ALT team delivered the processor prototype to ESA G-POD team, the input archive (SAR/SARIN FBR) and satellite footprints (ASCII tracks).

Now, the processor 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 in-house research themes that will be further exploited in the ESA-funded R&D projects
- to provide expert users with consolidated SAR geo-products to get acquainted with the novelties and specificities of SAR Altimetry

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



Service Registration and Access

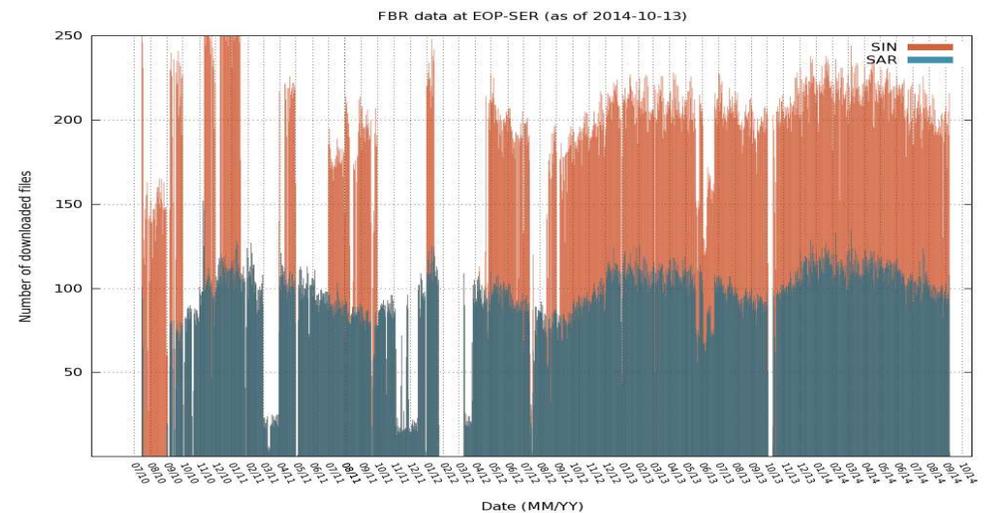
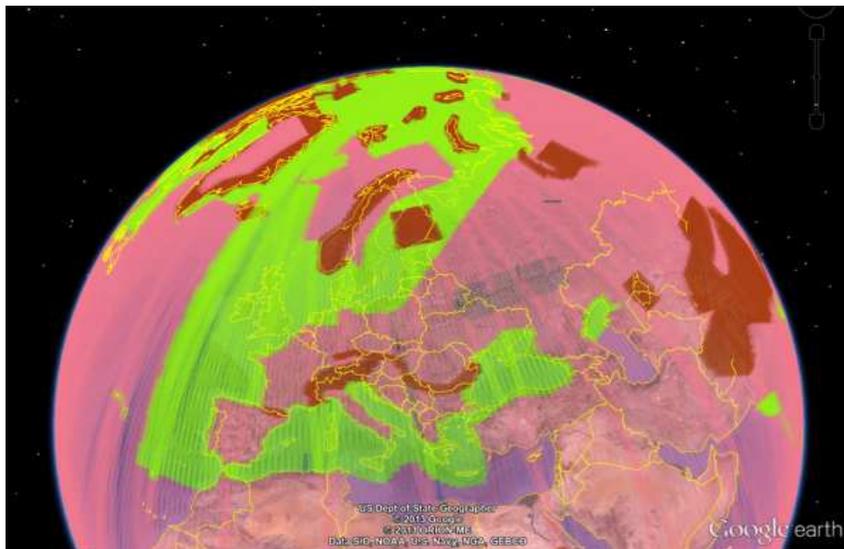
- ❑ The service is **open, free of charge and accessible on line from everywhere.**
- ❑ In order to be granted the access to the service, you need to have an EO-SSO (Earth Observation Single Sign-On) credentials (for EO-SSO registration, go at <https://earth.esa.int/web/guest/general-registration>) and 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/



CryoSat-2 DATA Catalogue in GPOD

The current GPOD service works only in **SAR Mode and SARIN Mode**. So far, in the service catalogue, we have stored **~150 thousands** of SAR passes over the all globe for time span 2010-2015. This amount to **20 TB** of CryoSat-2 FBR data archived into GPOD cloud storage.



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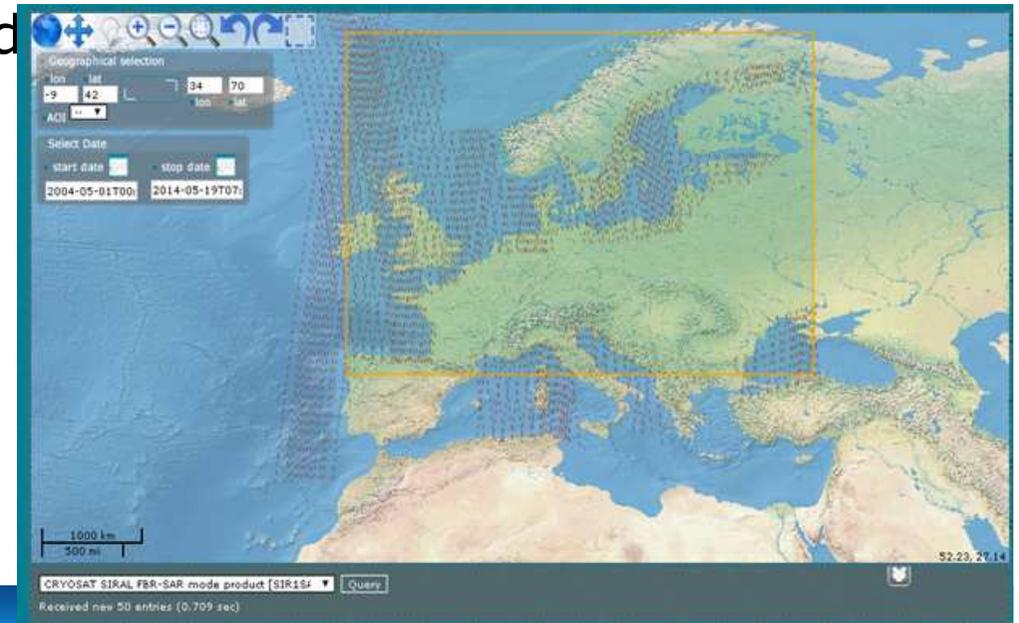
The Service Graphical User Interface

Once get to the service page, the first action to operate is to select **the region 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.

Regarding the **time of interest**, 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 the current date.

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



DATA SELECTION

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 shown on the world map in overlay.

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

The screenshot displays the SARvatore for CryoSat-2 interface. At the top, there are three tabs: "1- DATA SELECTION", "2- PROGRESSING STATUS", and "3- RESULTS VISUALIZATION". Below the tabs are four buttons: "Save in Workspace", "Process it!", "Schedule (Time-driven scheduler)", and "Schedule (Data-driven scheduler)".

The main area features a world map with a geographical selection overlay. The overlay includes fields for "lon" and "lat" with values "-180.0" and "90.00" respectively, and "AOI" set to "--". Below this, there are "Select Date" fields for "start date" (2010-04-08T00:00) and "stop date" (2014-08-02T11:00). A scale bar shows 2000 km and 2000 mi. A red circle highlights the "Query" button in the bottom right of the map area.

Below the map, there is a dropdown menu for "CRYOSAT SIRAL FBR-SAR mode product" set to "SIR1SAR" and a "Query" button. A message states "Received new 100 entries (4.285 sec)".

File Name	Start	End
CS_OFFL_SIR1SAR_FR_20111229T005752_20111229T010512_A001	2011-12-29T00:57:52.000Z	2011-12-29T01:05:12.000Z
CS_OFFL_SIR1SAR_FR_20111229T010706_20111229T010859_A001	2011-12-29T01:07:06.000Z	2011-12-29T01:08:59.000Z
CS_OFFL_SIR1SAR_FR_20111229T014149_20111229T014206_A001	2011-12-29T01:41:49.000Z	2011-12-29T01:42:06.000Z
CS_OFFL_SIR1SAR_FR_20111229T015311_20111229T015920_A001	2011-12-29T01:53:11.000Z	2011-12-29T01:59:20.000Z
CS_OFFL_SIR1SAR_FR_20111229T022819_20111229T022933_A001	2011-12-29T02:28:19.000Z	2011-12-29T02:29:33.000Z
CS_OFFL_SIR1SAR_FR_20111229T023104_20111229T023213_A001	2011-12-29T02:31:04.000Z	2011-12-29T02:32:13.000Z
CS_OFFL_SIR1SAR_FR_20111229T023226_20111229T023449_A001	2011-12-29T02:32:26.000Z	2011-12-29T02:34:49.000Z
CS_OFFL_SIR1SAR_FR_20111229T023706_20111229T024410_A001	2011-12-29T02:37:06.000Z	2011-12-29T02:44:10.000Z
CS_OFFL_SIR1SAR_FR_20111229T025215_20111229T025408_A001	2011-12-29T02:52:15.000Z	2011-12-29T02:54:08.000Z

Showing 1 to 100 of 100 entries

Buttons: Unselect All, Delete, Query

Results from 1 to 100 out of 80006 (4.285 sec)

next page

LIST OF PROCESSING OPTIONS

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

1. 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.
2. In the GPOD 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).

Received new 100 entries (5.228 sec)

File Name	Start	End
CS_OFFL_SIR1SAR_FR_20140201T193303_20140201T193357_B001	2014-02-01T19:33:03.000Z	2014-02-01T19:33:57.000Z
CS_OFFL_SIR1SAR_FR_20140202T063959_20140202T064108_B001	2014-02-02T06:39:59.000Z	2014-02-02T06:41:08.000Z
CS_OFFL_SIR1SAR_FR_20140202T064125_20140202T064137_B001	2014-02-02T06:41:25.000Z	2014-02-02T06:41:37.000Z
CS_OFFL_SIR1SAR_FR_20140202T183952_20140202T184139_B001	2014-02-02T18:39:52.000Z	2014-02-02T18:41:39.000Z
CS_OFFL_SIR1SAR_FR_20140203T054931_20140203T054950_B001	2014-02-03T05:49:31.000Z	2014-02-03T05:49:50.000Z
CS_OFFL_SIR1SAR_FR_20140203T072726_20140203T072912_B001	2014-02-03T07:27:26.000Z	2014-02-03T07:29:12.000Z
CS_OFFL_SIR1SAR_FR_20140203T073157_20140203T073332_B001	2014-02-03T07:31:57.000Z	2014-02-03T07:33:32.000Z
CS_OFFL_SIR1SAR_FR_20140203T193024_20140203T193117_B001	2014-02-03T19:30:24.000Z	2014-02-03T19:31:17.000Z
CS_OFFL_SIR1SAR_FR_20140204T183731_20140204T183917_B001	2014-02-04T18:37:31.000Z	2014-02-04T18:39:17.000Z

Showing 1 to 100 of 100 entries

Unselect All Delete Query

Results from 1 to 100 out of 3002 (5.228 sec)

next page

Processing Parameters

Here you find a list of processing options that you can select according to the processing level
For a wiki user manual of the service, go here: [wiki](#)

L1b Processor

- **Hamming Weighting Window**
Flag to set the application of the Hamming Weighting Window on the burst data (section 4.4 in REF1)
- **Exact Beam Forming**
Flag to set the application of exact or approximated Doppler Beam Steering (section 4.4 in REF1)
- **FFT Zero-Padding**
Flag to operate the Zero-Padding prior to the range FFT (section 4.8 in REF1). Zero-Padding is indicated for coastal zone analysis
- **Radar Receiving Window Size**
Flag to select the size of the radar receiving window: 128 range bins (standard) or 256 range bins (extended). Extended window is indicated for coastal zone analysis

L2 Processor

- **Restrict the re-tracking on specific surfaces**
Flag to limit the processing on open sea or on water (open sea, coastal zone and inland water) or to process the full pass
- **Slope effect**
Flag to switch on the slope term in the SAMOSA model (REF2)
- **PTR width alphap parameter**
Use a LUT (Look-Up Table) or a constant for PTR (Point Target Response) alphap parameter
- **SAMOSAS Model Generation**
Flag to select the generation of the SAMOSA model to use in the re-tracking. SAMOSA3 is a truncated version (only zero order term) of SAMOSA2 (REF2)

L1B Processing Options

Option Name	Option Value	Option Description
Hamming weighting Window	<ul style="list-style-type: none"> - Apply only in coastal zone - Yes, apply it - No. do not 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
Exact Beam-Forming	<ul style="list-style-type: none"> - Approximated - Exact 	User can decide here whether to operate an exact Beam-Forming or an approximated Beam-Forming
FFT Zero-Padding	<ul style="list-style-type: none"> - 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
Radar Receiving Window Size	<ul style="list-style-type: none"> - 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)
Data Posting Rate 20 Hz/80 Hz	<ul style="list-style-type: none"> - 20 Hz - 80 Hz 	User can decide here at which posting rate to post the geophysical parameters in output
Dump SAR Stack Data in output	<ul style="list-style-type: none"> -NO -YES 	User can command here to post in output SAR/SARIN Stack Data Products for each selected pass.

L2 Processing Options

Option Name	Option Value	Option Description
Restrict the re-tracking on specific surfaces	<ul style="list-style-type: none"> - Process all - Process only open sea points - Process only water points 	User can decide here whether to process the whole pass, only points in open sea or only water points
SAMOSA Model Generation	<ul style="list-style-type: none"> - Use SAMOSA 2 -Use SAMOSA 3 -Use SAMOSA + 	User can decide here which SAMOSA generation model to use in the processing (SAMOSA 2, SAMOSA 3 or SAMOSA+)
PTR width alphap parameter	<ul style="list-style-type: none"> - LUT - Constant 	User can decide here whether to use a LUT (Look-Up Table) or a constant for PTR (Point Target Response) alphap parameter
Dump SAR Echo Waveforms in Output	<ul style="list-style-type: none"> - NO -YES 	User can command here to attach in the output product the SAR Echo Waveforms
Dump SAR RIP Waveforms in Output	<ul style="list-style-type: none"> - NO -YES 	User can command here to attach in the output product the SAR RIP Waveforms

TASK SUBMISSION

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.

The screenshot displays the ESA Grid Processing on Demand web interface. At the top, the ESA logo and 'grid processing on demand' are visible, along with navigation tabs: Home, Services, Workspace, Catalogue, Products, Schedulers, My profile, Admin, Documentation, and Help. A user profile box shows 'Name: Salvatore Dinardo' and 'Credits: 3' with a 'Logout' button. The main content area features a task titled 'SARvatore for CryoSat-2' with a red box highlighting the 'PROCESS IT' button. Below this are buttons for 'Save in Workspace', 'Process it!', 'Schedule (Time-driven scheduler)', and 'Schedule (Data-driven scheduler)'. A world map is shown with a geographical selection tool, including input fields for longitude (47, 56, 48) and latitude (35, 48), and date selection fields (start: 2010-04-08T00, stop: 2014-08-13T18). A 'Main Parameters' panel on the right includes fields for 'Task Caption' (CryoSat-2 SARvatore), 'Publish Server' (Portal), 'Compression' (None, Single File, Unique Package), 'Computing Element' (Operational CE 02), and 'Priority' (Normal). At the bottom, a table lists received entries with columns for product ID, start time, and end time.

Product ID	Start Time	End Time
CS_RPRO_SIR1SAR_FR_20111009T230602_20111009T230639_B001	2011-10-09T23:06:02.000Z	2011-10-09T23:06:39.000Z
CS_RPRO_SIR1SAR_FR_20111011T230337_20111011T230413_B001	2011-10-11T23:03:37.000Z	2011-10-11T23:04:13.000Z
CS_RPRO_SIR1SAR_FR_20111013T230058_20111013T230145_B001	2011-10-13T23:00:58.000Z	2011-10-13T23:01:45.000Z
CS_RPRO_SIR1SAR_FR_20111015T225828_20111015T225916_B001	2011-10-15T22:58:28.000Z	2011-10-15T22:59:16.000Z
CS_RPRO_SIR1SAR_FR_20111016T105758_20111016T105809_B001	2011-10-16T10:57:58.000Z	2011-10-16T10:58:09.000Z
CS_RPRO_SIR1SAR_FR_20111018T105527_20111018T105540_B001	2011-10-18T10:55:27.000Z	2011-10-18T10:55:40.000Z

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:

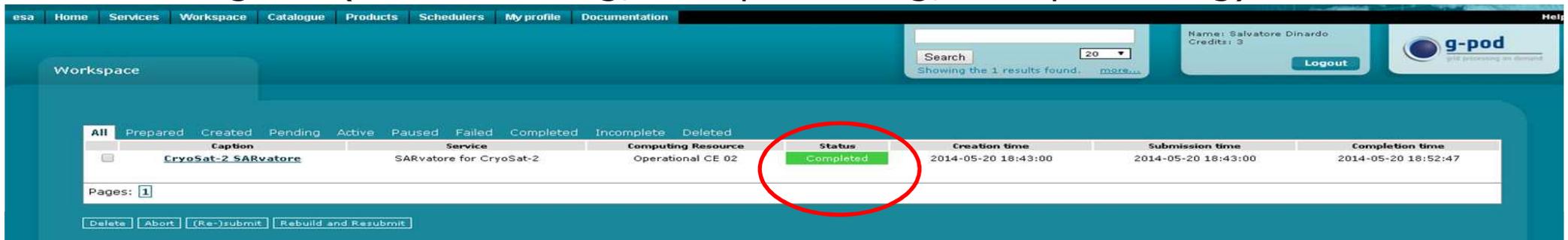
Orange → run under processing

Green → run completed

Red → 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)



The screenshot shows the g-pod workspace interface. At the top, there is a navigation menu with links: esa, Home, Services, Workspace, Catalogue, Products, Schedulers, My profile, and Documentation. On the right, there is a search bar, a dropdown menu set to '20', and a 'Logout' button. Below the navigation, there is a 'Workspace' section with a table of tasks. The table has columns for 'Caption', 'Service', 'Computing Resource', 'Status', 'Creation time', 'Submission time', and 'Completion time'. The 'Status' column for the first task, 'CryoSat-2 SARvatore', is highlighted in green and circled in red. Below the table, there are buttons for 'Delete', 'Abort', '(Re-)submit', and 'Rebuild and Resubmit'.

Caption	Service	Computing Resource	Status	Creation time	Submission time	Completion time
CryoSat-2 SARvatore	SARvatore for CryoSat-2	Operational CE 02	Completed	2014-05-20 18:43:00	2014-05-20 18:43:00	2014-05-20 18:52:47

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).

The screenshot displays the ESA Grid Processing on Demand portal interface. On the left, the 'Publish Server' configuration form is visible, with the 'my account' menu item highlighted in red. The form includes fields for Name (CRYOSAT), Protocol (FTP), Hostname (ftp.esrin.esa.int), Port (21), Path (group_rw/CRYOSAT/(UID)), Connection username (RA2data), Use password (checked), Connection password, Public key subject, Options, Download URL, Local file system folder, Selected by default, Use for task result metadata, and Delete task result files when task is deleted. On the right, the 'CryoSat-2 SARvatore' task results page is shown, with the '3- RESULTS VISUALIZATION' tab selected. The task details include Task ID, Service, Status (Completed), Progress (100%), Creation Time, Submission Time, Completion Time, Processing ID, and CE. A world map is displayed with a red box highlighting the download URL: `/tasks/download?url=http://gpod.esa.int/results/d1cd9d71-44b3-462b-8176-33d8111e09b7/results.tgz`. Below the map, a table shows the Result Identifier, Start Time, and End Time for the task. The table has one entry with the following details:

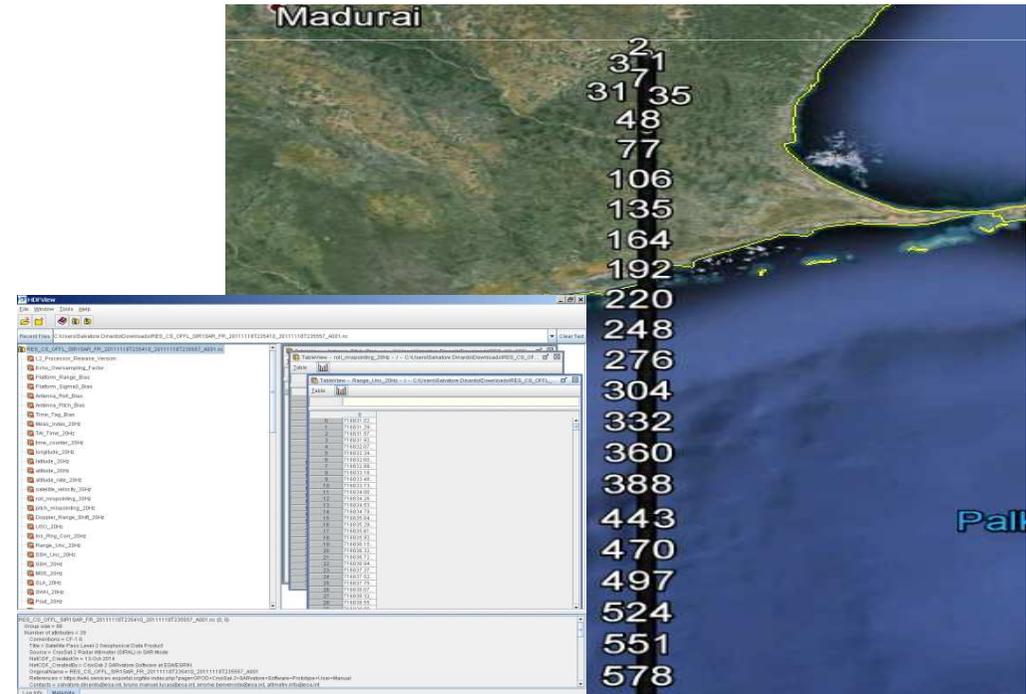
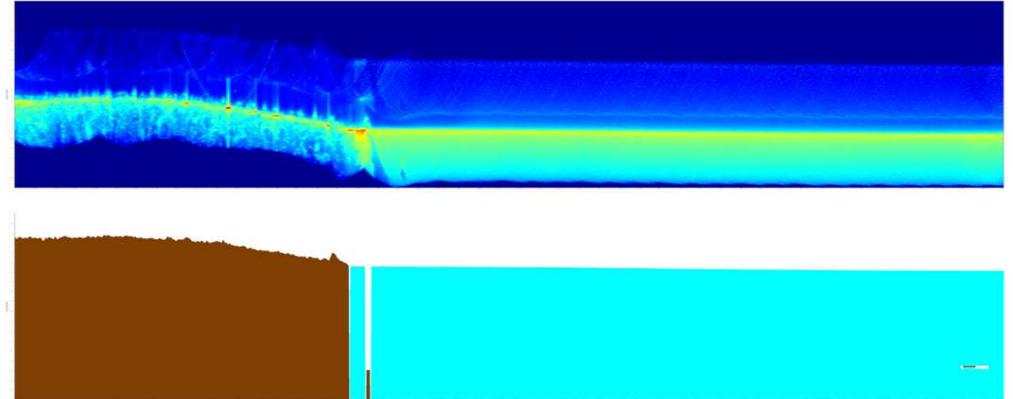
Result Identifier	Start Time	End Time
https://gpod.esa.int/d1cd9d71-44b3-462b-8176-33d8111e09b7	2010-04-08T00:00:00	2014-08-07T13:45:55

The 'Files' section shows the download URL. The 'Quicklook' section shows 'Showing 1 to 1 of 1 entries'. The 'Task Operations' section includes a 'Caption' field with the value 'CryoSat-2 SARvatore' and buttons for 'Copy', 'Schedule (Data-driven scheduler)', 'Schedule (Time-driven scheduler)', 'Clone', 'Recreate', 'Resubmit', 'Request Input Data', and 'Delete'. The 'Jobs Information' link is also visible at the bottom.

Output Package Content

The output package consists of :

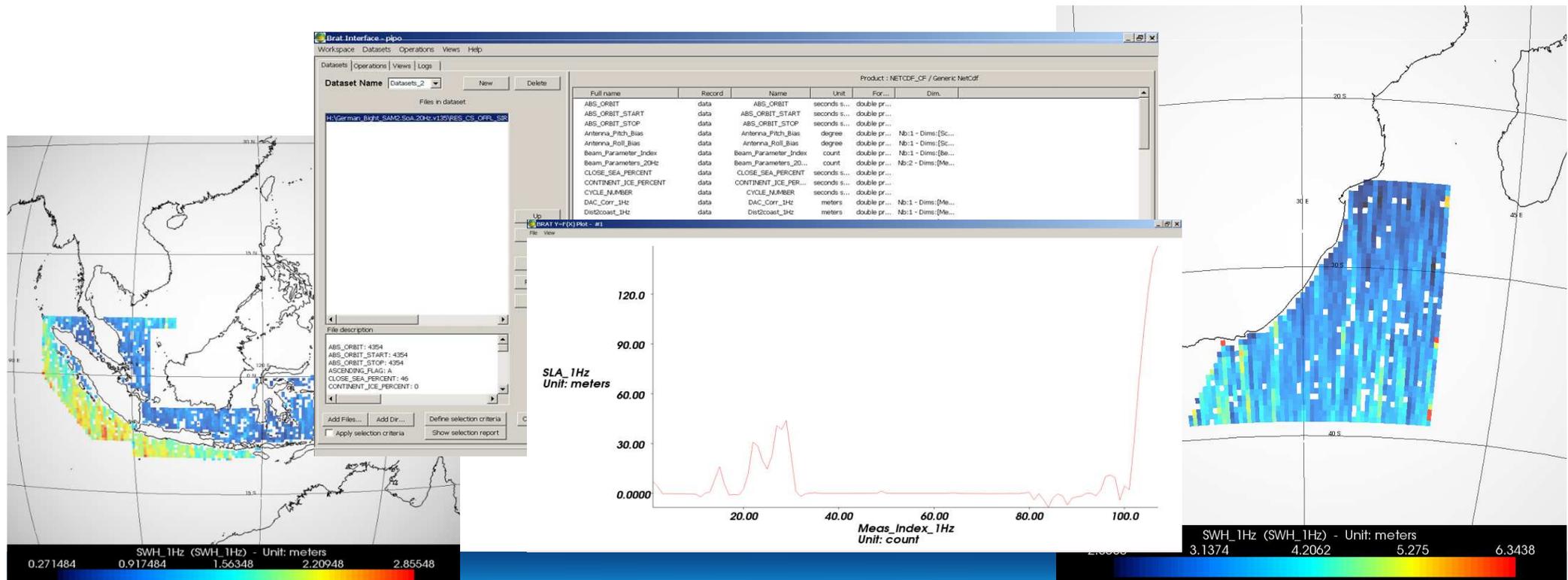
- Pass Ground-Track in KML format
- Radar Echogram Picture in PNG format
- L2 data product in NETcdf format with all the scientific results. The netCDF format is self-explanatory with all the data field significance described in the attributes



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



Evolutions since 2014

- Attachment of SAR ECHO Waveforms in the netCDF files ->> **DONE**
- Attachment of SAR RIP Waveforms in the netCDF files ->> **DONE**
- Attachment of STACK Data in the netCDF files ->> **DONE**
- Add support for posting rate at 80 Hz->> **DONE**
- Support for CryoSat-2 SARIN Data ->> **DONE**
- New HR Tide Model (TPX08) and HR Geoid (EGM2008) ->> **DONE**
- Enhancement of the retracking in coastal zone and inland water (SAMOSA+) ->> **DONE**

Next Evolutions for 2016

- Add Support for Sentinel-3 --> selecting the processing options properly , users can mimic the CryoSat-2 or the Sentinel-3 processing baseline **for an easy cross-comparison between the missions**
- Add support to UPorto GPD wet correction
- Add support to new HR Geoid (EIGEN-4C6) and HR Tide Model (FES 2012)
- Provide with an internal sea state bias solution

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

- ❑ 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, email at:
Altimetry.Info@esa.int**