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NATURAL ENVIRONMENT RESEARCH COUNCIL

CONSORZIO LaMMA

con il patrocinio di REGIONE TOSCANA

cnes

EUMETSAT

OSU Oregon State University

University of New Hampshire

esa

→ 10th COASTAL ALTIMETRY WORKSHOP

SAR Altimetry Training Course

SARvatore Demo and Hands-On

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21–24 February 2017 | Florence, Italy

SARvatore

SAR Versatile Altimetric Toolkit for Ocean Research & Exploitation

- ESA G-POD System Introduction
- CryoSat-2 SAR/SARin Processing Service Introduction
- Service Walk-Through
- SARvatore for Sentinel-3
- Conclusions

G-POD Distributed Environment

- The **ESA Grid Processing on Demand (**G-POD**)** system is a generic GRID-based operational computing environment providing users with a fast computational facility without the need to handle bulky data.

- 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:

g-pod
grid processing on demand

Over **600 CPUs** in about **90 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
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

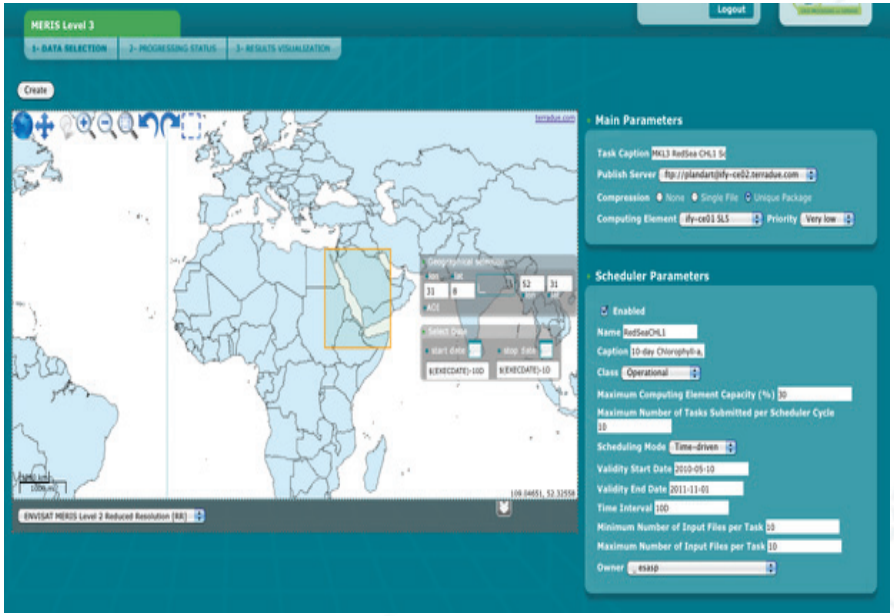
As of today, G-POD includes more than **300TB** of **EO data stored locally**.
EO Data available to G-POD services come from both ESA and non-ESA missions.

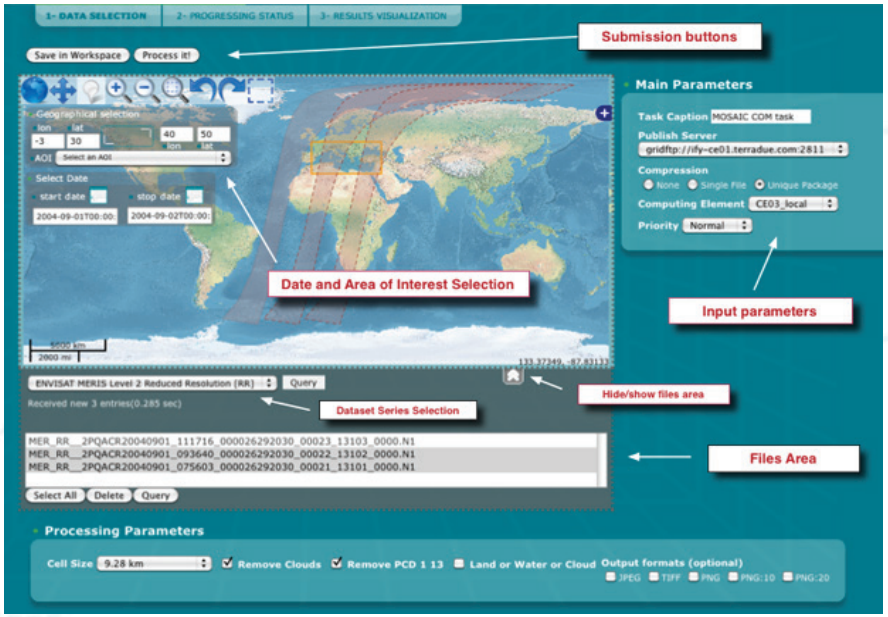
G-POD Web Portal

The **G-POD web portal** is a flexible, secure, generic and distributed web platform.

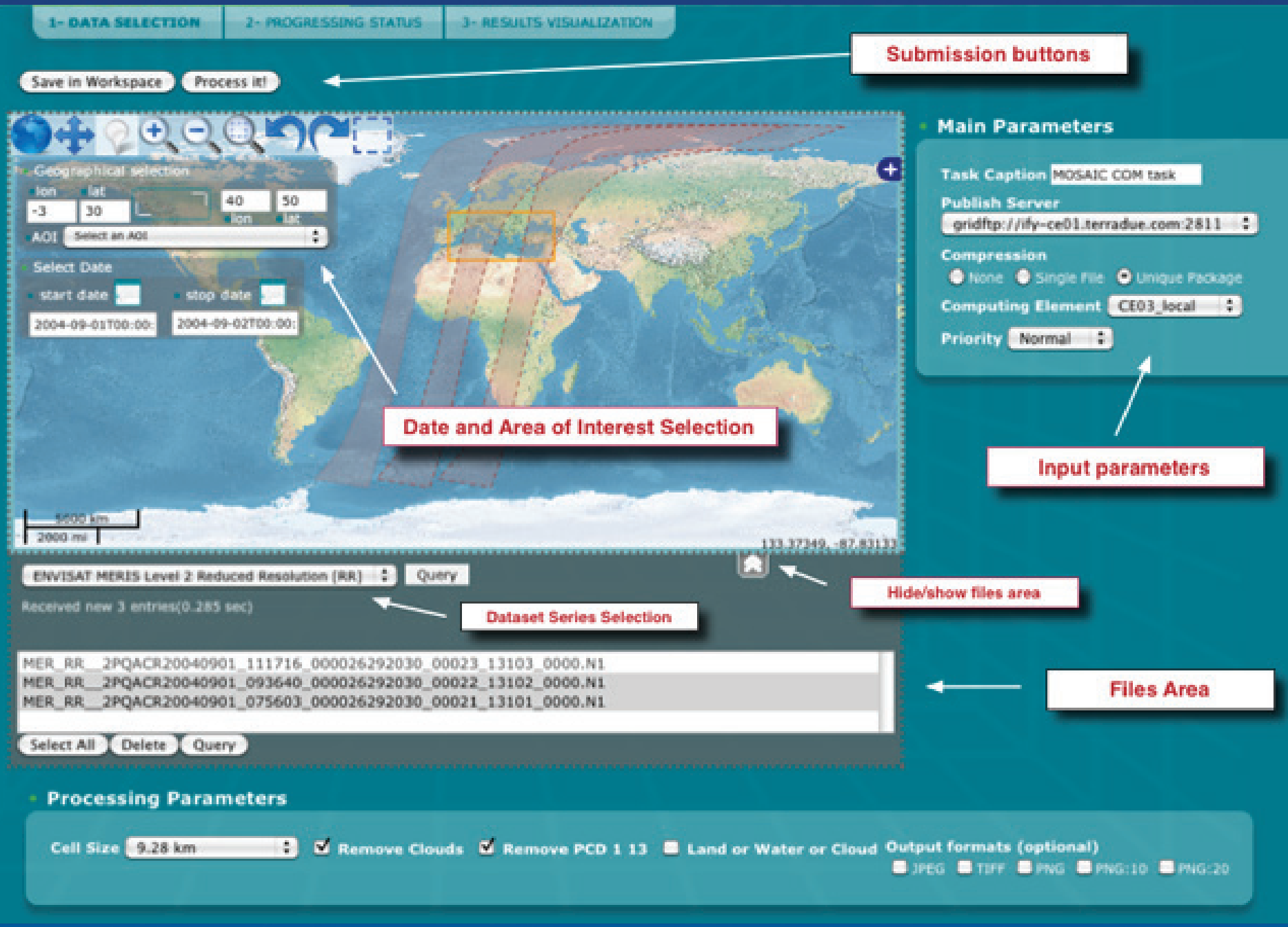
From the creation of a new task to the output/publication, passing through the data selection and the job monitoring, the user goes trough a **friendly** and **intuitive** user interface accessible from everywhere.

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






MERIS Level 3
1- DATA SELECTION
2- PROCESSING STATUS
3- RESULTS VISUALIZATION
Logout
Create
Main Parameters
Task Caption
Publish Server
Compression
None
Single File
Unique Package
Computing Element
Priority
Very low
Scheduler Parameters
Enabled
Name
RedSeaChL1
Caption
10-day Chlorophyll-a
Class
Operational
Maximum Computing Element Capacity (%)
30
Maximum Number of Tasks Submitted per Scheduler Cycle
10
Scheduling Mode
Time-driven
Validity Start Date
2010-05-10
Validity End Date
2011-11-01
Time Interval
100
Minimum Number of Input Files per Task
10
Maximum Number of Input Files per Task
10
Owner
ENVISAT MERIS Level 2 Reduced Resolution (RR)


1- DATA SELECTION
2- PROGRESSING STATUS
3- RESULTS VISUALIZATION
Submission buttons
Save in Workspace
Process it!
Geographical selection
lon
lat
-3
30
40
50
AOI
Select an AOI
Select Date
start date
stop date
2004-09-01T00:00:
2004-09-02T00:00:
Main Parameters
Task Caption
MOSAIC COM task
Publish Server
gridftp://ify-ce01.terradue.com:2811
Compression
None
Single file
Unique Package
Computing Element
CE03_local
Priority
Normal
Date and Area of Interest Selection
Input parameters
5000 km
2000 mi
ENVISAT MERIS Level 2 Reduced Resolution (RR)
Query
Received new 3 entries(0.285 sec)
Hide/show files area
Dataset Series Selection
MER_RR__2PQACR20040901_111716_000026292030_00023_13103_0000.N1
MER_RR__2PQACR20040901_093640_000026292030_00022_13102_0000.N1
MER_RR__2PQACR20040901_075603_000026292030_00021_13101_0000.N1
Files Area
Select All
Delete
Query
Processing Parameters
Cell Size
9.28 km
Remove Clouds
Remove PCD 1 13
Land or Water or Cloud
Output formats (optional)
JPEG
TIFF
PNG
PNG:10
PNG:20

G-POD Services Portfolio

AARDVARC
aeromeris
algal1
AMORGOS
Antarctica
ASARP
BEAMARITHM
BeamReproject
BIOMASAR-II
BRAT
download
ESCATSM
FAIRE2
GEOFIT

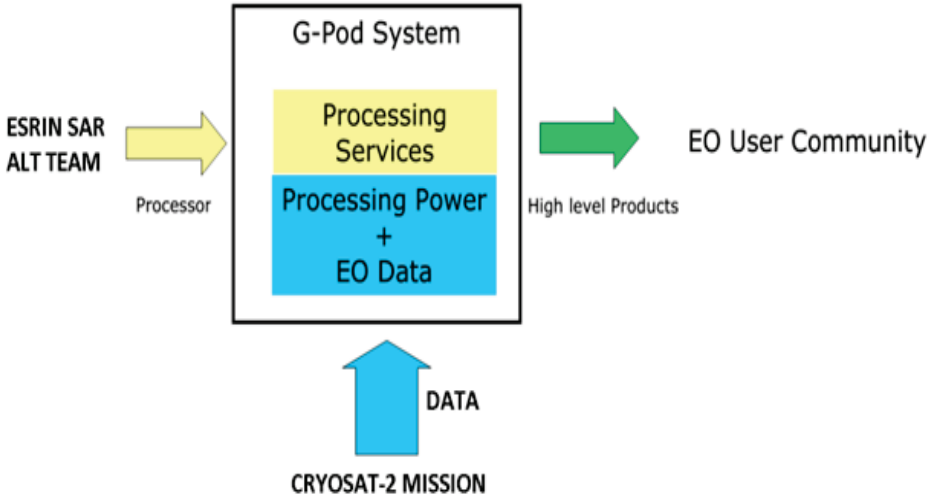
GlobTemperature
GMESCQC
GUT
Imager
INSAR
JLOEP
JURASSIC
KLIMA
LandsatIPF
MCFS
MGVIJRC2
MGVIRegional
MIOPS
MKL3
MOSAICOM

MSGBaroncini
MSGTimeseries
NEST
PHAVEOS
RAIES
RIVERLAKE2
SAROTECnFLO
SARvatore for CryoSat
SARINvatore for CryoSat
SMOSL1
SMOSL2OS
SMOSL2SM
SOIL MAPPER
SSEGridFAPAR
VASD
vomit
WACMOS

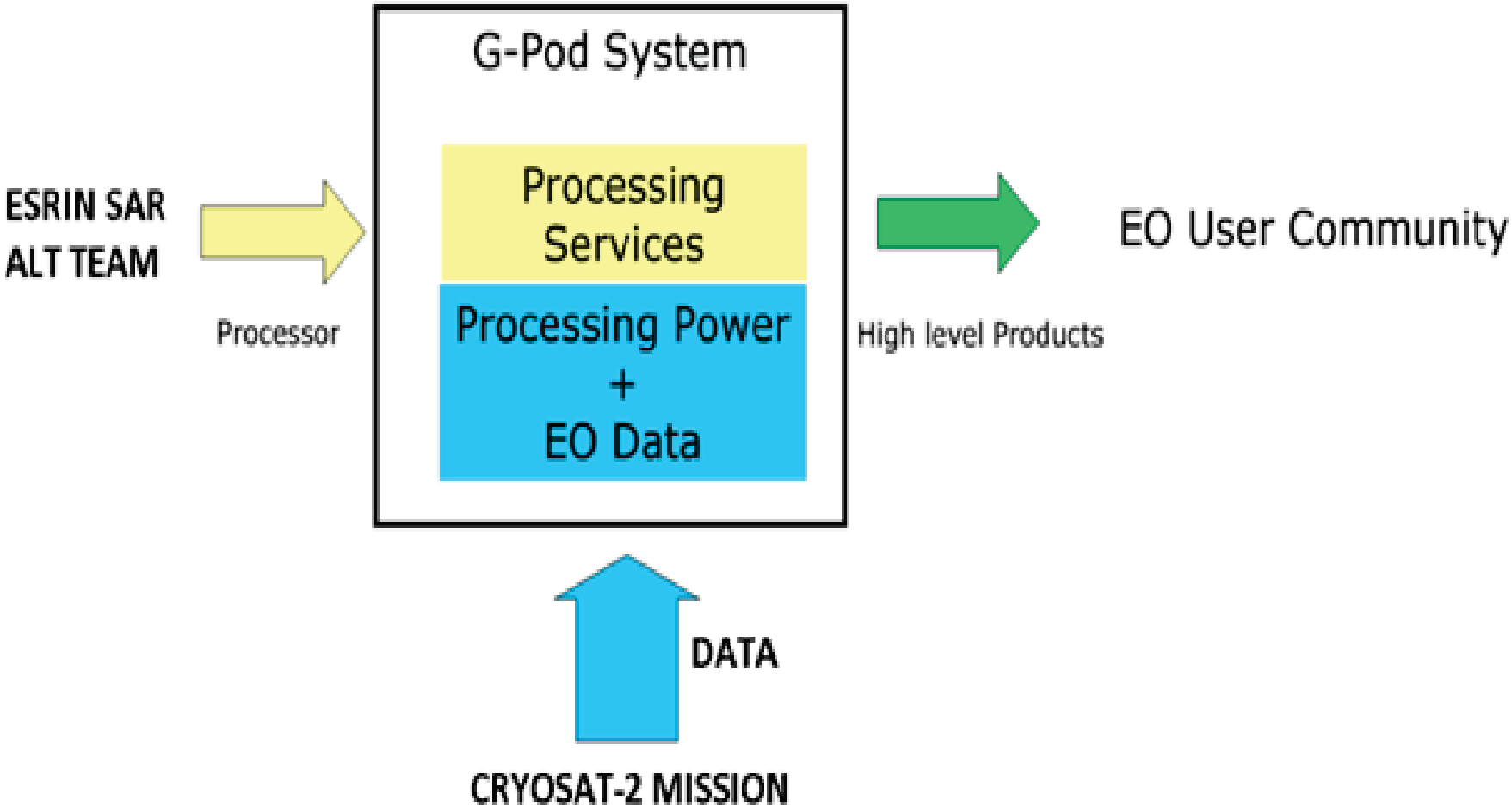
GPOD CryoSat SAR Processing Service

- The ESA G-POD Service, SARvatore (**SAR** **V**ersatile **A**ltimetric **T**oolkit for **O**cean **R**esearch & **E**xploitation) for CryoSat-2 is an Earth-Observation application that provides the capability to process remotely and on demand CryoSat-2 SAR/SARin data, from L1a (FBR) data products until SAR Level-2 geophysical data products.

- **The service to process Sentinel-3 data has been developed and used during commissioning phase. It will be opened to scientists with the release of Level 1A products.**



GPOD CryoSat SAR Processing Service



CryoSat-2 Processor Prototype

- The service is based on the SAR Processor Prototype that was developed by the ESRIN R&D Altimetry Team for CryoSat-2 validation purposes and preparation for Sentinel-3 mission.

- **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 – Sentinel-3 SAR Data

- Output L1b → Radar Echogram.
- Output L2 → SSH, SLA (W/O SSB), SWH, sigma0, wind speed.

CryoSat-2 Processor Prototype

- ESRIN R&D ALT team compiled the processor's MATLAB source code into a 64-bit Linux binary and delivered to ESA G-POD team the executables, the input archive (FBR data) and satellite footprints (ASCII tracks). The toolkit has been fully integrated in the GPOD System for grid on-demand computing.

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 validate CryoSat-2 for ocean applications and support the exploitation of Sentinel-3 data.

- to provide scientists with the access to SAR/SARin processing to get acquainted with the novelties and specifities of SAR/SARin Altimetry and to build their own customized products.

Service Registration and Access

- The service is **open, free of charge and accessible online 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 theG-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 services at:

  https://gpod.eo.esa.int/services/CRYOSAT_SAR/

  https://gpod.eo.esa.int/services/CRYOSAT_SARIN/

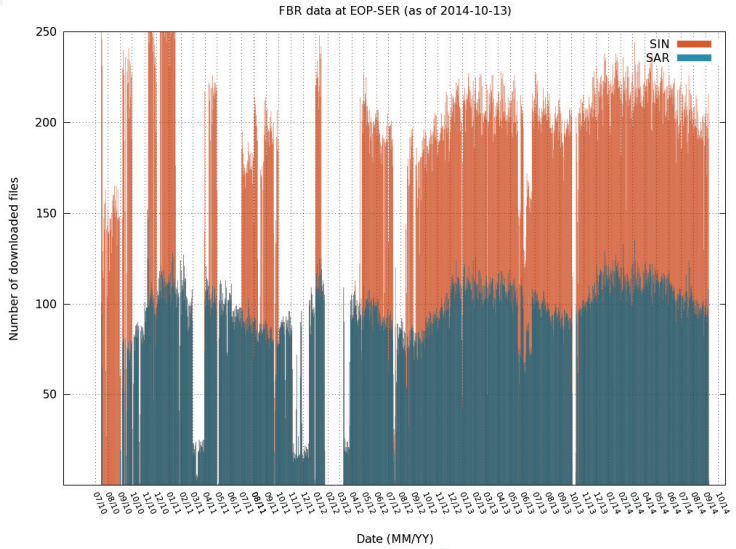
- These services are listed under the Marine Theme and can be found through the search bar.

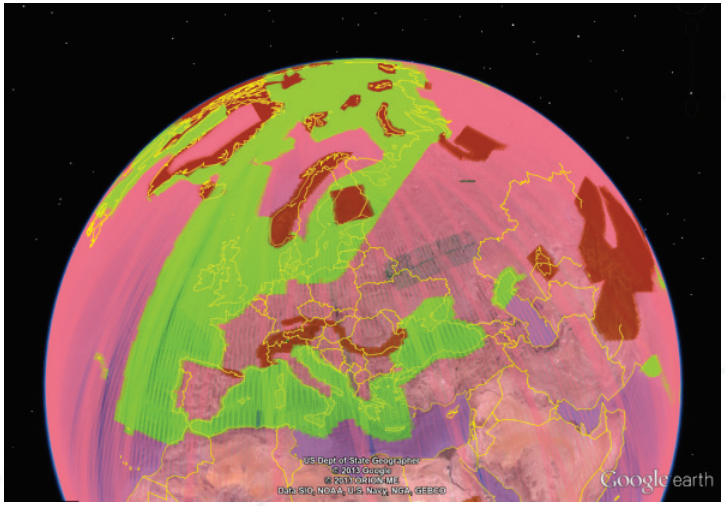
Service Registration and Access

Service Registration and Access

CryoSat-2 DATA Catalogue in G-POD

- The current GPOD service offers **SAR (SARvatore)** and **SARin (SARinvatore)** processing schemes.
- **376,376 SAR** passes and **293,936 SARin** passes have been stored in the service catalogue.
- An amount of **160 TB of** CryoSat-2 FBR data have been archived into the G-POD storage*.
- Data obtained from the ESRIN R&D ALT Team (historical) and CS-2 ftp servers (current).





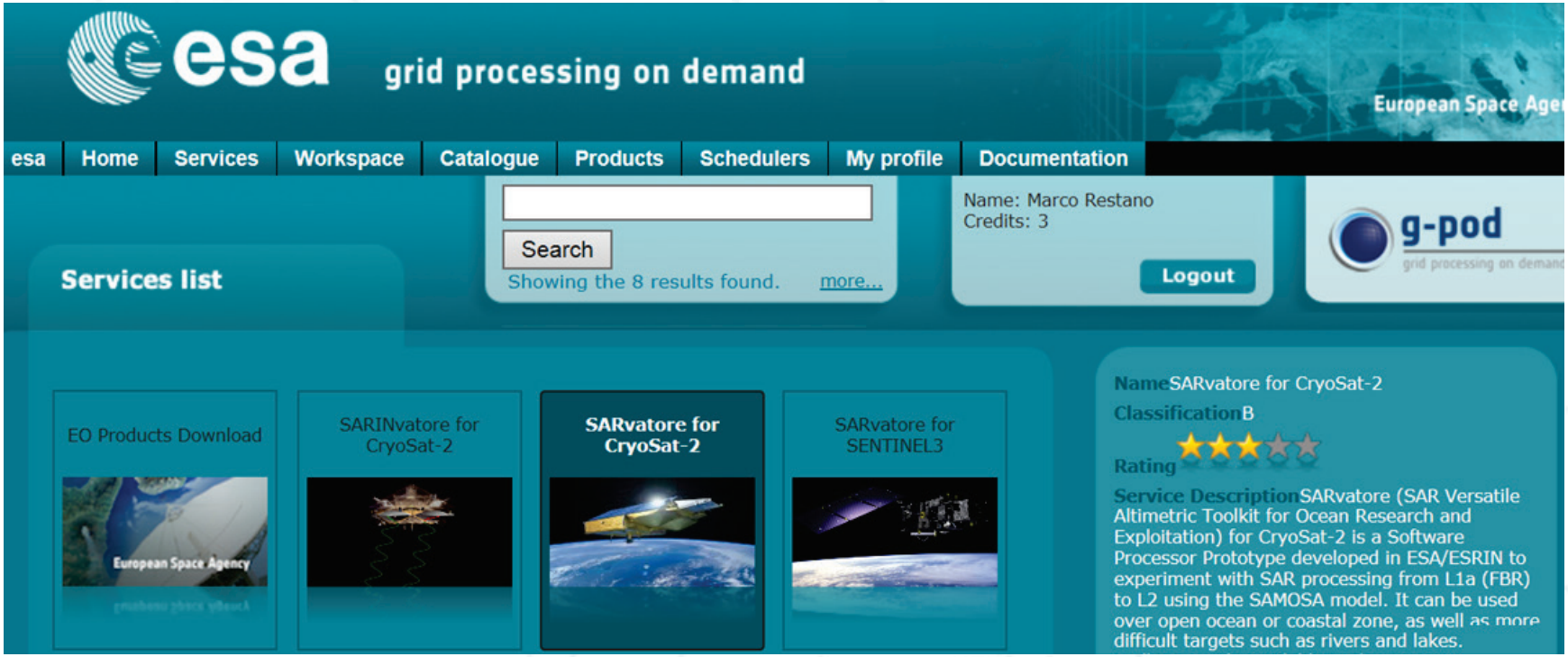
*Partial historical archive (<2012/05) were provided by NOAA/RADS and ESA/ESTEC.

SARvatore Usage Statistics

In last 2.5 years, 65 SARvatore and 62 SARINvatore users have been supported with:

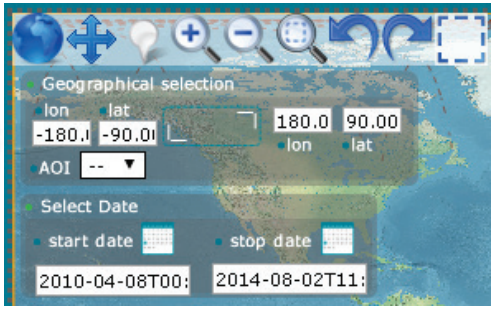
- 143748 CPU hours (that's 5990 days or 200 months or **16.7 years**)
- Number of processing tasks submitted for SARvatore: 7856
- Number of processing tasks submitted for SARINvatore: 229
- Input processed by SARvatore tasks: 70.7 TB
  - Output produced: 2.8 TB
- Input processed by SARINvatore tasks: 7.9 TB
  - Output produced: 29 GB

SARvatore for Cryosat-2



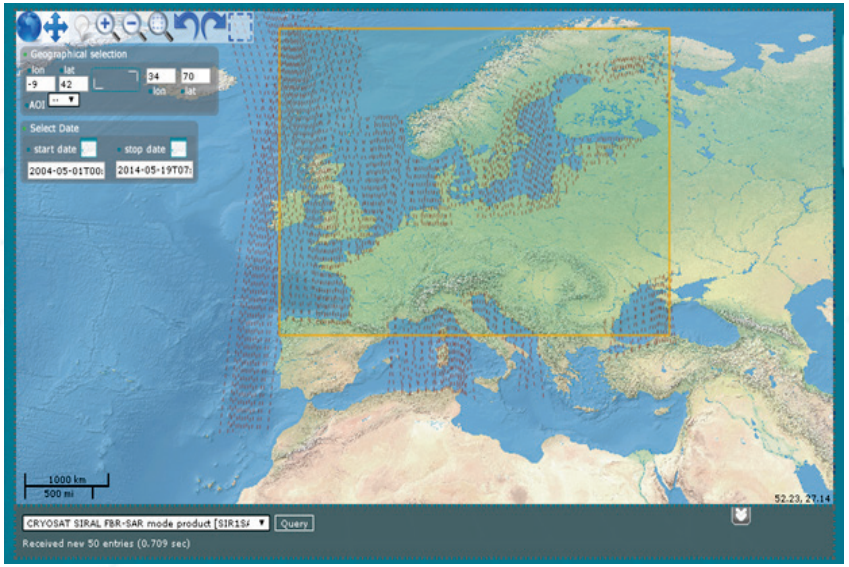
The Service Graphical User Interface

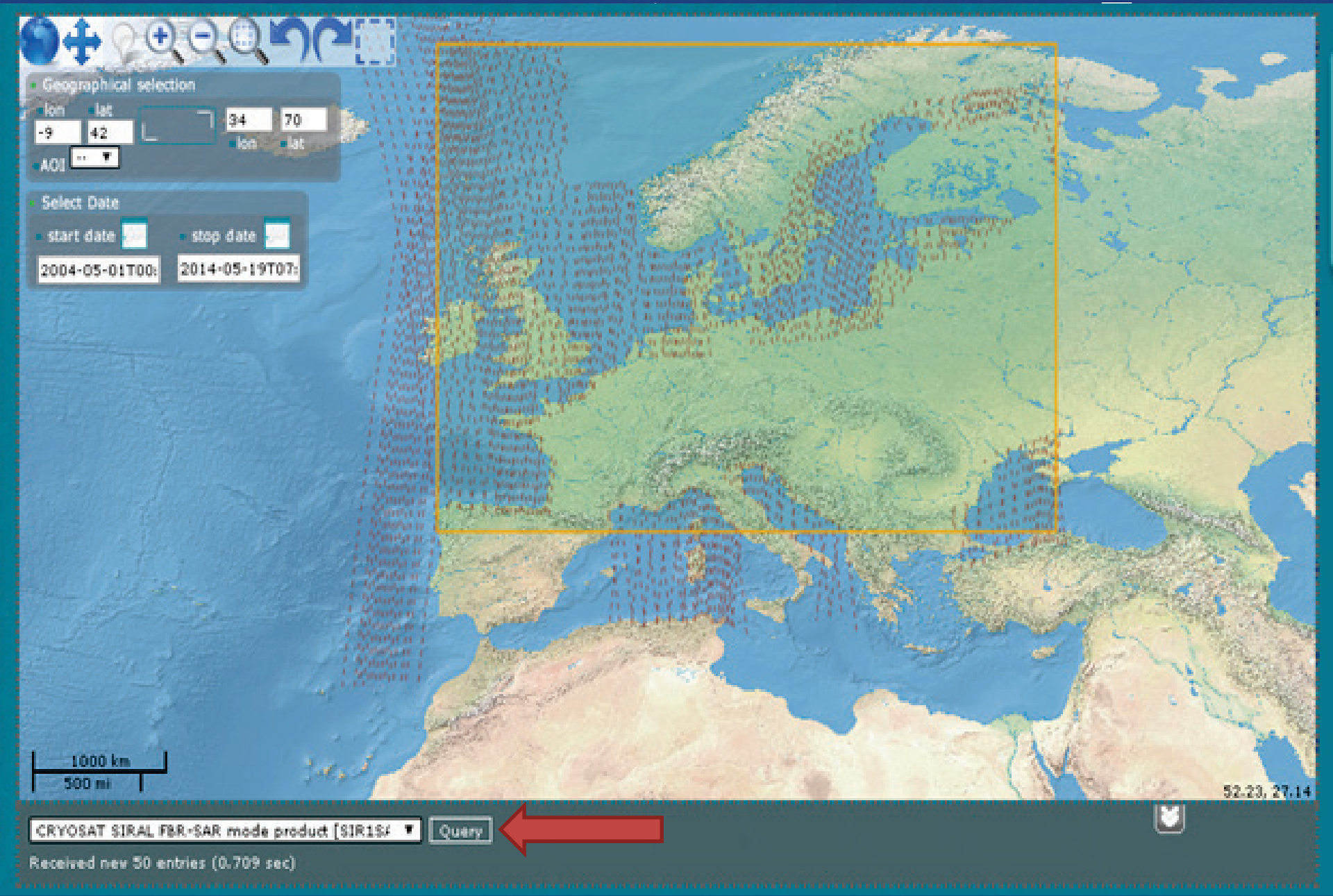
- Once get to the service page, the first action is to select **the zone of interest** (by either drawing a rectangle or typing coordinates) and **the time of interest** for the run (start –stop date).



- By default, the start date is the time of CryoSat-2 launch.

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




Geographical selection
lon
lat
-9
42
34
70
lon
lat
AOI
Select Date
start date
stop date
2004-05-01T00:
2014-05-19T07:
1000 km
500 mi
52.23, 27.14
CRYOSAT SIRAL FBR-SAR mode product [SIR1SA
Query
Received new 50 entries (0.709 sec)

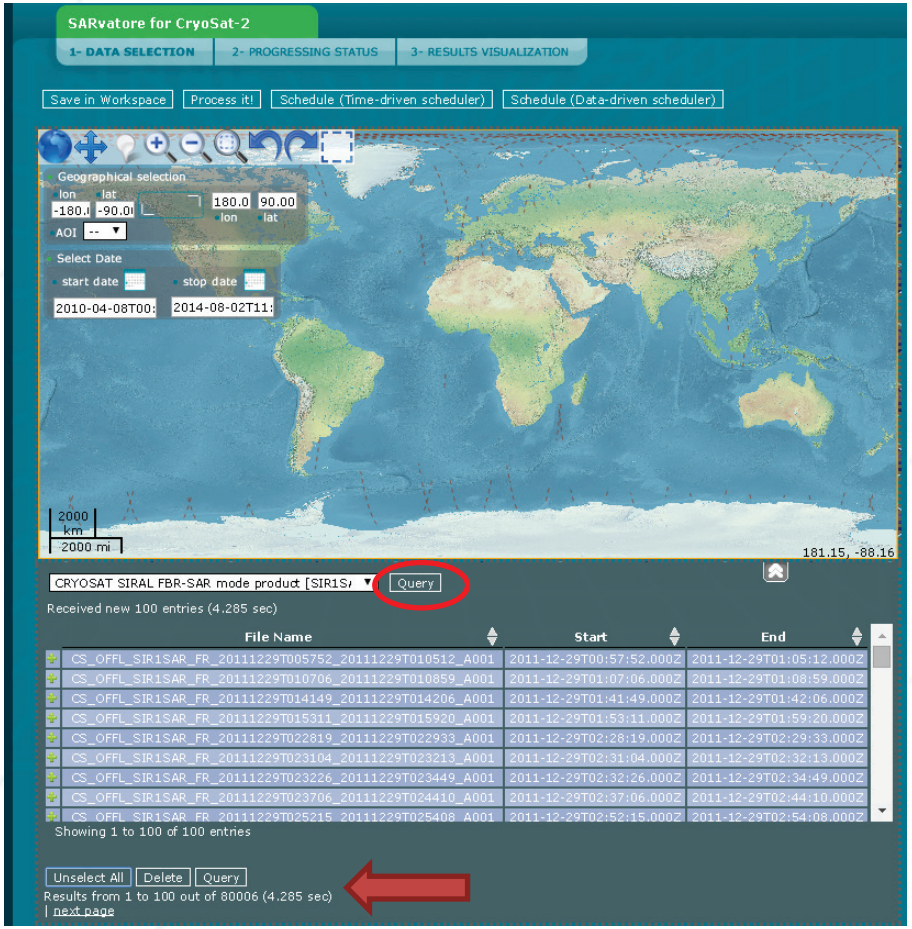
Data Selection

- After the temporal/spatial selection, by clicking on the "**QUERY**" button, the service lists all CryoSat-2 passes matching the temporal/spatial requirements.

- **CryoSat-2 SAR/SARin** tracks, crossing the area of interest, are then overlaid on the world map.

- The graphical interface lists up to 250 FBR products per page and informs users on the total number of passes found.

- The user can select products by: clicking on specific passes. A 'Select all' option is available.



CRYOSAT SIRAL FBR-SAR mode product [SIR1S/ ▼ Query

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

Unselect All | Delete | Query

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

| next page

Session Main Parameters Panel

On the top right, a **main parameters** panel allows users to set the:

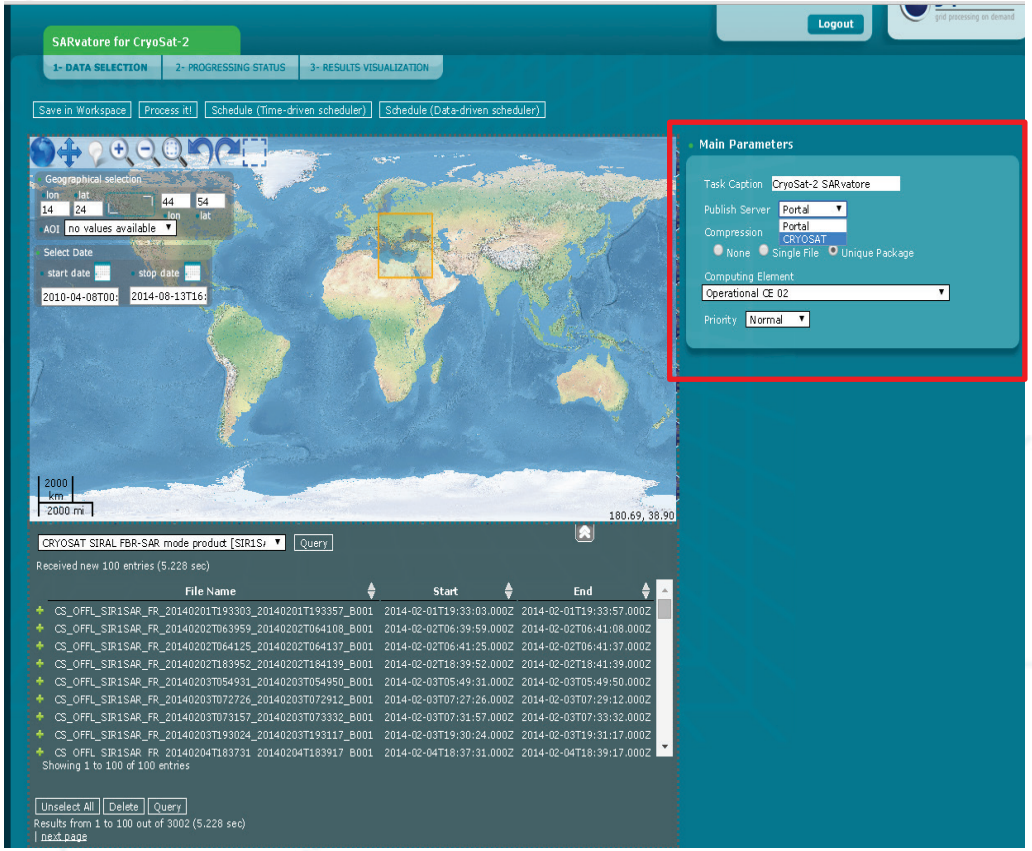
— Name of the current task.

— Ftp Server to publish results (portal or personal).

— Data compression format (tgz, none).

— Grid Computing Resources.

— Task Priority.



Main Parameters

Task Caption: CryoSat-2 SARvatore

Publish Server: Portal

- Portal
- CRYOSAT

Compression

- None
- Single File
- Unique Package

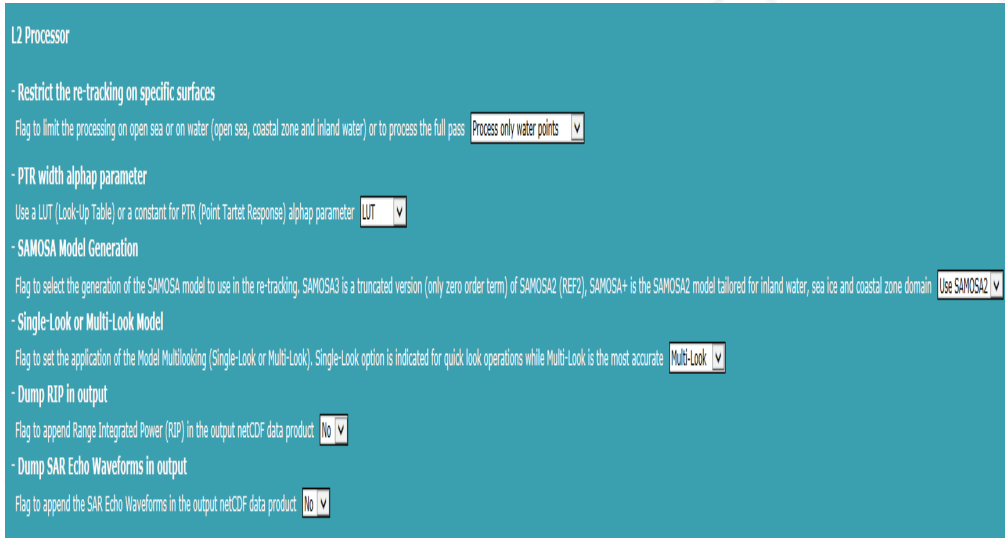
Computing Element: Operational CE 02

Priority: Normal

List of Processing Options

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

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



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

- **Filter out Duplicated CryoSat-2 Products during the processing time**

  Enable to filter out duplicated products during the processing: duplicated products will not be processed [Enable]

- **Data Posting Rate 20 Hz/80 Hz**

  Flag to set the data posting rate: 20 Hz (canonic posting rate) or 80 Hz (finer posting rate) [20 Hz]

- **Hamming Weighting Window**

  Flag to set the application of the Hamming Weighting Window on the burst data (section 4.4 in REF1) [Apply only in coastal zone]

- **Exact Beam-Forming**

  Flag to set the application of exact or approximated Doppler Beam Steering (section 4.4 in REF1) [Approximated]

- **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 [Yes, apply Zero-Padding]

- **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 [128 range bins]

- **Antenna Pattern Compensation**

  Flag to activate the antenna pattern compensation on the Stack Data [No]

- **Dump SAR Stack Data in output**

Be aware that SAR Stack Data are bulky data products (around 1 GB for single pass); do not process them massively but limit yourself at around 10/20 passes at the time

Flag to dump the SAR Stack Data in the output package [No]

List of Processing Options

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: Process only water points

- **PTR width alphap parameter**

  Use a LUT (Look-Up Table) or a constant for PTR (Point Tartet Response) alphap parameter: LUT

- **SAMOSA 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), SAMOSA+ is the SAMOSA2 model tailored for inland water, sea ice and coastal zone domain: Use SAMOSA2

- **Single-Look or Multi-Look Model**

  Flag to set the application of the Model Multilooking (Single-Look or Multi-Look). Single-Look option is indicated for quick look operations while Multi-Look is the most accurate: Multi-Look

- **Dump RIP in output**

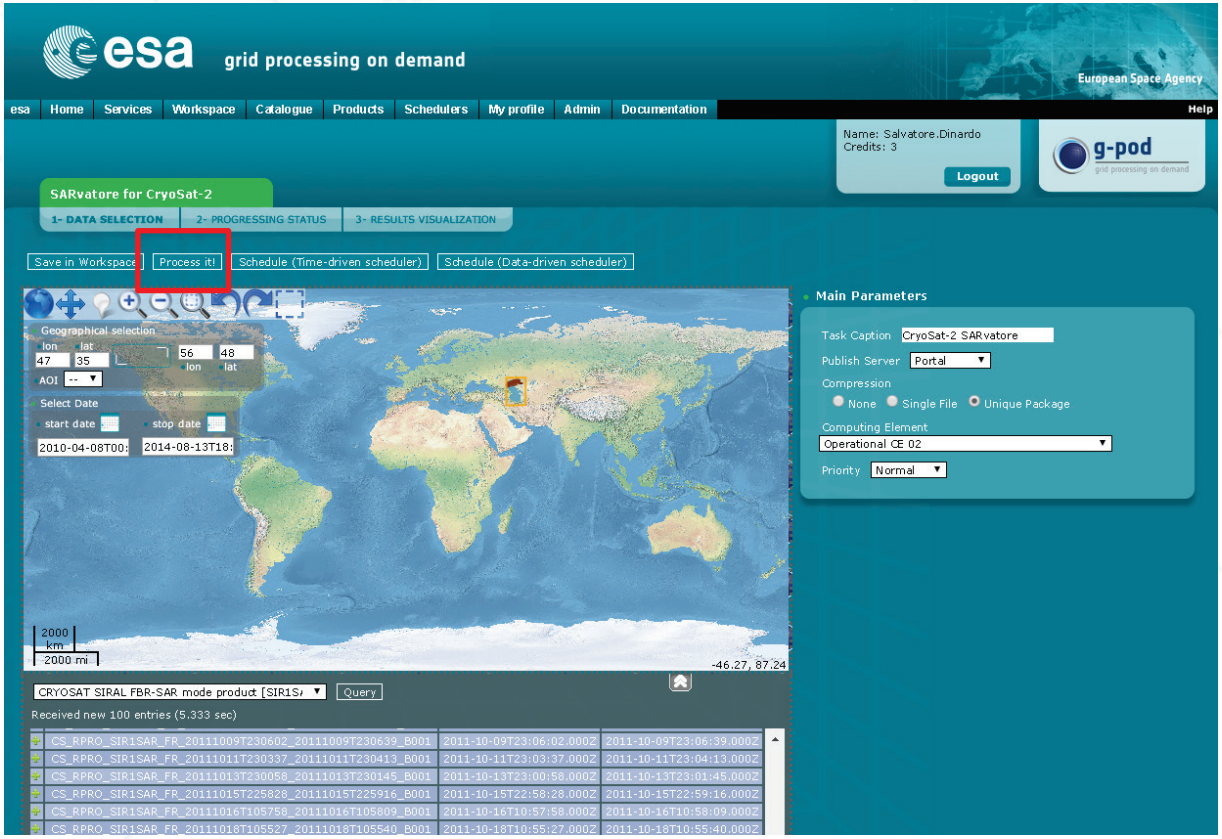
  Flag to append Range Integrated Power (RIP) in the output netCDF data product: No

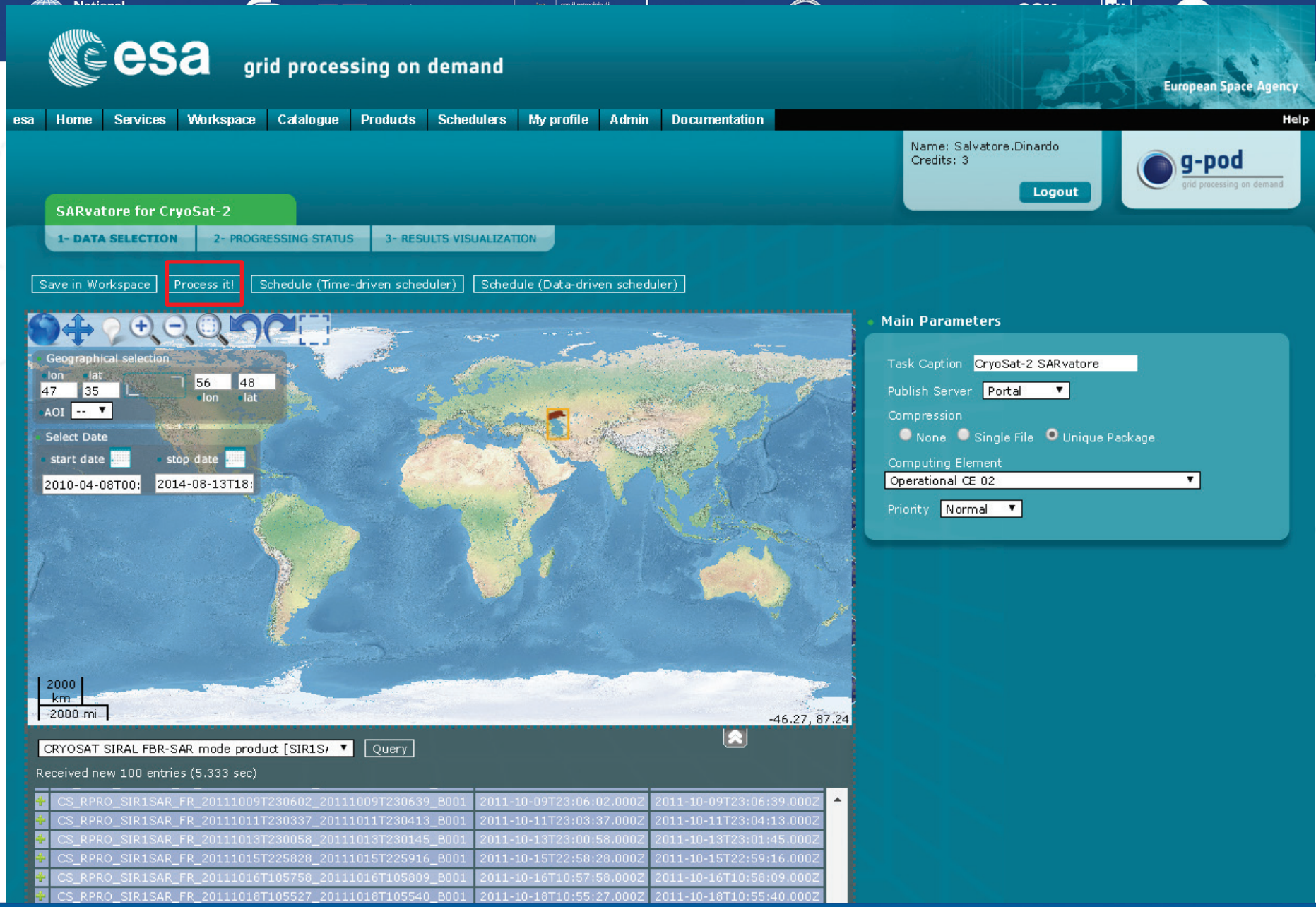
- **Dump SAR Echo Waveforms in output**

  Flag to append the SAR Echo Waveforms in the output netCDF data product: No

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.




esa
grid processing on demand
European Space Agency
esa
Home
Services
Workspace
Catalogue
Products
Schedulers
My profile
Admin
Documentation
Help
Name: Salvatore.Dinardo
Credits: 3
Logout
g-pod
grid processing on demand
SARvatore for CryoSat-2
1- DATA SELECTION
2- PROGRESSING STATUS
3- RESULTS VISUALIZATION
Save in Workspace
Process it!
Schedule (Time-driven scheduler)
Schedule (Data-driven scheduler)
Geographical selection
lon
lat
47
35
56
48
AOI
Select Date
start date
stop date
2010-04-08T00:
2014-08-13T18:
2000 km
2000 mi
-46.27, 87.24
Main Parameters
Task Caption
CryoSat-2 SARvatore
Publish Server
Portal
Compression
None
Single File
Unique Package
Computing Element
Operational CE 02
Priority
Normal
CRYOSAT SIRAL FBR-SAR mode product [SIR1S
Query
Received new 100 entries (5.333 sec)
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

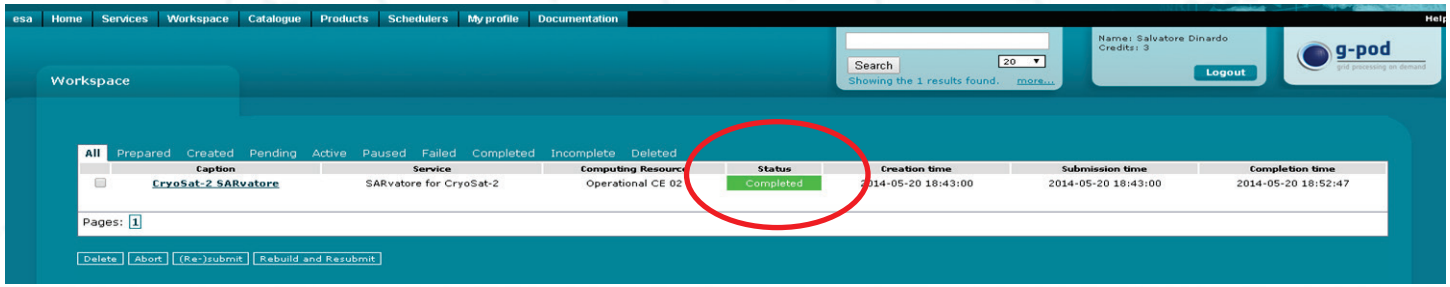
- After submission of the job, users will be directed to the workspace page where they can **check in real time the status of the run** and can be notified on the run status. The color code is:

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)
  - Task Creation Time



Task Viewer / Workspace

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Orange → run under processing

Green → run completed

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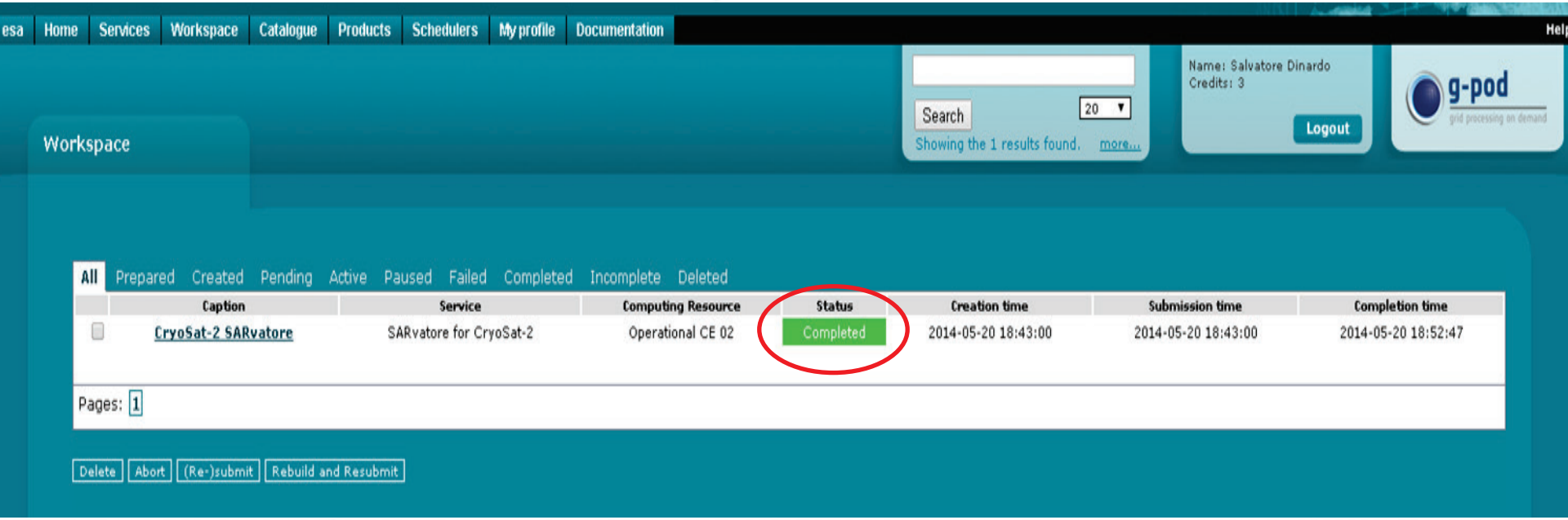
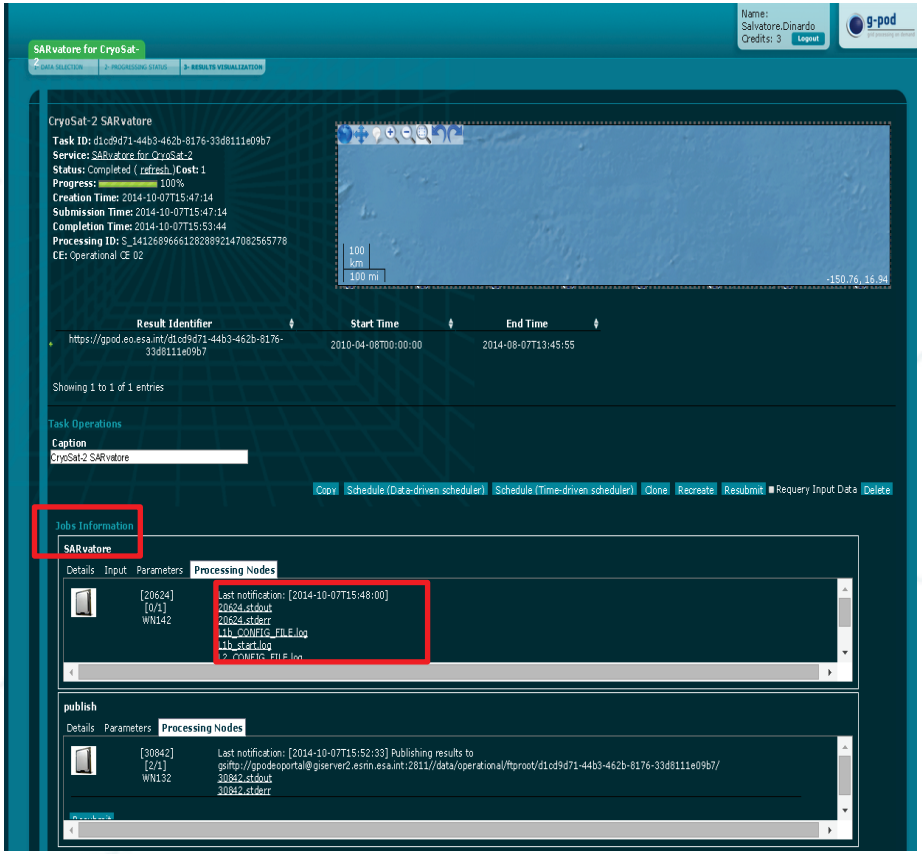


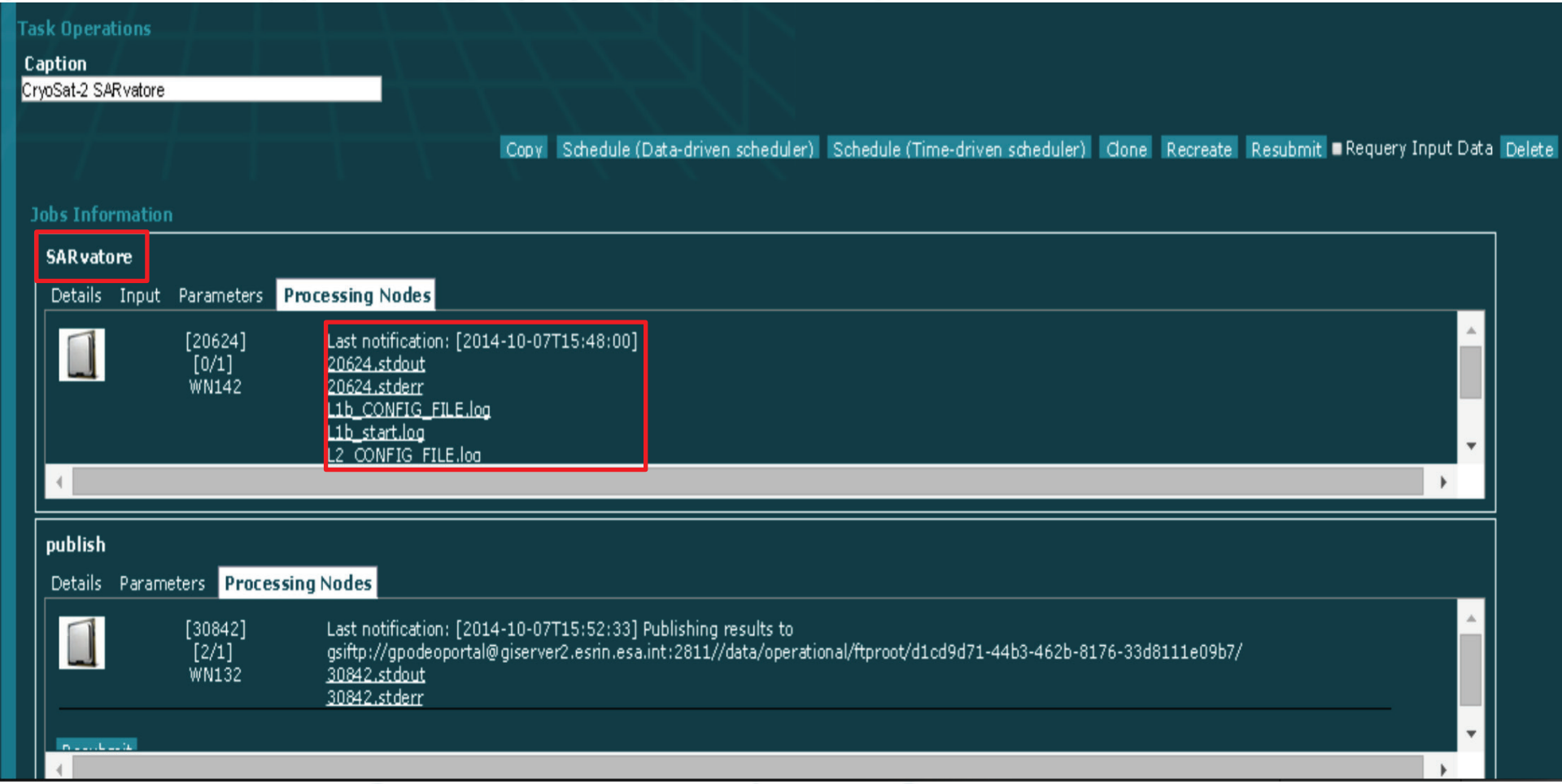
Task Viewer / Workspace

After run completion, clicking on the button "**Jobs Information**", the user can inspect:

- The **GPOD log file** (.stdout or .stderr) where **eventual errors on data retrieving or data storing** are reported.
- The **prototype configuration file** (L1b_CONFIG_FILE.log and L1b_CONFIG_FILE.log) where all the **processing options** are reported.
- The prototype log files (L1b_start.log and L2_start.log) where **eventual prototype processing errors** are reported .
- User can also decide to change one or more processing options and then re-submit the task.



Task Viewer / Workspace



Example of Config and Log Files (L1b)

```
##################### SARvatore L1b PROCESSOR PROTOTYPE CONFIGURATION FILE ###############################

#####################          SYSTEM PATHS                ###############################

DATA_FOLDER=/gpfs/gpfs01/RDIR/S_14126896661282889214708256577 8/SARvatore/20624/L1b_WDIR/

AUX_FOLDER=/gpfs/gpfs01/RDIR/AUX_DATA/

#########################################################################################################

#####################          CONFIGURATION FLAGS         ###############################

Weight_Flag=D
Beam_Forming_EXACT=N
Mean_Profile=N
Save_Stack=N
Gridding_Flag=LR
Extended_Window=Y
Zero_Padding_Flag=Y
#########################################################################################################

#####################        GEOGRAPHICAL SUBSETTING       ###############################

NORTH_LAT=-3
SOUTH_LAT=-13
EAST_LON=-32
WEST_LON=-38

#########################################################################################################
```

Configuration File Examples (L1B)

```
#########################################################################################################

SARvatore Processor Prototype
SAR Versatile Altimetry Toolkit for OLIW (Ocean-Land-Inland Water) Research and Exploitation

Current Run: CryoSat-2 SAR Mode L1b Processor
Current Version: 1.52

#########################################################################################################

Found 3 Passes to Process

-------------------------------------------------

Processing the Pass: CS_OFFL_SIR1SAR_FR_20140619T042952_20140619T043016_B001.DBL

Pass with 537 Records to Process

BLOCK START: 1 --> 200
Scenario Recovery: 1 --> 200
Gain and Calibration Correction: 1 --> 200
Beam Pointing: 1 --> 200
Beam Forming (Approximated): 1 --> 200
Beam Stacking: 1 --> 200
Scenario Recovery: 1 --> 200
Alignment and Range Compression: 1 --> 200
Elapsed time is 35.847286 seconds.
BLOCK END: 1 --> 200

BLOCK START: 201 --> 400
Scenario Recovery: 201 --> 400
Gain and Calibration Correction: 201 --> 400
Beam Pointing: 201 --> 400
Beam Forming (Approximated): 201 --> 400
Beam Stacking: 201 --> 400
Scenario Recovery: 201 --> 400
Alignment and Range Compression: 201 --> 400
Elapsed time is 27.736071 seconds.
BLOCK END: 201 --> 400

BLOCK START: 401 --> 537
Scenario Recovery: 401 --> 537
Gain and Calibration Correction: 401 --> 537
Beam Pointing: 401 --> 537
Beam Forming (Approximated): 401 --> 537
Beam Stacking: 401 --> 537
Scenario Recovery: 401 --> 537
Alignment and Range Compression: 401 --> 537
Extrapolation going on with more than 4 samples
Extrapolation going on with more than 4 samples
Extrapolation going on with more than 4 samples
Extrapolation going on with more than 4 samples
Extrapolation going on with more than 4 samples
Extrapolation going on with more than 4 samples
Elapsed time is 14.332029 seconds.
BLOCK END: 401 --> 537

Generating Output in kml, png and mat format

Output Generated -> Moving to Next Pass ...

Completed L1b Processing for the Pass: CS_OFFL_SIR1SAR_FR_20140619T042952_20140619T043016_B001.DBL

-------------------------------------------------

Processing the Pass: CS_OFFL_SIR1SAR_FR_20140619T042952_20140619T043016_B001.HDR

No CryoSat-2 L1b File for: CS_OFFL_SIR1SAR_FR_20140619T042952_20140619T043016_B001.HDR -> File Skipped

-------------------------------------------------

Processing the Pass: CS_OFFL_SIR1SAR_FR_20140619T042952_20140619T043016_B001.TGZ
```

Executi on Log

Example of Config and Log Files (L1b)

```
##################### SARvatore L1b PROCESSOR PROTOTYPE CONFIGURATION FILE ###############################

#####################          SYSTEM PATHS                ###############################

DATA_FOLDER=/gpfs/gpfs01/RDIR/S_14126896661282889214708256577 8/SARvatore/20624/L1b_WDIR/

AUX_FOLDER=/gpfs/gpfs01/RDIR/AUX_DATA/

#########################################################################################################

#####################          CONFIGURATION FLAGS         ###############################

Weight_Flag=D
Beam_Forming_EXACT=N
Mean_Profile=N
Save_Stack=N
Gridding_Flag=LR
Extended_Window=Y
Zero_Padding_Flag=Y
#########################################################################################################

#####################        GEOGRAPHICAL SUBSETTING       ###############################

NORTH_LAT=-3
SOUTH_LAT=-13
EAST_LON=-32
WEST_LON=-38

#########################################################################################################
```

Configuration File Examples (L1B)

```
#########################################################################################################

SARvatore Processor Prototype
SAR Versatile Altimetry Toolkit for OLIW (Ocean-Land-Inland Water) Research and Exploitation

Current Run: CryoSat-2 SAR Mode L1b Processor
Current Version: 1.52

#########################################################################################################

Found 3 Passes to Process

-------------------------------------------------

Processing the Pass: CS_OFFL_SIR1SAR_FR_20140619T042952_20140619T043016_B001.DBL

Pass with 537 Records to Process

BLOCK START: 1 --> 200
Scenario Recovery: 1 --> 200
Gain and Calibration Correction: 1 --> 200
Beam Pointing: 1 --> 200
Beam Forming (Approximated): 1 --> 200
Beam Stacking: 1 --> 200
Scenario Recovery: 1 --> 200
Alignment and Range Compression: 1 --> 200
Elapsed time is 35.847286 seconds.
BLOCK END: 1 --> 200

BLOCK START: 201 --> 400
Scenario Recovery: 201 --> 400
Gain and Calibration Correction: 201 --> 400
Beam Pointing: 201 --> 400
Beam Forming (Approximated): 201 --> 400
Beam Stacking: 201 --> 400
Scenario Recovery: 201 --> 400
Alignment and Range Compression: 201 --> 400
Elapsed time is 27.736071 seconds.
BLOCK END: 201 --> 400

BLOCK START: 401 --> 537
Scenario Recovery: 401 --> 537
Gain and Calibration Correction: 401 --> 537
Beam Pointing: 401 --> 537
Beam Forming (Approximated): 401 --> 537
Beam Stacking: 401 --> 537
Scenario Recovery: 401 --> 537
Alignment and Range Compression: 401 --> 537
Extrapolation going on with more than 4 samples
Extrapolation going on with more than 4 samples
Extrapolation going on with more than 4 samples
Extrapolation going on with more than 4 samples
Extrapolation going on with more than 4 samples
Extrapolation going on with more than 4 samples
Elapsed time is 14.332029 seconds.
BLOCK END: 401 --> 537

Generating Output in kml, png and mat format

Output Generated -> Moving to Next Pass ...

Completed L1b Processing for the Pass: CS_OFFL_SIR1SAR_FR_20140619T042952_20140619T043016_B001.DBL

-------------------------------------------------

Processing the Pass: CS_OFFL_SIR1SAR_FR_20140619T042952_20140619T043016_B001.HDR

No CryoSat-2 L1b File for: CS_OFFL_SIR1SAR_FR_20140619T042952_20140619T043016_B001.HDR -> File Skipped

-------------------------------------------------

Processing the Pass: CS_OFFL_SIR1SAR_FR_20140619T042952_20140619T043016_B001.TGZ
```

Executi on Log

Example of Config and Log Files (L1b)

```
##################### SARvatore L1b PROCESSOR PROTOTYPE CONFIGURATION FILE ###############################

#####################          SYSTEM PATHS                ###############################

DATA_FOLDER=/gpfs/gpfs01/RDIR/S_14126896661282889214708256577 8/SARvatore/20624/L1b_WDIR/

AUX_FOLDER=/gpfs/gpfs01/RDIR/AUX_DATA/

##########################################################################################

#####################          CONFIGURATION FLAGS         ######

Weight_Flag=D
Beam_Forming_EXACT=N
Mean_Profile=N
Save_Stack=N
Gridding_Flag=LR
Extended_Window=Y
Zero_Padding_Flag=Y
##########################################################################################

#####################          GEOGRAPHICAL SUBSETTING     ###

NORTH_LAT=-3
SOUTH_LAT=-13
EAST_LON=-32
WEST_LON=-38

##########################################################################################
```

You don't need to care about them

(if everything goes ok)

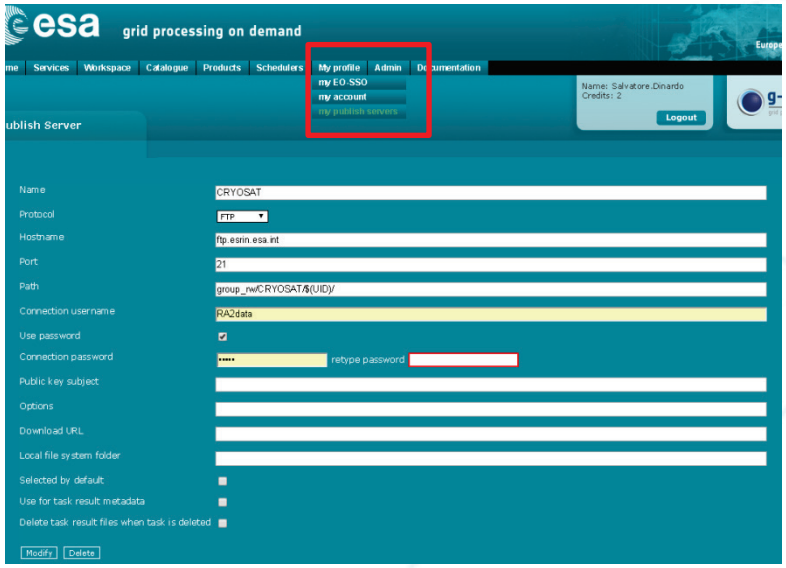
Configuration File Examples (L1B)

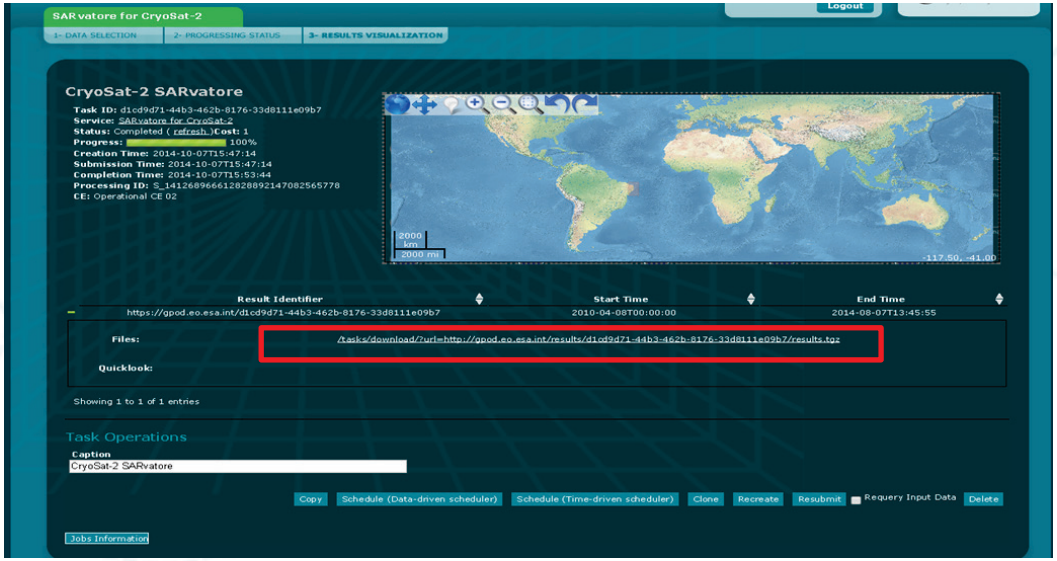
```
##########################################################################################

SARvatore Processor Prototype
SAR Versatile Altimetry Toolkit for OLIW (Ocean-Land-Inland Water) Research and Exploitation

Current Run: CryoSat-2 SAR Mode L1b Processor
Current Version: 1.52

##########################################################################################

Found 3 Passes to Process

-----------------------------------------------

Processing the Pass: CS_OFFL_SIR1SAR_FR_20140619T042952_20140619T043016_B001.DBL

Beam Stacking: 401 --> 537
Scenario Recovery: 401 --> 537
Alignment and Range Compression: 401 --> 537
Extrapolation going on with more than 4 samples
Extrapolation going on with more than 4 samples
Extrapolation going on with more than 4 samples
Extrapolation going on with more than 4 samples
Extrapolation going on with more than 4 samples
Extrapolation going on with more than 4 samples
Elapsed time is 14.332029 seconds.
BLOCK END: 401 --> 537

Generating Output in kml, png and mat format

Output Generated -> Moving to Next Pass ...

Completed L1b Processing for the Pass: CS_OFFL_SIR1SAR_FR_20140619T042952_20140619T043016_B001.DBL

-----------------------------------------------

Processing the Pass: CS_OFFL_SIR1SAR_FR_20140619T042952_20140619T043016_B001.HDR

No CryoSat-2 L1b File for: CS_OFFL_SIR1SAR_FR_20140619T042952_20140619T043016_B001.HDR -> File Skipped

-----------------------------------------------

Processing the Pass: CS_OFFL_SIR1SAR_FR_20140619T042952_20140619T043016_B001.TGZ
```

Executi on Log

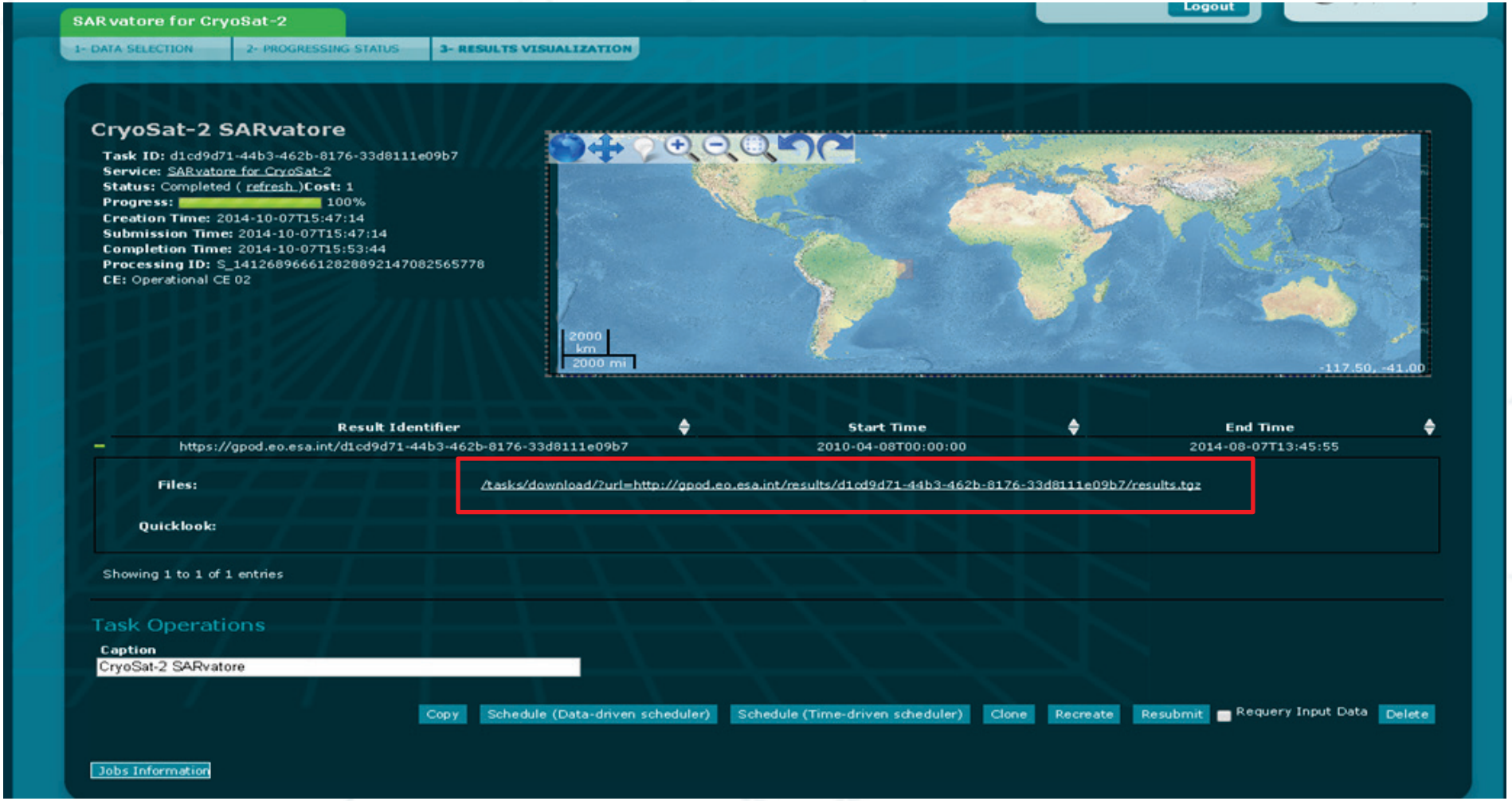
Output Package Publishing

- In case of successful run completion (green status), the portal will provide the user with a http link from where to download the output package on own local drive.
- The user can order to post the package directly on his **own personal ftp server** once the ftp server credentials have been inserted (through my “publish servers” sub-menu).
- This is the recommended option when processing large amount of data.

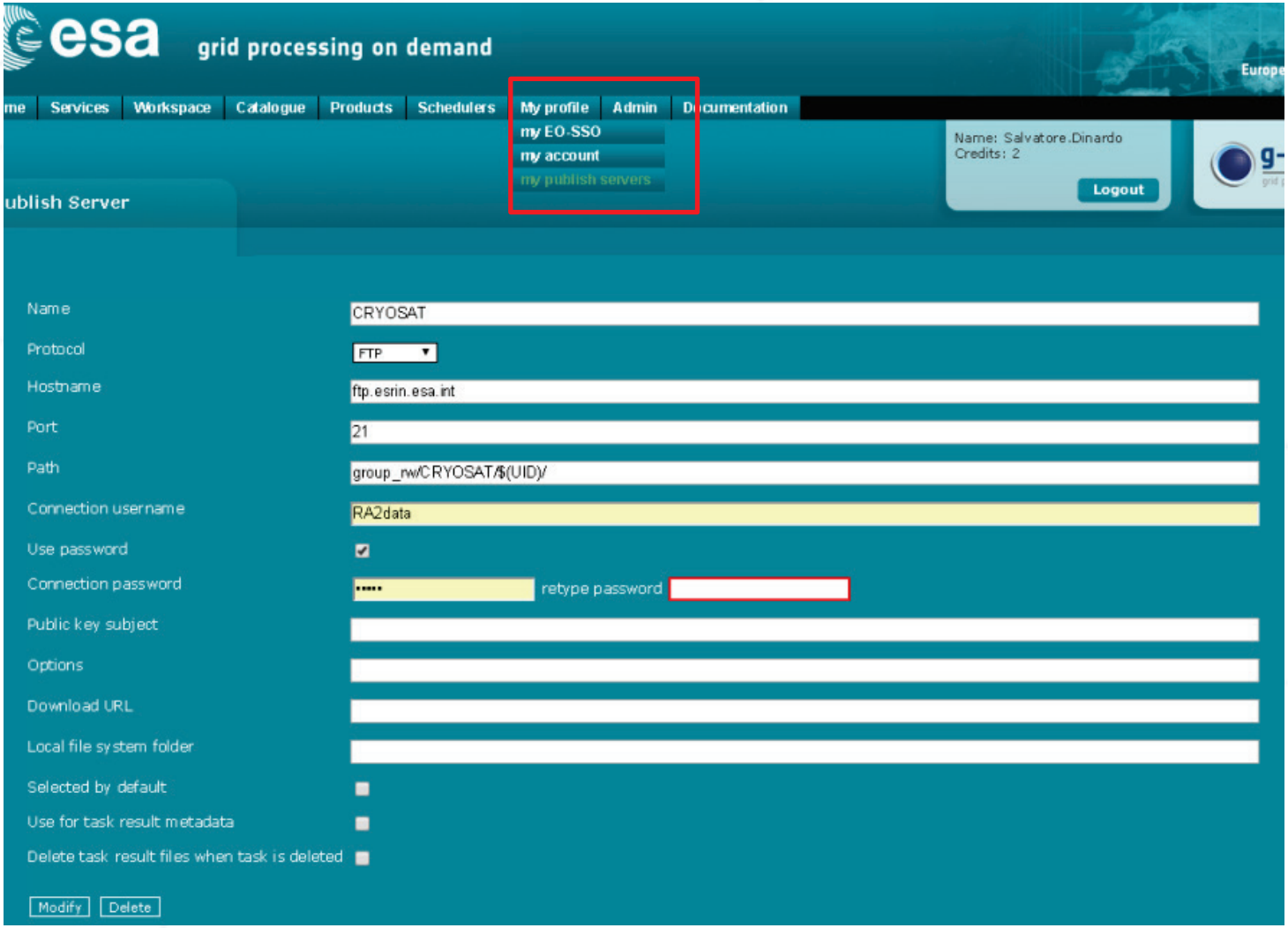




Output Package Publishing



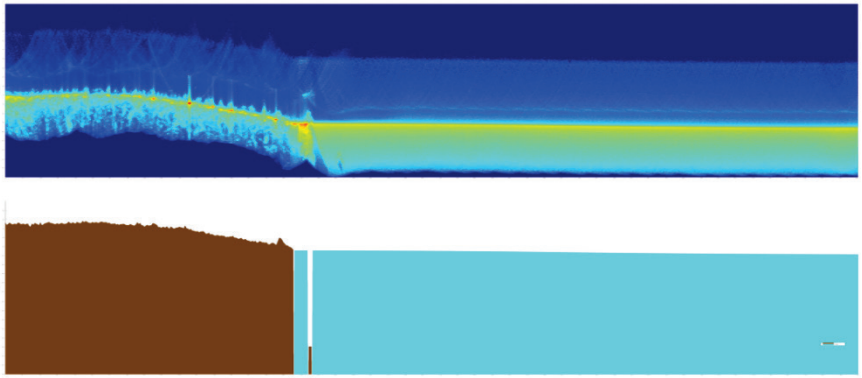
Output Package Publishing

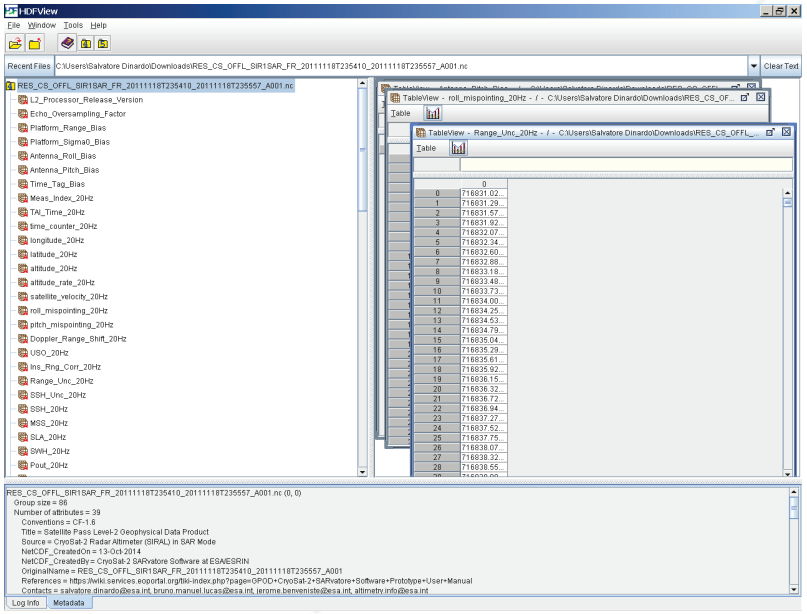


Output Package Content

The output package consists of :

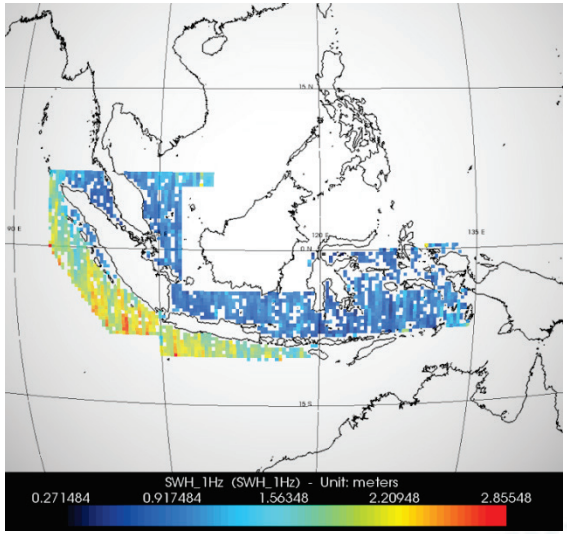
- Pass Ground-Track in KML format
- Radar Echogram Picture in PNG format
- L2 data product in NETcdf format with all the scientific results. The netCDF format is self-explanatory with all the data field significance described in the attributes

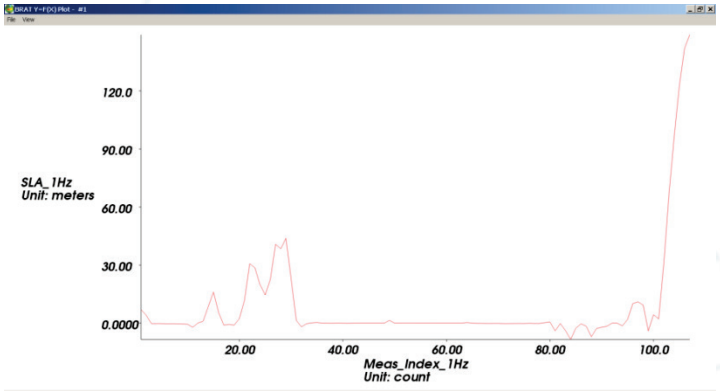


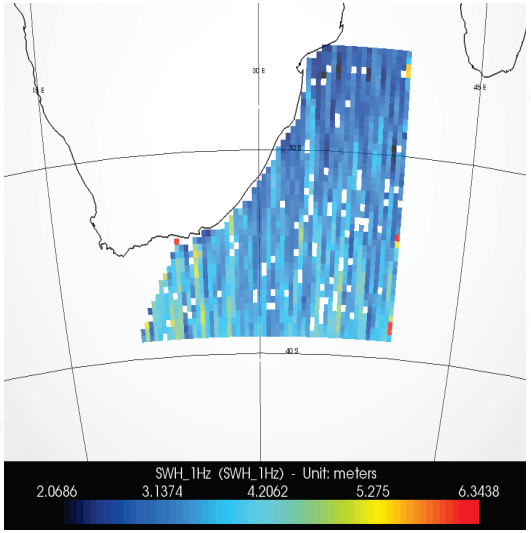


NetCDF Product in BRAT

- 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







R&D Projects using CryoSat-2 GPOD Data

- GOCP40 (Paolo Cipollini and Marcello Passaro, NOC & TUM)
- CE++ (Ole Andersen, DTU)
- SCOOP (Luciana Fenoglio, TU Bonn)
- SeaNice (Sara Fleury, LEGOS)
- SHAPE (Pierre Fabry & Nicolas Bercher, Along Track)
- Iceberg Detection (Jean Tournadre, IFREMER)
- Swell Detection (Saleh Abdallah, ECMWF)
- CRUCIAL (Philip Moore, NU)
- SAR SSB Study (Christine Gommenginger, NOC)
- ....

OFF LINE GPOD Processing

- For massive processing (years of data in large area of interest), it is recommended to request an off line processing: GPOD team is available to process the data for you in an off line configuration and post the output L2 in a personal ftp repository.

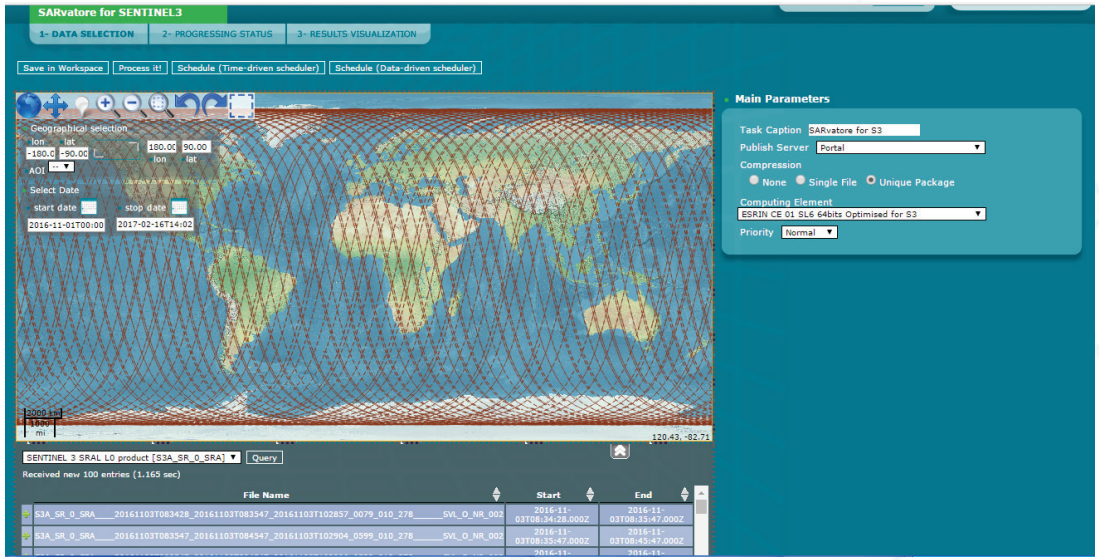
- In order to request an order of processing, please write your order description (ime of interest, region of interest, processing baseline) at:

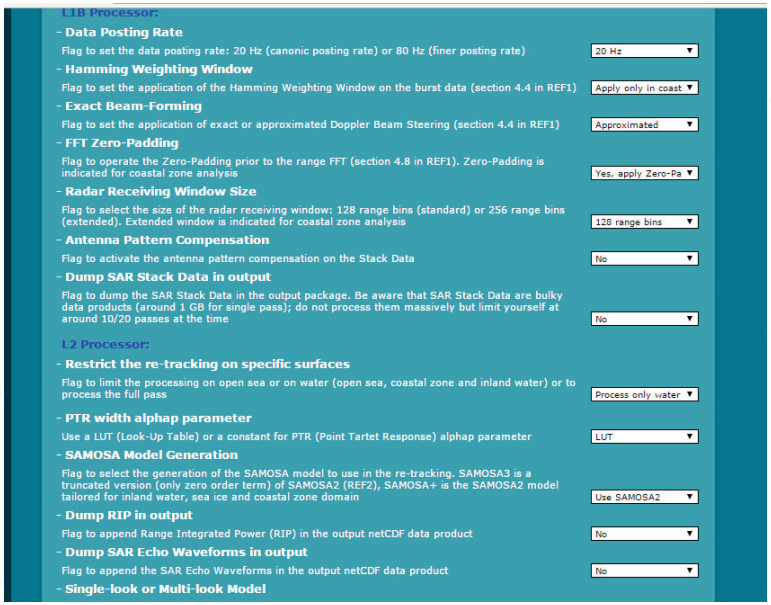
  eo-gpod@esa.int

  altimetry.info@esa.int

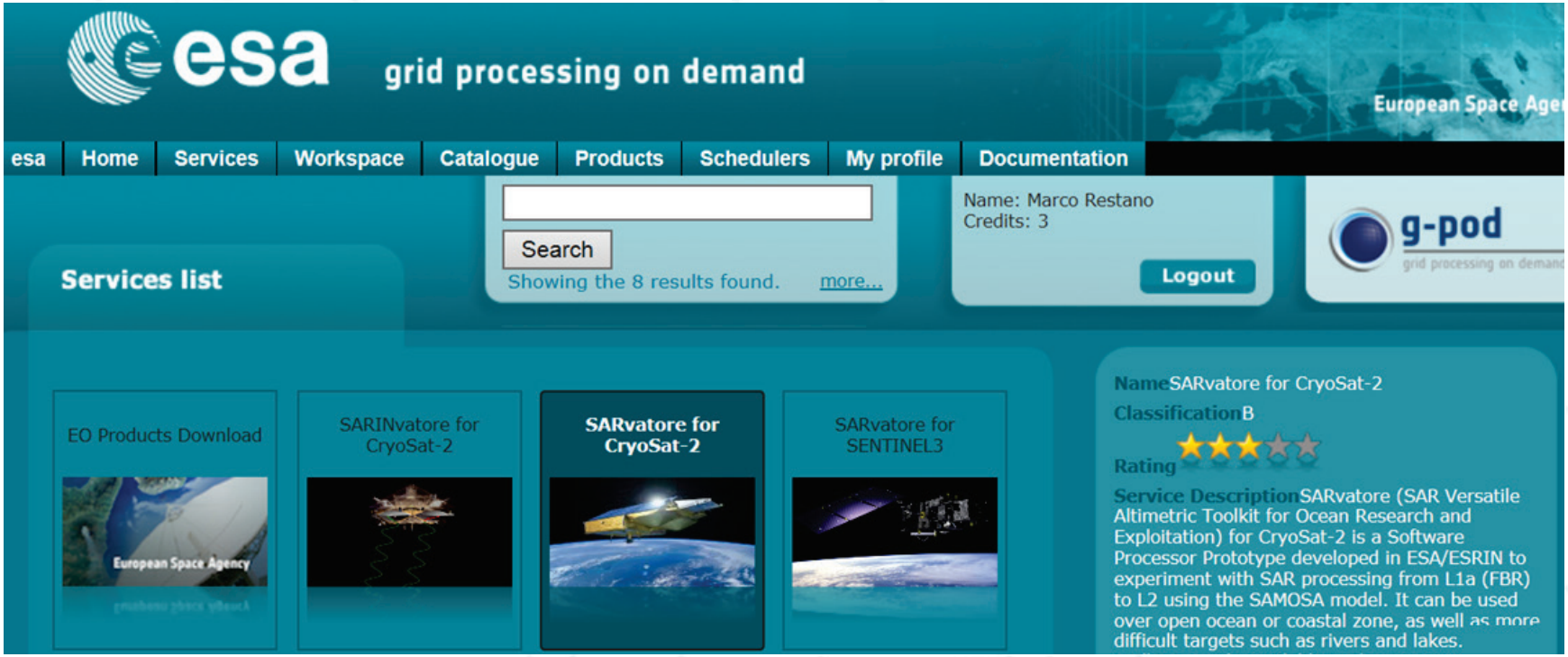
GPOD SAR Service for Sentinel-3

- The GPOD Service for Sentinel-3 SAR mode is currently under test phase; It is planned to make the service open when S3 L1A products will be released by ESA/EUMETSAT Agencies. The processing options will be the same as the CryoSat SAR service.





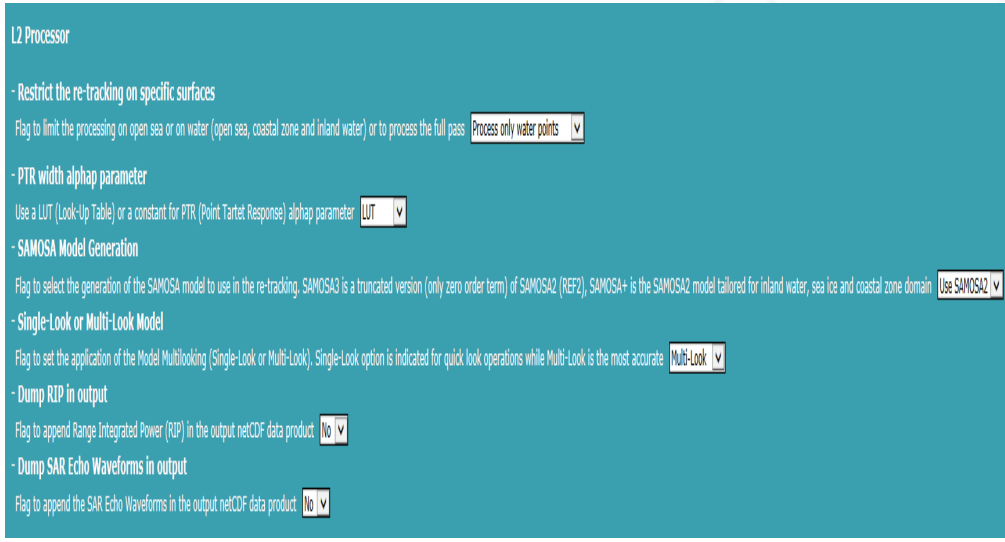
Options in SARvatore for Cryosat-2



List of Processing Options

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

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



L1b Processing Options

Option Name	Option Value	Option Description
Filter out Duplicated CryoSat-2 Products during the processing time	- Enable - Disable	Enable to filter out duplicated products during the processing: duplicated products will not be processed
Data Posting Rate 20 Hz/80 Hz	- 20Hz - 80 Hz	Flag to set the data posting rate: 20 Hz (canonic posting rate) or 80 Hz (finer posting rate)
Hamming weighting Window	- 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 (more info at REF1)
Exact Beam-Forming	- Approximated - Exact	User can decide here whether to operate an exact Beam-Forming or an approximated Beam-Forming (more info at REF1)
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 (section 4.8 in REF1). Zero-Padding is indicated for coastal zone and sea-ice analysis
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

L1b Processing Options(2)

Option Name	Option Value	Option Description
Antenna Pattern Compensation	- Yes - No	Flag to activate the antenna pattern compensation on the Stack Data
Dump SAR Stack Data in output	- Yes - No	Be aware that SAR Stack Data are bulky data products (around 1 GB for single pass); do not process them massively but limit yourself at around 10/20 passes at the time Flag to dump the SAR Stack Data in the output package

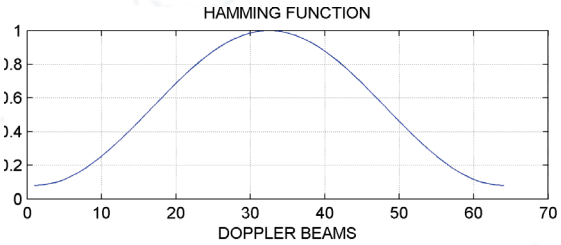
L1B Option – Hamming Window

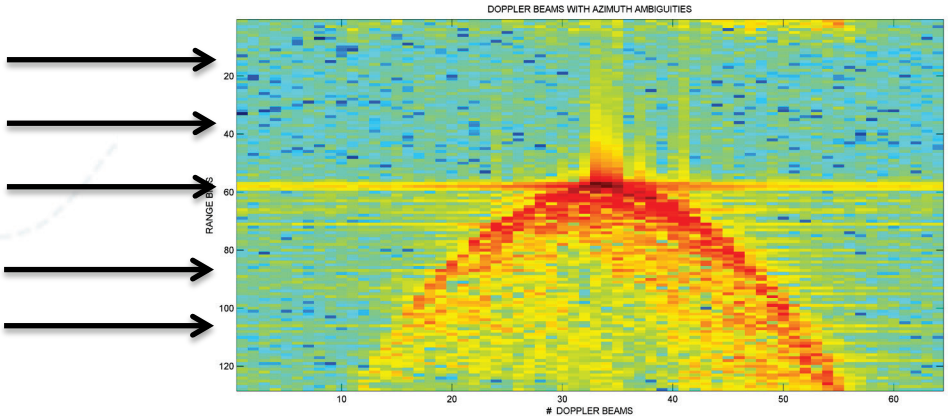
Option Name	Option Value	Option Description
Hamming weighting Window	- Apply only in coastal zone - Yes, apply it - No. do not apply it	User can decide here whether to apply a Hamming weighting window on the SAR burst data, do not apply it, or to apply it only for surface location in coastal area (more info at 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 the coastal zone (1)

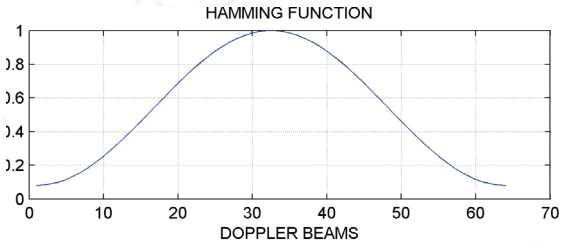
To suppress parabolic artifacts on the radargram to the quasi-specular coastal waters, => application of a weighting Function in Doppler Domain to Delay-Doppler Spectrum before the Beam Forming. Users can optionally apply the **Hamming** function.

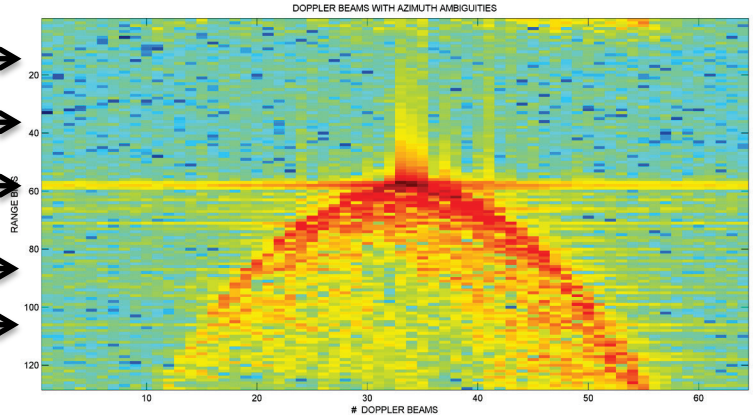


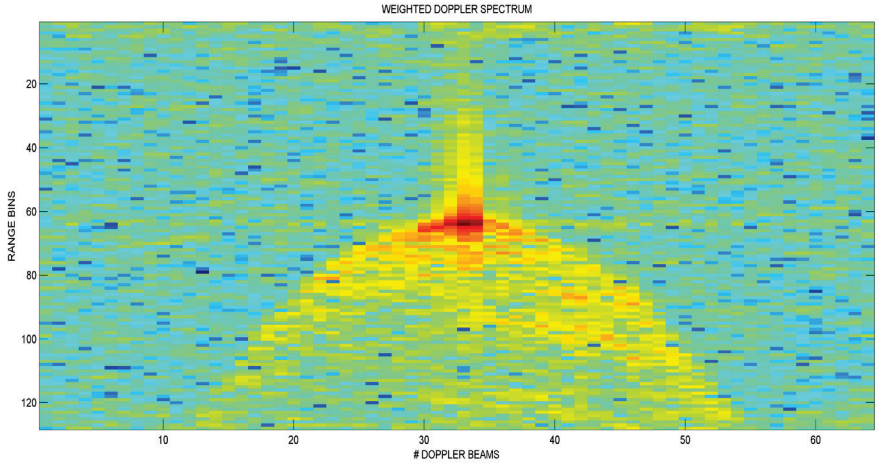


Weighting Function in the coastal zone (1)

To suppress parabolic artifacts on the radargram to the quasi-specular coastal waters, => application of a weighting Function in Doppler Domain to Delay-Doppler Spectrum before the Beam Forming. Users can optionally apply the **Hamming** function.

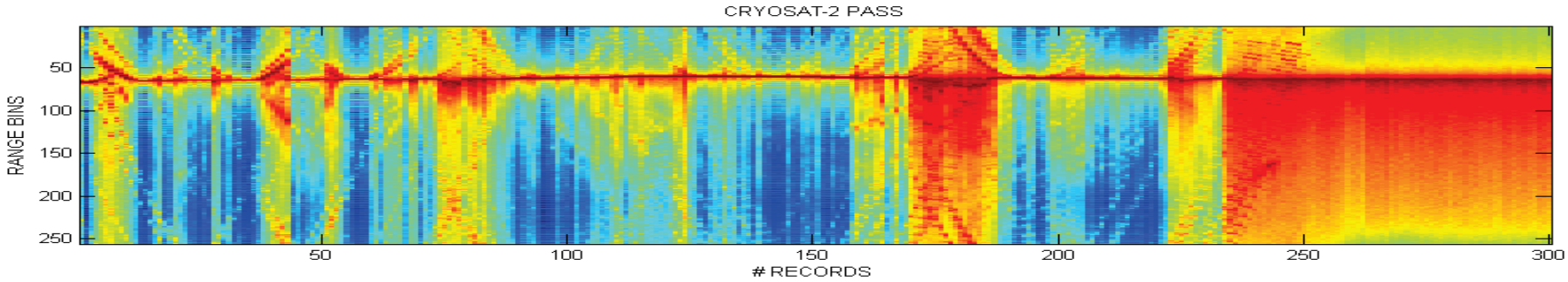






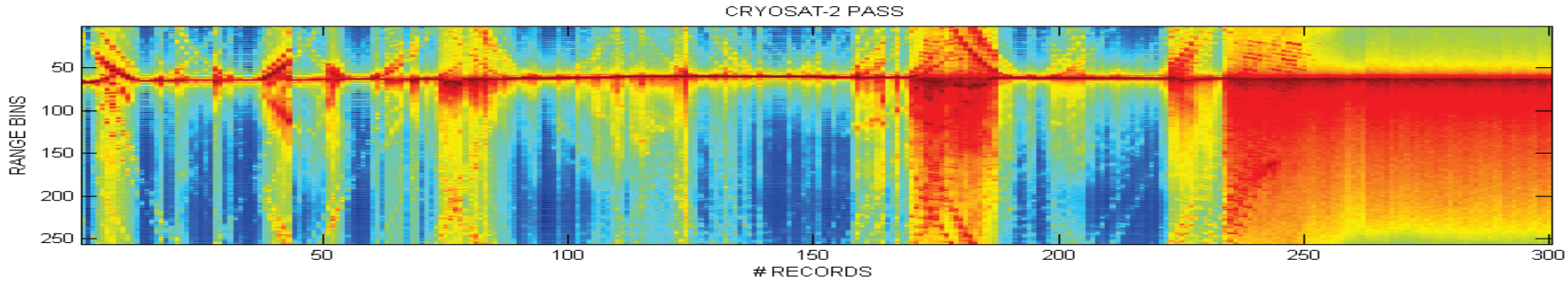
Weighting Function in the coastal zone (2)

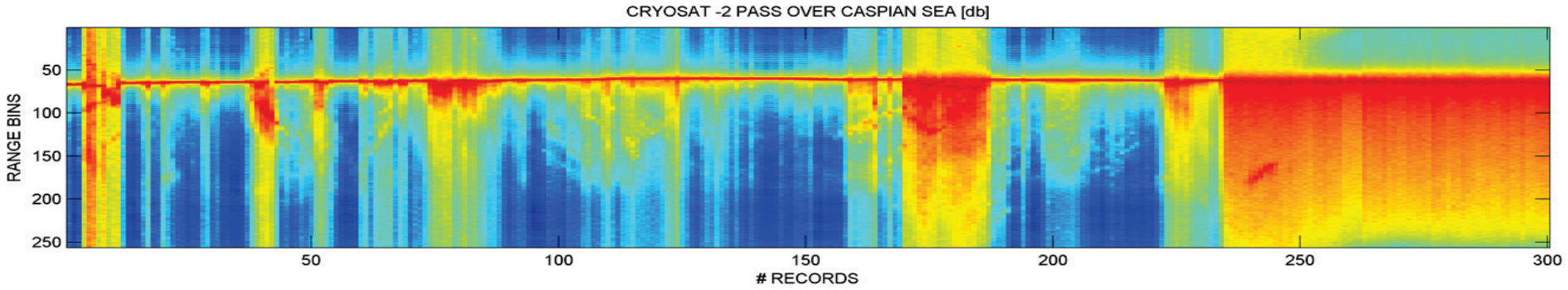
Effect of the application of the Hamming Function to eliminate parabolic artifacts on the radargram (echo stack)



Weighting Function in the coastal zone (2)

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





L1B Option – Exact Beam-Forming

Option Name	Option Value	Option Description
Exact Beam-Forming	- Approximated - Exact	User can decide here whether to operate an exact Beam-Forming or an approximated Beam-Forming (more info at REF1, section 4.4)

- 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)**.

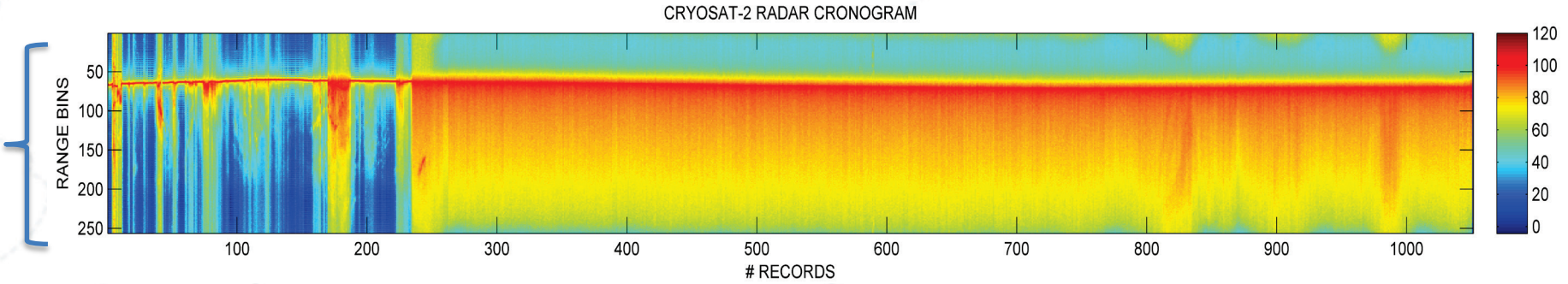
Default option: Approximated
Coastal Zone recommended: Approximated
Open Ocean recommended: Approximated

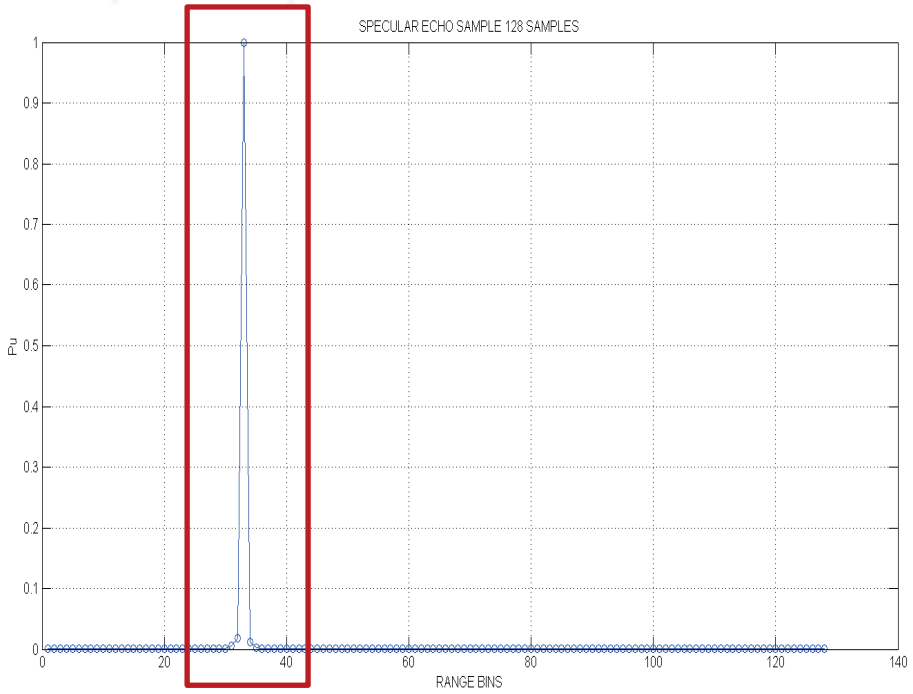
FFT Zero-Padding

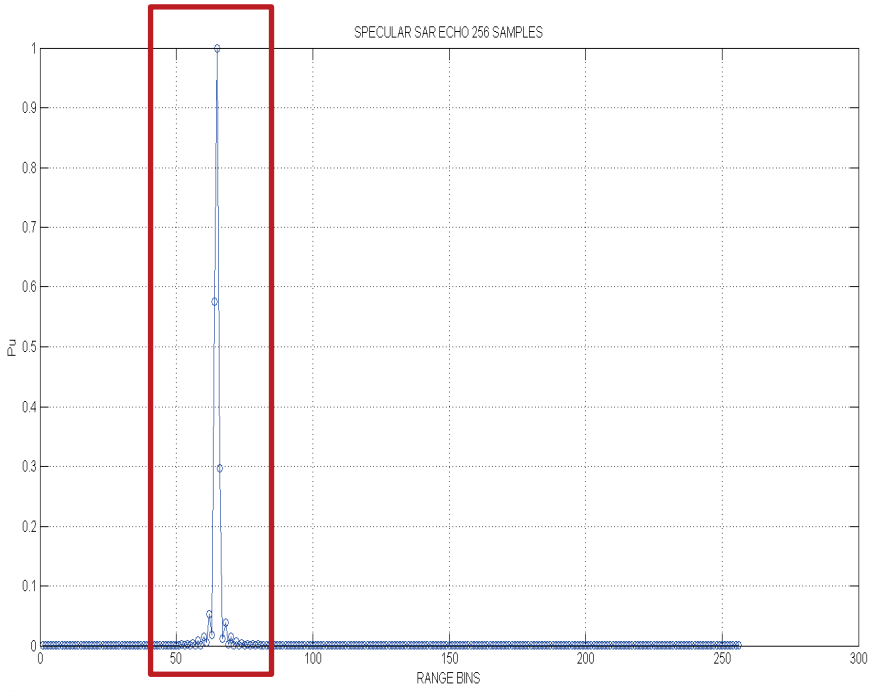
Option Name	Option Value	Option Description
FFT Zero-Padding	- Yes, apply Zero-Padding - No, don't apply Zero-Padding	User can decide here whether to operate the Zero-Padding prior to the range FFT (**section 4.8 in REF1**). Zero-Padding is indicated for coastal zone and sea-ice analysis

Default option: Yes, apply Zero-Padding
Coastal Zone recommended: Yes, apply Zero-Padding
Open Ocean recommended: User pref

ZERO-PADDING =>DOUBLE SAMPLING





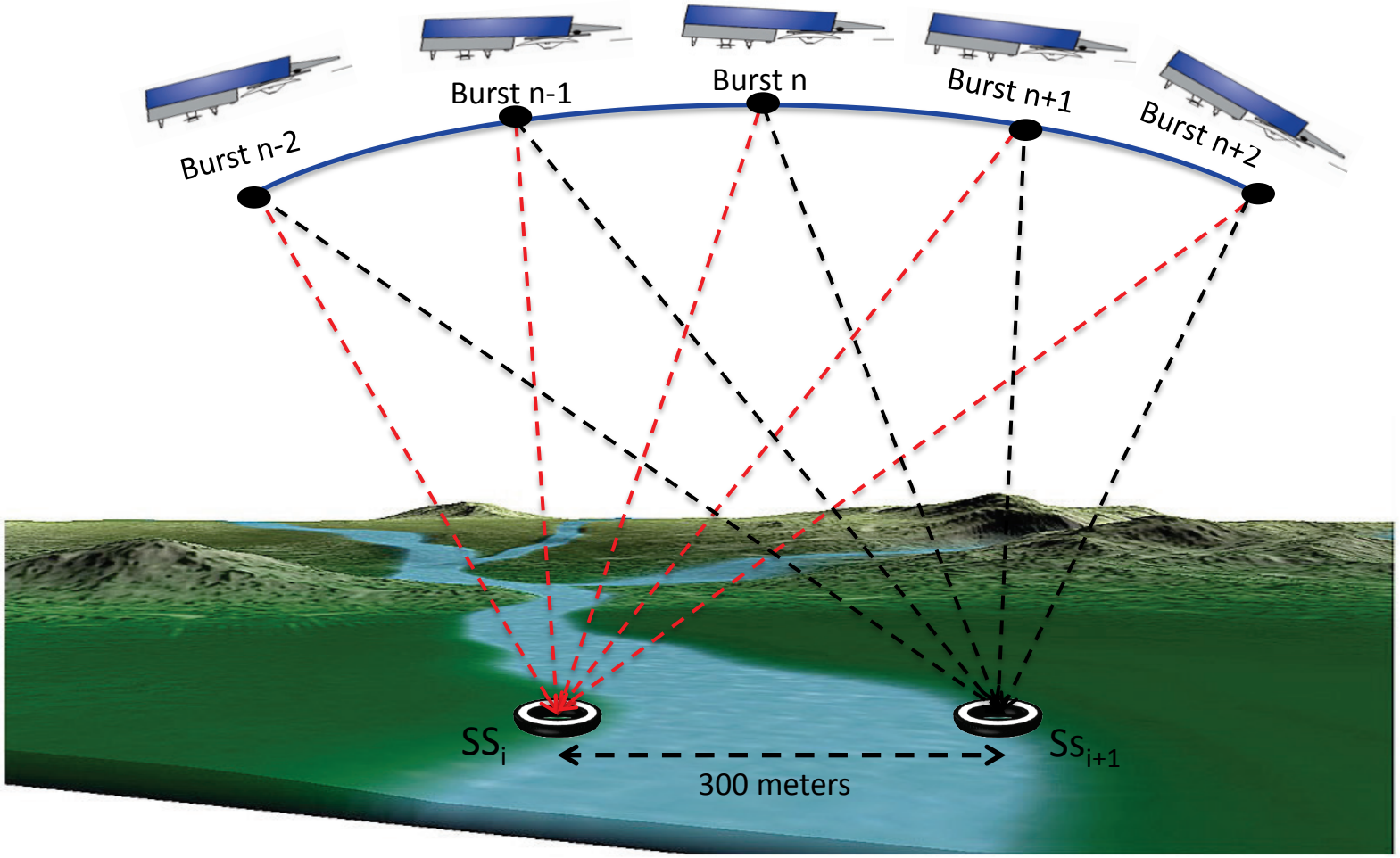


L1B Option – Posting Rate 20 Hz/80 Hz

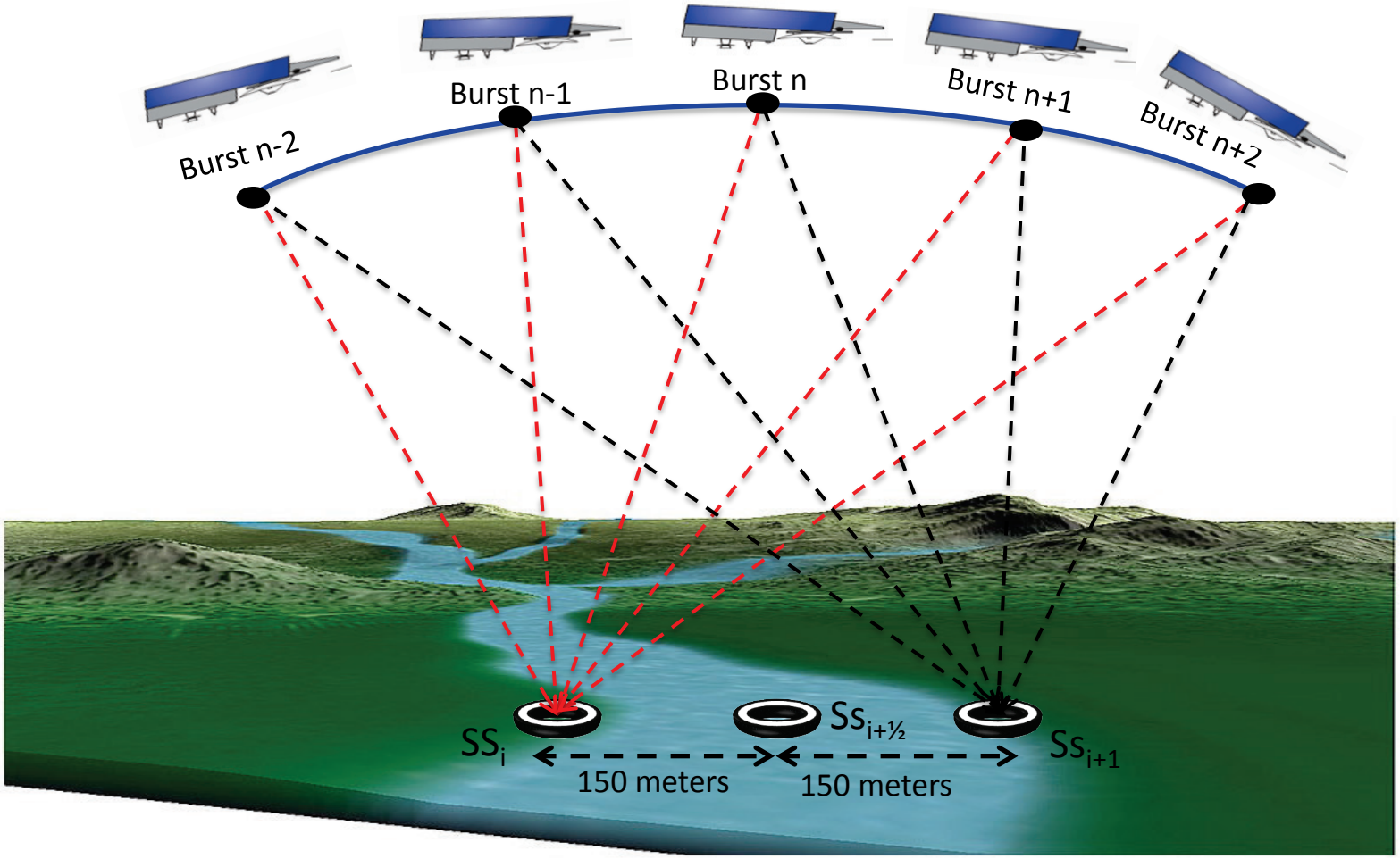
Option Name	Option Value	Option Description
Posting Rate	- 20 Hz - 80 Hz	Flag to set the data posting rate: 20 Hz (canonic posting rate) or 80 Hz (finer posting rate

Default option: 20 Hz

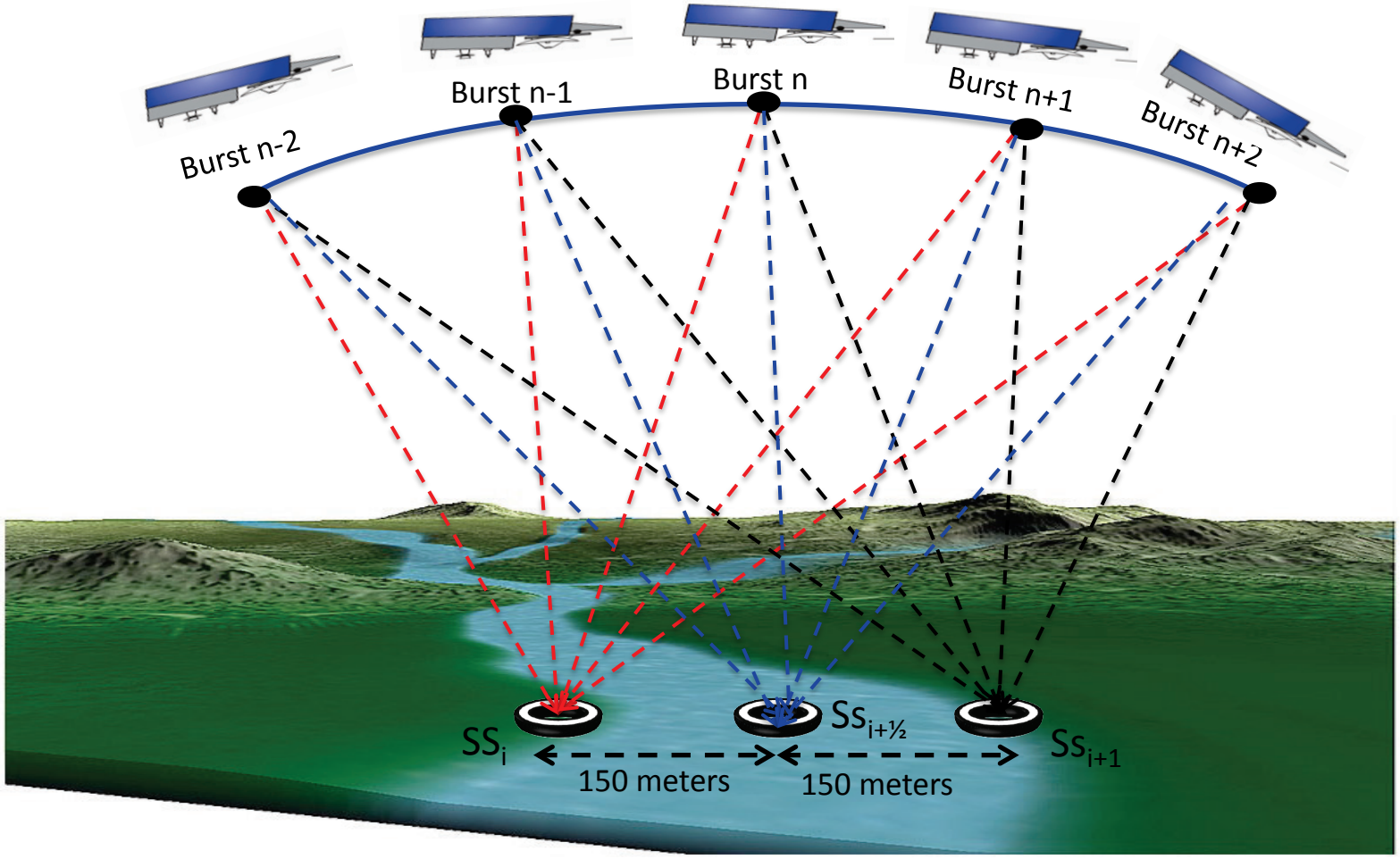
Posting Rate 20 Hz/80 Hz



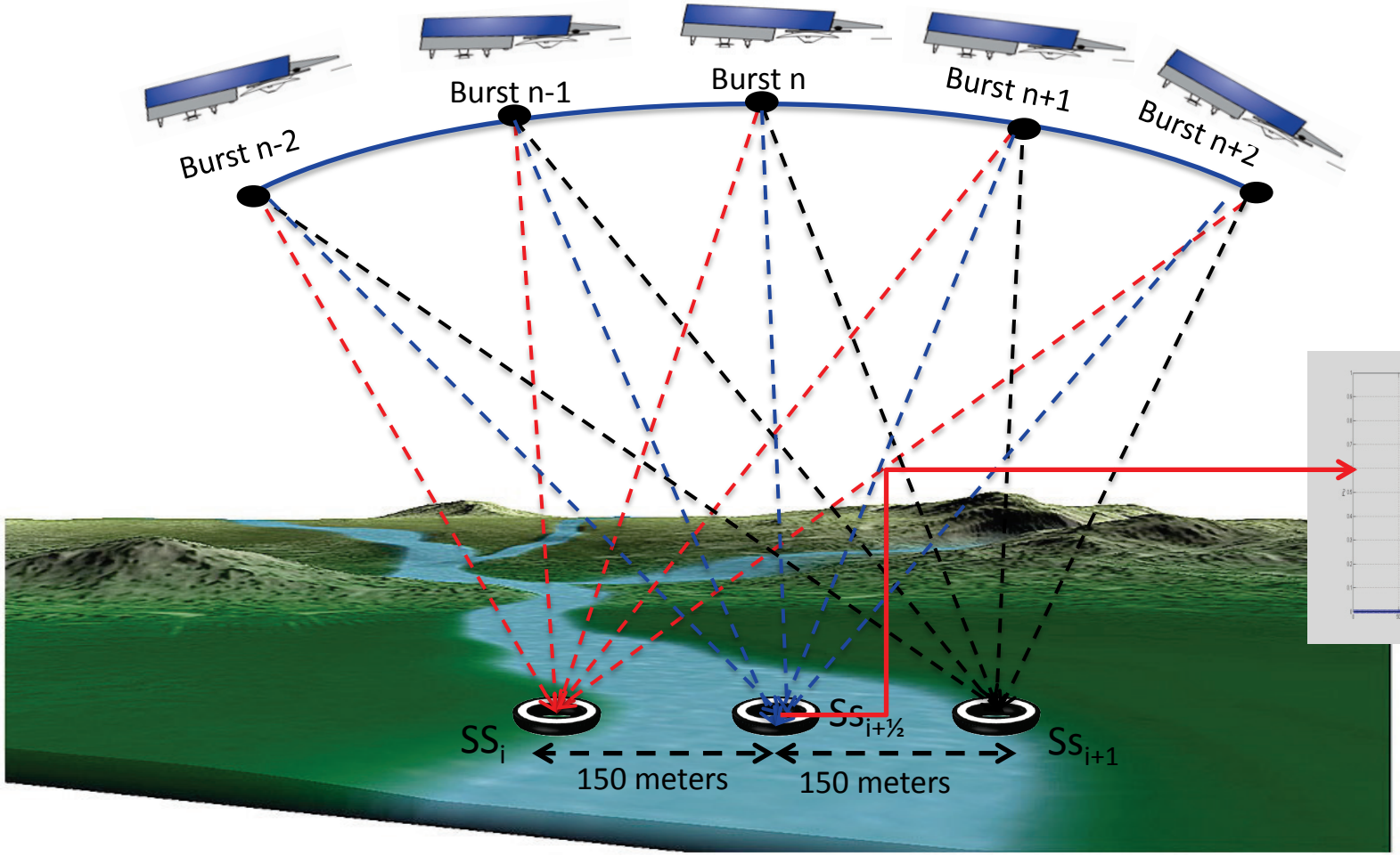
Posting Rate 20 Hz/80 Hz

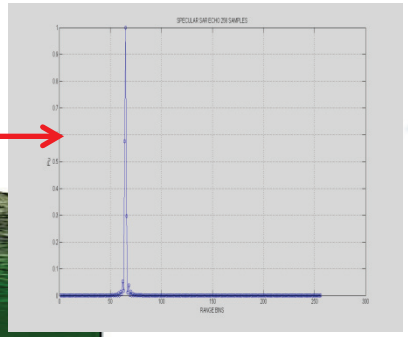


Posting Rate 20 Hz/80 Hz

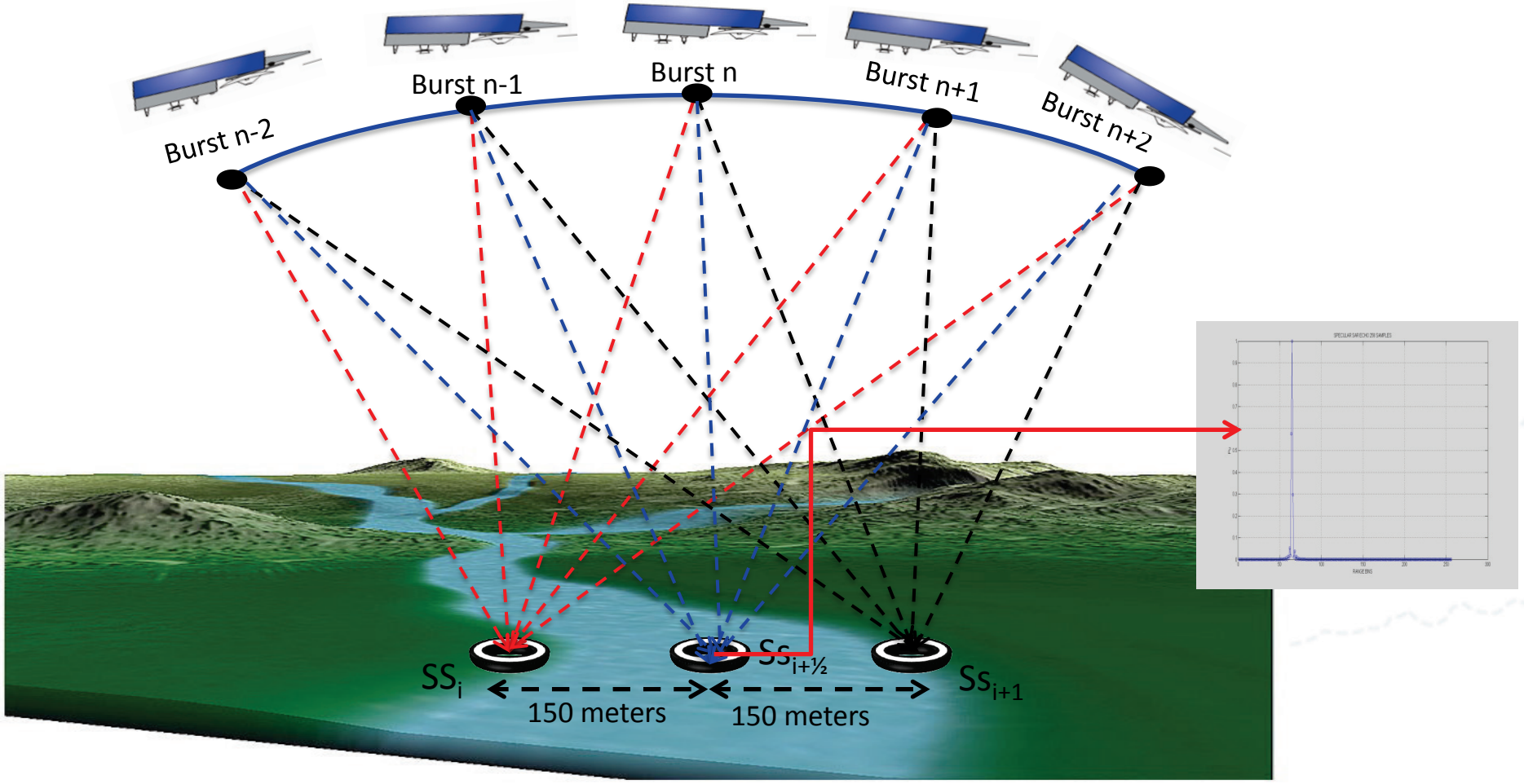


Posting Rate 20 Hz/80 Hz



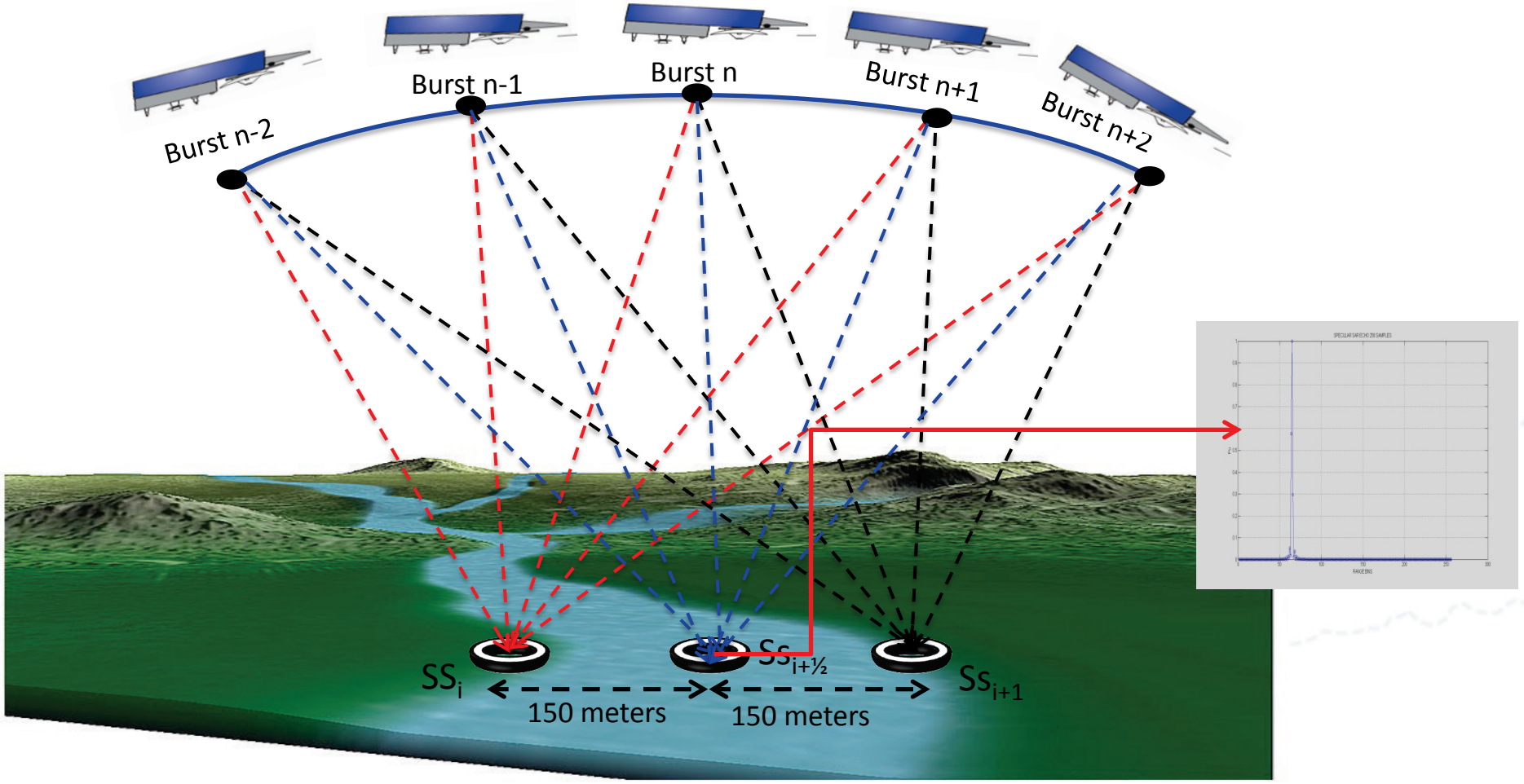


Posting Rate 20 Hz/80 Hz

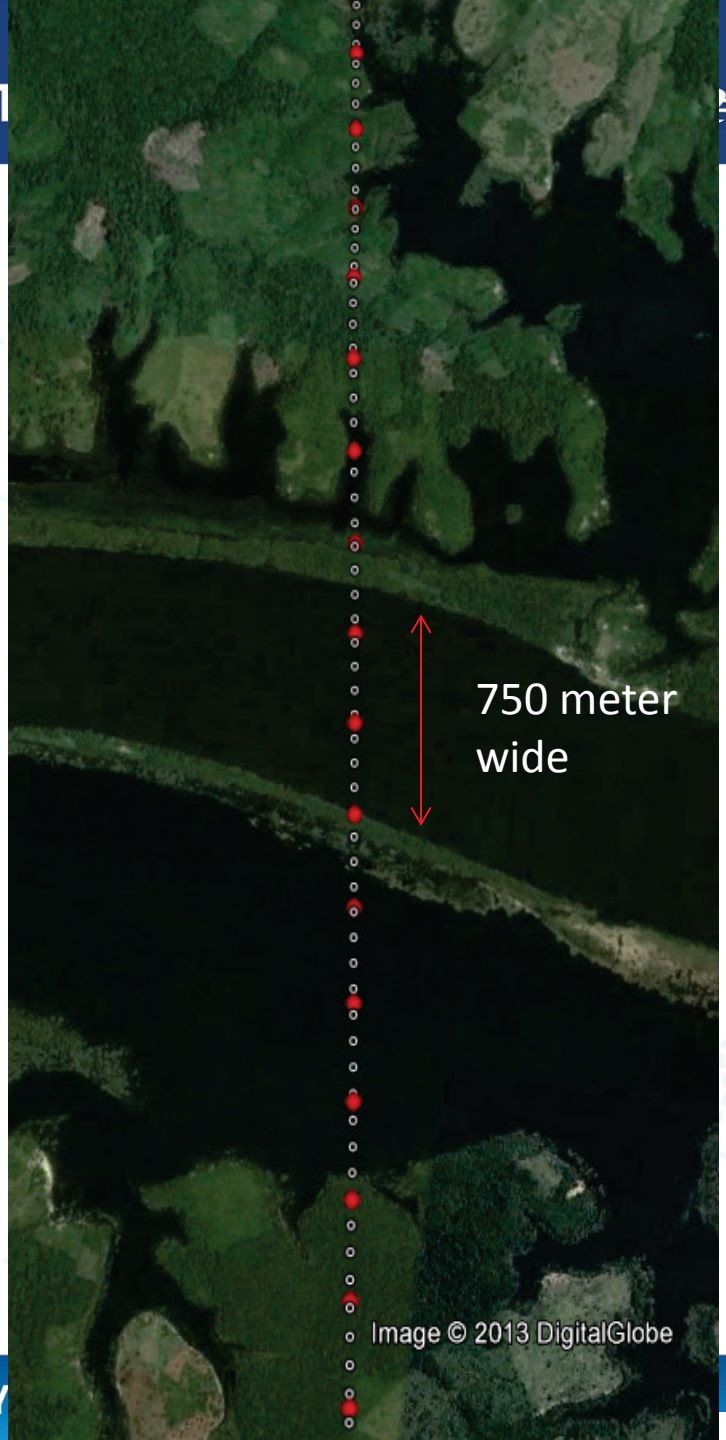


WE CAN HAVE A SAR ALTIMETRIC MEASUREMENT IN ANY GROUND POINT ALONG THE TRACK !

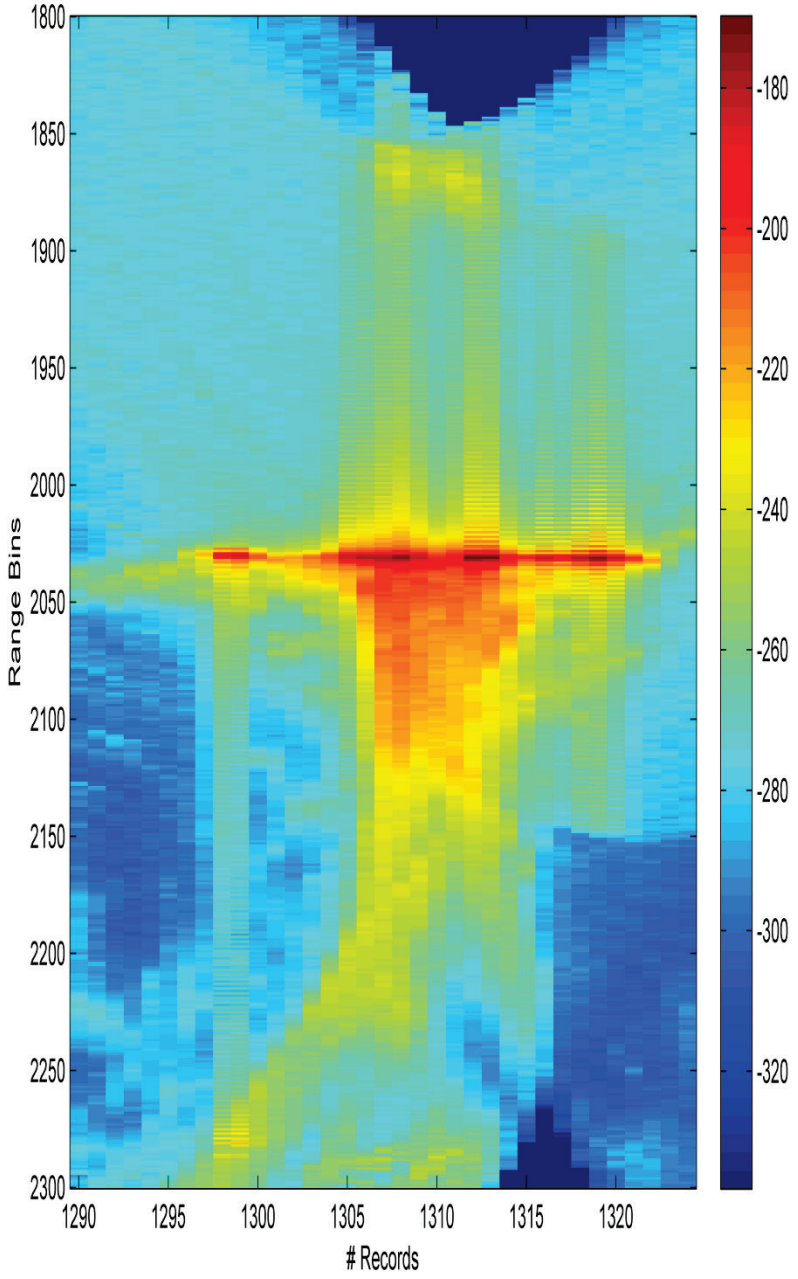
Posting Rate 20 Hz/80 Hz



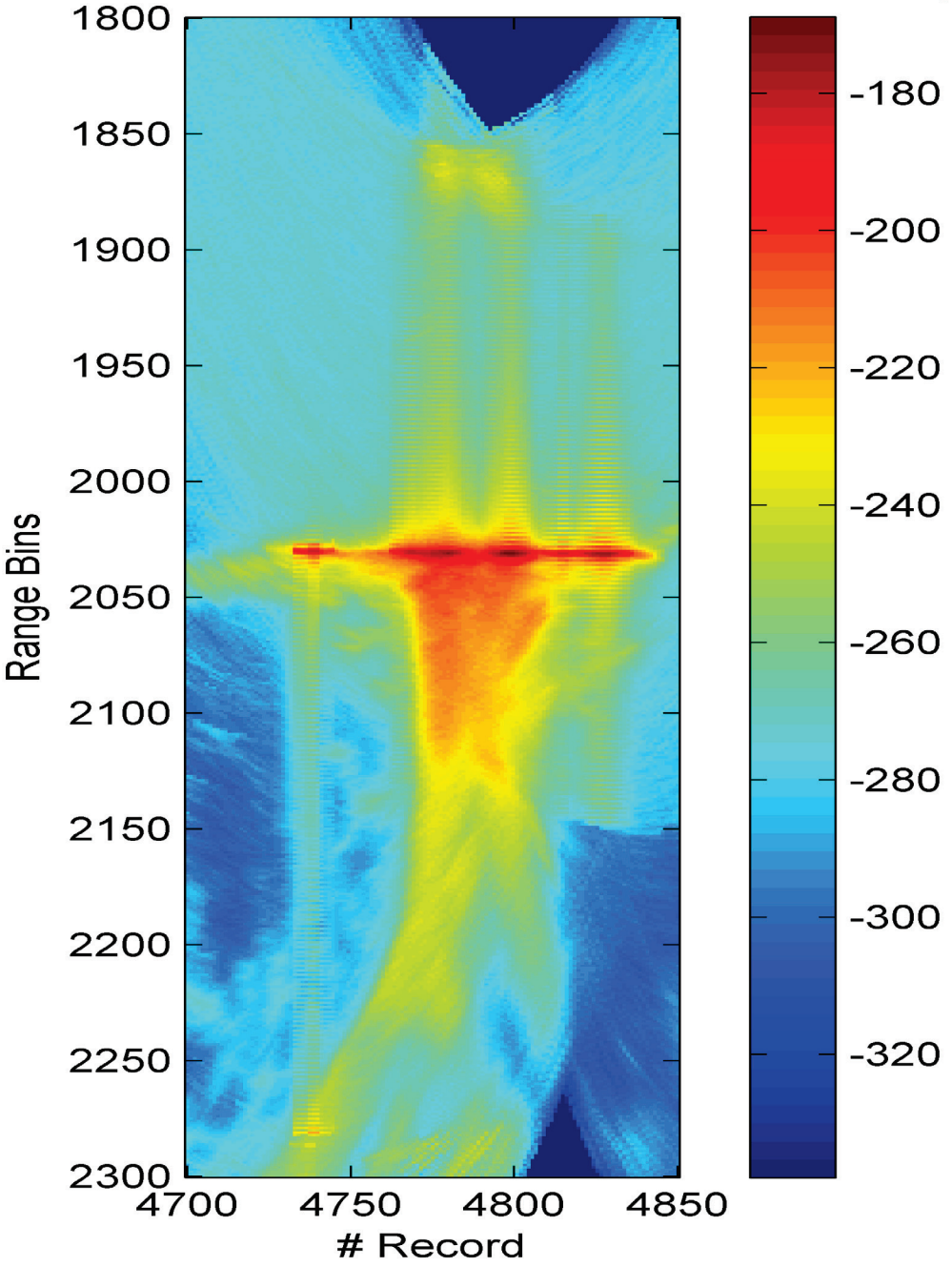
WE CAN HAVE A SAR ALTIMETRIC MEASUREMENT IN ANY GROUND POINT ALONG THE TRACK !


750 meter wide
Image © 2013 DigitalGlobe

SAR ALTIMETRY 20 Hz



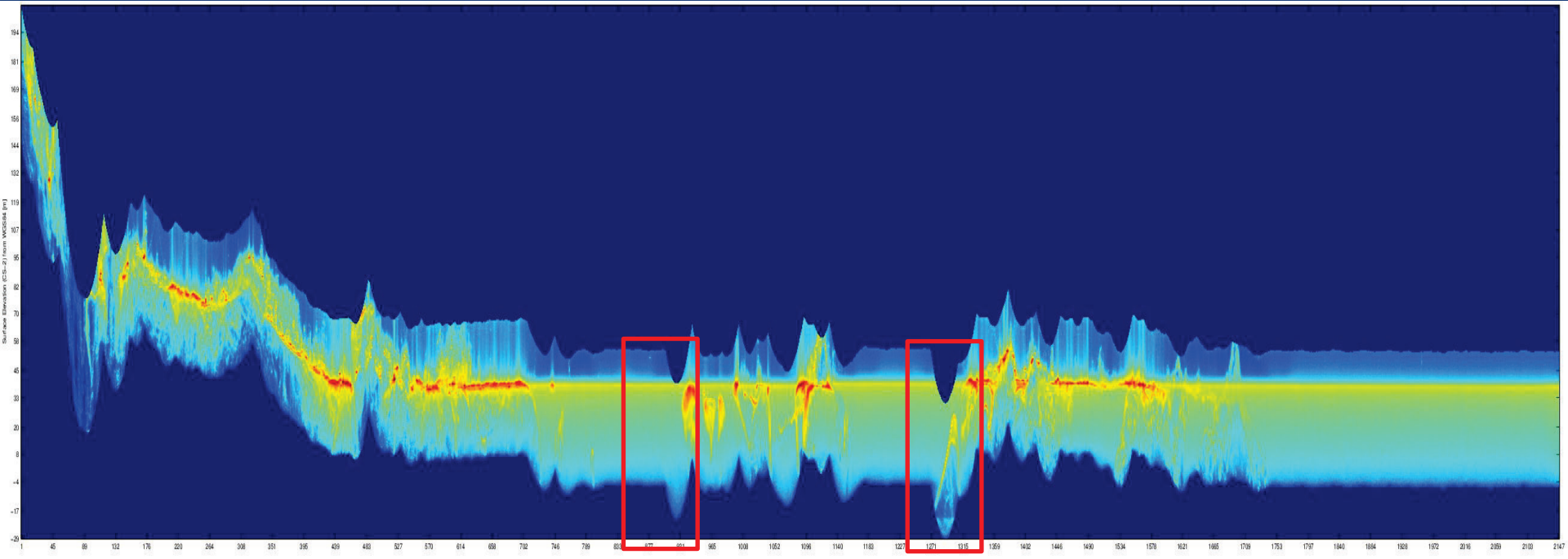
SAR ALTIMETRY 80 Hz

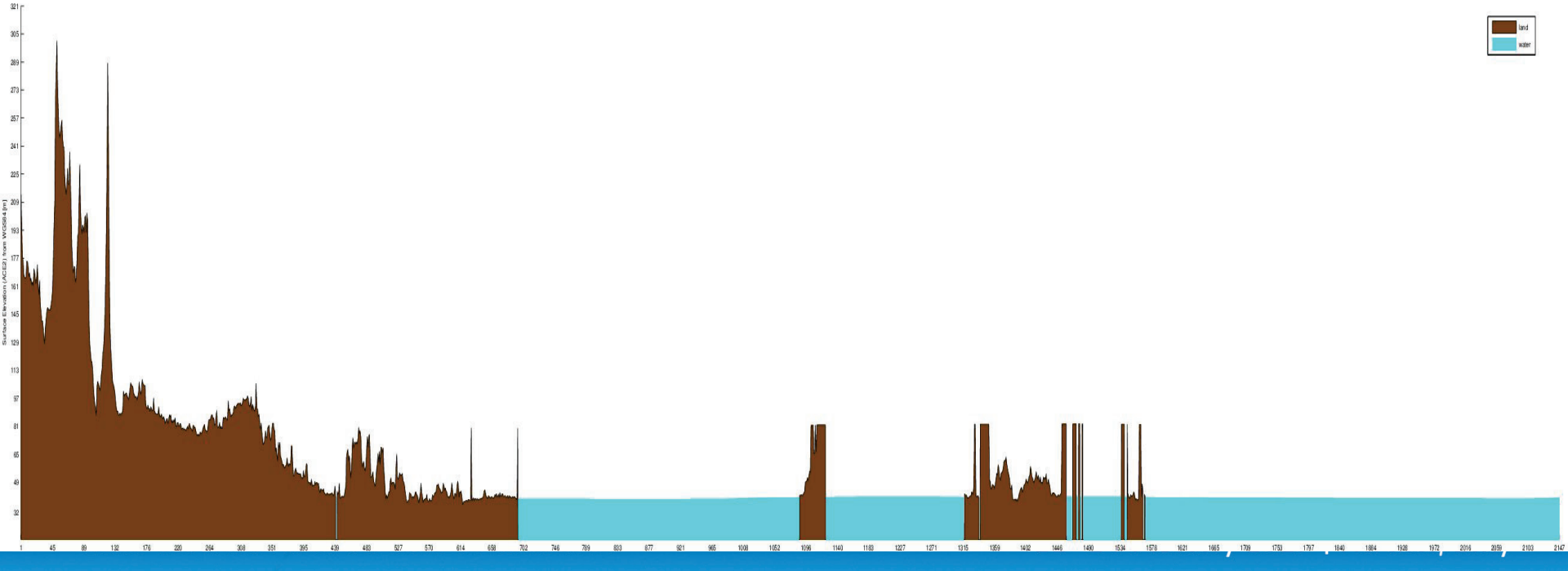


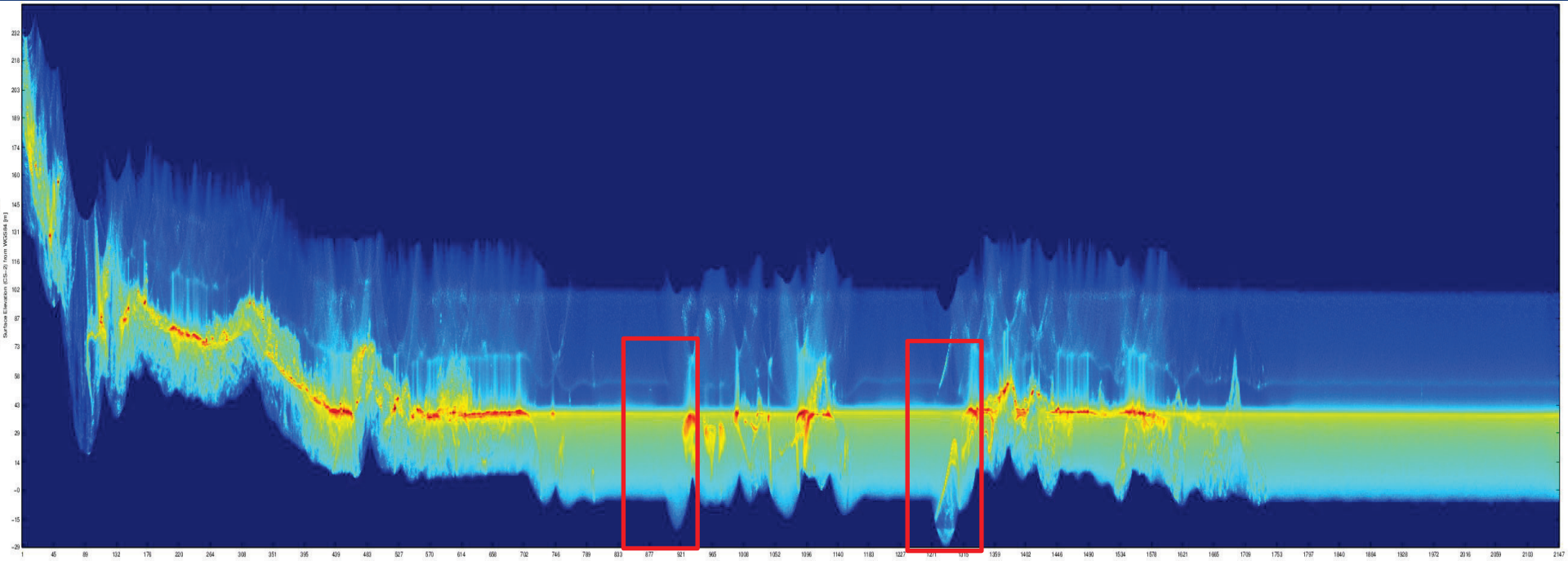
L1B Options – Window Size

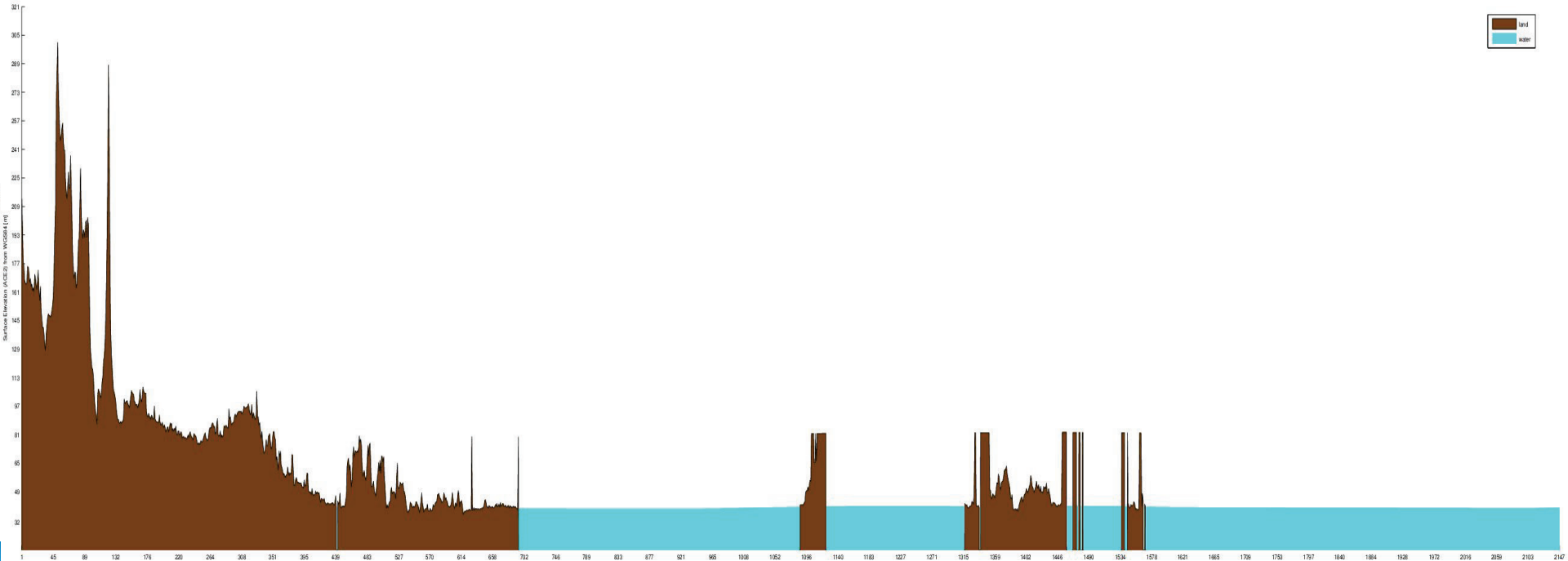
Option Name	Option Value	Option Description
Radar Receiving Window Size	- 128 Range Bins - 256 Range Bins	User can select here the size of the radar receiving window: 128 range bins (standard) or 256 range bins (extended). Extended window is indicated for coastal zone analysis

Default option: 128 Range Bins
Coastal Zone recommended:256 Range Bins
Open Ocean recommended: 128 Range Bins




land
water



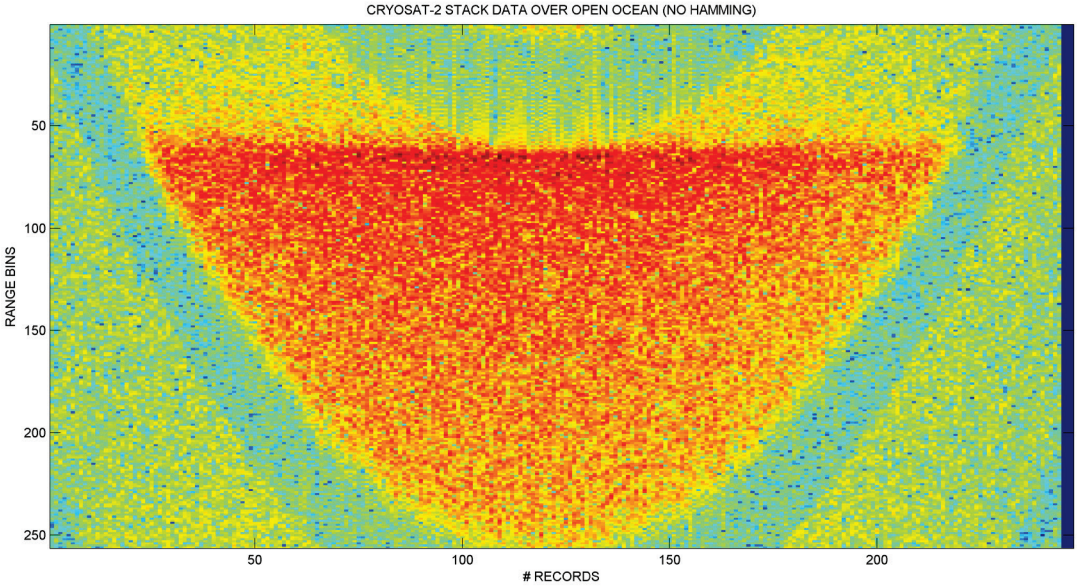

land
water

L1B Option – Dump Stack Data

Option Name	Option Value	Option Description
Dump SAR Stack Data in output	- Yes - No	Be aware that SAR Stack Data are bulky data products (around 1 GB for single pass); do not process them massively but limit yourself at around 10/20 passes at the time Flag to dump the SAR Stack Data in the output package

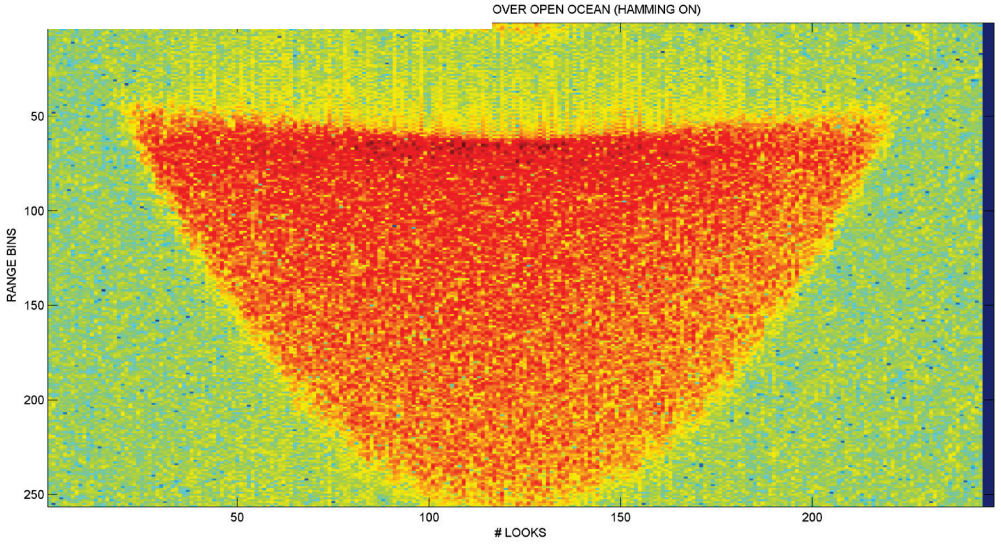
Default option: No

L1B Option – Dump Stack Data

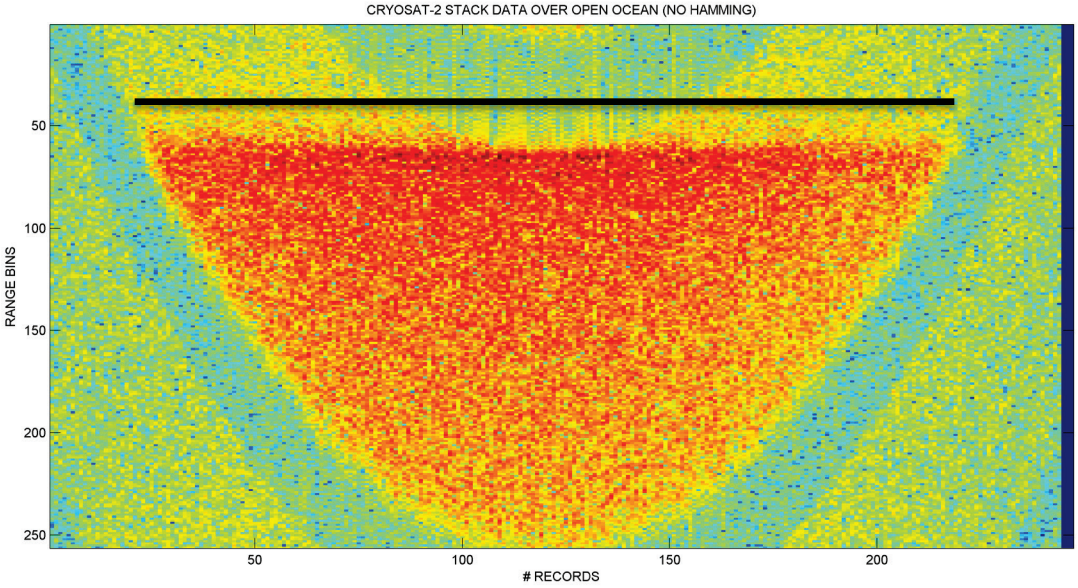


NO HAMMING

HAMMING ON

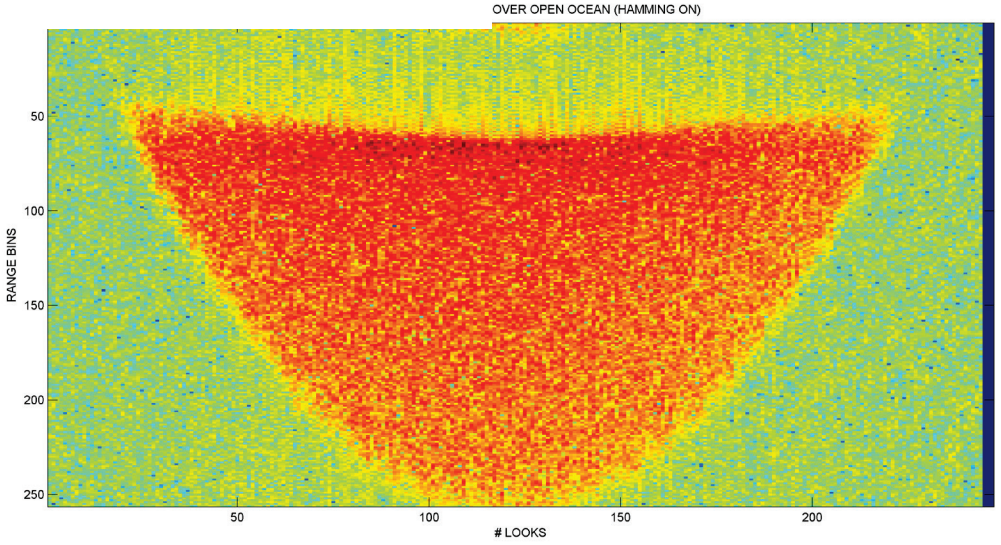


L1B Option – Dump Stack Data

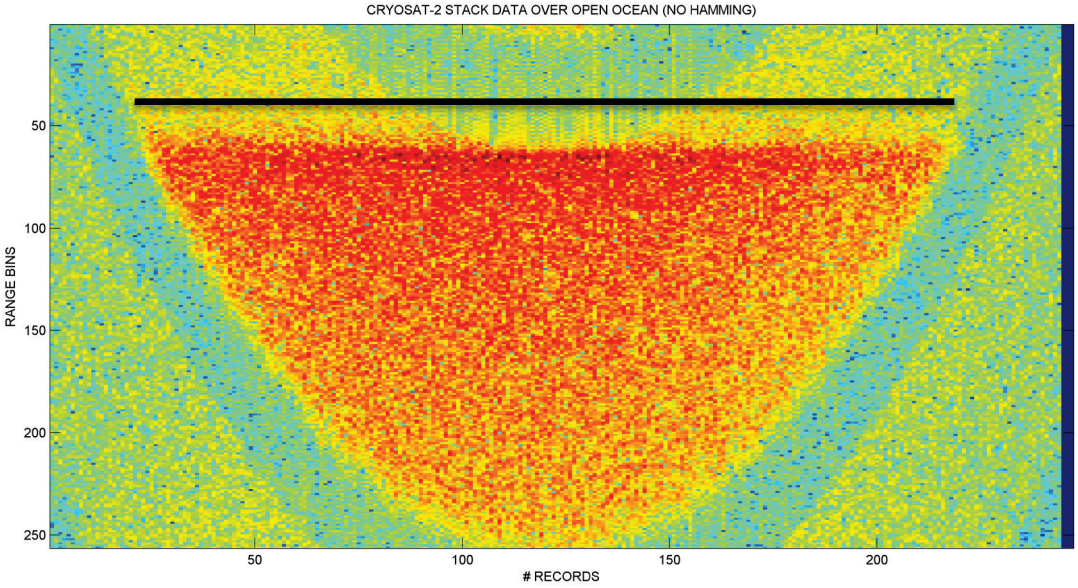


NO HAMMING

HAMMING ON

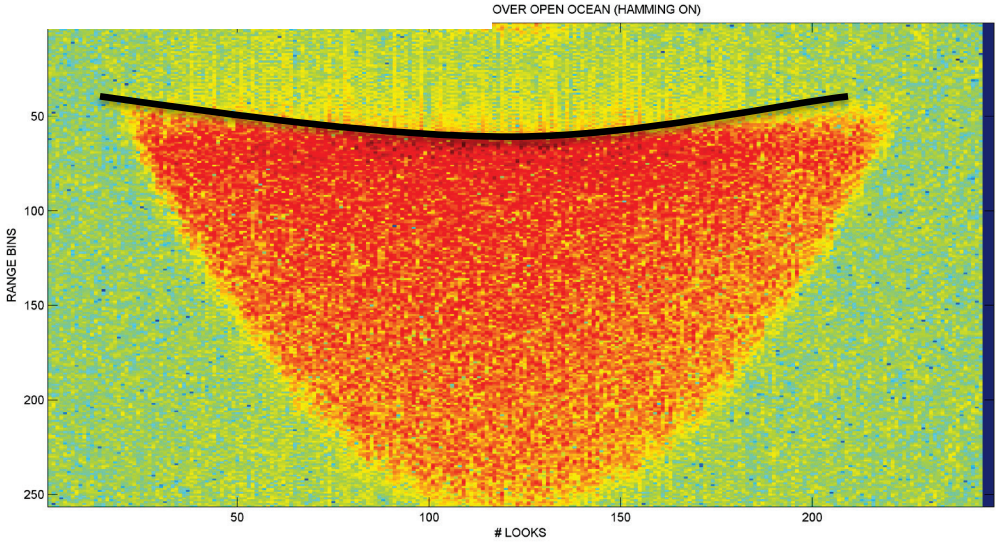


L1B Option – Dump Stack Data

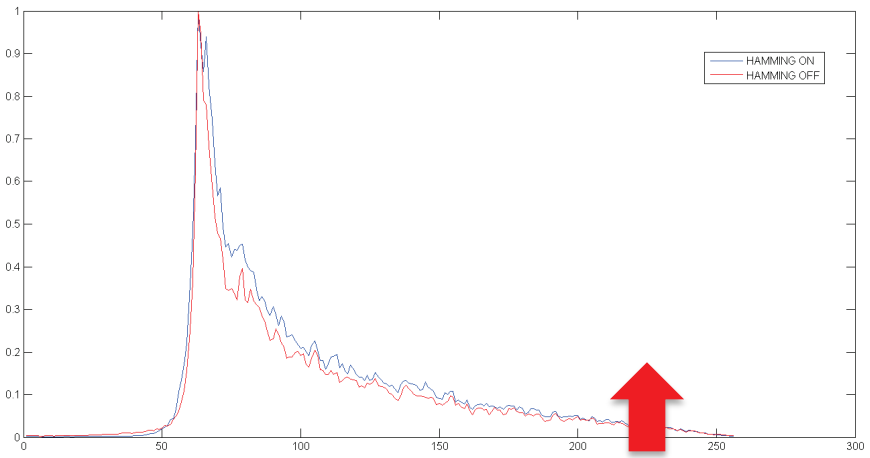


NO HAMMING

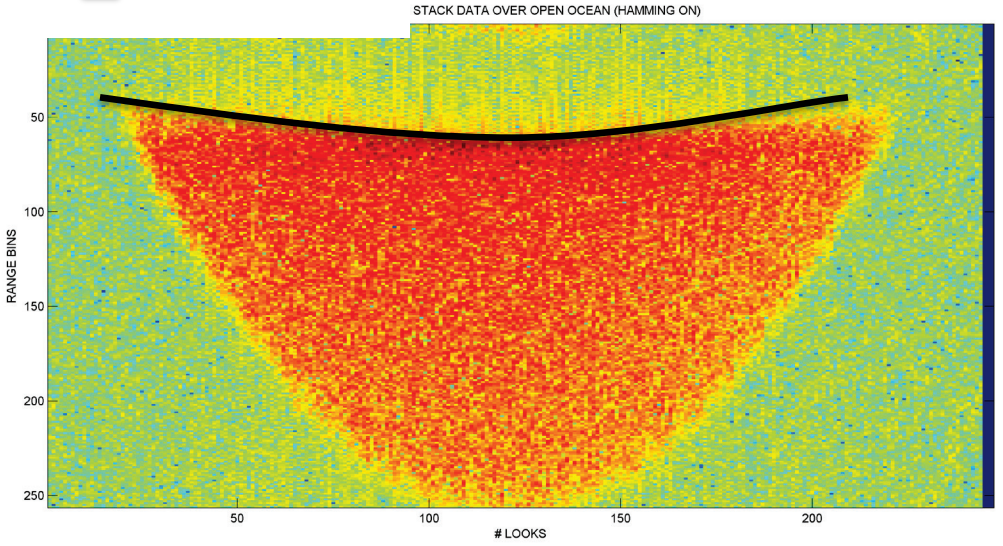
HAMMING ON



L1B Option – Dump Stack Data



HAMMING ON



L2 Processing Options

Option Name	Option Value	Option Description
Restrict the re-tracking on specific surfaces	- 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 (points in open sea, costal zone and inland water)
PTR width alphap parameter	- LUT - Constant	User can decide here whether to use a LUT (Look-Up Table) or a constant for PTR (Point Target Response) alphap parameter
SAMOSA Model Generation	- Use SAMOSA 2 - Use SAMOSA 3 - Use SAMOSA +	User can decide here which SAMOSA generation model to use in the processing. The SAMOSA 3 is a truncated version of SAMOSA 2 (only zero-order term). SAMOSA+ is the SAMOSA2 model tailored for inland water, sea ice and coastal zone domain

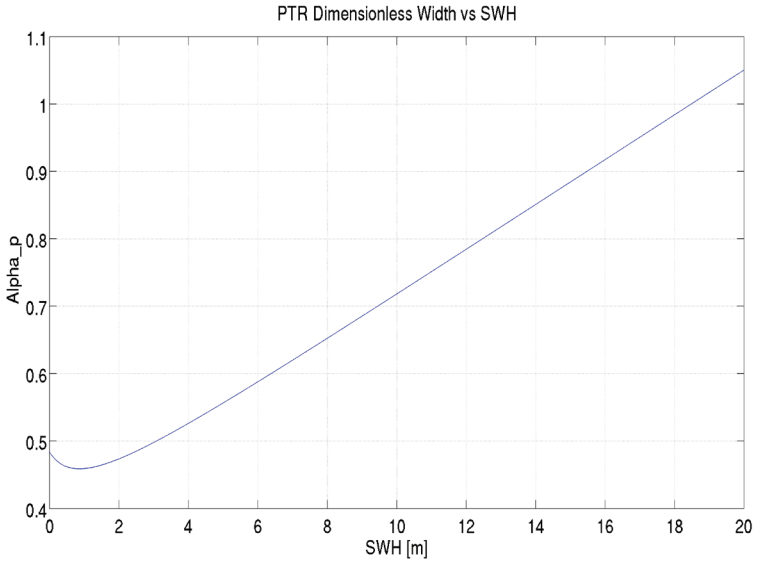
L2 Processing Options (2)

Option Name	Option Value	Option Description
Single-Look or Multi-Look Model	- Multi-Look - Single-Look	Flag to set the application of the Model Multilooking (Single-Look or Multi-Look). Single-Look option is indicated for quick look operations while Multi-Look is the most accurate
Dump RIP in output	- Yes - No	Flag to append Range Integrated Power (RIP) in the output netCDF data product
Dump SAR Echo Waveforms in output	- Yes - No	Flag to append the SAR Echo Waveforms in the output netCDF data product

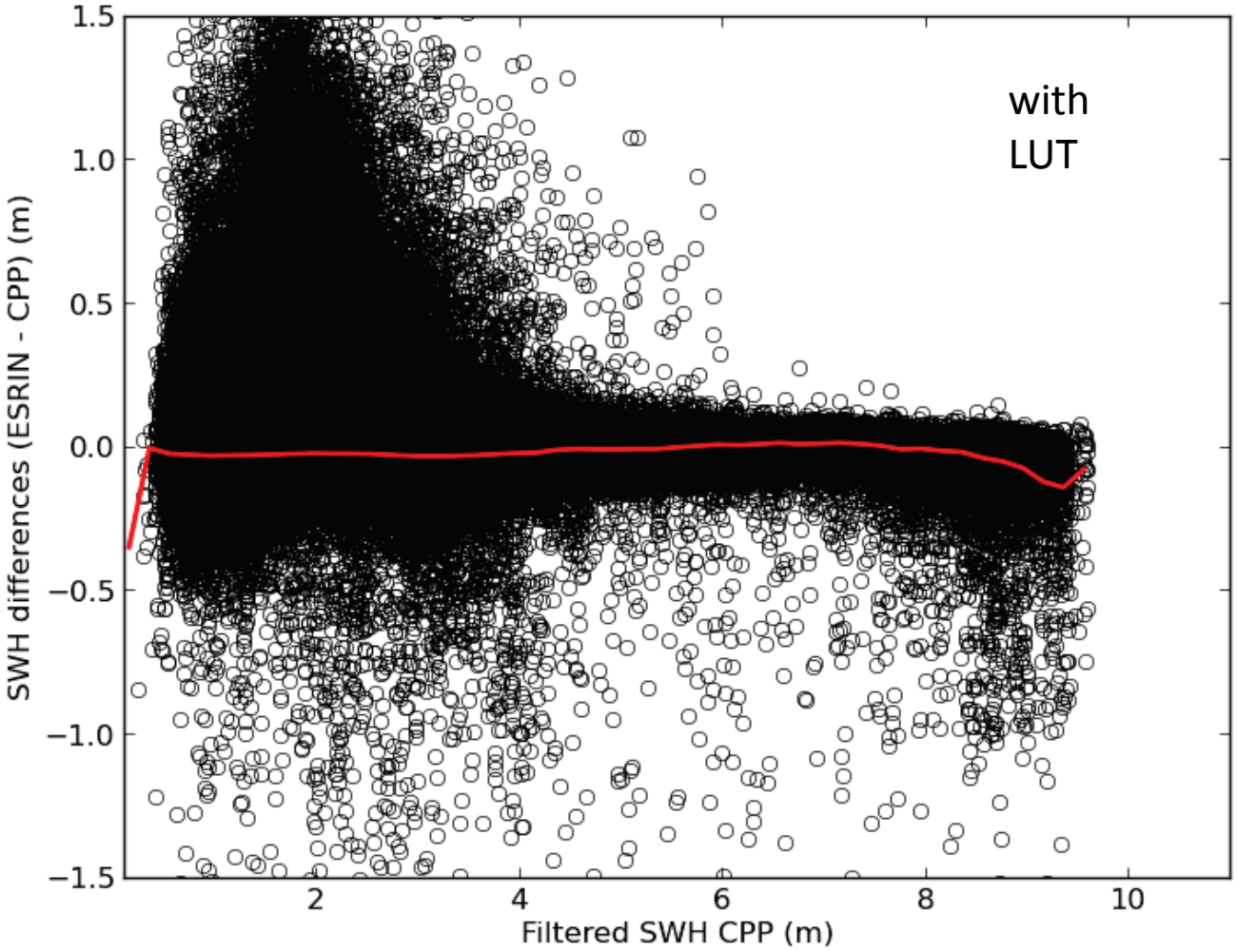
L2 Options – PTR width (1)

Option Name	Option Value	Option Description
PTR width alphap parameter	- LUT - Constant	User can decide here whether to use a LUT (Look-Up Table) or a constant for PTR (Point Target Response) alphap parameter

Default option: LUT
Coastal Zone recommended: LUT
Open Ocean recommended: LUT

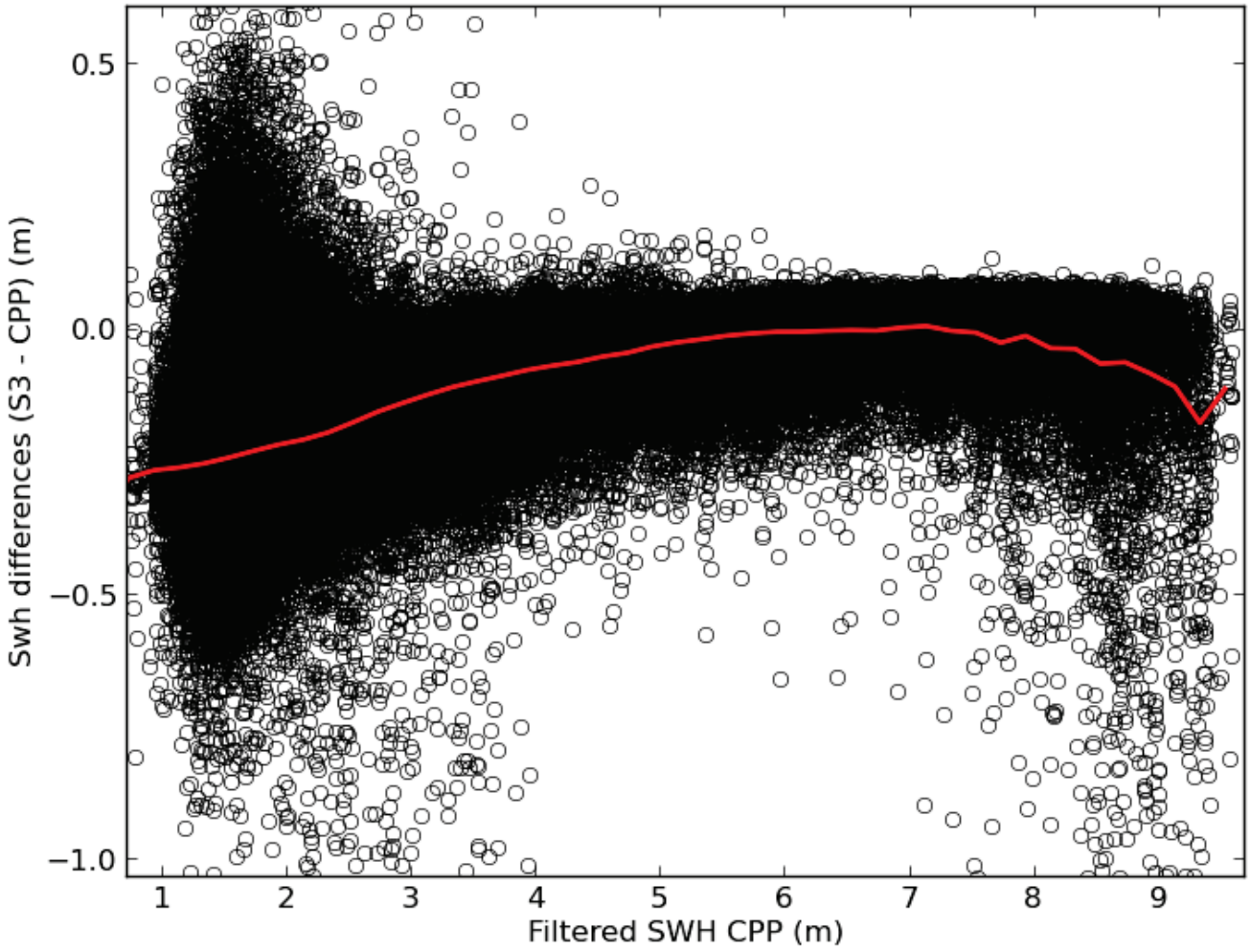


L2 Options – PTR width (2)



Credits CLS/CNES

L2 Options – PTR width (3)



"SWH residual depends strongly on wave height (up to 25cm at very low swh) that could be due to the Gaussian approximation for the PTR "

CNES/CLS

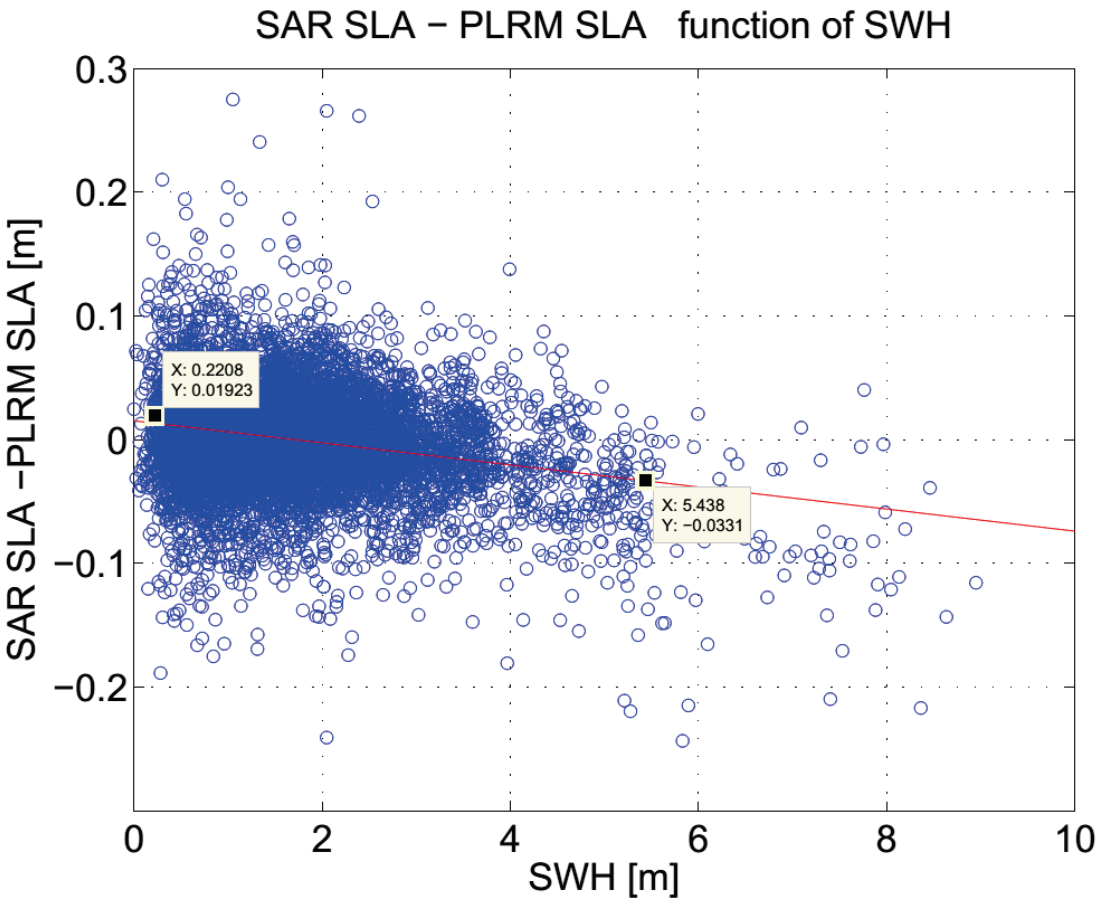
L2 Options – SAMOSA version

User can decide here which SAMOSA generation model to use in the processing.

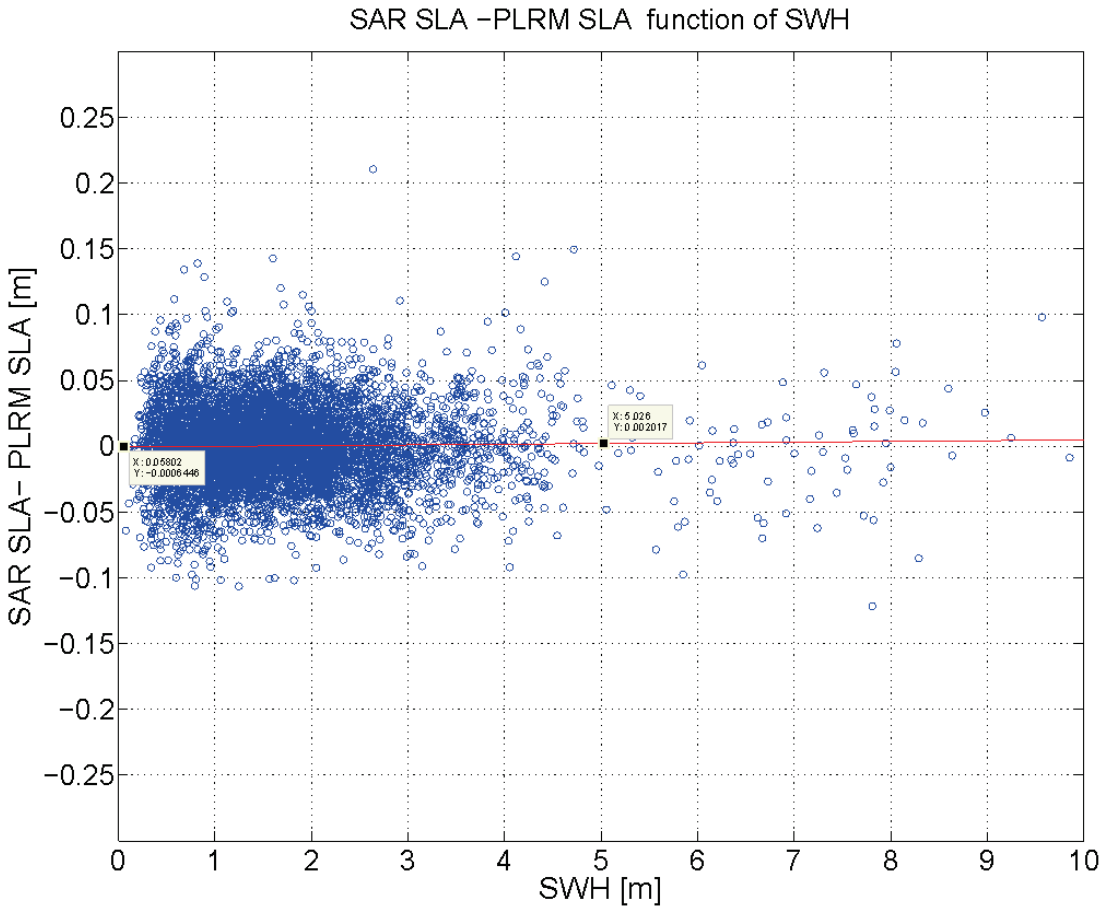
SAMOSA Model Generation	- Use SAMOSA 2 - Use SAMOSA 3 - Use SAMOSA +	The SAMOSA 3 is a truncated version of SAMOSA 2 (only zero-order term). SAMOSA+ is the SAMOSA2 model tailored for inland water, sea ice and coastal zone domain

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

L2 Options – SAMOSA3



L2 Options – SAMOSA2

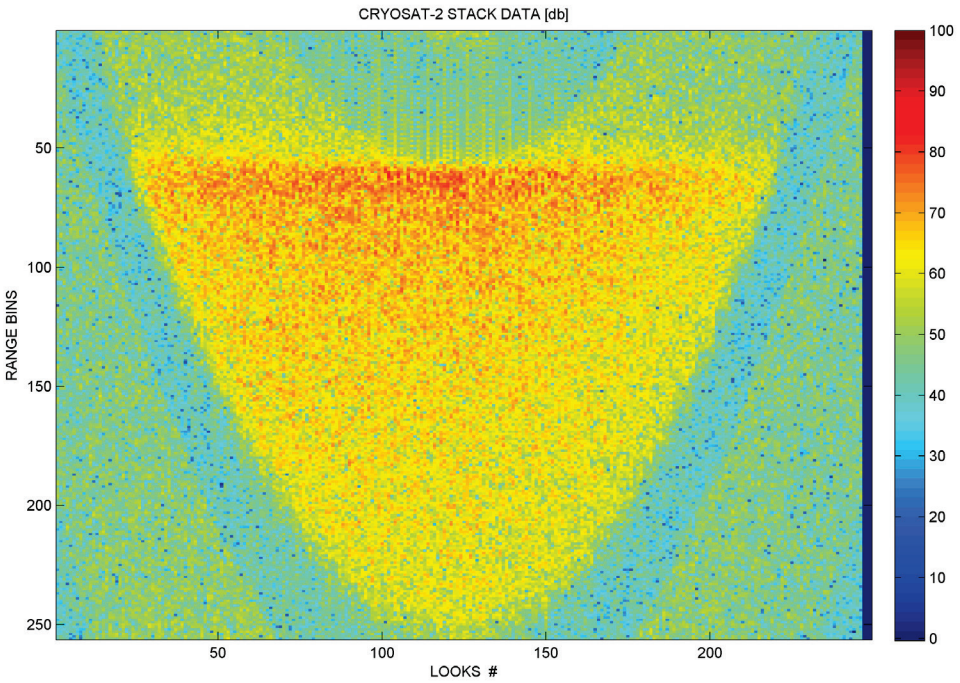


L2 Options – PTR width (1)

Dump RIP in output	- Yes - No	Flag to append Range Integrated Power (RIP) in the output netCDF data product

Default option: NO

So far, SAR users are starting to be famialiar with FBR DATA or with L1b Multilooked Waveforms DATA but indeed a third type of data could be exploited: **the STACK DATA**



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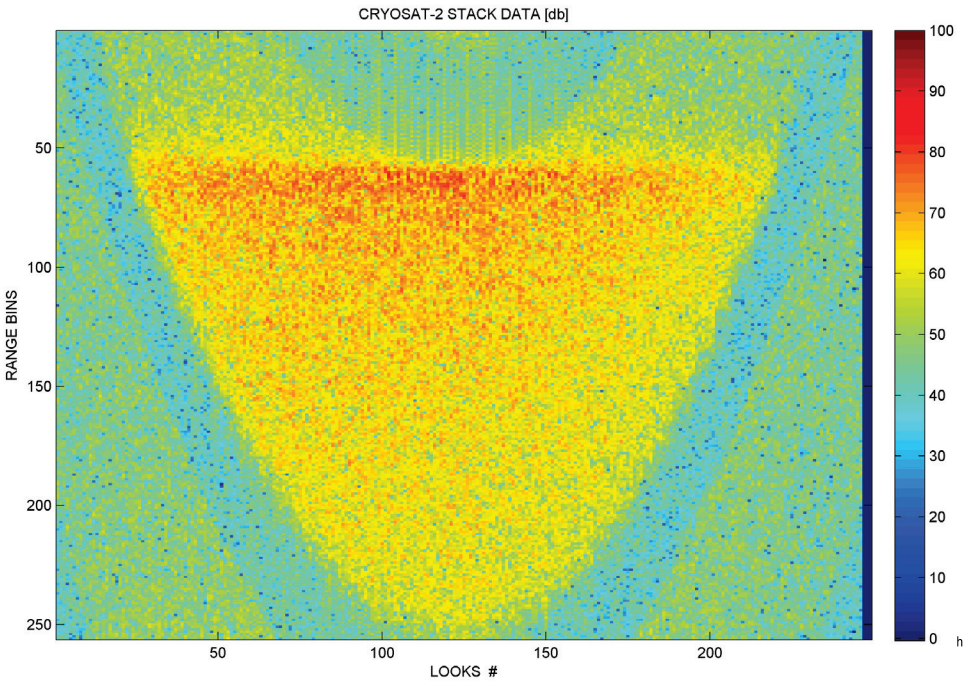

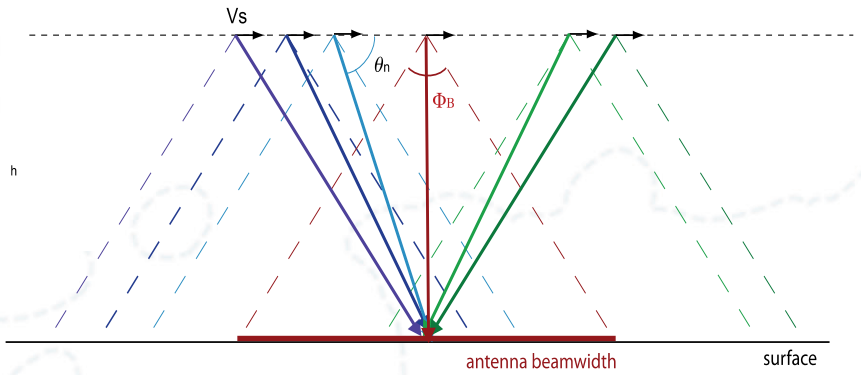

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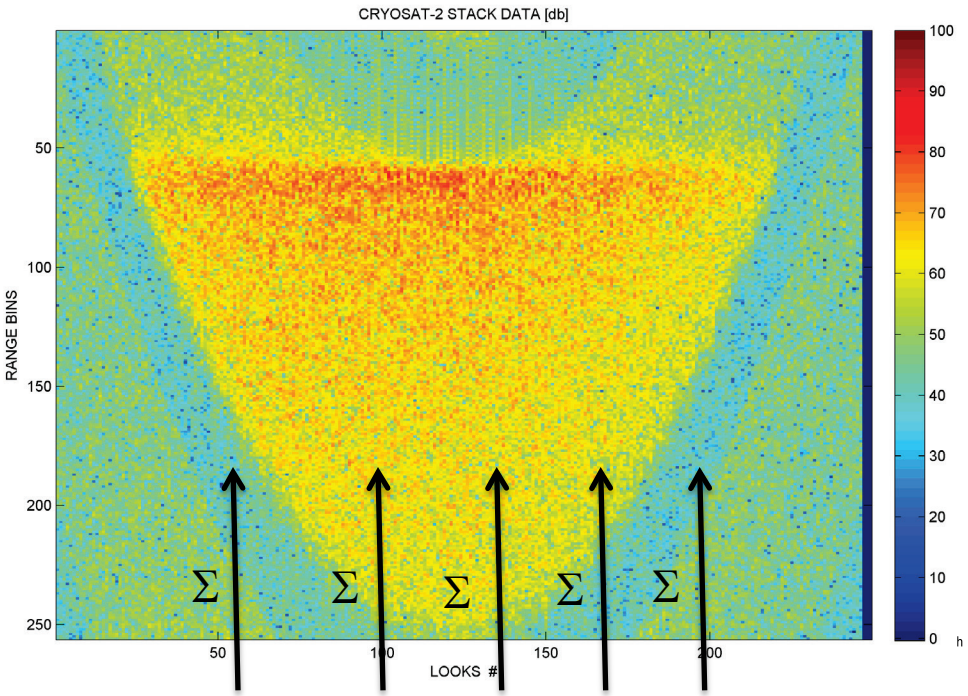

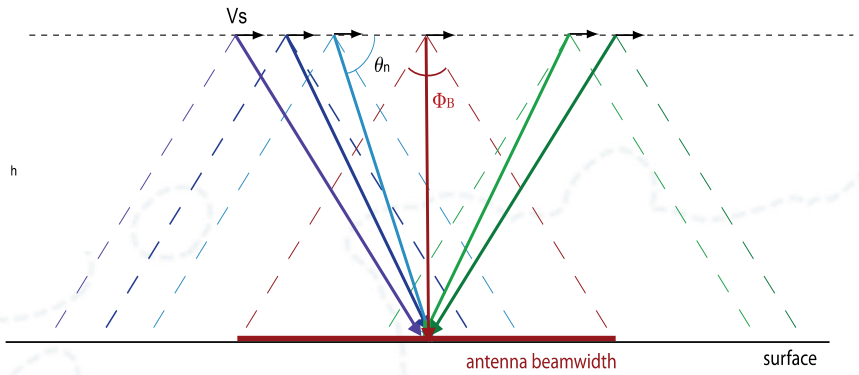

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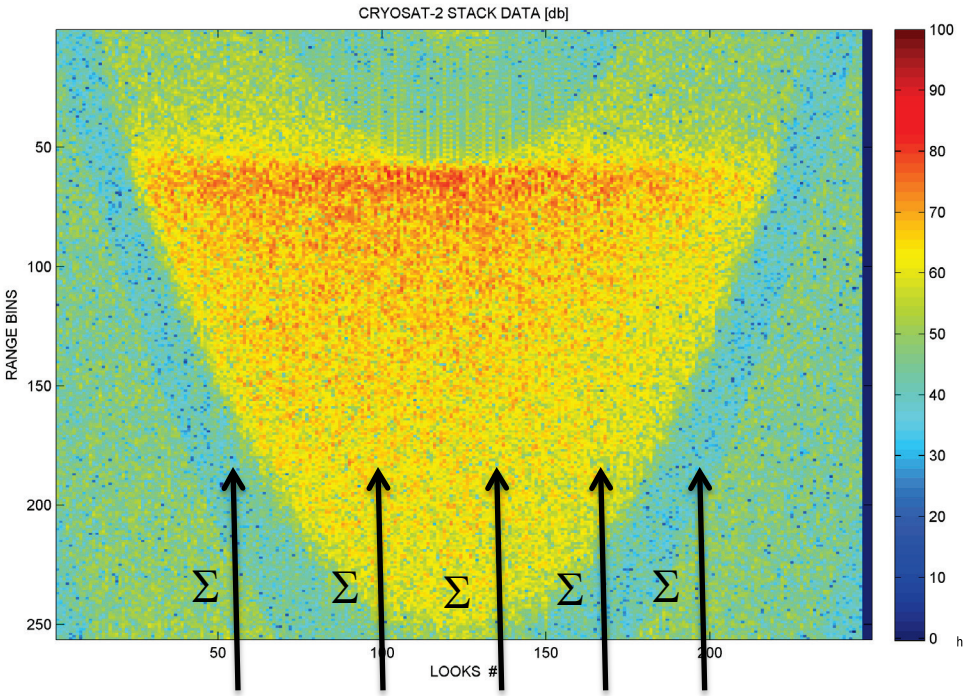

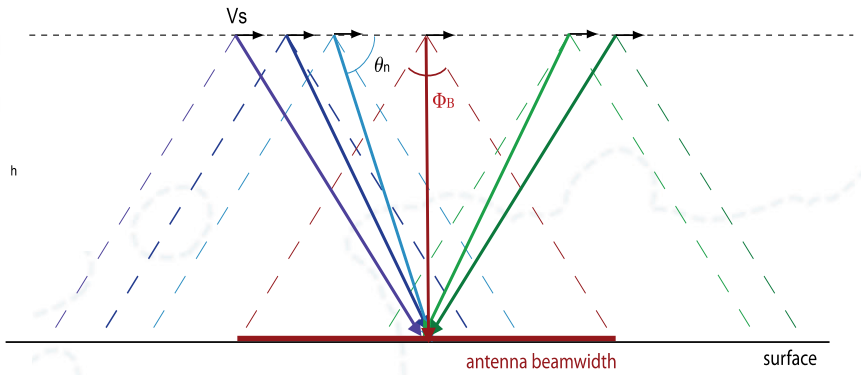

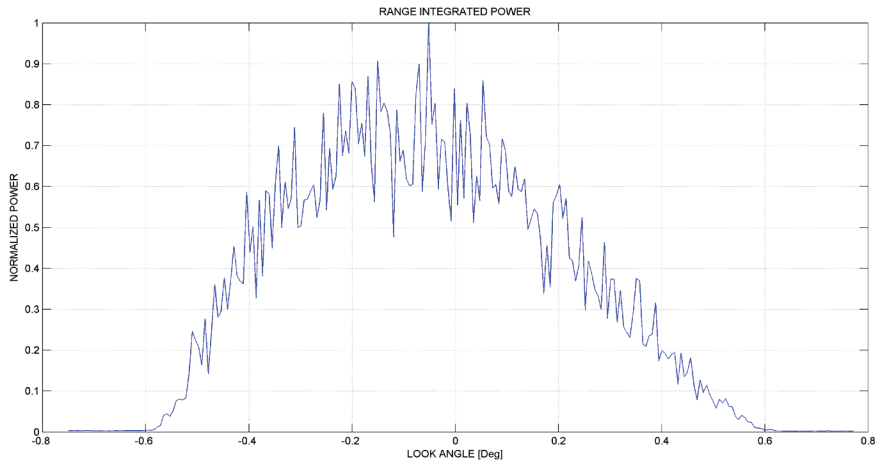

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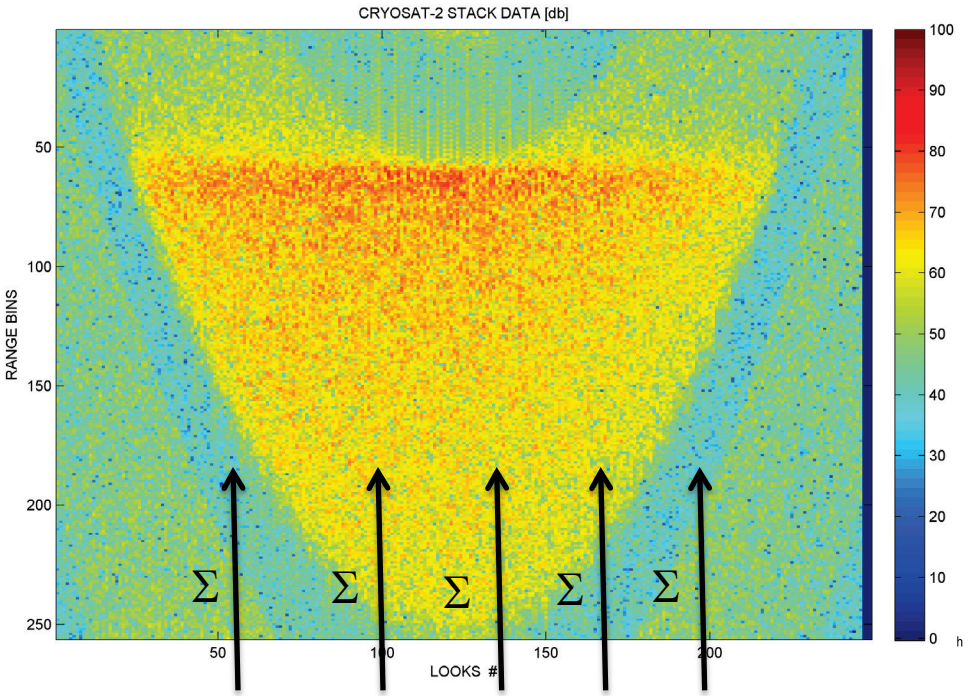

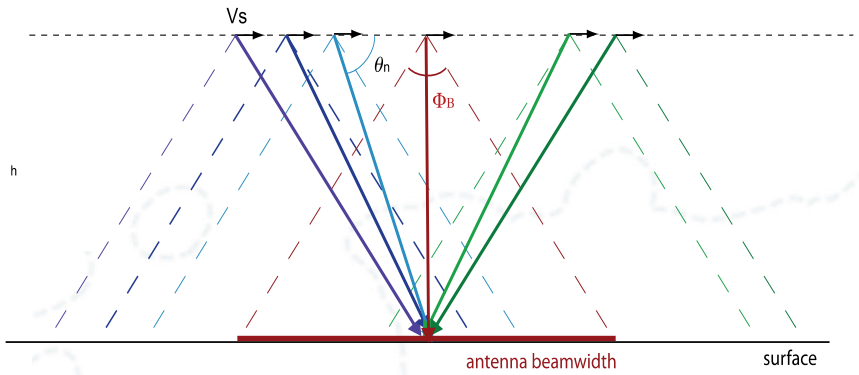

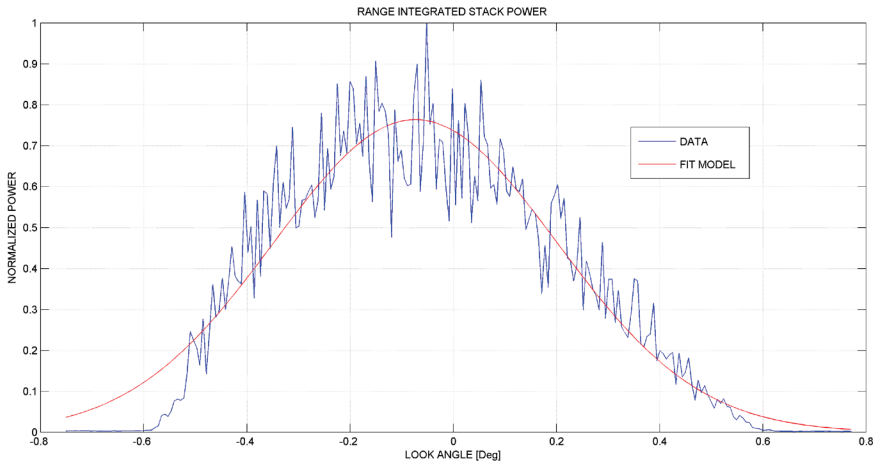

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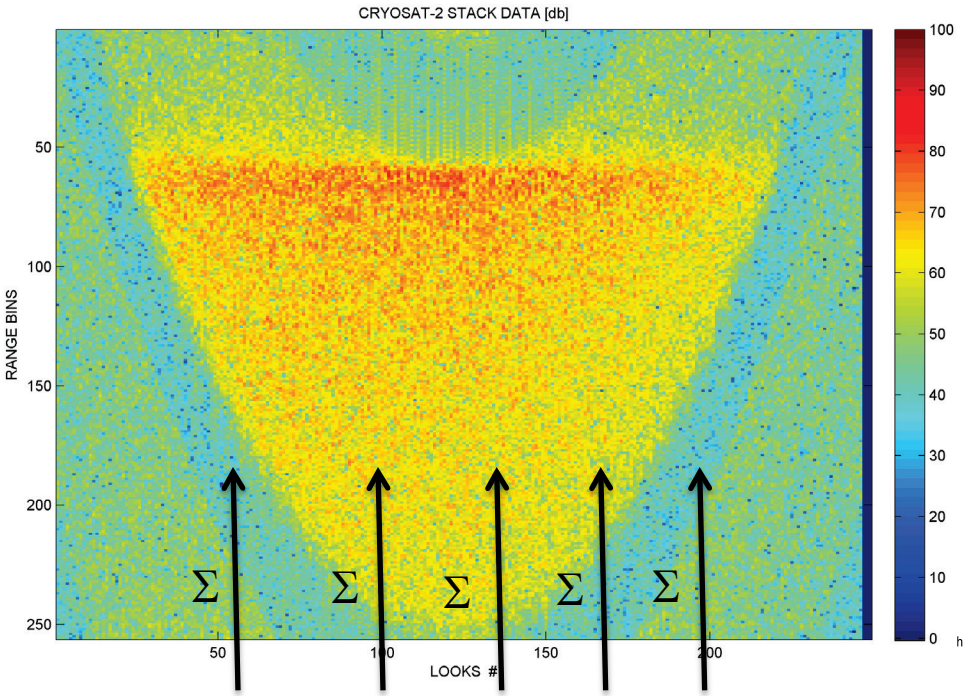

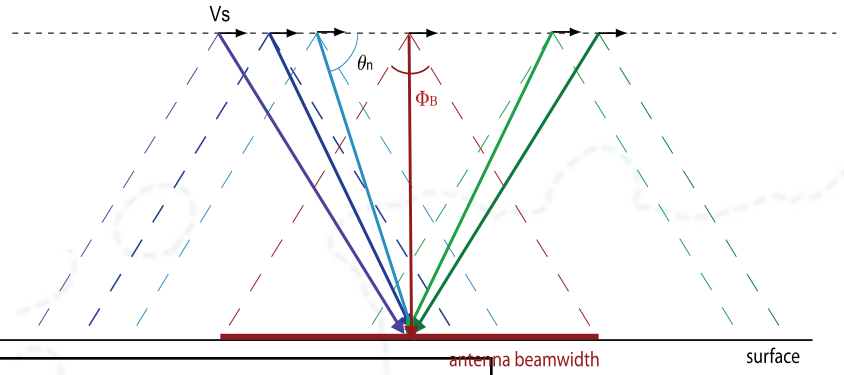

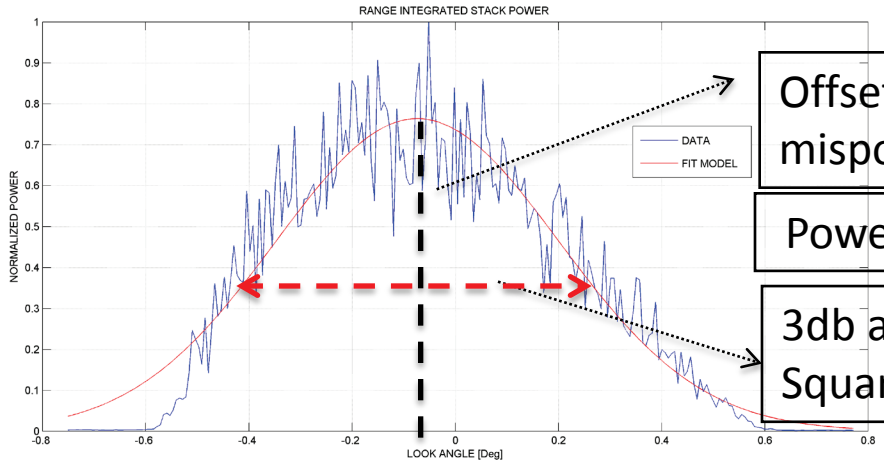

Offset depending on pitch mispointing

Power Distribution^with look angle

3db aperture depending on sea surface Mean Square Slope

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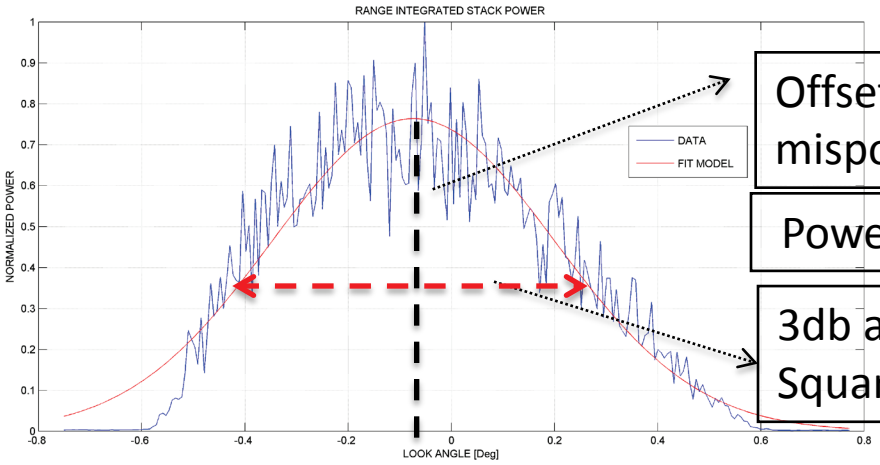

Offset depending on pitch mispointing

Power Distribution^with look angle

3db aperture depending on sea surface Mean Square Slope

L2 Options – Single Look / Multi Look Model

Single-Look or Multi-Look Model	- Multi-Look - Single-Look	Flag to set the application of the Model Multilooking (Single-Look or Multi-Look). Single-Look option is indicated for quick look operations while Multi-Look is the most accurate

Default option: Multilook

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, in press