

The ESA Altimetry Virtual Lab

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The EarthConsole® Altimetry Virtual Lab (AVL)



- 1) Support the Altimetry community in the development & operation of new Earth Observation applications.
- 2) Foster collaboration by leveraging on knowledge-sharing tools.

The ESA Altimetry Virtual Lab has been developed on the new EarthConsole® platform (<u>https://earthconsole.eu/</u>) and hosts the SARvatore (SAR Versatile Altimetric TOolkit for Research & Exploitation) family of processors which was previously available in the ESA Grid Processing On-Demand (G-POD) environment.

The GPOD/SARvatore service had 269 users supported with:

 \rightarrow 4082978 CPU hours (that's 466 CPU years), 84305 processing tasks completed,1407.0 TB processed.

Fostered more than 30 peer-reviewed publications and 4 PhD theses.







Available Services & Future enhancements in AVL

- The SARvatore (SAR Versatile Altimetric TOolkit for Research & Exploitation) for CryoSat-2 and Sentinel-3 services.
- The **SAMPY** processor service for **CryoSat-2**.
- The TUDaBo SAR-RDSAR (Technical University Darmstadt – University Bonn SAR-Reduced SAR) for CryoSat-2 and Sentinel-3 service.
- The ALES+ SAR (T. U. Munich) for CryoSat-2 and Sentinel-3 service.
- The Aresys Fully Focused SAR for CryoSat-2, Sentinel-3 & Sentinel-6 services.
- The SMAP FF-SAR processor by CLS.

- Improve the processing options available in all services to be aligned with the most recent advances in radar altimetry processing.
- **Extend the services** portfolio to allow the full exploitation of the new **Sentinel-6** mission data.
- Support the full exploitation of FF-SAR data by providing advanced retrackers (e.g. SAMOSA+/++ , DTU MWaPP, ...).
- Introduce a pre-processing stage to improve the geographical filtering of input data.





BRAT (Broadview Altimetry Toolbox)

Jérôme Benveniste (ESA-ESRIN) & the BRAT Team

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BRAT (Broadview Radar Altimetry Toolbox)

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- The universal **altimetry toolbox BRAT** (Broadview Radar Altimetry Toolbox) is **a collection of tools and tutorial documents** designed to facilitate the processing of radar altimetry data.
- The toolbox is freely available
 http://earth.esa.int/brat.
- It can read all previous and current altimetry missions' data up to Sentinel-3 L1 and L2 products.
- This project started in 2005 from the joint efforts of ESA (European Space Agency) and CNES (Centre National d'Études Spatiales).

RADAR ALTIMETRY Sesa & cnes TUTORIAL & TOOLBOX

Workspace and Datasets



BRAT (Broadview Radar Altimetry Toolbox)

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- Several kinds of computations can be done within BRAT, involving both user defined combinations of data fields that can be saved for posterior use and the BRAT's predefined formulas from oceanographic altimetry.
- BRAT also includes the Radar Altimeter Tutorial, which contains an extensive introduction to altimetry, showing its applications in different fields such as Oceanography, Cryosphere, Geodesy and Hydrology, among others.
- Use cases are also available, with step-by-step examples, covering the toolbox usage in the different contexts.

Operations – Data editing



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earth.esa.int/gut







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→ GOCE USER TOOLBOX

GOCE USER TOOLBOX (GUT)



- The GOCE User Toolbox (GUT) is a compilation of tools for the use and analysis of GOCE gravity field models.
- It is freely available at: earth.esa.int/gut.
- It facilitates the use, viewing and post-processing of GOCE Level
 2 mission data and allows the gravity field data, in conjunction and consistent with any other auxiliary data sets, to be pre-processed
 by laymen on gravity field processing, for oceanographic and hydrologic as well as solid earth applications, both regionally and globally.
- Hence, GUT is an important tool for facilitating a wide use of the existing gravity data acquired from GRACE and GOCE.
- GUT generates all output files in netCDF format in compliance and gridded results may be visualised using the BratDisplay tool from ESA's Broadview Radar Altimetry Toolbox (BRAT).



Figure 7: A user can easily build processing chains of multiple workflows using the GUT3 GUI, visualising the output using the BratDisplay tool from ESA's BRAT. (Credits S&T)

Figure 13: Gravity anomaly at 8 km height calculated with the GUT software tool. Rivers in blue, national boundaries in black, principal faults and main sutures in black. (Credits UNITS)

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GOCE USER TOOLBOX (GUT)

 Individual workflows can be edited by manipulating automatically generated graphs, depicting structure and relations of processing units. Advanced users can create new workflows for their unique needs.

Figure 8: Users can create their own custom workflows by connecting multiple processing units of choice and linking the dependencies as the user sees fit. (Credits S&T)

With **GUT** a user can:

- Read the GOCE level 2 products and ancillary datasets, including a priori surfaces, calibrated gravity gradients and geoid height errors.
- Read **global and local gravity models** in ICGEM format.
- Compute geoid heights at a chosen maximum degree and order over a grid or transect.
- Compute **gravity and height anomalies**, and **vertical deflections** on the surface of the terrain for a range of maximum degree and order expansions over a grid or transect.
- Compute the **spherical harmonic synthesis** and **calculate the 6 potential gradients**.

• Compute the ocean's mean dynamic topography and associated geostrophic velocities, kinetic energy and the vertical component of relative vorticity.

EXPEDITION 7° CONTINENT septiemecontinent.com

Chasing microplastic in eddies With the support of altimetry

Patrick Deixonne and all the « Expedition 7eme Continent » Team Alexandra ter Halle (CNRS IMRCP) Isabelle Pujol, Yannice Faugere (CLS) Gerald Dibarboure, Thierry Guinle (CNES)

DUACS

Expedition 7eme continent

Expedition 7eme continent is a NGO dedicated to study of plastic pollution :

- **Expeditions** into the gyres with a sailing boat to collect observations and bring back samples.
- **Research** in collaboration with more than ten laboratories in complementary fields of expertise such as oceanography, biology, chemistry, ecology, physics, mathematics,
- **Education** to increase understanding of the impact of pollution on the world ocean and the need to reduce its sources

septiemecontinent.com | seventh-continent.com

Sea campaign in North Atlantic / June 2015

Anticyclonic eddies increase accumulation of microplastic in the North, Atlantic subtropical gyre, Bracha et al, Marine Pollution Bulletin, 2018

- The results here corroborate the hypothesis that **mesoscale ocean dynamics impact plastic debris distribution** at the sea surface within subtropical gyres
- In this case, the averaged microplastic surface concentration was ~10 times higher in the anticyclonic eddy

- Next Campaign leaving very soon from France through the North Atlantic
- One of the scientific objectives is to consolidate 2016 results on plastics in eddies

=>Meta information from Aviso will be sent every day on the boat in Real time

 Also an opportunity to support Oceanography Research by conducting experiments on a new in situ device: the Wavy drifting buoys (sea state, SST and Current)

5 devices foreseen to be launch in SWOT 1-day crossovers to support CalVal activities (Adac)

SWOT Applications Program Goals

Primary objectives

SWC

- Maximize the societal impact of SWOT post launch.
- Make data available and accessible to a broad community of users
- Mechanism: SWOT Early Adopters (EA) Program

Benefit to user community;

- Accurate measurements
- Large (local to global) spatial coverage
- Reliable time series
- Societal benefit from their applications

SWOT Applications Areas Floods River Commerce Climate **Reservoirs** Drought **Marine Operations Costal Zone** Transboundary Management **Rivers Fisheries** Insurance

swot.jpl.nasa.gov/applications

SWOT Early Adopters

- Stakeholder engagement; engage innovators in new and existing partner organizations; advocates with tangible and potential applications that would benefit from the use of SWOT data...→Full spectrum from pure science to purely operational users
- Demonstrate utility and societal value of SWOT data through applied research
- Facilitate feedback on mission products pre-launch
- Accelerate the use of mission products *post-launch* by providing specific and continuous support to Early Adopters

→ Build Capacity and Benefit Society

Total – 26 EAs

		ORGANIZATION	COUNTRY
	1	Alexandria Univ.	Egypt
	2	ADPC	Thailand
	3	BRLi	France
	4	CWRDM	India
	5	CLS	France
	6	CNR	France
	7	CUAHSI	USA
	8	ECCC	Canada
-	9	FM Global	USA
-	10	FUNCEME	Brazil
-	11	Hydro Matters	France
-	12	ICUBE SERTIT	France
	13	IIT-Bombay	India
-	14	IIT-Delhi	India
-	15	Magellium	France
	16	Mercator Ocean	France
	17	NASA SPoRT	USA
_	18	NOAA/CIRES	USA
	19	Ohio State Univ.	USA
	20	PCRWR	Pakistan
	21	Stantec	USA
	22	TWDB	USA
	23	Univ. Bonn	Germany
_	24	USAF-LIS	USA
	25	USGS	USA
	26	vorteX.io	France

swot.jpl.nasa.gov/applications_ea.htm

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SWOT Applications Activities 2013-2022

- SWOT Applications Working Group (SAWG)
- Applications Mission Studies Data latency study → 3-day product
- 25 SWOT Early Adopters program launched in 2018
- Training (reports published/available online)
 - 8 Application Workshops 2015-2022
 - 3 Virtual Hackathons
- Communications

SWOT

- Applications web sites JPL & UW
- Conference/ST participation
- Launch Media (video, article) & Outreach support
- 2 Quarterly SWOT Applications Newsletters
- Publications
 - **10** wide-audience dissemination (BAMS, ASCE, EOS, AWRA, SERVIR)
 - **14** peer-reviewed research pubs by EA lead authors-8 *directly related to EA Projects*

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Information Resources

Details on Hydrology Data Products;

https://www.dropbox.com/sh/xevbyqguxfpddk6/AABex-EMzqXwC5K4Kj4m8M-_a/PPT?dl=0&preview=DAY+1+-+SWOT_Hackathon+2020+-+DataProducts+-+Tamlin+Pavelsky.pptx&subfolder_nav_tracking=1

- SWOT Applications Training; http://depts.washington.edu/saswe/swot/
- ESA Copernicus Program; <u>http://www.esa.int/Applications/Observing_the_Earth/Copernicus</u>
- SWOT Data Products Hydrology;

https://podaac.jpl.nasa.gov/SWOT?discipline=terrestrial%20hydrosphere&tab=datasets§ions=about

• SWOT Data Products - Ocean & Coasts;

https://podaac.jpl.nasa.gov/SWOT?discipline=coast&tab=datasets§ions=about%2Bdata