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AITiS Software for generating Time-Series of Water Levels from Radar Altimetry Data

Fabien Blarel; Sylvain Biancamaria; Damien Allain; Florence Birol; Sakaros Bogning; Robin Chevrier; Jean-François Crétaux; Lucrèce Djeumeni; Julien Lefebvre; Lancelot Leclercq; Fabien Léger; Rosemary Morrow; Fernando Niño

LEGOS, Université de Toulouse, CNES, CNRS, IRD, UPS:



AITiS (Altimetry Time Series) is a **radar altimetry data processing and visualization software**, tailored for fine-grained analysis of small scale water bodies.

Its goal is the obtaining **water-level time-series** derived from the altimetry measurements, but it can also be used to generate time series of any altimetry-based parameters (e.g., corrections applied to the range, backscattering coefficients, or brightness temperatures).

AITiS software is used to compute **Water Surface Elevation from nadir altimeters** within the [ESA-CCI River Discharge precursor project](#).

CTOH Altimetric products available for AITiS processing

Mission	Prod. Name	Cycle		Date		Orbit
		start	end	start	end	
Cryosat-2	cs2_b_gop_c_gdr	1	11	2010-07-16	2021-02-25	Nominal orbit (369 days)
	cs2_b_ice_d_gdr	2	10	2010-07-16	2021-02-25	Nominal orbit (369 days)
EnvSat	env_a_esa_v0300_sgdr	6	94	2002-05-14	2010-10-23	Nominal orbit (35 days)
	env_b_esa_v0300_sgdr *	95	113	2010-10-26	2012-04-08	Drifting orbit
ERS-2	ers2_a_ctoh_v0100_gdr	1	89	1995-05-17	2003-11-24	Nominal orbit (35 days)
	ja1_a_cnes_e_sgdr	1	259	2002-01-15	2009-01-26	Nominal orbit (10 days)
Jason-1	ja1_b_cnes_e_sgdr	262	374	2009-02-10	2012-03-03	Interleaved orbit (10 days)
	ja1_c_cnes_e_sgdr *	500	537	2012-05-07	2013-06-21	Drifting orbit
	ja2_a_cnes_d_sgdr	0	303	2008-07-04	2016-10-02	Nominal orbit (10 days)
Jason-2	ja2_b_cnes_d_sgdr	305	327	2016-10-13	2017-05-17	Interleaved orbit (10 days)
	ja2_c_cnes_d_sgdr	500	537	2017-07-11	2018-07-18	Long-repeat-orbit (LRO)
	ja2_d_cnes_d_sgdr *	600	644	2018-07-25	2019-10-01	Geodetic orbit
Jason-3	ja3_a_cnes_f_sgdr	0	227	2016-02-12	2022-04-07	Nominal orbit (10 days)
	ja3_b_cnes_f_sgdr	300	312	2022-04-25	2022-07-27	Interleaved orbit (10 days)
Sentinel-3A	s3a_a_lan_%_sgdr	1	89	2016-03-01	2022-08-30	Nominal orbit (27 days)
	s3a_a_wat_%_sgdr	1	89	2016-03-01	2022-08-30	Nominal orbit (27 days)
	s3b_a_lan_%_sgdr	3	19	2018-05-11	2018-11-27	S3A Tandem orbit (27 days)
Sentinel-3B	s3b_a_wat_%_sgdr	2	19	2018-05-11	2018-11-27	S3A Tandem orbit (27 days)
	s3b_b_lan_%_sgdr	19	70	2018-11-28	2022-09-01	Nominal orbit (27 days)
	s3b_b_wat_%_sgdr	19	70	2018-11-28	2022-09-01	Nominal orbit (27 days)
Sentinel-6A	s6a_a_lrm_f06_gdr	4	65	2020-12-17	2022-08-15	Nominal orbit (10 days)
	s6a_a_sar_f06_gdr	4	65	2020-12-17	2022-08-15	Nominal orbit (10 days)
Saral	sr1_a_cnes_f_sgdr	1	35	2013-03-14	2016-07-04	Nominal orbit (35 days)
	sr1_b_cnes_f_sgdr *	100	162	2016-07-04	2022-07-18	Drifting orbit
Swot-nadir	swot_a_nadir_f_igdr *	475	578	2023-03-29	2023-07-10	Calval orbit (1 day)
	swot_b_nadir_f_igdr *	1	6	2023-08-03	2023-11-15	Nominal Sci. orbit (21 days)
Topex	tpx_a_cash_v0220_gdr	10	359	1992-12-21	2002-06-22	Nominal orbit (10 days)

* Product supplied to expert users only.

AITiS accepts **CTOH GDR altimetry products** (Level 2 high frequency 10/20/40Hz data supplied by the CTOH). These data have been specifically conditioned to optimize the data size by making a geographical selection and includes the right altimetry parameters for hydrological studies.

Data requests

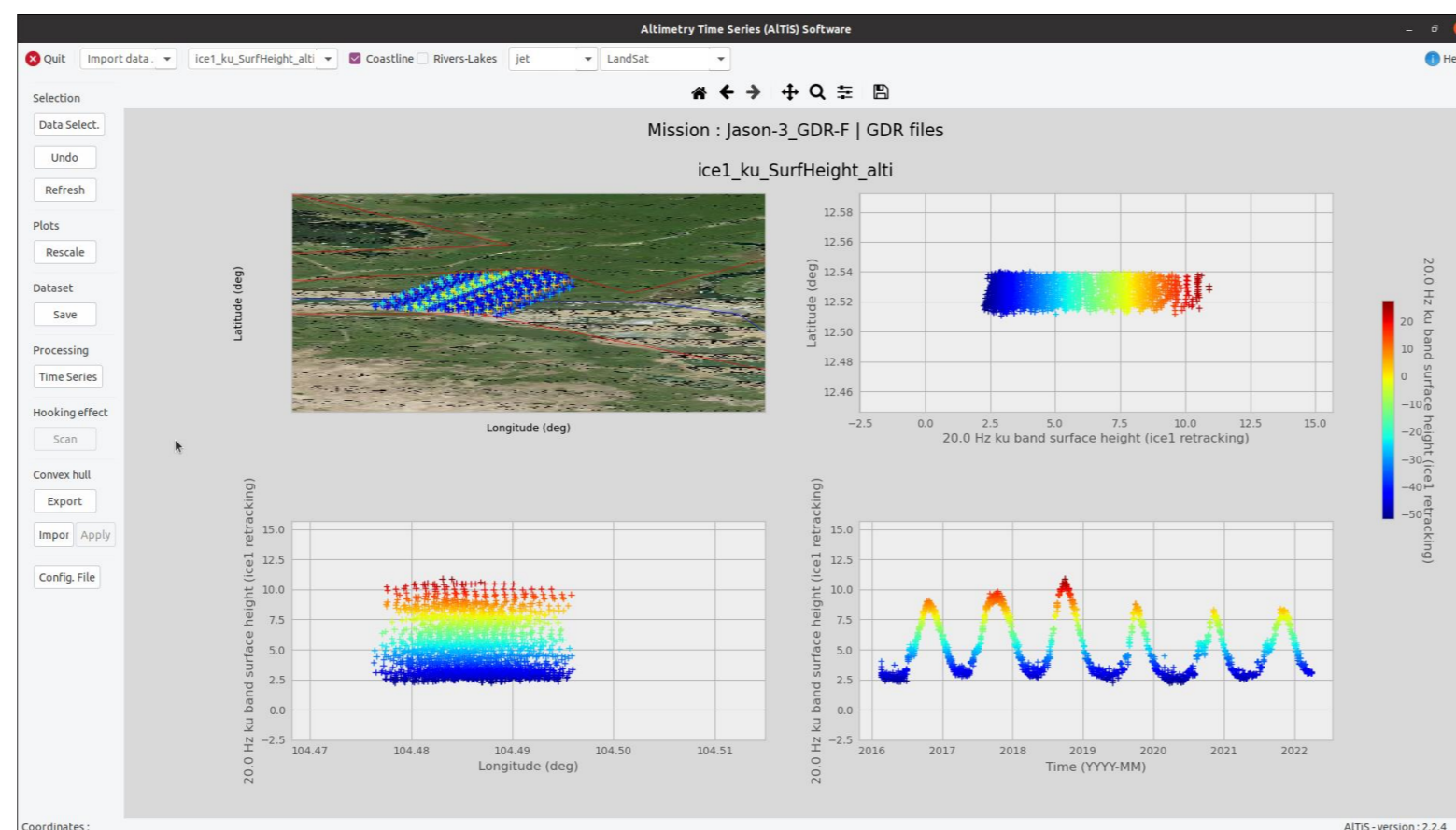
AITiS can process altimetric data products from the missions : Jason-1/2/3, ERS-2, ENVISAT, SARAL, Sentinel-3A/B, Sentinel-6/Jason-CS and soon the nadir altimeter onboard SWOT. They are supplied for free through a web request [form on the CTOH website](#).



Graphical User Interface

Using a **Graphical User Interface (GUI)**, without requiring any particular skills in data processing, the user can handle altimetry data in order to :

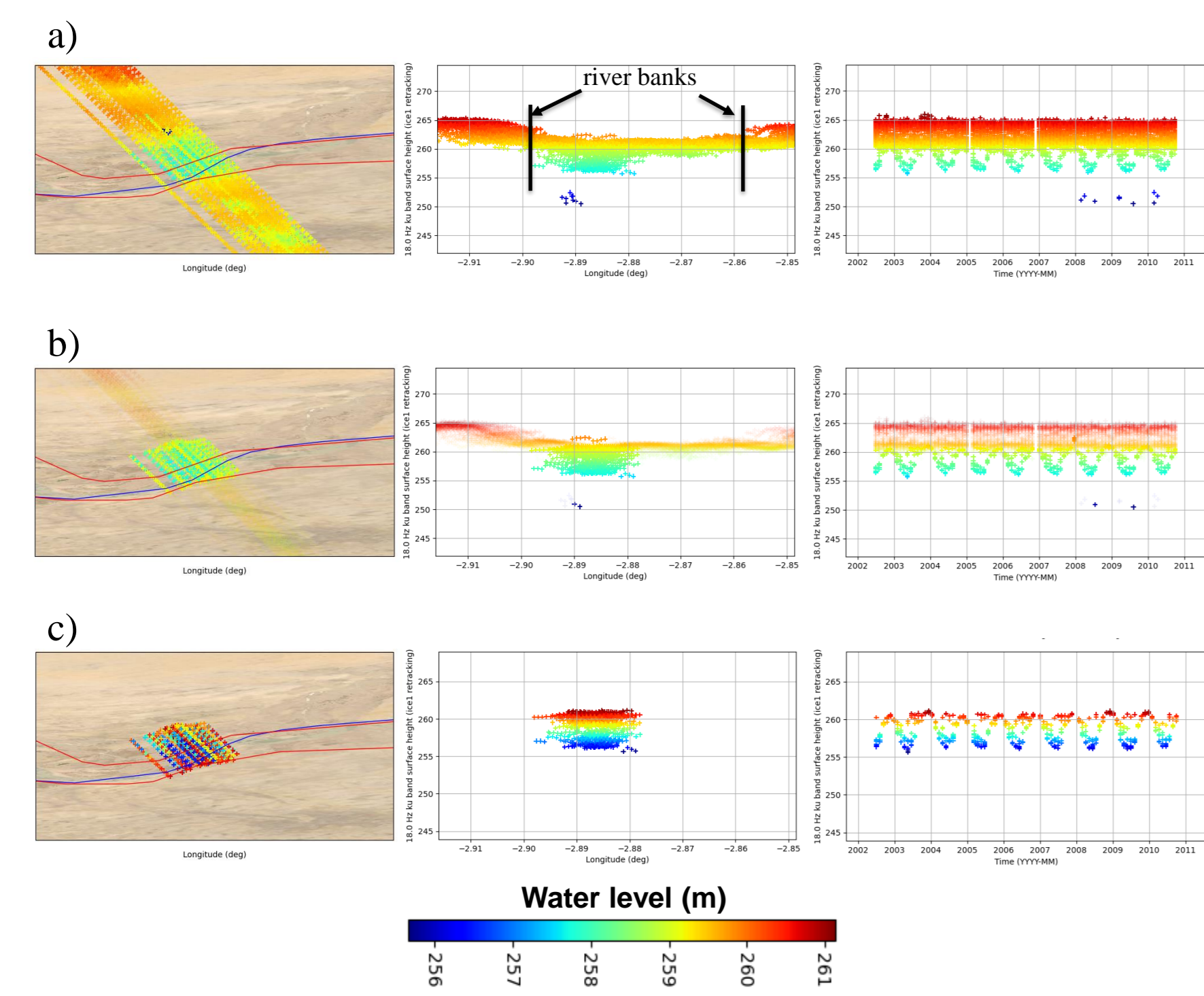
- **Plot several parameters of altimetric measurement** like surface height, altimetric range, atmospheric corrections applied to the range (ionospheric correction and wet and dry tropospheric corrections) as a function of latitude/longitude.
- **Display along-track characteristic parameters of the waveform** like the backscatter coefficient, and peakiness.
- **Using a (Landsat) background map**, easily select altimetric measurements to remove outliers.
- **Generate water height time series** from the valid altimetry data previously selected
- **Export** the time series into various files format as **CSV and HydroWeb**



Screenshot of AITiS GUI : 4 displays windows in order to edit altimeter measurement graphically



On left-hand side, mean time series computed and its variability associated; on right-hand side, the distributions.



An example of the altimetry data editing in the case of a river in the Inner Niger Delta area :

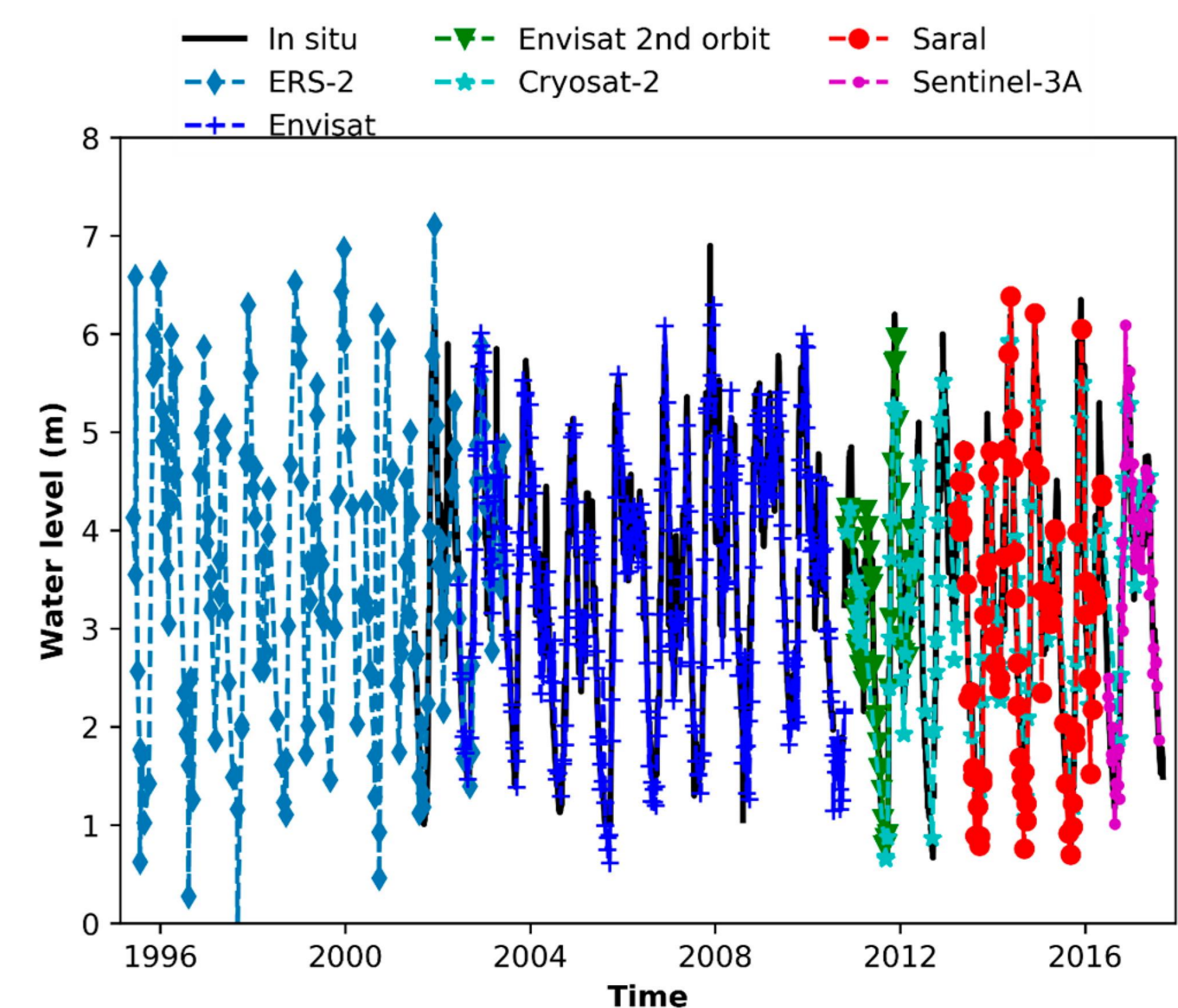
- First, a rough selection of the altimetry data is performed: (a) all altimetry data located a few kilometers away from the center of the river are selected (left panel), the major topographic features, such as hills, river banks, tributaries, etc. can be identified (central panel), temporal variations of the altimetry signal cannot be related to any hydrological signal (right panel).
- Then, a more accurate selection is made; (b) the number of data is decreasing and outliers are removed (left panel), the shape of the river and its temporal variations in width (central panel) and height (left panel) becomes clearer.
- This process is repeated until the final selection is achieved; (c)



A regularly updated documentation is available on the AITiS wiki.

Hydrological applications

AITiS is mainly employed for **hydrological applications** and can be used for **training courses on radar altimetry** at bachelor or master levels. It is also a very **convenient tool to analyse** the radar altimetry data contained in the GDR over any type of land surfaces.



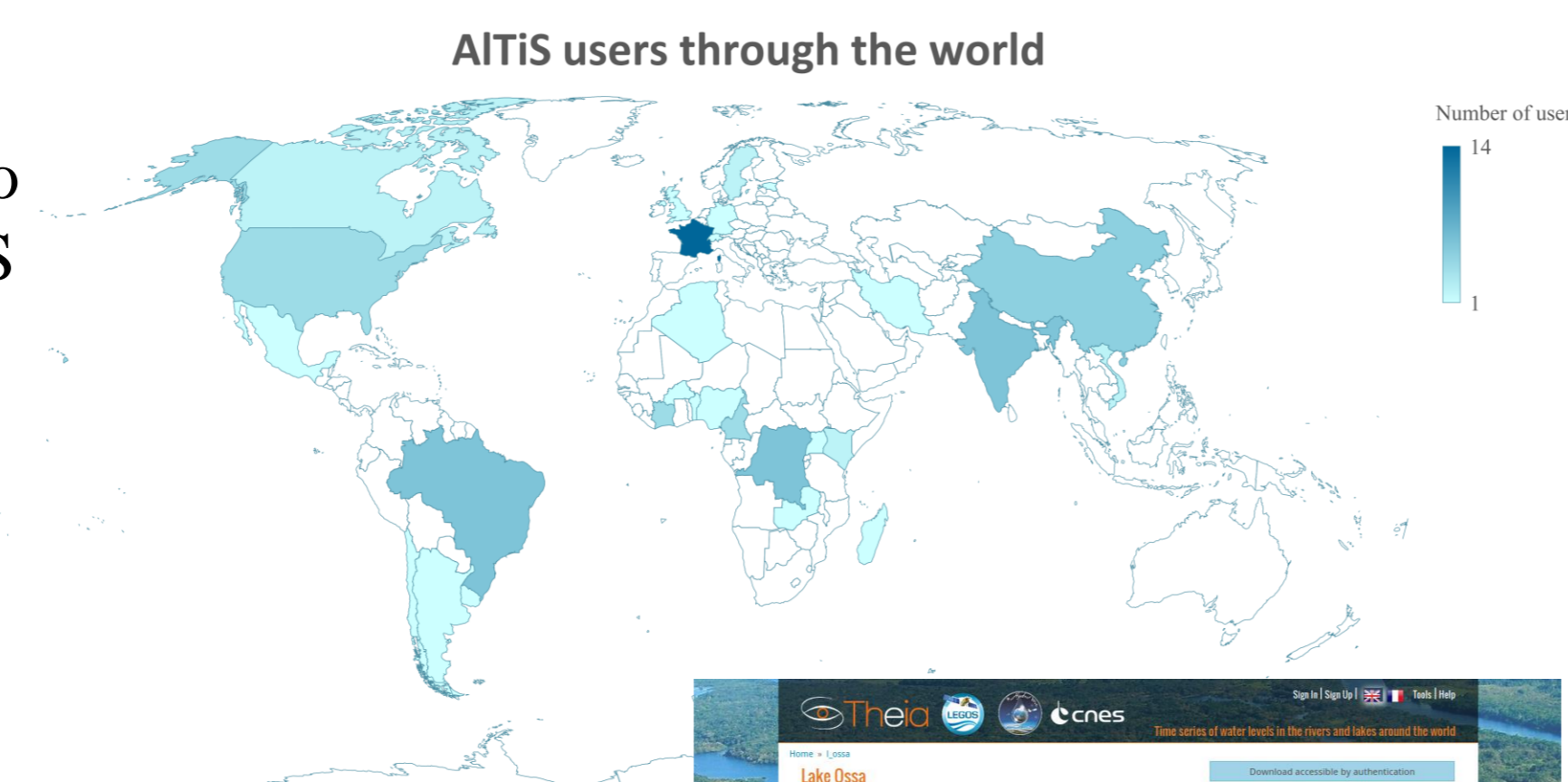
An example of a time series of water level at **Lambaréné (Ogooué River Basin in Gabon in Equatorial Africa)** from the in-situ gauge record (black continuous line), the **multi-mission altimetry-based** record (ERS-2 data are represented with diamonds, ENVISAT with blue crosses on its nominal orbit and with green triangles on its second orbit, Cryosat-2 with green-blue stars, SARAL with red circles, Sentinel-3 with purple dots) [Bogning, Sakaros, et al., Remote Sensing, 2018].

AITiS users

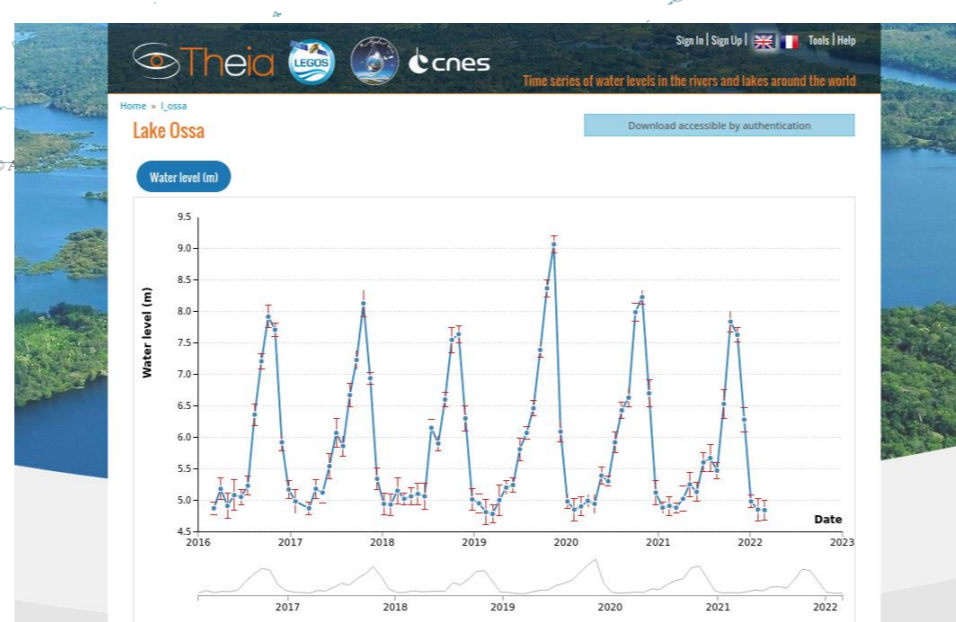
Today, more than **70 users** of over **21 countries** have processed altimetric data to generate water level time series with AITiS software. It is used for research and training activities.

The CTOH holds its own **AITiS teaching courses for students, engineers and researchers** in the Midi-Pyrénées Observatory in Toulouse, France. In addition, it has created an **AITiS user network** to provide information about software updates and new altimetric products.

On the current year, the CTOH has already answered more than 220 data requests.



HydroWeb uses AITiS for its research and validation studies.



Time series can be exported to the HydroWeb web site. Here we show an example of the Ossa lake (Cameroon).

Open source software

AITiS is **free software developed by CTOH** as part of its activities as a National Observation Service. AITiS is released as open source under the CeCill License and target GNU/Linux and, Windows 10/11 operating systems under python3 environment. [AITiS is available on GitLab](#).



<https://www.legos.omp.eu/ctoh>

