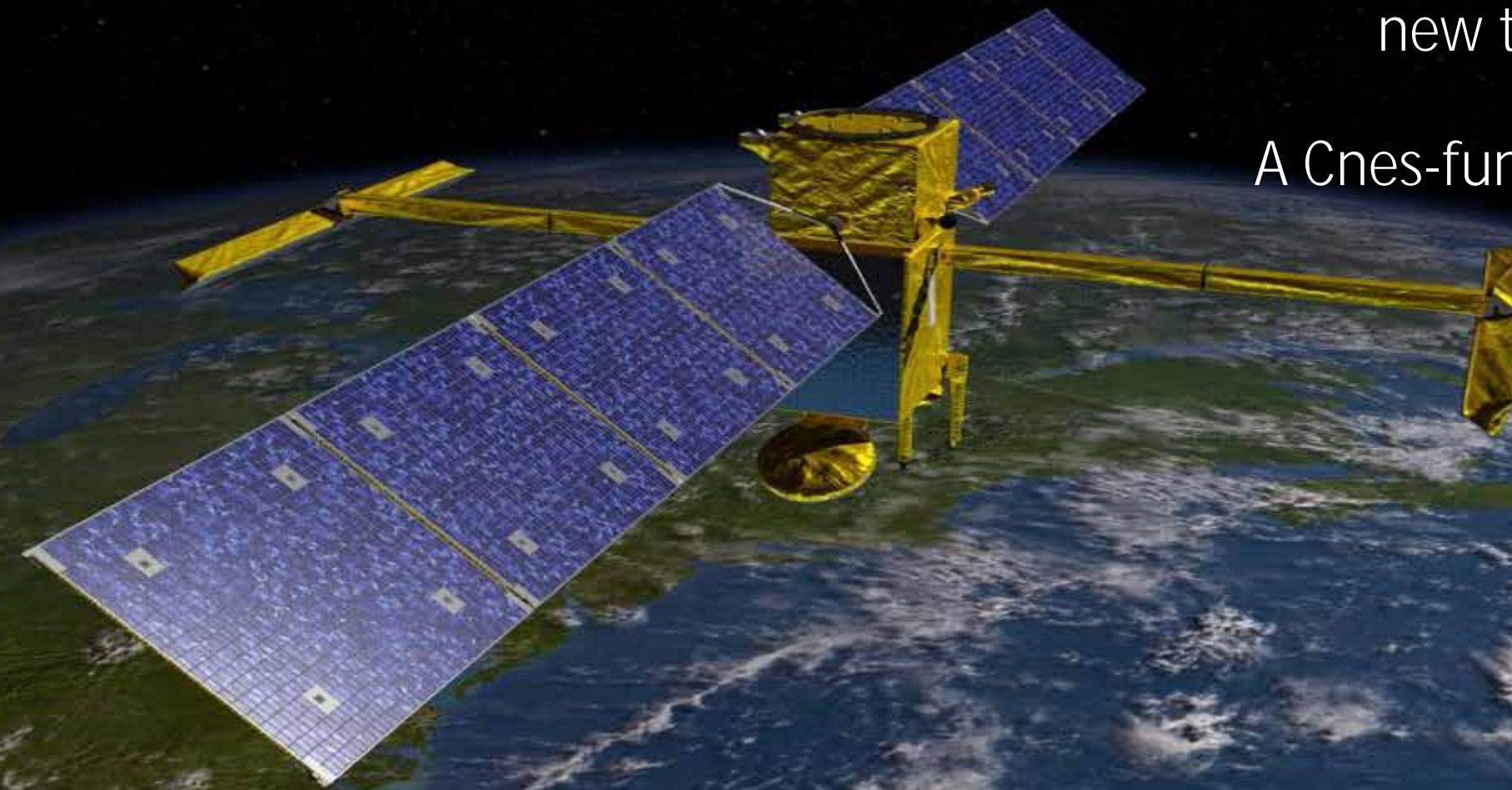
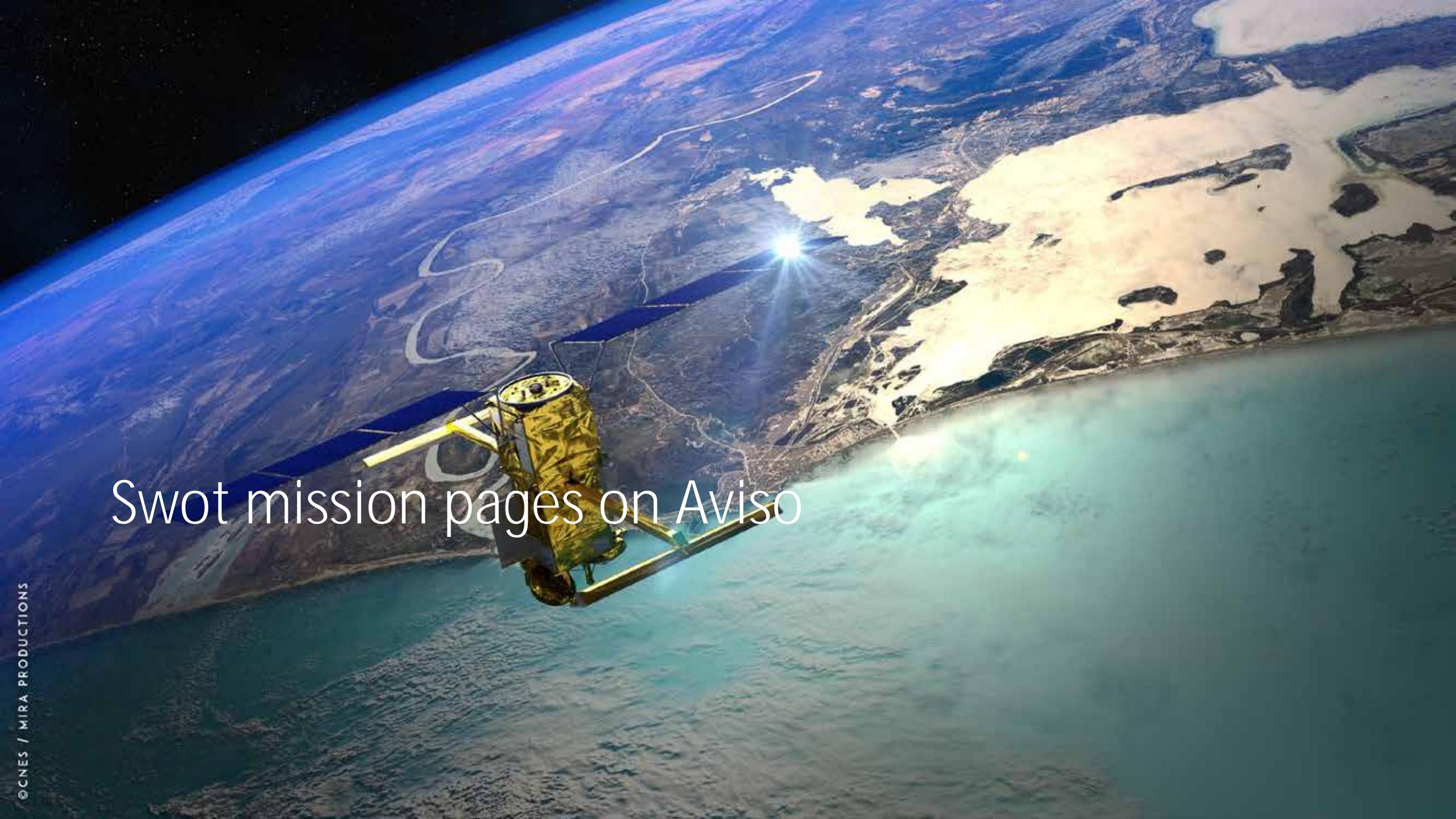


Swot outreach
Promoting & explaining a
new technology

A Cnes-funded effort



Vinca Rosmorduc (CLS), Nicolas Picot (Cnes)
with the help and participation of a lot of people, from Cnes, CLS, JPL, Science Team...



Swot mission pages on Aviso



Swot on Aviso web

- The usual Aviso “mission” section content, adapted to this specific mission, PLUS:
 - links & refs
 - Access to data (ocean only)
 - Portfolio of first results
 - Practical info on Cnes infra
- Data products (links)
- Other pages
 - Techniques
 - Applications
 - Gallery
 - Courses
- News

MISSIONS

Timeline & history
Past missions
Current missions
Cryosat
Sentinel-3
Sentinel-6
COSMO-Sat
KV-38
KV-39
KV-40
Sentinel-6
Sentinel-6
Links and references on board
Objectives & applications
Program
Access to data
Next missions
Paltos: 1980 (with altimeter in Ka-band)
Sentinel-3C
AATRS: Advanced Altimeter
Gauss
GPM
LISA
Data products
Error budget
Mission performances (Nadir)
Orbits
Portfolio of first results
Measurements
Driving CNES HR Interferometer for first project testing
Future missions

INSTRUMENTS

The SWOT satellite carries a wide-swath altimeter-interferometer in Ka-Band (KaLIn), a cluster of multi-looking altimeters, as well as the usual complement of altimetry, satellite precise location systems and radiometers.

The core technology for SWOT is the Ka-band SAR interferometer, originally developed from the efforts of the wide-swath ocean altimeter (WSOA). Altimetry resolutions at high precision and spatial resolution, known to complement with the following suite of instruments: a Jason-type (C- and Ku-band) multi-looking conventional altimeter, a three-frequency microwave radiometer, similar to the advanced microwave radiometer (AMSR) flown in the ocean surface topography mission (OSTM) (Jason-2 B-SAT), as well as global positioning system (GPS) receivers and a DORIS (Doppler Orbitography and Radiopositioning Integrated by Satellite) transponder for precise orbit determination.

TECHNIQUES

ALTIMETRY
Principle
Basic principle
Pulses and waveforms
Frequencies used
Delay-Doppler / SAR altimetry
Interferometers
History
Multi-satellites
Future evolutions
Altimetry close to the coast: technical issues & solutions
DORIS
Radiometry

ALTIMETERS-INTERFEROMETERS

The altimetry interferometric technique relies on the measurement of the relative delay between observations of a same ground given point observed from two slightly different positions (from two antennas separate with a mast in the case of SWOT). This relative delay expresses a slant range difference that can be interpreted as a geo-localised height measurement.

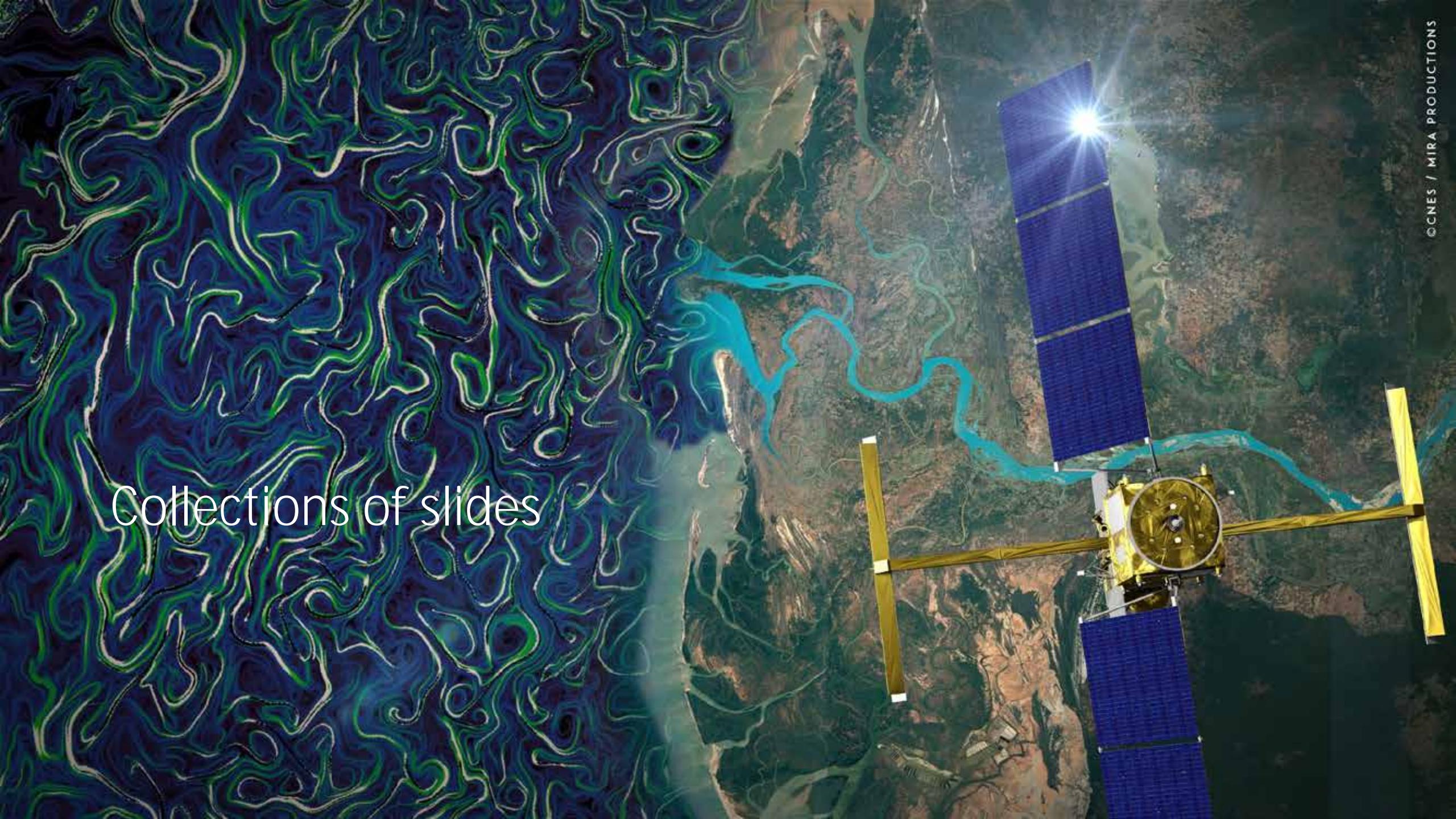
The main limitations of standard nadir-pointing radar altimeters have been understood for a long time. They include the lack of coverage (intertrack distance of typically 150 km for the T/P / Jason tandem) and the spatial resolution (typically 2 km for T/P and Jason), expected to be a limiting factor for the determination of mesoscale phenomena in the deep ocean. In this context, various solutions using off-nadir radar interferometry have been proposed to provide higher resolution objectives. An initial approach was based on the Wide-Swath Ocean Altimeter (WSOA) which was intended to be implemented onboard Jason-2 but has been abandoned. **Swot** will integrate this new interferometric altimetric technique. Planned from 2021, it will be the first satellite to address both ocean and hydrology objectives.

Swot : nadir and off-nadir altimeters

The SWOT satellite includes two kind of altimeters: a dual-frequency (C and Ku-band) conventional altimeter which is only available for the nadir point over a ground footprint of 5-10 km.

The second altimeter is the core instrument: a Ka-band radar interferometer (KaLIn). KaLIn contains two Ka-band SAR antennas at opposite ends of a 10-meter boom (A1 and A2 on the figure) which forms the interferometric baseline (B on the figure). The interferometric is a dual-swath system, alternatively illuminating the left and right swaths on each side of the nadir track. These two swaths measure 50 km wide in a 1°-4° plan.

CNRS **Manage services** 9



Collections of slides



Rationale

è Provide would-be users, teachers & trainers with a basis they can re-use as they need

- In English and in French
- Mostly meant for graduated- / engineering school- level audiences
- Several can be used at secondary school level (some at primary school), with explanations by someone knowledgeable
- Multimedia > Education > Altimetry Courses section

NADIR ALTIMETRY FOR HYDROLOGY



Find a series of pptx files presenting altimetry for hydrology applications. They are provided in English and in French (separate files), and with a lighter version if need be (no illustrative images, no video embedded, images compressed). They are splitted in three series of slides:

- "Water heights (altimetry): how does it work?" is on the technique ([English](#) -- [English light](#) -- [French](#) -- [French light](#))
- "Water Heights (altimetry): the satellites / sensors" is on the different altimetry satellite missions and their instruments used for hydrology applications ([English](#) -- [English light](#) -- [French](#) -- [French light](#))
- "Water heights (altimetry): How are they used?" is showing some examples of past and current use ([English](#) -- [English light](#) -- [French](#) -- [French light](#))

Feel free to use them in your lectures, courses by picking the slides you need. Don't hesitate to send us your feedback.

HYDROLOGY FROM SPACE AND SWOT

Find a series of pptx files presenting hydrology from space and the Swot mission. They are splitted in six series of slides (a seventh is being designed). They are provided in English and in French (separate files), and with a lighter version if need be (no illustrative images, no video embedded, images compressed).



- "Swot in a nutshell": the future Swot mission in 5 slides ([English](#) -- [English light](#) -- [French](#) -- [French light](#))
- "Why study water on Earth?": facts and figures on freshwater on Earth ([English](#) -- [English light](#) -- [French](#) -- [French light](#))
- "Hydrology from space": main reasons to observe freshwater from a satellite ([English](#) -- [English light](#) -- [French](#) -- [French light](#))
- "Hydrology from space - what can be measured": the different observations which can be made from space in the broad field of hydrology ([English](#) -- [English light](#) -- [French](#) -- [French light](#))
- "How Swot is working": the technique of Swot ([English](#) -- [English light](#) -- [French](#) -- [French light](#))
- "Swot mission": the different aspects of the mission (applications, spacecraft, orbit, launch, ground segment) ([English](#) -- [English light](#) -- [French](#) -- [French light](#))

Feel free to use them in your lectures and courses, whole or by picking the slides you need. Don't hesitate to send us your feedback.

HYDROLOGY FROM SPACE TO HELP PRESENT AT SCHOOLS

Find a series of pptx files presenting hydrology from space (upcoming: the Swot mission & altimetry applications), to be used when explaining such topics at schools. Note that the slides' level of understanding varies, so some may be complex to show to general public or primary school, or will need more oral explanations than others.

They are splitted in four series of slides (a fifth is being designed). They are provided in English and in French (separate files).

- "Why study water on Earth?": facts and figures on freshwater on Earth ([English](#) -- [French](#))
- "Water cycle" ([English](#) -- [French](#))
- "Hydrology from space": generalities on satellites, main reasons to observe freshwater from a satellite ([English](#) -- [French](#))
- "Hydrology from space - what can be measured": the different observations which can be made from space in the broad field of hydrology ([English](#) -- [French](#))

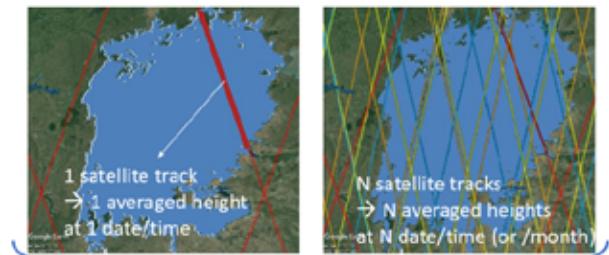
Feel free to use them in your lectures at primary, middle or high schools, whole or by picking the slides you need. Don't hesitate to send us your feedback.



Nadir altimetry for hydrology Collection

- "Water heights (altimetry): how does it work?" is on the technique
- "Water Heights (altimetry): the satellites / sensors" is on the different altimetry satellite missions and their instruments used for hydrology applications
- "Water heights (altimetry): How are they used?" is showing some examples of past and current use

Lakes: integrated surface height

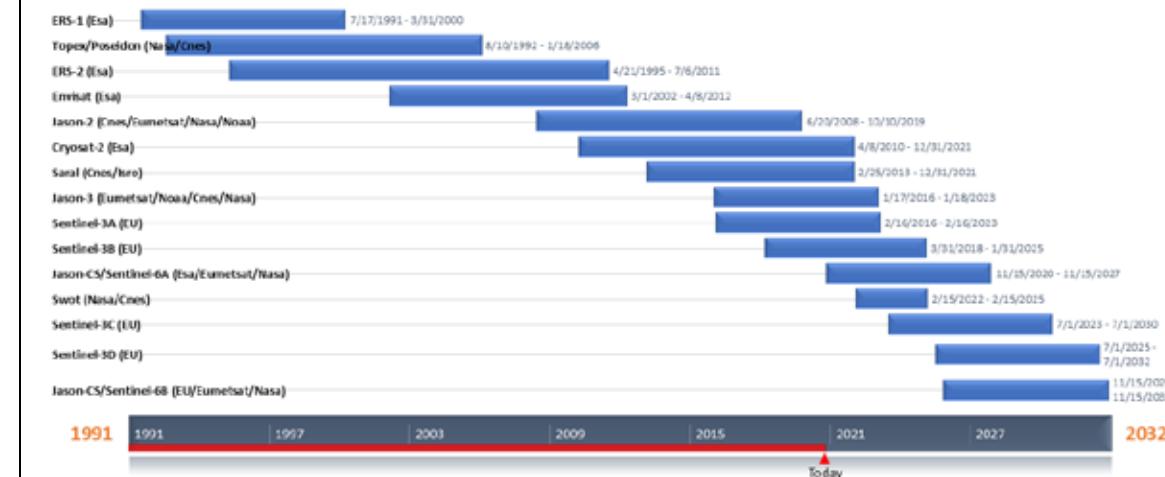


All measurements done over a lake by one given satellite along one of its ground track are averaged dated at a mean hour (before Nov. 2011: per month).

Several tracks and several satellites can be used to build a time series.

The water height is given with respect to a reference (geoid).

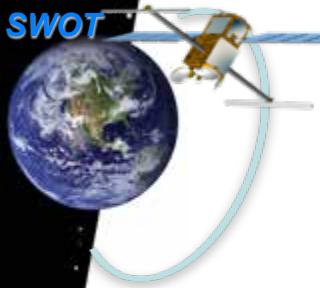
Altimetry missions used in hydrology



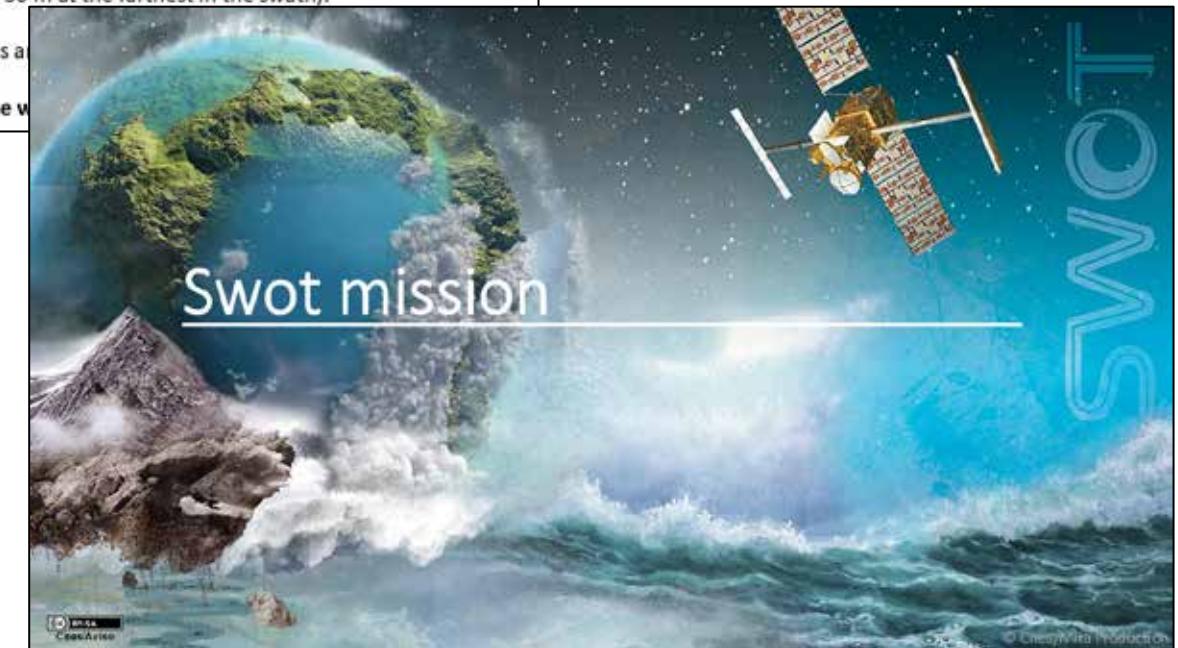
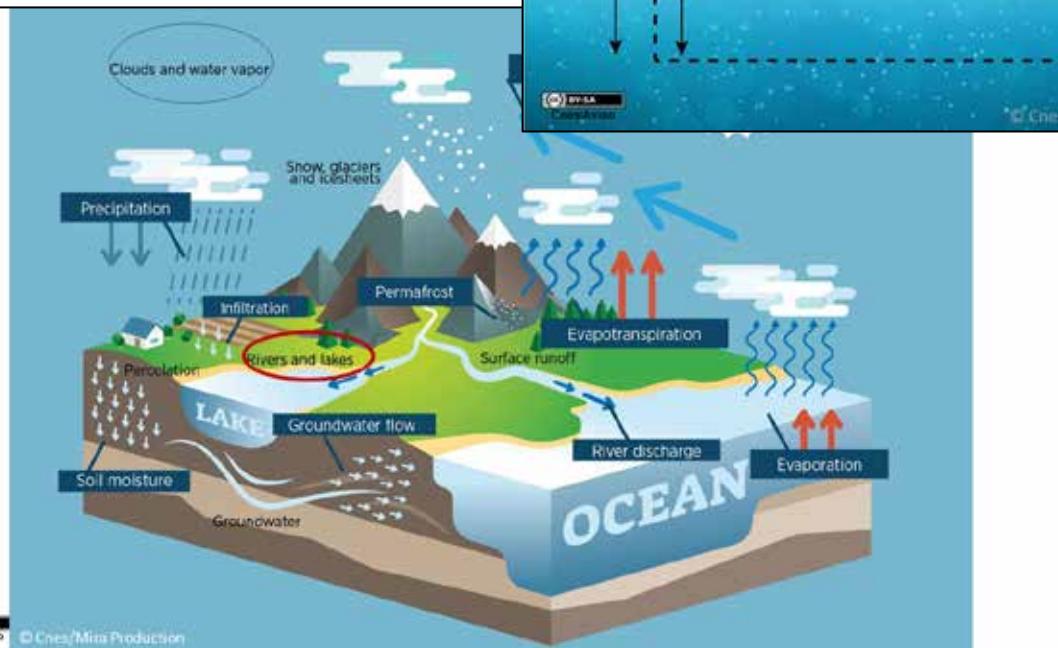
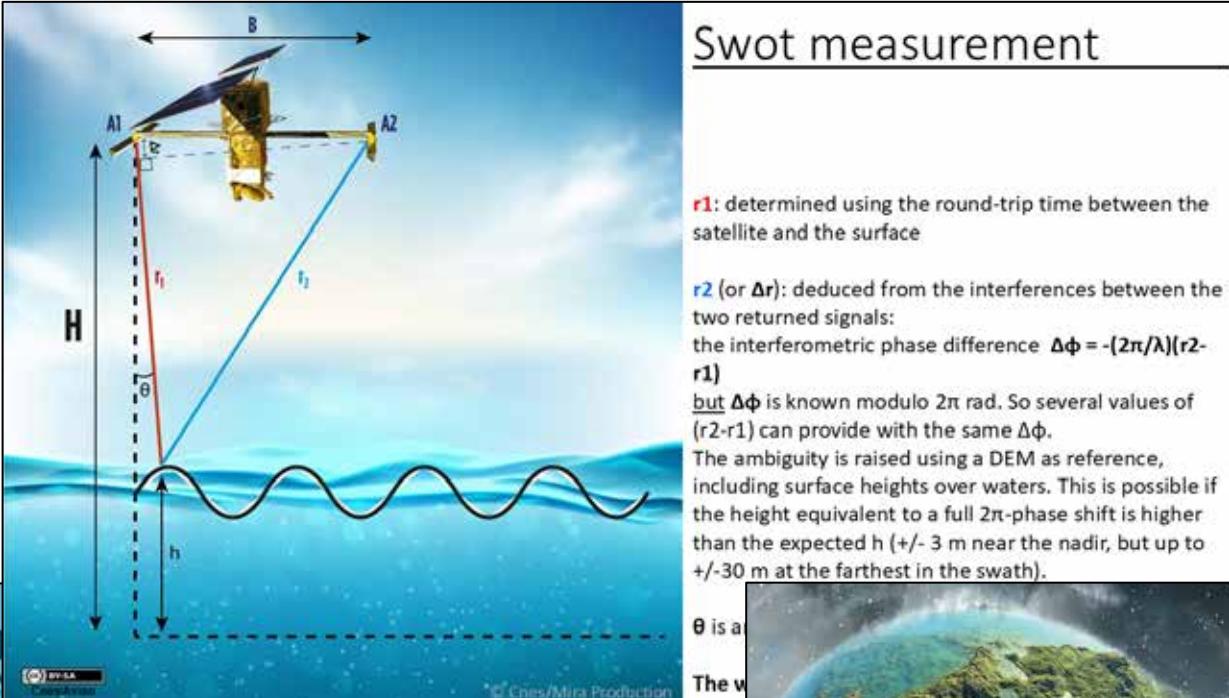


Hydrology from space and Swot Collection

- "Swot in a nutshell": the future Swot mission in 5 slides
- "Why study water on Earth?": facts and figures on freshwater on Earth
- "Hydrology from space": main reasons to observe freshwater from a satellite
- "Hydrology from space - what can be measured": the different observations which can be made from space in the broad field of hydrology
- "How Swot is working": the technique of Swot
- "Swot mission": the different aspects of the mission (applications, spacecraft, orbit, launch, ground segment)



Hydrology from space and Swot Collection





"Hydrology from space to help present at schools" Collection

- "Why study water on Earth?": facts and figures on freshwater on Earth
- "Water cycle"
- "Hydrology from space": generalities on satellites, main reasons to observe freshwater from a satellite
- "Hydrology from space - what can be measured": the different observations which can be made from space in the broad field of hydrology

(part of the latter was adapted for the ArgoHydro Argonautica web tutorial – in French only, & only on the techniques used by this project)



"Hydrology from space to help present at schools" Collection

We need water to



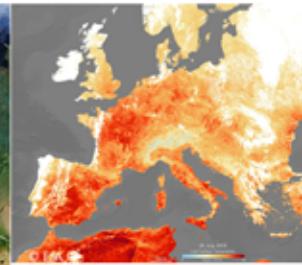
grow plants (including those we are eating, or animals are eating)



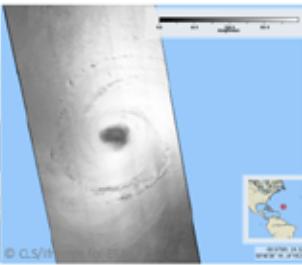
All satellites are not doing the same things



Some are taking images looking like photos « optical imagers »



Others are taking images but that our eyes would not see « infrared or microwave imagers »

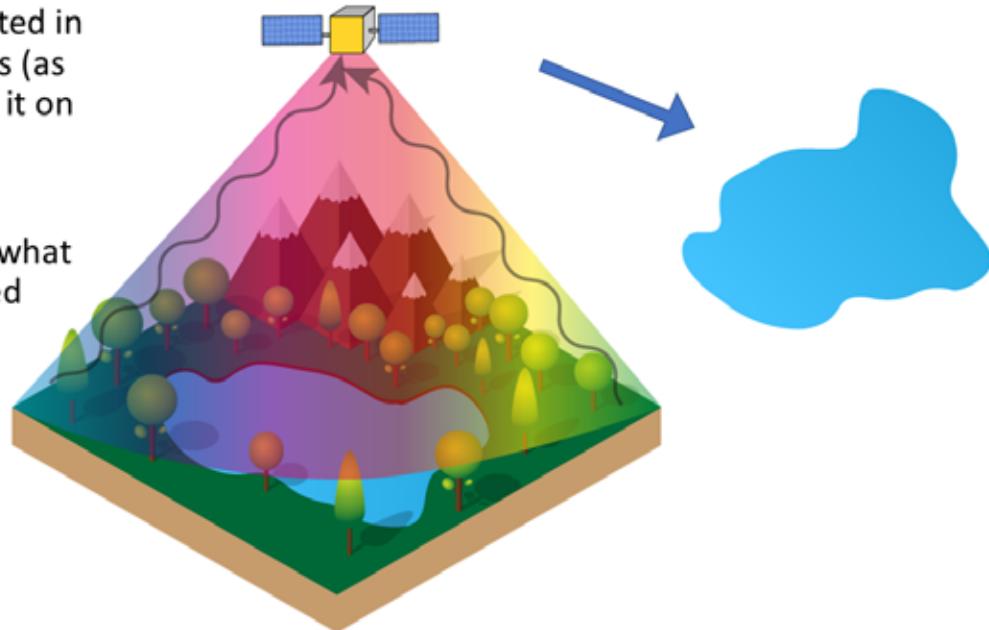


Others again are taking images but after the satellite sent a signal towards the surface « imaging radars »

Passive instruments (collect what is emitted/reflected by the surface)

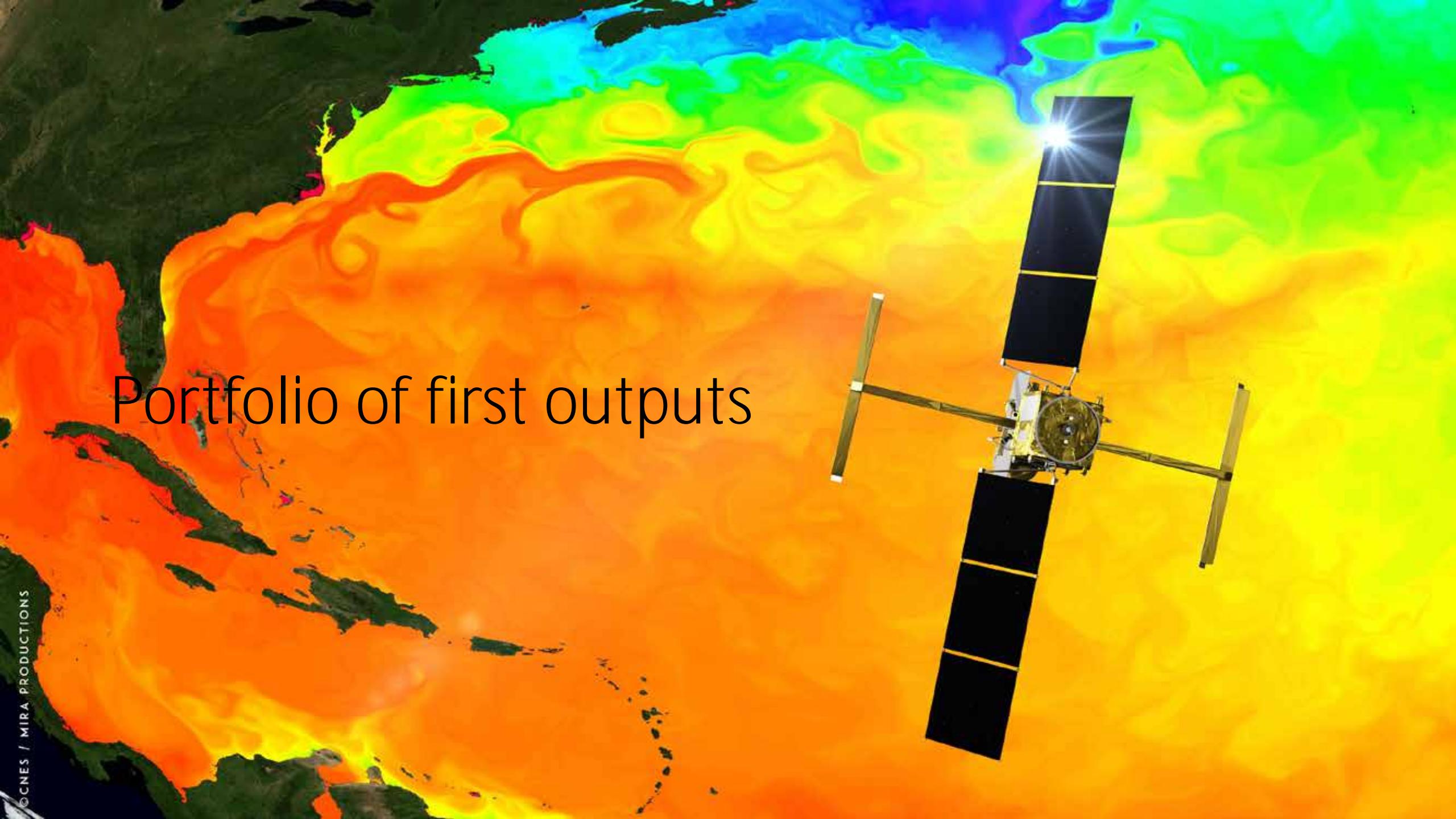
How?

- Water is detected in satellite images (as you would see it on a photograph)
- Variations are what is mostly looked upon



Other are taking measurements just beneath themselves (and not images) « altimeters »

Active instruments (send a signal towards surface and collect what is reflected to them)



Portfolio of first outputs



Swot “portfolio” of first results

- showing promises fulfilled – and also unexpected results
- 8-9 posts on Cnes web site during Summer 2024 (in French only) & also on Aviso for ocean results (both English and French, more technical)

Publié le 26 juillet 2024

SWOT étudie l'étendue des inondations

Système Terre Eau Climat

Grâce à la détection des masses d'eau à la surface des continents, la mission franco-américaine SWOT récolte des données essentielles sur les phénomènes climatiques tels que les inondations.



© SWOT Project, NASA



Image recomposée à partir de deux acquisitions du satellite SWOT à un an d'intervalle au-dessus de la ville de Saint-Omer. © CNES, 2024

L'image ci-dessus est une image recomposée à partir de deux acquisitions du satellite SWOT à un an d'intervalle au-dessus de la ville de Saint-Omer. La partie supérieure délimitée par une ligne blanche montre l'écoulement normal de la rivière, l'Aa, le 3 décembre 2023. Les données du satellite, en violet, nous indiquent alors que sa largeur est de 60 mètres et sa hauteur d'eau d'environ 1,50 mètres.

Publié le 02 août 2024

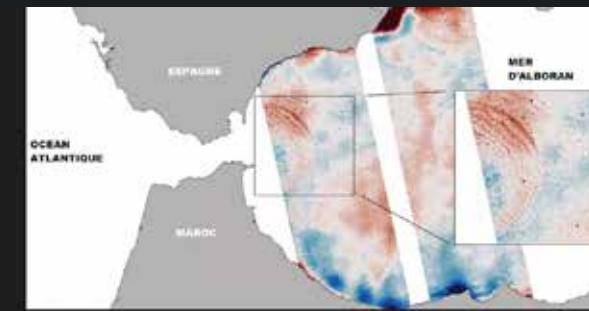
SWOT sur les ondes du détroit de Gibraltar

Système Terre Eau Climat

Grâce à un instrument innovant, la mission SWOT témoigne avec précision des ondes internes générées par les mouvements d'eau dans le détroit de Gibraltar.



Vue du détroit de Gibraltar depuis l'ISS © NASA, 2021



Ondes internes observées au niveau du détroit de Gibraltar par le satellite SWOT © M. Archiv / JPL

Sur l'image ci-dessus, la mission SWOT offre une observation détaillée du phénomène d'ondes internes au niveau du détroit de Gibraltar. La configuration de la côte et le relief sous-marin provoquent des ondes dans le sillage du détroit. Les données acquises par le satellite en nuances de bleu et de rouge représentent les hauteurs de mers par rapport à un niveau moyen "0" en blanc et laissent apparaître les ondes qui se dirigent vers l'intérieur de la Mer Méditerranée.

De telles ondes ont pu être observées par le passé par des satellites radars ou optiques comme Sentinel-1 et Sentinel-2. Elles restent cependant difficiles à détecter dans les mesures des missions altimétriques classiques qui ne mesurent que le long d'une ligne. L'instrument KaLIn à bord de la mission SWOT du CNES et de la NASA, développé avec des contributions des agences spatiales du Canada et du Royaume-Uni, permet non seulement de détecter ces ondes en deux dimensions, mais



Portfolio cont'd on Aviso web site (on ocean)



AVISO+

MISSIONS

CURRENT MISSIONS

SWOT

PORTFOLIO OF SWOT FIRST RESULTS

PORTFOLIO OF SWOT FIRST RESULTS

- A third tsunami observed by Swot, due to Kamchatka earthquake
- Swot observes interactions between waves, winds, and currents
- Swot tracks significant inflow of oxygen-rich waters to the Baltic Sea
- Tsunami waves observed by Swot for the second time
- Waves trapped along the coasts monitored by altimetry, thanks to Swot (and others)
- Little eddy in a big ocean, seen by Swot
- Computing vertical mixing from Swot sea surface heights
- Earthshaking waves from a landslide observed by Swot in a fjord
- Swot & swell
- Changing scale in eddy observation
- Gibraltar's internal wave viewed by Swot
- Global view of seafloor gravity and bathymetry from one year of Swot
- Swot close to the coasts
- Sea ice observed by Swot
- Swot monitors its first El Niño
- Currents in 2 dimensions
- Internal tides by Swot
- Mega-icebergs seen by Swot
- Video with First Swot images
- Rapid-changing ocean circulation seen thanks to the 1-day orbit
- Swot's detailed view of the ocean
- Swot scans the Southern Ocean
- Sea-surface heights in a part of the Gulf Stream off the coasts of America seen by Swot
- Highly detailed views of surface water in the region around Toulouse
- Swot first (nadir) ocean altimetry data
- First waveforms over river from the nadir altimeter on Swot



Videos & images



HYDROLOGY OF THE MARONI BASIN

Space Hydrology

The Maroni is the longest river in French Guiana and France's longest tropical river. With an average discharge of 1,700 m³ per second, it winds...

[WATCH NOW](#)



ANTARCTIC OCEAN – OCEAN CIRCULATION

Space Oceanography, Glaciology

The oceans absorb most of the heat and a big proportion of the carbon dioxide generated by humans. This process is most efficient in the...

[WATCH NOW](#)



ANTARCTIC OCEAN – SEA ICE

Space Oceanography, Glaciology

As for the Arctic, the LEGOS research laboratory has processed 30 years of data from the European ERS-1, ERS-2, Envisat and CryoSat-2 radar satellites to...

[WATCH NOW](#)



ARCTIC OCEAN – SEA ICE

Space Oceanography, Glaciology

Since the late 70s, satellite data have shown how sea ice is receding as a result of global warming. However, sea ice dynamics are driven...

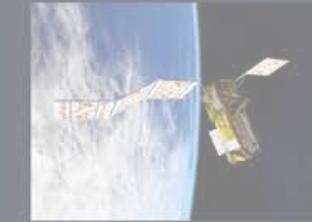
[WATCH NOW](#)



MERCATOR - COPERNICUS

Animations

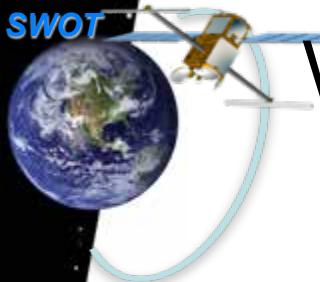
[WATCH NOW](#)



SWOT - 3D

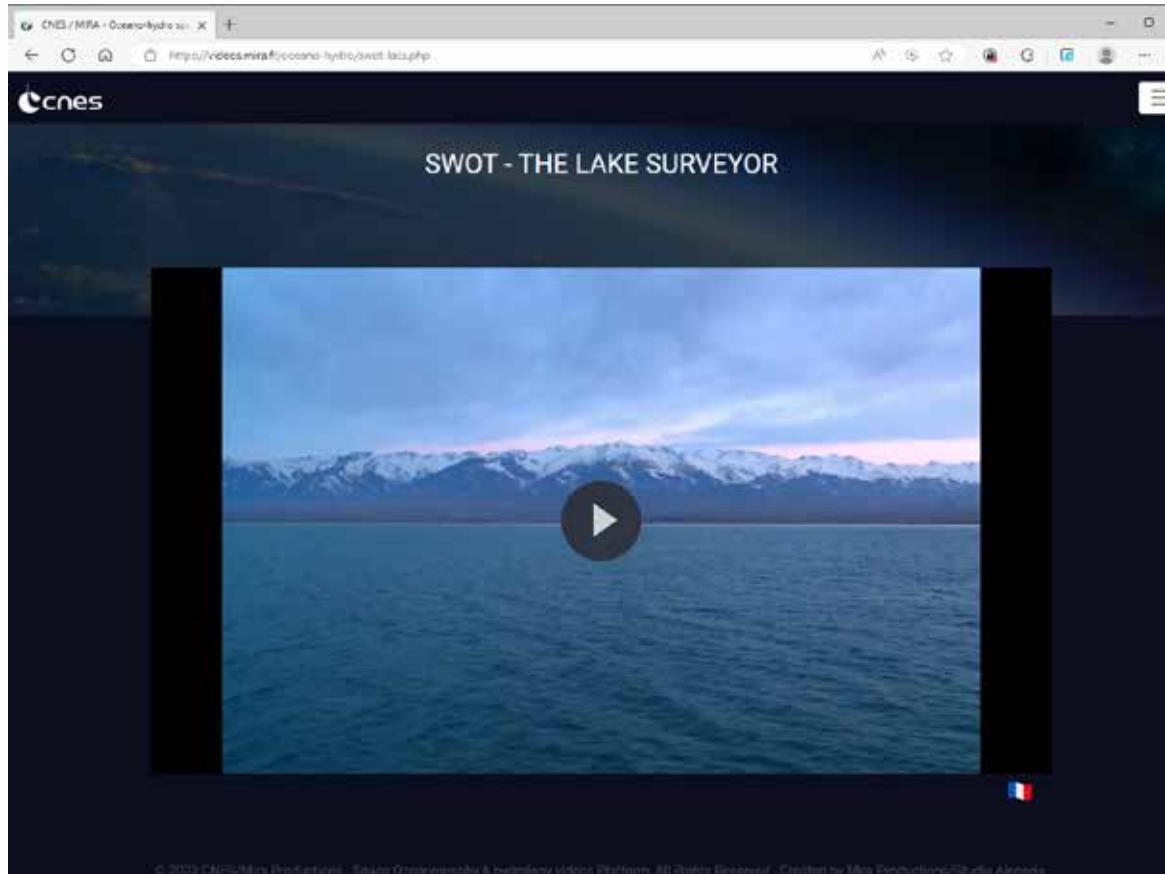
Animations

[WATCH NOW](#)



Video gallery

- <https://oceano-hydro-spatiale.mira.fr/>
- + permalink video by video



62 Movies & Animations

Space Oceanography & Hydrology

Altimetry satellites have been surveying the world's oceans since the early 1970s, using a single measurement technique that was employed for the first time by the first satellites, notably Seasat, launched in 1978. Since then, each new generation of satellites—TOPEX/Poseidon and then Jason—has increased spatial resolution by continuously improving the quality of instruments, data processing and geophysical corrections needed to observe the signature of the ocean circulation.

Explore Credits

OCEANO-HYDRO

Categories

- Space Oceanography
- Space Hydrology
- Coast
- Cryology
- Cloud
- Cloud Water
- Animations
- Mission movies

20 Results

FIRST SWOT IMAGES

Animations

WATCH NOW

HYDROLOGY OF THE AMAZON

Space Hydrology, Coast

A river of prodigious proportions with a catchment basin equivalent to a small continent: 10 million km², 10 times the size of France, the...

WATCH NOW

WATER RESOURCES IN MADAGASCAR

Space Hydrology

Madagascar: the Great Island, a land of contrasts... while river runoff is stable despite the changing climate, the...

WATCH NOW

WATER RESOURCES IN THE UNITED STATES

Space Hydrology

As complex as it is immense, the United States' network of rivers is studied by its many Space Hydrology teams with its hydrology mission...

WATCH NOW

THE MAIN RIVERS OF FRANCE

Space Hydrology

France's main rivers are, in some instances, comparable to the Amazon, the Congo, the Nile, the Mississippi, the Amazon, and the Yangtze. The...

WATCH NOW

WATER RESOURCES IN THE PYRENEES

Space Hydrology

Like most of France's rivers, the Garonne suffered during the summer of 2010 some high temperatures and low levels of water that caused the river to...

WATCH NOW

THWAITES GLACIER

Space Oceanography, Cryology

The last major unexplored Antarctic glacier is melting at an ever faster rate, and this is not to be taken lightly. Thwaites Glacier is of the...

WATCH NOW

DETERMINING COASTAL BATHYMETRY

Space Oceanography, Coast

Optical Earth observation satellites like Proba-2 track bathymetric data (ERS and Sentinel-1) measures wave height, velocity, and wavelength. These parameters can help us determine bathymetry, that...

WATCH NOW

CALVING AND MONITORING OF ICEBERGS

Space Oceanography, Cryology

Icebergs, sometimes thousands of kilometers in diameter, are tracked by satellite. But the 2008 series made detection of small bergs (100 m wide, or 200 meters long)...

WATCH NOW

© 2023 CNES/Mira Productions. Space Oceanography & Hydrology video Platform. All Rights Reserved. Created by Mira Productions/Studio Alceste.



Swot along one cycle animation

- Ocean



- Hydrology





MULTIMEDIA GALLERY SEARCH

Search results

Search for : swot

A 5x8 grid of 40 images showing various SWOT mission-related content, including artist's views, data visualizations, and mission documents. The images are arranged in five rows and eight columns. The first row contains images of the SWOT satellite in orbit, filaments in the Antarctic, and a presentation leaflet. The second row contains a 'kakemono' (scroll) showing ground tracks, a poster for space hydrology, and a poster for space hydrology. The third row contains images of 'Filaments altimetry on a thread' poster, simulated data over land, coastal erosion in Camargue, a zoom on Indian Ocean triple, 25 years of space oceanography video, SWOT and the Camargue video, SWOT - The lake surveyor video, and Swot River Products video. The fourth row contains leaflets for the SWOT mission, the ocean surveyor, the lake surveyor, the river surveyor, the SWOT programme, the SWOT Garonne estuary kakemono, Mont St Michel SWOT kakemono, and Niger SWOT kakemono. The fifth row contains images of the SWOT satellite in orbit, an artist's view of the SWOT poster, and various scenes of the satellite observing coastlines, lakes, and rivers.



ArgoHydro: Cnes educational project

STATION : RIVIÈRE GARONNE, 500 KM

- Hydro data available on Argonautica ArgoHydro platform
=> <https://argonautica.jason.oceanobs.com/> (Fr/En)
=> rainfall, soil moisture, land cover, water presence, snow cover
- Swot rivers & lakes added these days (work in progress)
- Your ideas are most welcomed to improve this for teachers to adopt this new part of the project

Select a date 01/09/2025



Rain



Surface sol moisture



Land cover



Water bodies



Lake water level

Select a date 01/09/2025



Rain



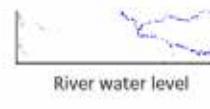
Surface sol moisture



Land cover



Water bodies



River water level

Référence : R_GARONNE_GARONNE_KM0500

Bassin : Garonne

Position (longitude,latitude) : 0.6734°, 43.1062°

Début des mesures : 18/03/2019

Dernière mise à jour : 09/08/2024

Source : Hydroweb / satellite altimétrique

Satellite: Sentinel-3A

Station active, 68 mesures

Mesures

Figures

Cartes

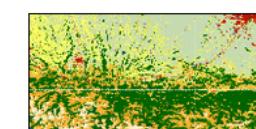
Cartes



Préférences



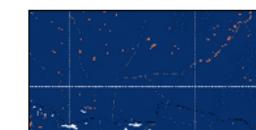
Humidité des sols



Occupation des sols



Présence d'eau



Couverture neigeuse



Summary

- Web pages <https://www.aviso.altimetry.fr/swot/>
- Portfolio (Missions > Swot > Portfolio)
<https://www.aviso.altimetry.fr/?id=5492>
- Collections of slides (Multimedia > Education > Altimetry Courses)
<https://www.aviso.altimetry.fr/?id=292>

What have you used (if any)?

What is missing?

What would you prefer another way?