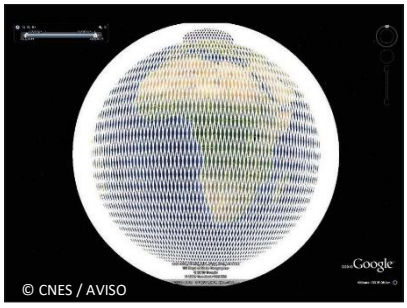
France

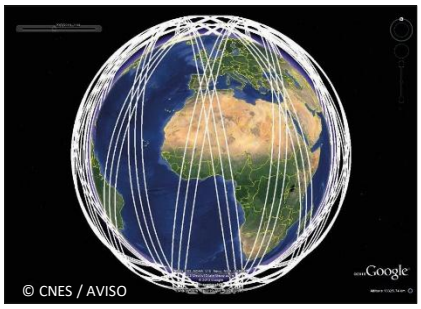
The SWOT satellite

A joint venture between NASA (USA)/CNES (France)/CSA (Canada)/UKSA (UK), the SWOT (Surface Water and Ocean Topography) satellite pursues a twofold mission. Implementing a breakthrough instrument, the KaRIn wide-swath radar interferometer, SWOT opens up a new field of study – spatial hydrology – and a new area of oceanography: high-resolution broadband altimetry.
February 2022: SWOT is launched from the Vandenberg base in California, USA.

The purpose of the SWOT mission is to inventory and monitor continental water resources and to address the problem of freshwater management at global level. Marking a scientific first with the use of small-scale operational oceanography, the mission will study the submesoscale circulation of the oceans in order to fine-tune ocean forecasting models.

ORBITAL CHARACTERISTICS



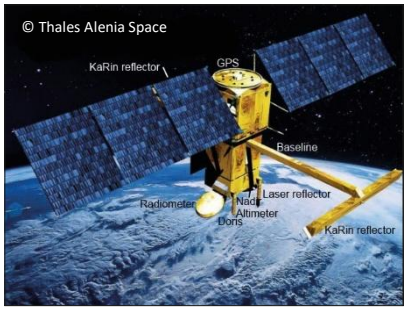


Ground tracks of the SWOT satellite orbit (left for the 21 full days, right in 3 days)

The SWOT satellite flies at an **altitude of 890.6 km** in a 21-day repeating orbit (21-day period) allowing for coverage of the entire globe and more frequent sampling.
Inclined at 77.6°, the satellite can fly in a non-heliosynchronous orbit, in order to minimise interference with the tides and cover the main bodies of water on each continent.

THE SATELLITE

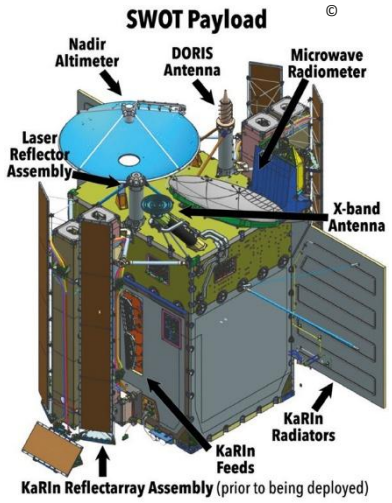
The SWOT satellite has a total width of 15m and weighs 2,000 kg, with power consumption of 1,500W. It has a new-generation platform designed for controlled re-entry.



The SWOT satellite and its instruments

The SWOT payload comprises:

- **a radar altimeter and interferometer – KaRIn –** measuring highly reflective water surfaces.
- a conventional nadir-looking radar altimeter of the type used onboard the Jason missions (C and Ku bands),
- a microwave radiometer,
- a laser retroreflector
- A GPS receiver for precise orbit determination (alongside DORIS)
- A DORIS *(Doppler Orbitography and Radiopositioning Integrated by Satellite)* orbitography system for precise orbit determination.



Payload of the SWOT satellite

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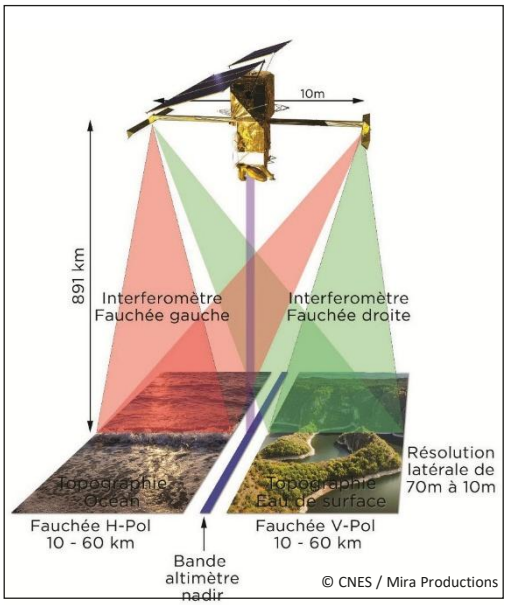
LARGE-SWATH RADAR INTERFEROMETER (KARIN)

The main instrument on SWOT is KaRIn, a wide-swath radar interferometer. This major innovation combines altimetry and interferometry. A Franco-American cooperation, KaRIn illuminates two swaths on either side of the track. This improves observation efficiency for studies, while also enabling the monitoring of continental waters and oceans, with high-resolution measurements on small spatial scales over a large area.



Wide-swath altimeter and interferometer (KaRIn)

- *Two swaths 50 km wide with nadir data at the centre, pole to pole*
- *Radar processing (all weather + day/night) with aperture synthesis*
- *A Ka-band source (35.75 GHz)*
- *Two SAR antennas at opposite ends of a 10m mast*

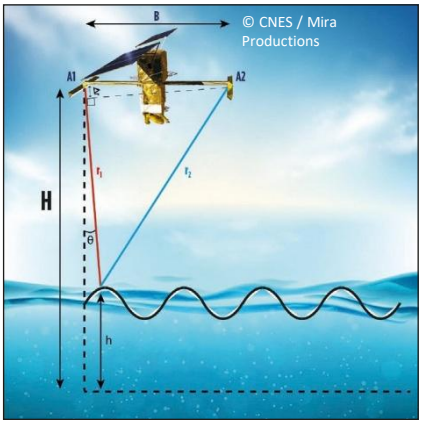
In oceanology, SWOT will make it possible to observe ocean circulation with two-dimensional views, and resolution improved by a factor of 10. KaRIn will observe sub-mesoscale and mesoscale circulation (from a few hundred to a few dozen km) such as eddies and filaments. It will characterise highly dynamic vertical transport, study coastal circulation and fine-tune existing oceanographic and climate forecasting models with centimetre-level accuracy.

Operating on the same principle as a SAR (synthetic aperture radar), KaRIn is able to take measurements over a dual swath of 120 km, whereas other radar altimeters are limited to a band of a few km vertical to the satellite.

The KaRIn interferometer provides:

- a high level of precision for minor variations in height
- two-dimensional topography images owing to the presence of two antennas on the same satellite
- "direct" measurements: Water height, Gradient, Width
- indirect measurements: Water flow, tidal speed and amplitude, wave amplitude, current speed, etc.

In terms of spatial hydrology, SWOT will be able to monitor rivers more than 100m wide through a system of predefined sections (around 200,000 sections across all continents) with points for river height and width (one point every 200m along the central line of the river). SWOT will also monitor lakes and flood zones with an area of over 250m x 250m (6 ha). It should be possible to observe more than 20 million lakes.
Based on the 21-day revisit time, the lakes and rivers will be observed between one (on the equator) and 12 times (at high latitudes) every three weeks.



Geometry of SWOT measurements

The two antennas receive the same signal reflected from the surface, but not from the same distance. This makes it possible to calculate surface height.

r1 *is measured using the round-trip time between the satellite and the surface.*

*(***r1-r2***) is estimated*

θ *is deduced from r1-r2*

B is the distance between the two antennas

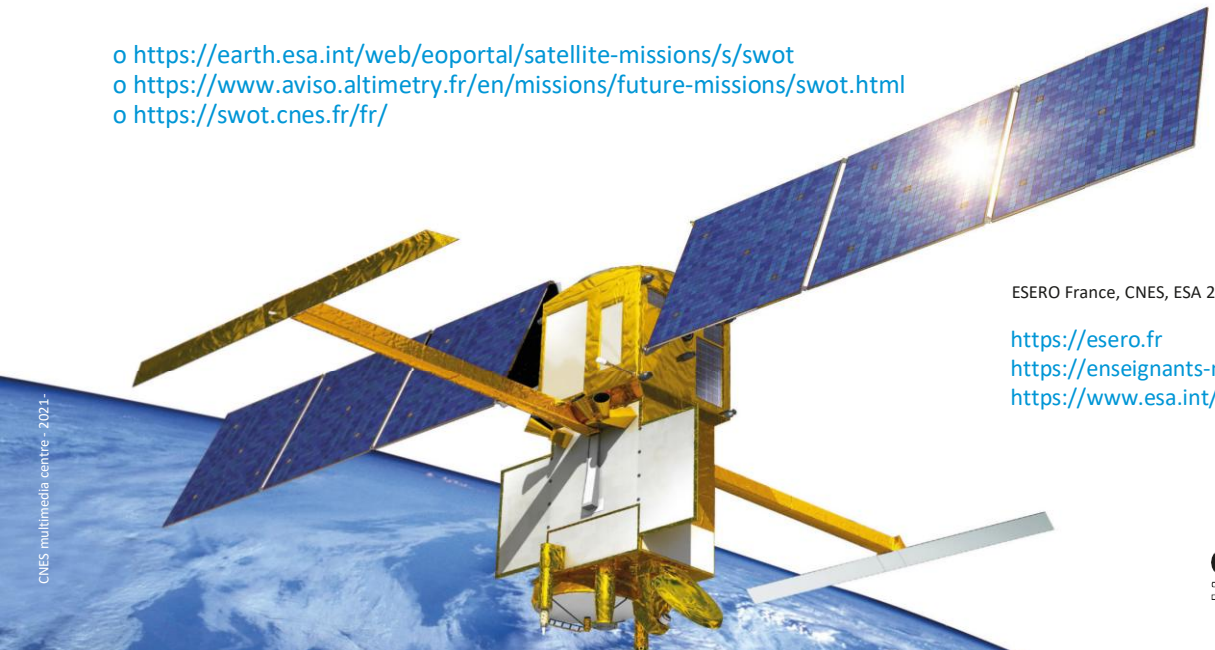
H *(satellite altitude) is measured by the onboard location systems (Doris, GPS/GNSS).*

Water height is **h = H – r1 cos (θ)**

Data from the SWOT mission will contribute to a wide range of oceanological applications: optimising shipping routes, managing fishing zones and providing support for oil platforms by forecasting currents and eddies. The mission also has hydrological applications: water management, improved flood modelling, hydroelectricity, etc.

FIND OUT MORE:

- https://earth.esa.int/web/eoportal/satellite-missions/s/swot
- https://www.aviso.altimetry.fr/en/missions/future-missions/swot.html
- https://swot.cnes.fr/fr/



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