Updates on the Committee on Earth Observation Satellites Altimetry White Paper:

"A Coordinated International Satellite Altimetry Virtual Constellation: Towards 2050"

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Buellton, California

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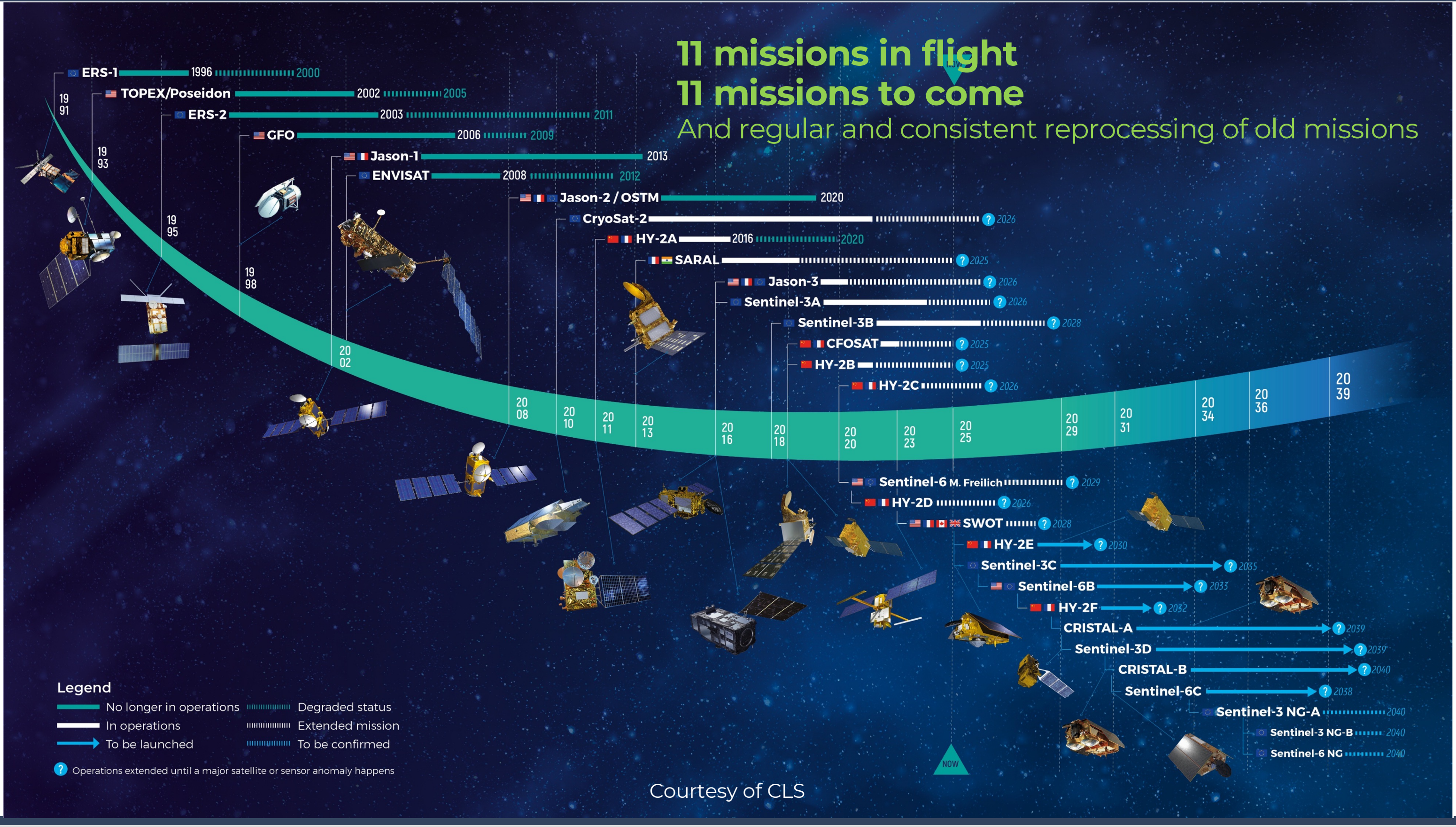
CEOS
Committee on Earth Observation Satellites

Current constellation

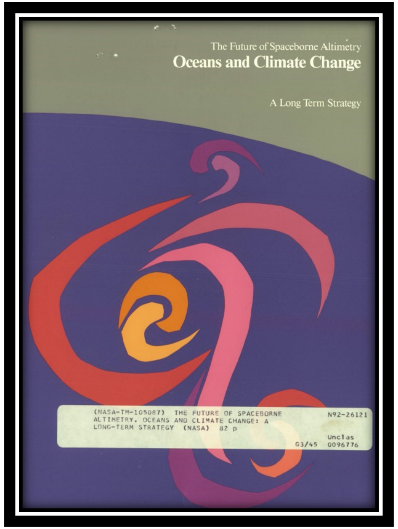


Scope

- The future of Spaceborne Altimetry, also called the Purple Book, was published in 1992.
- Then, in 2006, CEOS initiated the gathering of user requirements for a satellite constellation in support of ocean surface topography monitoring for the years 2010 to 2025.
- In 2009 the Assmannshausen report (*Escudier and Fellous*, 2009) was published under EUMETSAT and NOAA leadership.

All the high-level requirements from that document have since been implemented.

1992



2009

Purpose

Update needed to consider:

- New emerging applications from historically "ocean missions":
  - Coastal applications, marine meteorology, waves and currents;
  - Polar monitoring of sea level, ice thickness and glaciers;
  - Hydrological applications such as lake, river and wetland levels, slopes, volumes and discharges;
  - Climate monitoring, through the assessment of global and regional sea level change, its trend and acceleration.
- New innovative technologies implemented on-board recent altimetry missions:
  - The use of Ka-band as implemented in SARAL/AltiKa, SWOT/KaRIn and planned for the CRISTAL mission;
  - Synthetic Aperture Radar (SAR, also known as delay-Doppler) altimetry as implemented on CryoSat-2, Sentinel-3, and Sentinel-6;
  - Wide-swath altimetry as demonstrated with SWOT and planned for Sentinel-3 Next Generation Topography mission.

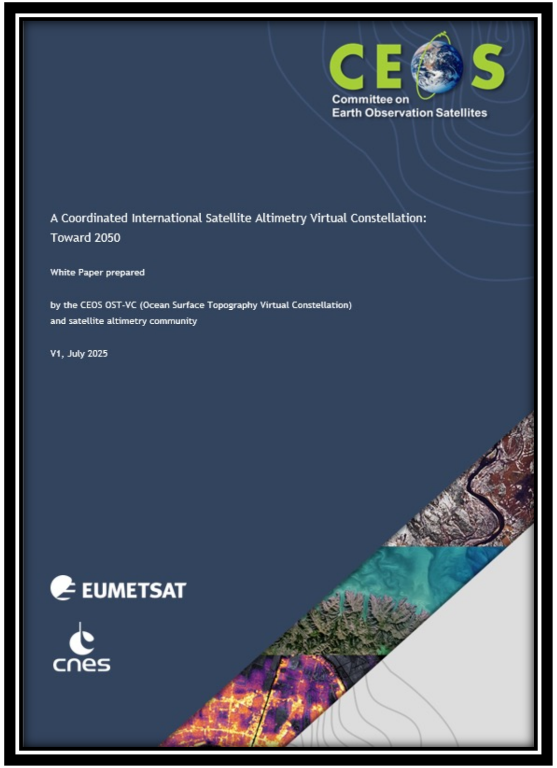
Purpose

“A Coordinated International Satellite Altimetry Virtual Constellation: Towards 2050”

- Inventory of current user needs* including emerging ones;
- Identification of gaps in the current international space constellation.

(*) It is up to agencies, once the coordinated space programmes are decided, to set up mission requirements documents.

2025



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** OSTST : Ocean Surface Topography Science Team*

Summary of the user needs and gap analysis

For all applications:

- Ocean Dynamics
- Operational oceanography
- Biology
- Sea state and surface currents
- Inland waters
- Coastal and continental shelf waters
- Ice
- Geodesy
- Extreme events
- Weather monitoring and forecast
- Climate Monitoring and Research

And transversal activities:

- Calibration and Validation
- Data and user service components

Application	Horizontal Resolution	Temporal Resolution	Delivery Timeliness	Accuracy	Stability
Open ocean mesoscale topography	1-10 km	1-5 days	few hours (for operational purposes)	1 cm	
Open ocean wind speed	<10 km	<1 day	< 3 hour	< 1 m/s (wind speed)	
Open ocean SWH	<10 km	<1 day	< 3 hour	<10%	
Open ocean currents	<10 km	1 day	< 3 hour	5 cm/s (currents	
Open ocean directional wave spectra	60-1000m < 20km	1 day	< 3 hour	< 15%	
Coastal waters (topography)	<100 m	< 1 hour	<1 hour	1 cm	
Inland Waters topography	<50m	1 day	few hours (for operational purposes)	10cm	
Land ice topography	< 1 km	< 1 month	< 1 month	< 50 cm	1 cm/yr
Sea ice thickness	< 1 km	< 1 day	< 1 day	< 10 cm	
Geodesy	< 1 km	< 1 month	< 12 months	< 1 microrad	
Extreme events	meters to kilometers	minutes to days	minutes (for events), months for baseline	phenomenon dependent	
Global Mean Sea Level	< 100km	< 30 days	< 12 months	< 4 mm	<0.1 mm/yr (90% CL) over 10-year and longer periods, and an accuracy of the GMSL acceleration of 0.5 mm/yr/decade (90% CL) over 20-year and longer periods
Regional Mean Sea Level	< 100km	< 7 days	< 12 months	< 1 cm	0.3 mm/yr (90% CL) over 20-year and longer periods.

Key outcomes (1/3)

- For most of the applications related to water level, both over sea and inland, relatively poor spatio-temporal sampling today (either lack in coverage or revisit time, or both). For example, ocean model resolution will soon reach a few kilometers at the global scale and 1 km or less at regional and coastal scales
  - Need to fly swath altimeters : will be implemented with the *Sentinel-3 Next Generation* operational swath altimeters in the *Copernicus programme*
- For the monitoring and understanding of climate change and its contributors
  - Need to ensure the continuation of the now three decades long time series of reference altimeter missions, preferably maintaining the same ground track to ensure uninterrupted continuity (*Sentinel-6 and Sentinel-6NG*)
- For sea state and surface currents considered a still underdeveloped domain of satellite altimetry
  - Need to investigate *SAR* and *swath altimetry* to aid the disentangling between wind driven waves from swell as well as surface and geostrophic currents
  - Need surface current observations for science (understanding of ocean-atmosphere interaction, the energy transport, …) and many applications

Key outcomes (2/3)

- Relatively poor coverage of polar areas which is key to climate change monitoring
  - Need to continue the observation of the poles with altimetry (potential gap between Cryosat-2 and CRISTAL missions if any should be minimized)
- In-situ / FRM data for calibration and validation
  - Need to maintain and further develop transponders, corner reflectors, tide gauges, drifting/profiling floats...
- Gap and opportunity in developing higher level products in synergy with other satellite-borne sensors
  - Need combination with SAR, scatterometers, radiometers, visible or infrared imagers, etc.) and/or other geophysical parameters (ocean color, sea surface temperature, ocean salinity, etc.)
- Service to users could be improved to serve more applications and to reach a broader user community
  - Need to follow the data distribution technologies for a larger user uptake, maintain open and free data policies, provide adequate and accessible documentation, develop further cloud/hosted processing

Key outcomes (3/3)

The international collaboration across continents has been key to the success story that is satellite altimetry (e.g. *OSTST*):

- Most of the altimeter missions have been multi-national and multi-institutional;
- Incredible user community that has historically been very open and collaborative, spanning an immense array of disciplines: oceanography, geodesy, weather monitoring and forecast, hydrology, space technology, and many more.

Strong expectation is that such transnational and transformative collaboration continues for the coming decades.

Way forward

- Final draft version of the White Paper delivered to CEOS in October 2025;
- Presented to SIT WG on 11 September for information and discussion;
- Presented to CEOS Plenary on 6 November for recommendation;
- Presented today to the community during the OSTST to share contents;
- Coordination with the CEOS Secretariat on the formatting and contextualization prior to publication.

Thank you