Overview and Status of the Copernicus Polar Ice and Snow Topography Altimeter (CRISTAL)

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Copernicus: Global European Leadership in EO

> 226.000
registered users
= tip of the iceberg

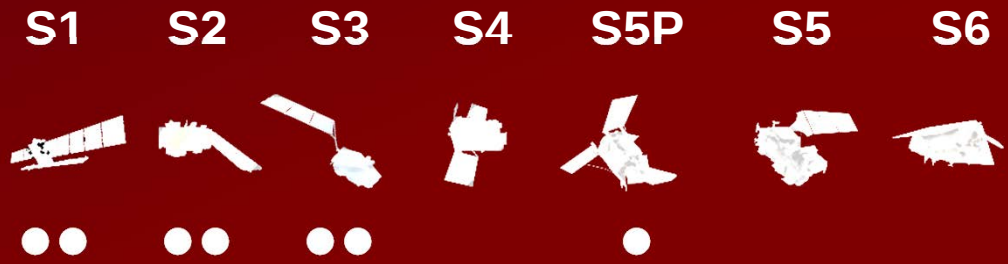
6 operational services

Land | Atmosphere | Ocean | Climate | Disaster | Security

150 TB satellite data distributed per day

full, free & open data policy

7 satellites flying



preparing Copernicus 2.0

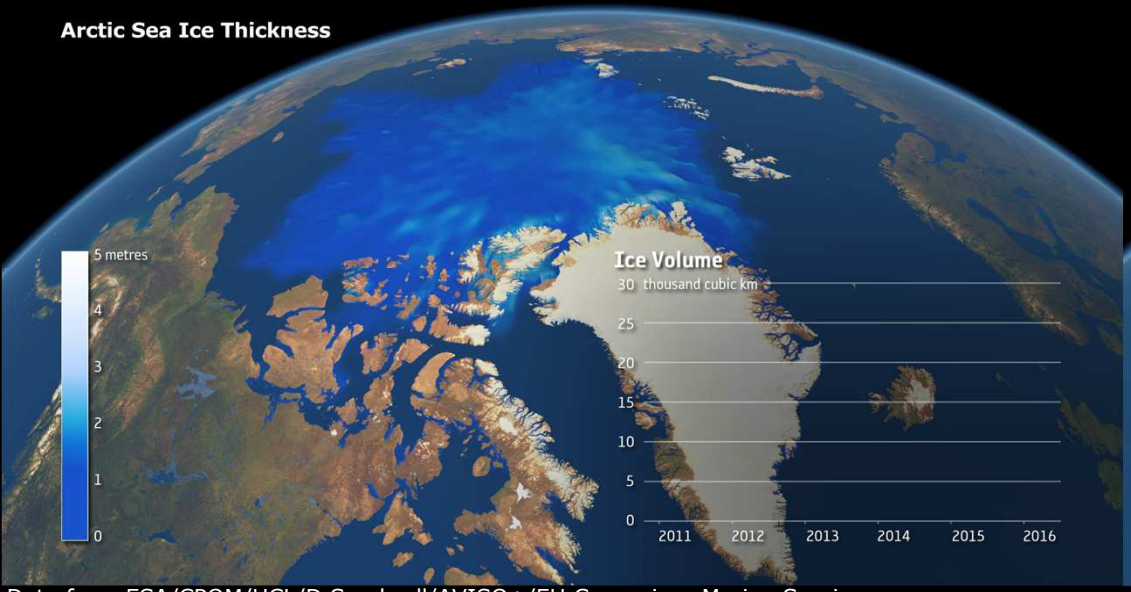
Copernicus 2.0 – New Monitoring Missions

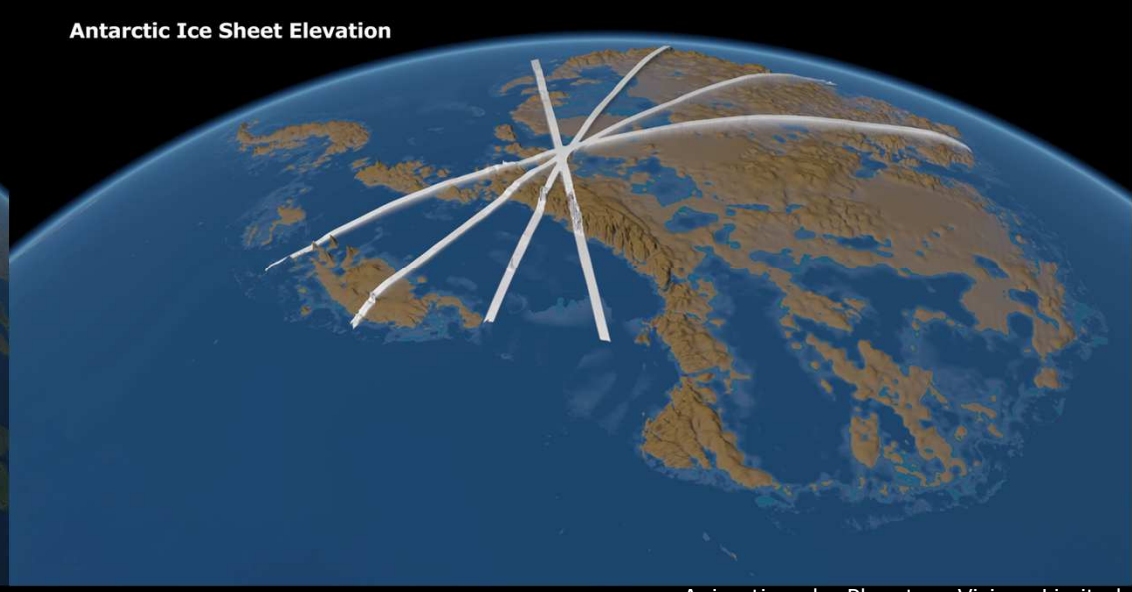
Six High Priority Candidate Missions

Progress Status

- Preliminary Requirements Review concluded successfully for all 12 Phase A/B1 studies
- Consolidation of inputs for preparation of ESA ITTs for Phase B2/C/D/E1 contracts

CRISTAL will provide sea ice thickness and land ice elevation measurements





Data from ESA/CPOM/UCL/D Sandwell/AVISO+/EU Copernicus Marine Service

Animations by Planetary Visions Limited

The **Arctic's fragile environment** is a direct and key **indicator of the climate change**, requiring specific mitigation and adaption actions.

Mass loss from **Antarctic and Greenland ice sheets** is responsible for about half of the current sea level change.

CRISTAL addresses key user requirements

CRISTAL

PEG reports

1. Floating ice parameters	Floating ice parameters (Sea Ice Thickness and Change, Iceberg Detection and Change, Ice Shelf Volume and Change)
2. Glaciers, caps ar…arameters	Glaciers, caps and ice sh…eters (Land Ice Elevation and Change, …ion, Ice Sheet Mass / Volume
3. Sea level/sea …meters	Sea level/ Sea Level …obal Ocean, Polar Ocean …and
4. All weather …rature (SST)	
5. Surface Al…	
6. Surface Fres…	
7. Snow	Snow (Snow Depth on Se…ce)
8. Permafrost	Permafrost (Land Elevation Change in Regions underlain by Permafrost, Snow in Regions underlain by Permafrost)

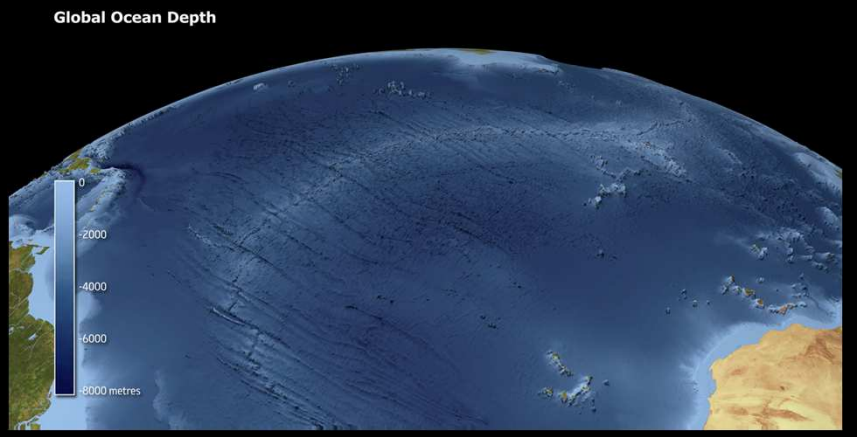
CRISTAL Mission Objectives

Primary Objectives

- To measure and monitor variability of Arctic and Southern Ocean **sea-ice thickness** and its **snow depth**.
- To measure and monitor the **surface elevation and changes** therein of **glaciers, ice caps and the Antarctic and Greenland ice sheets**.

Secondary Objectives

- To contribute to the observation of **global ocean** topography **as a continuum up to the polar seas.**
- To support applications related to **coastal and inland waters**.
- To support applications related to **snow cover and permafrost**.



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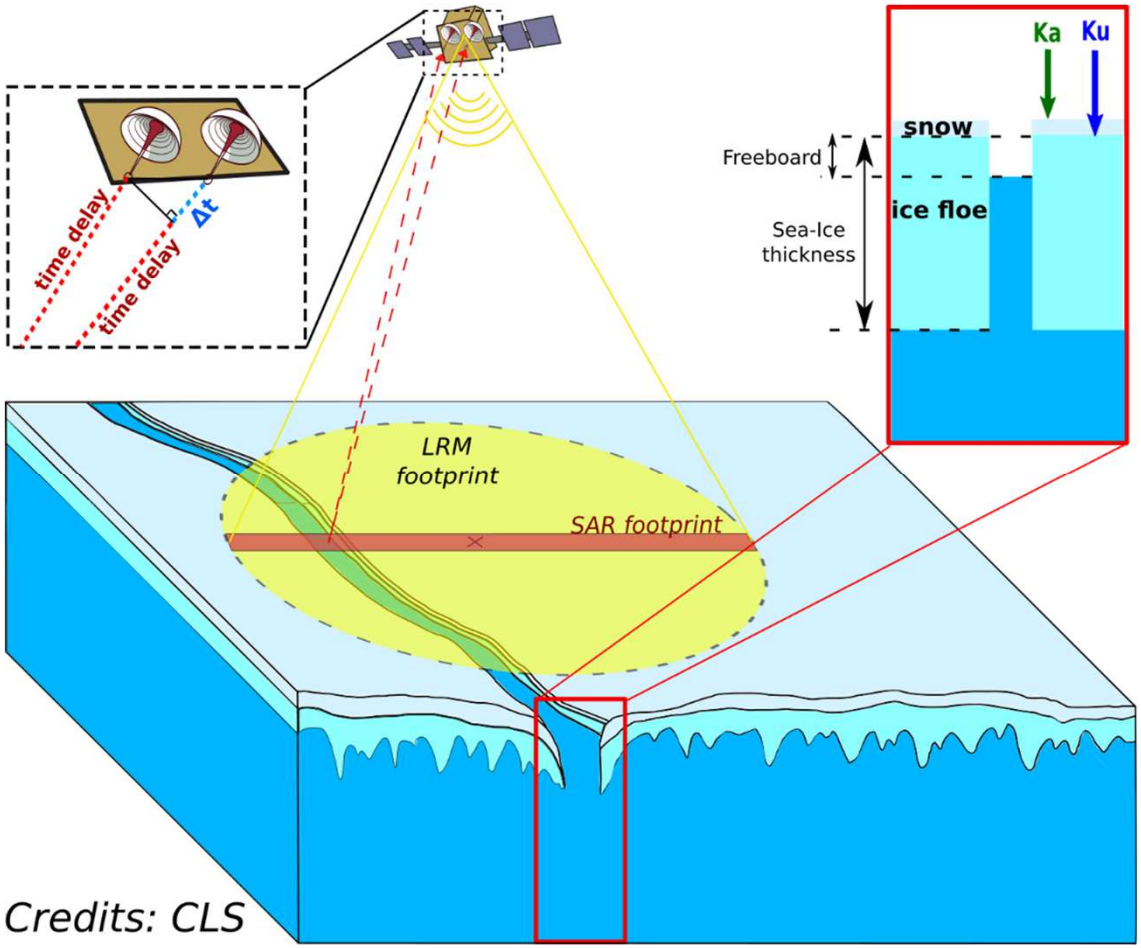
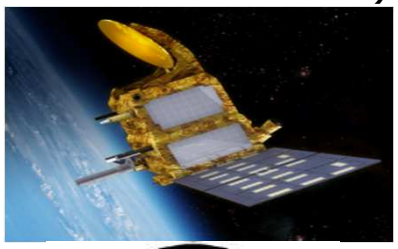
CRISTAL's main observation concept is a SAR Radar Altimeter with capability of interferometry

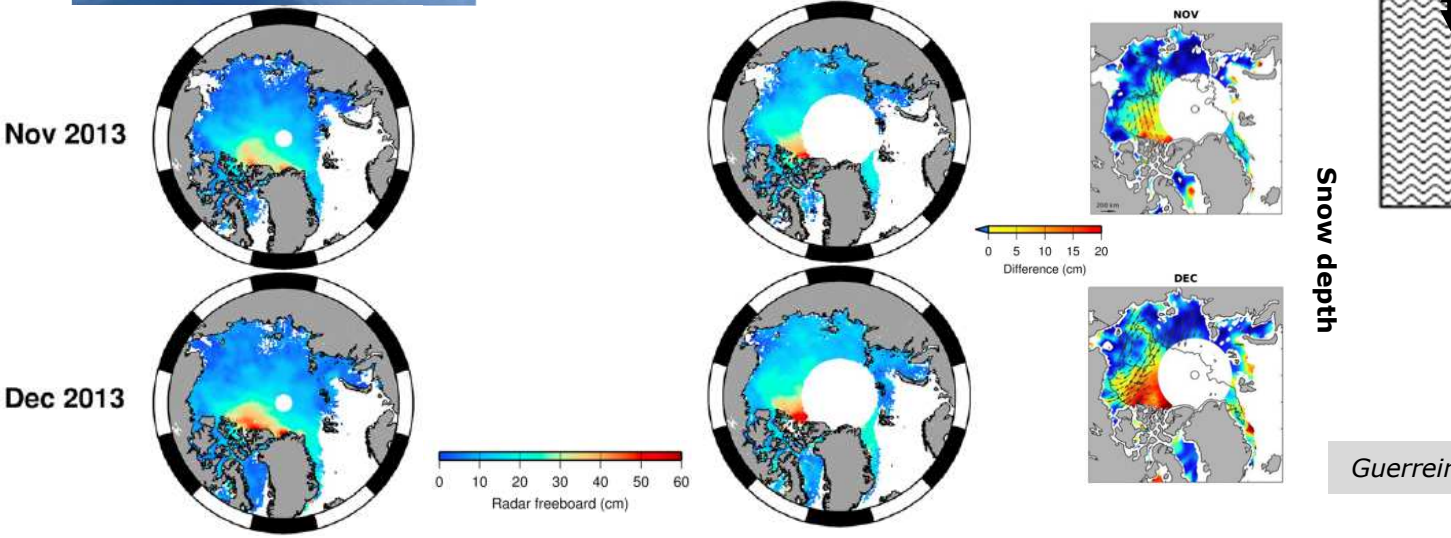


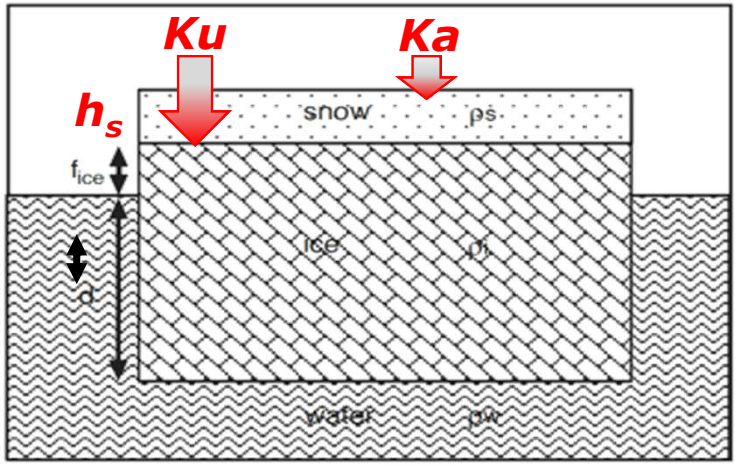
CRISTAL employs a dual-band altimeter

CryoSat-2
(Ku-band altimeter)

AltiKa
(Ka-band altimeter)







Guerreiro et al, 2016

Armitage & Ridout, 2015

✓ CRISTAL addresses snow on ice surfaces, which is a limiting factor in determining the source and amount of glaciological change.

CRISTAL's Payload Complement

The mission draws from the heritage experience of several in-orbit missions and from the on-going development of the Sentinel-6 and MetOp-SG programmes


CryoSat-2

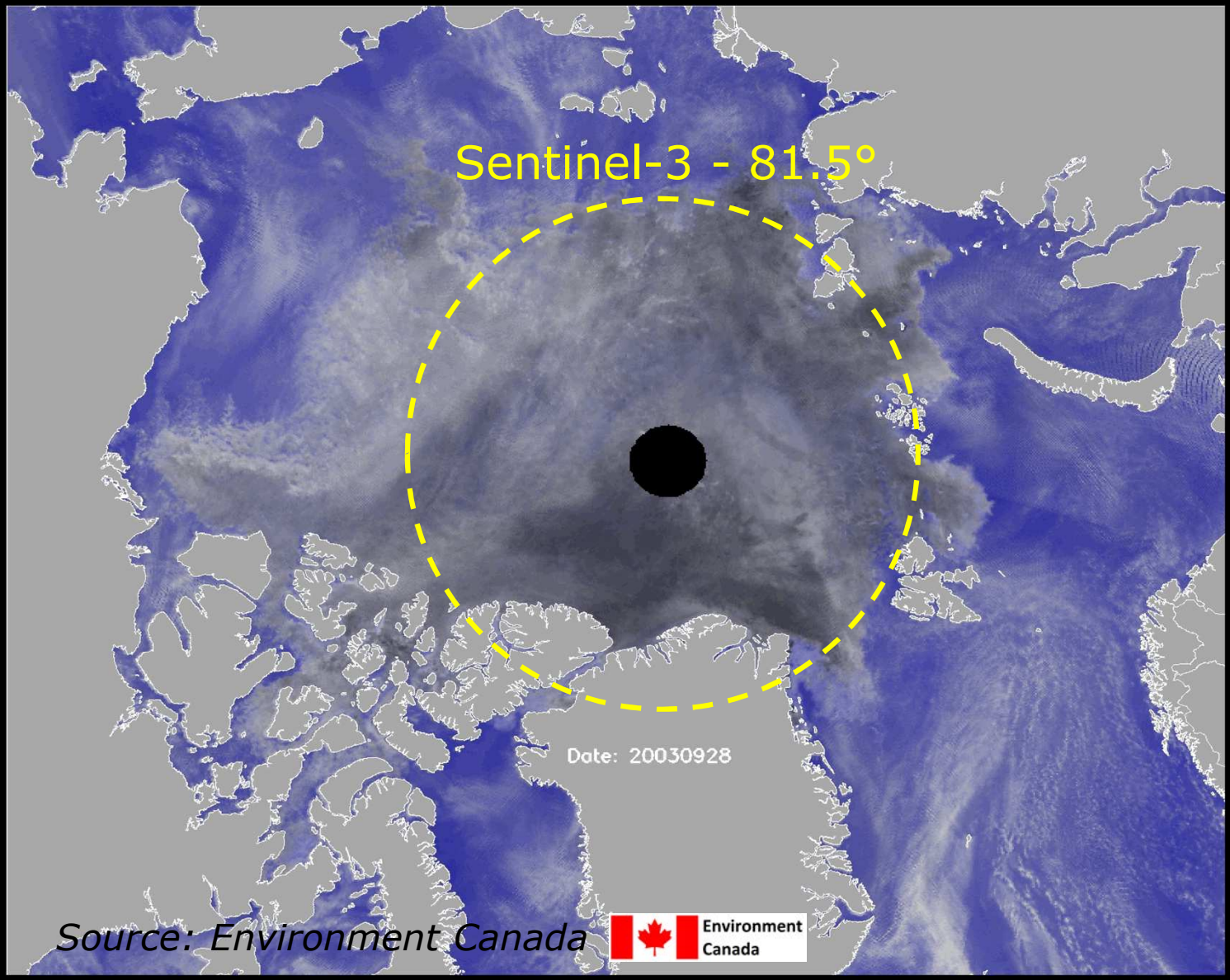

SARAL


MetOp-SG


Sentinel-6


Sentinel-3

- A high spatial resolution dual Ku/Ka-band SAR altimeter to make observations of sea ice and land ice elevations expanded to cover the major land ice sheets and provide data that allow improved coverage by means of on-ground swath algorithms
- A Passive microwave radiometer with capability provide data allowing global ocean retrieval of Total Column Water Vapour up to 10 km from the coast
- GNSS receiver compatible with Galileo and GPS constellations
- Laser Retro-reflector Array for satellite laser ranging used for short arc validation of the orbit



Source: Environment Canada

Status science support study (CRISTAL Polar Monitoring Mission study)

- Project consortium led by CLS, France

- Objective of CRISTAL PMM science study is to:
  - Analyse and assess **user requirements**, and support the **consolidation of mission requirements**
  - Conduct **simulations and performance analysis** with a **focus on coupling a snow model** with an **altimetry simulator** to analyse snow depth **retrieval from Ku- and Ka-band** observations
  - Provide ad-hoc input to scientific questions from industry
- Status: Ongoing

CryoVEx/CRISTAL 2019 Campaign

ESA continuation of airborne validation and monitoring program in support of CS-2 and CRISTAL

- CryoVEx/CRISTAL 2019 flights end of March 2019
- **First** airborne cross-validation of ESA CryoSat-2/NASA ICESat-2
- Campaign will greatly benefit the CRISTAL mission by **acquiring Ku- and Ka- data** from several sea-ice regions around Greenland
- CRISTAL **ground component** over land ice (EGIG line)

The campaign airborne payload consisted of:

- KAREN Ka-band SARIn radar altimeter (MetaSensing)
- ASIRAS Ku-band radar (ESA)
- NIR Laser scanner, Riegl Q240i (DTU Space)

CRISTAL in brief

Characteristics:

Essential part of the Topographic Ocean and Ice Measurement Family

Single satellite covering polar regions embarking:

- Ku-band Interferometric Synthetic Aperture Radar Altimeter with supporting Ka-band channel measuring sea ice freeboard and land ice elevation
- High and low frequency passive microwave radiometer (wet troposphere correction)

7.5 years design lifetime

Optimised orbit covering polar regions (omission not exceeding 2°; sub-cycle < 10 days)

High along-track resolution sufficient to distinguish open ocean from sea ice surfaces

Product latencies from NRT to 24 hrs depending on application

Capable of tracking steep terrain with slopes < 1.5°

Sea ice thickness and Freeboard:

Horizontal resolution of sea ice thickness products <=80 m

Vertical uncertainty of sea ice thickness of 0.1 m

Ice Sheets, Glaciers and Ice Caps

Ice surface elevation with uncertainty of 2 m

Temporal sampling of 30 days or less

Status:

Currently in Phase B1; concept studied by two industrial consortia

Launch mid 2020-2030

Copernicus Services:

C3S, CMEMS, CLMS, CAMS, CEMS

- ✓ Directly addresses the EU Arctic Policy and Primary User Requirements expressed in PEG reports
- ✓ Responds to needs for continual altimetric monitoring of Arctic Ocean North of 81.5°N
- ✓ Builds on heritage experience of several in-orbit missions

EUMETSAT

European Space Agency

Earth Explorer-9 Reports for Mission Selection will be published today!

https://atpi.eventsair.com/QuickEventWebsitePortal/19m11---earth-explorer-9-user-consultation-meeting/website