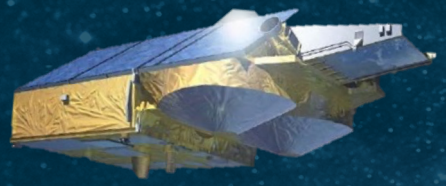


CRYOSAT-2 | MISSION STATUS & DATA PRODUCT UPDATES

Jérôme Bouffard - Tommaso Parrinello - Marco Meloni

OSTST-2020 | 20-24 October 2020

OUTCOMES

- Mission Status
- R&D Projects
- Data Quality Status
- Conclusions

MISSION STATUS

CONTEXT

Launched: 8 April 2010

Launcher: DNEPR from Baikonur Cosmodrome

Orbit: Altitude of 720km, near-circular not sun-synchronous, inclination 92° , repeating ground track every 369 days

Main Payload: SAR Interferometric Radar Altimeter (SIRAL) operating at 13.6 GHz (Ku band)

Mission Objectives: precise measurement of arctic sea-ice thickness and polar land ice elevation changes

Mission Management and Operations: ESRIN, ESOC

Mission Lifetime: 3.5 years (still in operations, consumables for another 5+, 2025+)

Other: CryoSat-2 follows CryoSat-1 launched in 2005

https://earth.esa.int/eogateway/missions/cryosat

MISSION STATUS

PRIMARY MISSION OBJECTIVES

SECONDARY OBJECTIVE

Open Polar Coastal

Ocean topography

GLOBAL & REGIONAL MSL TREND / CLIMATE (IPCC)

METEO (WAVE,WIND)

MESOSCALE , CROSS-SHELF EXCHANGES & IMPACTS

Sea Ice

Freeboard

REGIONAL TRENDS & SEASONAL VARIATIONS

THERMOHALINE CIRCULATION ....

Land Ice

Ice Elevation

ICE SHEET/CAPS/GLACIERS THICKNESS VARIATIONS

CONTRIBUTION TO GLOBAL & REGIONAL SEA-LEVEL ...

SECONDARY OBJECTIVE

River & Lake

Water Height

VARIATION OF INLAND WATER STORAGE

RIVER DISCHARGES AND IMPACT ON COASTAL ECOSYSTEM ...

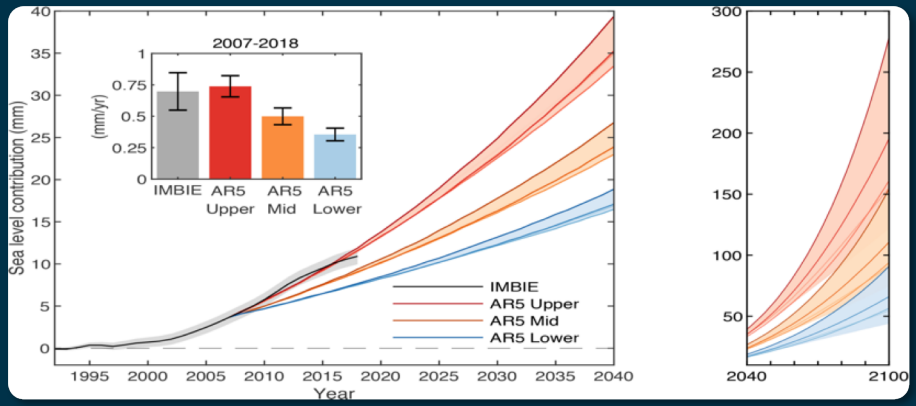
INTERCONNECTED

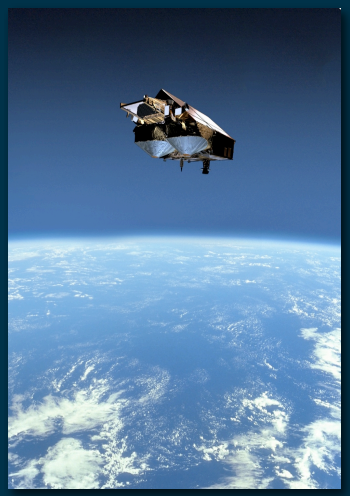
MISSION STATUS

SOME UPDATES

On the 8th April 2020, CryoSat celebrated **10 years in operations.**

One decade of high quality data to understand the cryosphere & hydrosphere with contributions to **key climate change indicators** and operational services





The overall performance of the mission remains in **excellent condition**, above design specifications.

All CryoSat lifetime critical items allow to continue operations **until end of 2022** for which, programmatic funds have just been confirmed

Root cause of the fuel leakage has been found. **Mitigation actions** under discussion

Products are continuously evolving taking into consideration new user requirements and innovative **R&D projects**

MISSION STATUS

NEW CHALLENGES

Swath Processing

Assess time space variability of ice-sheet margins, glaciers and ice caps at high spatial resolution

Polar Oceanography

To assess mesoscale and large scale oceanic variations in Polar regions in support of climate and emerging operational services

Operations and Forecast

Assess the impact of product latency to support different operational and forecasting services

Cryosphere Meteorology

Assess the contribution to cryosphere meteorology: snow fall and melting on sea-ice and land-ice over Polar Regions

Antarctic Sea-ice

To demonstrate the capability of retrieving a sea-ice thickness in Antarctica oceans and other polar marginal zones

River and Lakes

To monitor Inland water, river discharge, Lake Volume variations at high spatial resolution

LONG-TERM RECORDS

To extend the current data record into the next decade and improve the current geophysical retrievals and explore the option of generating new dataset from innovative methods

R&D PROJECTS

Cryosphere Meteo

SEE ALSO

SPICE project : optimise processing of SAR altimetry over ice sheets (CLOSED)

esa

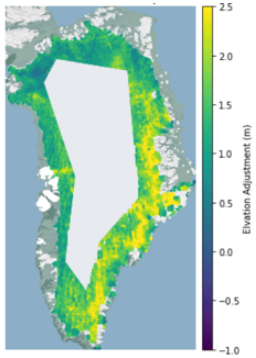
CRYOSURF

OBJECTIVES

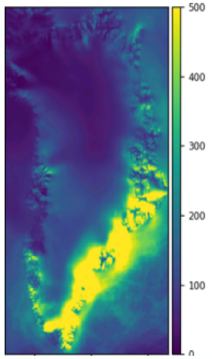
- Create a timeseries of maps of penetration of CryoSat-2 Swath land ice data into the snow
- Using CryoSat-2 elevation, NASA's OIB airborne Lidar & ICESAT2 together in a multi-layer NN

STATUS

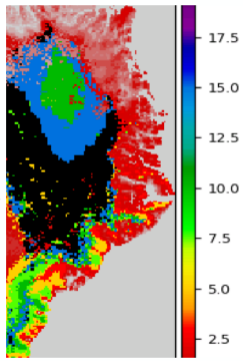
- KO on Q1 2020 | On going
- Data collections and set-up of Neural Network model for several regions of Greenland.



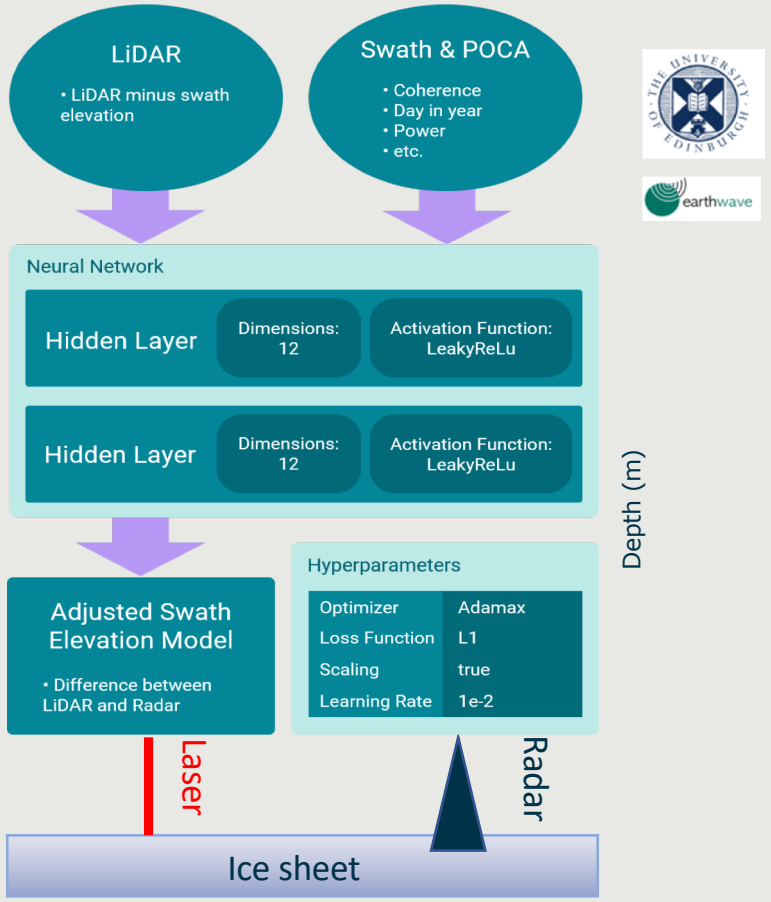
Model Elevation Adjustments for whole of Greenland, April 2015



Snowfall for 2015 (MAR model accumulated snowfall)



Depth of 500 kg/m^3 density layer, April 2015 (from MAR, R01 - 18 layer snow density)



R&D PROJECTS

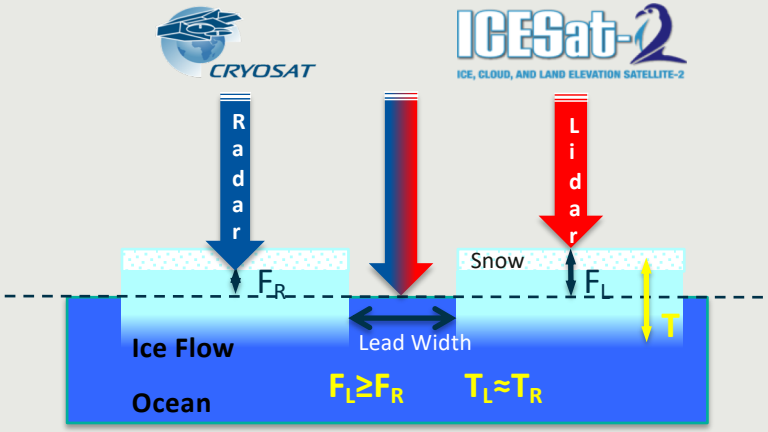
Cryosphere Meteo

CRYO2ICE RESONNANT ORBIT

OBJECTIVE

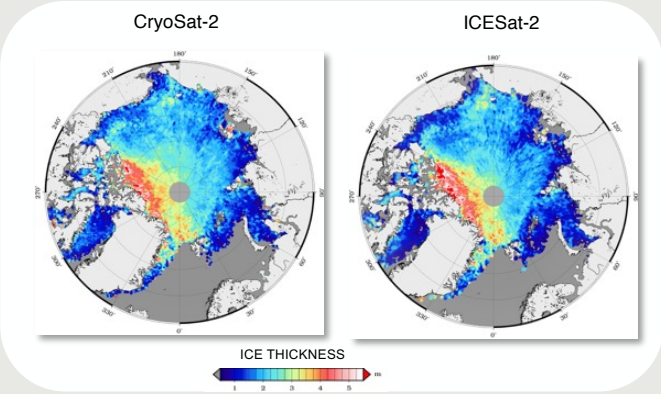
- Unique (and probably unrepeatable) possibility to have coincident laser and altimeter data over polar areas which are key to understand climate change

- Derive snow depth, the largest source of uncertainty in retrieving sea ice thickness one of the most important climate indicators
- Understand the change in scattering horizons and different seasonal penetration seasonal on snow/firn/ice with laser and radar signals
- Review the ice sheet mass balance records (IMBIE, CCI) and improve climatology
- Better characterization of SSB, DOT and SSH and improved understanding of polar ocean circulation and (sub)mesoscale dynamics at high latitude



STATUS

- CryoSat-2 semi-major axis was raised by 900m between 16th & 31st of July 2020 with no majot issues
- Next steps: dedicated calval campaigns, joint ESA/NASA sea-ice thickness product (TBC) and organise workshop



R&D PROJECTS

Antarctic Sea-ice
Polar Ocean

SEE ALSO

CP4O CCN (NEW ARTIC TIDAL ATLAS), CCI+ COASTAL projects: SCOOP, BALTIC+ SEAL…

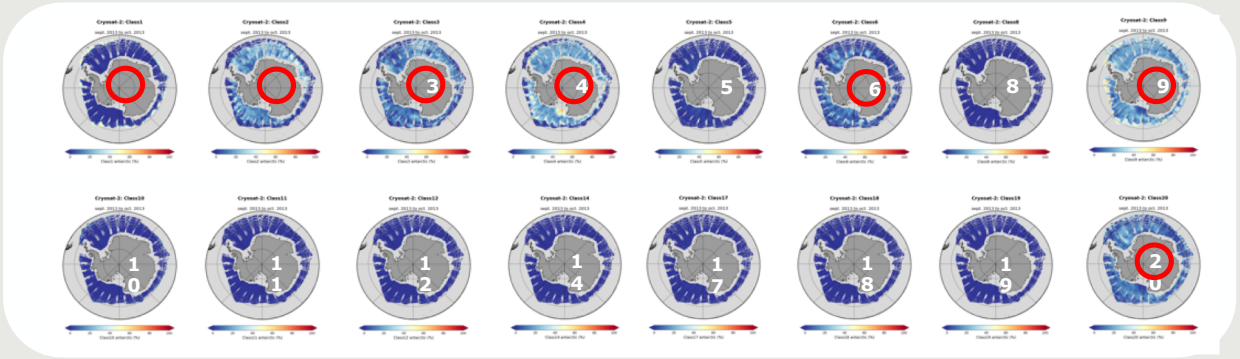
CRYOSAT+ ANTARCTIC

OBJECTIVES

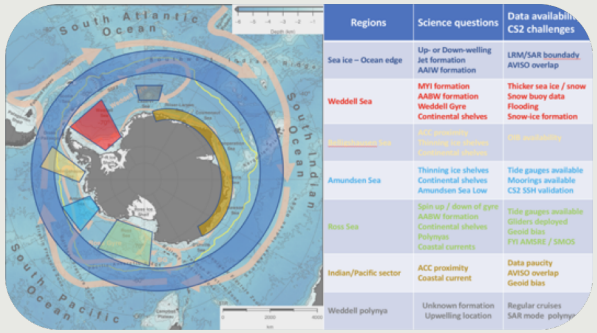
- Exploring optimal altimetry SAR processing methods over the Antarctic Sea ice
- Generate experimental pan-Antarctic along-track + gridded products of sea ice thickness, ocean topography & geostrophic currents

STATUS

- KO on Q2 2019 | On going
- Consolidation of Baseline Requirements document
- Collection of all relevant data sets (space, airborne and in-situ) is on going



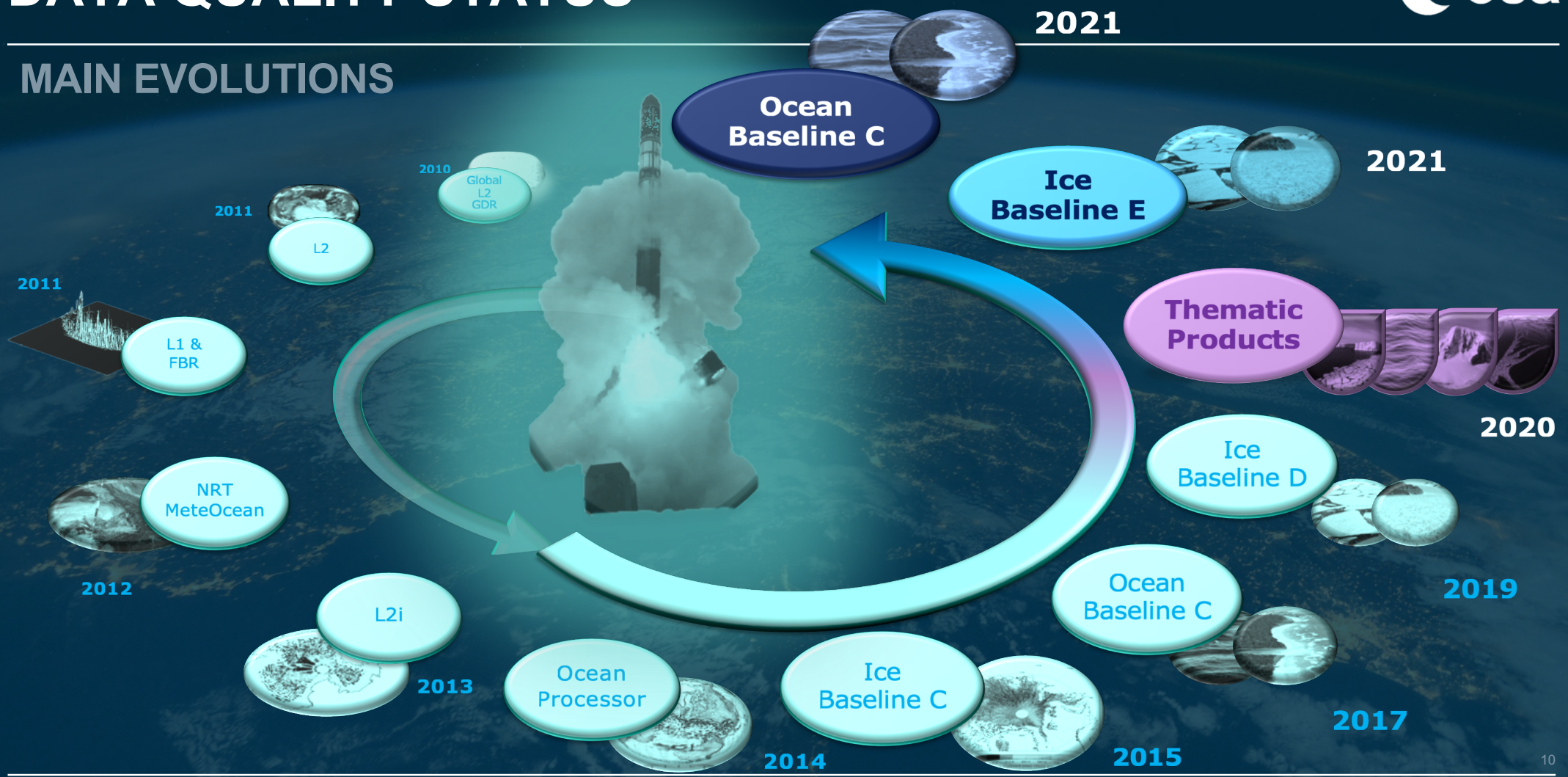
Example of Neural Network waveform classification



Science questions & technical Challenges

DATA QUALITY STATUS

MAIN EVOLUTIONS



DATA QUALITY STATUS

Long term records
Operations

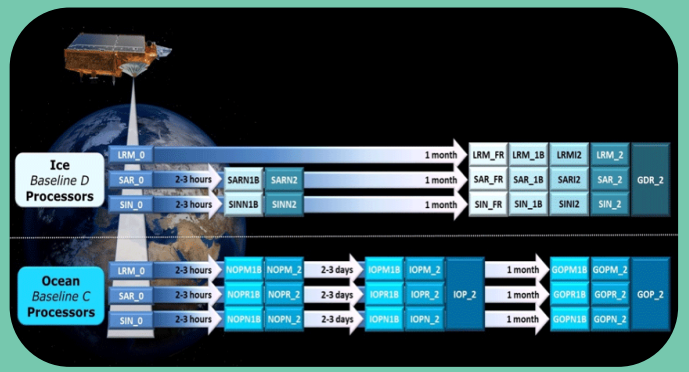
ESA LEVEL-1 AND LEVEL2 PRODUCTS

OBJECTIVES

- Extend the current data record into the next decade & improve the current geophysical retrievals.
- Assess the impact of products latency to support operational and forecasting services.

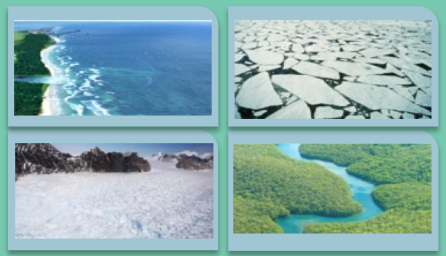
STATUS

- Ocean Baseline-C since April 2017 | Re-processing complete. Baseline D* planed for Q4 2021
- Ice Baseline-D since May 2019 | Re-processing completed. Baseline E planed for Q3 2021.
- New NRT chain (since August 2019): Support to forecasting services in polar regions.



See Meloni, M., Bouffard, J., Parrinello, T., Dawson, G., Garnier, F., Helm, V., Di Bella, A., Hendricks, S., Ricker, R., Webb, E., Wright, B., Nielsen, K., Lee, S., Passaro, M., Scagliola, M., Simonsen, S. B., Sandberg Sørensen, L., Brockley, D., Baker, S., Fleury, S., Bamber, J., Maestri, L., Skourup, H., Forsberg, R., and Mizzi, L.: CryoSat Ice Baseline-D validation and evolutions, The Cryosphere, 14, 1889–1907,* **https://doi.org/10.5194/tc-14-1889-2020, 2020.

NEW (!) CRYO-TEMPO



- Generate operationally products in the areas of sea ice, polar oceans, land ice, coastal and hydrology.

OBJECTIVES

- Project KO on October 2020. (Prime : Lancaster University)
- Operational production planed on Q3 2021

STATUS

DATA QUALITY STATUS

Swath Processing

SEE ALSO

CRYOSAT+ MOUNTAIN GLACIERS PROJECT (http://www.cryosat-mtg.org/)

CRYO-TEMPO EOLIS

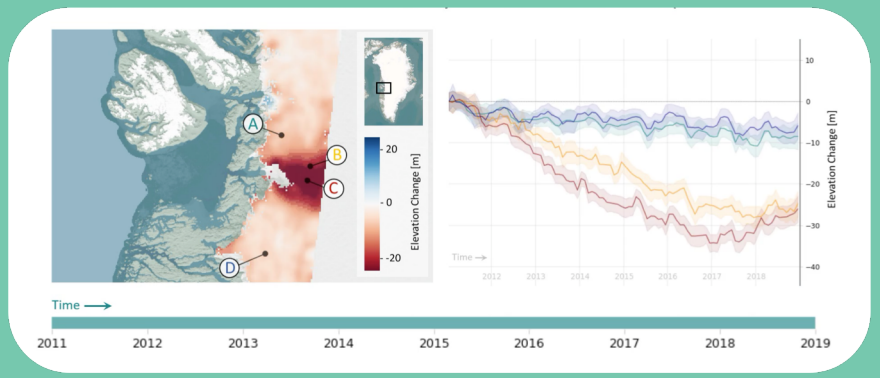
OBJECTIVES

- Generate operational CryoSat swath and gridded Elevation products over Ice Sheets and Glaciers
- Heritage from ESA R&D CryoTop projects

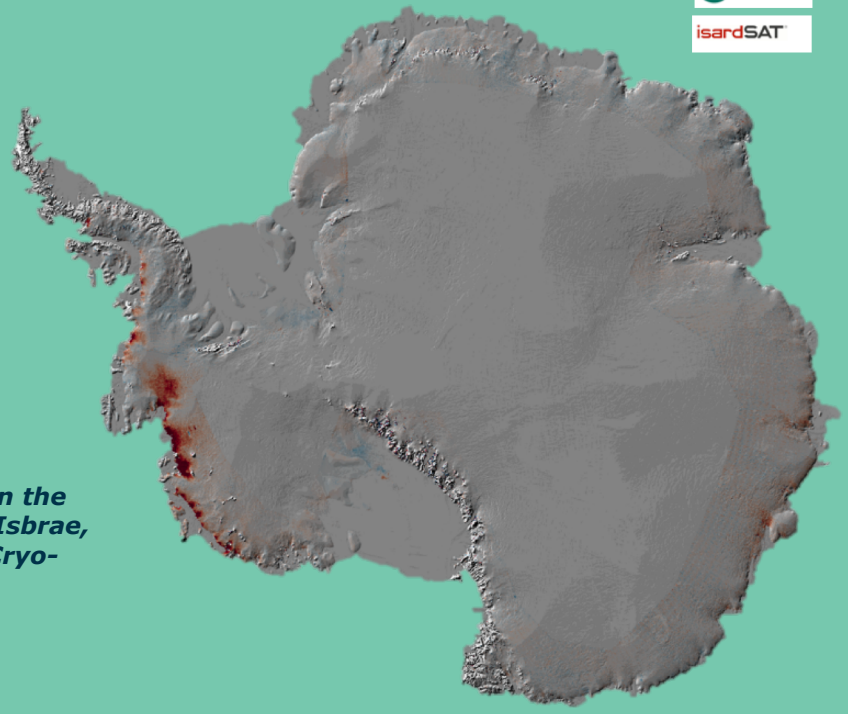
STATUS

- KO on Q3 2019 | On going
- The entirety of the Greenland, data back to 2010, is now processed and available since July.
- CryoTEMPO-EOLIS has been extended to cover Antarctica.

CryoTEMPO-Swath Land Ice



Ice thickness change in the region of Jakobshavn Isbrae, Greenland Ice sheet. Cryo-TEMPO EOLIS data



CONCLUSIONS

CryoSat is in **GOOD SHAPE**. There were no technically limiting factors or programmatic constraints that has restrict its extension until **2022**

The quality of CryoSat ice and ocean data is excellent and allows to fully achieve the mission objectives and **LARGELY BEYOND** …

CryoSat is a flying laboratory and key component for cooperation (**ICESAT-2**) and the development of future missions (**CRISTAL**).

Additional R&D studies & CAL/VAL campaigns planed to tackle **NEW SCIENCE CHALLENGE** and support the development of improved data products