

A CryoSat satellite is shown in orbit over a vast expanse of sea ice. The satellite is a rectangular prism with a large solar panel array on top, covered in a grid of solar cells. The body is wrapped in gold thermal insulation. The background shows the Earth's horizon and the dark space of the sky.

CryoSat:

ESA's Ice Mission

A brief overview of characteristics and status

Dr Jerome Bouffard (RHEA for ESA, EOP-GMQ)

On the behalf of Tommaso Parrinello, Pierre Femenias and the Cryosat Team

- Chronology of an ice-oriented altimetric mission
- Mission objectives and characteristics
- Status: Payload, platform and ground segment
- Product evolution and availability
- Conclusion

- CryoSat-1 selected as the first Earth Explorer Opportunity mission in 1999
- CryoSat-1 destroyed in a launch failure in 2005
- PB-EO decision to rebuild the satellite in 2006:
“CryoSat is more important now than when it was first selected”
- CryoSat-2 launch: 8 April 2010
- Commissioning phase: April – October 2010
- Start of operational phase: 1st November 2010
- ***Cryosat Mid-Term Review: 13 May 2014***
Mission accomplished !! ESA Science Advisory Committee would recommend the continuation of the C-2 until Feb 2017



Primary Mission Objectives

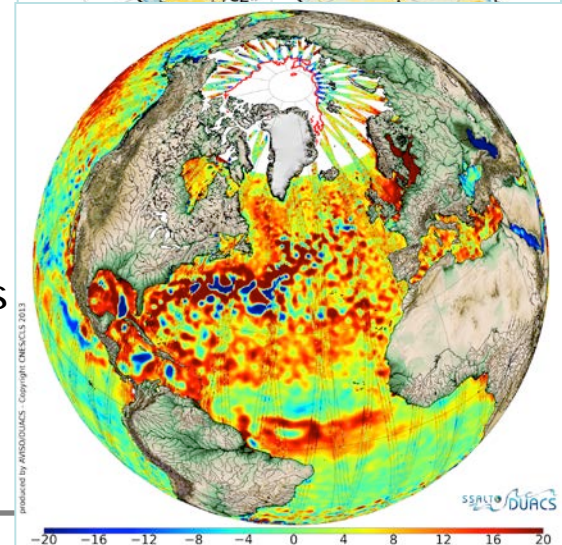
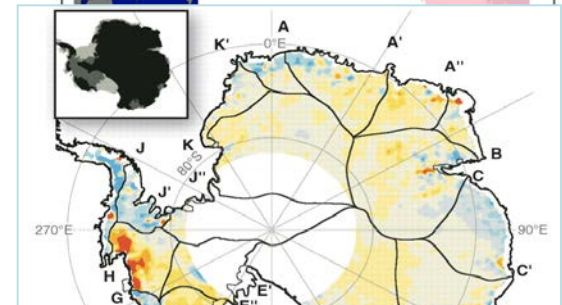
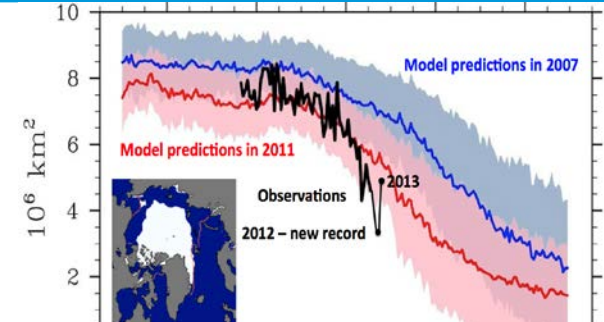
- Determination of regional and basin-scale **trends** in perennial Arctic sea ice thickness and mass
- Determination of contributions to global **sea-level** of the Antarctic and Greenland ice sheets

Secondary Mission Objectives

- Observation of **seasonal cycle** and **variability** of Arctic and Antarctic sea ice mass and thickness
- Observation of variation in thickness of the world's ice caps and glaciers

Additional portfolio: NEW IOP/GOP

- Ocean products to **bridge the gap between** previous ocean-oriented missions and the future S3
- Contribute to our knowledge on **Cryosphere Ocean interactions**



Mission and System Requirements

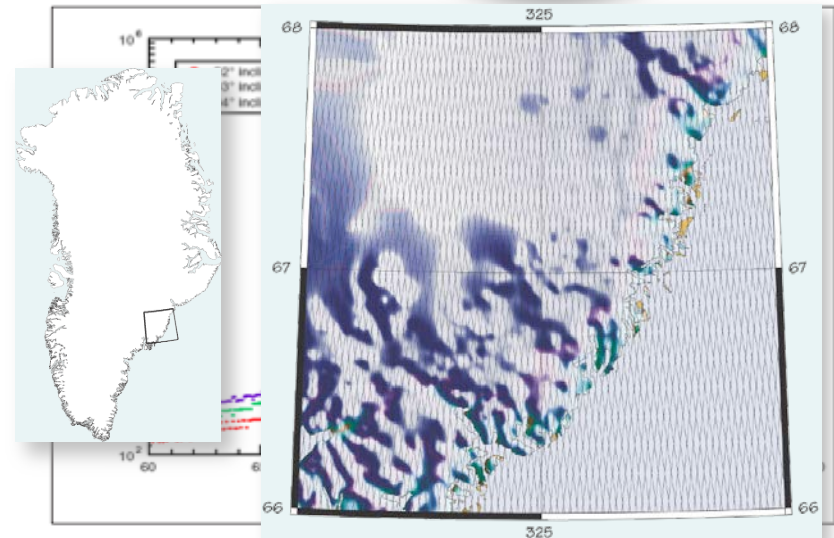
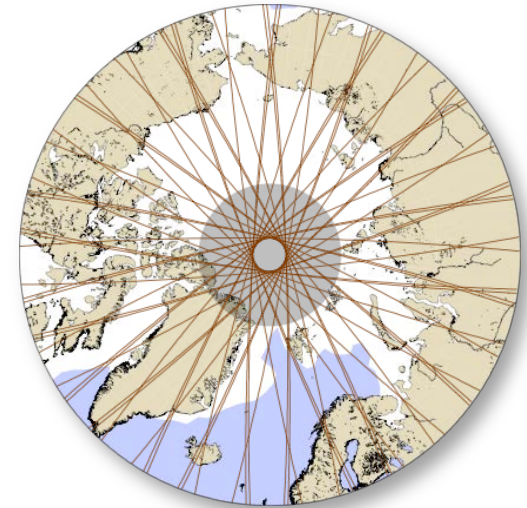
Requirements	Sea Ice 10 ⁵ Km ²	Ice Sheets Regional scale 10 ⁴ Km ²	Ice Sheets 13.8 • 10 ⁶ Km ²	Ocean	
Minimum Latitude	50°	72°	63°		
Mission Requirement	3.5 cm/yr	8.3 cm/yr	1.0 cm/yr (130 Gt/y)	No yet defined But ~ RA2 ...	
Mode	SAR	LRM	SARIn	SARIn / LRM	LRM / Pseudo LRM



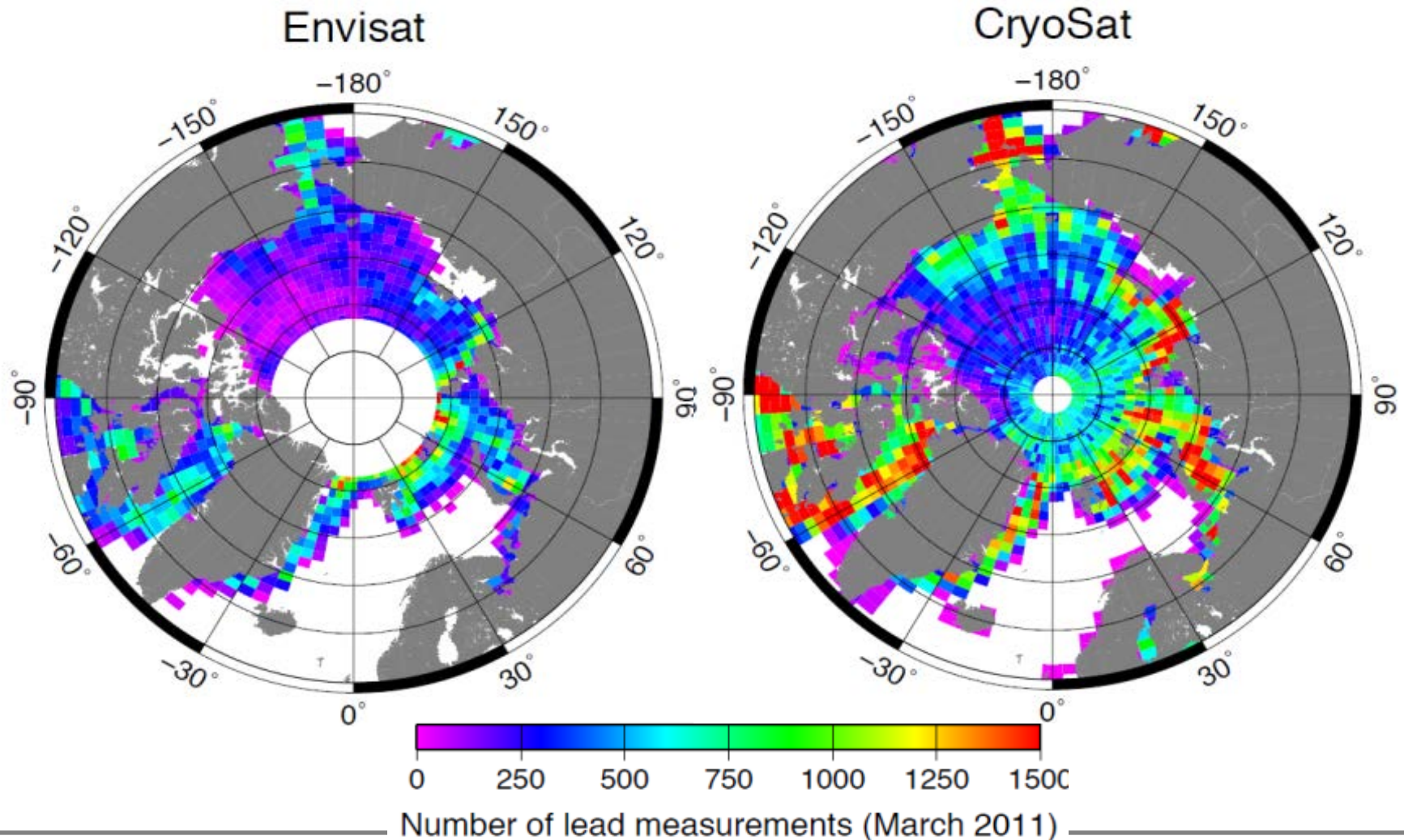
- *Dedicated **mode** operating function of the considered areas*
- ***Orbit** allowing a high density of measurements over the Poles*

An usual drifting orbit to meet the mission requirement

- High density coverage of crossover points
- Need cover sufficiently the south Greenland
- ❖ LEO, non sun-synchronous, 369 days (30 day sub-cycle)
- ❖ Mean altitude: 717 km, $T \approx 99$ min
- ❖ Nodal regression: 0.25° /day (i.e. the sun angle drifts 0.75° d)
- ❖ Inclination: 92° → increased coverage at poles

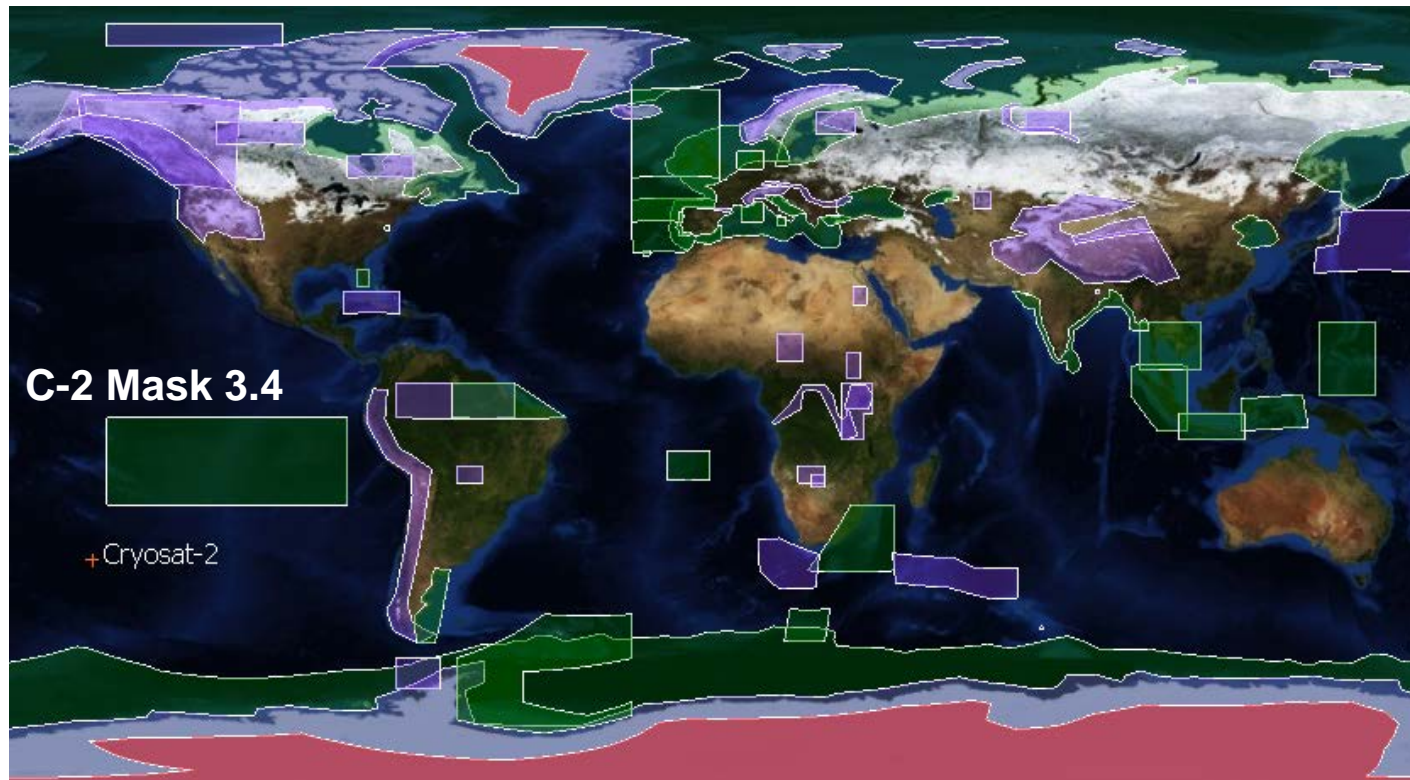


An usual drifting orbit to meet the mission requirement

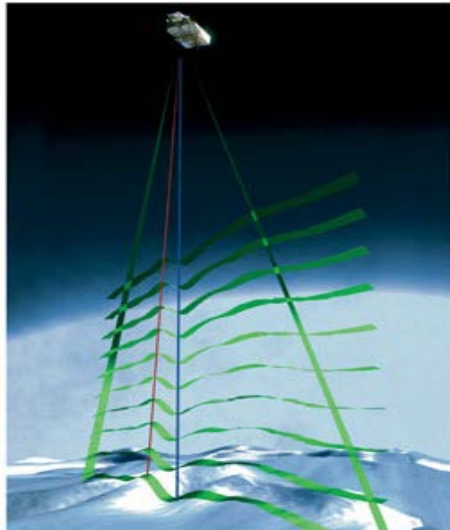


Different modes operating to meet the mission requirement

- Mode of operation selected from a mask of geographical zones
- Mask **updated** every two weeks to allow for changes in sea ice extend
- Mask **not frozen**, specific request can be taken on-board (SAR over Land ice ...)



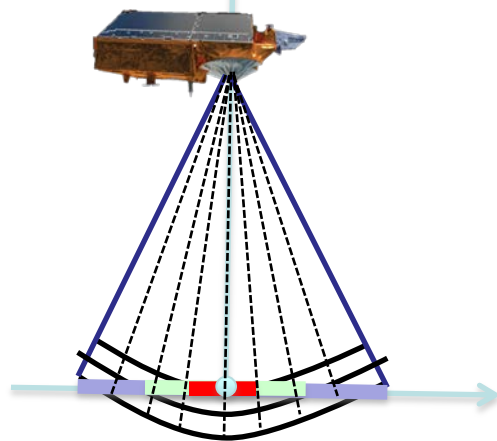
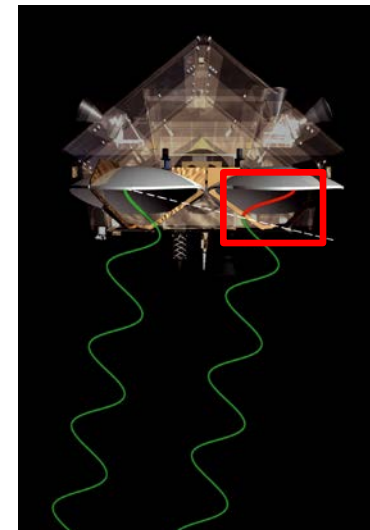
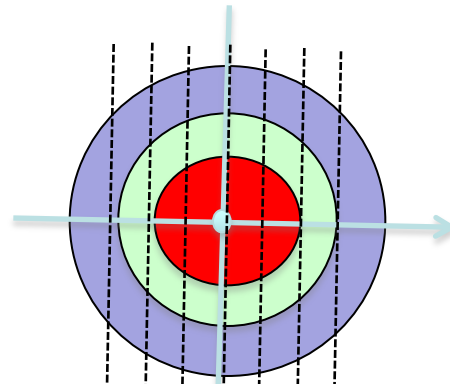
SIRAL: A new generation of altimeter



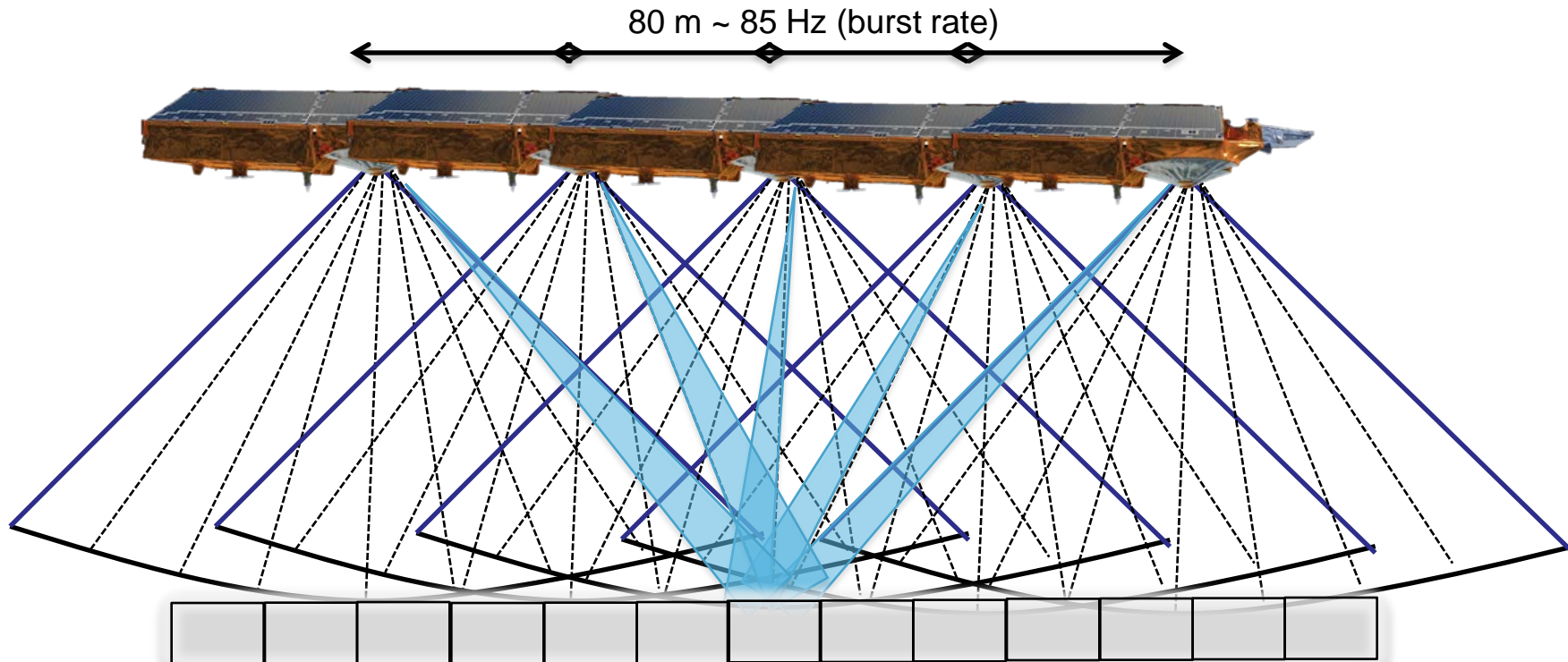
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SAR: Over sea ice, coherently transmitted echoes are combined, to reduce the illuminated surface area to carry out HR measurements

SARIn: Around ice sheet margins and glaciers. Uses a 2nd antenna as an interferometer to determine the across-track angle to the earliest radar returns

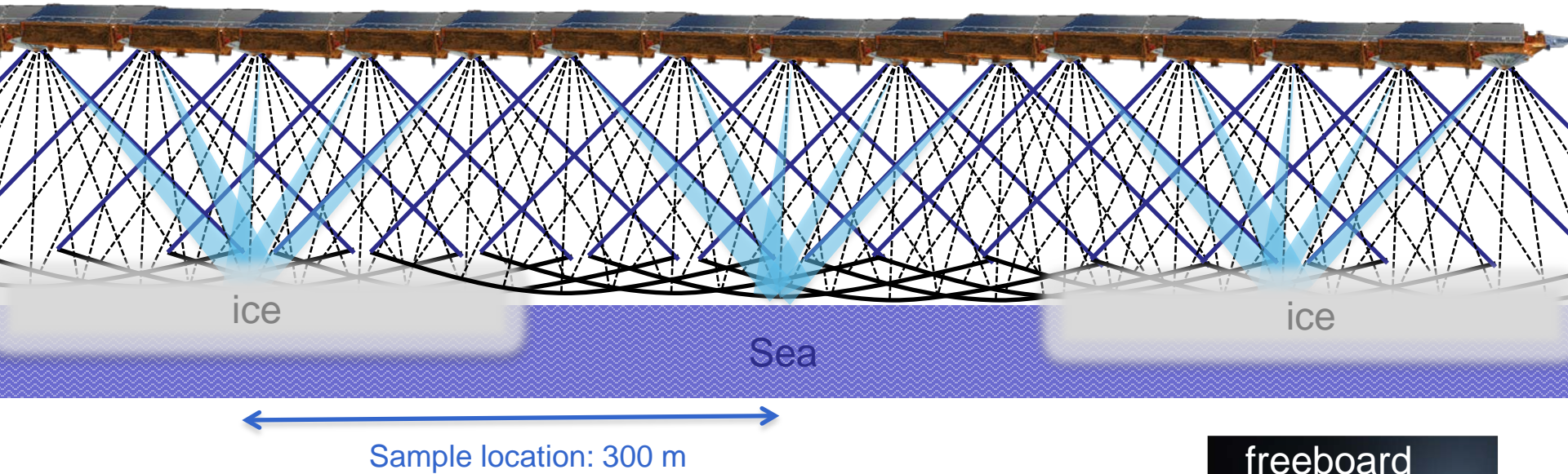


SIRAL: First SAR altimeter concept to be flown on Earth !

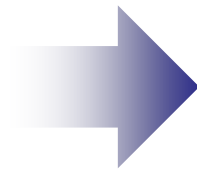


- The key idea is to use the Doppler effect (**shift in frequency**) to divide the radar footprint in slices by using 64 pulses per burst
- Doppler cells illuminated by **several beams** from different positions

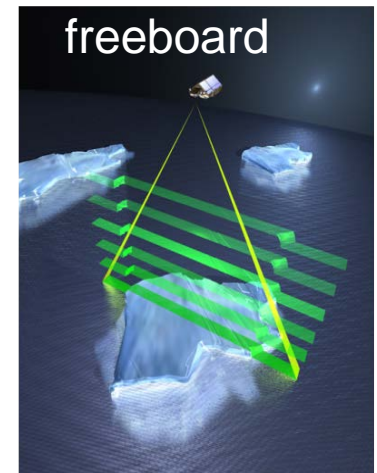
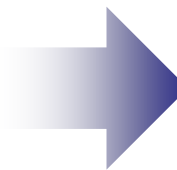
SIRAL: First SAR altimeter concept to be flown on Earth !



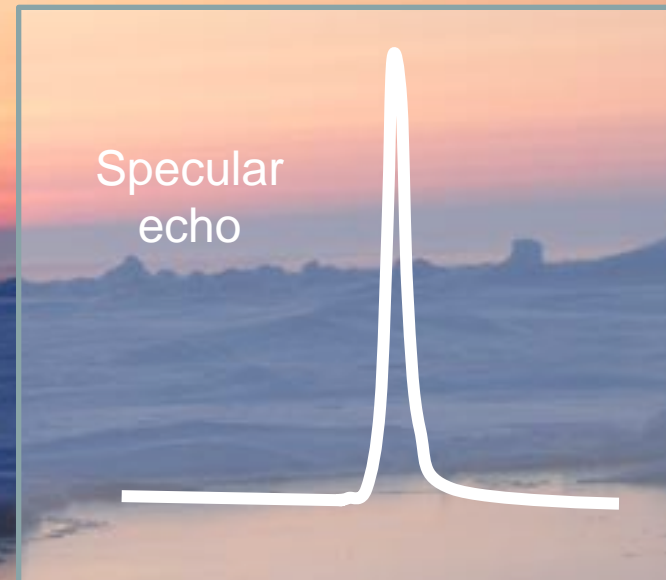
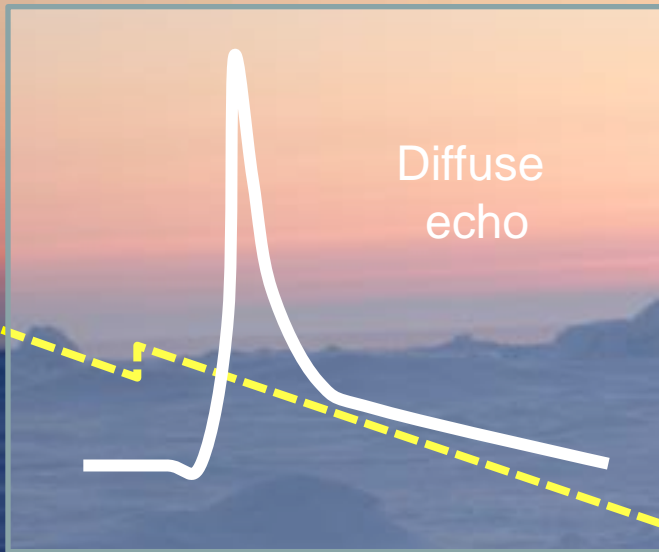
*The speckle noise is reduced by averaging (**multi-looking**) all the 230 return echos*



Increase of the along track resolution



SIRAL: First SAR altimeter concept to be flown on Earth !



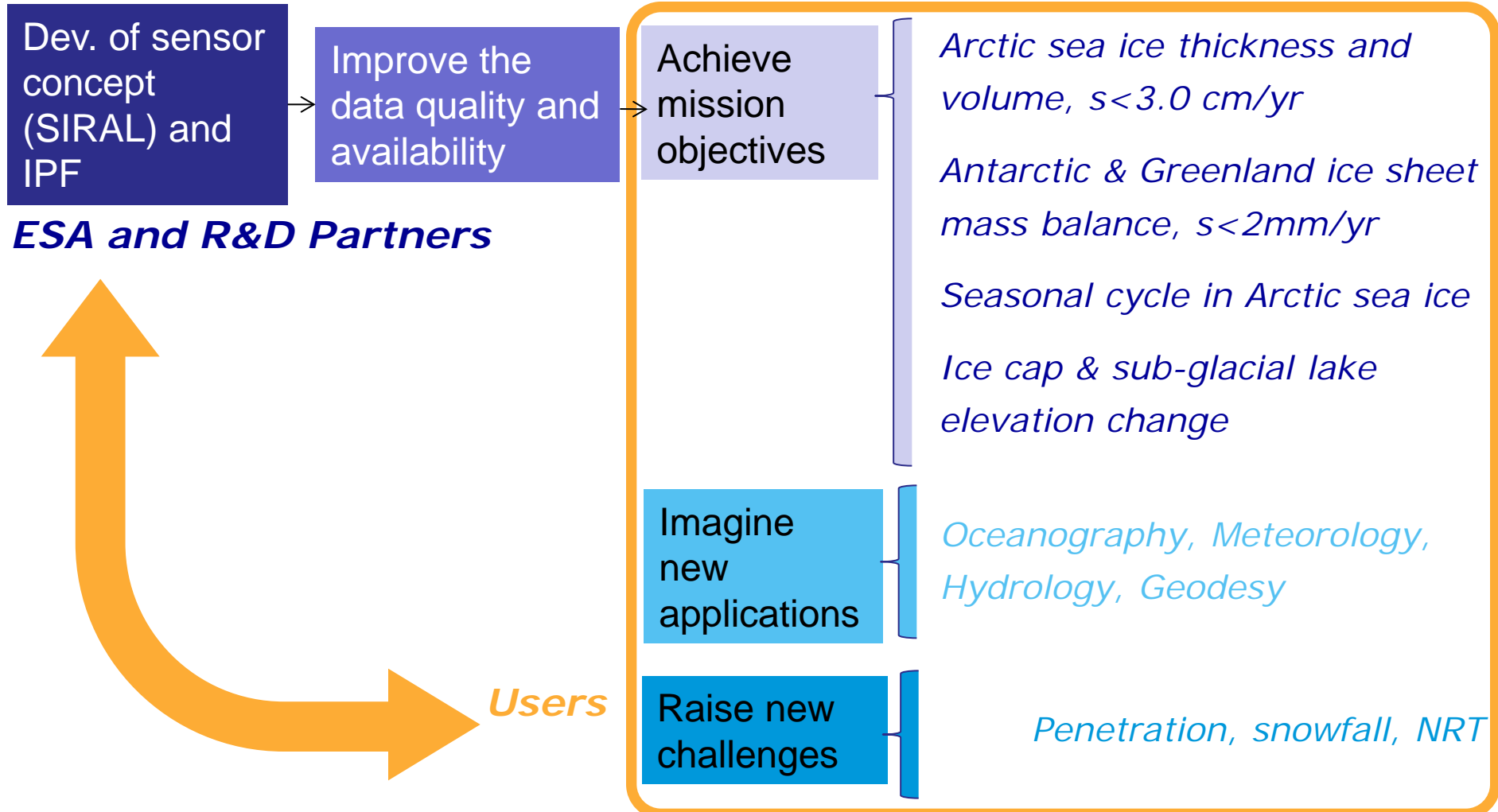
Freeboard



A red double-headed vertical arrow indicating the height of the ice surface above the water level. A dashed yellow line represents the water surface slope.

Sea ice achievements: Retrieval concept

Necessary interactions between ESA and the scientific community



Payload

- ❑ Payload in **very good conditions** after for 4 years of operations
- ❑ Excellent instrument availability **99.6%**
- ❑ Operations, scientific return and data quality are guaranteed till **2023** and beyond, unless unpredictable catastrophic events

Platform

- ❑ Platform in **very good conditions** after for years 4 years of operations
- ❑ Orbit and attitude **stable**
- ❑ Overall platform availability **98.9%**

Ground segment operation

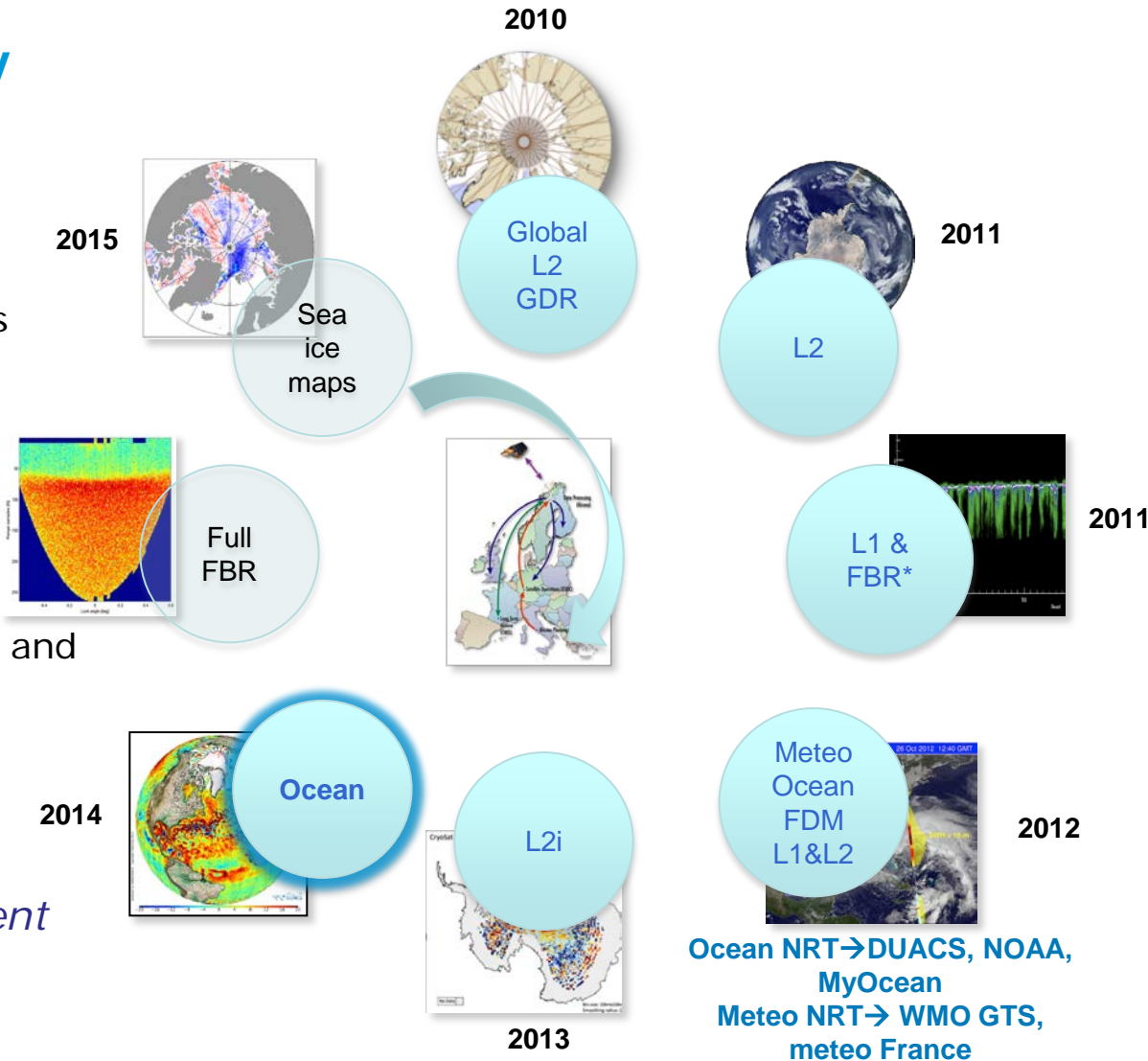
- ❑ Ground Segment is **functioning well** with no major issues since launch.
- ❑ Ground segment in continuously evolving to satisfy growth on science community which has **increased by 170%** since launch.
- ❑ Two major Product Baseline released to users since launch.
- ❑ 1st data **reprocessing** completed in December 2013.

High data data availability

- Overall mission performance **97.7%** well above mission expectation (i.e. >94%).
- Calibration: **0.4%** of observations

Evolution of Products Portfolio

- Driven by new user requirements and by improved GS capacity
- Data disseminated to users: from 3GB/d to ~ 50GB/d (i.e. FBR)
- New IOP/GOP released*
- Baseline C under development*
- Preparation of the 2nd reprocessing started*



- Novel technology: **first SAR and SARIN** altimeter in Earth space
- Platform and Payload full compliant to system requirements
- No technically limiting factors for extended C-2 mission operations
- ➔ ***Mission extended until February 2017 !***

- **High data availability** for science community and Operational agencies (ECMWF, CNES, NOAA)
- Ground segment **continuously evolving** to accommodate new products and demand from worldwide community
- ➔ ***New Baseline C, reprocessing campaign, IOP/GOP ...***

- Improve the C-2 data quality is a permanent challenge which requires systematic comparisons with other missions (e.g. **AltiKa**)
- ➔ ***We need the user feedback ... i.e. your feedback !!***

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Data Access:

<https://earth.esa.int/web/guest/-/how-to-access-cryosat-data-6842>

Requests, questions, feedback or problems relating to CryoSat products should be addressed and sent to :
eohelp@esa.int