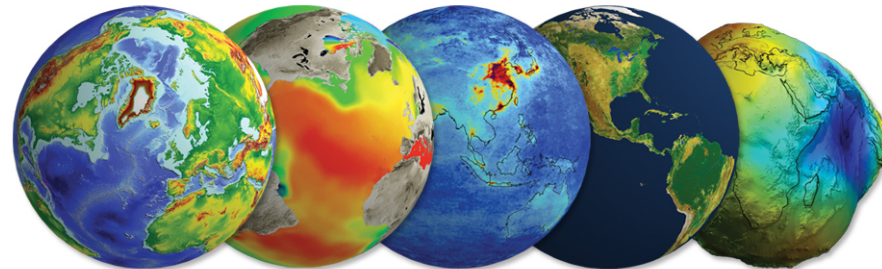


CryoSat Mission Status – December 2015

The CryoSat Mission

T. Parrinello



CryoSat: The Mission Requirements



Primary Mission Objectives

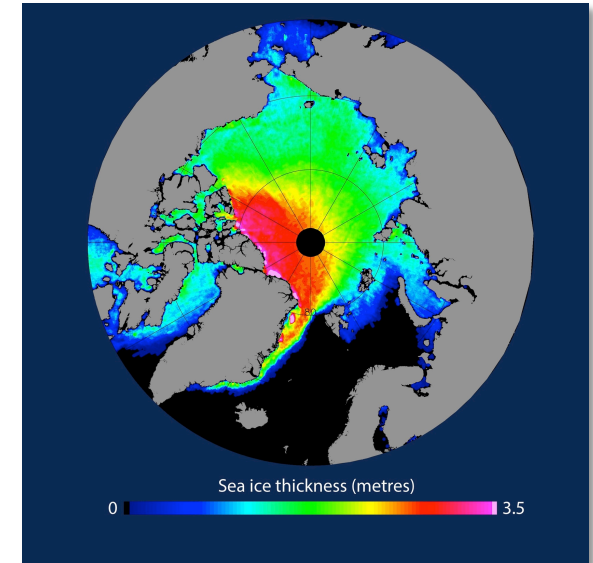
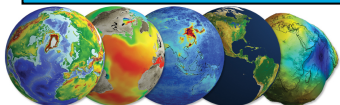
- Determination of regional and basin-scale trends in perennial Arctic sea ice thickness and mass
- Determination of regional and total contributions to global sea-level of the Antarctic and Greenland ice sheets

Secondary Mission Objectives

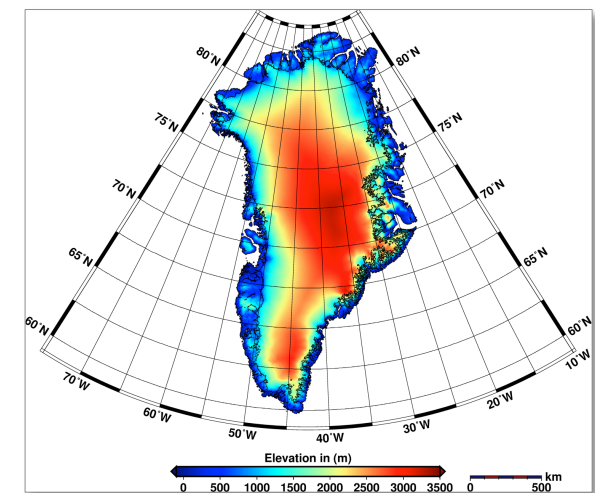
- To make observation of the seasonal cycle and variability of Arctic and Antarctic sea ice mass and thickness
- To make observation of the variation in thickness of the world's ice caps and glaciers

	Sea Ice 10 ⁵ Km ²	Ice Sheets Regional scale 10 ⁴ Km ²		Ice Sheets 13.8 · 10 ⁶ Km ²
Mode	SAR	LRM	SARIn	SARIn/LRM
Mission Requirement	3.5 cm/yr	8.3 cm/yr		1.0 cm/yr (130 Gt/y)
Measured	< 3.0 cm/yr	<4.8 cm/yr		<0.2 cm/yr

Cryosat Mission Requirements (tabular form) were verified over Antarctica and Arctic basin successfully. Confirmation and improvement of the accuracy of measurements is continuing throughout the (first) extended phase of the mission [2015-2017].



Average thickness of Arctic sea [2010 - 2015]
Credits: CPOM



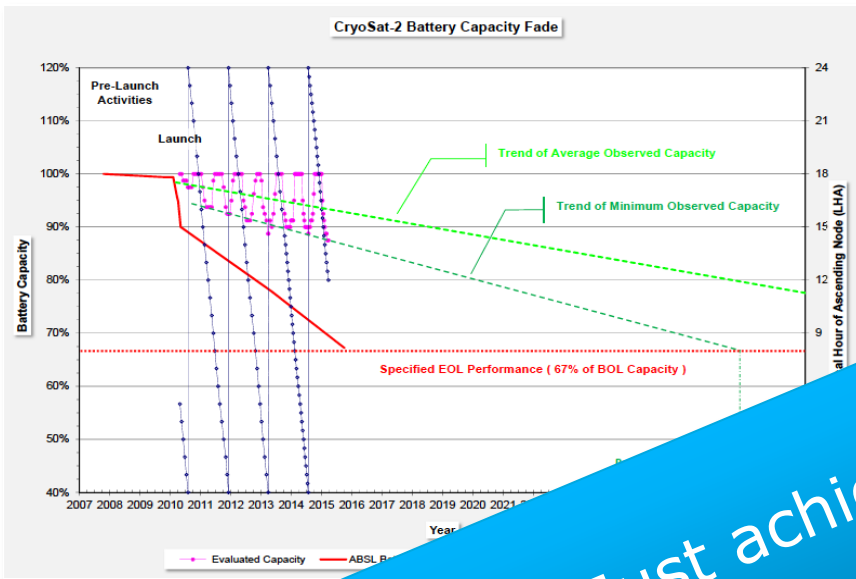
Credits: Helm et al., 2014

CryoSat: Space Segment Performance



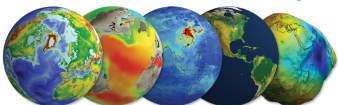
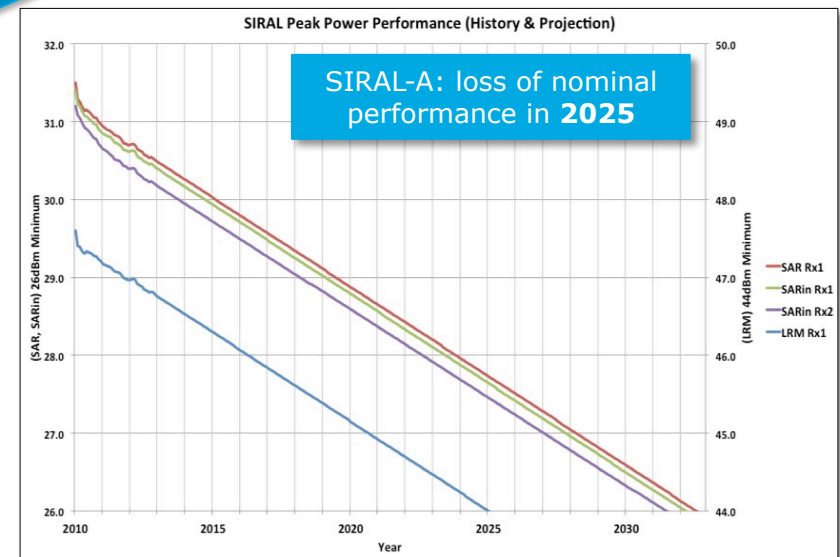
No technical limitations to continue mission exploitation until 2025

- Platform is fully operational with all subsystems in Branch A but the Power Control Data Unit (PCDU) since October 2013, after a component failure of the Telemetry acquisition chain.
- Battery is fading much less than predicted. Recent trend shows that 67% (end-of-mission) will be reached in **2029** (worst case).
- The average yearly fuel usage is much less than predicted. End of fuel (worst case) will be reached in **2029**.
- Star Trackers (STR) are operating within specifications but with different profiles. Development to improve robustness is ongoing.
- Expected end of mission is not earlier than **2025**.
- Platform availability is **99.78%**.
- Collision avoidance manoeuvres since launch.

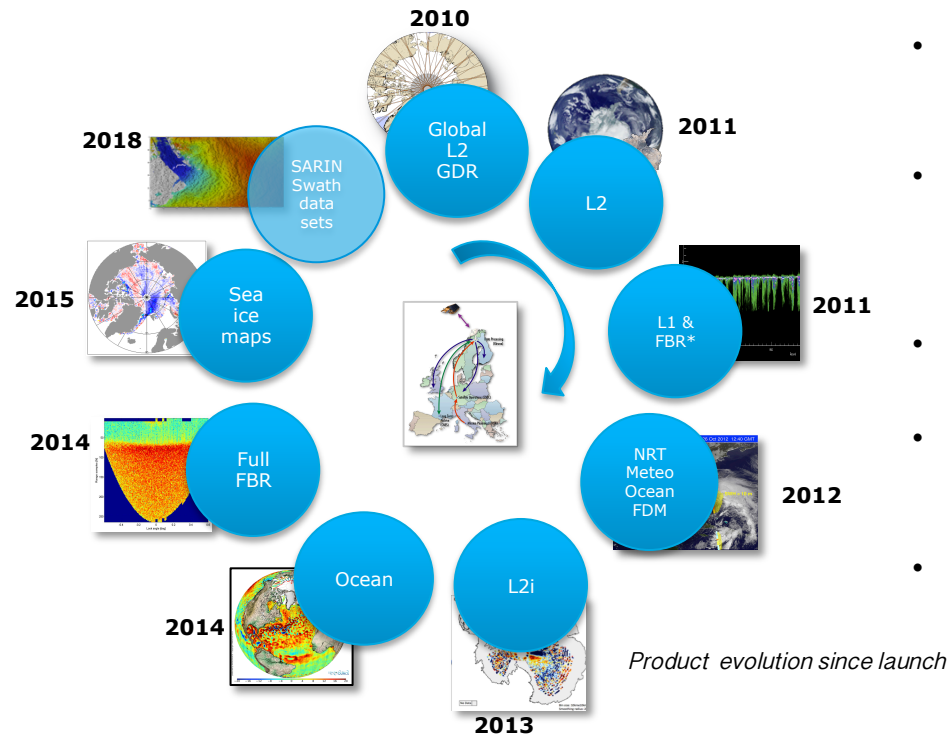


Just achieved 30,000 orbits

- Payload is very successful and has surpassed
- Fundamental radar performance is stable in time and show linear degradation that is compensated by ground processing with no impact on data quality.
- Projection of loss of nominal performance of SIRAL-A will happen not earlier than **2025** with Branch B still available
- Payload availability is **99.45%**
- Just reached **30,000** orbits



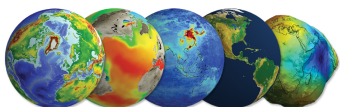
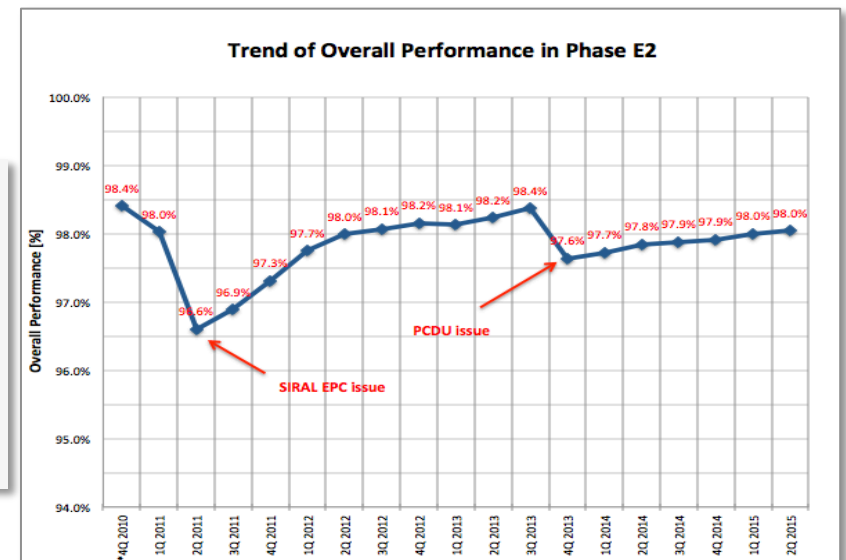
CryoSat: Ground Segment Performance



- Excellent reliability of the ground segment continuously evolving in capacity to adapt to new products. Well fitted to continue exploitation until **2021**
- Product Portfolio continuously evolving taking into consideration new demands and novel applications from worldwide community, including NRT. New product baseline foreseen in **2017** and **2019**
- Reprocessing campaigns follow the releases of new baselines. 2nd reprocessing campaign to be completed in **Jan 2016**
- High data availability for science community. Overall performance of the mission is **98.0%** well above mission expectation (i.e. 94%)
- *Free-and-open* data disseminated to users is around **50GB/d**

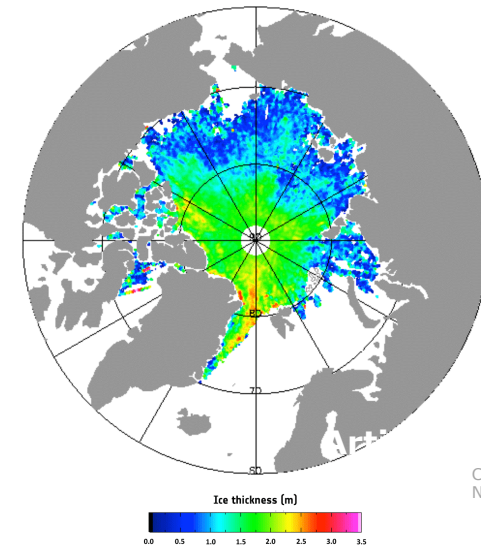
NRT & Operational use

- Fast generation products (**NRT**) for use of meteo, marine forecasting and operational agencies (ECMWF, CNES, NOAA, DUACS, WMO GTS)
- Sea-ice thickness interactive maps (i.e. every 2, 14 and 30 days) available to Polar operational agencies



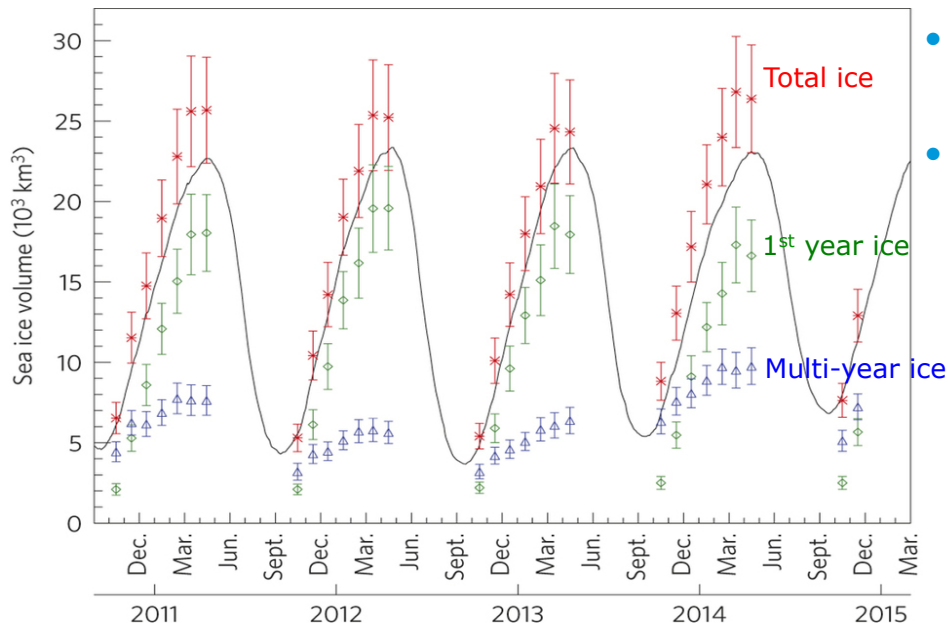
Unique Polar Mission with extensive geographical coverage, accurate volume estimation of ice and exclusive ability with SAR/SARIN technology

- Providing extensive sea-ice thickness measurements and trends (up to 88 latitude) at unprecedented accuracy with better spatial resolution and tenfold improvement in capacity to detect floes.
- Extending the climate time record started in early nineties, revealing complete seasonal and annual distribution of signals
- Contributing to the improvements of important assimilation and forecasting models (e.g. PIOMASS) at regional and global scale

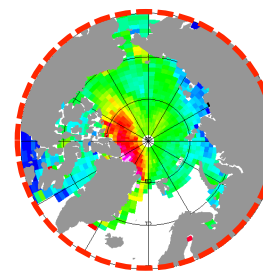


→ October/November 2010
 October/November 2011
 October/November 2012
 October/November 2013
 October/November 2014

Credits: R. L. Tilling et al., Nature Geoscience, 2015

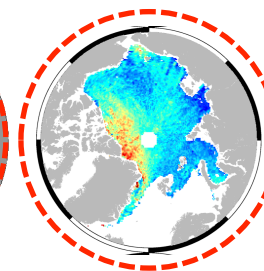


- Sea-ice products available from three groups (UCL, NASA, AWI). Others in preparations (e.g. FMI, CCI)
- Future work focussed on characterisation of snow load and Antarctica sea-ice



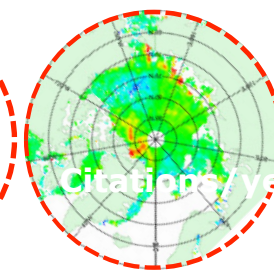
UCL

Thickness (m)



AWI

Thickness (m)



NASA

Freeboard (m)

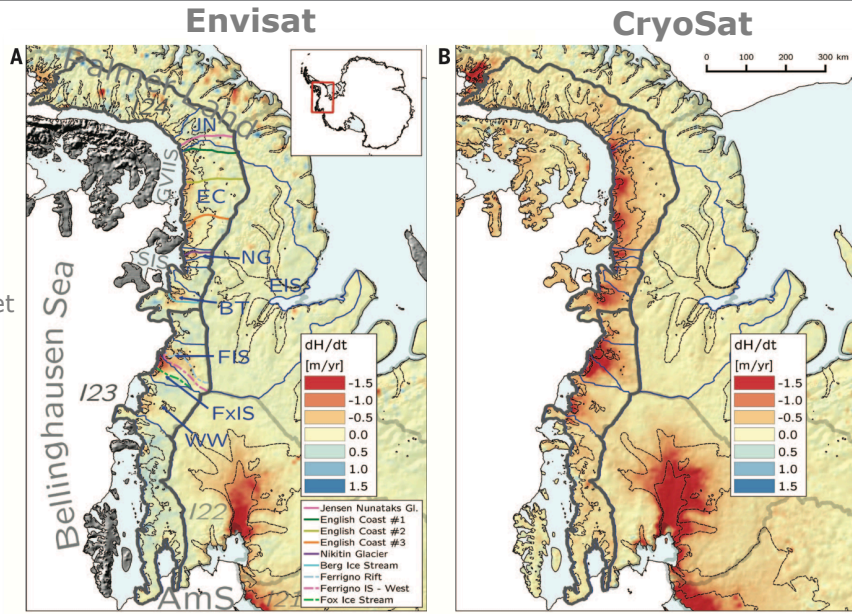


Space Agency

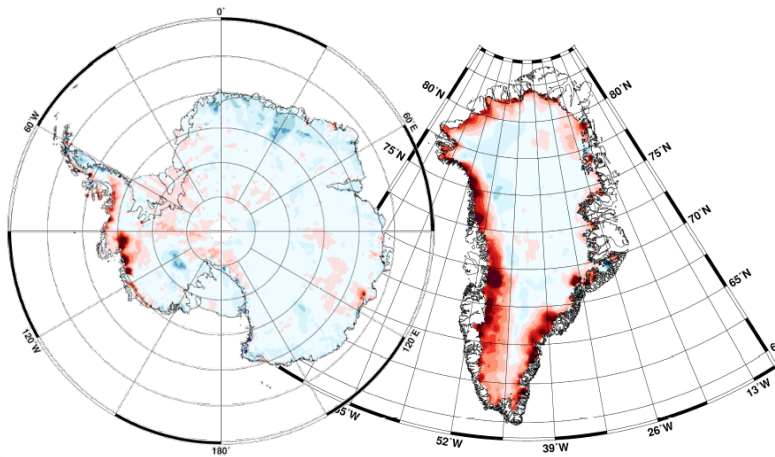
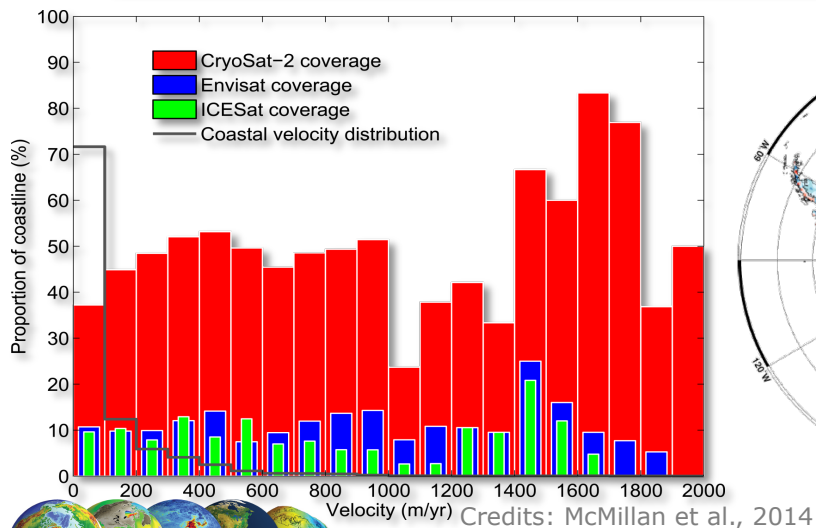
CryoSat: Scientific achievements – Land ice



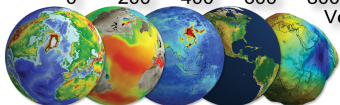
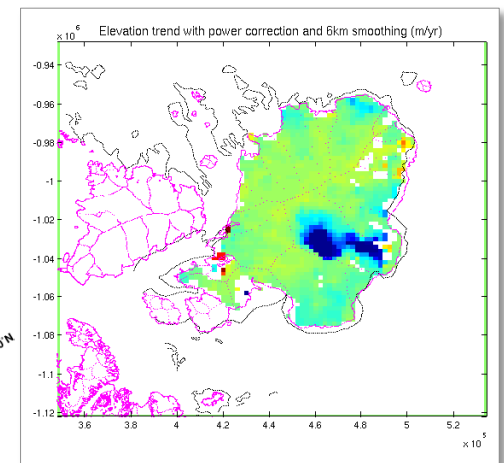
Wouters et al., 2015

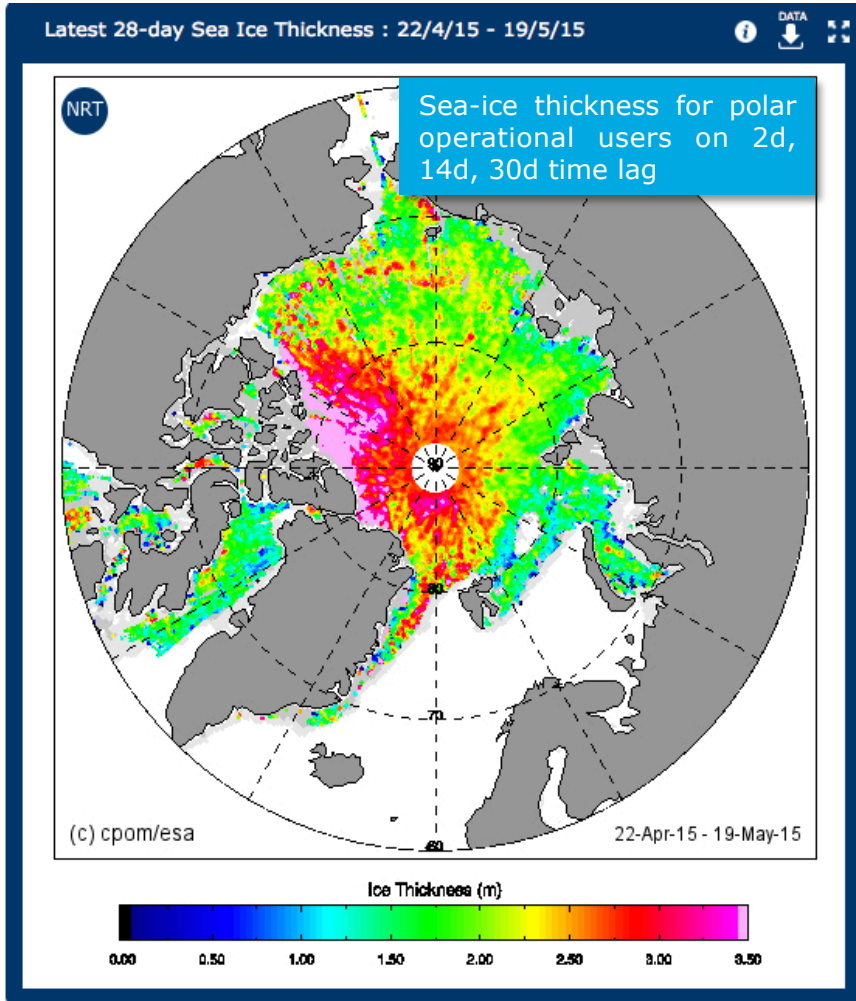


- Providing new assessment of mass balance for all ice sheets compared to IMBIE project and with better accuracy: mass loss from Antarctica and Greenland has increased over recent years
- Able to retrieve on average 70% of coastline and in key areas of high ice flow and dynamic change, five time better than any previous mission
- Providing first assessment of mass balance of ice caps and mountain glaciers which will be one of the main focus in the extended phase of the mission
- Providing fundamental climate long term data records that need to be operational secured in future

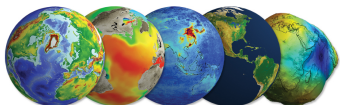


Credits: Helm et al., 2014

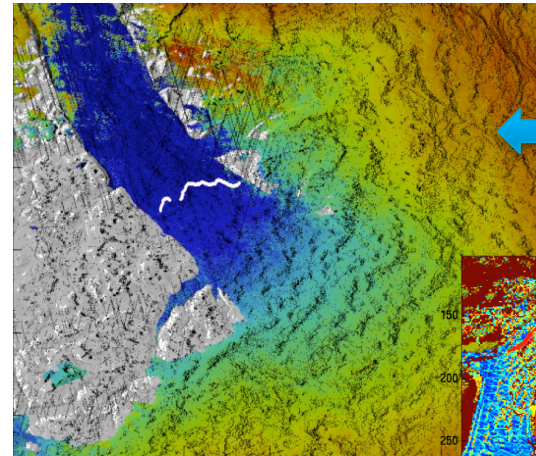




<http://www.cpom.ucl.ac.uk/csopr/seaiice.html>



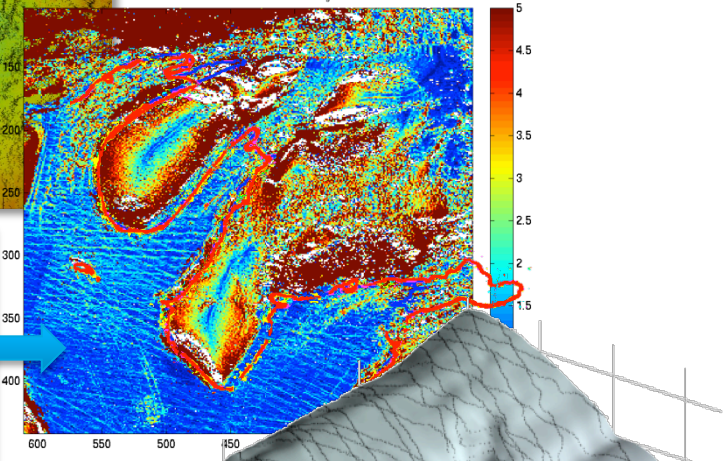
Stimulating new scientific streams for innovative applications and avenues for future research and potential operational activities



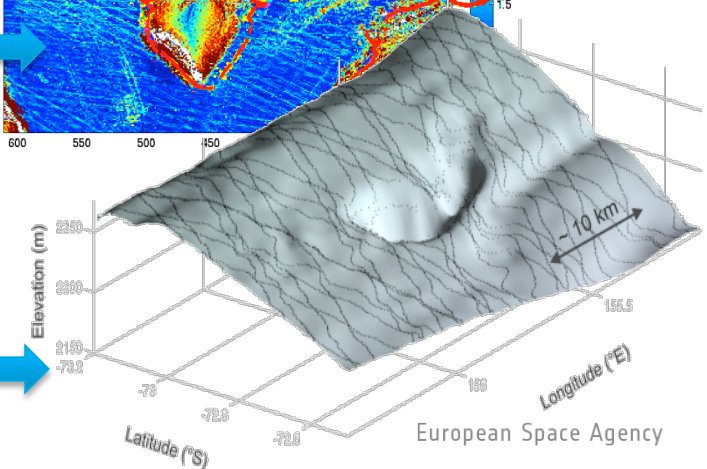
Developing new algorithm (SWATH) to deliver SARIN measurements of fine glacier and ice sheet margin derived through CryoSat-2 interferometric altimeter. Turning an altimeter into imaging sensor!

RF mean elevation Delta rms1km rid

Identification of grounding lines, thickness and ice flux using SAR/SARIN, identifying changes around ice sheet periphery useful for accurate estimation of ice sheet mass balance



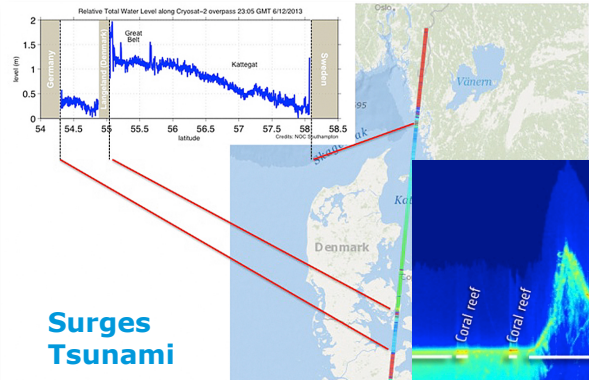
Sub-glacial lakes, providing evidence of a dynamic hydrological system beneath the Antarctic Ice Sheet at high resolution using SARIN



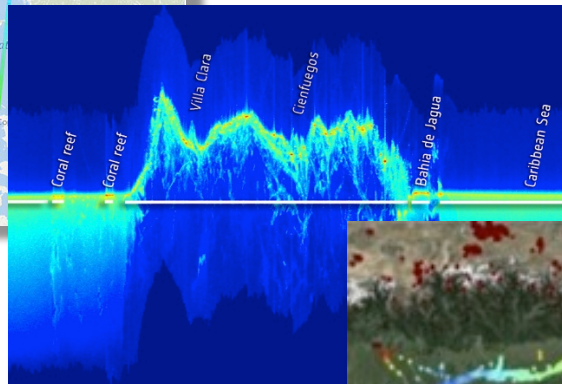
CryoSat: Scientific achievements – Beyond ice



CryoSat is providing high quality data for Oceanography, Coastal Zones, Gravity, Hydrology with valuable contributions to key climate change indicators, operational services and stimulating new applications leading to societal benefits at global and regional scale

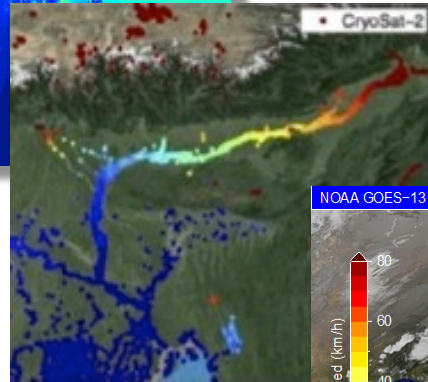


Surges
Tsunami

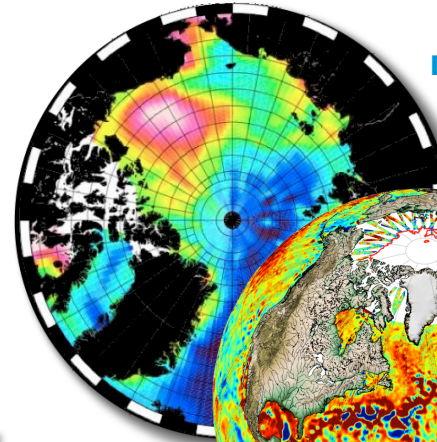
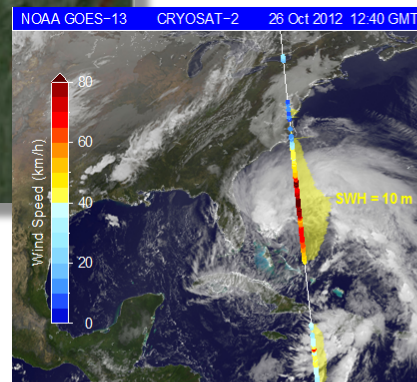


Coastal Zones

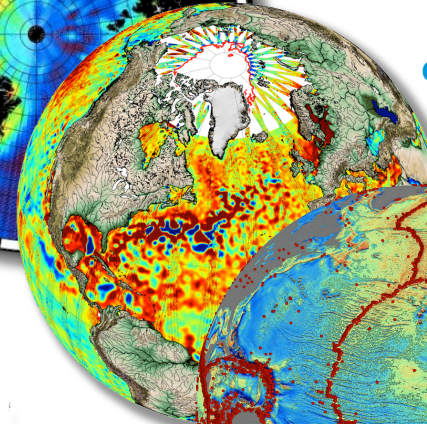
River & Lakes



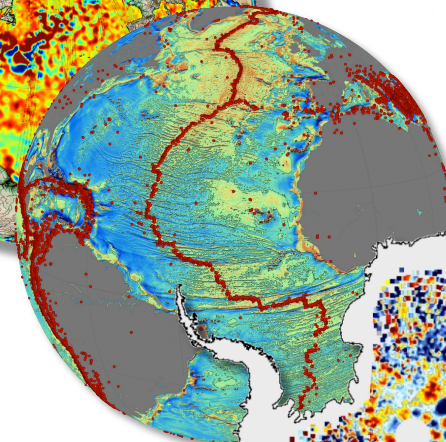
Wind Speed Maps



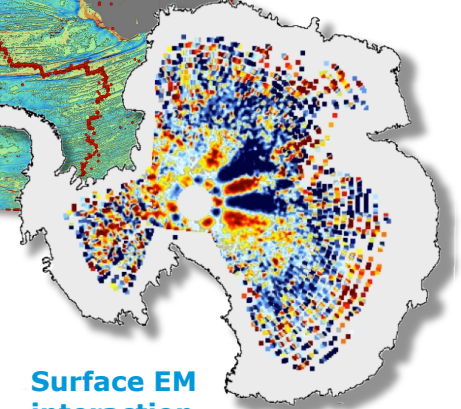
Dynamic Topography



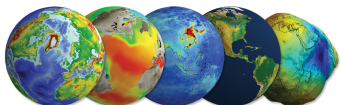
Ocean Currents



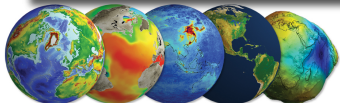
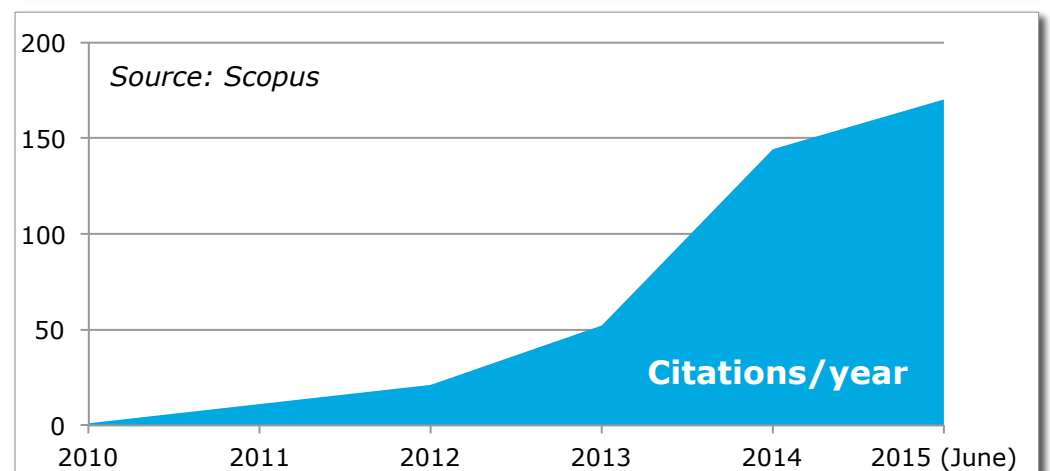
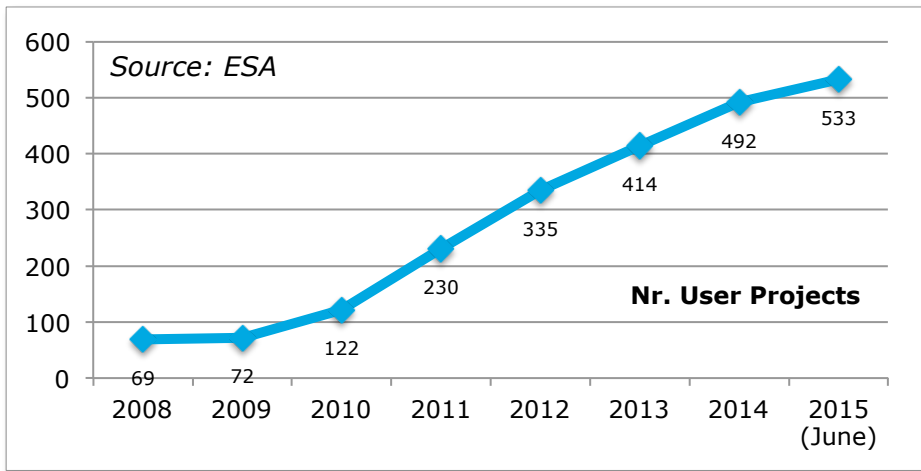
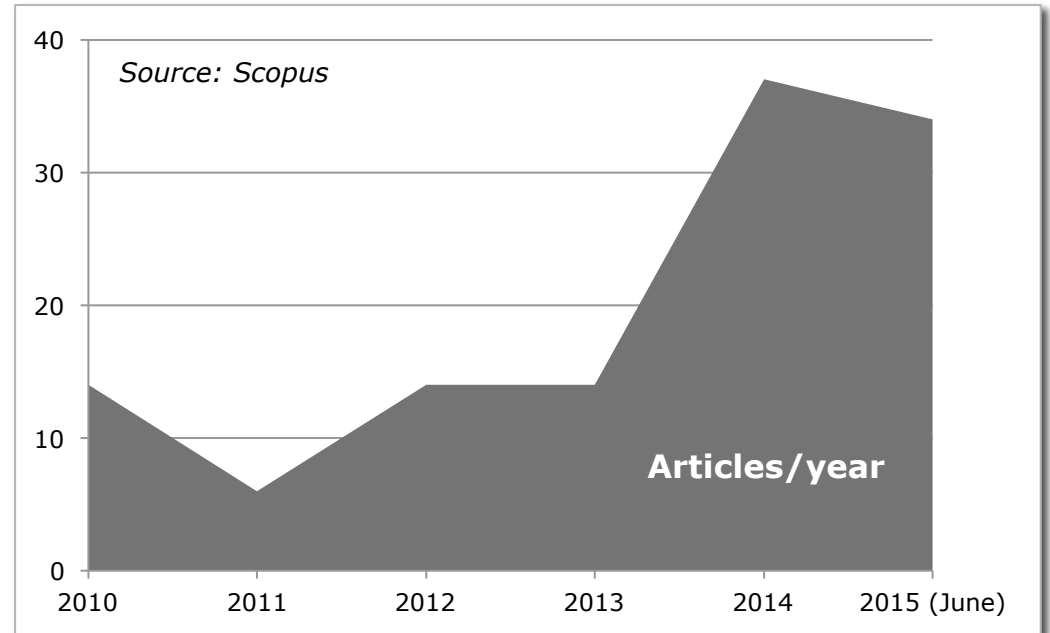
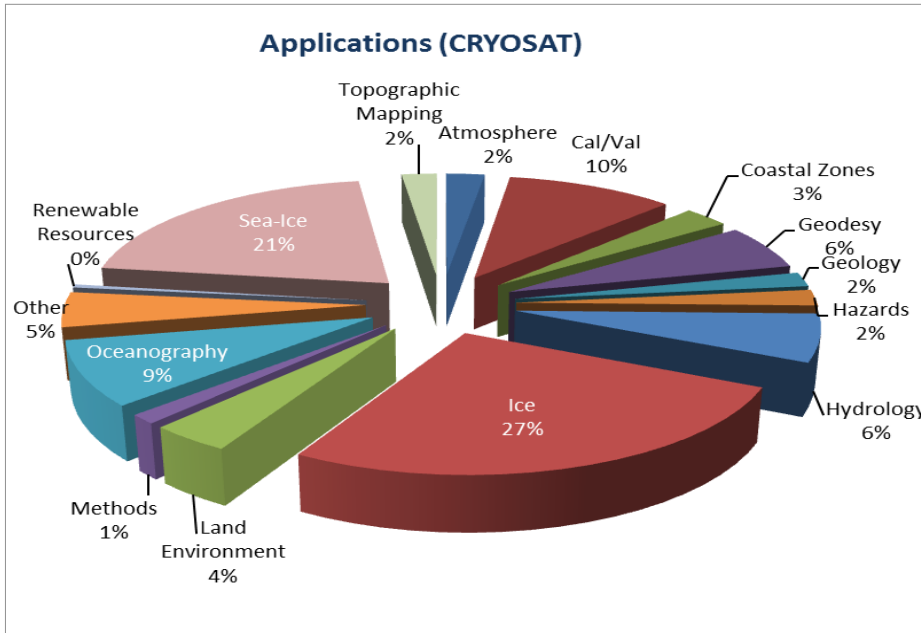
Bathymetry
Gravity



Surface EM
interaction



CryoSat: User uptake and science impact



- New operational mode mask (3.7): 14 December 2015
- End of 2nd reprocessing campaign: January 2016
- Release of the ocean product Baseline C: Q1 2017
- 4th CryoSat User Workshop (Living Planet Symposium): 9-13 May 2016
- Arctic Cal/Val campaigns: Q4 2016
- Proposal for mission extension beyond 2017: Q1 2016 (EOEP-4 review)
- Release of ice product Baseline D: Q4 2016
- 3rd reprocessing campaign: Q1 2017 - Q3 2017
- Tandem operations with ICESAT-2 (>2018)

