CryoSat Mission

Overview of data quality status, evolutions and SAR acquisitions over Antarctica

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CryoSat Mission Geophysicist

**With inputs from Tommaso Parrinello and Pierre Femenias*

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- Context
- Product Evolutions
- SAR acquisitions over Interior Land Ice
- Conclusions and Perspectives

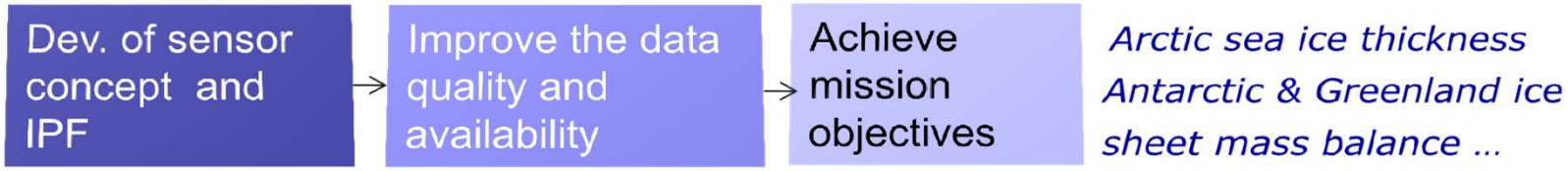
Context

- **CryoSat Mission Main Challenges**

Need to quantify how the thickness of the ice is changing to understand…

… how Global changes are affecting polar regions and …

… how polar regions are affecting by the Global Changes



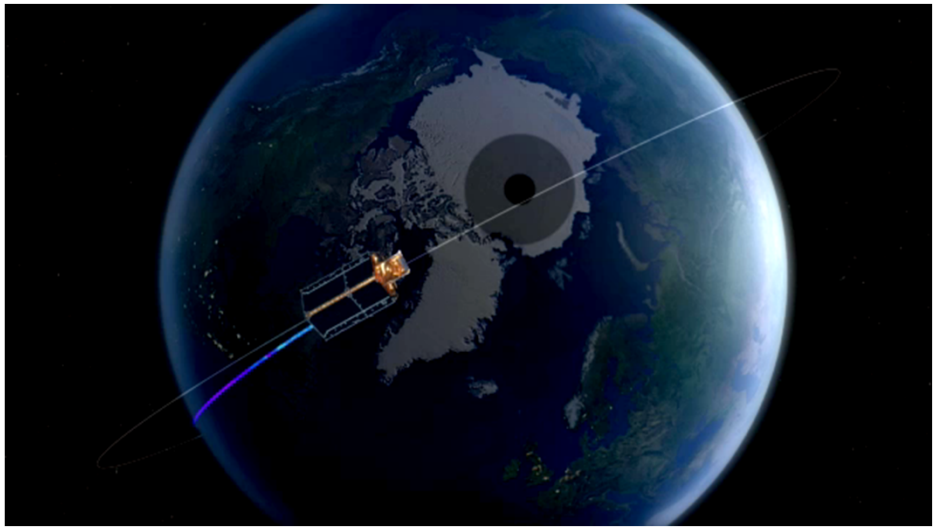
ESA and Partners

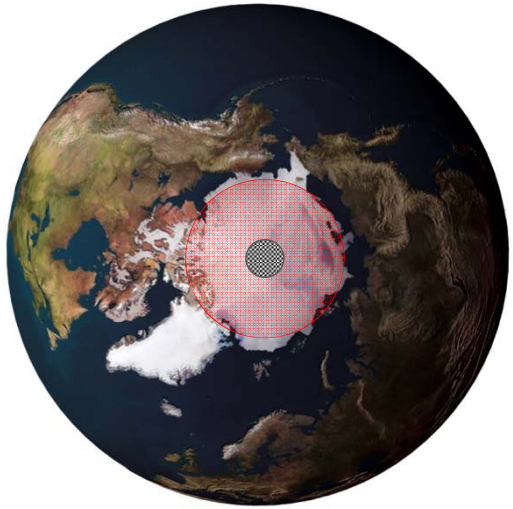
Context

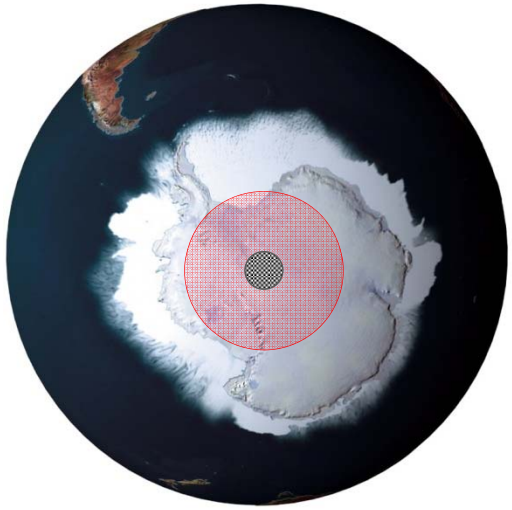
- **An unusual Orbit**

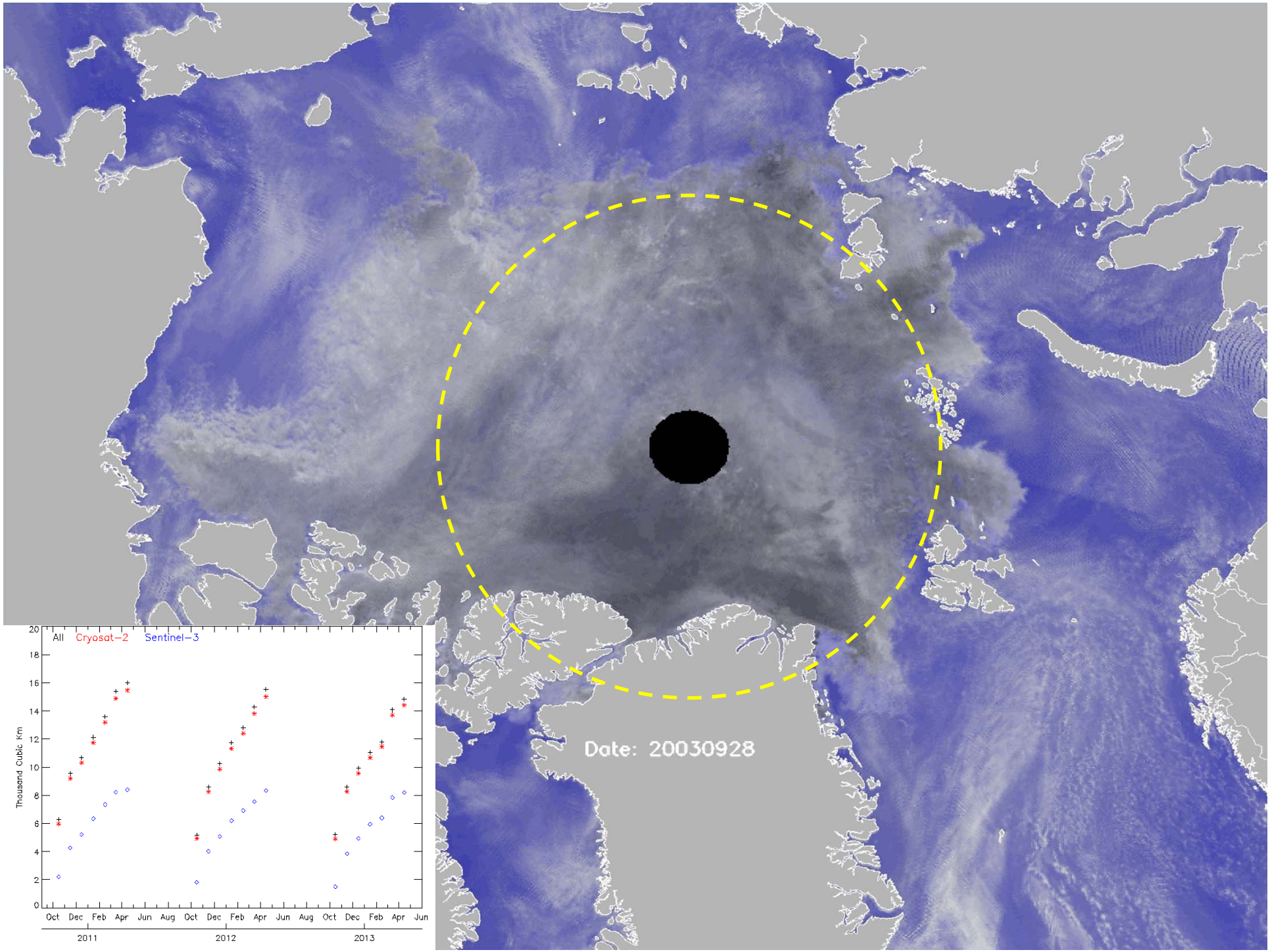
92 degree orbit inclination to survey Arctic Sea Ice & Antarctic and Greenland ice sheets.

369 day repeat with 30 day sub cycle provides dense across track sampling and captures temporal change








Date: 20030928
All
Cryosat-2
Sentinel-3
Thousand Cubic Km
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2
4
6
8
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12
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16
18
20
Oct
Dec
Feb
Apr
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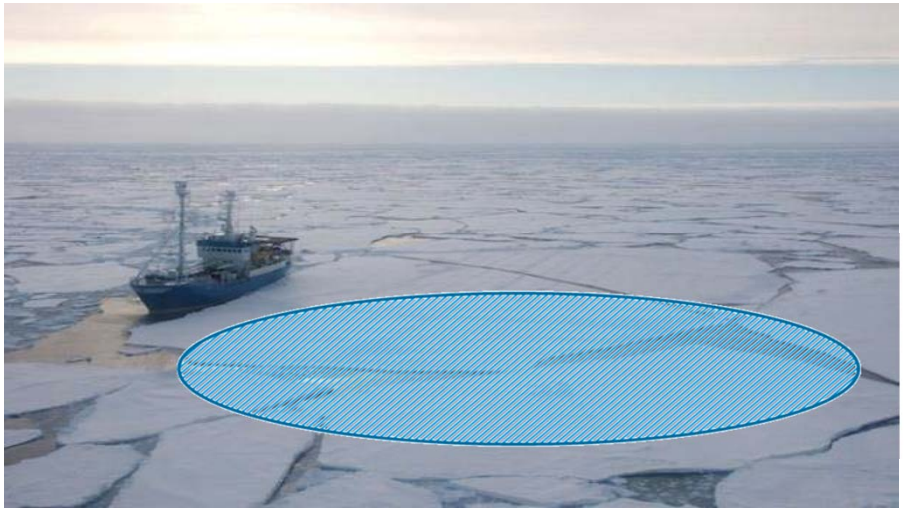
Apr
Jun
2011
2012
2013

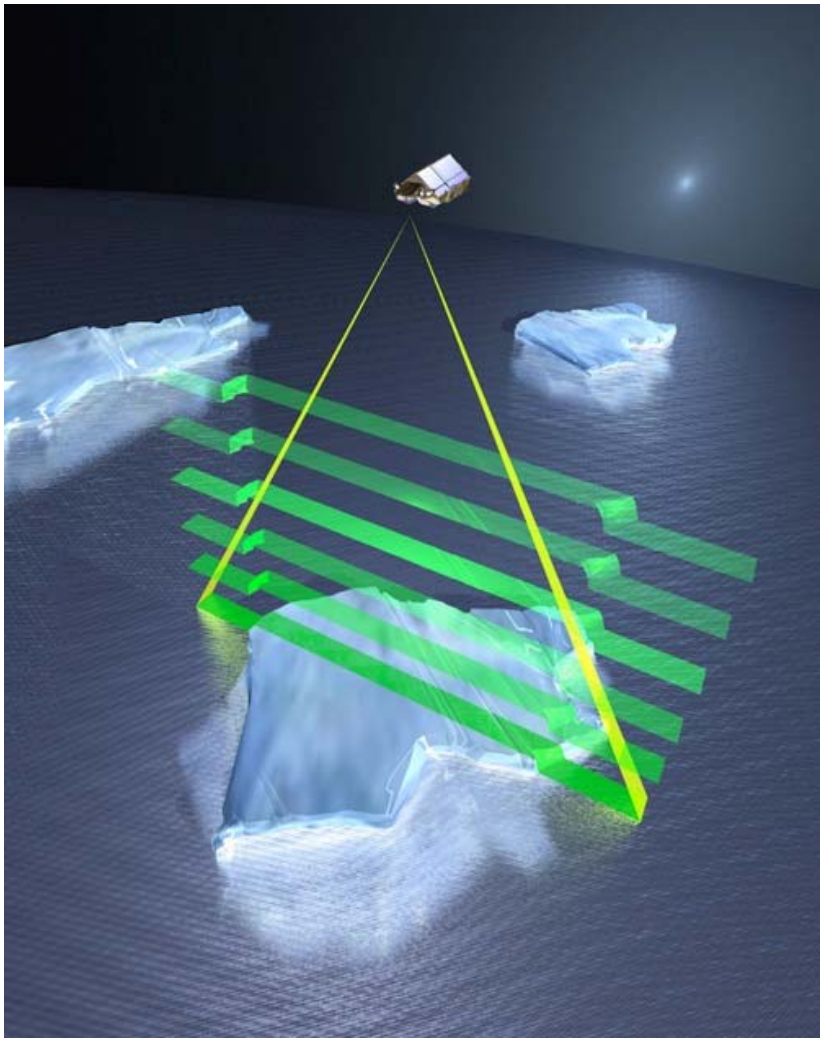
Context

- **Finer Spatial Resolution**

SAR mode improves along track resolution, designed to pick out leads

SARIn mode improves across track resolution, designed for rugged terrain





Context

- **CryoSat Mission Main Challenges**

Need to quantify how the thickness of the ice is changing to understand…

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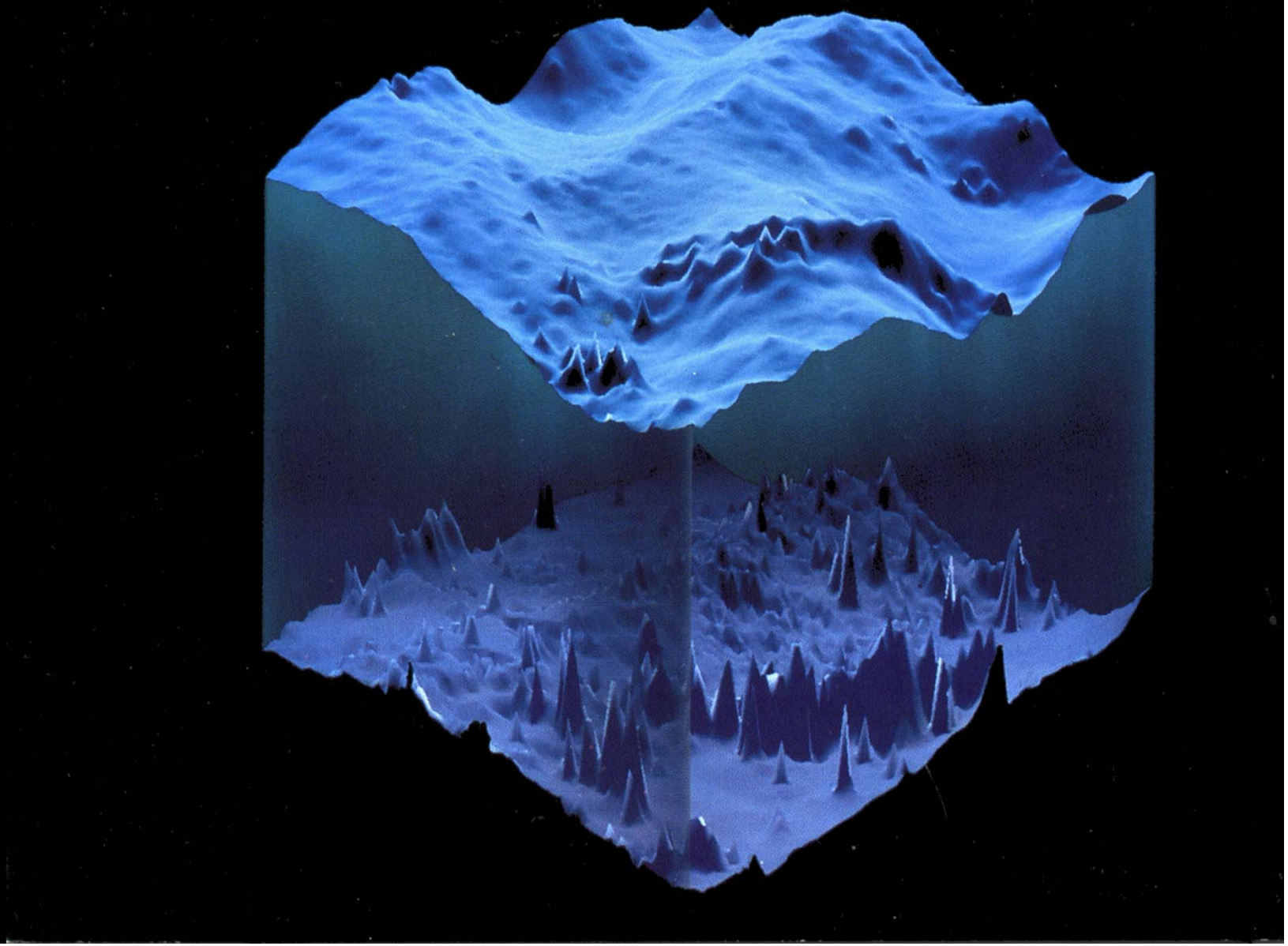
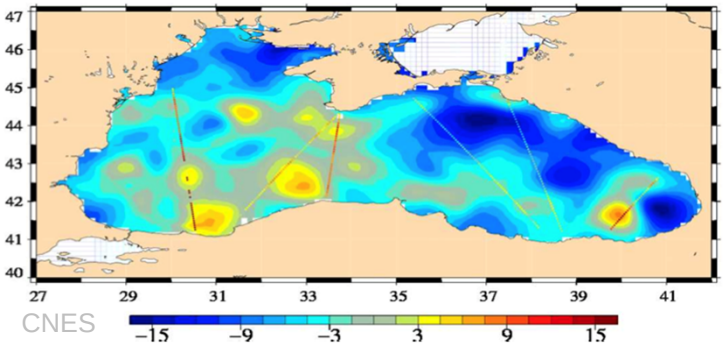
Wider scientific achievements beyond ice



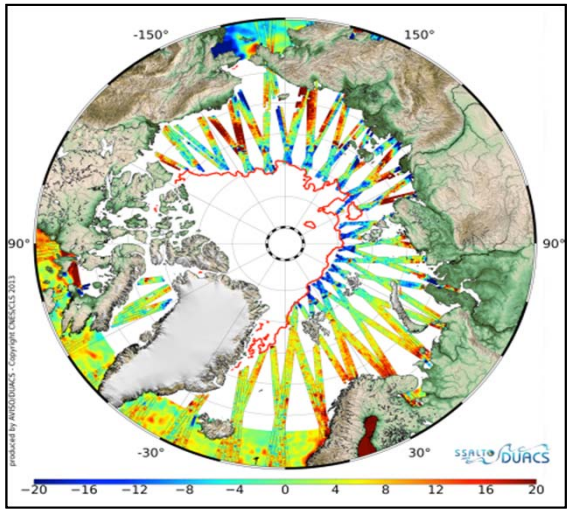
Context

- **Beyond ice:** *Ocean Dynamics*

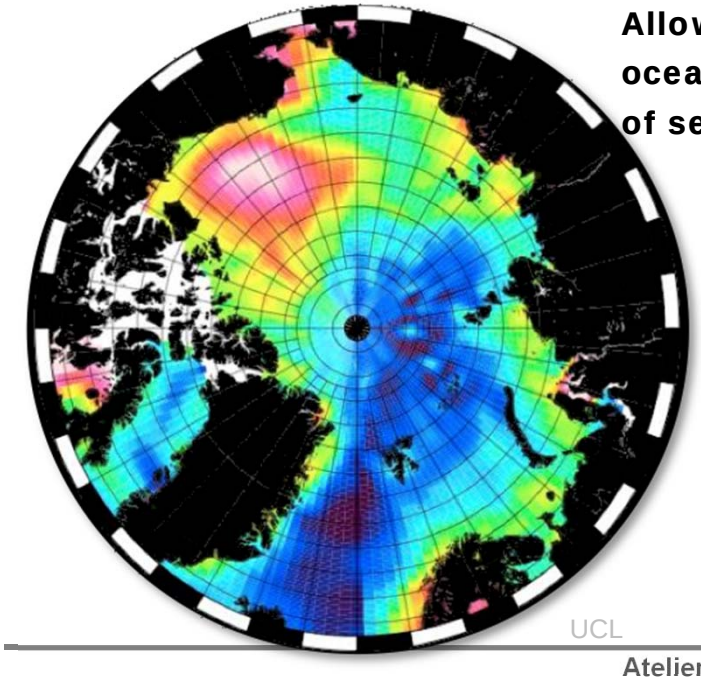
Extends capability to polar oceans, small basins, and coastal regions



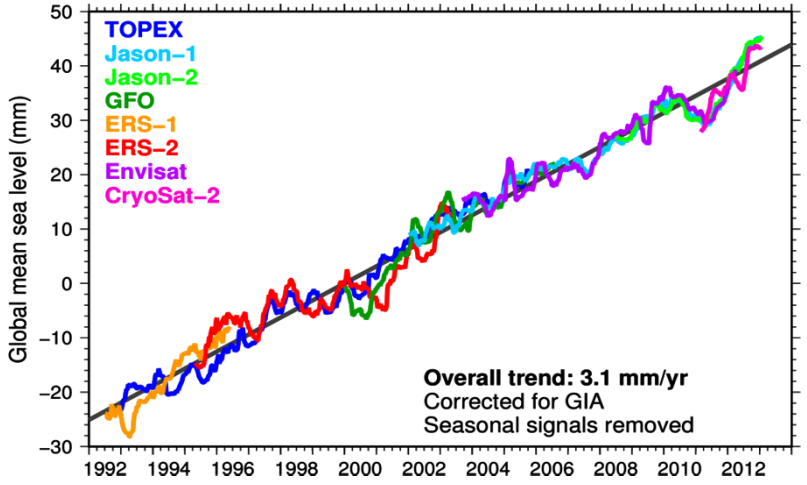
CNES



Allows tracking of dynamic ocean topography in presence of sea ice



UCL



Additional source of sea level data

R. Scharoo, Eumetsat

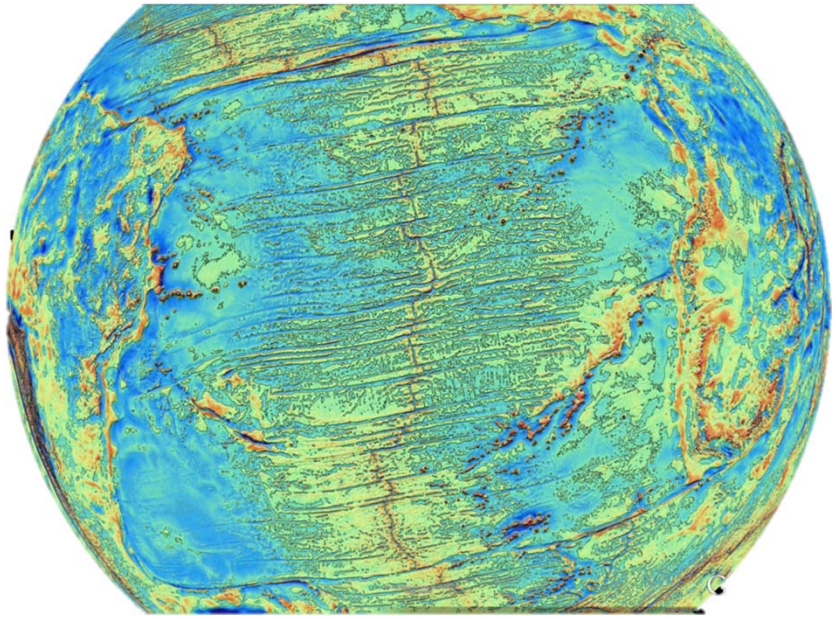
Context

- **Beyond ice:** *Marine Gravity and Wetlands*

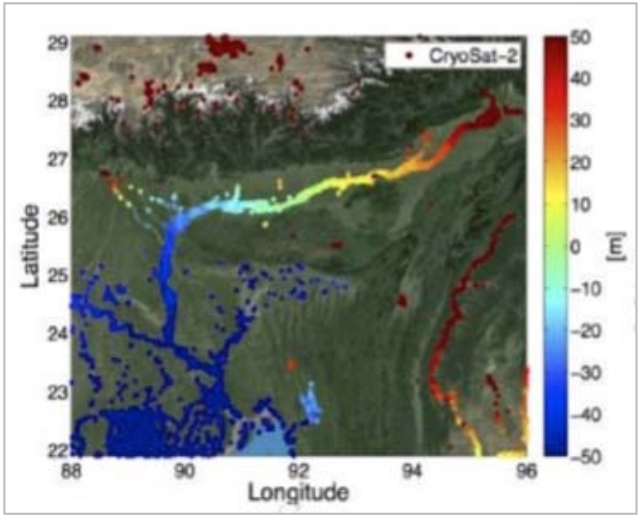
Marine Gravity

CS2 range precision >2 times ERS

SIRAL can detect seafloor characteristics at 5-10 km scale



D. Sandwell, Scripps



Inland water

Mapping of inland water storage

CS2 only mission sampling high Arctic rivers and lakes

Credits: FP7-LOTOS

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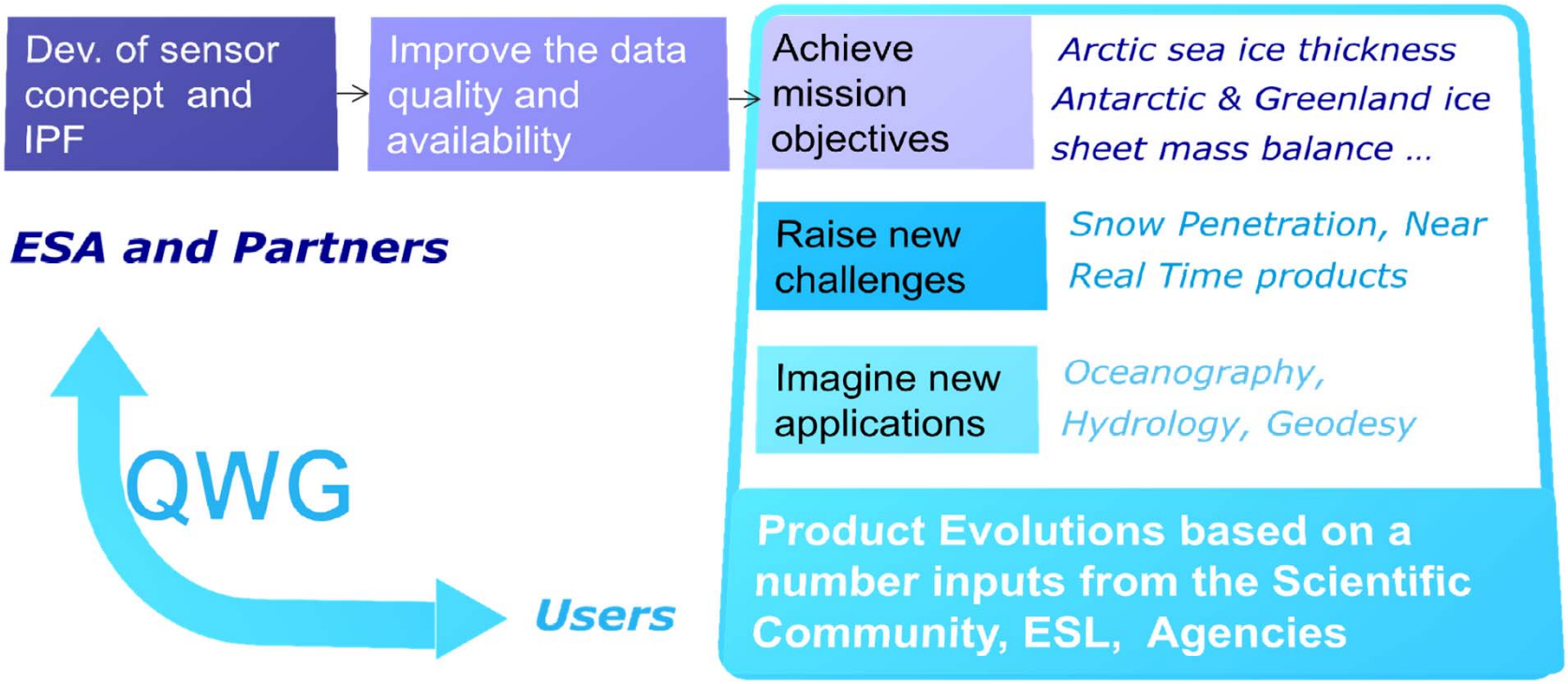

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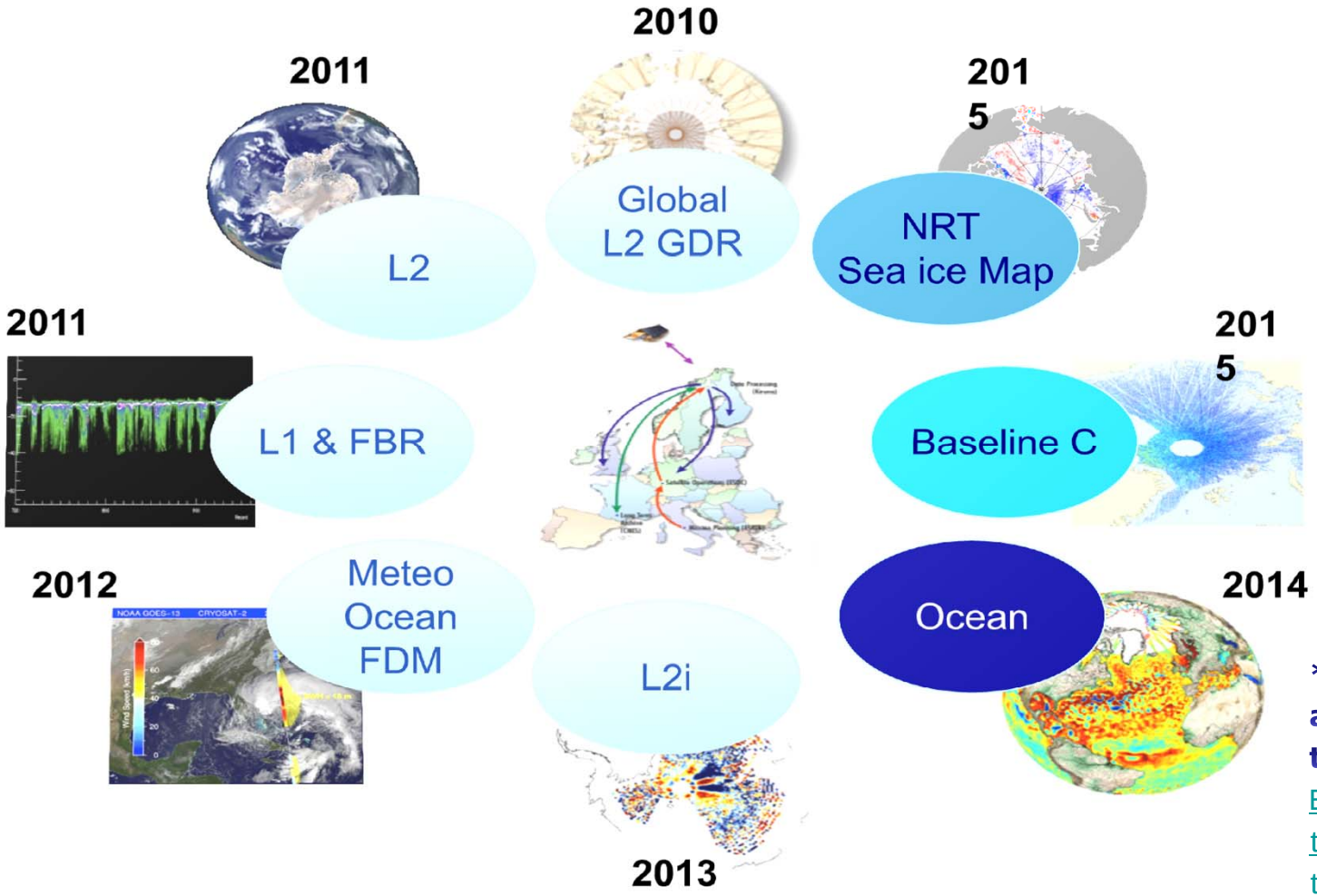
Product Evolutions

- **5 years of product evolutions**



Driven by new user requirements** & improved GS capacity

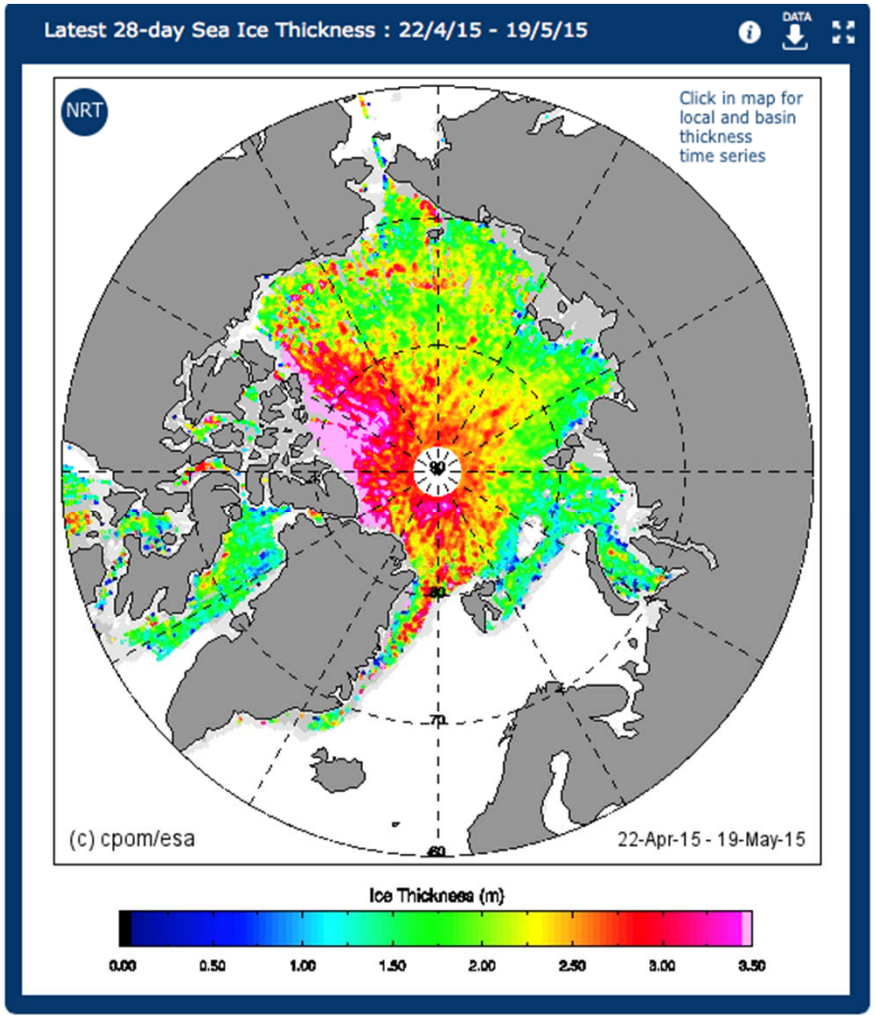
Data disseminated to users increases from 3GB/d to ~ 50GB/

**** Contact for questions and feedback regarding the CS missions**

Eohelp@esa.int,
tommaso.parrinello@esa.int
Jerome.bouffard@esa.int

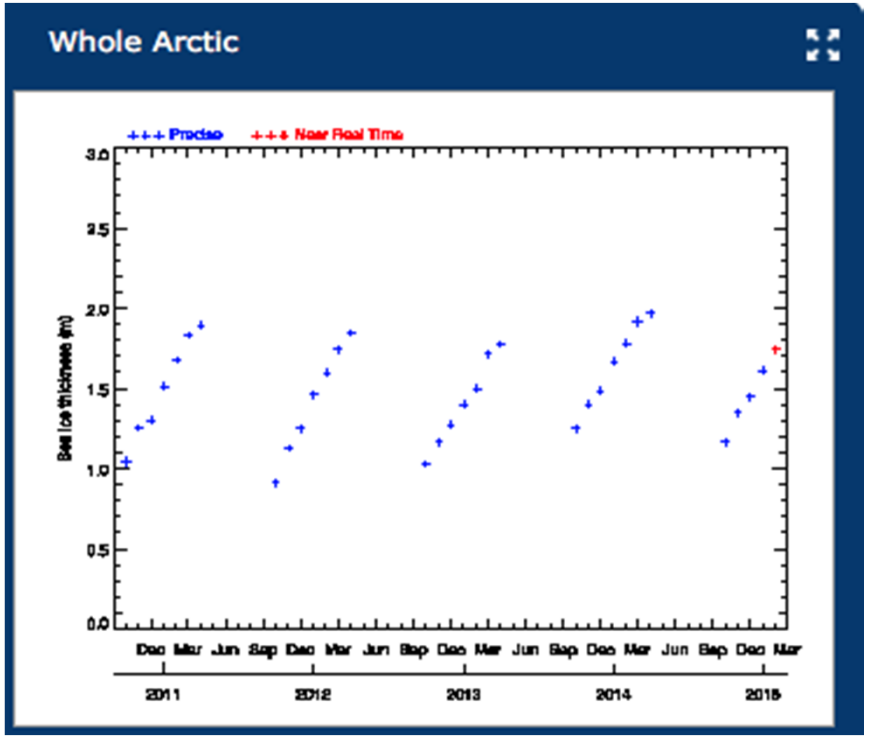
Product Evolutions

- **Operational Polar Monitoring**



CRYOSAT cpom

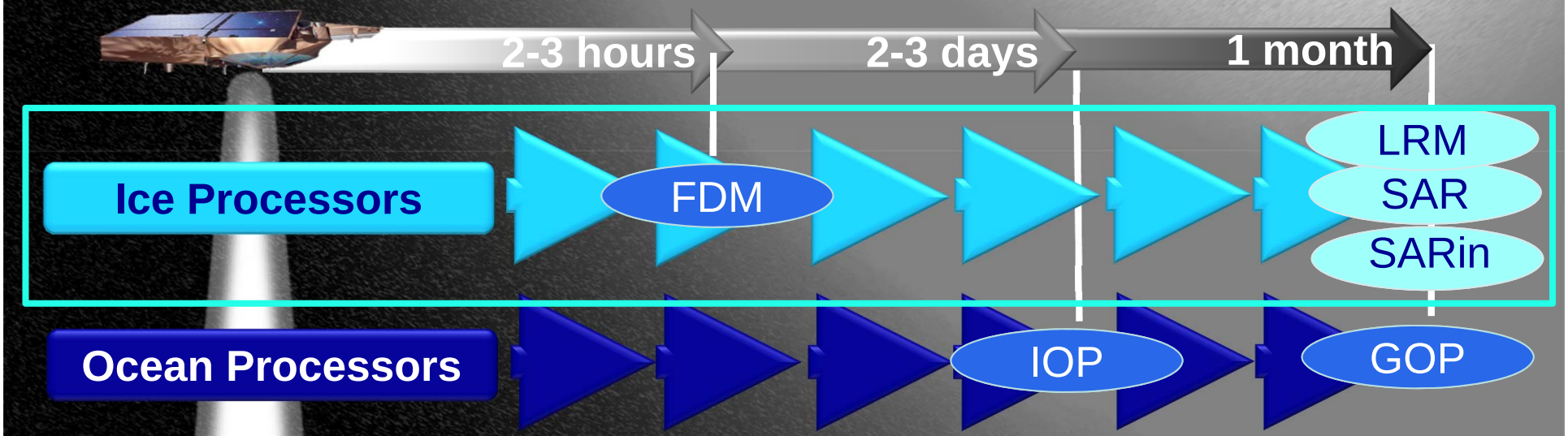
Sea-ice thickness: 2 days, 14 days, 28 days



http://www.cpom.ucl.ac.uk/csopr/

Product Evolutions

- **2 CryoSat Processors**



Ocean products distributed in order to bridge the gap between previous & future ocean-oriented missions

Ice IPFs: L1B & L2 ice products are distributed in order to achieve the Mission objectives over the cryosphere

Only the ice products are generated with the Baseline C

Product Evolutions

- **Baseline C: A Major Processor Upgrade**

  - Processor upgrades to improve the CS2 products **quality and Content**

  - Fix issues from previous release, **refine IPF1 / IPF2 algorithms** and integrate new fields (e.g. **Freeboard** for the L2 SAR products).

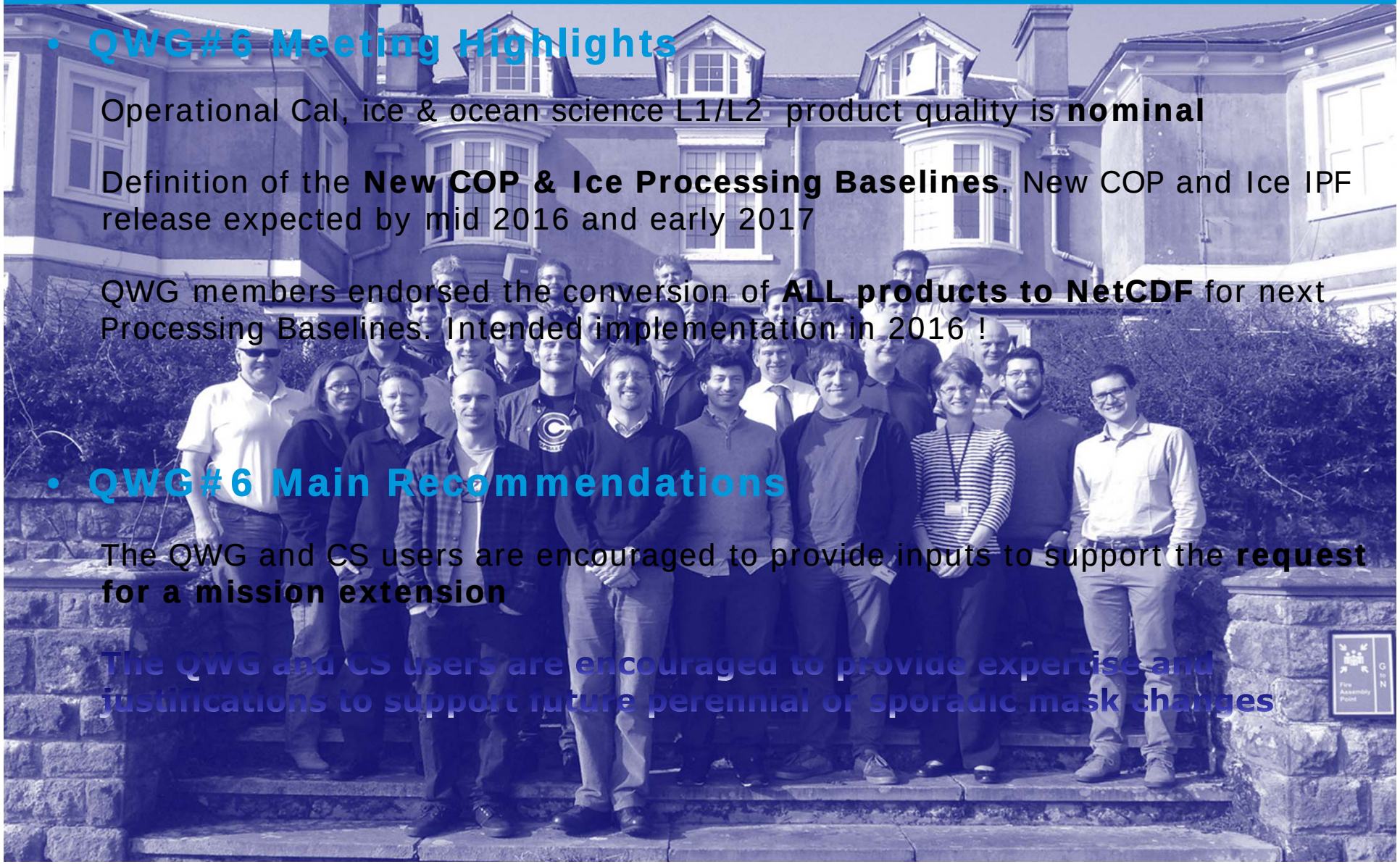
  - Baseline C TDS analysis show that the **data quality is improved** as expected !

  - The CCVS-PR (MSSL, March 2015) endorsed the Baseline C to go in operation and to reprocess data during the **second global reprocessing campaign**

Information on the Baseline C changes and improvements:

https: //earth.esa.int/web/guest/pi-community/news/-/article/expected-changes-for-upcoming-release-of-cryosat-baseline-c

Product Evolutions



- **QWG#6 Meeting Highlights**

  Operational Cal, ice & ocean science L1/L2 product quality is **nominal**

  Definition of the **New COP & Ice Processing Baselines**. New COP and Ice IPF release expected by mid 2016 and early 2017

  QWG members endorsed the conversion of **ALL products to NetCDF** for next Processing Baselines. Intended implementation in 2016 !

- **QWG#6 Main Recommendations**

  The QWG and CS users are encouraged to provide inputs to support the **request for a mission extension**

  The QWG and CS users are encouraged to provide expertise and justifications to support future perennial or sporadic mask changes

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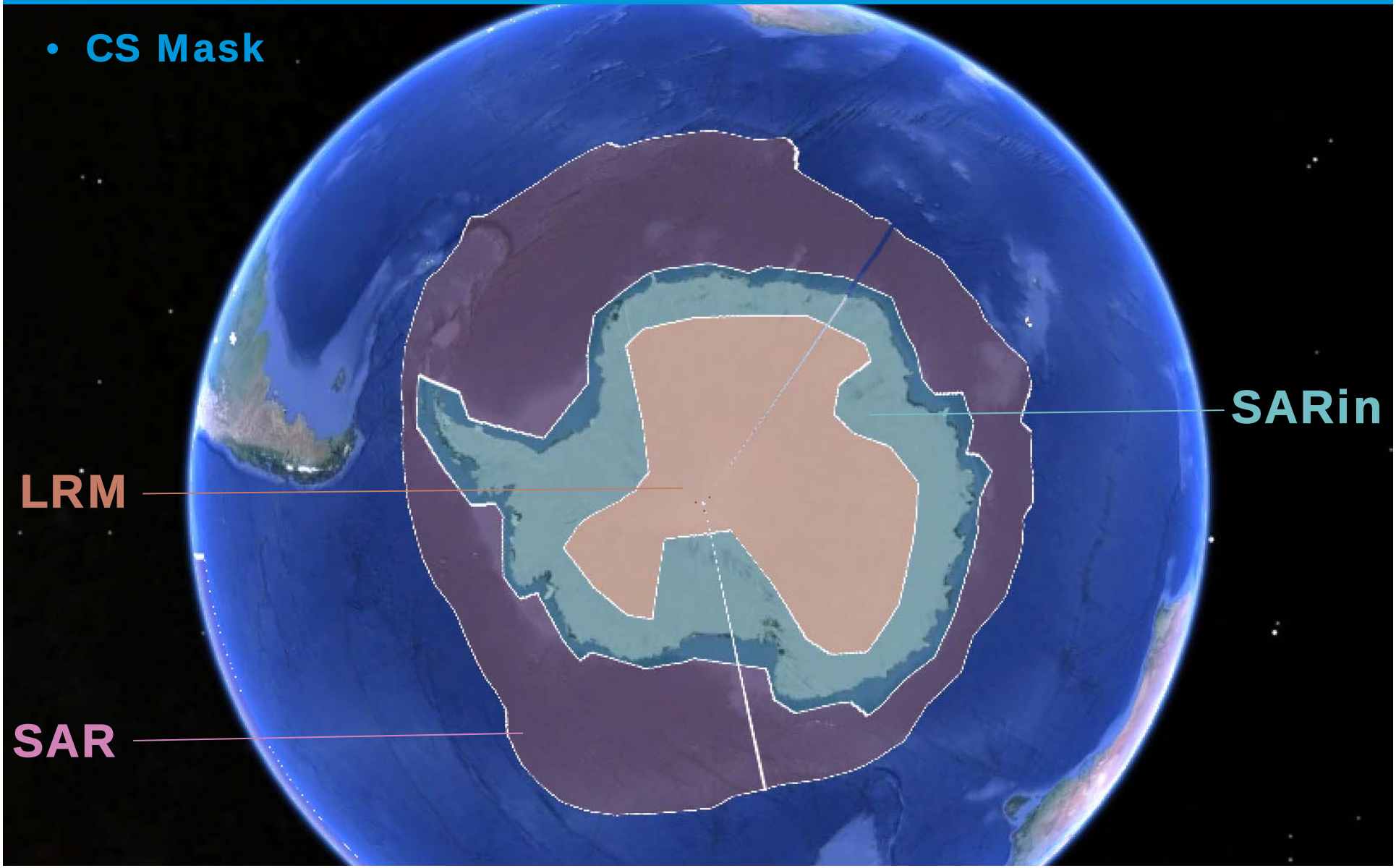
SAR acquisitions over interior Land Ice



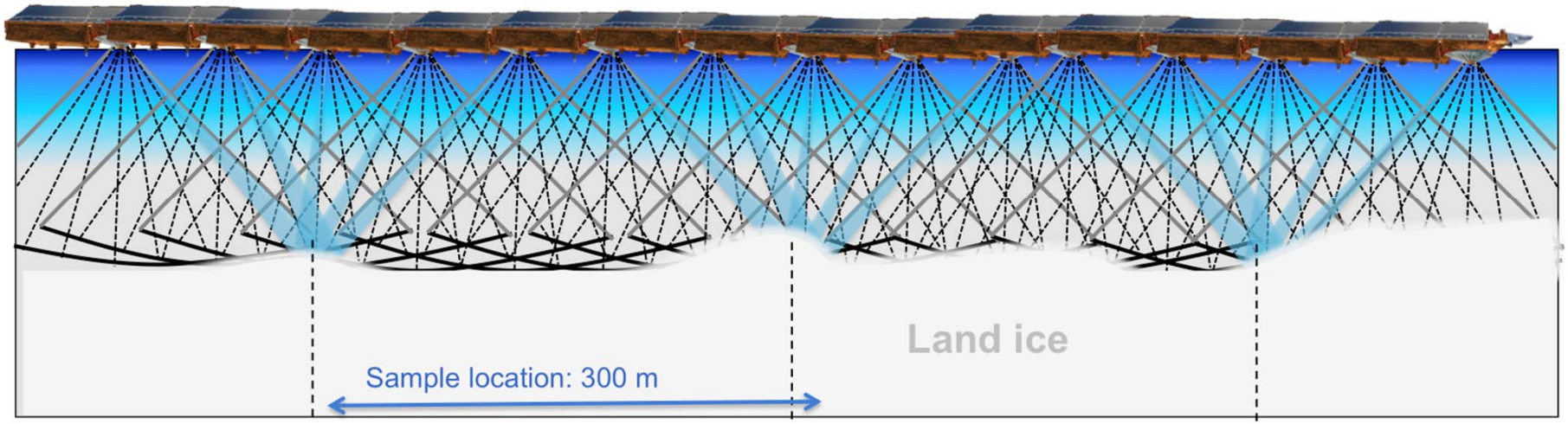
SAR acquisitions over interior Land Ice

- **Why ?**

Conventional altimetry acquisitions are **not always suitable** over areas of rough topography inside the interior ice sheet of Antarctica.

CS is the 1st **SAR(in) altimeter concept** to be flown on Earth and represents the unique opportunity to process **SAR data over land ice prior to** the S3 Launch

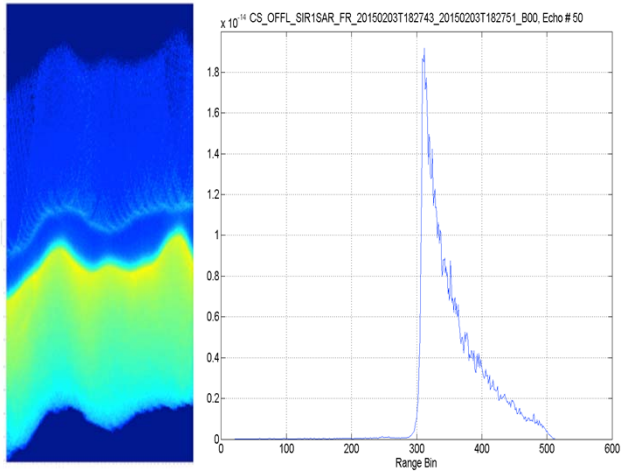
In theory, SAR altimetry should allow better **detections of small scale ice sheet gradients** than LRM



SAR acquisitions over interior Land Ice

- **Preliminary results from past Acquisitions**

12/09/2013 (still on going)
Very small area

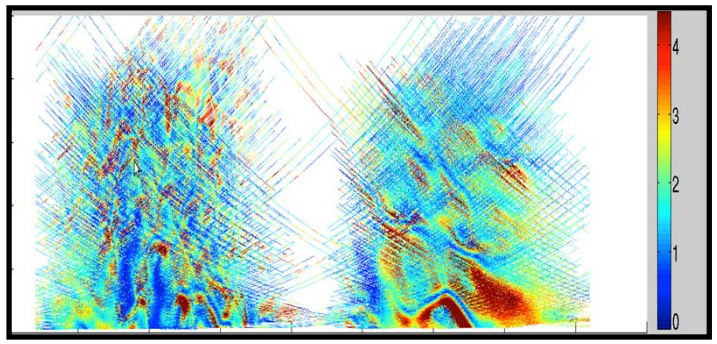


Courtesy S. Dinardo, ESA

Typical SAR waveforms from land ice's interiors similar but **fatter than open-sea waveform** (rougher surface)

SAR waveform over interior Land-ice will **required to be properly modeled** in order to be adequately retracked

DEM (m) from CS SAR



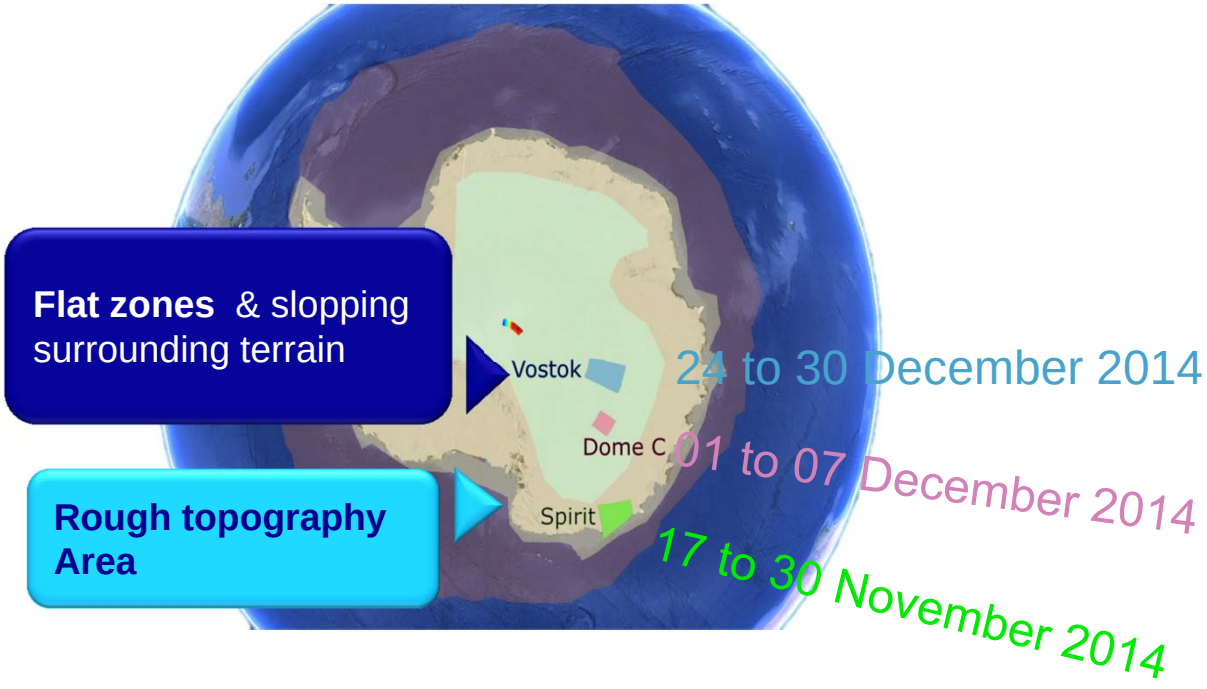
Roughness (m) from CS SAR

Good qualitative topography retrieval for short scale features and lower % of outliers than in LRM

SAR acquisitions over interior Land Ice

- **New Acquisitions**

In cooperation with CNES, ESA's CryoSat mission carried out SAR acquisition experiments over Antarctica in order to



Support the development, the validation and the fine-tuning of the **S-3 Ground Processing Algorithms**

Proceed to collocated **comparisons** between LRM, SAR, SARin ….

…. and with other dataset (*in situ*, Stereoscopic DEM from the **SPIRIT**, **TerraSAR-X** acquisition)

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Conclusions and Perspectives

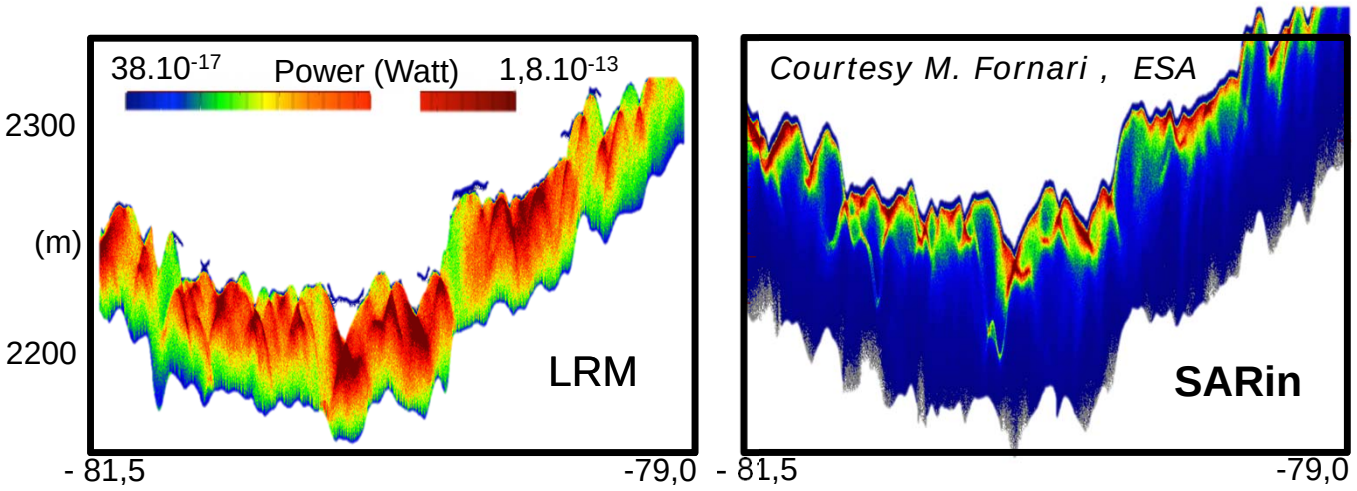
- **SAR Acquisition over Interior Land Ice**

  First results are promising but space/time limited because inconvenient for usual LRM users and on-board resource consuming

  The full land-ice SAR datasets are made available to the whole registered CS users

  Feedback from the Scientific Community of CS users to ESA are highly encouraged in order to support future mask changes

- **SARin Acquisition over Interior Land Ice**



SARin acquisitions have been also performed over Antarctica LRM area

SARin tracking never failed, allow High Resolution & **across-track** discriminations

Conclusions and Perspectives

- **Perspectives**

Demonstrate the potential of SARin over transitory areas between land ice and sea ice areas as well as over the coastal ocean

Develop Operational ice products, parameters and index responding to short and long term societal need (tools for policy maker)

Implement **NetCDF Format** for both COP and Ice Processors (**CR#3**)

Processor upgrades and within the new Baselines of **COP (CR#2, 2Q 2016)** and of the **Ice Processor (3Q 2016)**

Proposal for mission extension beyond 2017: 3Q 2015 – 1Q 2016 (as part of EOEP-4 science review)

4th CryoSat User Workshop **(in LPS16): 9-13 May 2016**

PRAGUE 09-13 MAY 2016

living planet symposium | PRAGUE 09-13 May 2016

Main Objective:
Presentation of Exploitation Results based on ESA Earth Observation Measurements

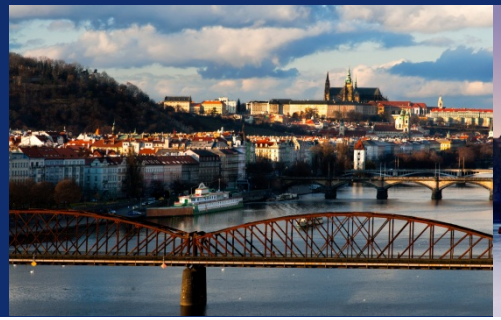
Important Dates:

Deadline for abstract submission	16 October 2015
Notification of Acceptances	End January 2016
Issue of Preliminary Programme	February 2016
Opening of Registration to the Symposium	February 2016

Themes:

Atmosphere, Oceanography, Cryosphere, Land, Hazards, Climate and Meteorology, Solid Earth/Geodesy, Near-Earth Environment, Methodologies and Products, Open Science 2.0

http://lps16.esa.int



Contacts

Information to access to the CryoSat products:
https://earth.esa.int/web/guest/-/how-to-access-cryosat-data-6842

For questions regarding the CS mission and products:

Eohelp@esa.int, tommaso.parrinello@esa.int and jerome.bouffard@esa.int

Information on the Baseline C changes and improvements:

https: //earth.esa.int/web/guest/pi-community/news/-/article/expected-changes-for-upcoming-release-of-cryosat-baseline-c

Quality-Control Reports are accessible via the ESA CS webpage:

https://earth.esa.int/web/guest/missions/esa-operational-eo-missions/cryosat in the tabs /daily-performance-reports and /cyclic-reports

Ice interior data have been extracted from the G-Pod user service:
https://gpod.eo.esa.int/services/CRYOSAT_SAR/