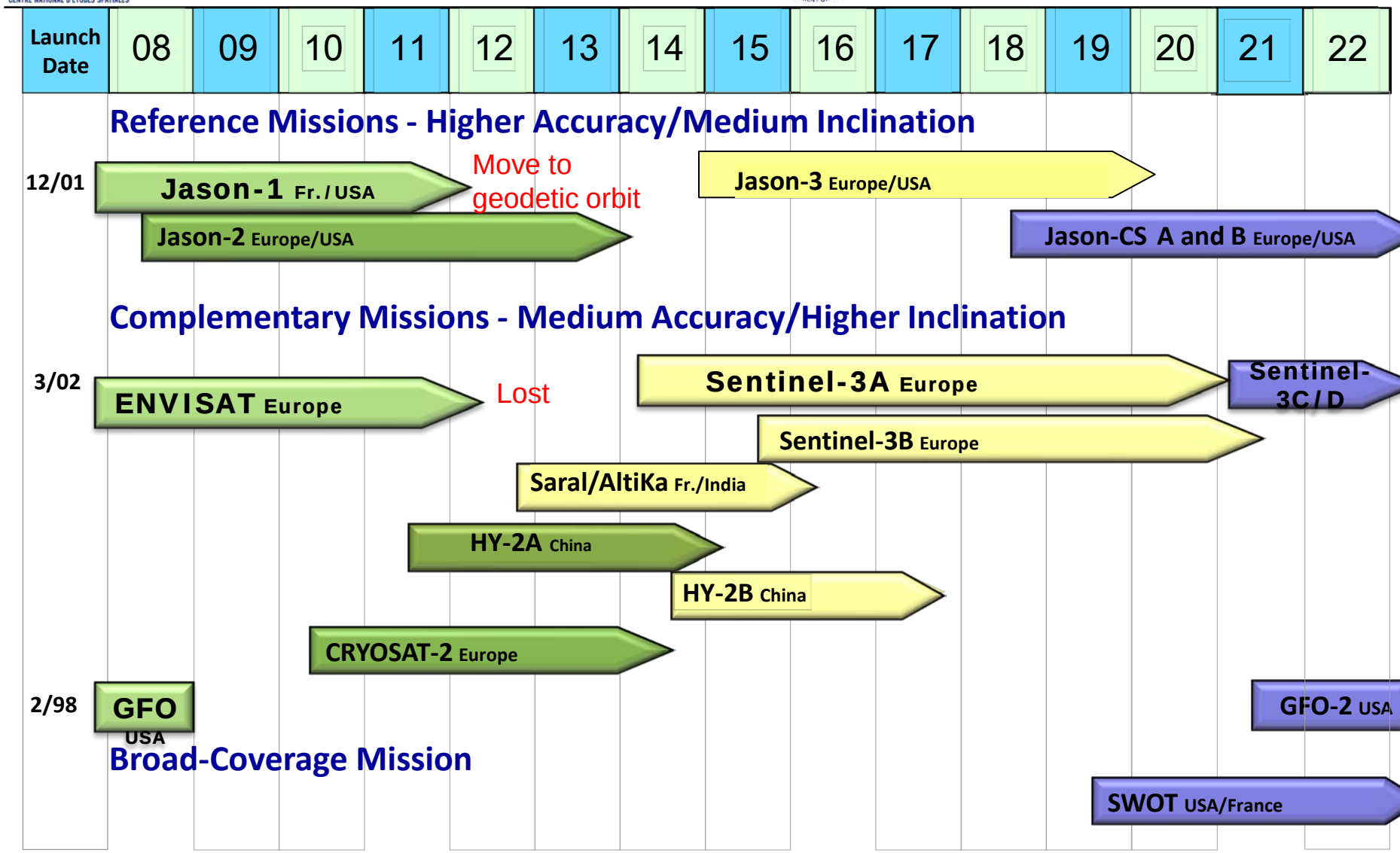
OSTST 2012

Venice

Mission / Program Status

With contribution from CNES, ESA,
EUMETSAT, NASA and NOAA


Launch Date
08
09
10
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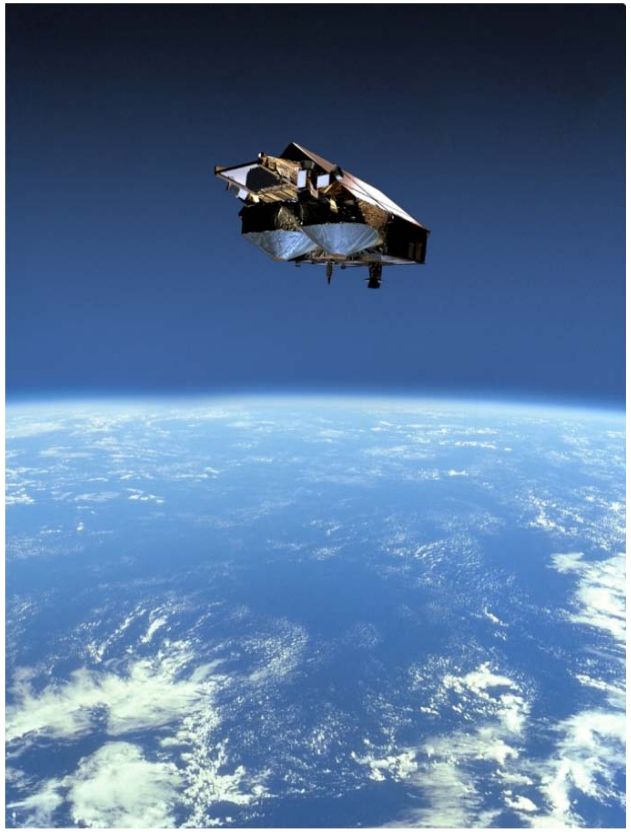
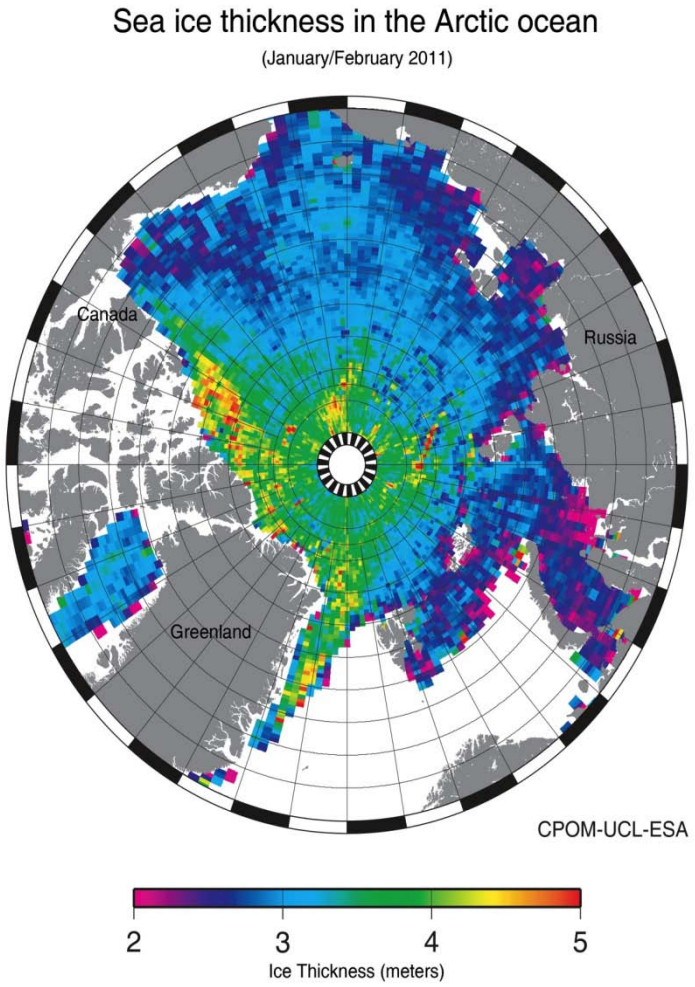
Reference Missions - Higher Accuracy/Medium Inclination
12/01
Jason-1 Fr./USA
Move to geodetic orbit
Jason-3 Europe/USA
Jason-2 Europe/USA
Jason-CS A and B Europe/USA
Complementary Missions - Medium Accuracy/Higher Inclination
3/02
ENVISAT Europe
Lost
Sentinel-3A Europe
Sentinel-3C/D
Sentinel-3B Europe
Saral/AltiKa Fr./India
HY-2A China
HY-2B China
CRYOSAT-2 Europe
2/98
GFO USA
GFO-2 USA
Broad-Coverage Mission
SWOT USA/France
Design Life
Extended Life
Approved
Proposed
Operating

Content

- Missions status
  - Jason 1, 2, 3 covered later on
  - Cryosat, SARAL, S3, Jason-CS, SWOT …
- Some points on Jason-CS for you to be discussed during splinter session, dedicated meetings, pause etc…
  - Altimeter modes
  - Radiometer(s)
- OSTST, CEOS Virtual Constellation developments

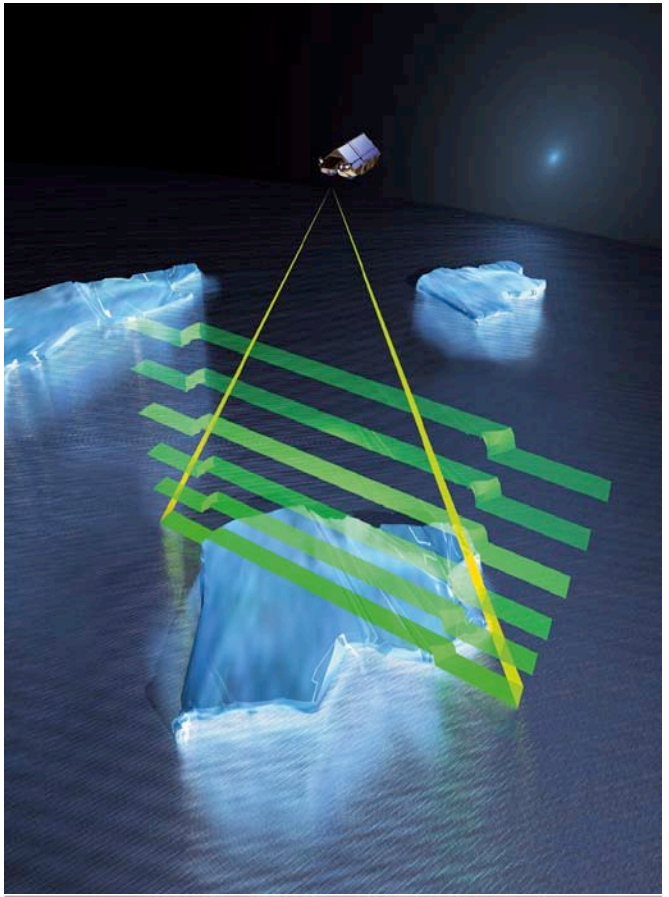




CryoSat Mission Status

Space and ground segment status

- Space and ground segment are very stable
- Instruments are functioning very well with no sign of major degradation
- Around 3 GB of data/day are delivered to the international community which has increased by 65% since launch
- CryoSat mission is delivering high quality data to various user communities (i.e. ice, ocean, marine gravity) and to operational services (i.e. DUACS, NCEP)
- Baseline B was released on the 1st Feb 2012
- First reprocessing campaign has started
- Mission performance (i.e. Mission data return) is >97%
- Expected life time > 5 years



Summary instrument

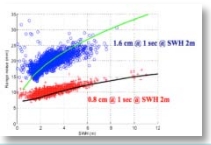
Mode	Type	Specification	Observed	Comment
LRM/FDM	Altimeter radar range noise	**Not specified**	**1.42 cm**	Computed average range noise at 1Hz for significant wave height (SWH) of 2 m. Note: better range noise than Jason-2 (**1.72 cm**). *Credits: W. Smith NOAA, OSTST 2011*
	Signal-to-noise ratio	**> 8 dB**	**≈31 dB**	≈ 9 dB Better SNR than Jason-2 *Credits: W. Smith NOAA, OSTST 2011*
SAR	Altimeter radar range noise	**Not specified**	**0.8 cm**	*Credits: Phalippou, et al, 'Optimal re-tracking of SAR altimeter echoes over open ocean: theory versus results for SIRAL2 data', OSTST 2011*
	Signal-to-noise ratio	**> 18 dB**		Not evaluated yet
SARIN	Altimeter radar range noise	**Not specified**	**1.6 cm**	Indirect experimental value based on SAR observation: 2 x 0.8 cm of SAR performance. No experimental evaluation yet.
	Signal-to-noise ratio	**> 18 dB**		Not evaluated yet
	Residual across-track precision at 1 second	**60 µrad**	**24 µrad**	Calibration of interferometer leads to a residual contribution to ice sheet elevation error of **0.3 mm** against initial specification of **1.5 cm** *Credits: N. Galin, et al, 'Calibration of the CryoSat-2 Interferometer and Measurement of Across-Track Ocean Slope', Trans on Geoscience and Remote Sensing, in press*
	Residual across-track bias at 2000 km	**141 µrad**	**4 µrad**	

Mission status main message

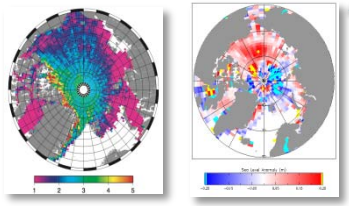
- CryoSat continues to meet and exceed its engineering specifications in all modes (LRM/SAR/SARIN) proving to be a precursor for future altimetry missions.
- Preliminary results show that the mission will meet its geophysical specifications and primary mission goals.
- The experimental verification of the scientific requirements must take into account a number of challenges some of which are constantly being tackled since the launch and even beforehand
- A road map has been established by ESA with the support of expert teams to assess, by the end of next year, to which extent CryoSat has met its scientific requirements. By that time, the first estimation of the residual uncertainty and of the trend of sea ice mass in the Arctic will have been shown. The assessment of mission objectives for land ice will follow.
- Oceanographers and Marine Geodesists have shown that CryoSat will significantly contribute to their field (eg. SAMOSA Project final report).

http://www.satoc.eu/projects/samosa/docs/SAMOSA-CCN-D13-Final_V13.pdf

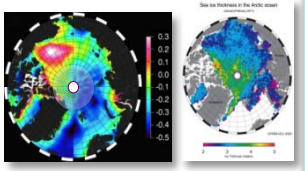
Challenges and roadmap to achieve mission objectives



Monitoring System Performance *(continuous)*

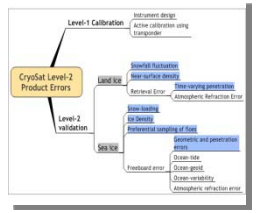


New Mean Sea Surface
First estimation of sea ice mass rate and residual uncertainty
(2O 2012 – Living Planet)



Results: sea-ice maps, etc. *(continuous)*

Requirements	Sea Ice 10^5 Km²	Ice Sheets 10^2 Km²		Ice Sheets $13.8 \cdot 10^6$ Km²
Minimum Latitude	50°	72°		63°
System Measurement Requirement	1.6 cm/yr	3.3 cm/yr		0.7 cm/yr
Pre-launch Performance	1.3 cm/yr	2.7 cm/yr	3.3 cm/yr	0.12 cm/yr
Measured	[xx cm/yr]	[yy cm/yr]	[zz cm/yr]	[ww cm/yr]
Mode	SAR	LRM	SARIn	SARIn/LRM



Estimation of L2 errors
Time stability of biases
(continuous)

Valida
Dedic
(*CryoVex 2005, 2011, 2012, ..*)

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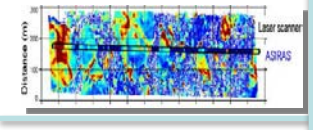
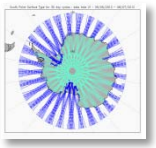
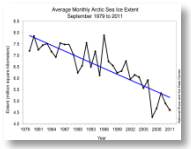
on
Report (CECR)



Consolidation of campaign data (*contract)*



Monitoring Data Quality *(continuous)*



Availability of at least 2 yr of data *(continuous)*

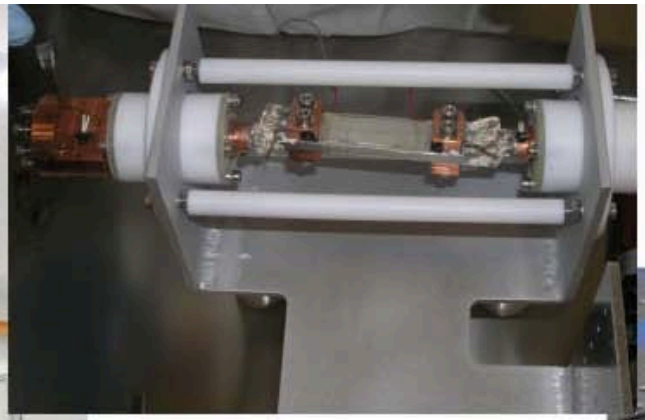
Reprocessing Campaign (*Completed by June 2013)*

GMES Space Component:Sentinel-3 Status

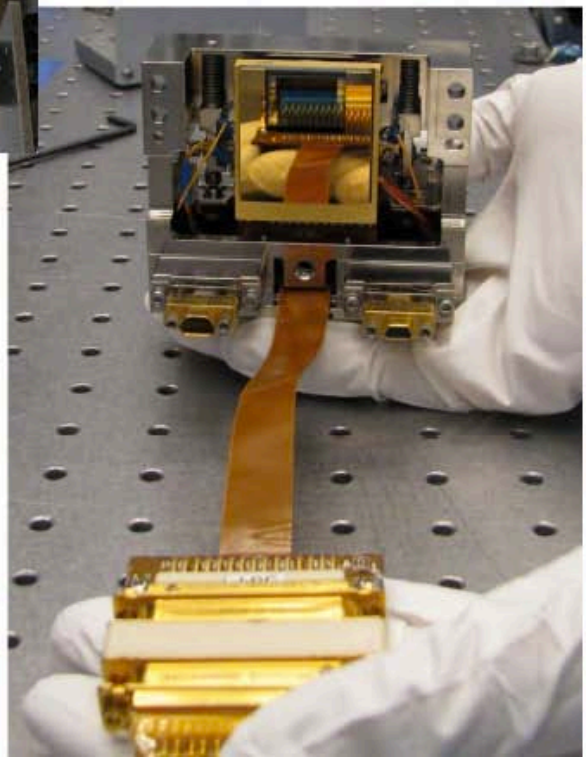
- **Programmatic**
  - Phase C/D ongoing - manufacture and testing of satellite flight units proceeding
  - Significant technical progress (see photographs): testing proceeding at instrument level
  - Preliminary Mission Analysis Reviews (PMAR's) with A- and B-unit launch providers (Eurockot and Arianespace) kicked-off
- **Recent achievements**
  - Electrical Integration of Platform Module close to completion, with Platform Integrated System Tests starting in September
  - Formal and final delivery of fully Validated Flight Software V1 required for SVT-0 planned in September 2012
  - All SLSTR Flight detectors (IR and VIS) delivered
- **Main issues**
  - SLSTR and OLCI development schedules remain on "critical path" (i.e. driving the schedule), mainly due to anomalies investigation (Cryocooler, Blackbodies) and implementation of corrective actions (FPA thermal control)
  - Anomaly during Solar Array Deployment Mechanism testing (slip-ring contact instability)under investigation

Sentinel-3 Hardware

Platform Module undergoing electrical Integration Test (courtesy of TAS-I)

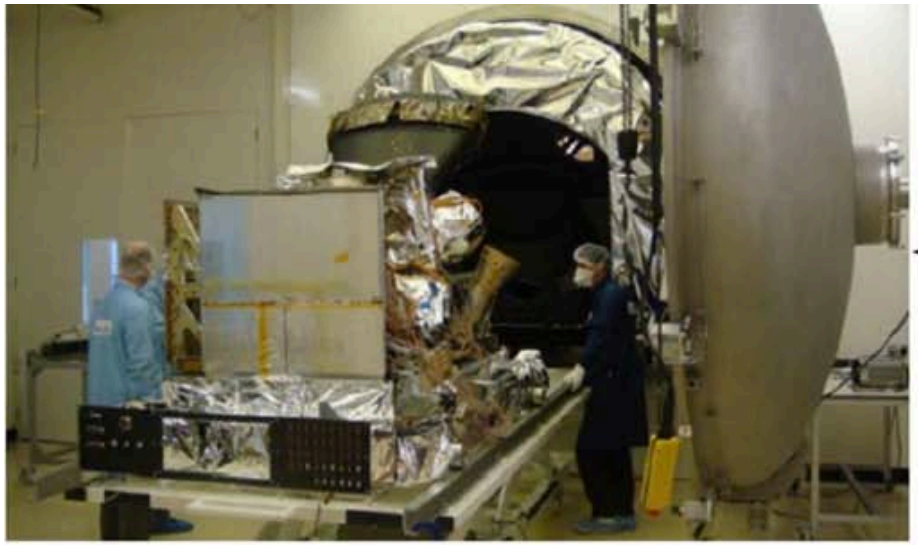


Heat Load Testing

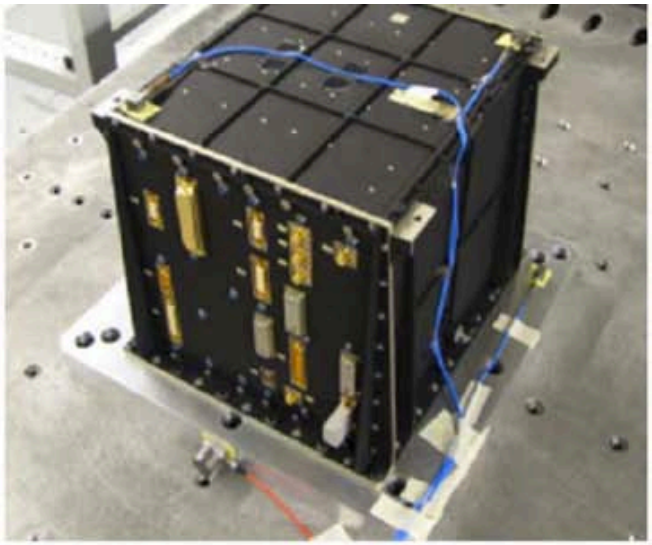


OLCI FPA PFM

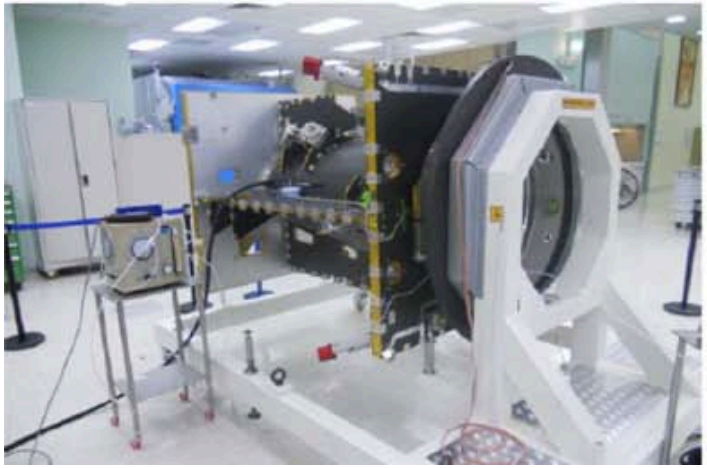
Sentinel-3 Hardware



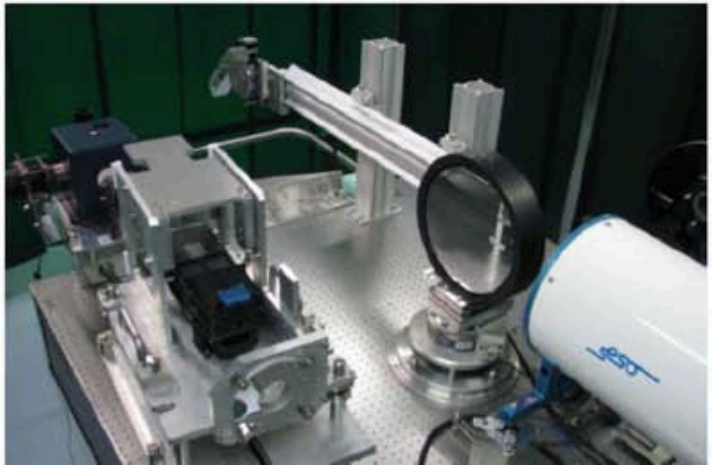
in RAL for TV Calibration Facilities validation



SRAL DPU PFM



Platform propulsion Module Integration



OLCI EM COSA under test

SENTINEL	LAUNCH DATE	LAUNCHER Rockot (Eurockot)
Sentinel-3A	Apr 2014	Vega (Arianespace)
Sentinel-3B	2015	

- Completion of platform integration – Oct. 2012
- October 2012 Sentinel-3 Mission Advisory Group meeting
- Commissioning and Cal/Val preparations between ESA & EUMETSAT
  - Cal/Val Plan issue soon
- S-3 Validation Team Call – foreseen 3rd Qtr 2012
- End-to-End Ground Segment CDR and verification review: Q1-2013
- Instrument integration into platform – starting early 2013

One slide on… HY-2A

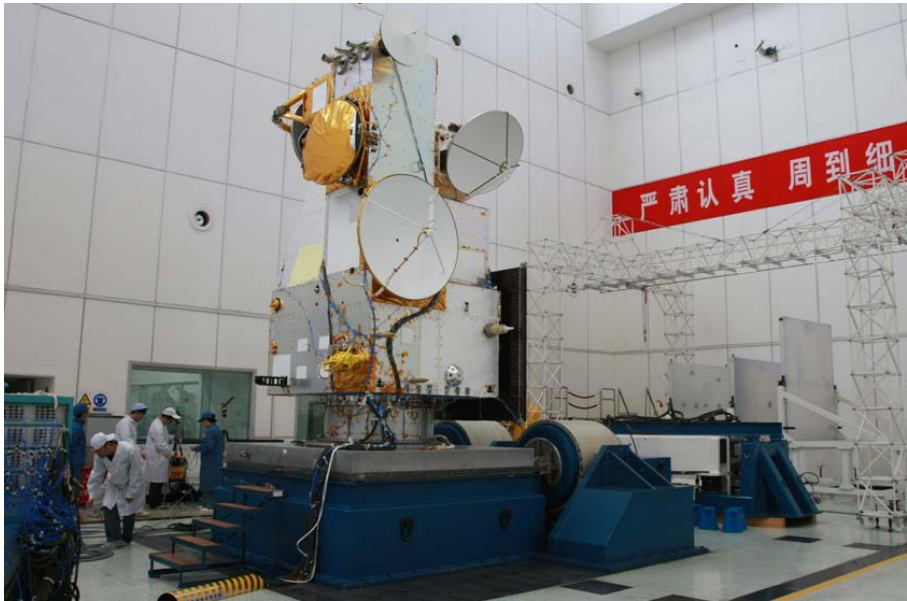
- Physical oceanography satellite from "China National Space Administration" (CNSA),
  - Altimetry payload: Ku-C altimeter, Ku/K/Ka radiometer, LRA, GPS, DORIS
  - Ku-band Wind scatterometer
  - 5-frequency radiometer (SST°)
- CNES participation:
  - POD processing
  - Inclusion of altimetry data into AVISO multimission product (after validation)
- Launched August 15, 2011
  - DORIS, GPS « on »: August 31th, 2011
  - Altimeter, radiometer « on »: Sept 1st
  - Final orbit reached on Sept 28th
- Orbit data of good quality
- Limited set of altimetry data received at CNES : see poster

HY for Hai Yáng (ocean)

SSO orbit, ~970 km

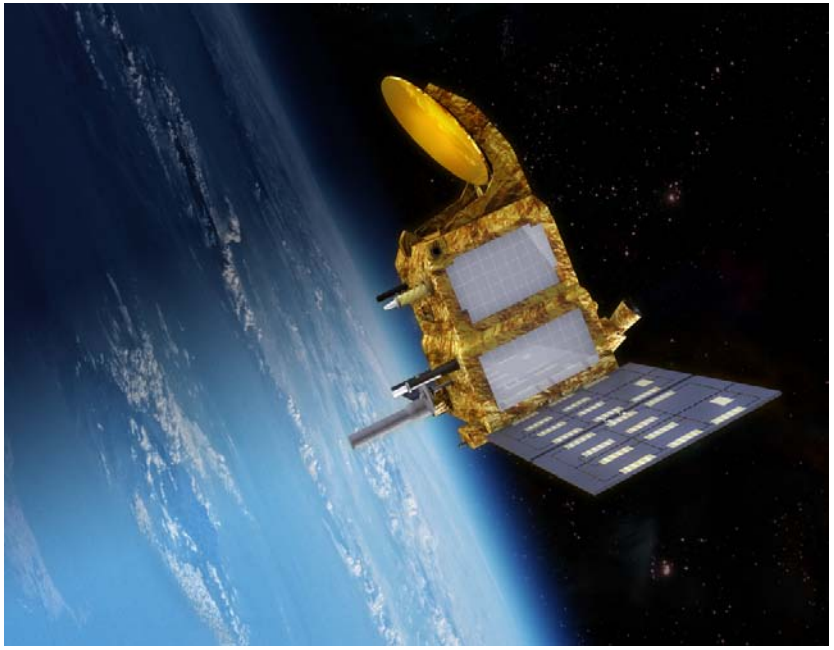
14-day cycle (2 years), then

168-day (geodetic) orbit for 1 year



One slide on... SARAL Satellite for Argos and ALtiKa

- Cooperation with ISRO (India Space Research organization)
- Ka-band nadir altimetry mission
  - Gap filler between ENVISAT & SENTINEL3
  - Same orbit as ENVISAT (35 days, SSO)
  - New Ka-band altimeter, higher precision, compact design, integrated radiometer/altimeter
  - POD: DORIS, LRA
  - Other CNES payload Argos-3 instrument, X-band telemetry
- Status:
  - Payload module arrived in ISRO mid-july
  - Bus-payload module mating completed
  - Final testing on-going
- India side: launched scheduled 12/12/12
- *Data policy : ~ the same as JASON missions*
- *PI: Jacques Verron (LEGI)*

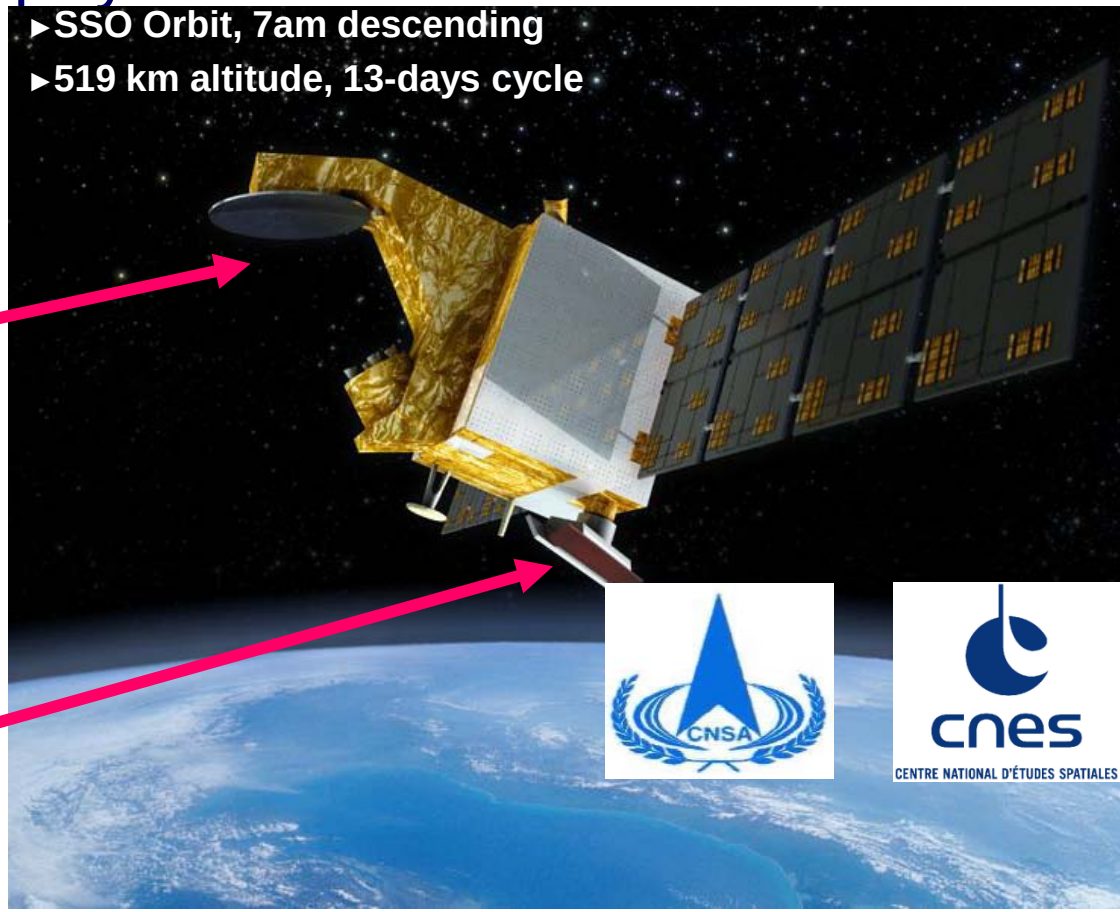


Two slides on... CFOSAT
China-France Oceanography SATellite

- China-France Cooperation
  - Currently in phase C/D
  - Launch date end of 2014

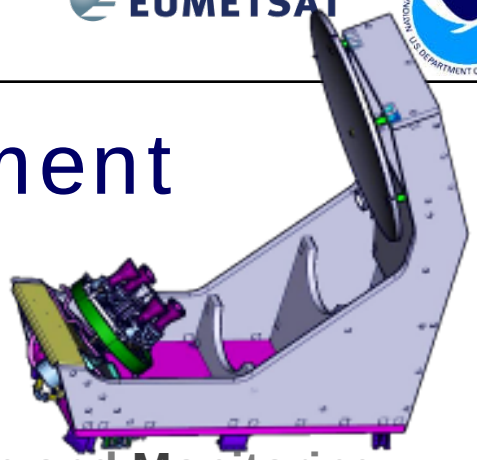
- SWIM, new spaceborne instrument
  - technology innovations (antenna, on-board digital processing)
  - Nadir chanel ~altimeter

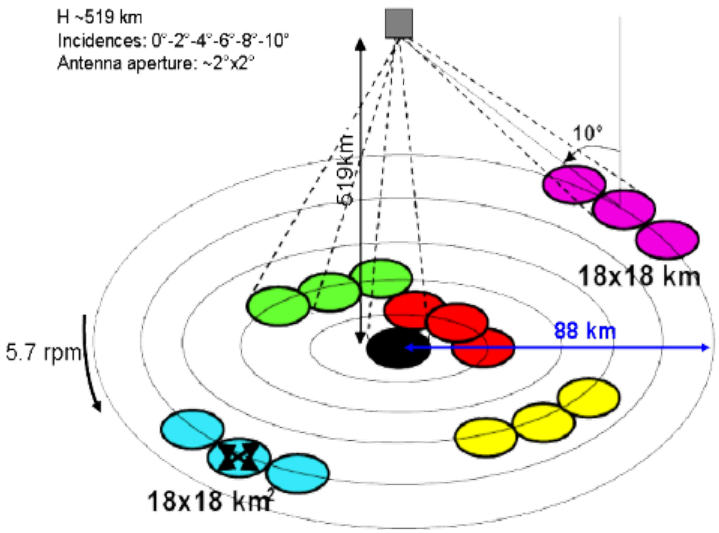
- SCAT, new concept of wind scatterometer
  - Ku-band, rotating fan-beam



- Access to 2D wave spectrum with high angular resolution and with global scale
- Joint measurements of winds and waves

SWIM instrument



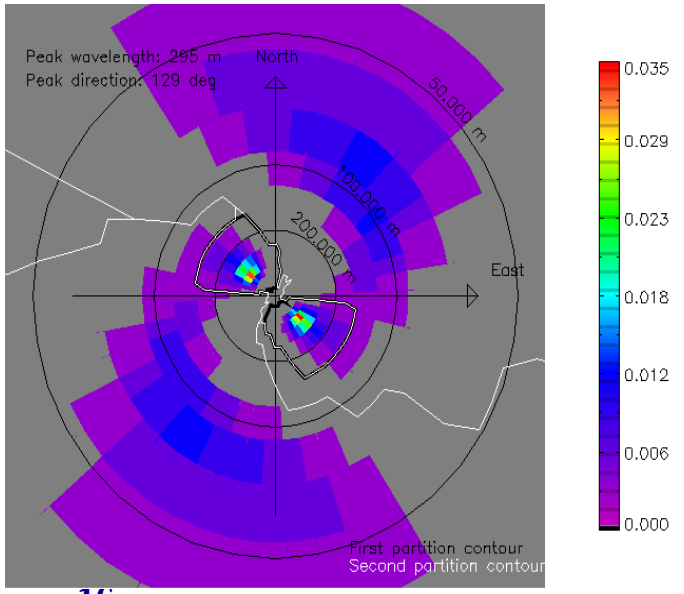


Surface Waves Investigation and Monitoring

- **Real aperture radar in Ku-band**
  - **6 incidence angles: 0°, 2°, 4°, 6°, 8° et 10°**
  - **Rotation speed: 5.7 rpm**
- **Will measure:**
  - **Directionnal wave spectrum in the wavelenght range 70-500 m**

    Accuracy: 10% on wavelength, 15° on direction, 15% on spectral level around the peak
  - **SWH and wind speed from nadir**
  - **Normalized radar cross-section from 0° to 10°**

    Absolute accuracy of ±1 dB, relative accuracy between incidences ± 0.1 dB
- **Airborne instrument in 2012 (KUROS)**



Phase 0 study: altimetry microsat constellation

- Context of this study
  - The study "Iridium-NEXT" (to embark 12-24 altimeters as passengers) showed that such concept could provbide a very viable and interesting approach to altimetry constellation. However the study , constrained by the Iridium constellation design, could not explore other orbital configurations, payload concepts requirering new tech developpment etc.
  - - SWOT program was started: it will provide very high resolution over a relatively small swath, adn a fairly long revisit, so this is an "extreme" in the resolution-coverage/revisit trade space. Other altimetry missions in constellation ("operational constellation" Jason2/3/CS + SARAL/S3A/S3B … or other) will be needed to provide the revisit capability.
  - - The current "virtual constellation" concept is not sufficient for a variety of applications that are not mainstream altimetry (real-time, coastal/inland/ice, sea state…) => need to reopen some of the user requirements in a constellation design.
  - As there is no imminent programmatic opening on CNES side to really decide such a constellation, our phase 0 study is more intended to define different scenarii and what would be the steps to achieve for their realization.
- Need to define a « groupe mission » representing different potential user of such constellations

Jason-CS

Jason-CS Programme status

- Satellite Phase B on going, some key trade off on going, see dedicated slides
- Preliminary Programme Proposal approved by last EUMETSAT Council
  - Potential Participant meetings to be organized to prepare the Programme Proposal
- Two letters of NOAA are confirming the U.S. Interest to participate in the programme with the contributions defined above (14 December 2011 and 9 May 2012)
- A letter of comfort from the European Commission confirmed that EC shares the common baseline (4 April 2012) but cannot commit on its funding now
- Next milestone is ESA C-MIN in November this year for a decision for Phase B2/C0, decision on phase B/C/D in 2014.
- **Need a coordinated and timely aligned decision process by all partners : Commitment by March 2014 latest**
- Need to work at System and Ground System level
  - Documentation tree, End User Requirement Document, Mission Requirement Document, System Requirement Document
  - Products definition
  - Ground System Architecture, Earth terminal network, Operation Concept

Two important open points on Jason-CS

- **Altimeter mode (SARM / LRM / Interleaved)**
  - Jason-CS Poseidon 4 (TAS note): Summary of interleaved mode requirements and preliminary results, JC-TN-TAF-P4-00075
  - Jason-CS (ESA note) Poseidon-4 Modes of Operation, JC-TN-ESA-MI-0036, Issue 2.0
- **Radiometer Configuration (2 or 3 freq;1or 2 radiometers)**
  - Microwave Radiometer Design Configuration Options, JC-TN-ESA-MI-0034
- **OSTST recommendations needed on both points**
- **Final choice will result from cost / benefits analysis also taking into account programmatic constraints**
- **Dedicated short introduction later by Hans Bonekamp**

SWOT (Surface Water Ocean Topography)

- July 2012 Science Definition Team Review (41 proposals submitted to NASA; results to be announced early in FY2013.)
- Sep. 13-14, 2012 SWOT MCR at JPL (Mission Concept Review)
- October 31, 2012 KDP-A an NASA HQ (Key Decision Point)

Data and Reprocessing

- Jason-1 Geodetic Mission OSDR, IGDR and GDRs are now available (PO.DAAC, AVISO)

- Jason-2/OSTM reprocessing of GDR-D in progress, completion end of 2012 (NOAA NODC, AVISO)

- Jason-2/OSTM operation data also available at EUMETSAT

http://podaac.jpl.nasa.gov/

http://www.aviso.oceanobs.com/

http://www.nodc.noaa.gov/

http://www.eumetsat.int/

Status of Joint Research Announcement

- Joint CNES-EUMETSAT Research Announcement for OSTST renewal was issued 31/01/2012
- Full alignment with NASA ROSES Call for OST
- July 2012,60 proposals reviewed at NASA
- Over 50 proposals have been received by EUM and CNES
- Selection process is ongoing.
- Outcome will be released after OSTST meeting, but before Jan 2013.

Future of the OSTST

- The Joint Research Announcement covers the period from Jan-2013 to Dec-2016 (Jason-3). After that perhaps a new future for the OSTST (Jason-CS period) with wider agency participation

- Link OSTST - OST Virtual constellation to be further elaborated also look at the VC for SST, Ocean Surface Winds, Ocean Colour

ANNEX : EXTRA SLIDES STORAGE

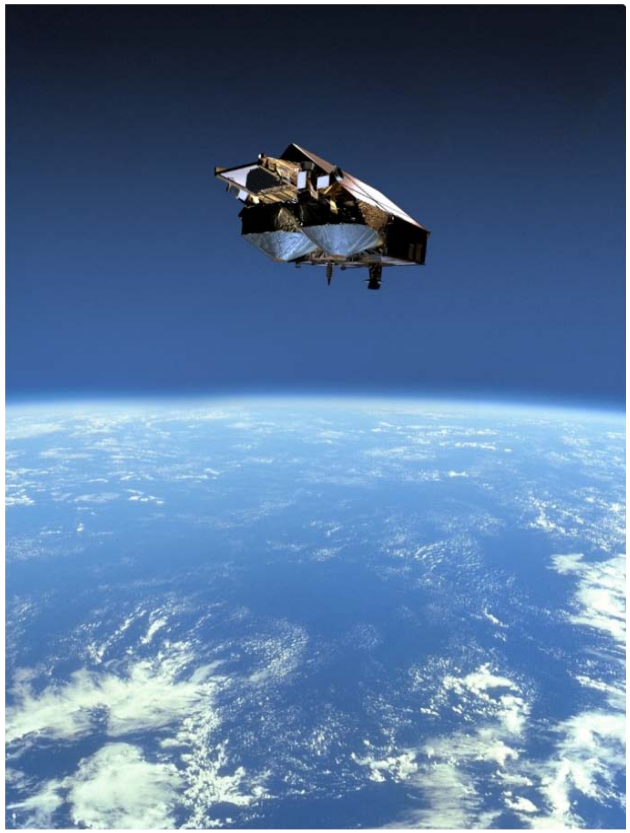
Mission Objectives

Primary Mission Goals

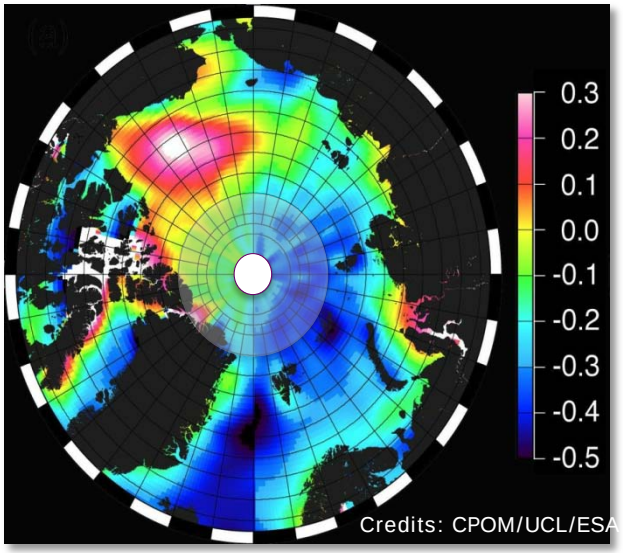
- Determination of regional and basin-scale trends in perennial Arctic sea ice thickness and mass
- Determination of regional and total contributions to global sea-level of the Antarctic and Greenland ice sheets

Secondary Mission Goals

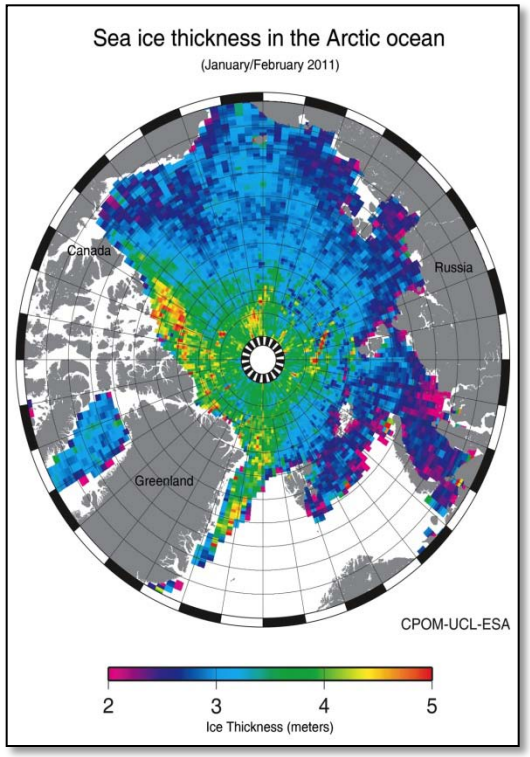
- Observation of seasonal cycle and variability of Arctic and Antarctic sea ice mass and thickness
- Observation of variation in thickness of the world's ice caps and glaciers



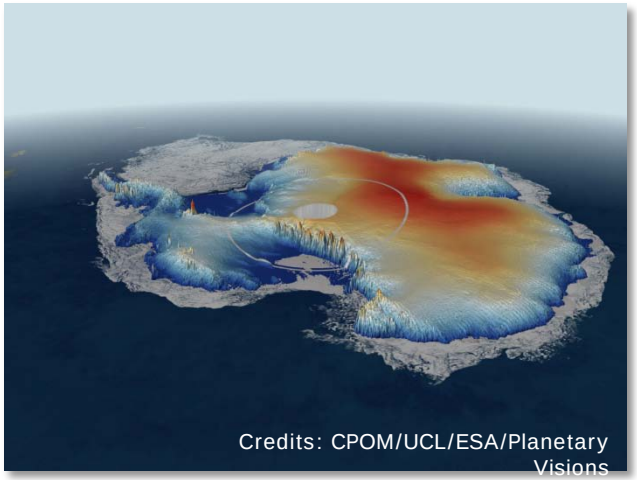
CryoSat highlights



Dynamic Topography: revealed the first complete picture of ocean Dynamic Topography in the Arctic Ocean up to 88° latitude

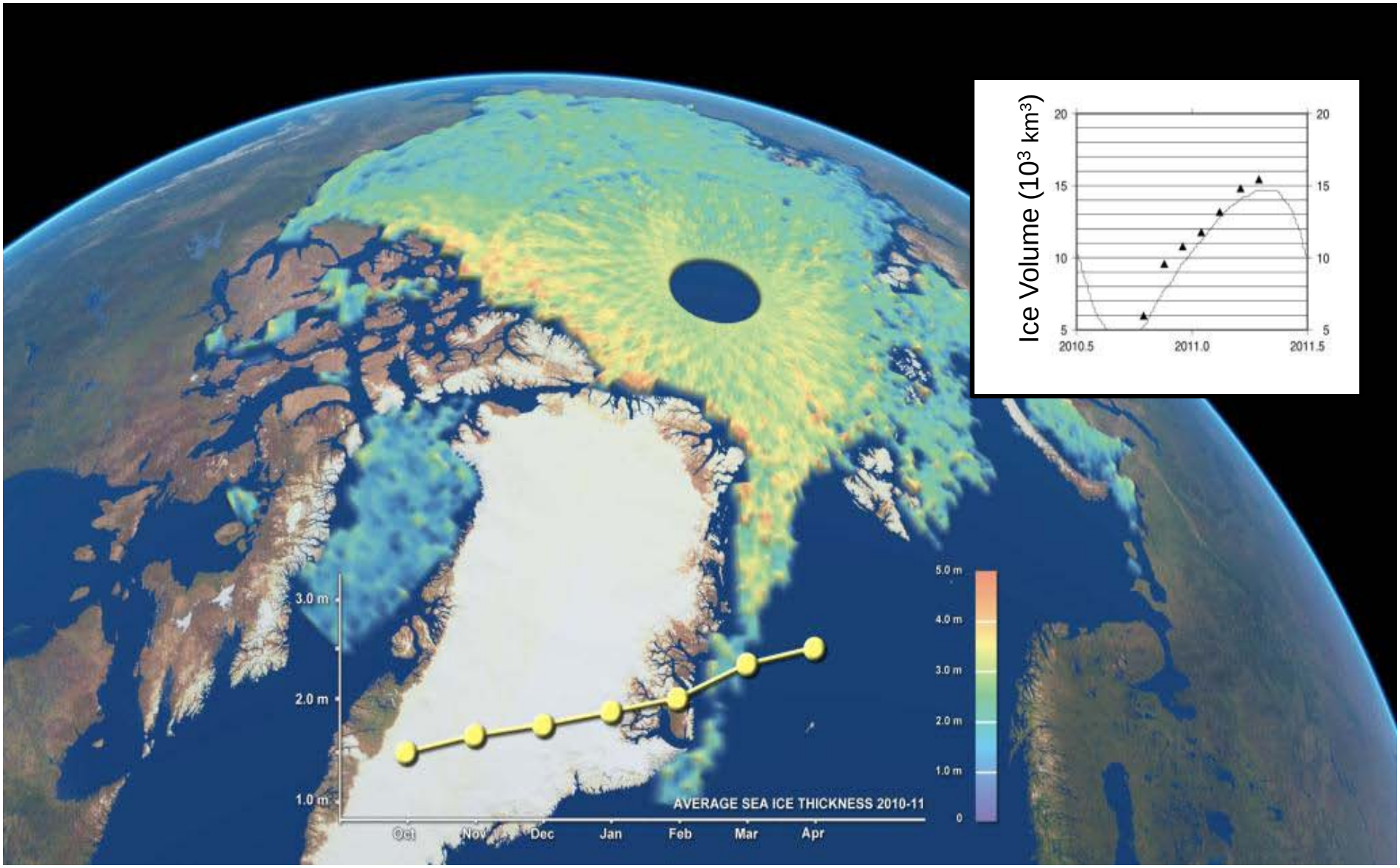


Sea-ice Thickness in the Arctic ocean (Jan-Feb 2011): First view of the sea-ice thickness across the entire Arctic Ocean basin



Antarctic ice sheet DEM 88° S: Details of the Antarctica ice-sheet measured by Cryosat

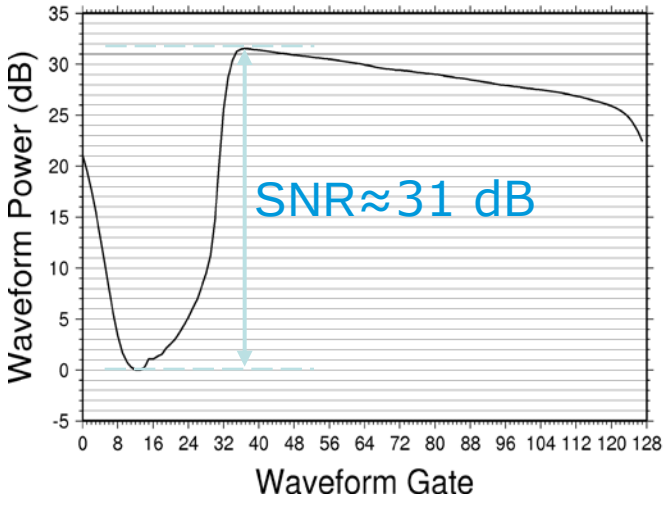
CryoSat highlights:



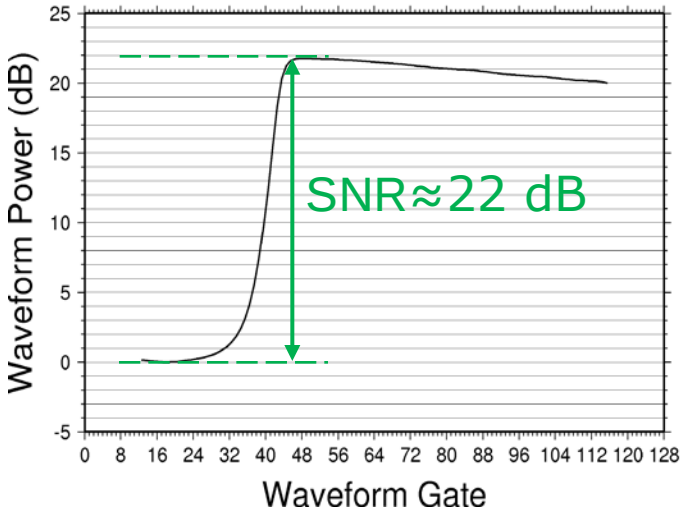
Level 1b performance: LRM signal-to-noise

There was no range noise system requirement in CryoSat, SNR instead.
The required signal-to-noise ratio for LRM/FDM is ≥ 8 dB for backscattering coefficient of -10 dB[1,3]

CryoSat-2 FDM Mean Waveform



Jason-2 Mean Waveform



- ❑ CryoSat-2 is in specification
- ❑ Better SNR than Jason-2 (≈ 9 dB), that results in a smaller range noise:

	CryoSat-2	Jason-2
Range noise at 1Hz for significant wave height (SWH) 2 m	1.42 cm	1.7 cm

(1) CryoSat-2 System Requirement Document, CS-RS-ESA-SY-0006
(2) Source: W. Smith, NOAA
(3) CryoSat: A mission to determine the fluctuations in Earth's land and marine ice fields, D.Wingham et al, 2006

Scientific requirement

Requirements	Sea Ice 10^5 Km^2	Ice Sheets 10^2 Km^2		Ice Sheets $13.8 \cdot 10^6$ Km^2
Minimum Latitude	50°	72°		63°
System Measurement Requirement	1.6 cm/yr	3.3 cm/yr		0.7 cm/yr
Pre-launch Performance	1.3 cm/yr	2.7 cm/yr	3.3 cm/yr	0.12 cm/yr
Mode	SAR	LRM	SARIn	SARIn/LRM

"Cryosat will, in its own life time,
reduce the uncertainty in the ice sheet contribution to sea level to a magnitude similar to that associated with other sources of sea level rise; and

determine whether the observed changes in sea ice signal important trends in Arctic climate or merely the ephemera of inter-annual variability at short spatial scales."