European Space Agency
Agence spatiale européenne

ESA Earth Observation Programme and Missions Status

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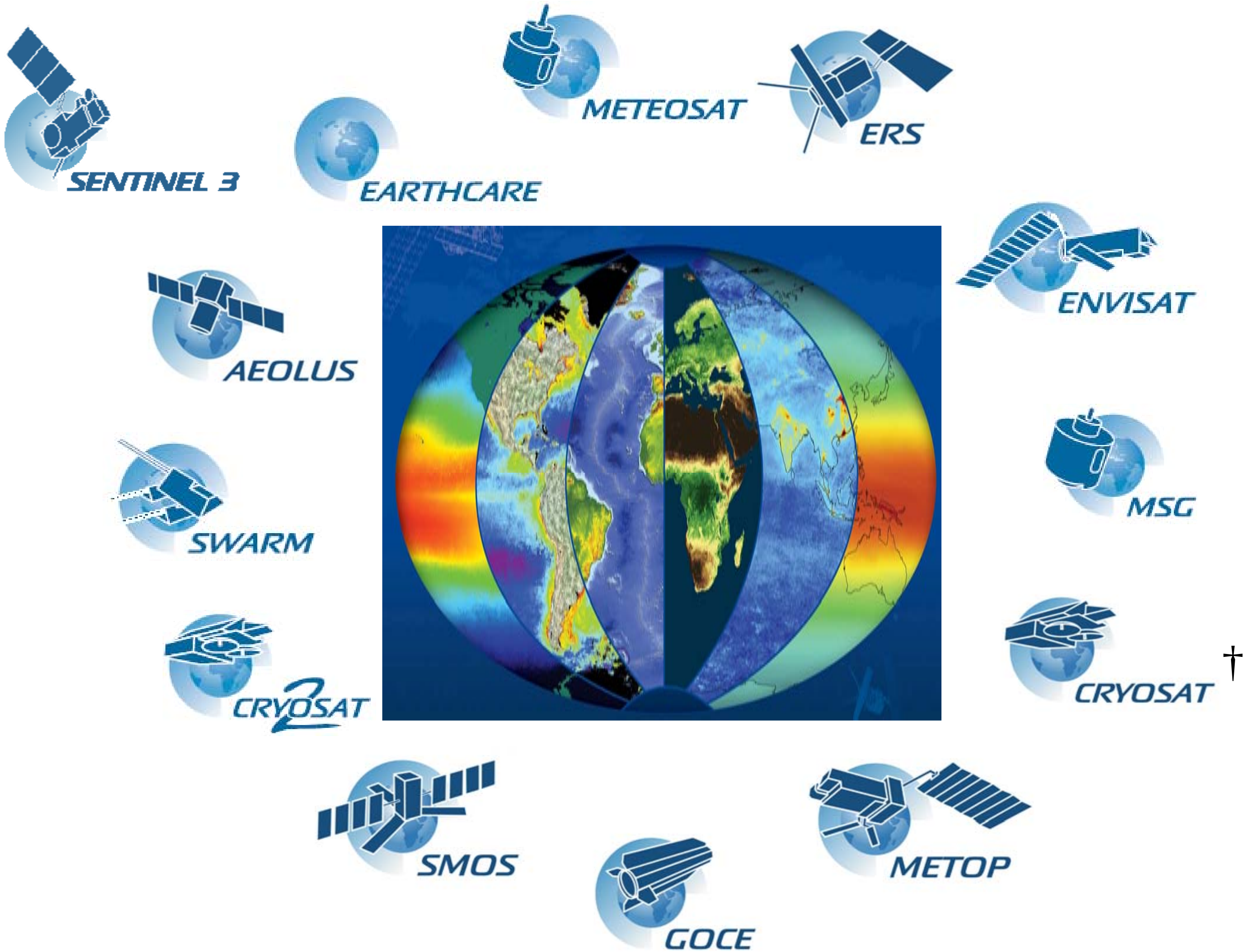
Earth Observation Science, Applications and FutureTechnologies Department

OSTST, 10 Nov 2008, Nice

the Living Planet

ESA's Earth Observation Toolkit



Focus on …..

ERS

ENVISAT

SENTINEL 3

CRYOSAT 2

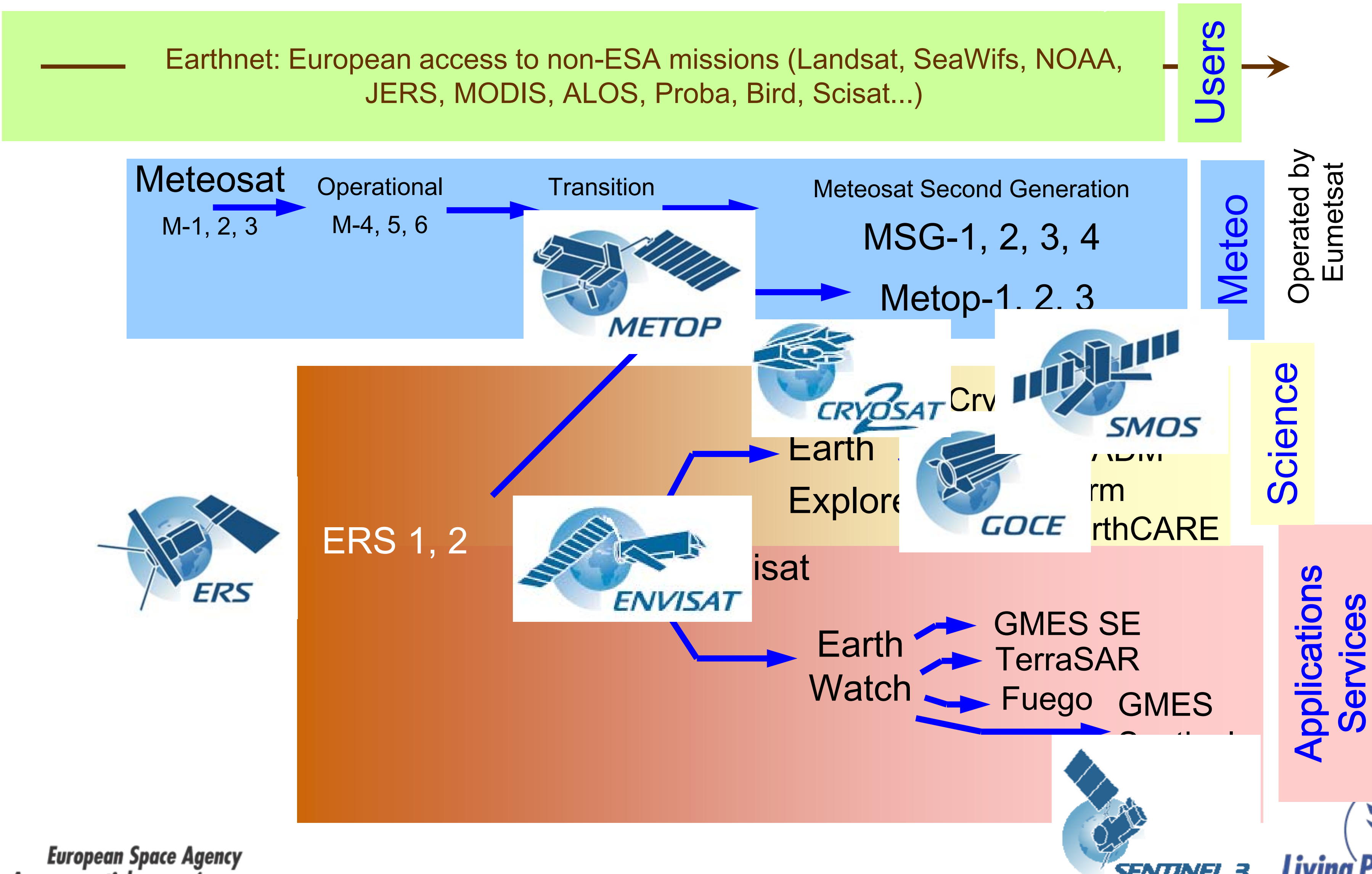
SMOS

GOCE

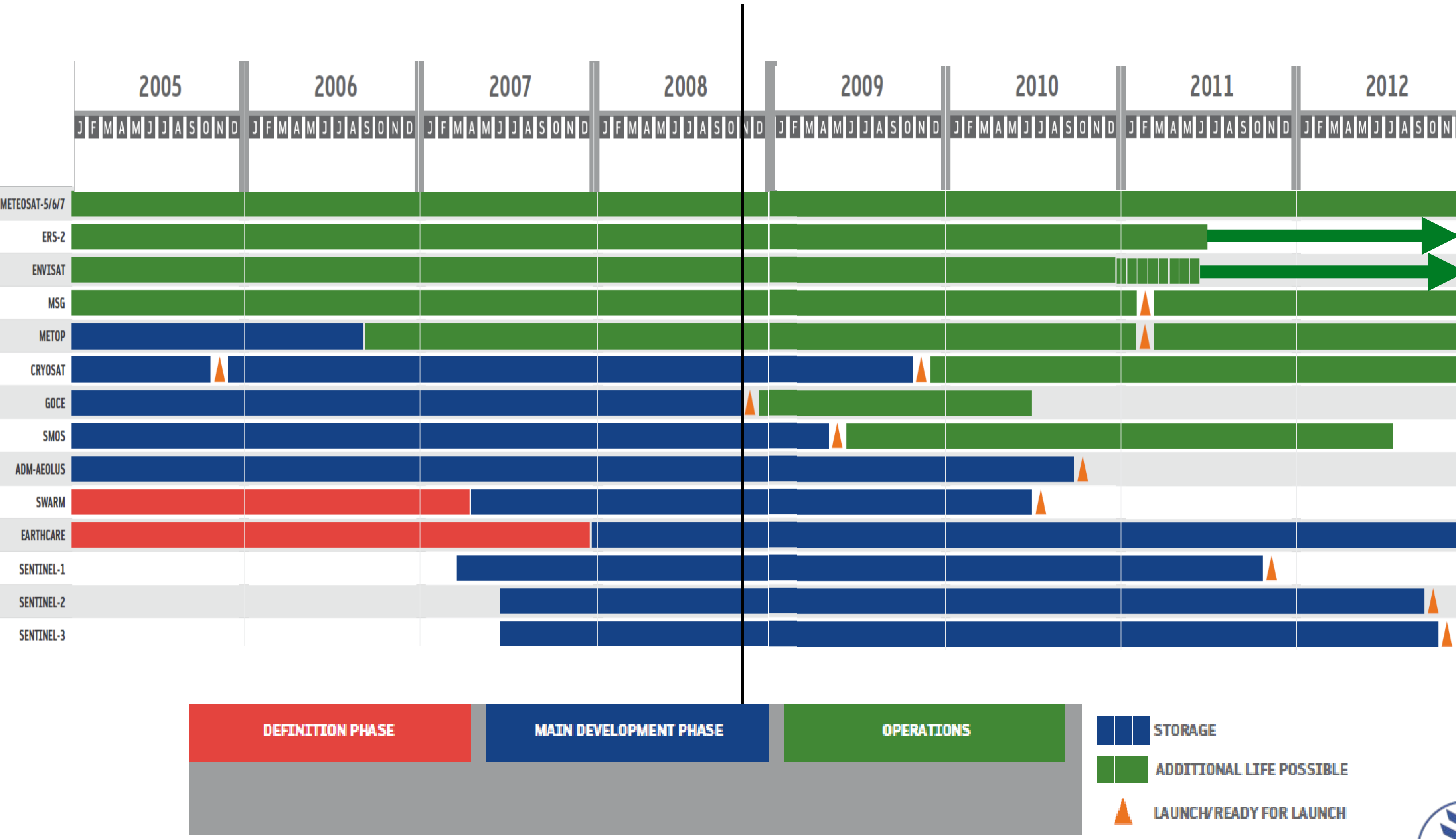
METOP

esa

EO Missions handled by ESA



EO SCHEDULE



2005
2006
2007
2008
2009
2010
2011
2012
J F M A M J J A S O N D
METEOSAT-5/6/7
ERS-2
ENVISAT
MSG
METOP
CRYOSAT
GOCE
SMOS
ADM-AEOLUS
SWARM
EARTHCARE
SENTINEL-1
SENTINEL-2
SENTINEL-3
DEFINITION PHASE
MAIN DEVELOPMENT PHASE
OPERATIONS
STORAGE
ADDITIONAL LIFE POSSIBLE
LAUNCH/READY FOR LAUNCH

Forthcoming Attractions

- ESA's Living Planet Programme contains the Earth Explorer line of "science-driven" missions

- Approved Earth Explorer Missions:
  - GOCE (planned Q1-2009 launch)
  - SMOS (planned mid-2009 launch)
  - CryoSat-2 (planned end-2009 launch)
  - Swarm (planned mid-2010 launch)
  - ADM-Aeolus (planned end-2010 launch)
  - EarthCare (planned end-2012 launch)

- *5 7th explorer in pre-phase A, selection process on-going*

ESA's Earth Explorers: 1- 6

GOCE

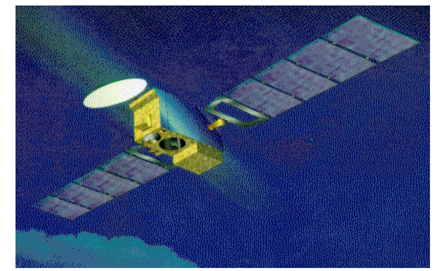
Gravity Field and Steady State Ocean Circulation Explorer

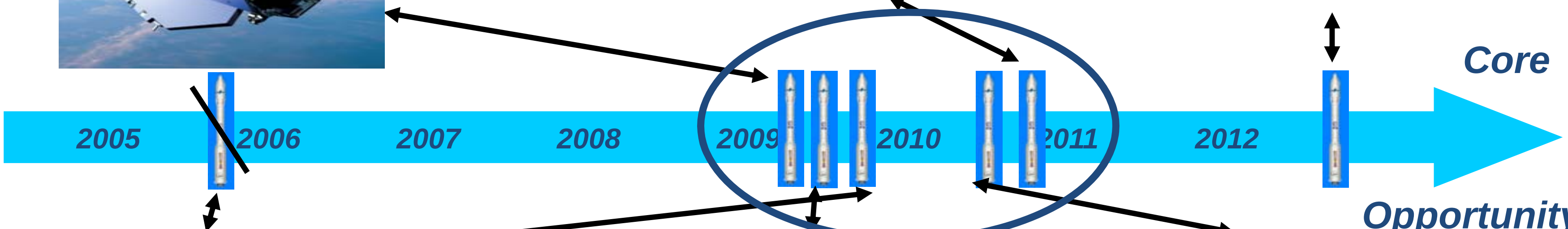
ADM-Aeolus

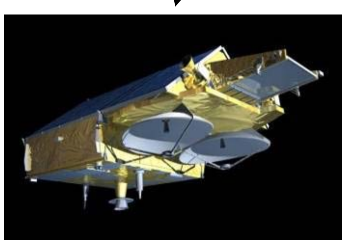
Atmospheric Dynamics Mission

EarthCARE

Cloud, Aerosols & Radiation Explorer





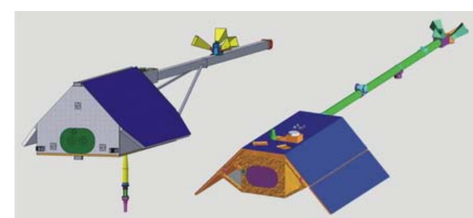


Cryosat 1† & 2

Sea Ice thickness and Ice sheet topography

SMOS

Soil Moisture and Ocean Salinity

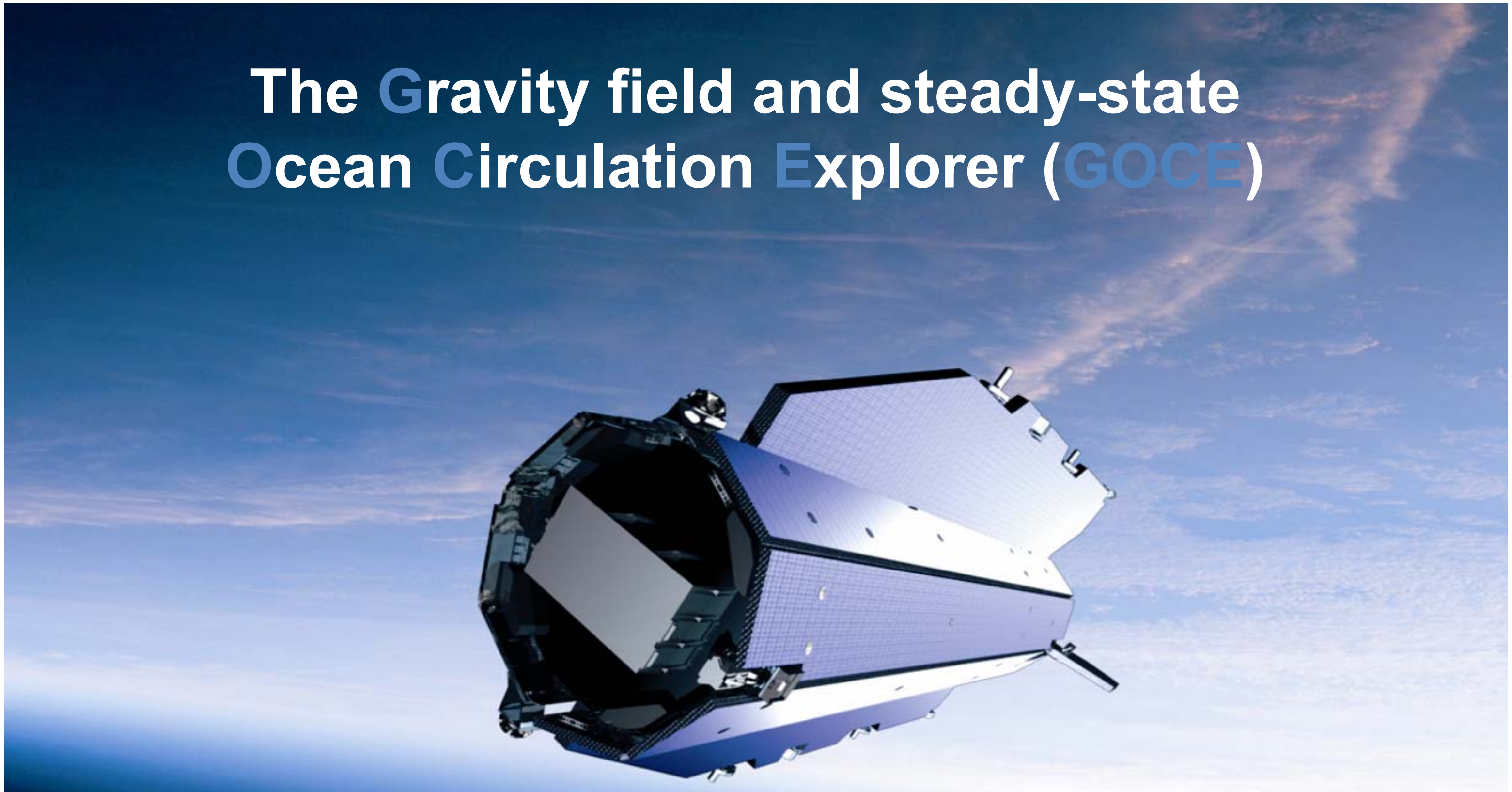


Swarm

Geomagnetic field survey

GOCE: ESA's Gravity Mission

The Gravity field and steady-state Ocean Circulation Explorer (GOCE)

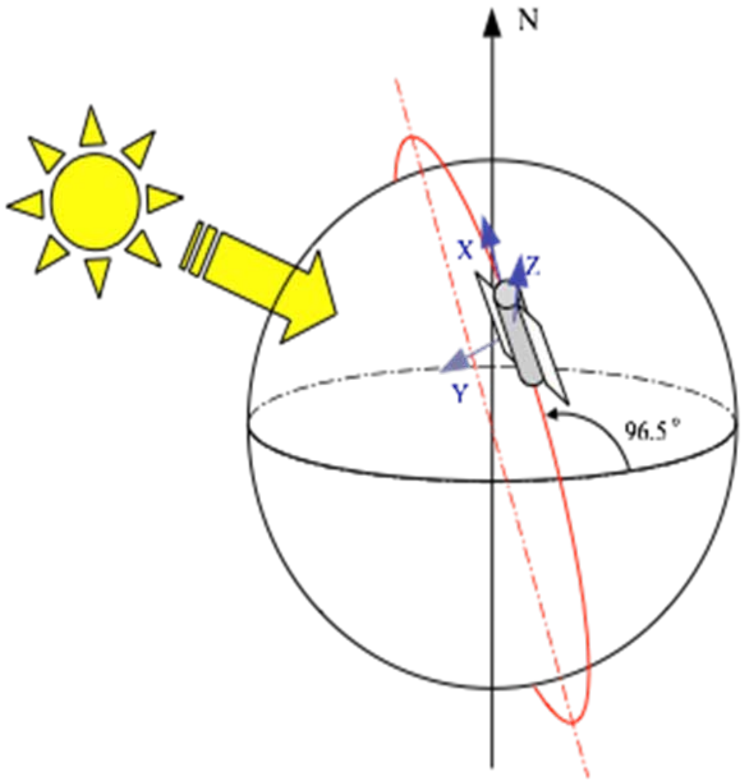


Its objectives are to improve understanding of:

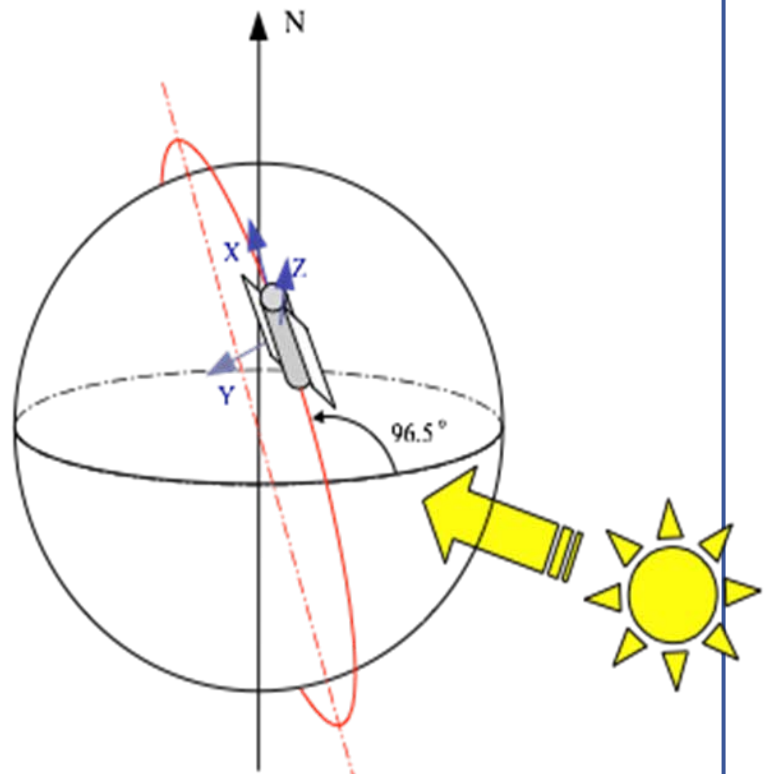
- global ocean circulation and transfer of heat
- physics of the Earth's interior (lithosphere & mantle)
- topographic processes, evolution of ice sheets and sea level change

www.esa.int/livingplanet/goce

Orbit configuration

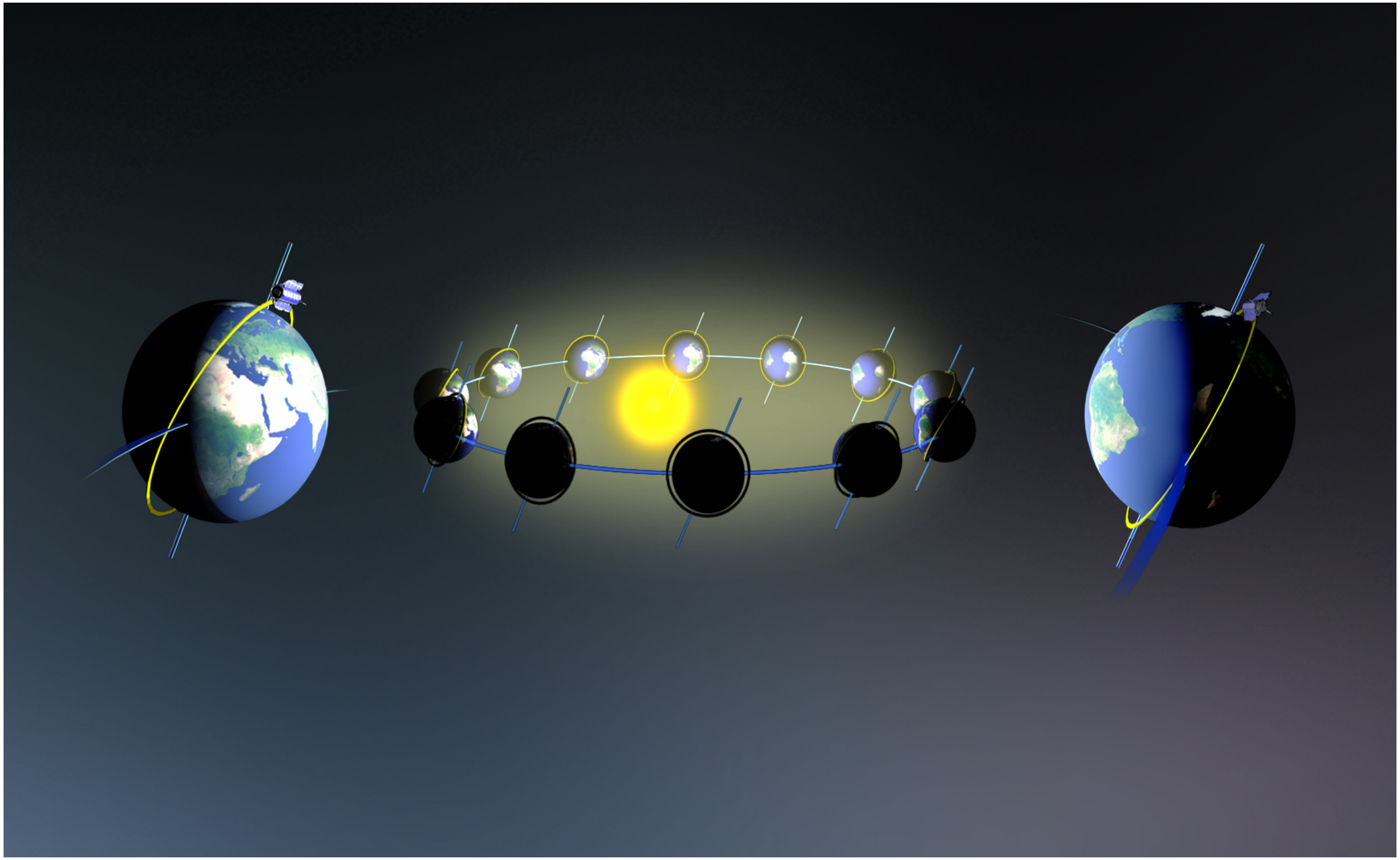


Dusk-dawn (actual)



Dawn-dusk (previous)

Illumination of GOCE orbit



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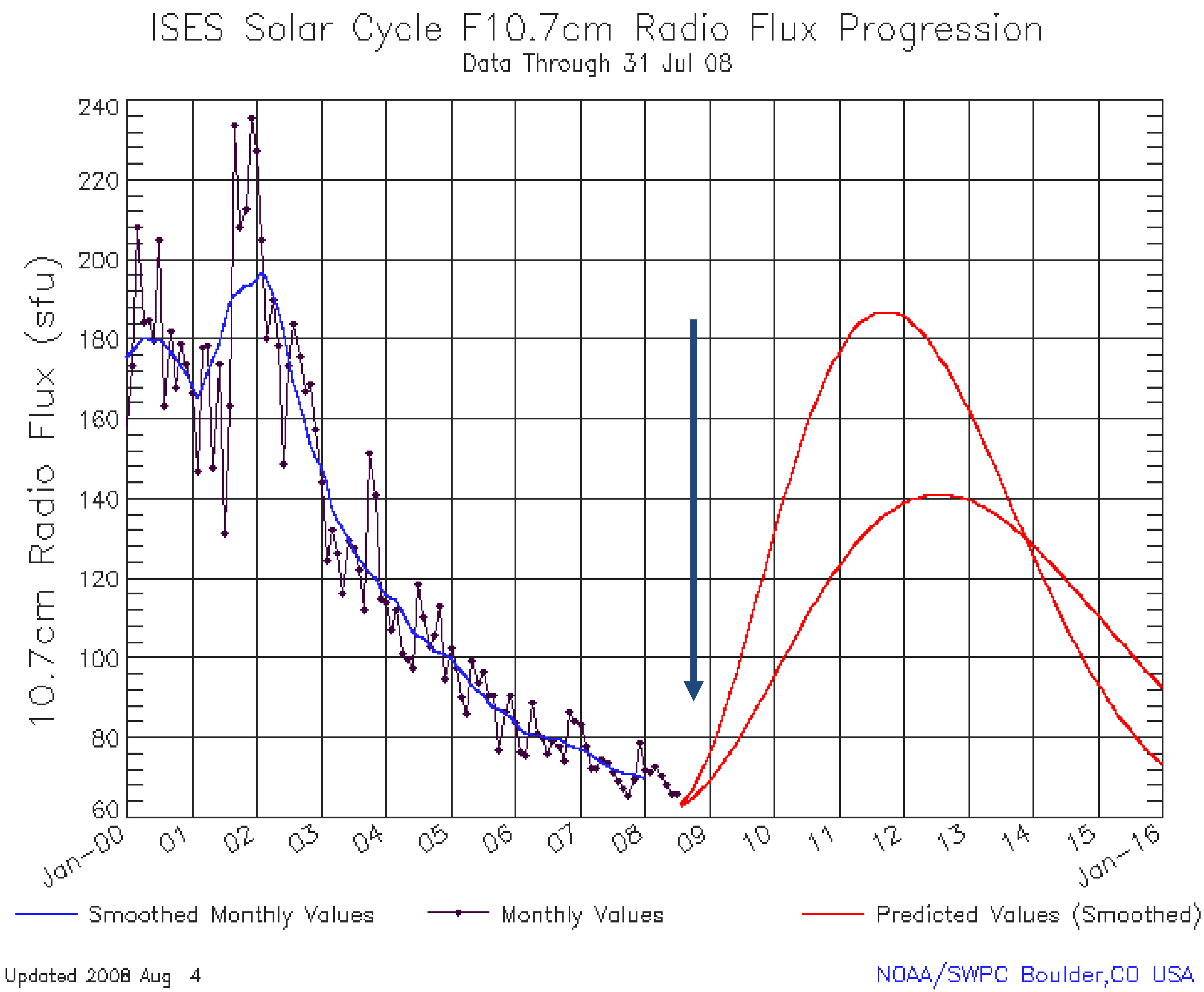
Satellite re-configuration

- 10 September launch = "summer configuration"
- Dusk-dawn orbit (was dawn-dusk)
- Why: Allows LEOP & commissioning in full sunlight and gives sufficient duration of first MOP
- Success story...
- Satellite has been reconfigured (involving star cameras, GPS antennas, S-band communication, laser retro-reflector and platform application software)

Satellite re-re-configuration

- Q1-2009 launch = "winter configuration"
- dawn-dusk orbit (was Dusk-dawn)
- Why: Allows LEOP & commissioning in full sunlight and gives sufficient duration of first MOP
- Satellite needs to be re-reconfigured… (involving star cameras, GPS antennas, S-band communication, laser retro-reflector and platform application software)

Current prediction (August '08)



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Baseline mission scenario

- ✓ Revisited for 10 September launch

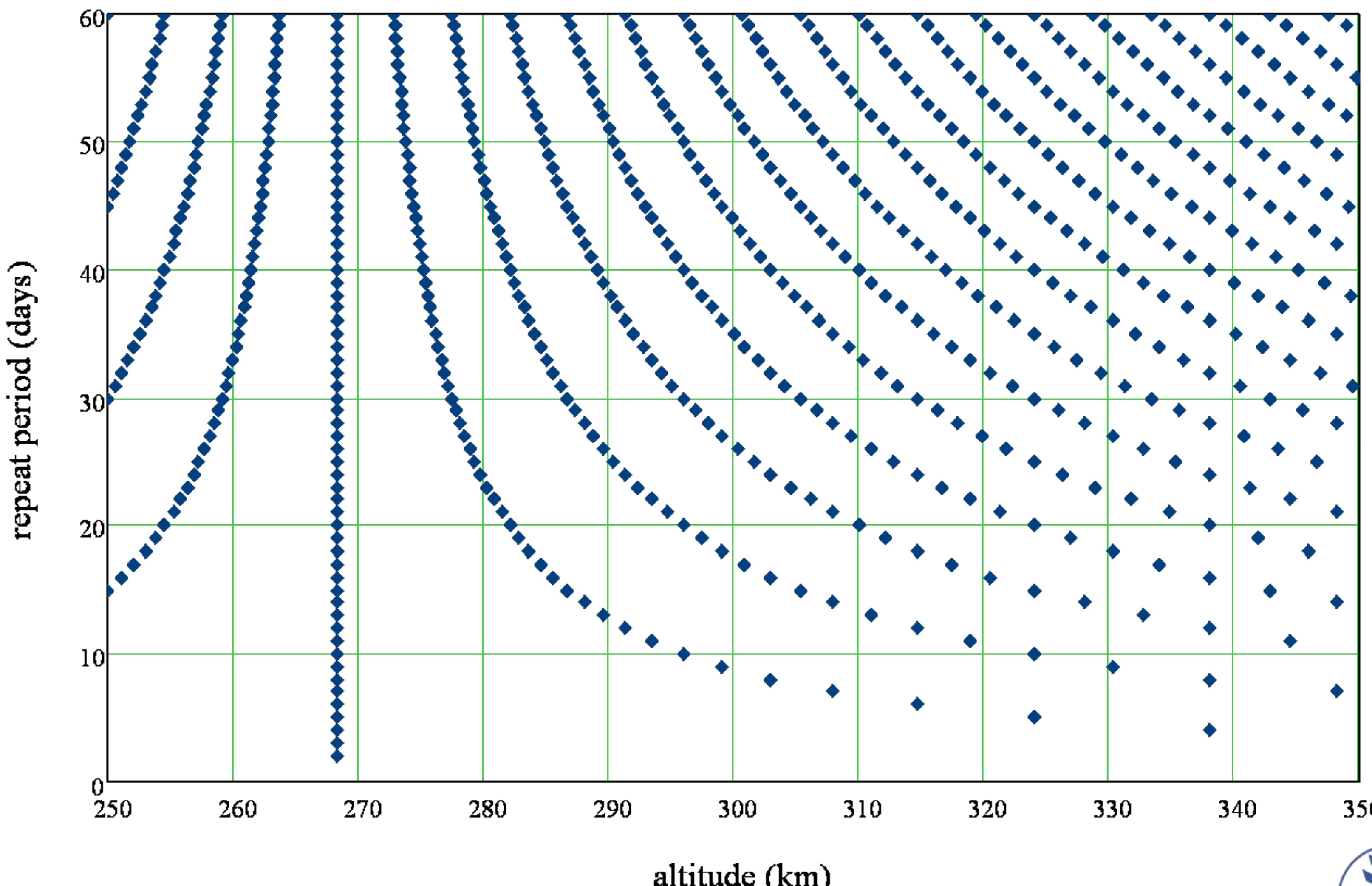
Phase	Altitude	Previous value
Injection	280 km	290 km
MOP1	263 km	263 km
HOP1	280 km	302 km
MOP2	273 km	273 km

(altitudes are given as semi-major axis minus mean Earth radius)

- ✓ Improvement is feasible due to late on-set of solar cycle 24, implying lower-than-anticipated air drag
- ✓ MOP2 altitude may even be set as low as 263 km
- ✓ 95% percentile + 30% margin (!) on density forecast
- ✓ Tuning of semi-major axis to optimise spatial sampling is foreseen

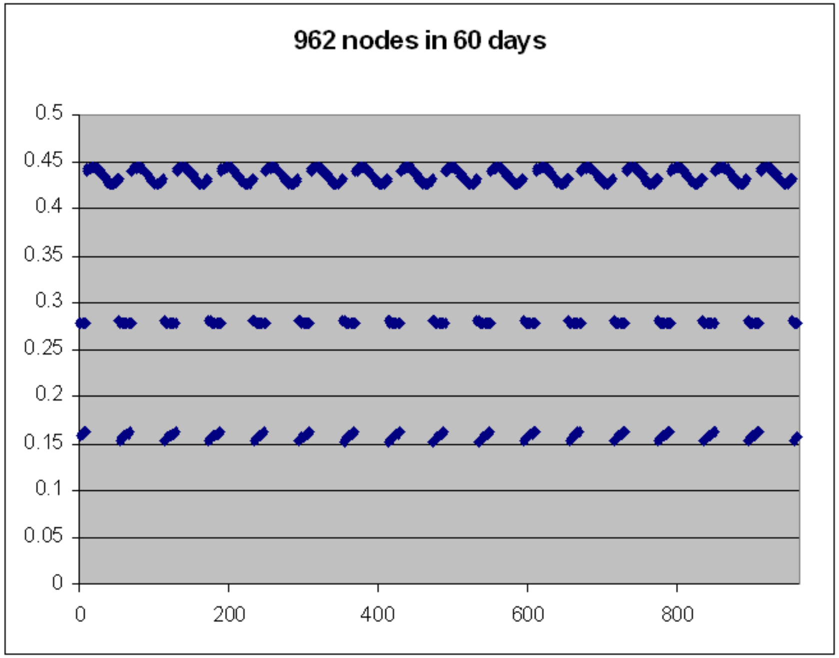
To be updated for Q1-2009 launch!

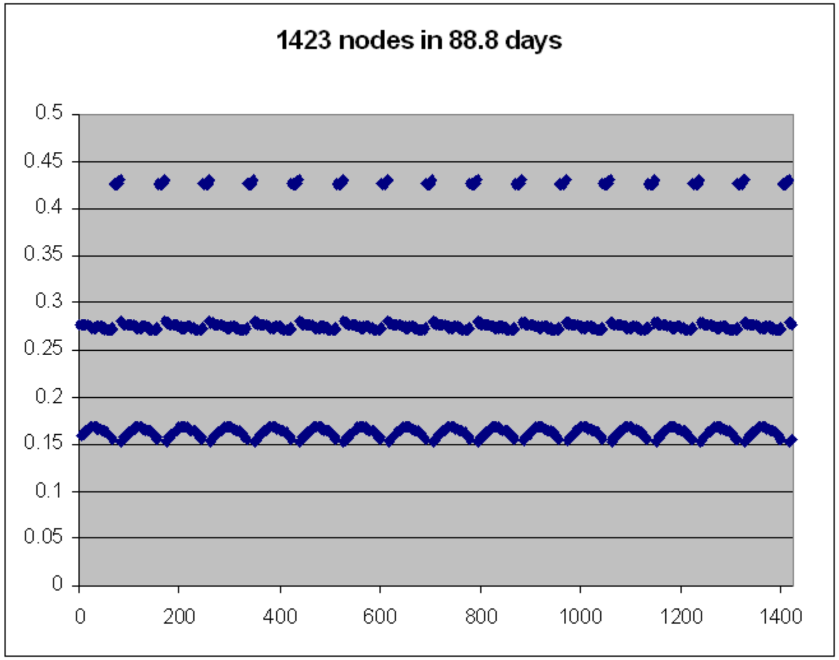
Orbit repeat cycles



Spatial sampling

- ✓ Requirement: longitudinal spacing at ascending node <0.45° after a MOP
- ✓ 263 km MOP altitude yields:



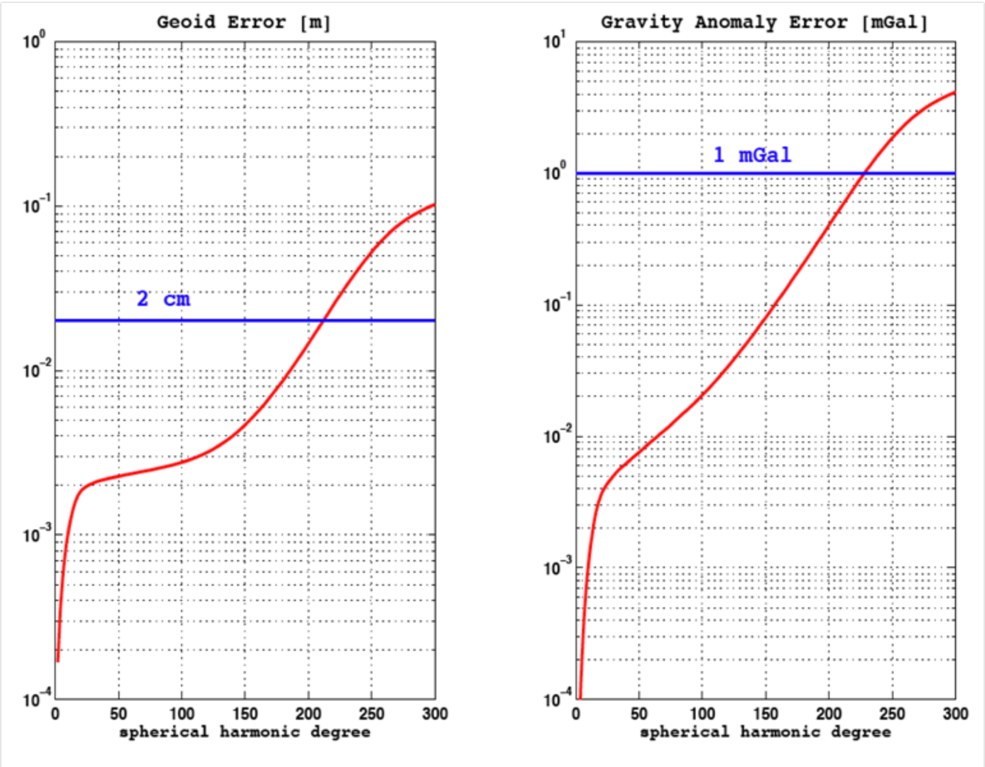


Observations

- ✓ Current density predictions significantly below previous values... but rising...
- ✓ Adequate spatial sampling is paramount and fulfilled for selected MOP altitudes
- ✓ Gradiometer instrument is within specification

GOCE Preformance summary

- ✓ Mission requirement of 1 mGal gravity anomaly and 1-2 cm geoid accuracy at 100 km spatial resolution can still be met
- ✓ Launch delay has been compensated by the late on-set of cycle 24 of the Sun



GOCE Ready for Launch

- The readiness of the ground segment to support LEOP, commissioning and calibration, as well as regular science operations was confirmed in the Operations Readiness Review held on 20 August 2008.

GOCE

GOCE Launch

- the GOCE launch scheduled for Wednesday, 10 September, from the Plesetsk cosmodrome in northern Russia by Eurockot
  - Eurockot Launch Services GmbH is the joint venture of EADS Astrium (51%) and Khrunichev Space Centre (49%) and performs launch services for operators of Low Earth Orbit satellites using the Rockot launch vehicle.
- on 7 September the GOCE spacecraft was declared launch-ready after successfully passing all the so-called Integrated System Check test cases on the launch pad.
- 8 September news (2 days before launch):
- Launch postponed, not before Sunday 5 October, due to an anomaly in one of the units of the guidance and navigation subsystem of the launcher's upper stage (Breeze KM). A launch with this unit would have resulted in loss of the mission.
- The correction of the problem will require to replace this unit. it will be necessary to de-mate the launcher's upper composite and transport it from the launch pad back to the integration room. Once in the clean room, the protective fairing that shelters the satellite will be opened and the spacecraft and its adaptor system will be dismounted in order to allow access to the Breeze KM equipment to be replaced.

GOCE Launch

- 15 September news : the current launch date for GOCE is 8 October.
- Following the detection of the anomaly in the gyro platform (electronics + power supply) at L-3 days, the upper composite consisting of the GOCE satellite, the adapter system and the Breeze-KM upper stage has been removed from the 1st & 2nd stage booster assembly, and brought back to the integration hall. The satellite has been de-mated from Breeze, and the Russian engineers have access to the Breeze-KM upper stage for the removal of the failed components of the gyro package.
- Contrary to previous information, the Breeze-KM upper stage had to be de-fuelled before removal of the failed components, and this activity has caused a delay w.r.t. the 5 October launch date previously announced.
- The real confirmation of the launch date of GOCE was expected when the satellite was again mated with the rocket on 28 September. By then we had the final confirmation of the root cause of the problem with the gyro package units, including the comparison with other units of the same lot…

GOCE Launch delayed until 2009

- The launch was further postponed to 27 October
- 16 October 2008: The foreseen 27 October launch date of GOCE has had to be postponed to allow the enquiry board time to conclude its work. A new launch date will be announced here as soon as possible.
- 24 October 2008:The Russian authorities responsible for the Rockot launcher have completed the investigation of a failure in the guidance and navigation system of the launcher's Upper Stage (Breeze KM).
- The cause of the anomaly in the guidance and navigation system has been identified and reproduced. The necessary hardware changes will require a minimum of two months of additional work by the manufacturer.
- As a consequence, the launch of GOCE cannot take place earlier than February 2009.
- The exact launch date will only be decided at a later stage once the corrective measures have been fully implemented and validated.

Launch… Q1-2009

- Toolbox implementation
  - Started in January 2008
  - Prototype now under testing.

http://earth.esa.int/gut

GUT Tutorials

Include:

- GUT objectives
- How to compute a Mean Dynamic Topography
- How to use the toolbox -- « use cases »
- For more technical details use the User Manual

Distributed soon !

TOOLBOX STATUS

- Technical Specification and Architectural Design

  --> Document accepted
- Toolbox SW Development Started 1 April
- First Prototype released in July
- Evaluation and Testing on-going
- The release of Version 1 is phased with the end of GOCE commissioning
- User satisfaction survey and further requirements

GUT OPEN GROUP

- The GUTS and GUT are supported by ESA with collaborators from many European countries working in a core group with an open group of observers, reviewers and advisors.
- The Members of this open group are de facto the first users of the toolbox.
- Some have also contributed existing source code to improve the Toolbox.
- Any scientist can join this group and contribute to the toolbox requirements validation process.

CryoSat-2: ESA's Ice Mission

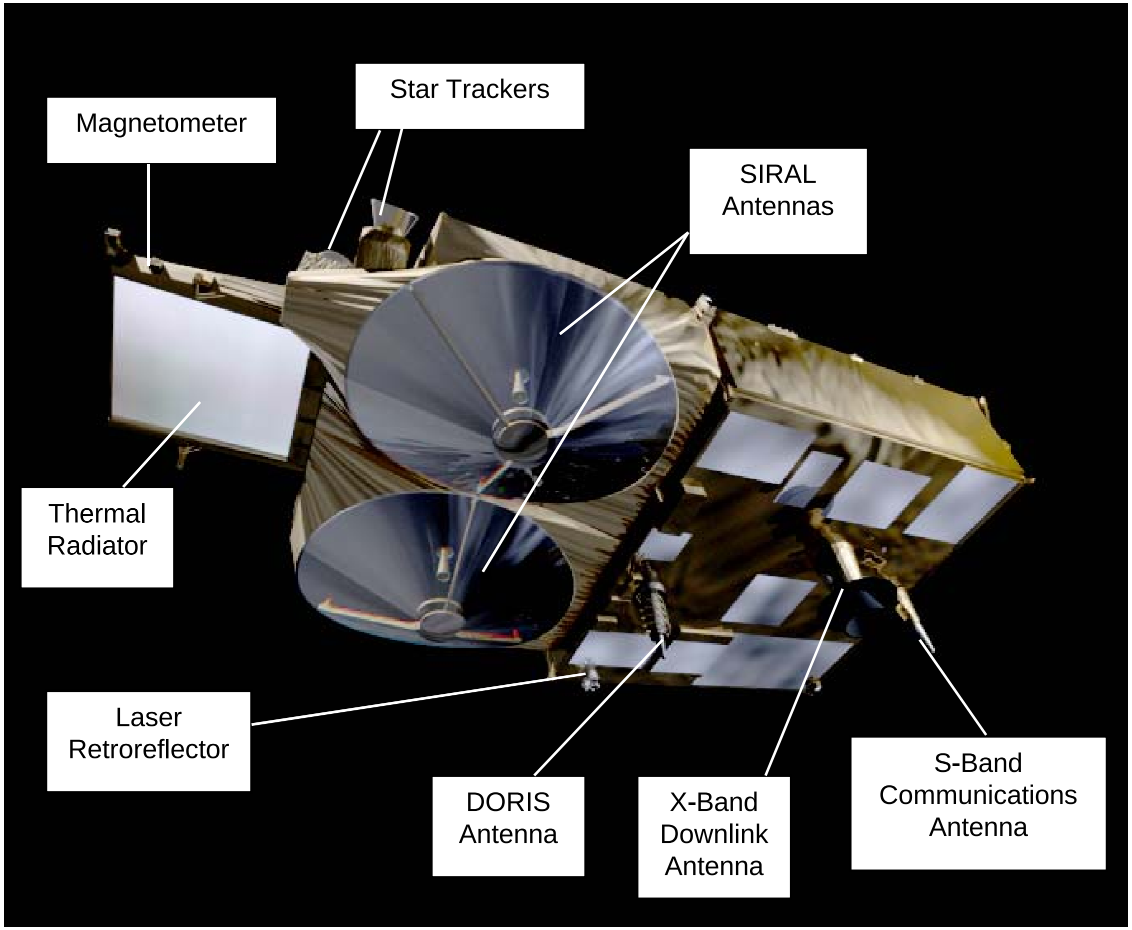
Its objectives are to improve our understanding of:

- thickness and mass fluctuations of polar land and marine ice
- to quantify rates of thinning/thickening due to climate variations

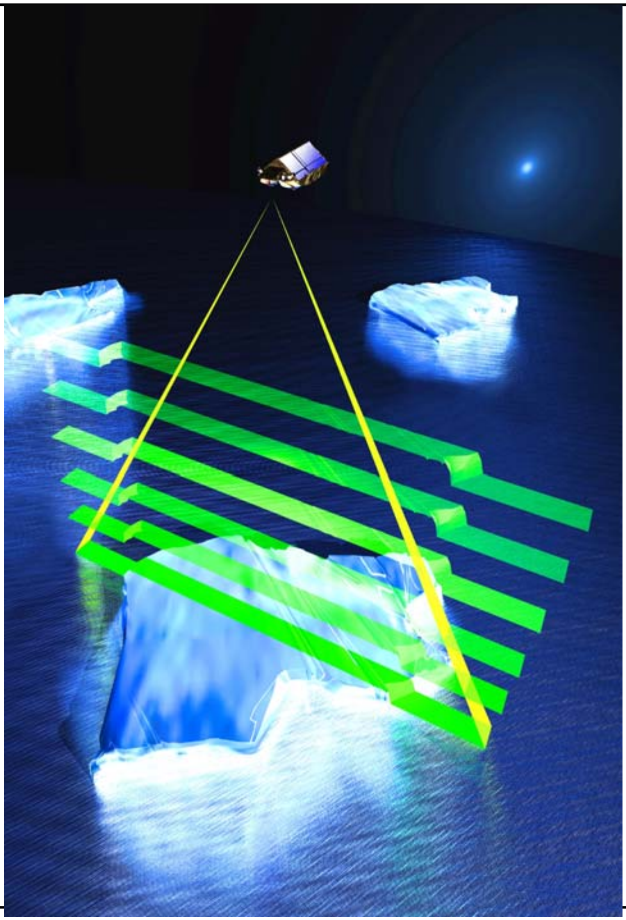
www.esa.int/livingplanet/cryosat


CryoSat will carry a new generation Altimeter

The satellite and its instruments

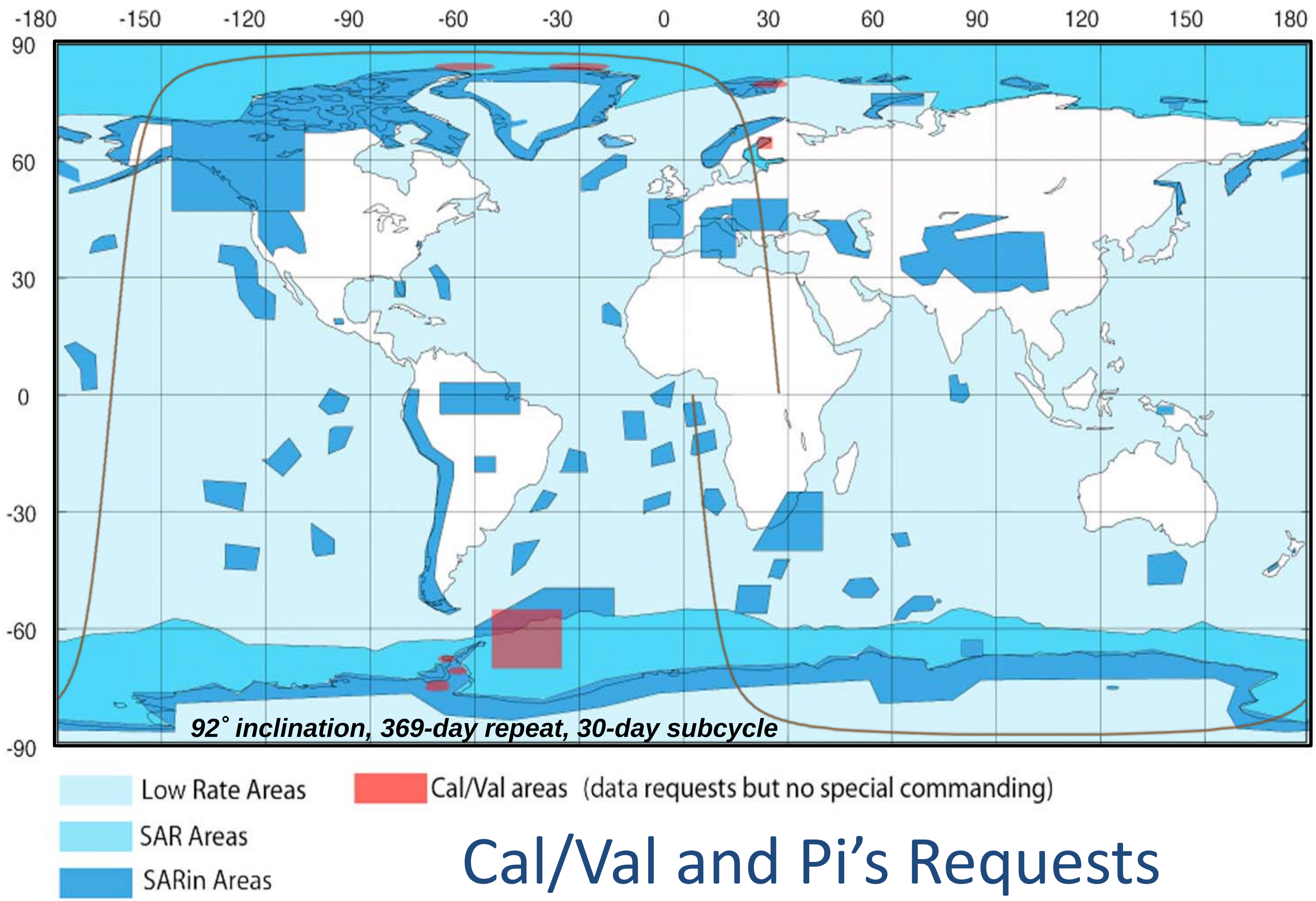


CryoSat's High-Resolution



- Transmits bursts of 64 pulses: sequential echoes are correlated
- Satellite moves 250 m between bursts
- Aperture Synthesis technique gives 250 m along-track resolution, much higher than conventional altimeters (ERS-2/Envisat RA-2)
- SAR Mode used over sea-ice to measure ice-floe freeboards and retrieve thickness

SIRAL Mode Operation

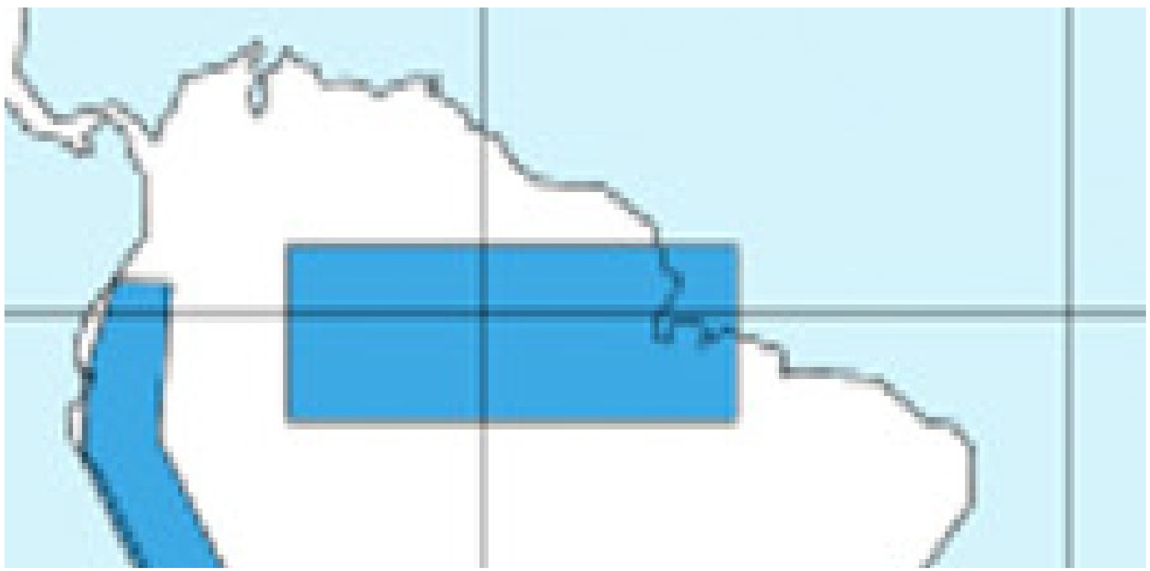


Cal/Val and Pi's Requests

SIRAL Mode Operation

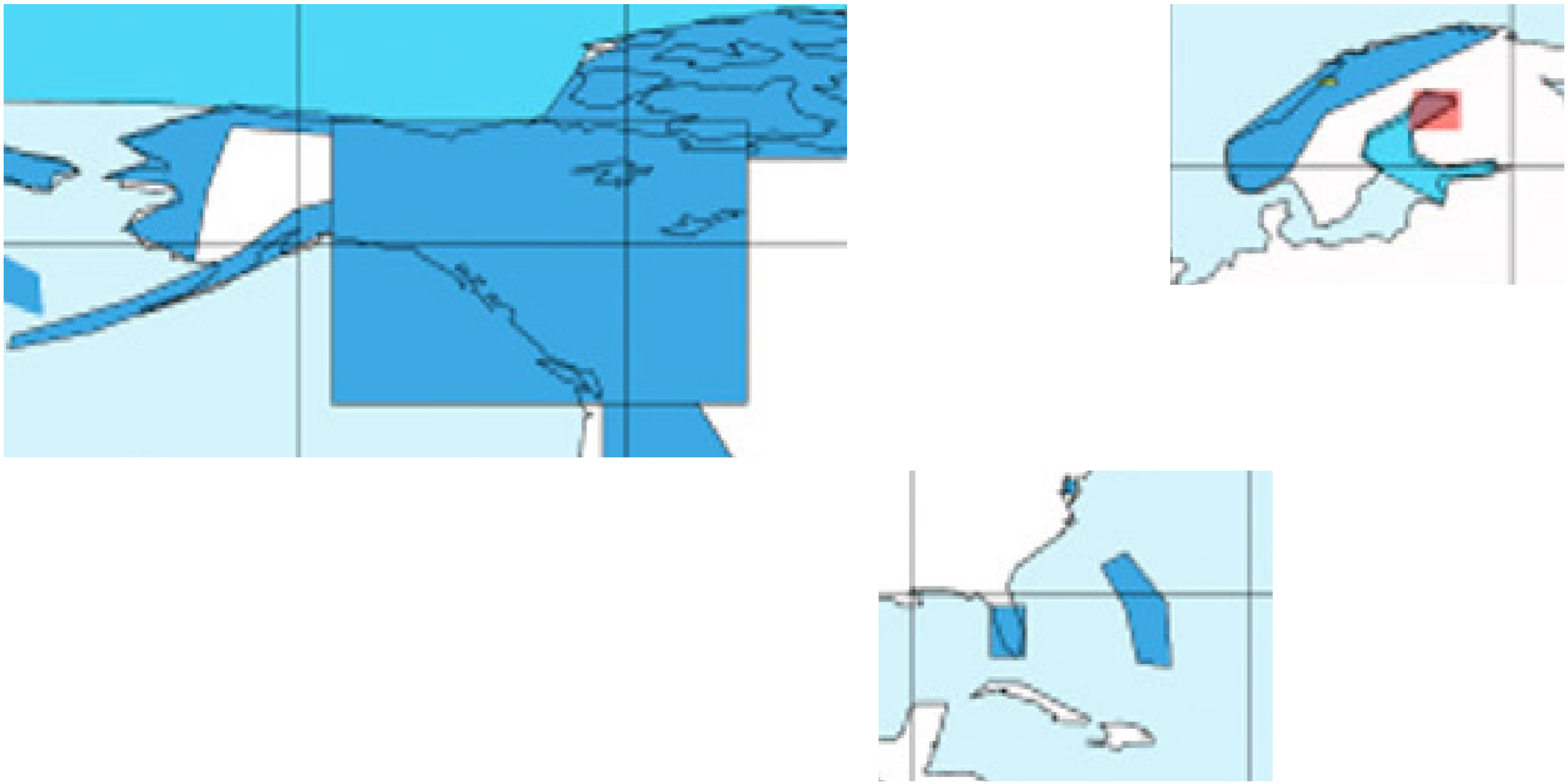
Low Rate Areas
SAR Areas
SARin Areas
Cal/Val areas (data requests but no special commanding)

SIRAL Mode Operation



Low Rate Areas
SAR Areas
SARin Areas
Cal/Val areas (data requests but no special commanding)

SIRAL Mode Operation



CryoSat Launch: 8 Oct 2005

European Space Agency
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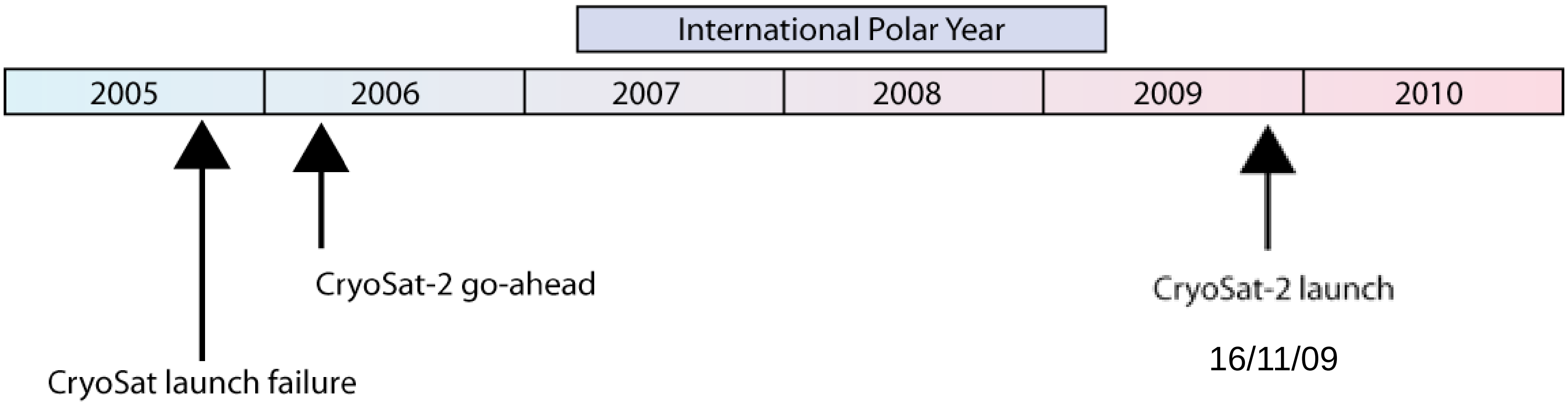
CryoSat-2 Launch: 16 Nov 2009



CryoSat-2 Mission Fact Sheet

CryoSat Mission

To determine fluctuations in the mass of the Earth's major land and marine ice fields.

Mission Duration

- 6 months commissioning
- 3 year operational mission.

Mission Orbit

- Type: LEO, non sun-synchronous
- Repeat cycle: 369 days (30 d sub-cycle)
- Mean altitude: 717 km
- Inclination: 92°
- Nodal regression: 0.25° /d

Spacecraft and Payload

Recurrent spacecraft and payload from lost CryoSat 1

Instruments

SIRAL (SAR/Interferometric Radar Altimeter):

- Low-Resolution Mode provides conventional pulse-width limited altimetry over central ice caps and oceans;
- SAR Mode improves along-track resolution (~250 m) over sea ice by significantly increased pulse repetition frequency and complex ground processing;
- -SAR Interferometric Mode adds a second receive chain to measure the cross-track angle of arrival of the echo over topographic surfaces at the margins of ice caps.

Star Trackers (3) measure the interferometric baseline orientation, as well as driving satellite attitude control.

DORIS enables precise orbit determination, as well as providing on-orbit position to the satellite attitude control.

Laser Retroreflector enables tracking by ground-based lasers.

Spacecraft

Simplified rigid structure with no moving parts; all electronics mounted on nadir plate acting as radiator; SIRAL antennas on iso-statically mounted plate with Star Trackers; dedicated SIRAL radiator. 2x GaAs body-mounted solar arrays, with 850 W each at normal solar incidence; 78 Ah Li-ion battery. Attitude: 3-axis stabilised local-normal pointing, with 6° nose-down attitude, using magneto-torquers and 10 mN cold-gas thrusters.

- Dimensions 4.60 m x 2.34 m x 2.20 m
- Mass 720 kg (incl. 37 kg fuel)
- Power 850 W
- Datavolume: 320 Gbit/day
- on-board storage by SSR 256 Gbits

Launch Vehicle

DNEPR

Flight Operations

Mission control from ESOC *via* single ground station at Kiruna. Up to 11 useable downlink passes for science data.

RF Links

- X-band data downlink: 100 Mbps at 8.100 GHz
- S-band TTC link: 2 kbps uplink,16 kbps downlink

Payload Data Processing

Data processing facility at the Kiruna ground station. Local archiving of data with precision processing after one month following delivery of precision orbits from DORIS ground segment (under CNES responsibility). Possibility of quick-look data. Direct dissemination of data from Kiruna.

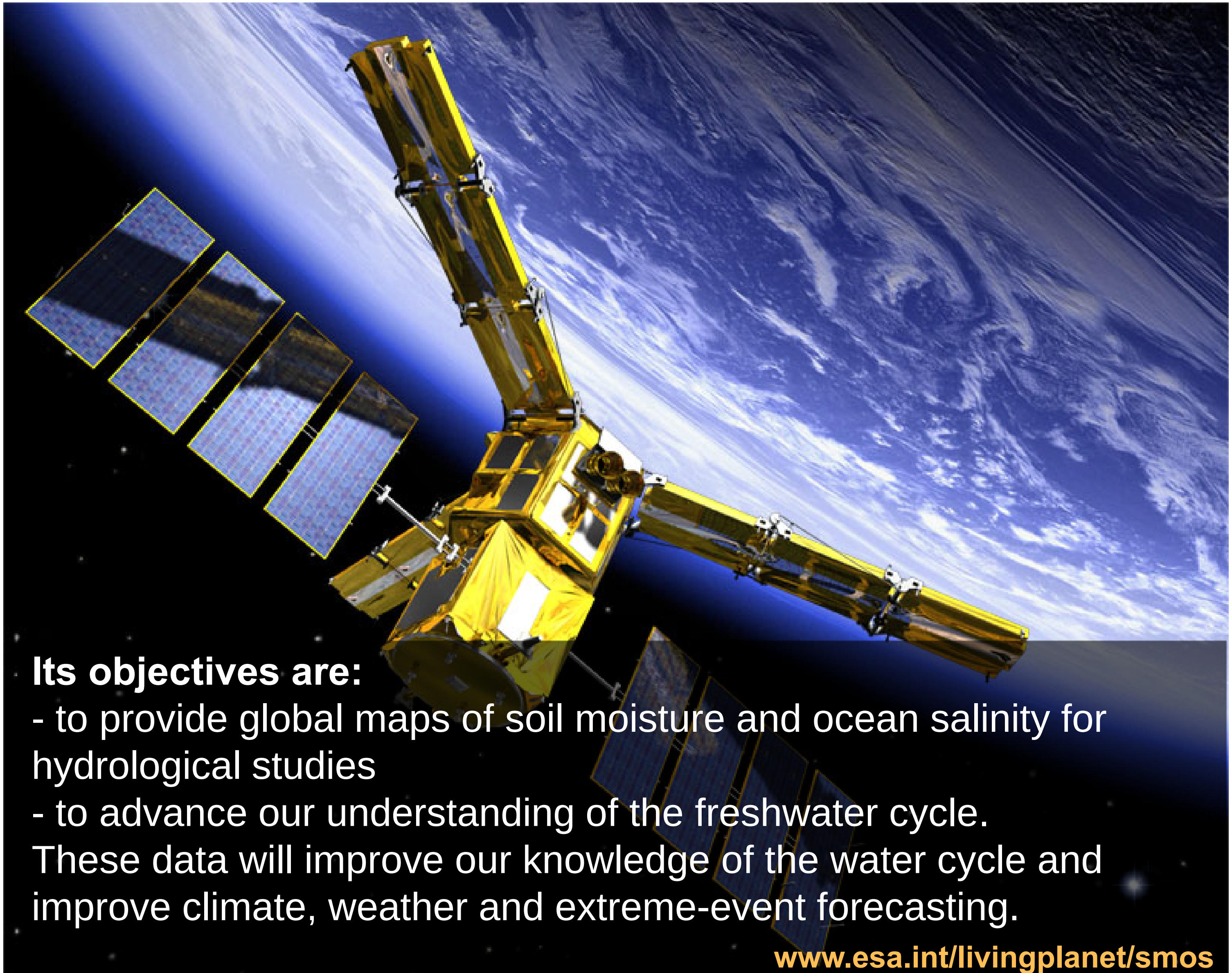
User Services coordinated *via* ESRIN.

CryoSat Testing

- System-level testing of the satellite continued through summer 2008, despite the non-availability of both nominal and redundant units of a vital subsystem, the S-band transponder. An engineering model was used in place, allowing a large amount of testing to proceed.
- Very good Progress, thanks to the experience gained during the earlier CryoSat development.
- In early September, the second System Validation Test (SVT-2) was successfully performed, with very few anomalies detected.
- Afterwards the satellite was moved to IABG in Munich (D) to begin the environmental testing.
- Test programme scheduled first the tests that can be performed without the missing S-band transponder. (delivery is expected in October).
- Testing of the overall ground segment continues, with extensive testing of the interfaces between facilities.

Launch… 16 Nov 2009

SMOS: ESA's Water Mission



Its objectives are:

- to provide global maps of soil moisture and ocean salinity for hydrological studies
- to advance our understanding of the freshwater cycle.

These data will improve our knowledge of the water cycle and improve climate, weather and extreme-event forecasting.

www.esa.int/livingplanet/smos

The SMOS Mission

Objectives

To improve understanding of:

- the water cycle
- its representation in mesoscale models (Hydrology, Oceanography and Climate).

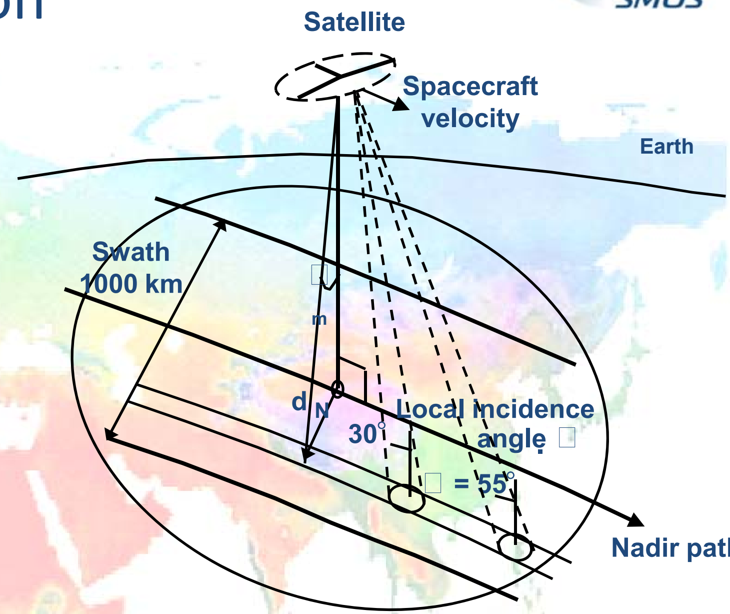
Approach

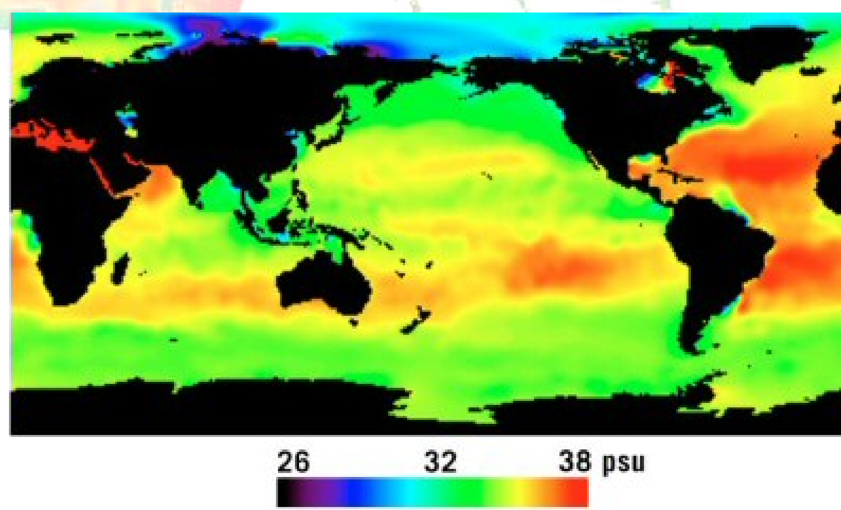
Global soil moisture and ocean salinity estimated from dual-pol., multi-angular, L-band interferometric brightness temperature measurements.

Benefits

Enhanced model parameterisations will:

- improve weather predictions
- improved ocean/hydrology models
- better extreme event forecasting





SMOS Testing

- The satellite is in storage at Thales Alenia Space, Cannes,and will be retrieved at the end of the year for final flight software upload, System Validation Test 3 and a repeat of the launcher adaptor fit check.
- The Satellite Qualification Review was successfully concluded with recommendations by the panel and board members being pursued as normal work.
- The ground segment development proceeds, with the version 2 on-site acceptance test of the data-processing ground segment scheduled this month.

Launch… mid-2009

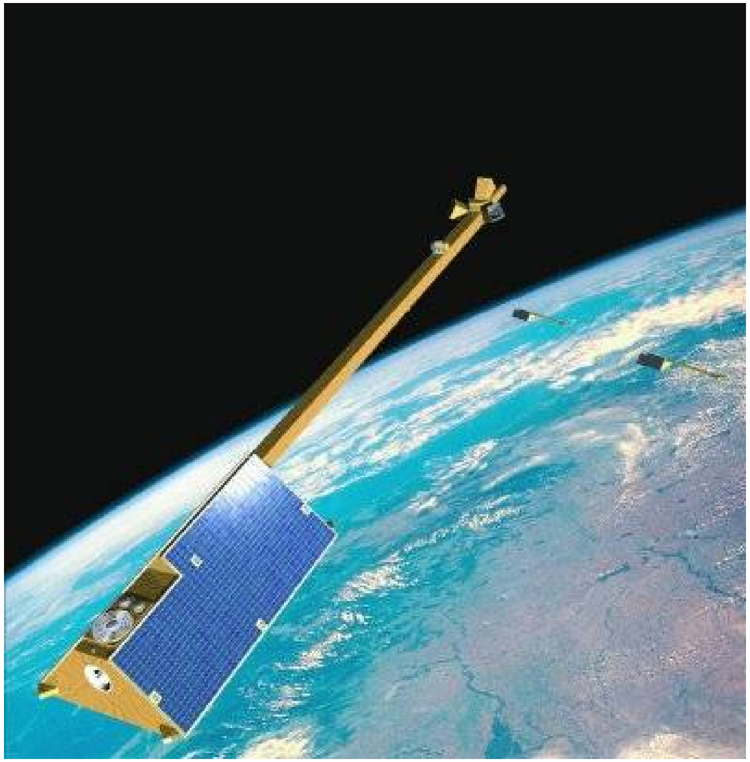
ADM-Aeolus: ESA's Wind Mission

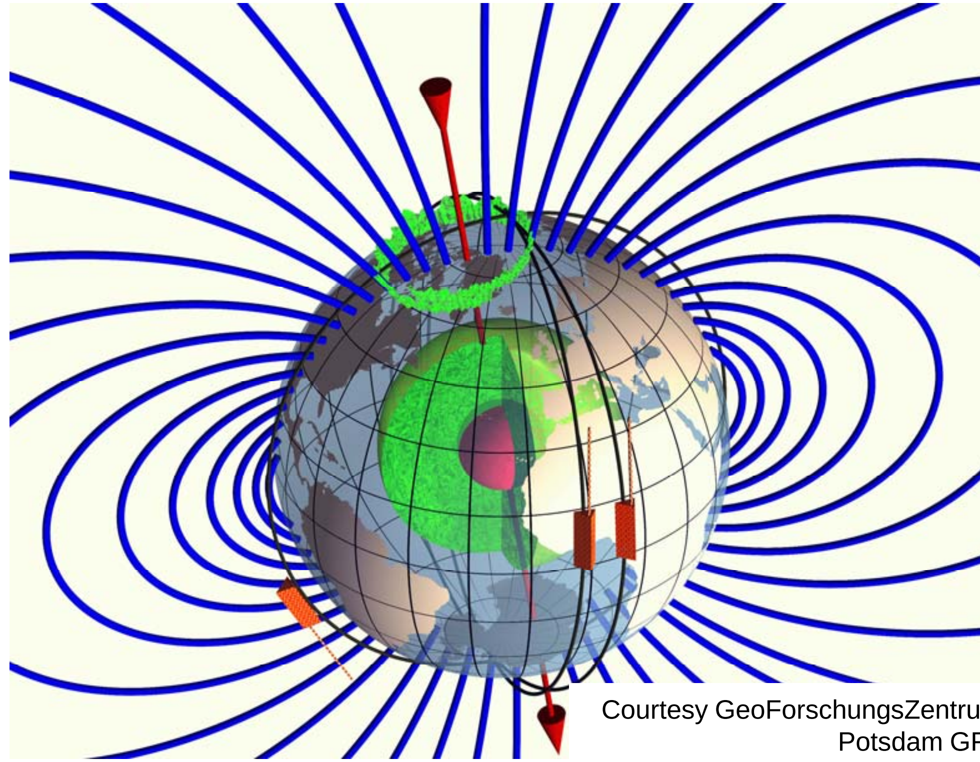
ADM-Aeolus Testing

- A critical review of the ALADIN laser design and its technological margins was concluded in July 2008
  - Identified the need for a number of design improvements in order to achieve the required stability of the laser and adequate design margins. The implementation of these measures has been initiated.
- A design modification will be implemented in the laser master oscillator
  - Allows reduction in the fluency level of the laser beam without impact on the laser output energy.
  - This modification increases the margins against laser induced damage within the master oscillator.
- The satellite application software has successfully passed the software qualification review.
  - The formal system level test campaign has made good progress. Several data-handling system tests were successfully completed.

Launch… end-2010

Swarm: ESA's Magnetic Field Mission





Courtesy GeoForschungsZentrum Potsdam GFZ

The objectives of the Swarm constellation are:

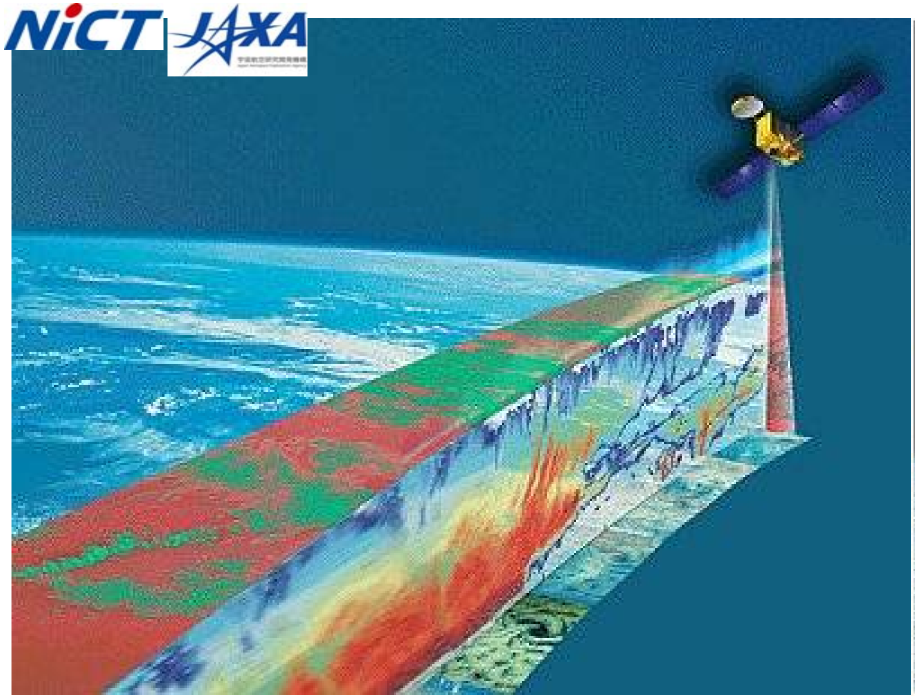
- to provide the best-ever survey of the Earth's geomagnetic field and its variation in time
- to use these data to gain new insight into the Earth's interior and climate.

www.esa.int/livingplanet/swarm

Launch… mid-2010

EarthCARE: ESA's Cloud & Aerosol Mission

NiCT JAXA



EarthCARE is a joint European - Japanese mission with the objective:

- to improve understanding of cloud-aerosol-radiation interactions, such that these parameters correctly and reliably included in climate and weather prediction models.

Launch… end-2012

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GMES

Global Monitoring for Environment and Security (GMES)

- GMES is ESA's contribution to GEOSS
- ESA GMES Preparatory programme:

  4 Elements

  - Socio-economic analysis
  - Architecture
  - Ground Segment
  - Space observation component - "Sentinels"

EarthWatch - GMES

ESA GMES Space Component

- Sentinel 1 – Imaging Synthetic Aperture Radar
  - Continuity of established SAR applications, interferometry
- Sentinel 2 – Super-spectral imaging
  - Continuity of Landsat/SPOT class measurements
- Sentinel 3 – **Operational ocean monitoring**
  - Wide-swath multi-spectral sensors, altimeter
- Sentinels 4/5 – Geostationary & LEO atmospheric
  - atmospheric composition monitoring, trans-boundary pollution

Close cooperation/coordination with all European resources (+ Canadian)

SENTINEL 3

Sentinel-3

will carry a new generation Altimeter, similar to CryoSat but with no interferometry mode

S-3 Observational Requirements

The objectives for a series of Ocean Observer Missions (GMES Sentinel-3) encompass the commitment to consistent, long-term collection of remotely sensed marine data, of uniform quality, for operational ocean state analysis, forecasting and operational service provision, in the context of Global Monitoring for Environment and Security (GMES). A network of global ocean observations is required to provide input data for advanced numerical forecasting models. For the remote sensing variables the following set of observational requirements have been established:

- Sea surface topography (SSH) and, significant wave height (SWH) over the global ocean to an accuracy and precision equivalent to that of Envisat RA-2.
- Sea surface temperature (SST) determined globally to an equivalent accuracy and precision as that presently achieved by A/ATSR (i.e. <0.3 K), at a spatial resolution of 1 km. Coastal zone waters require an increased resolution of < 300 m.
- Visible and Thermal Infrared radiances ("Ocean Colour") for oceanic and coastal waters, determined to an equivalent level of accuracy and precision as MERIS data with complete Earth coverage in 2 to 3 days, and coregistered with SST measurements.

S-3 Observational Requirements

Coastal Zones Monitoring: Demands for information on the state of coastal waters are growing in response to population pressure. Thus, there is a requirement for environmental monitoring of phenomena such as harmful algal blooms (HAB) and habitat assessment in addition to weather and ocean nowcasting and forecasting.

The characteristics of the coastal phenomena and the importance of the area for aquaculture, sea-defences, and tourism each justify the observation of coast related parameters with enhanced accuracy and resolution.

Sentinel-3 Requirements

GMES Initial Service	S-3 Requirement
Marine and **Coastal** Environment	sea-surface topography mesoscale circulation water quality sea-surface temperature wave height and wind sediment load and transport eutrophication
Polar Environment monitoring	sea-ice thickness ice surface temperature
Maritime Security	ocean-current forecasting water transparency wind and wave height
Global Change Ocean	global sea-level rise global ocean warming ocean CO_2 flux

Surface Topography:
- **SSH, SWH, Wind, Currents**
- **Sea-ice thickness**

Ocean Surface Colour
- **Cla, PFTs, HAB, Transparency, Sediment loading, Turbidity**

Sea Surface Temp.

Global Monitoring for Environment and Security

Sentinel-3 is one element of the overall GMES system providing 2 days global coverage earth observation data for sea and land applications with real-time products delivery in less than 3 hours.

Operational oceanography & global land applications

Acquire data to feed ocean/atmosphere models and to derive global land products and services.

- Sea/land colour data, in continuation of Envisat/Meris.
- Sea/land surface temperature, in continuation of Envisat/AATSR.
- Sea surface and land ice topography, in continuation of Envisat altimetry.
- Along-track SAR for coastal zones, in-land water and sea ice topography.
- Vegetation products by synergy between optical instruments.

Mission duration

A series of satellites, each designed for a lifetime of 7 years, shall be launched to provide an operational service over 15 to 20 years. Furthermore, two satellites shall operate at any time to fulfil the mission requirements.
(Only one satellite is in development at this moment)

Mission orbit

Type: Frozen, sun-synchronous low earth orbit
Repeat cycle: 27 days (14+7/27 orbits per day).
Average altitude: 814.5km over geoid
Mean solar time: 10h00 at descending node.
Inclination: 98.65°
Launcher: VEGA/Kourou (Eurockot/Plesetzk backup)

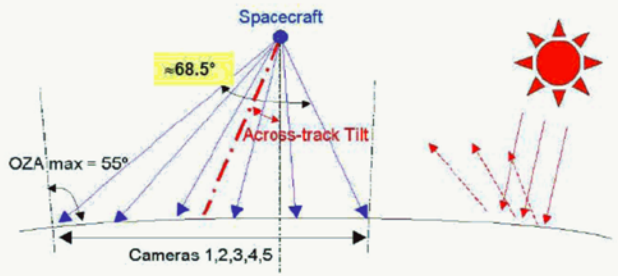
Spacecraft configuration

Launch mass: 1198kg (with maturity margins + 10% system margin, 95kg hydrazine in 130kg tank)
Stowed dimensions: (H) 3712 mm (W) 2202 mm (L) 2172 mm
Attitude control: Gyroless, 3 axis stabilised platform with 3 star tracker heads, 4 reaction wheels and magnetic off-loading. Geodetic pointing and yaw sterring
Orbit control: 8x1N hydrazine thrusters for in-plane and out-out plane manoeuvres. 130kg hydrazine tank 3 meter accuracy real-time onboard orbit determination based on GPS and Kalman filtering.
Power: 2.1 kW rotary wing with 10 m^2 triple junction GaAs European solar cells. LiIon battery, 160Ah
Communications: 64kbps uplink, 1Mbps downlink S-band command and control link (with ranging). 2x225Mbps X-band science data downlink. 330Gbit solid state mass memory.
Autonomy: Position timeline and onboard sun ephemeris for >2 weeks nominal autonomous operations.

Sentinel-3 Configuration and Payload

OLCI: Ocean and Land Color instrument

Swath: 1270km, with 5 tilted cameras



Spatial sampling: 300m @ SSP
Spectrum: 21 bands [400-1020]nm
Radiometric accuracy: 2% absolute, 0.1% relative

SLST: Sea and Land Surface temperature

Swath: 180rpm dual view scan, 750km (nadir) and 1675km (backwards)
Spatial sampling: 500m (VIS, SWIR), 1km (MWIR, TIR).
Spectrum: 9 bands [0.55-12]um
Noise equivalent dT: 50mK (TIR)

SRAL: Synthetic Radar Altimeter

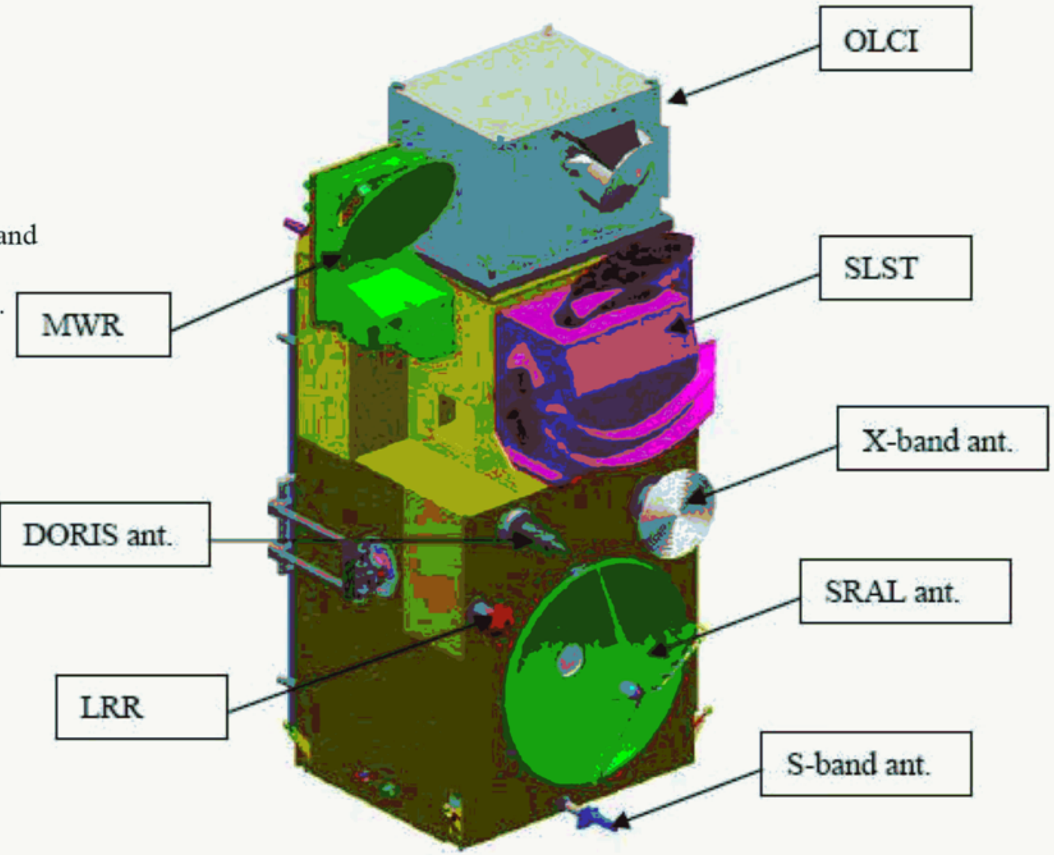
Operation frequency: dual C and Ku bands
Pulse Repetition Frequency (PRF): 1923.87 Hz
Radar measurement modes: LRM and SAR
Tracking modes: Closed-loop and Open-loop
Total range error: 3cm

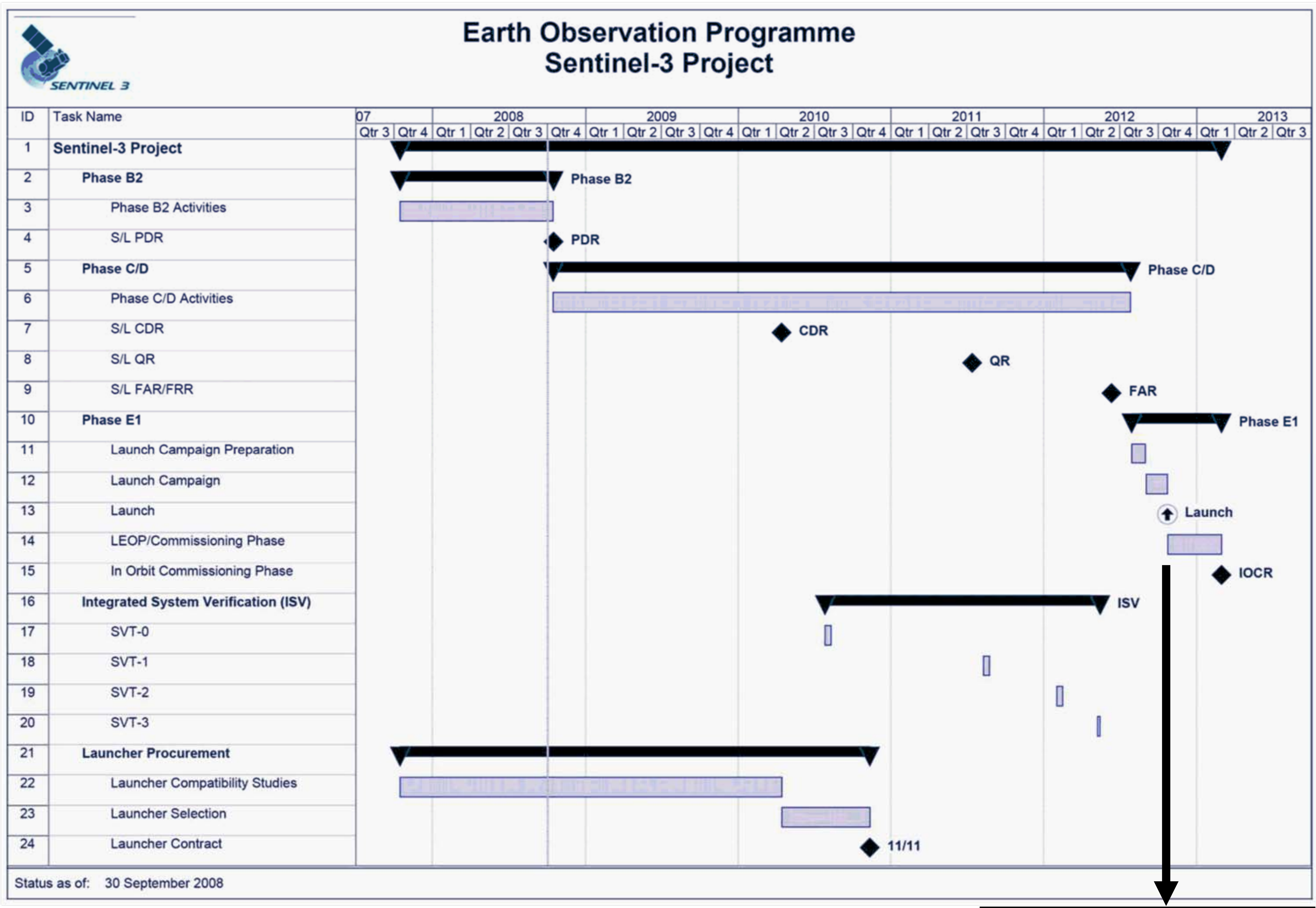
MWR: MicroWave Radiometer (support to SRAL)

Operation frequency: dual 23.8GHz 36.5GHz
Radiometric accuracy: 3K absolute, 0.6K relative

POD: Precise Orbit Determination (support to the whole payload)

Ground processing of GPS data with enhancement through Laser Retro-Reflector and DORIS (CFI)
Final accuracy: 3cm





LAUNCH : Q4-2012

Sentinel-3 Status

- Phase B2 activities proceeded as planned and the PDR process has started.
- The first PDR, for the OLCI instrument, began in July, followed by the Satellite and Platform PDRs in August and the SRAL Instrument PDR in September. The remaining two instrument PDRs (MWR and SLSTR) are planned during Q4-2008.
- These reviews will allow an evaluation of the satellite and instrument technical consolidations performed during the Phase B2, and will lead to the freezing of the design that will be then considered during the subsequent Phase C/D as the basis for the detailed definition, manufacturing and testing.
- On the technical side, two major achievements were the consolidation of the SLSTR thermo-mechanical design, such to satisfy the operational constraints required to reach the desired instrument performance and the decision of the radiofrequency (RF) switch configuration to be implemented on the MWR instrument.
- At satellite level, the main task has been the gradual introduction of specific unit technical data that became available after start of the selected sub-contracts.

Research & Development in

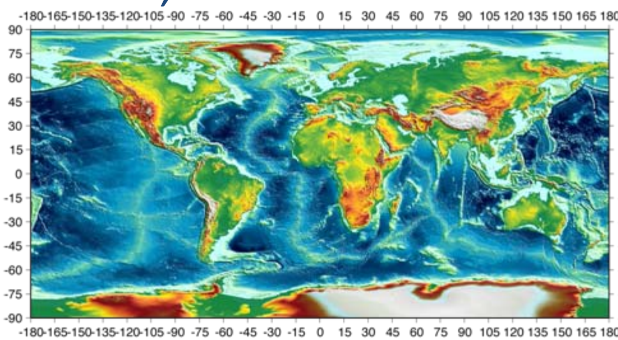
Radar Altimetry

Altimetry Research & Development

- Recently finished
  - RA Individual Echoes and S-band, CLS
    - S-band calibration
  - RA Individual Echoes and S-band, NOCS
  - River and Lake Level, DMU
  - Basic Radar Altimeter Toolbox (BRAT)
    - Radar Altimeter Tutorial (RAT)
  - Goce User Toolbox Specification (GUTS)
    - Support to GOCE Products Users
    - Merging Radar Altimeter and GOCE products for absolute ocean circulation

Altimetry Research & Development

- On-going in 2008
  - RAIES Follow-on
    - RAIES Users Group, Data processing, Web access
  - Altimetry Corrected Elevations 2nd Generation, DMU
    - Correcting STRM with RA
  - River and Lake Follow-on , DMU
    - Ra performance over inland water
    - Assimilation in hydrological models
    - In-situ data



  - SAMOSA: Exploiting the Altimeter SAR mode over Ocean, Coastal Zone and Inland water, SATOC
  - COASTALT, Coastal Zone LRM Atlimetry ,NOCS
  - GUT (GOCE User Toolbox implementation), DNSC
  - BRAT V2 (waveform movie, MacOS X, ergonomy), S&T, CLS
  - SMOS User Toolbox (plug-in of BEAM)

http://earth.esa.int/altimetry

esa

ACE2 - rationale 1

- The SRTM collected a unique dataset of interferometric SAR from which a near-global digital elevation model was derived.
- However, latitudes above roughly +/- 60 degrees were not covered. Additionally, voids occur over inland water, and problems in the InSAR processing caused systematic errors in the resulting GDEM.
- Where tree canopy was present at the time of the overpasses, a proportion of the canopy height appears in the DEM.

ACE2 - Rationale 2

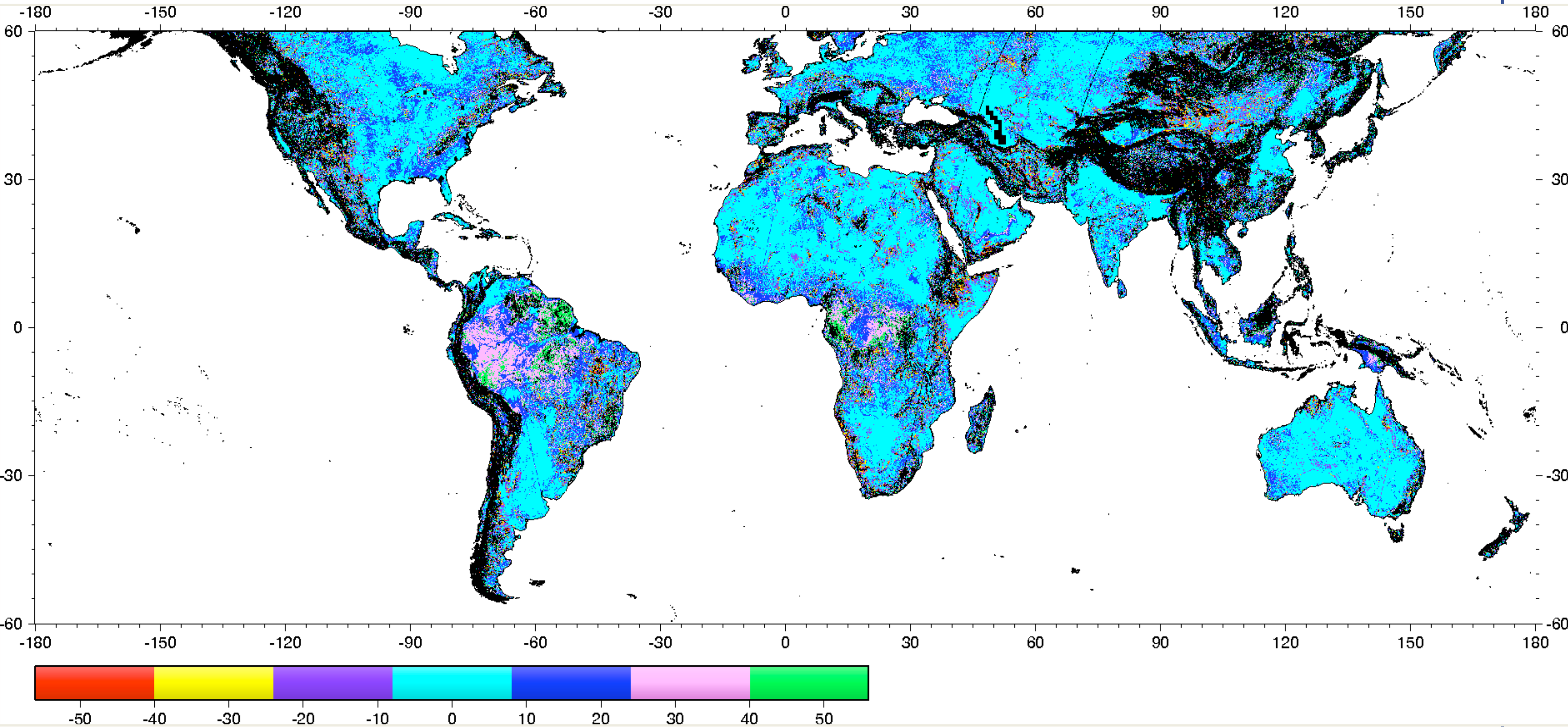
- Large-scale validation of the SRTM dataset has been confined to a few regions where good DEM data are available, much of this over the USA.
- However, there IS a completely independent height dataset available, derived from satellite radar altimetry, especially the ERS-1 Geodetic Mission.
- By retracking the waveform data over land from ERS1, ERS2 and EnviSat, using an Expert System approach, over 150 million orthometric heights have been derived.
- Supplemented with ERS2, Topex and Jason-1 heights for ACE2 generation.

ACE version 2

- The SRTM near-global DEM represents a considerable enhancement in mapping
- Development of new fused GDEM ACE2, using multi-mission satellite altimeter heights to enhance SRTM dataset,
- Particular care to the representation of global assessment of inland water heights
  - known difficulty in SRTM is representation of inland water

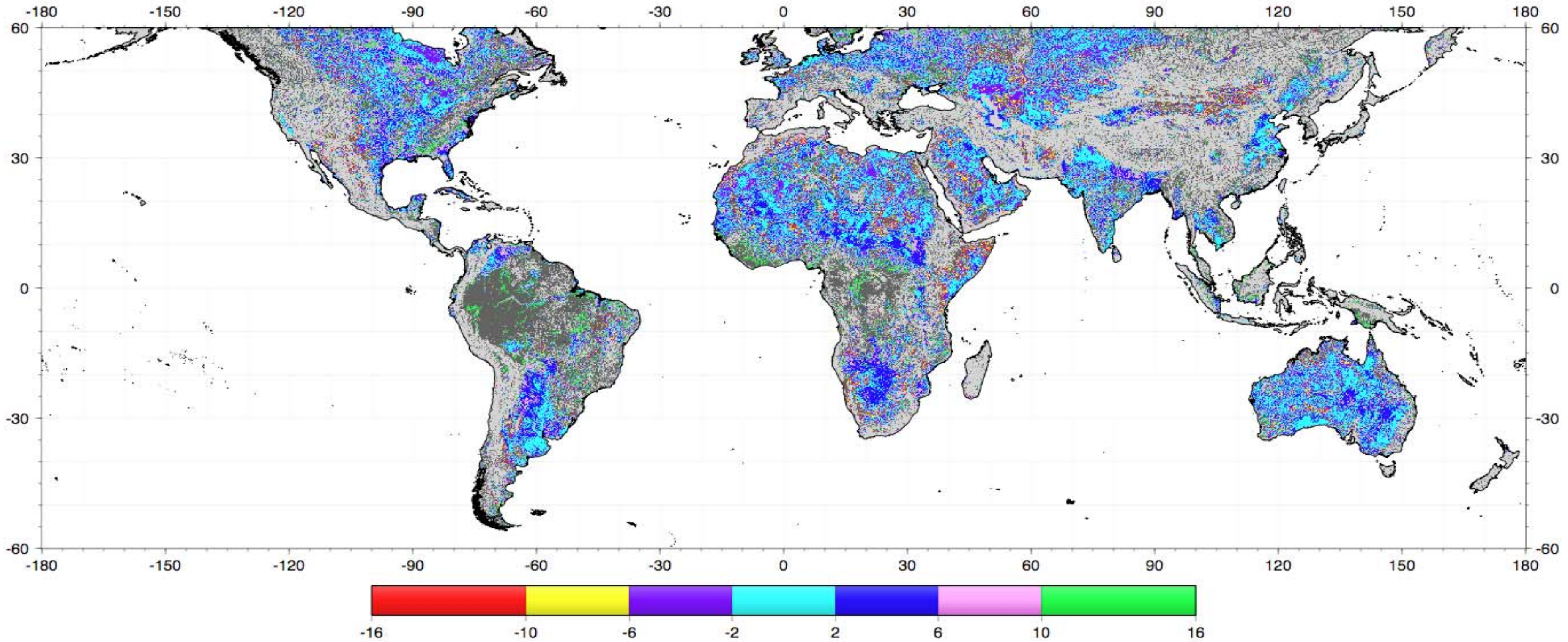
(ACE2 = Altimetry Corrected Elevations V.2)

SRTM comparison with ERS1 GM Heights



Global comparison performed to +/- 60m. Areas where altimeter did not get good data were masked off (Black areas).
Comparison shows correlated areas of good and poor agreement.

Areas of agreement within ±16M

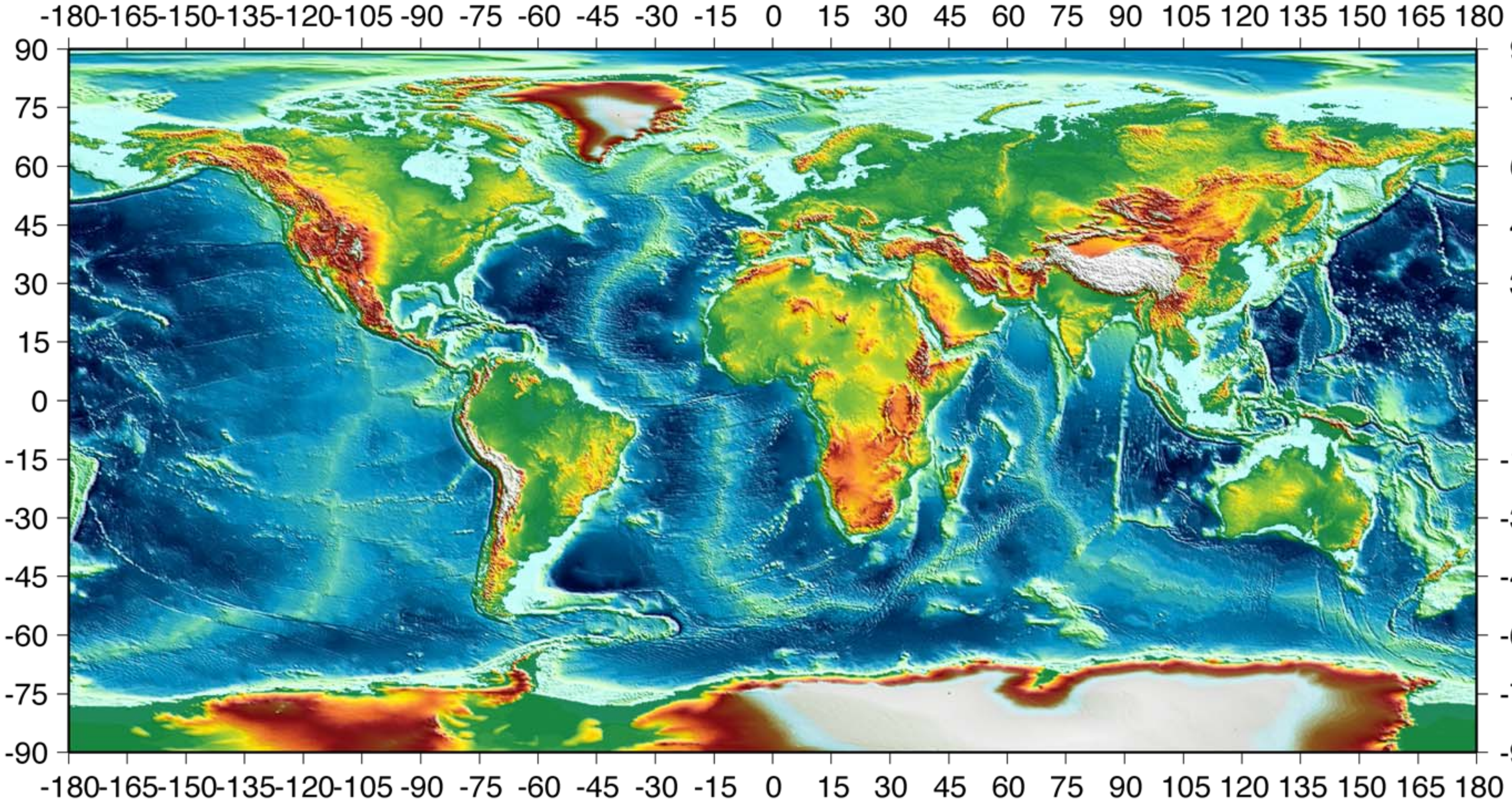


As part of ACE2 development, analysis performed of areas where agreement extremely good. Above shows global comparison, note pixels binned to 5’ for plotting. Many areas where SRTM good to a couple of metres. In all areas globally where altimeter heights obtained, SRTM heights corrected.

ACE2 Release

- First release of ACE2 on 7 November 2008.
- Accuracy estimate and data source given for each pixel for full resolution release.
- User Satisfaction survey and final release March 2009.
- Further enhancements as more data become available e.g. from Jason-2 and CryoSat-2.

Altimetry Corrected Elevation - Version 2



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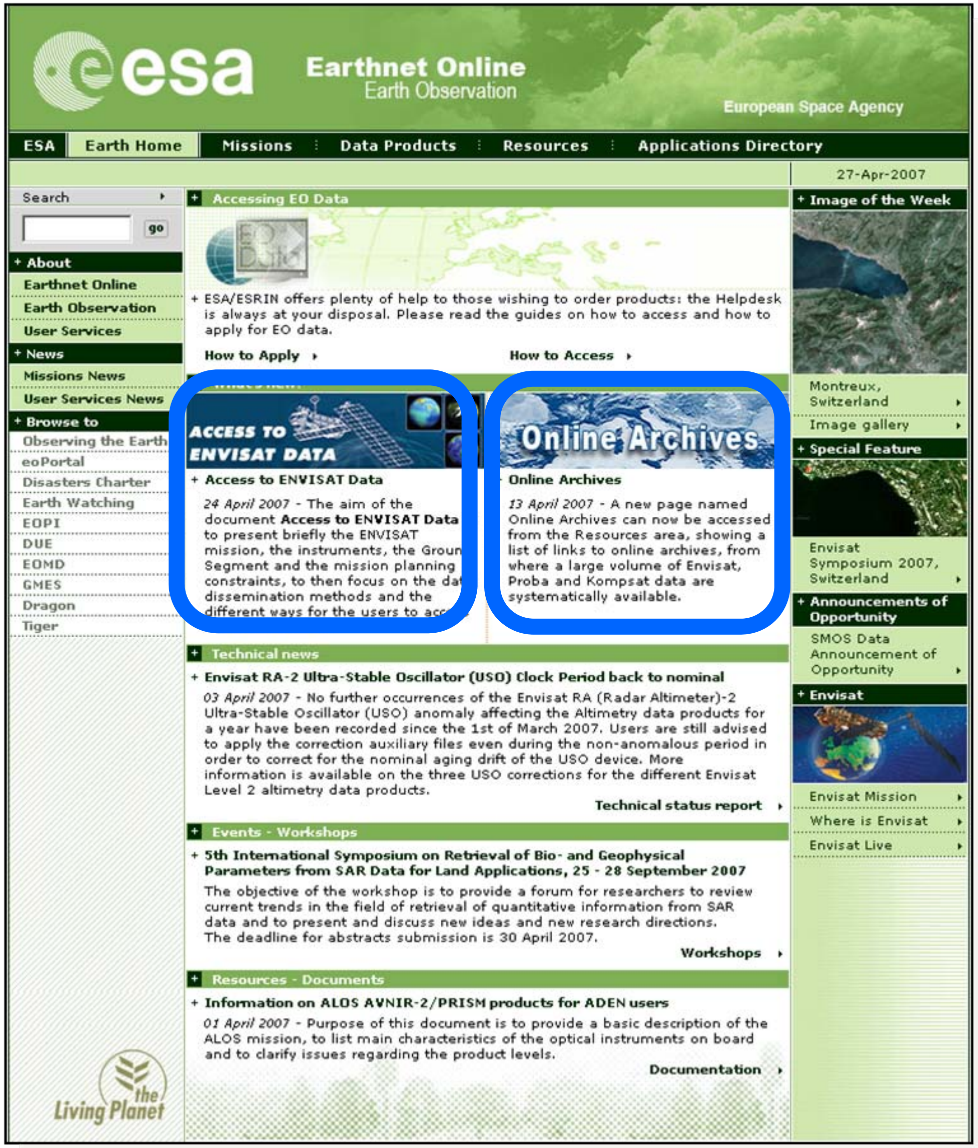
ESA EO data access



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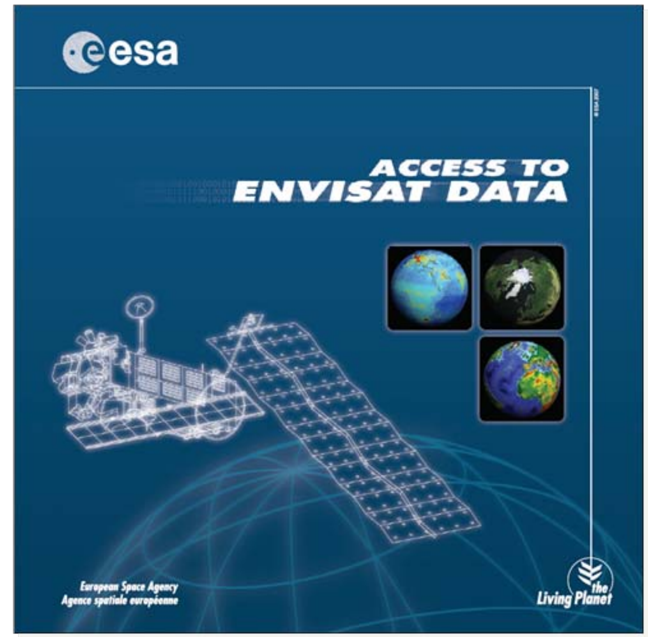

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Data Exploitation

- On-going AOs involve more than 1500 projects.
- The Category-1 continuous mechanism witnesses a growing success, with currently 25 proposals submitted monthly and more than 800 projects in total.
- 200 Projects using ERS or Envisat Altimeter
- Cat-1 is supported by the EO PI portal:

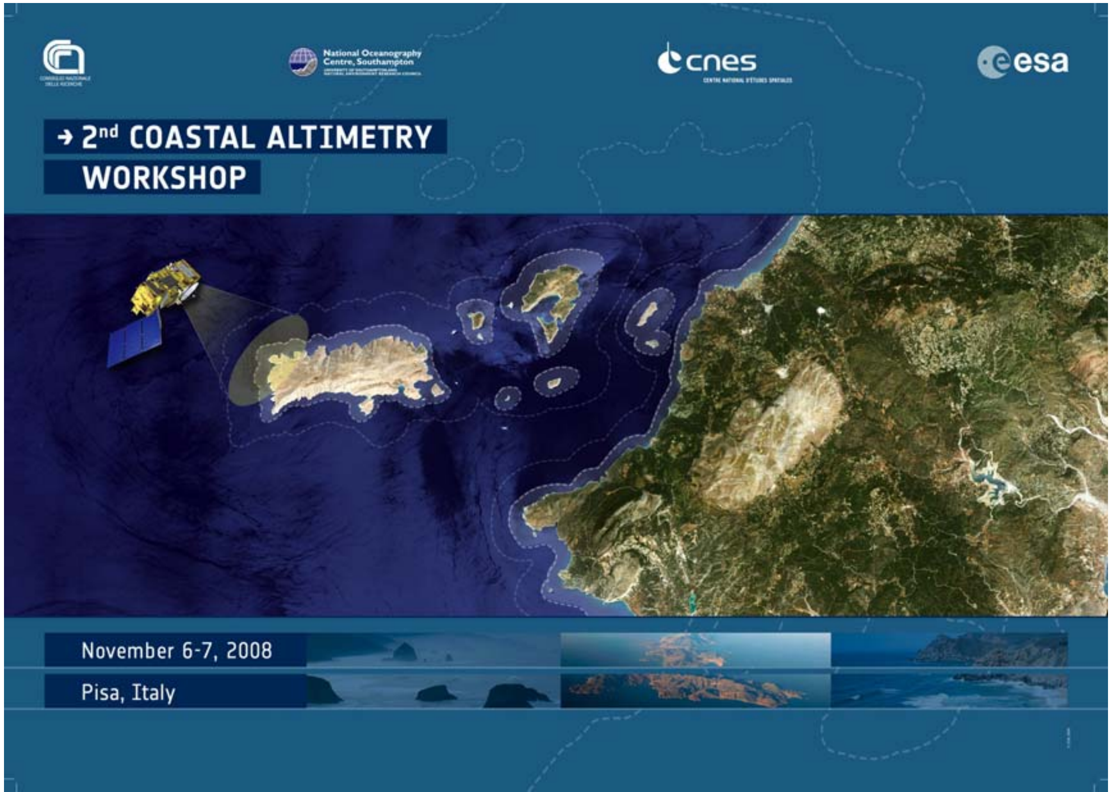
http://eopi.esa.int

Data Exploitation

- The EO PI portal is increasingly popular. Practical information includes stories about “PIs of the month”, round tables on scientific topic, public and scientific news.
- Projects correspondents (ESA Staff) are assigned to stimulate one-on-one dialogue with all PIs.
- Intense scientific promotion efforts:
  - Workshops…
  - Summer schools…
  - Provision of open-code software toolboxes…

http://eopi.esa.int

- This workshop, sponsored by CNR-Pisa, ESA and CNES, was a showcase of the results obtained so far by COASTALT and PISTACH
  - –Started 10m/1yr ago for 18 months
- Summary presented in OSTST



- Final results to be presented at the

  3rd COASTAL ALTIMETRY WORKSHOP

  ESA-ESRIN -- September 2009

  (the week before OceanObs'09, 21-25/09/09 in Venice)

  (http://www.oceanobs09.net)

RA-2/MWR Health

RA-2 Health

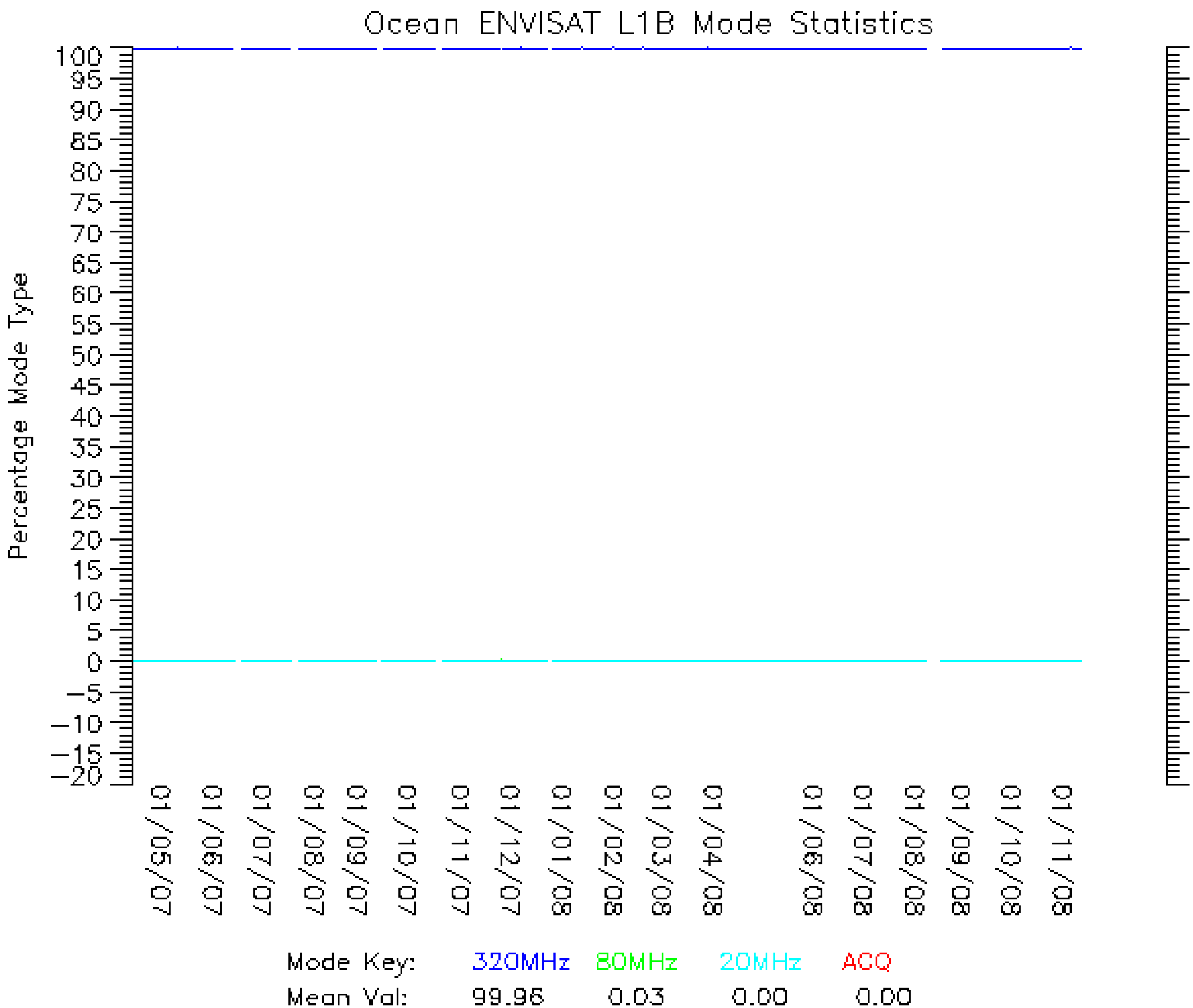
- S-Band amplifier failed on 17 January 2008
- For cycle 72, 08-09-2008 13-10-2008, data availability was around 99.29% for RA-2 products, 99.21% for MWR products and 93.96% for DORIS products
- Cycle 72 has been processed with IPF processing chain V5.06, installed in both PDHS-E and PDHS-K on 20th June 2007, orbit 27729.
- IPF V5.06 contains the following main evolutions:
  - 1. Increase performance in the usage of DORIS Navigator in NRT products due to DORIS Navigator threshold update to 900 seconds coverage RA2/DORIS;
  - 2. Alignment of Chain B to Prod Spec 3/N

- RA-2 Tracking

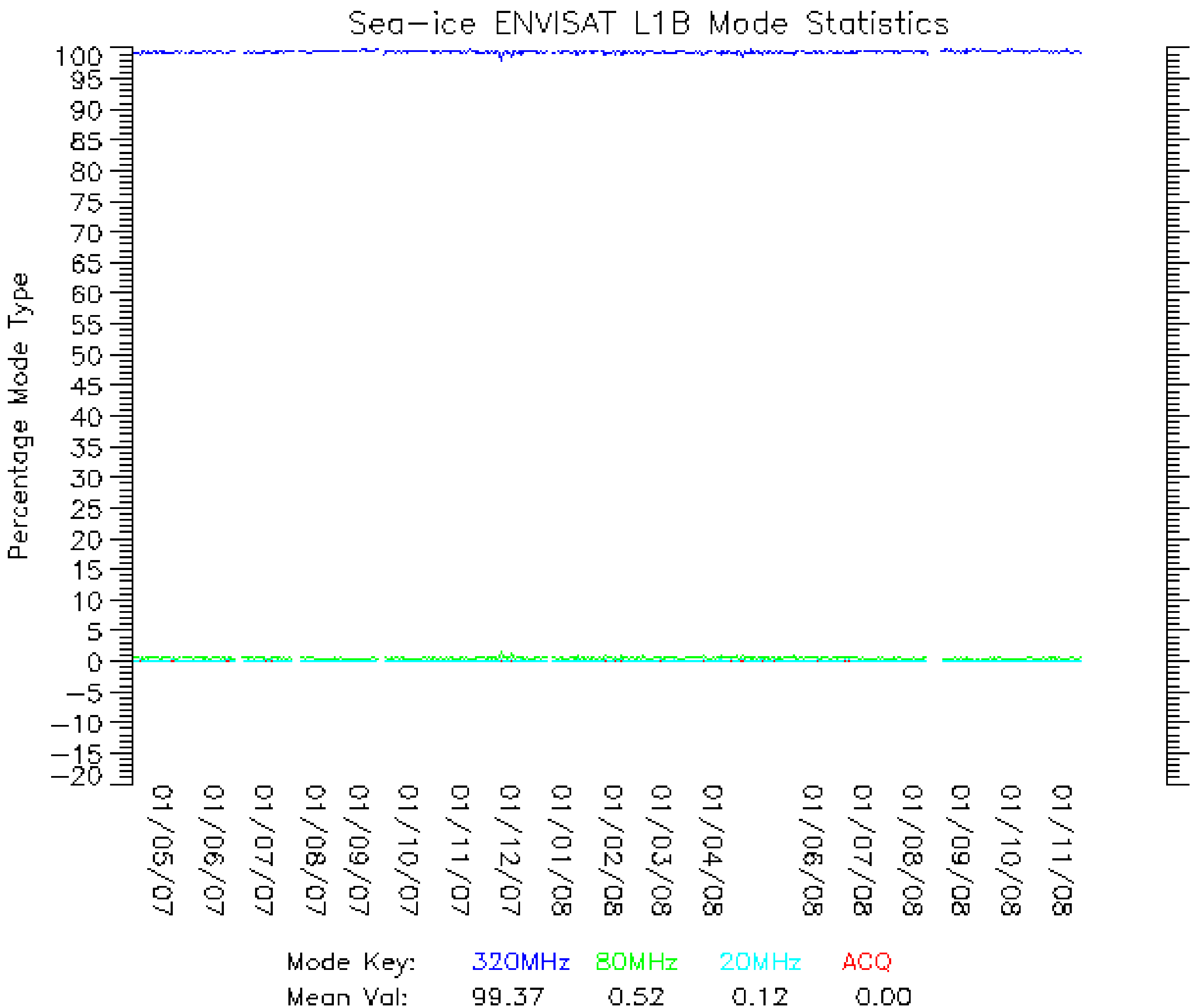
Surface type	320 MHz	Commissioning Phase objective 320 MHz	80 MHz	20 MHz
Open Ocean	99.82	$> 99\%$	0.17	0.01
Coastal water	98.93	No specific requierement	1	0.07
Sea ice	98.95	$> 95\%$	0.95	0.09
Ice sheet	95.49	$> 95\%$	3.79	0.70
Land	81.86	No specific requierement	14.19	3.54
All world	95.25		3.84	0.89

95.25+3.84+0.89=99.98! Almost never in Acq!

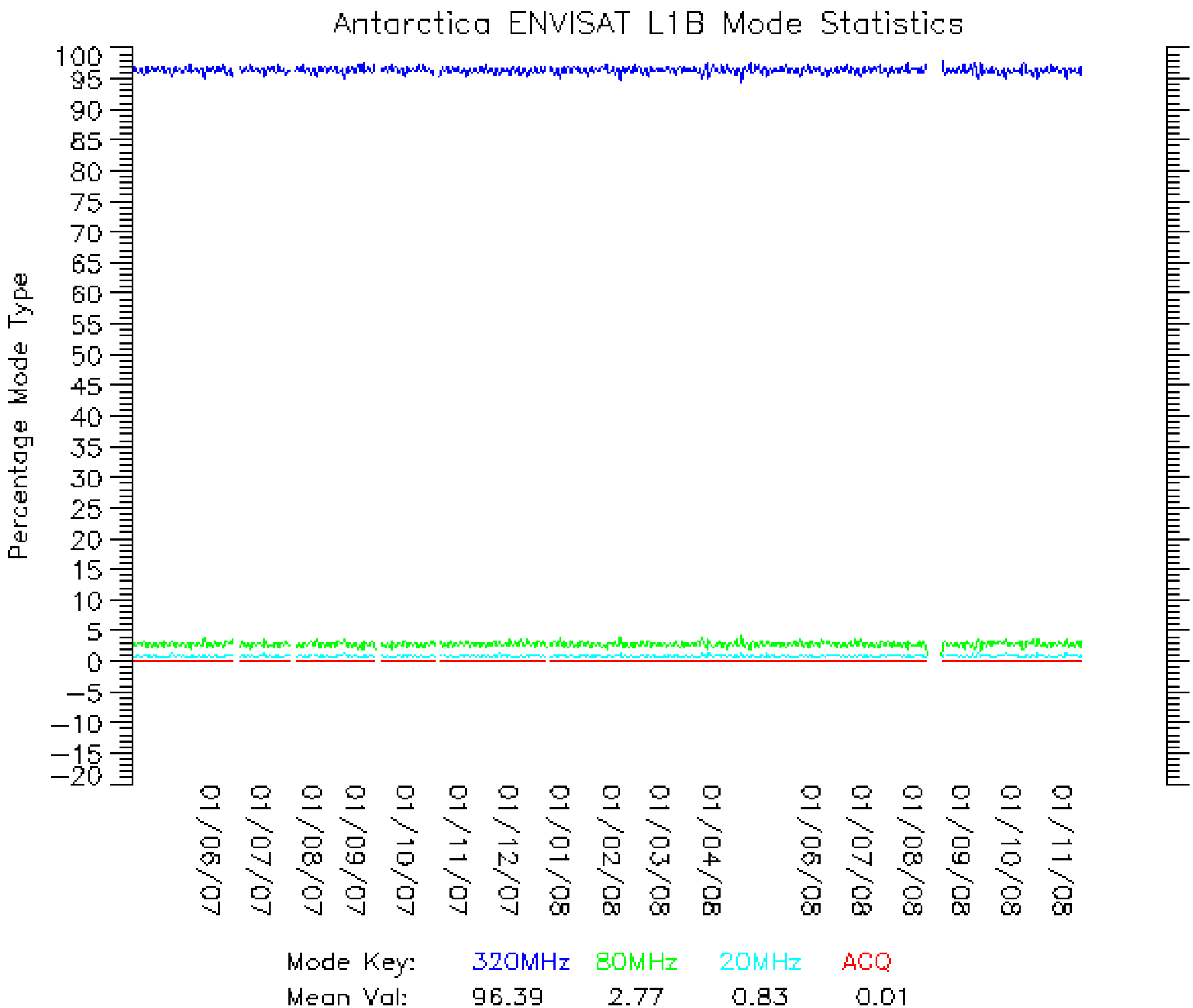
RA-2 Tracking



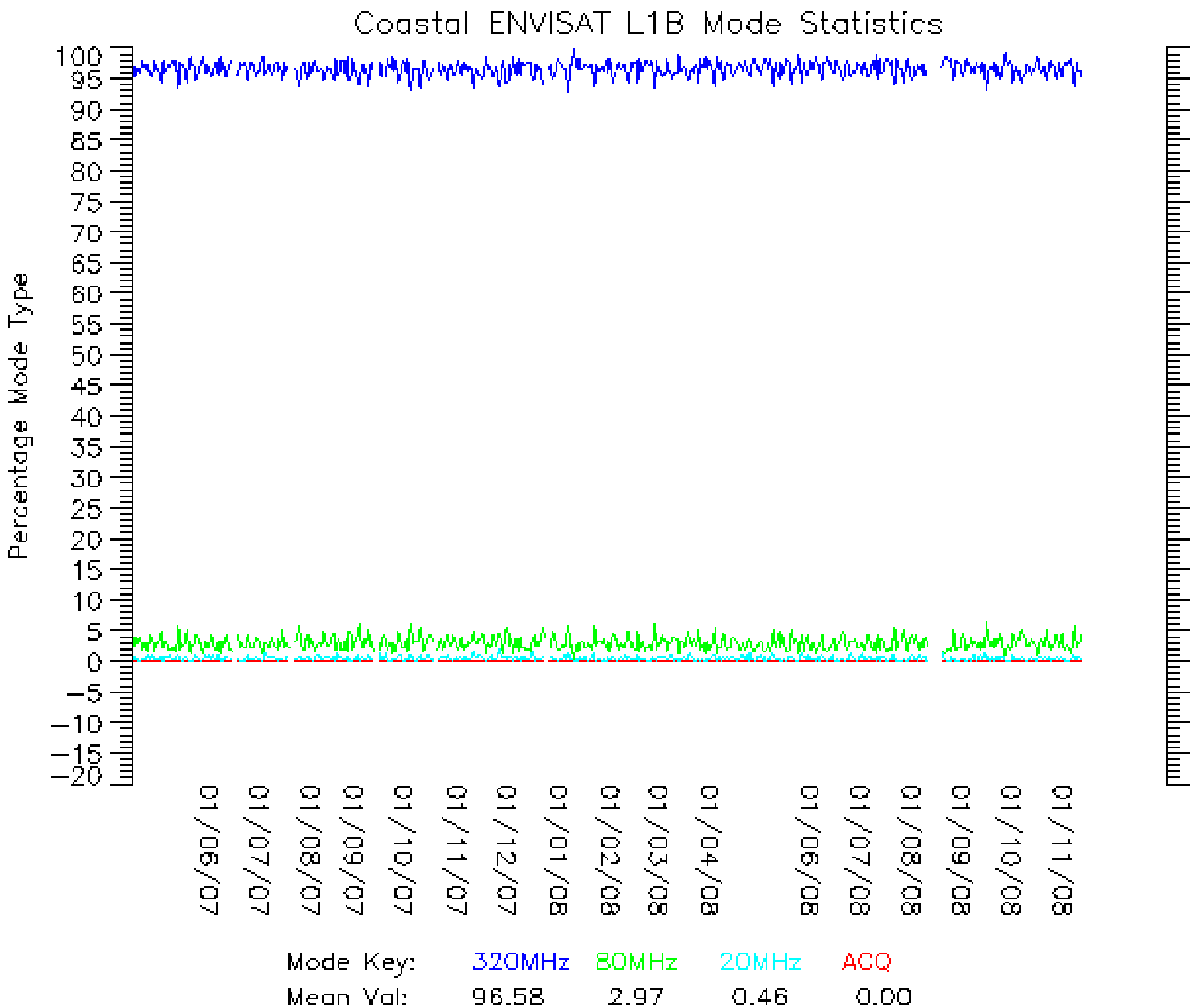
RA-2 Tracking



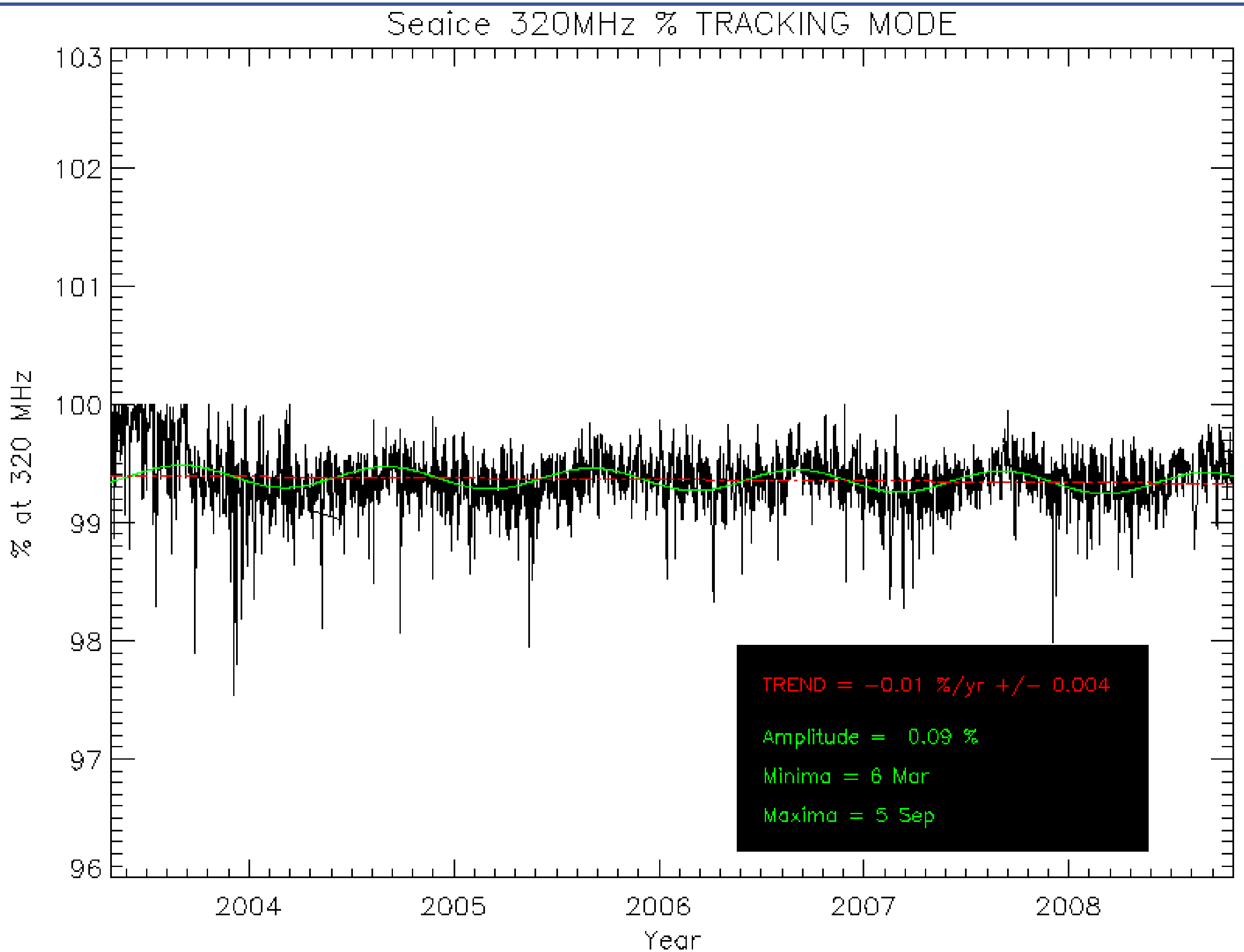
RA-2 Tracking



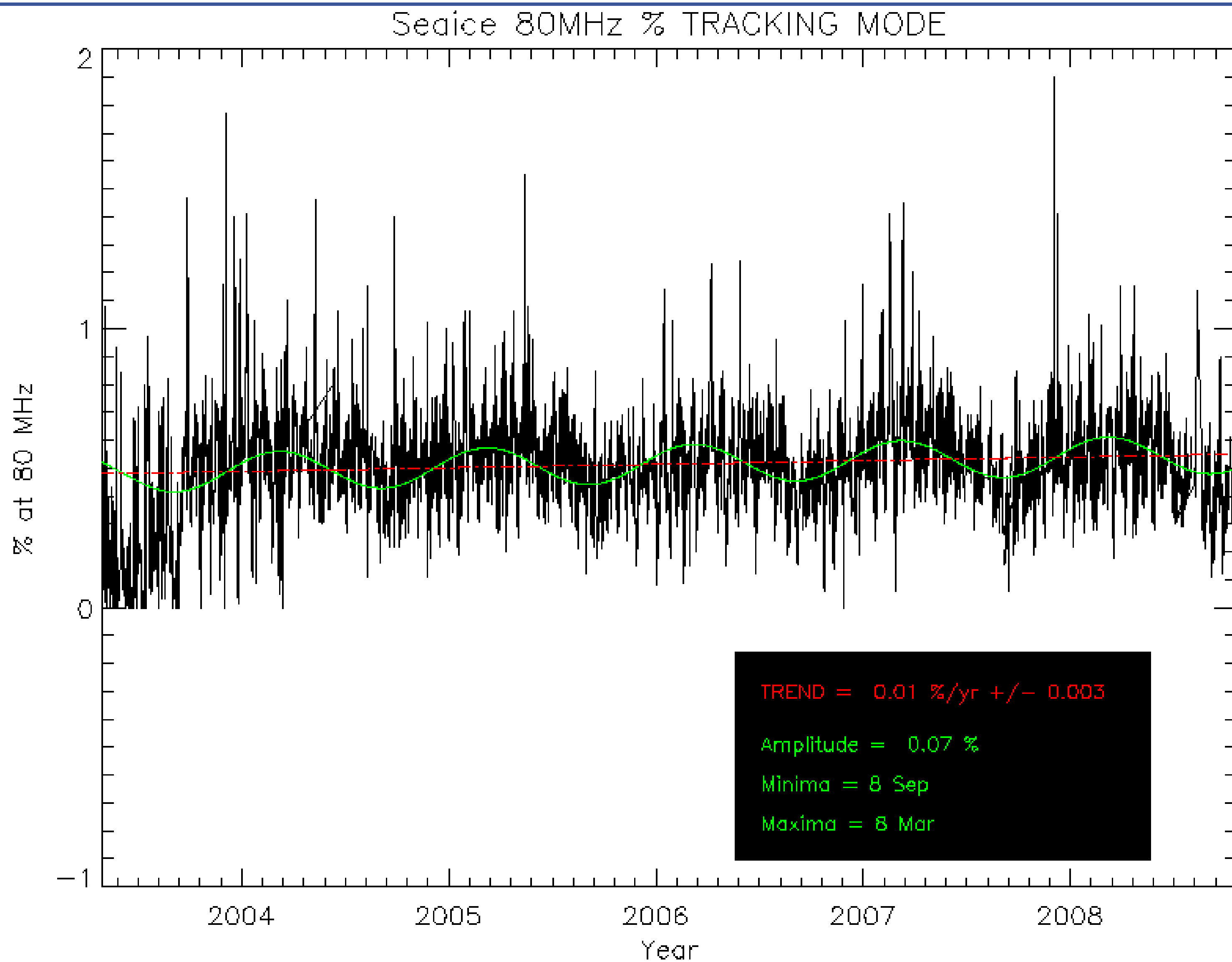
RA-2 Tracking



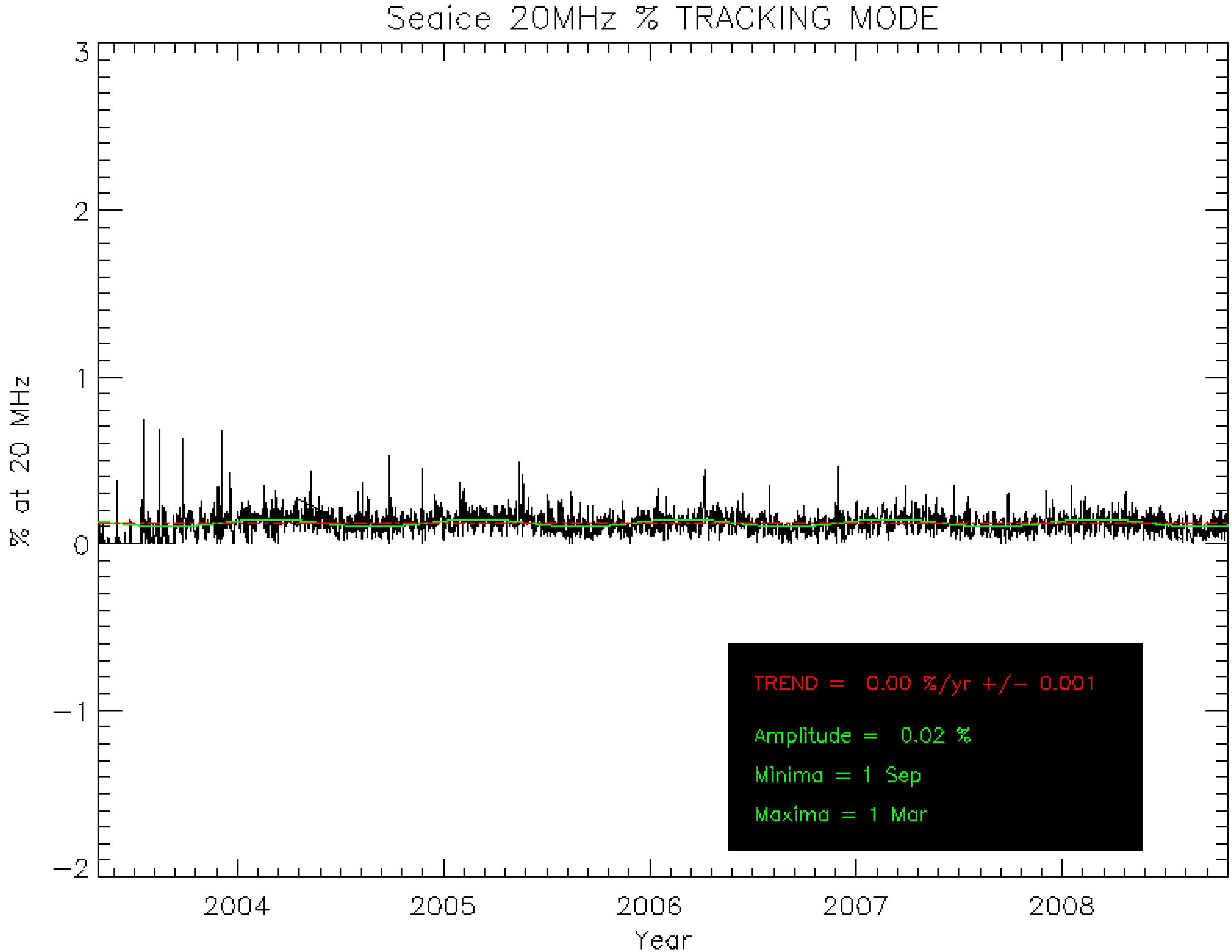
RA-2 Tracking



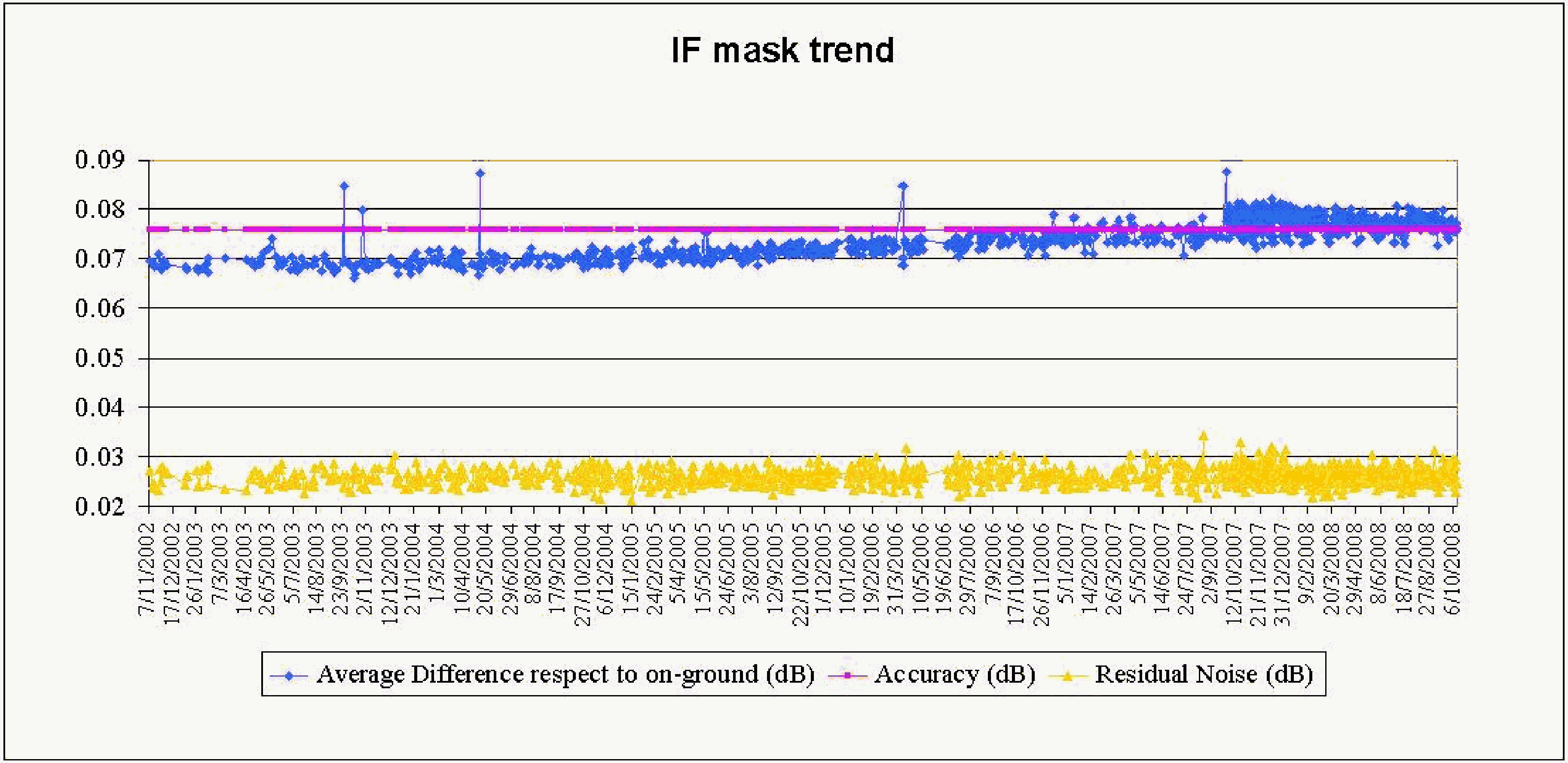
RA-2 Tracking



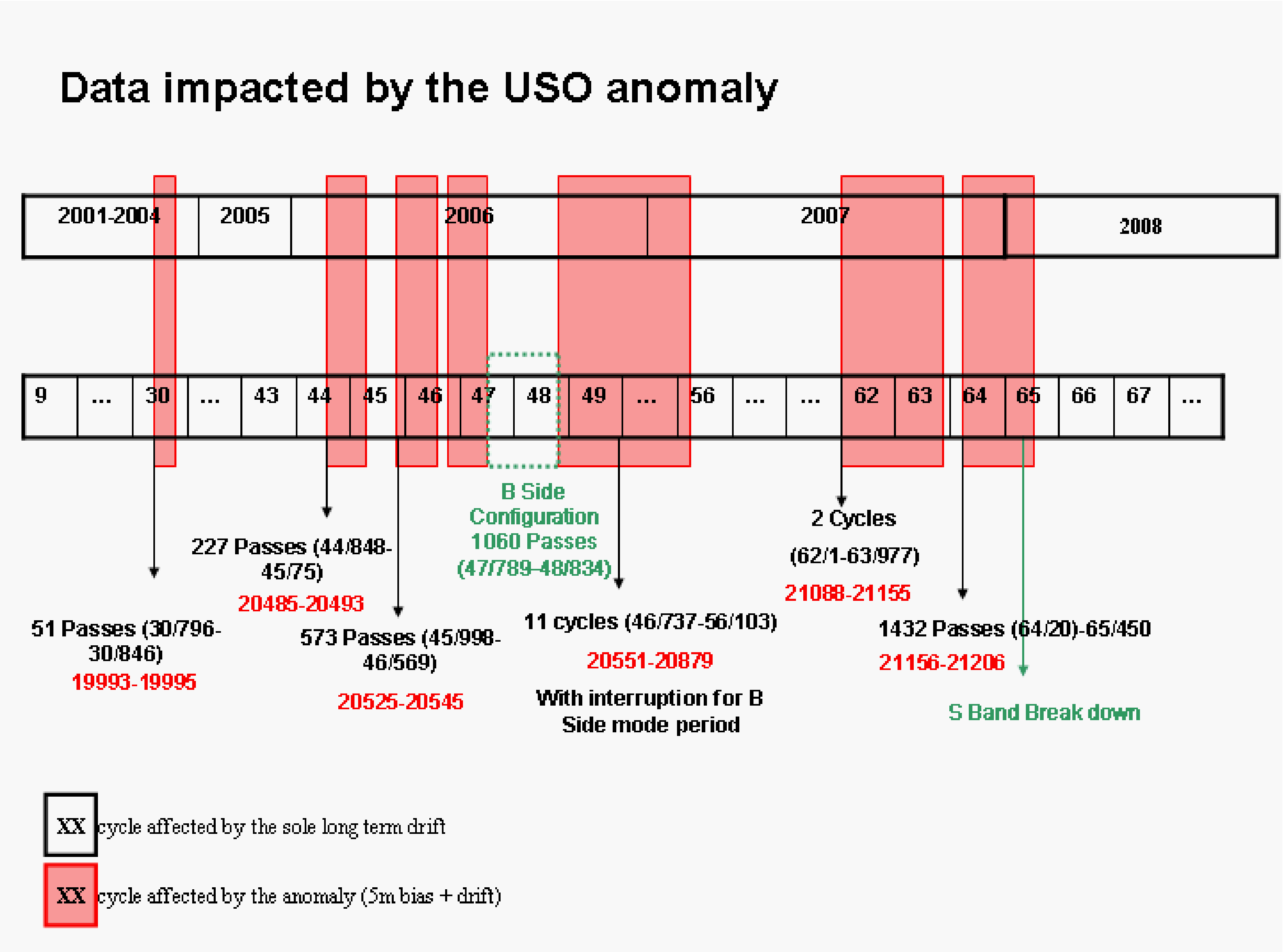
RA-2 Tracking



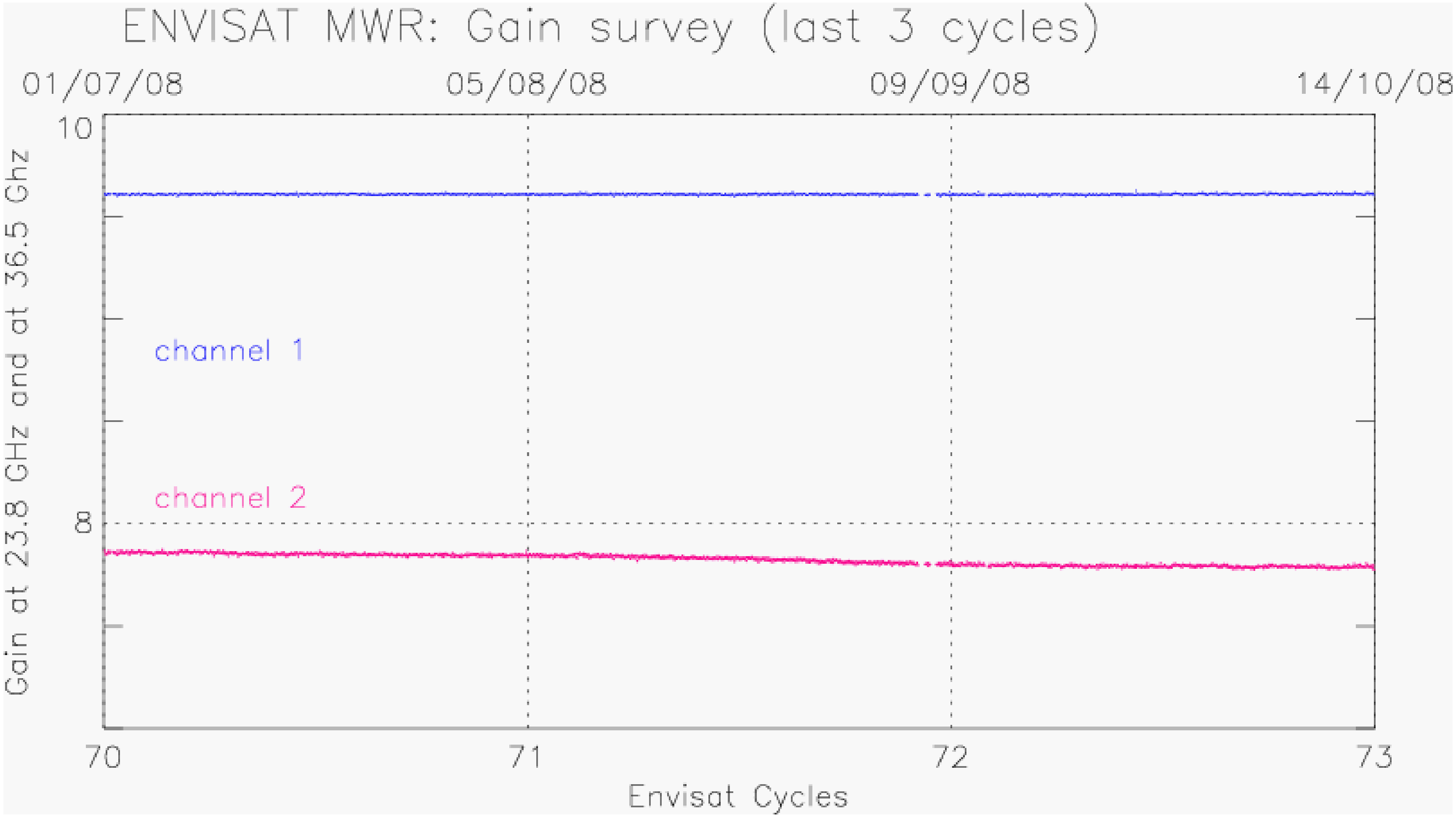
RA-2 IF Mask Trend



RA-2 USO Anomaly History



MWR Gain drift



Channel 2, 36 GHz, continues to drift slowly

Summary

- ESA has a broad variety of satellite tools for delivering met/ocean data
- New ESA Earth Explorer missions poised to provide new insights
- GMES Sentinel missions to fulfil operational global monitoring (from 2011/12 onwards)

- EO data requirements (acquisition mode, area) for Inland Water and Coastal Zone should be documented further (CryoSat-2, Sentinel-3): recommendations welcome.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→ 2nd COASTAL ALTIMETRY WORKSHOP

www.coastalt.eu

→ TOPICS

1 → User requirements for coastal altimetry
2 → Retracking
3 → Corrections: Dry/Wet Tropospheric, Ionospheric, Tides & HF
4 → SSB & Waves
5 → Data Products, quality and dissemination
6 → Synergy with other data and models
7 → Forthcoming technologies
8 → International Cooperation and Future Programs

→ ORGANIZING COMMITTEE

Jérôme Benveniste - *European Space Agency - ESRIN, Frascati, Italy*
Nicolas Picot - *Centre Nationale d'Etudes Spatiales (CNES), Toulouse, France*
Stefano Vignudelli - *Consiglio Nazionale delle Ricerche (CNR), Pisa, Italy*
Paolo Cipollini - *National Oceanography Centre, Southampton, U.K.*

November 6-7, 2008

Pisa, Italy

→ www.coastalt.eu/pisaworkshop08

Thank you for your attention !

And for further reading the PDF file in the Proceedings...

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Jerome.Benveniste @esa.int