



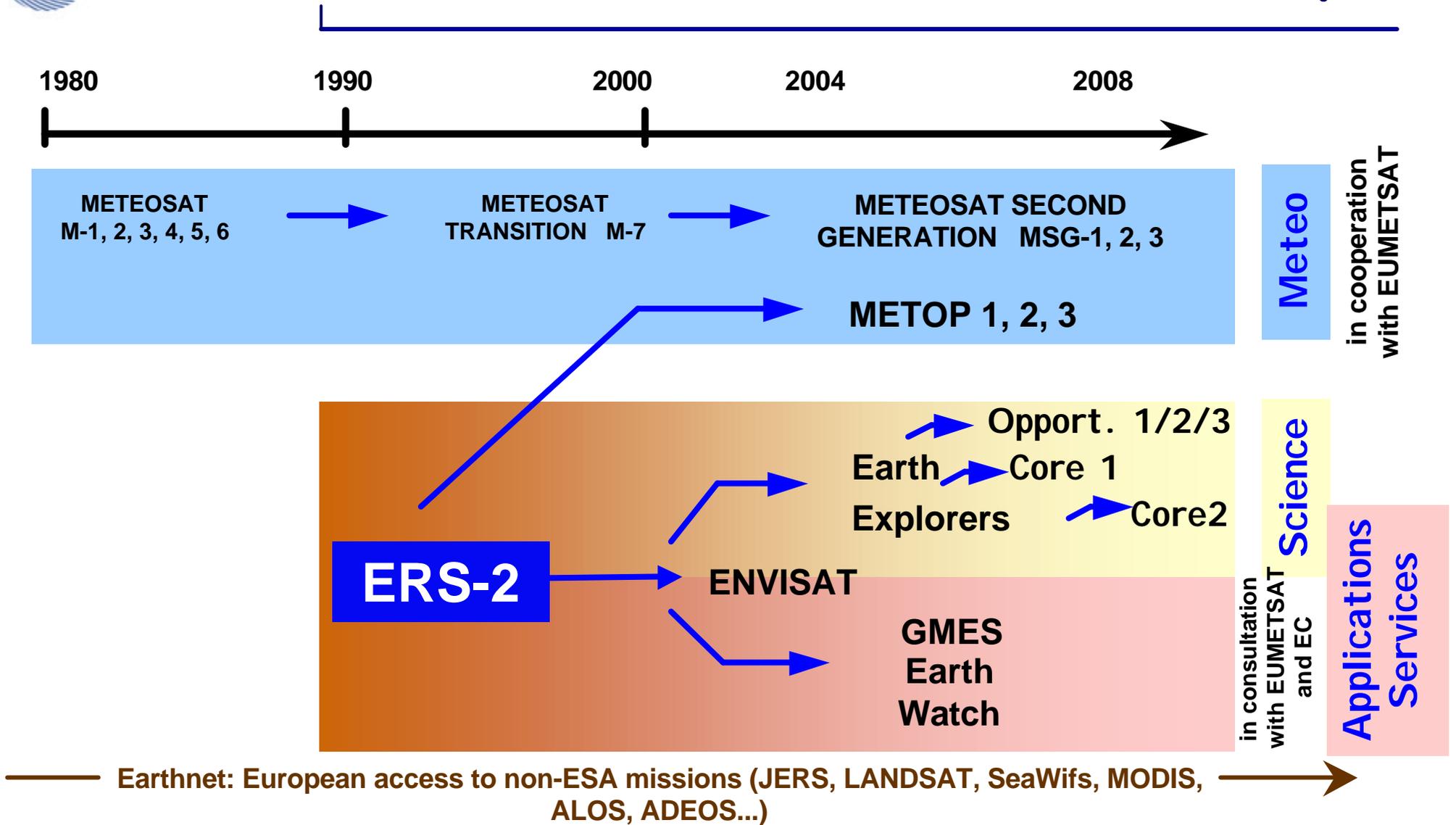
ESA Earth Observation Programme Overview and Status

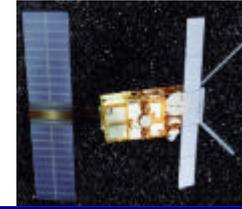
Jérôme Benveniste

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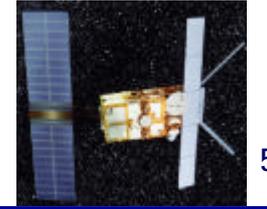
From Topex-Poseidon to Jason SWT meeting - ARLES, 18-21 November 2003

- ERS-2
- ENVISAT
- METOP
- EO Preparatory Programme
- EO Market Development
- EO Data User Element
- GMES (EC+ESA) /GMES-Service Element (ESA)
- The ESA Living Planet Programme
 - Earth Explorers (CryoSat, GOCE, SMOS, ADM-Aeolus)
 - Earth Watch (TerraSAR, Fuegosat)
- The Road Ahead

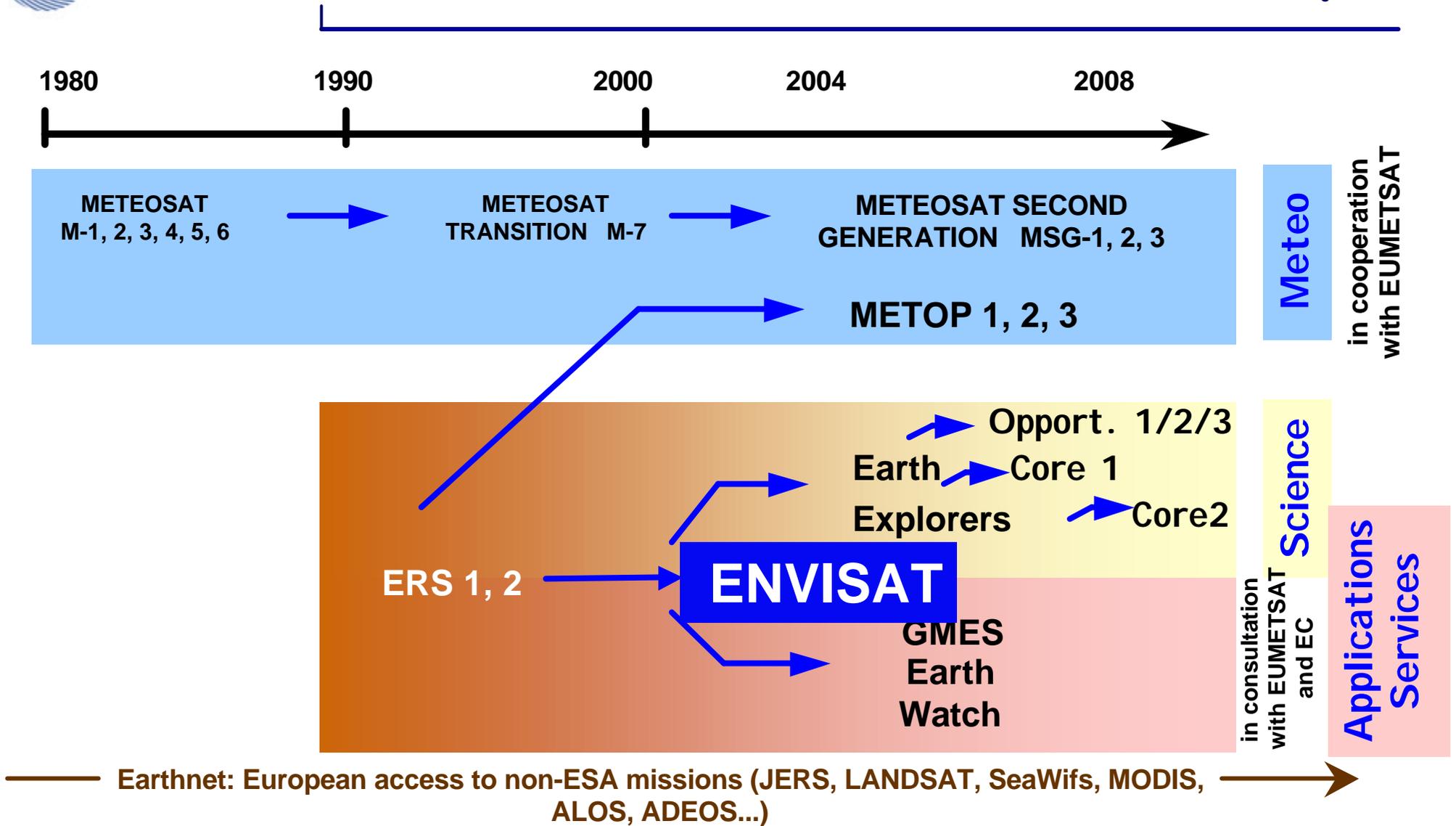




- ERS-2 space and ground-segments have performed nominally according to the revised mission scenario (after tape recorder failure).
- LBR mission is in direct downlink over Europe, North Atlantic, the Arctic and western North America and the stations are acquiring more passes than before the recorder failure. Furthermore the ERS LBR station network is progressing towards extension with West Freugh and Matera, plus O'Higgins for GOME NRT data.
So far no financial impact.



- The Wind Scatterometer NRT service has recommenced mid of August after the Gyro failure of Jan 2001, and Met Offices have restarted using ERS Scatterometer data for data assimilation.
- The ERS-2 orbit has been affected by the recent solar flare (decreased altitude by some 5 km). This was recovered the following day, using a negligible amount of propellant.





- ENVISAT went through its second Operations Readiness Review and has accordingly entered its routine operations: remaining problem areas are related to data ordering and dissemination.
- ENVISAT platform and instruments show an excellent behavior, with however some anomalies to be reported with MIPAS, under investigation.



- Off the 48 ENVISAT products, 40 are effectively available, 7 will be released by Q4-2003-Q1-2004
- The internet data dissemination for small volume products and the use of DVD for products above 600 MB are indeed operational.
- PDS operations show good progress, at cost of many manual workaround solutions both in PDHSSs and PACs. User requests and corresponding production for ASAR and MERIS products have been multiplied by 3 between June and October.

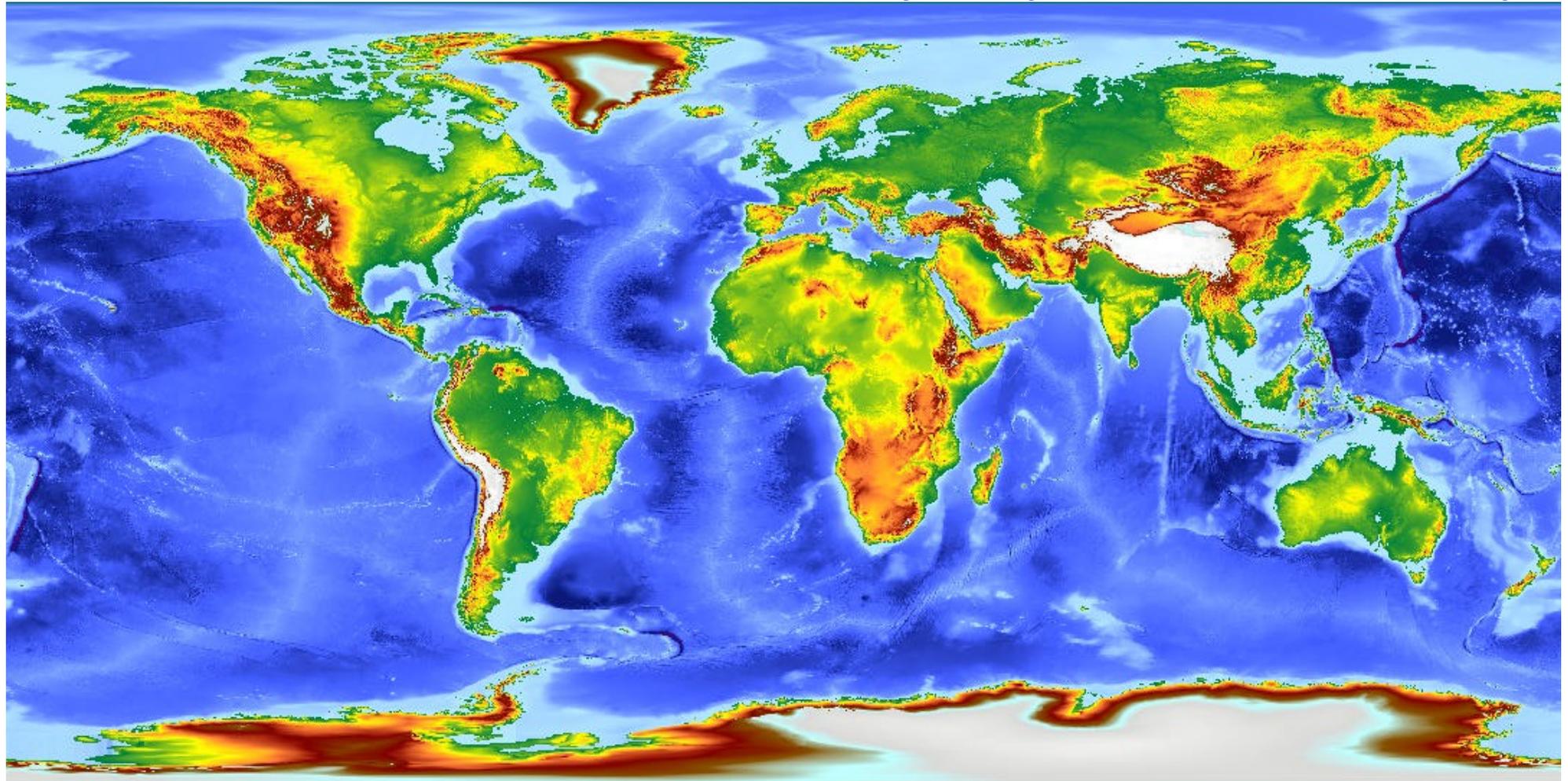


- New Global Land Digital Elevation and Ocean Bathymetry, based on a careful merge and re-sampling of the
 - ACE GDEM (Ph. Berry, De Monfort Univ) and the
 - W. Smith (NOAA) and D. Sandwell (SIO) Bathymetry

Both based on Radar Altimetry,
proposed to update outdated ENVISAT-wide DEM
auxiliary file.



Global Land Elevation and Ocean Bathymetry from Radar Altimetry





- Four on-going AOs and the Category-1 continuous submission mechanism.
- On-going AOs involve more than 650 projects.
- Recent AOs dedicated to extent the use of data in well defined scientific and/or geographical areas (P, GR, TK, WMO) will add some 80 projects.
- The Category-1 continuous mechanism witnesses a growing success, with currently 12 proposals submitted monthly and more than 320 projects in total. This Cat-1 mechanism management is supported by the EO PI portal: <http://eopi.esa.int>

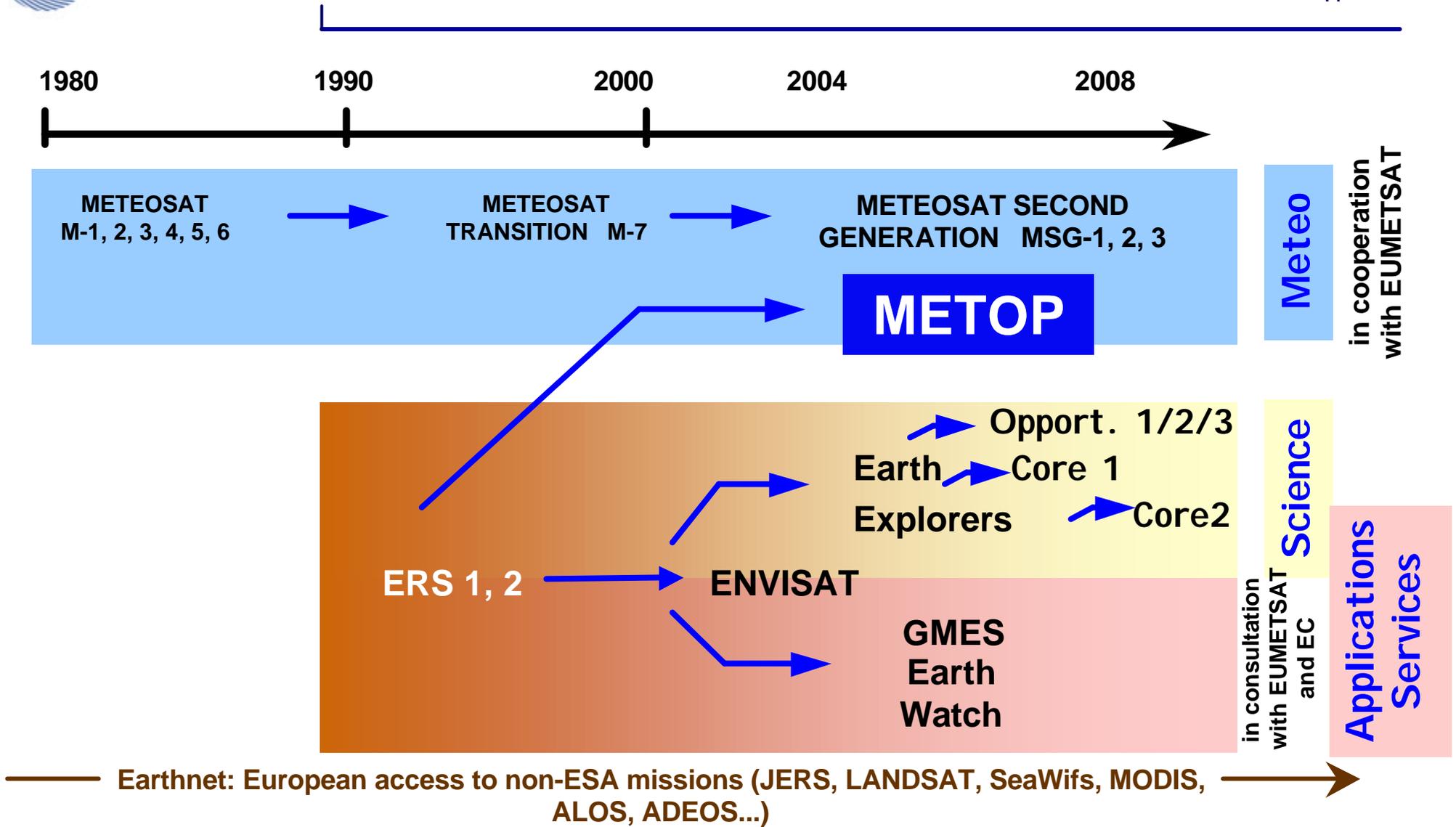


- The EO PI portal is increasingly popular. Practical information includes stories about “PIs of the month”, round tables on scientific topic, public and scientific news.
- Projects correspondents (ESA Staff) are assigned to stimulate one-on-one dialogue with all PIs.
- Intense scientific promotion efforts: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

<http://eopi.esa.int>



- Organization of numerous scientific events:
 - PolinSAR WS,
 - ENVISAT data assimilation summer school,
 - WS on Coastal and Marine Application of SAR,
 - Radar Altimetry session organised by ESA at CNES Hydrology from Space WS,
 - MERIS 2003 WS,
 - Fringe 2003 WS.
 - GOCE 2004 WS
 - ENVISAT/ERS Symposium in Salzburg, 09/2004.



- The MetOp integration programme is progressing according to schedule, with the MetOp-1 mechanical testing scheduled for the end of the year, and the FAR-1 maintained for Q2-2004. The MetOp-2, the first satellite to be launched end 2005, activities remain on track.
 - The critical issue for MetOp-2 remains the in-time delivery of the IASI flight model.
 - Good progress achieved with ASCAT and GOME-2, but slower progress with GRAS, whose Qualification Review has been delayed to December.

- The availability of the IASI flight model 2 is a matter of concern but appears to be on track for a retrofit on MetOp-2 end-2004, to replace the (not-flightworthy) FM-1.
- US instruments for MetOp-1 and 2 have all been delivered. The impact of NOAA's integration accident on the actual delivery of US instruments for MetOp-3 has still to be investigated, with results now expected in March 2004. AVHRR is very marginally compatible with the Soyuz launcher shock environment.

- The only point of concern is related to the G/S availability.

- Phase A of the candidate Earth Explorer Core missions, SPECTRA, WALES and EarthCARE are reaching the Preliminary Requirements Reviews
- Phases A for the candidate Earth Explorer Opportunity missions (ACE+, EGPM and SWARM) have reached the Preliminary Concept Reviews
 - Investigations on possible merging of ACE+ and SWARM: suffers from conflicting orbital requirements

- Regarding Earth Watch studies, the release of the ITT for Meteosat Third Generation is planned for December 2003. Activities related to global atmospheric and **oceanographic missions** also have been released or about to be, in line with GMES-related requirements expressed in DUE, EOMD and GSE.
- For a future Solid Earth mission, the low-low satellite to satellite tracking based on laser interferometry is considered.

EO Market Development

EO Data User Element

- Objective of both programmes is to build long-standing relations with industry and with user-organisations (in line with the new ESA “Agenda 2007”). Many of the supported contracts have also paved the way towards GSE activities.
- The interest of both EOMD and DUE is evidenced by an increasing number of replies to the ITTs and an established portfolio of more than 60 committed users (national administrations and institutions, global convention secretariats, ONG, international organizations, engineering and commodity industry)

- The initial batch of short-term exploratory activities in EOMD activities have achieved raising customer awareness, new product releases and new service opportunities through follow-on commercial contracts with both public and private customers.
- The on-going longer-term activities have achieved substantial engagement of downstream (non-EO) companies. Several agreements for commercial exploitation have been put in place and some joint-ventures set up.

- EOMD/DUP has also generated a lot of promotional material that allows EO news stories to score high in media
 - front page newspaper releases
 - articles in professional trade magazines,
 - company news releases.

- 11 service oriented and 7 industry capability consolidation activities on-going.
- 9 other activities launched now, related to:
 - Land motion service for pipelines
 - Mining and civil engineering sectors
 - EO services for renewable energy in the Wind, Hydro-Power and Solar industries.
 - Marine information services for Off-shore engineering, Maritime transport and recreational sailing industries.

- 4 projects to start before end 2003, with users such as:
 - RAMSAR convention
 - Institut Pasteur
 - EUROCONTROL
 - **GODAE MEDSPIRATION (GHRST)**
- 6 DUE projects will be launched in 2004
- Call for ideas for 2005 actions

- USER-driven Pilot Project
- Sea Surface Temperature: an essential ancillary product required for SMOS SSS processing
- Cooperation of the R&D and Operational Agencies
- Merging of SSTs from R&D and Operational Sensors
- Merging of Infrared and Microwave SSTs
- Merging of Regional and Global Satellite SSTs
- Merging available SSTs to generate cloud free, high temporal/spatial resolution SST products for GODAE
- ESA-funded UKMO Project Office for climate-quality operational SST product

- Satellite Ocean Monitoring forms one of the key elements of Global Monitoring for Environment and Security (GMES)
 - Satellite systems are a unique, globally available data source and facilitate local, regional and global applications and related services.
 - GMES will establish operational capabilities providing information to the user community as specified in the EC Action Plan^[1] (2001-2003).
- The economic and environmental importance of the oceans dictate that oceans and marine GMES applications are initially focused on:
 - fisheries and vessel monitoring
 - maritime traffic and security
 - coastal zones and open ocean environment monitoring
 - ice monitoring.
- The general objective of the GMES programme is to realise the benefits of EO data for markets and society.

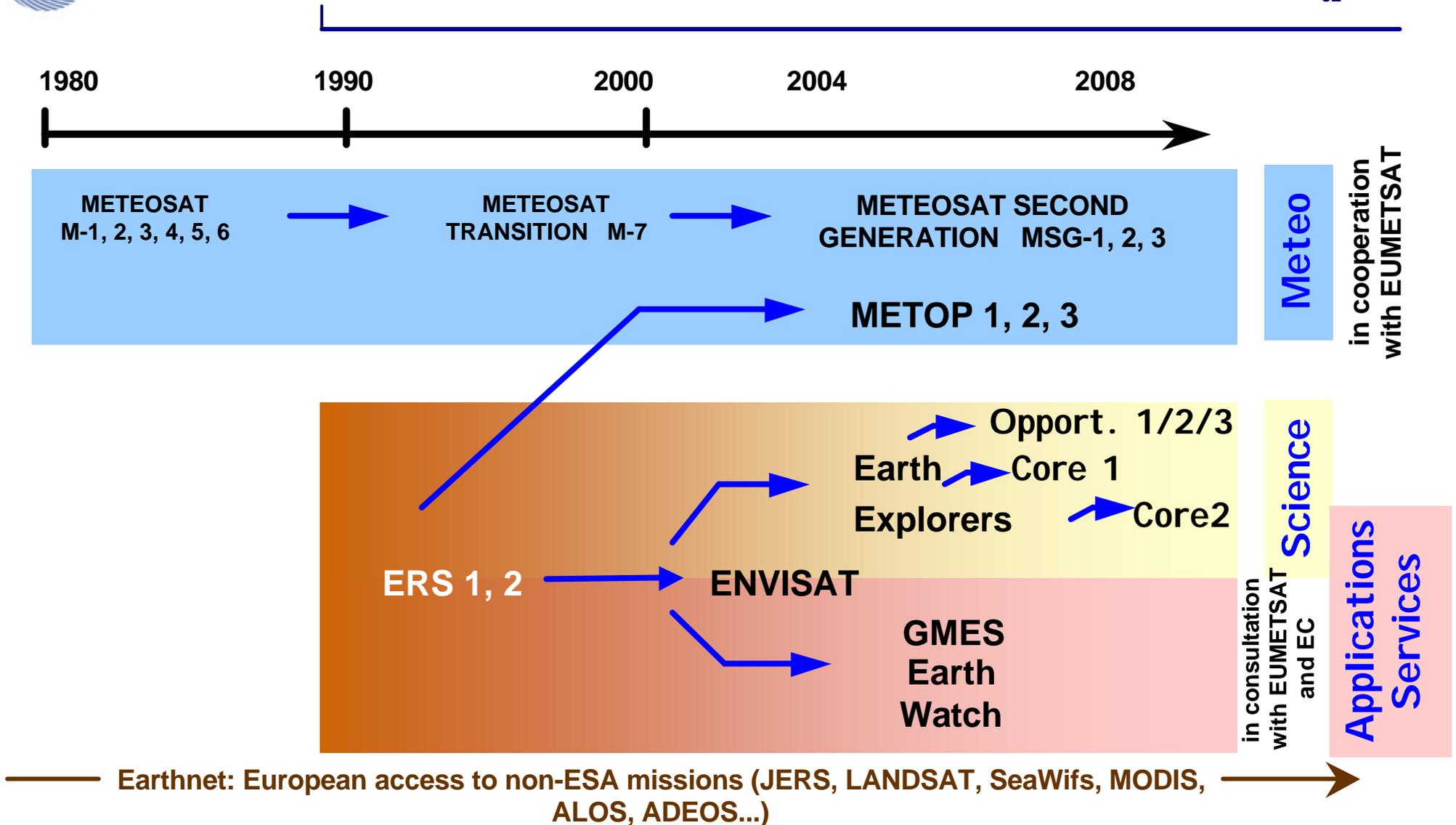
^[1] COM(2001) 609 final GMES: Outline EC GMES Action Plan

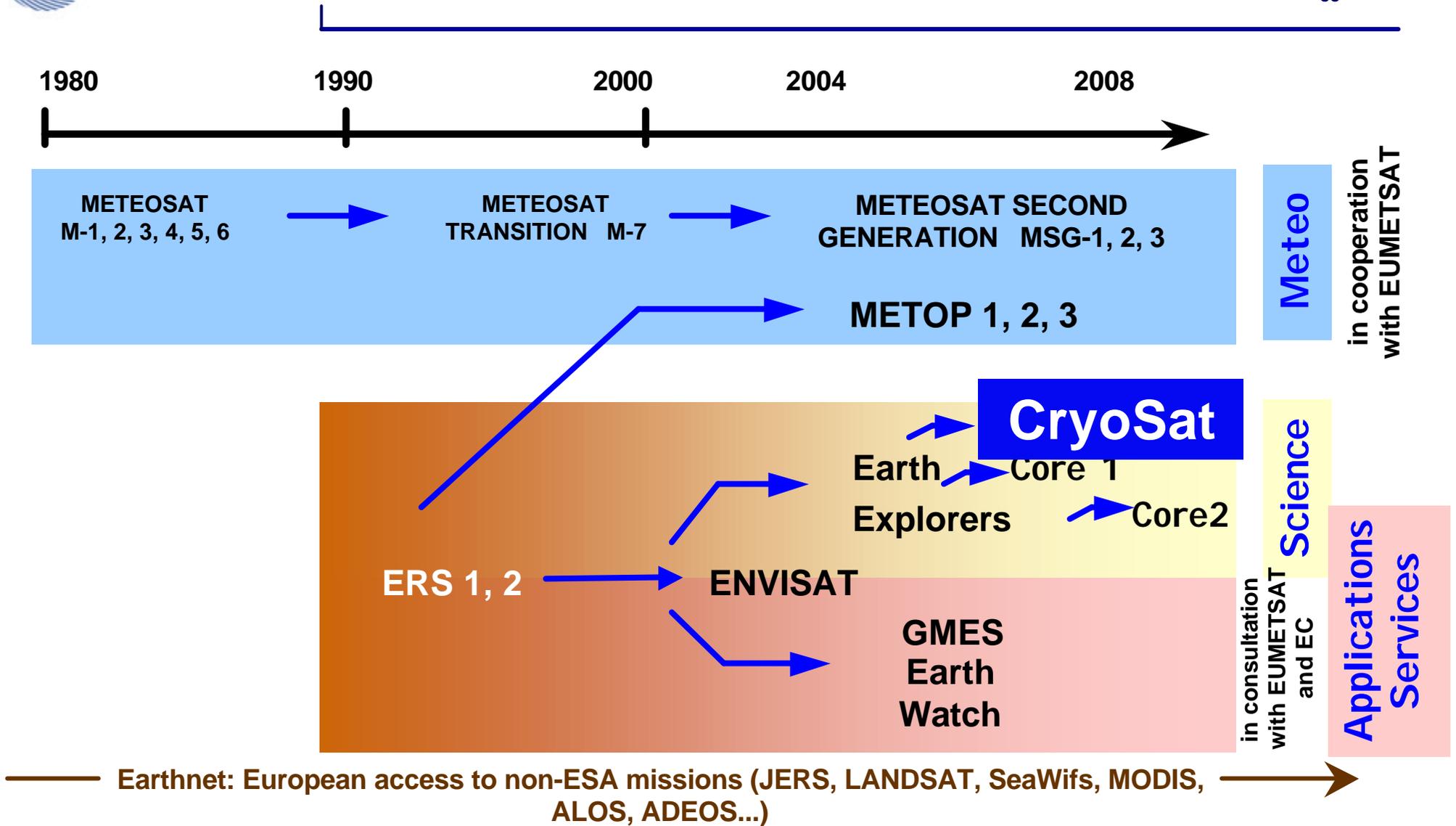
- The primary actors in GMES ocean-related projects need to have existing access to the "tools" needed to establish operational services.
- Since these tools must (in most cases) include operational ocean forecasting capability, these groups are logically also participants in the Global Ocean Data Assimilation Experiment (GODAE). Ocean modelling efforts are: TOPAZ, MERCATOR, FOAM, MFS, HICOM-US, NLOM.
- There is an important overlap, in terms of capacity building, between GODAE and GMES, and thus **ESA needs to serve the primary data requirements of these established users** (operational and scientific)

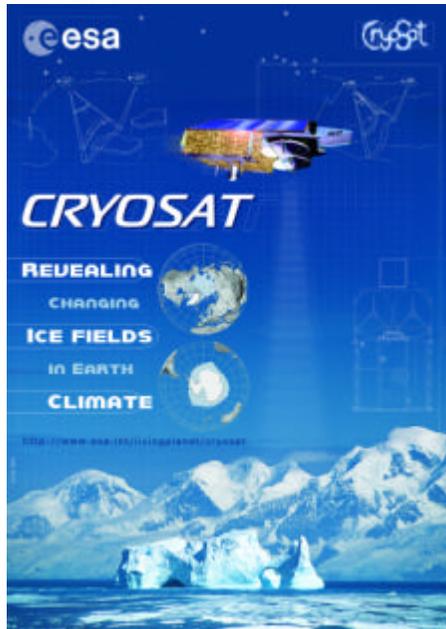
- The GSE consortia are doing well and their successful activities are the result of earlier efforts in DUP, EOMD, national and EC RTD programmes. The second GSE collocation took place on October 8-10 in ESRIN and delivered 4 main findings:
 - data continuity identified as a prerequisite for any operational, with at least C-band SAR with interferometry capacity, multispectral imagery 20m resolution and widefield ocean colour/global vegetation multispectral imagery) (NDLR/NFTE: No mention of Altimeter mission)
 - users expectations are growing and must be met
 - growth above current planned level is required
 - expansion of the services beyond Europe must be addressed

- Besides the GSE industrial activities, the work is on going with EC to draft the Final Report for the Initial Period (2001-2003) that will contain the proposal for the period 2004-2008.

- ESA's Living Planet Programme contains two types of missions:
 - Earth Explorers
 - Earth Watch
- Earth Watch missions are operational service-oriented missions
- Earth Watch Missions shall complement the more research-driven Earth Explorers, and provide continuity in observations



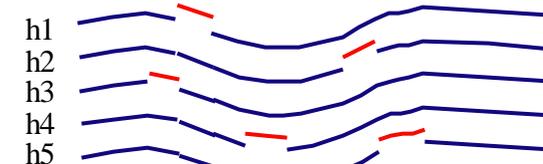
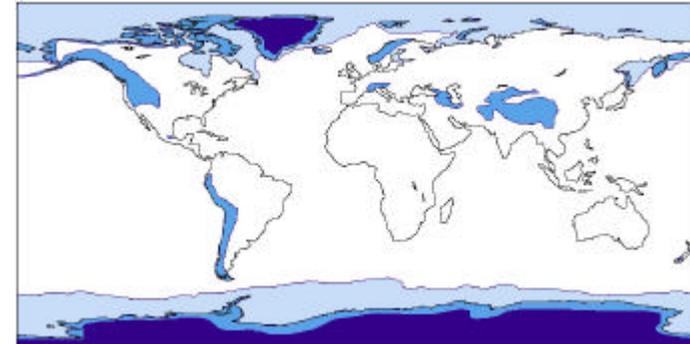




CRYOSAT (Launch end 2004)
Status: Phase C/D ongoing

Ku-band Altimeter
SAR/Interferometric Capability
Along-track res. 250 m (SAR mode)

Sea-ice objective:
To characterise trends/variations in sea-ice thickness/mass to an accuracy of:
1.6cm/year - on a space scale of 100,000 km² (~320 x 320 km)

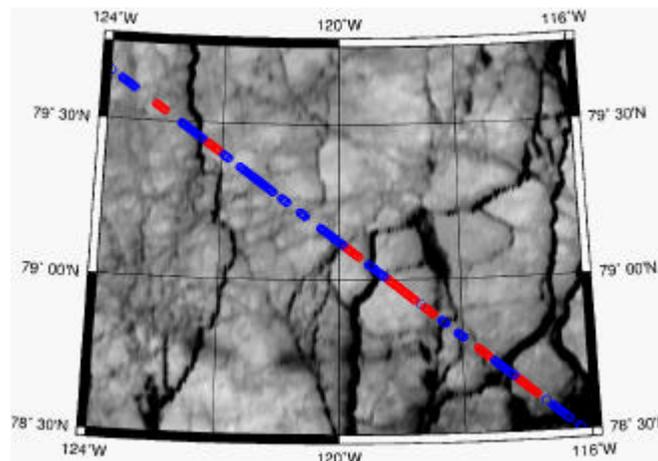


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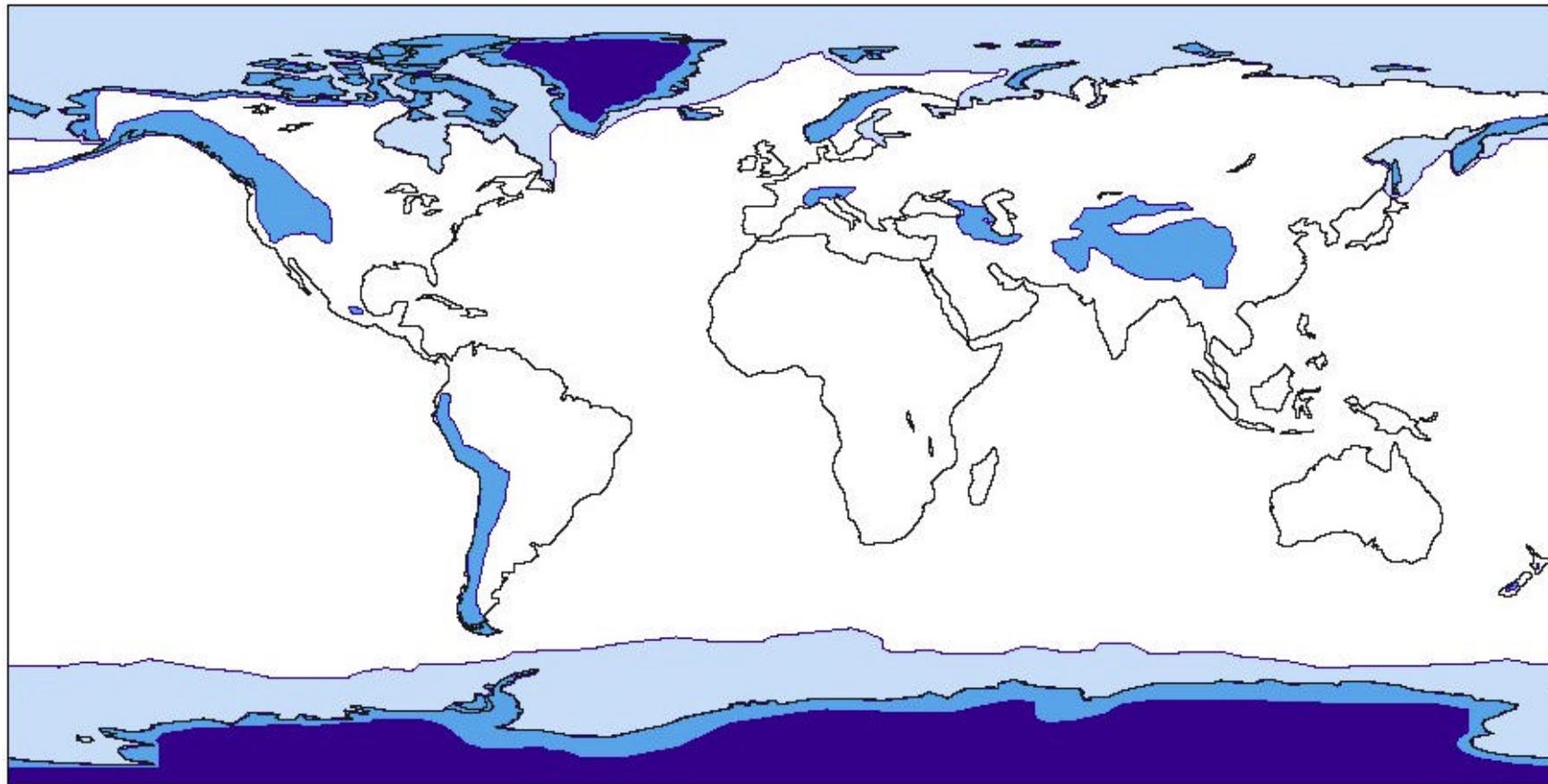




- CryoSat space-segment is progressing well but a bit slower than expected. Launch date is still 27 September 2004, but a several weeks shift cannot be excluded, depending on the efficiency of the recovery actions.
- The development of the G/S is on schedule with the Design Review completed in July. The first GSOV compatibility test between the various elements of the G/S has started; the first tests between the satellite and the G/S (SVT tests) are scheduled early 2004.



- While there is no formal exchange with NASA regarding ICESat, exchanges do take place at scientific level, in the frame of the CryoSat Calibration Validation and Retrieval Team.
- The possibility to also deliver LRM NRT products, is being discussed. An NRT product and algorithm design study is to start in December. The objective is to deliver SWH and Wind speed to met offices in NRT. Range and the DORIS navigator orbit can also be included.



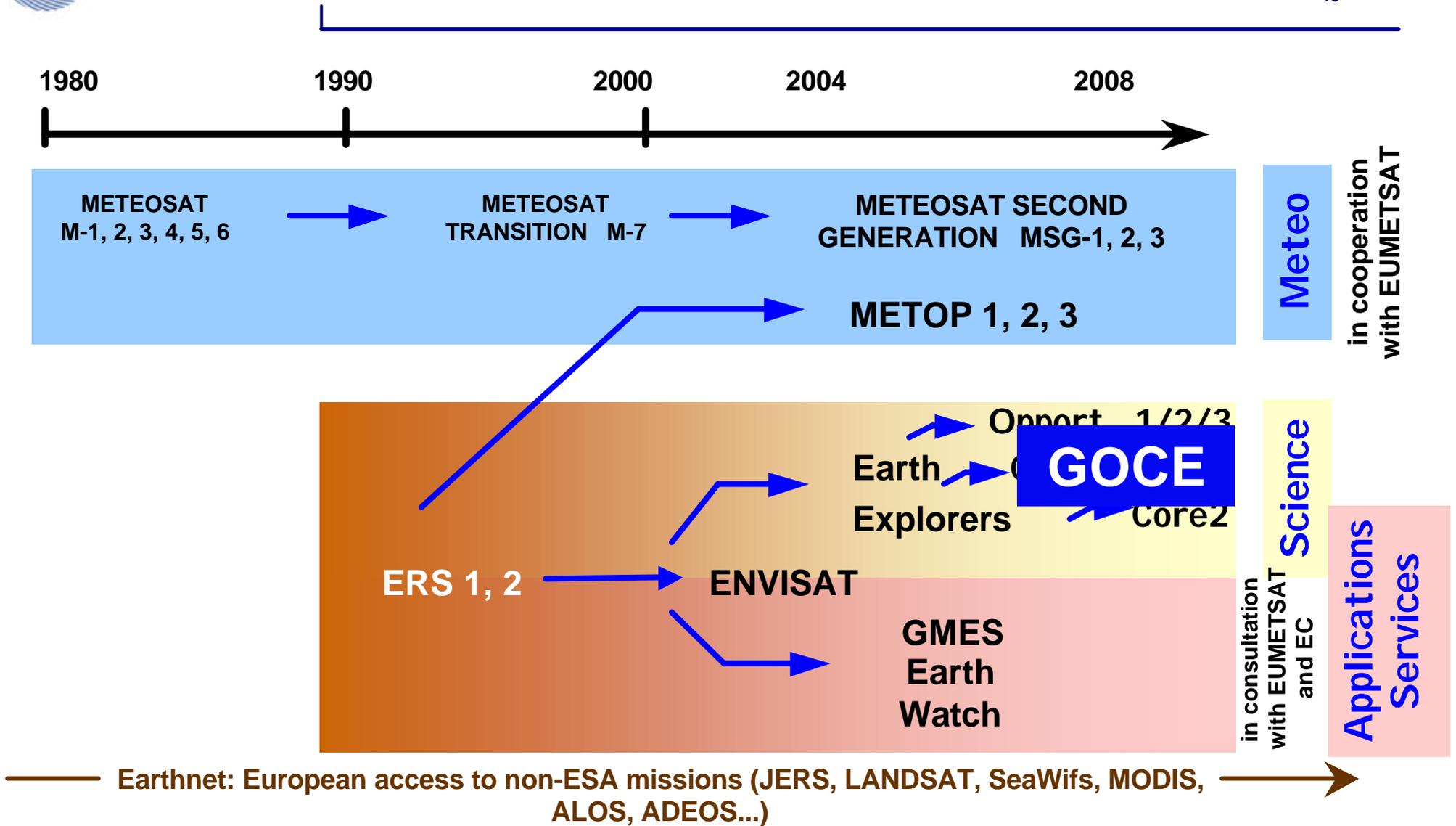
-  **High resolution altimetry SARIn and SAR**
-  **Not required by CryoSat mission objectives, but will be operated in Low Resolution mode**
-  **Low Resolution mode**



- Conventional Altimetry (LRM) will be operated over ocean and non-cryosphere land
- Development and validation of a Near Real Time product similar to the ENVISAT FDMAR:
 - Significant Wave Height
 - Wind Speed
 - Range, DORIS Navigator orbit
 - 10 orbit/day in less than 3 h for the Kiruna orbits
 - 4 orbit/day in up to 7 h for the Kiruna-blind orbits

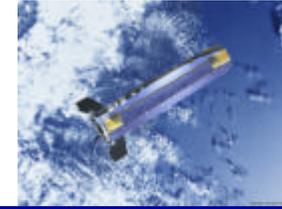


- A CryoSat data AO will be issued in December
- It will also call for oceanographic science and applications
- CryoSat has some spare system resources (power, data memory) to acquire some samples of SAR and SARin over ocean, coastal zones, lakes, rivers, land
- AO Proposals should request small samples of SAR and SARin over non-cryospheric surfaces to be used in scientific experiments for demonstration purposes.

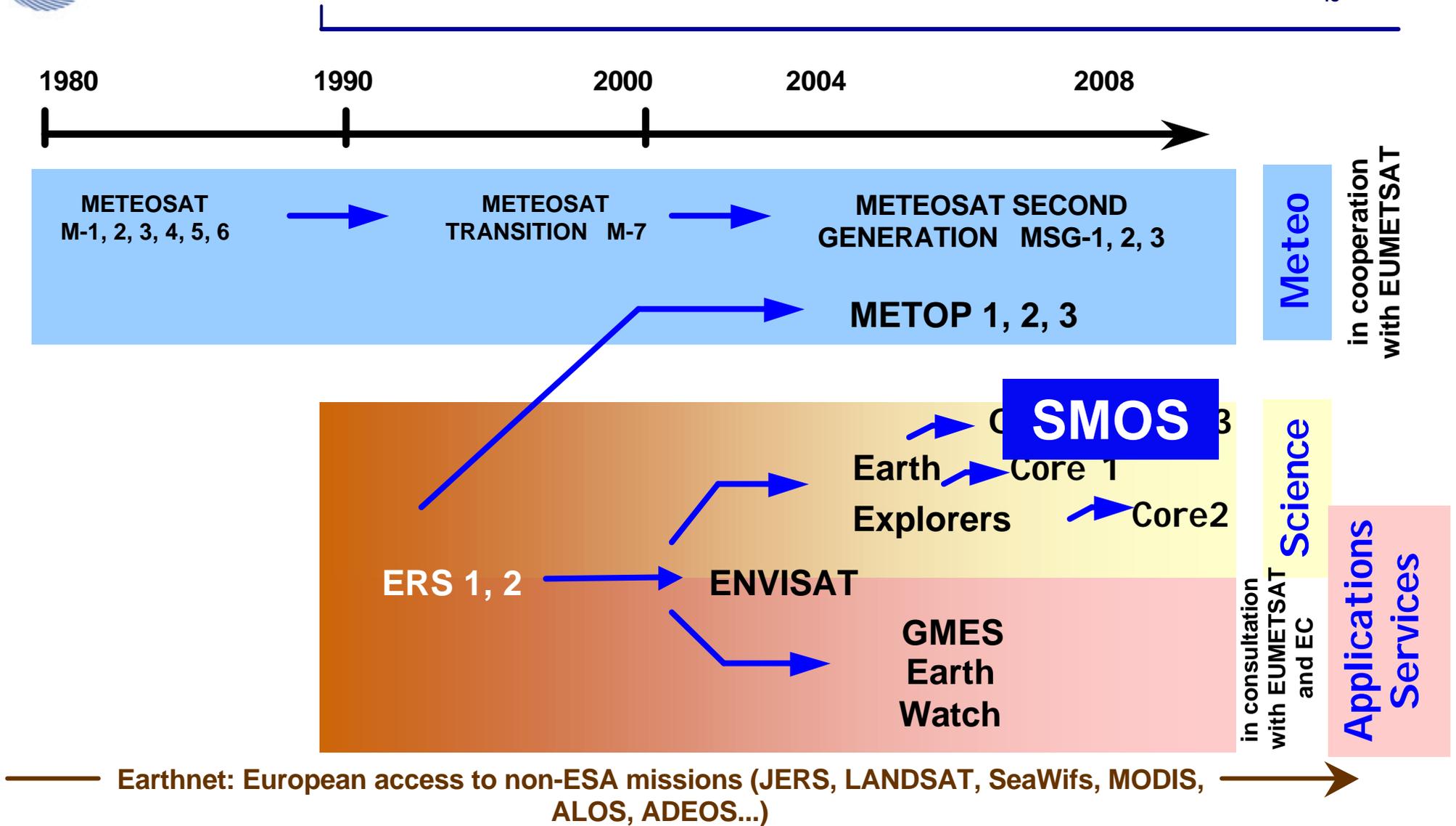


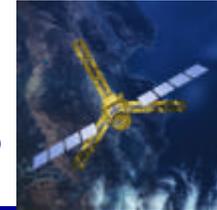


- The PDRs for spacecraft and payload are completed. The major event is the decision to disembark the constant propulsion ion thrusters (air-drag compensation) mitigated by an extended use of the existing magneto-torquers.
 - Simulations have shown that the 1mgal gravity field requirement is met, while geoid precision will be degraded from 1 to 2cm (in high-level orders). With more processing effort in the Level 2 data processing, GOCE would still be significantly better than any other available missions results. Altogether, the ion thrusters disembarkment has eliminated a major risk area.



- Otherwise, both space and ground segment show a satisfying progress. The re-organization of the industrial responsibilities in the area of the gradiometer and the disembarkment of the MPA however leads to a reconsolidation of the schedule.
- The launch window lasts until January 2007, without any mission degradation due to solar forcing. Current launch date is February 2006.
- The GOCE Cal/Val AO process has just concluded.





SMOS (Launch 2007)

Status: Phase C/D starting Nov '03

L-band Radiometer

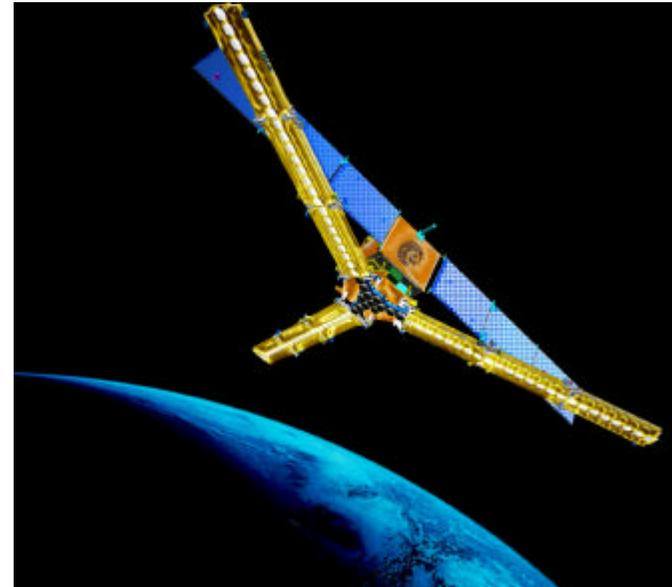
2D Interferometer design (15 - 50° incidence angles)

~ 35 km res. (in mid-FOV) and ~ 600 km swath width

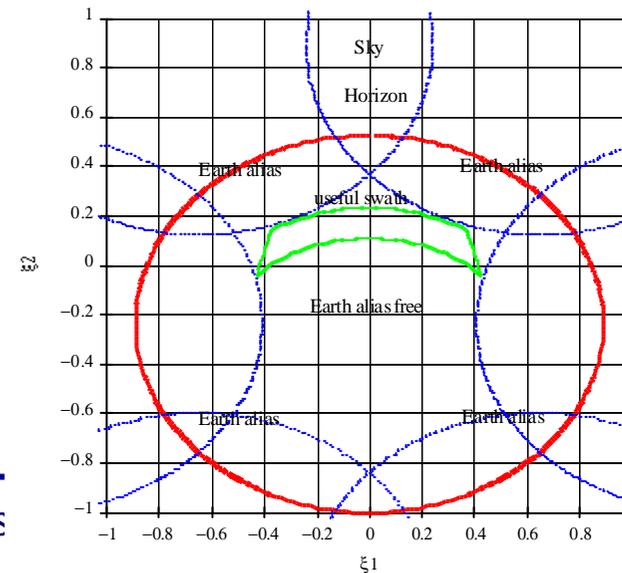
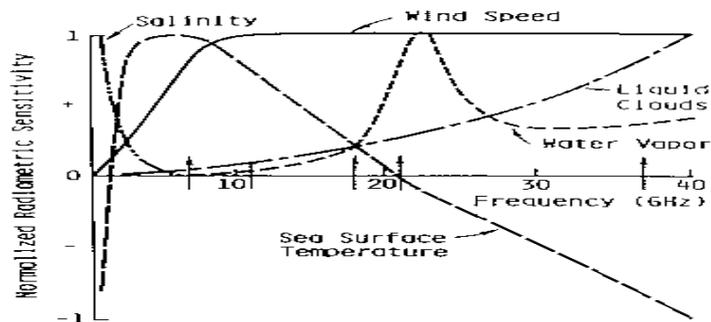
Nom. 3 year mission

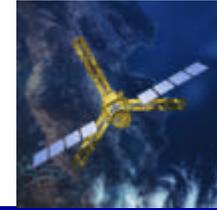
Ocean Objective:

To measure ocean salinity to an accuracy of 0.1 psu with a resolution of 200 km (40,000 km²) and 10 days in space and time.



Passive Microwave Sensitivity versus Frequency - Relevance for SMOS





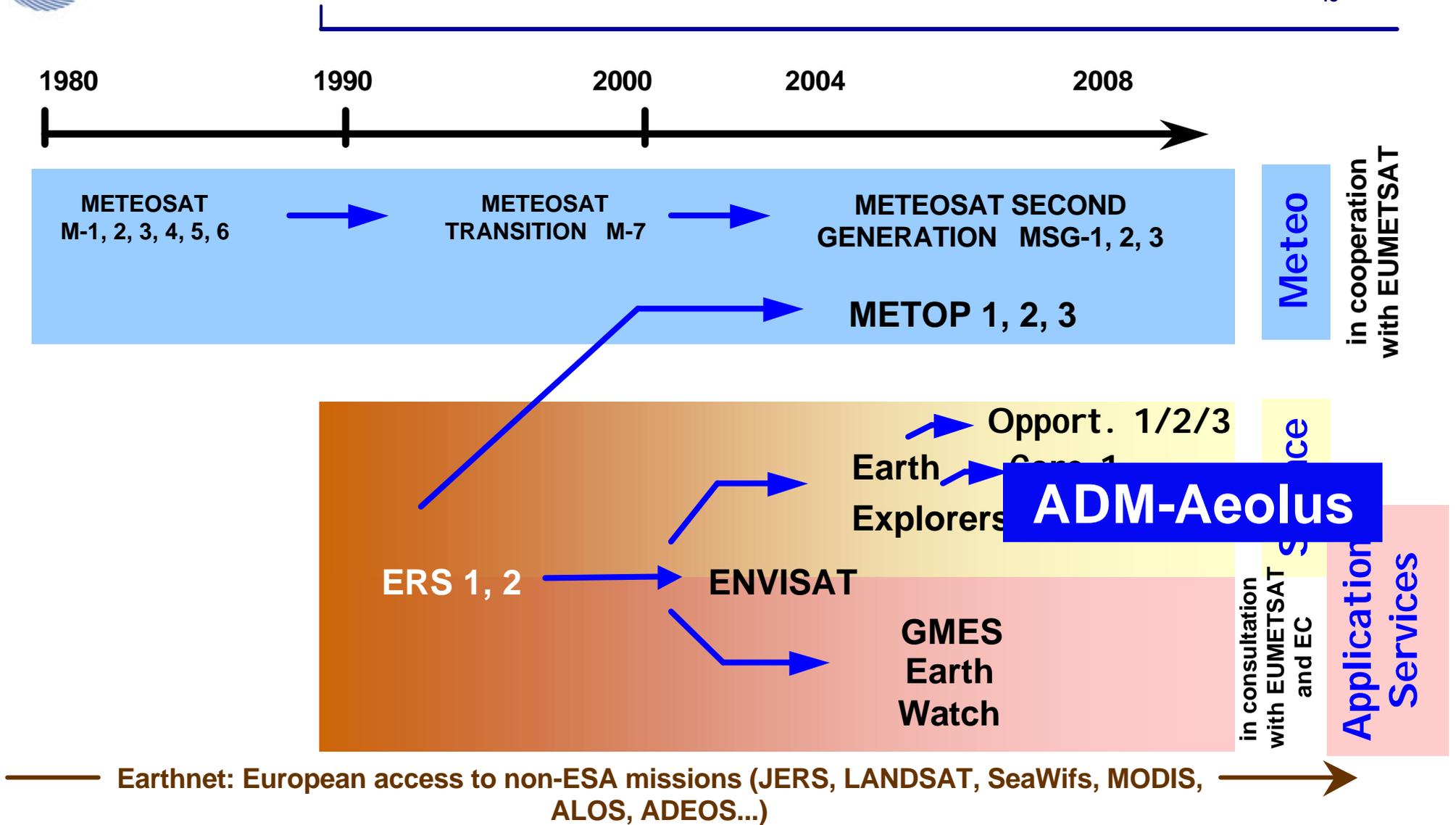
- Approval for the full implementation of the SMOS mission by PBEO. Following positive results of the system requirement review held in April 2003.
- Some problems were encountered in the procurement of long lead items for phase C/D:
 - The procurement of Monolithic Microwave Integrated Circuits, experiencing a low yield for some of the components.
 - The radio-frequency switch used in subsystems showed poor performance and significant quality problems.



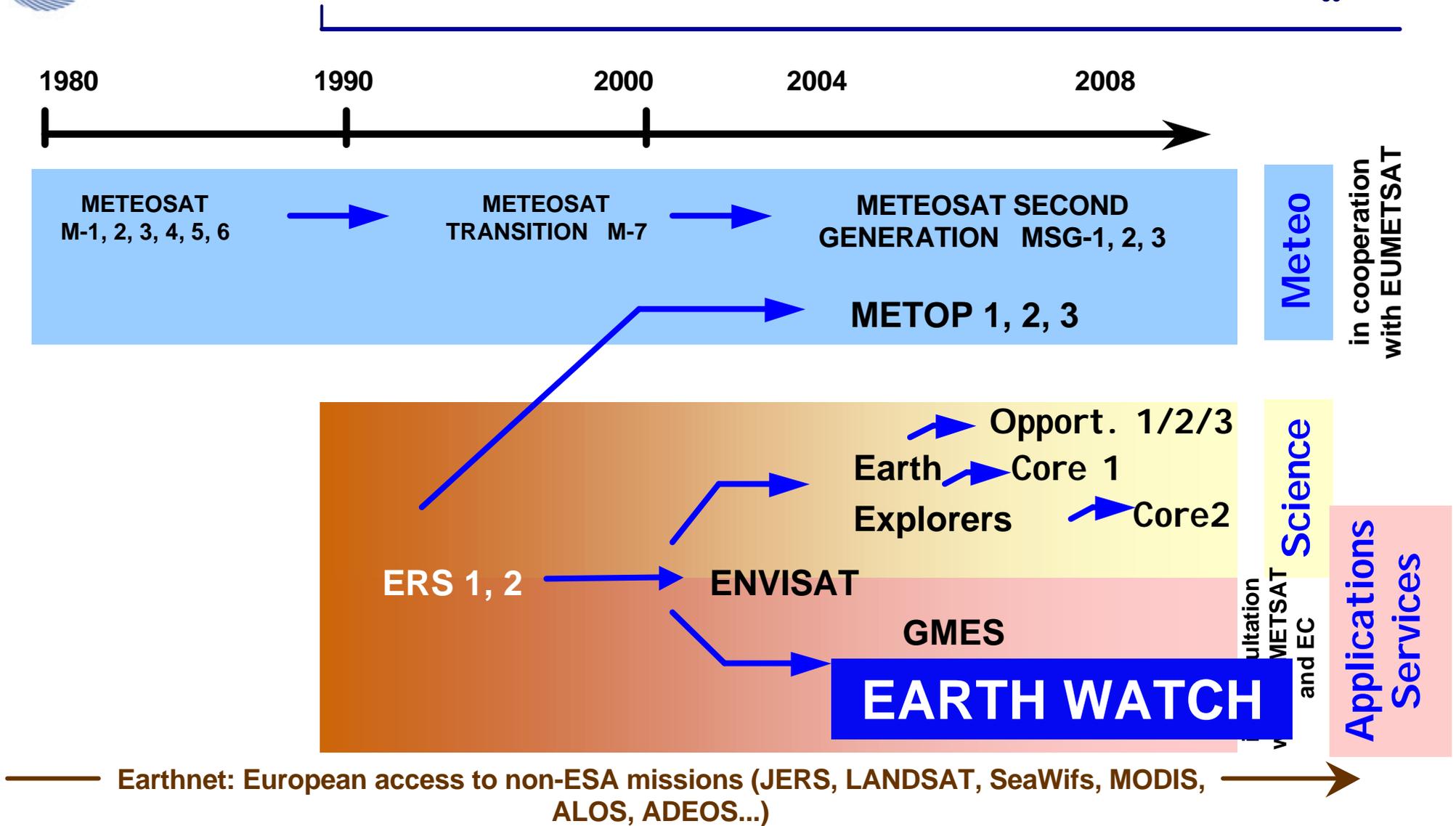
- Solutions to both problems are pursued and seem solvable without impact on the payload C/D schedule, but need for consolidation of a credible schedule. The launch remains scheduled for Feb 2007.
- Concern about the mass budget and the limited remaining margin (10 kg):
 - The current payload mass (360 kg including a 60 kg allocation for "uncertainties") will get full attention in the imminent Preliminary Design Review process. The Proteus payload capacity with a Eurockot launcher is 370 kg.



- The reported potential loss of 10% of data due to the shared use of Vilspa X-band station is not acceptable. Workaround solutions do exist and their financial and operational impacts are being investigated, for an optimised solution.
- The supporting scientific studies and the SAG still have to conclude on the campaign instrumentation and the field measures needed for cal/val activities.



- Two major milestones were met successfully in past 4 months: Instrument Baseline Review and Satellite Preliminary Design Review. The contract for Phases C/D/E1 of the satellite was signed on October 27th.
- Launch remains in October 2007.
- Compatibility with Dnepr, Eurockot and Vega will be maintained until launcher selection in late 2005. Remaining issues with Vega are the shock levels and the dispersion on insertion, which requires extra fuel.



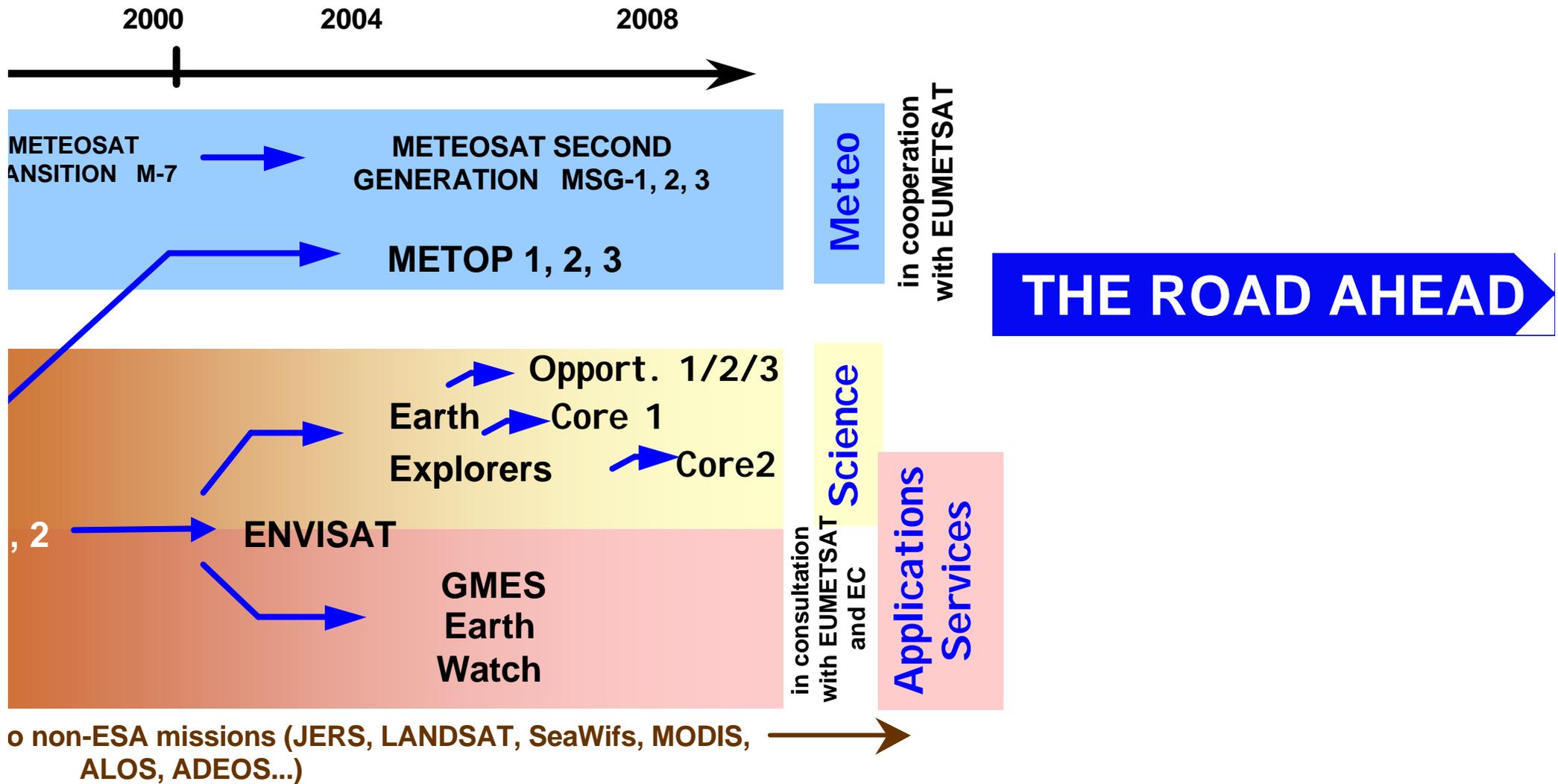
- Two Earth Watch missions are under preparation:
 - Terrasar
 - Consolidation Intermediate Review is scheduled for January 2004.
 - Fuegosat
 - Four parallel activities in step 1 of the consolidation are on-going
- There is no Ocean Watch mission!

- An Earth Watch ocean mission would provide remote sensing data required to provide operational services for applications related to ocean, coastal zones and ice
- Was formulated for a phase A in 2001 but not given a high enough priority
- The GMES Initial Period report requires, among other, operational satellite ocean mission, in the context a world-wide global ocean observing system.....

- An Earth Watch ocean mission should be a GMES/Operational Oceanography user-driven mission that would be developed with interagency partnerships.
- ESA would capitalise on its experience in development of ERS-1/2 (*RA*, *ATSR*), ENVISAT (*RA-2*, *AATSR*; *MERIS*) and CryoSat (*SIRAL*); and ongoing instrument studies
- A future mission concept should meet the goal of long-term provision of:
 - High-inclination, high-quality altimeter (SSH, SWH, Wind speed, ice thickness)
 - High-quality SST in continuity of AATSR
 - Ocean Colour data in continuity of MERIS

And meet the stringent data delivery timeliness and measurement accuracy requirements

- The present study identifies the need of a launch in the 2008 time frame, but the concept is not approved yet...



- We are at an important crossroad of the history of Earth Observation from Space, with converging efforts:
- GMES Initiative end of the 2001-2003 Initial Period implemented according to a shared EC/ESA Action Plan producing requirements and way forward for operational EO services in 2004-2008 time frame.
- New ESA Director General with his “AGENDA 2007”
- White Paper from the COMMISSION OF THE EUROPEAN COMMUNITIES, presented by European Research Commissioner
 - “Space: a new European frontier for an expanding Union -
An action plan for implementing the European Space policy”



Thank you for your attention!