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STATUS OF THE FUTURE ESA EARTH OBSERVATION MISSIONS

CGMS is informed of the status of the future European Space Agency Earth Observation missions. Two of them, MSG and Metop are in co-operation with EUMETSAT. The Living Planet Program has three lines of implementation: Earth Explorer satellites, Earth Watch satellites plus services & applications demonstration.

After decision on the implementation of SWARM and EarthCARE missions, a new Core Explorer is under selection. CRYOSAT is scheduled for launch 8 October 2005.

The Earth Watch includes since January 2002 the Global Monitoring for Environment and Security (GMES) services element. From the 10 portfolios selected, six will start services as from September 2005. The ESA proposal for the GMES space component programme is under preparation in view of the Ministerial conference foreseen in December 2005.

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STATUS OF THE FUTURE ESA EARTH OBSERVATION MISSIONS

1. - INTRODUCTION

The Earth Observation Directorate of the European Space Agency (ESA) is currently running or planning a number of programmes. Two of these, MSG and Metop are in co-operation with EUMETSAT. The Living Planet Program has three lines of implementation: Earth Explorer satellites, Earth Watch satellites plus services & applications demonstration. The Earth Watch includes since January 2002 the Global Monitoring for Environment and Security (GMES) Services Element. The GMES Space Component Programme is under preparation. A new batch of Explorers is under selection.

2. -STATUS OF THE EARTH EXPLORER MISSIONS

2.1 Scope of the Earth Explorers

The Earth Explorers are research oriented space missions tackling critical Earth science issues. There are two types of such missions, subject to programmatic functions i.e.

- *Core* Missions, are ESA-led and dedicated to long term research objectives. They are complex and large in scope missions, which must tackle a range of fundamental problems of wide community interest whilst remaining well focused. It must be supported by a wide (international) community of scientists.

- *Opportunity* Missions are smaller-scale projects, not necessarily led by ESA. They are designed to be a fast and flexible response to a single critical scientific issue and subject to strong financial and development constraints..

The financial limits only relate to the ESA contribution, but the Earth Observation Envelope Program is designed to encourage international co-operation. In the context of international co-operation, a core mission would be expected normally to be led by ESA, but can include important contribution from partner Agencies.

In the past years, a number of missions have been selected for implementation, and are well advanced: namely three *Core* missions:

- GOCE (Gravity and steady-state Ocean Circulation Explorer)
- ADM-Aeolus (Atmospheric Dynamics Mission)
- EarthCARE (clouds, aerosols and radiation)

and three *Opportunity* Missions:

- Cryosat (Polar Ice Monitoring)
- SMOS (Soil Moisture and Ocean Salinity)
- Swarm (magnetic field)

2.2- GOCE

The aim of the GOCE mission is to provide global and regional models for the Earth's gravity field and for the geoid, its reference equipotential surface, with high spatial resolution and accuracy. Such models will be used in a wide range of research and application areas, including global ocean circulation, physics of the interior of the Earth and leveling systems based on GPS.

The mission responds to the requirements put forward by many international scientific programs such as the WOCE, CLIVAR and GOOS. It is designed for the determination of an accurate description of the ocean dynamic topography and, thereby, the mean ocean circulation, as an essential complement to the precise monitoring of ocean temporal variability already provided by altimetry.

The gravity vector cannot be measured directly in orbit, but can be inferred from other observations. The GOCE carries a gravity gradiometer that measures gravity gradients and GNSS (Global Navigation Satellite Systems) receivers for precise satellite position.

2.2.1- GOCE project status

The GOCE Space Segment development is currently in phase C/D. Following a bottom-up approach, the sequence of Critical Design Reviews (CDRs) held at equipment, Platform and Gradiometer and GPS receiver levels has culminated in the System-level CDR, which was successfully concluded in July. The engineering models of the payload instruments have been delivered to the prime contractor, and Assembly, Integration and Testing activities are well underway in all areas. Significant effort has furthermore been put on the functional testing of the Platform, using an Engineering Model Test Bench (EM TBh). The current launch date is end of November 2006.

The Ground Segment Design Review was successfully completed in November 2004, demonstrating the suitability of the design to meet all GOCE requirements. The Payload Data Segment (i.e. data processing up to Level 1B) is proceeding nominally, and a first version of the system has been delivered to the Agency. The High-Level Processing Facility, responsible for the generation of the Level 2 products, has passed its CDR and is working towards a first complete system towards the end of 2005. The development of the offline Calibration and Monitoring Facility is also proceeding nominally.

2.2.2- GOCE science

Following the Announcement of Opportunity for the "Scientific Pre-Processing, External Calibration and Validation of Level 1B Data products for the GOCE Mission" a Cal/Val Team has been established. A second Announcement of Opportunity for the Data Exploitation of GOCE data (L1B and L2 products) is planned for release towards the end of 2005.

2.3- ADM-AEOLUS

The scope of the Atmospheric Dynamics Mission, Aeolus, is to demonstrate the possibility of providing observations of winds at altitudes between the surface and about 30 Km. This will help to correct a major deficiency in the current (meteorological) operational observing network. The data will be assimilated into Numerical Weather Prediction models. The mission will also provide data needed to address some of the key concerns of the World Climate Research Programme i.e. quantification of climate variability, validation and improvement of climate models and process studies relevant to climate change. The data will help as well to accomplish some of the objectives of the Global Climate Observing System, by contributing directly to the study of the Earth's global energy budget by measuring wind fields globally in cloud free air. It will further provide information for the study of the global circulation and relate features such as precipitation systems, the El Niño and the Southern Oscillation phenomena and stratospheric/tropospheric exchange.

The main space element of the ADM is the ALADIN instrument i.e. a Doppler wind Lidar intended to provide profiles of the horizontal tropospheric wind above or in absence of thick cloud.

2.3.1 Aeolus Project Status

The Phase C/D Contract for the Satellite was signed in October 2003. The Critical Design Review is being held in August and September of 2005.

Many of the flight equipments have already been delivered, and the majority of the remainder will be delivered by the first quarter of 2006.

A structural model test programme at Satellite level has qualified the satellite for all mechanical environments. An optical, structural and thermal test programme for the instrument has proved the thermal control design (using flight model heat pipes) and has also demonstrated telescope stability under the thermal environment in space.

As expected the laser is proving the greatest development challenge. After some early disappointments there are now, however, sufficient laser pump diodes for flight. Integration of an Engineering Qualification Model of the laser is on-going. A demonstration of adequate Ultra Violet performance is expected before November 2005. An extensive set of experiments is being conducted into Laser Induced Damage of optical components in vacuum both with and without contaminants. The majority of the laser components are well on the way to qualification as a result of this programme, but one or two problem cases remain. Multiple solutions are being actively pursued in each of these cases.

As a result of delays in the laser development launch is now planned for September 2008.

2.3.2 Aeolus Science

Various science activities in support of Aeolus science are being performed.

ECMWF (European Centre for Medium-Range Weather Forecasts) carried out a study on the "expected benefits of DWL for data assimilation". Radiosonde/profiler denial and (simulated)

Aeolus observations had been used for a 6 week period. The study extended the assimilation ensemble method to assess the impact of adding simulated Aeolus data to the 2004 Observing System. The method was calibrated by assessing the impact of radiosondes and wind-profiler data in the same way (i.e. by a data-denial ensemble). The additional benefits from the Aeolus data were mainly in the Tropics and over ocean regions in both hemispheres, e.g. the North Atlantic storm track - these are widely acknowledged as priority areas for improvement. The ensemble results were consistent with independent measures of information content.

KNMI (Royal Dutch Meteorological Institute) is assessing the added value of Aeolus data in numerical weather prediction (NWP) to enhance the predictive skill of high-impact weather systems. A new system for studying impact is tested focusing on the sensitivity observing system experiment (SOSE) concept. Three scenarios, namely 'ADM tandem' (two ADM satellites in similar orbits), 'ADM dual perspective' (two ADM satellites measuring different components) and 'ADM smart tandem' (two ADM satellites in different orbits), have been considered for an ADM-Aeolus follow-on mission providing different coverage.

Expected spin-off products of Aeolus would include (a) the presence of cloud and aerosol layers (height), (b) cloudiness, (c) scattering ratio, (d) optical depth of cloud and aerosol layers and (e) the backscatter-to-extinction ratio. Prototype algorithms are being considered. Two activities are carried out by LMD (Laboratoire Meteorologique Dynamique, Palaiseau, France) and IfT (Institute for Tropospheric Research, Leipzig, Germany) focusing on (a) the overall potential of deriving such products and (b) the probability of building up a long term data base taking into account that other satellite missions (Calypso and EarthCARE) will provide similar data sets.

There are plans for starting an activity addressing Aeolus observations in the stratosphere as the potential for providing useful observational data in the lower stratosphere is high. Current performance estimate indicate this.

A contribution to an OSSE tool-kit jointly developed by various satellite operating and data exploitation agencies was under consideration by ESA. ECMWF had already committed to deliver a new series of nature runs to the scientific community for OSSE-type studies as a contribution to the THORPEX International Programme. These runs would become available around mid-2006 and would be distributed to the interested scientific community on appropriate media.

2.4 EarthCARE

2.4.1 Objectives

EarthCARE addresses the interaction and impact of clouds and aerosols on the Earth;s radiative budget. The difficulty of representing clouds and aerosols and their interactions with radiation constitutes a major source of uncertainty in predictions of climate change sing numerical models of atmospheric circulation. Accurate representation of cloud processes is also critical for the improvement of NWP.

2.4.2 Concept

EarthCARE will be implemented in cooperation with JAXA and consists of a single satellite in low Earth sun-synchronous orbit of 450 km altitude. It will carry a set of active and passive sensors:

- Backscatter Lidar (ATLID) - ESA High-spectral resolution and depolarisation
- Cloud Profiling Radar (CPR) - JAXA/NICT -36 dBZ sensitivity, 500 m vertical range, Doppler
- Multi-Spectral Imager (MSI) - ESA 7 channels, 150 km swath, 500 m pixel
- Broadband Radiometer (BBR) - ESA 2 channels, 3 views (nadir, fore and aft)

The satellite mass would be 1300 kg, it would need 1.2 kW in average and generate data at 1.5 Mbps that would be downlinked to Northern European latitudes and distributed, often in near-real time.

2.4.3 Planning

After selection in 2004, EarthCARE is being subject to bridging and risk retirement activities in ESA and JAXA. Phase B will be initiated in 2006 and the launch is planned for 2012.

2.5- CRYOSAT

The goals of CryoSat are to measure fluctuations in marine and land ice mass fluxes within the limit set by natural variability. Predicting future climate and sea level depends on knowledge of such fluctuations, while present observations are deficient in time and space. CryoSat and International Programs will provide a decade of focussed study of the roles of the cryosphere.

The technical concept consists of a single spacecraft in a high inclination (92 degree) orbit, carrying a Ku-band altimeter, measuring altitude with detailed precision, capable of operating in conventional pulse limited mode, synthetic aperture mode and interferometric mode.

2.5.1 Project status- as of July 2005

Good progress has been made in the Space Segment area. All repair activities on SIRAL *SAR/Interferometric radar Altimeter) and the valve of the reaction control system have been successfully performed in a timely manner. All environmental tests are now completed. The remaining activities to e performed during the AIT campaign are related to the finalization of the OB S/W.

Preparation for the launch campaign is nominal.

ESOC (Darmstadt, Germany) has been preparing the simulation campaign for the Flight Operations segment. A second round of the Ground segment overall validation has been successfully performed.

Activities related to the Ground Segment Readiness Review and the Flight Acceptance Review have started.

The launch date is now scheduled for 8 October 2005, from Plesetsk. Launch vehicle: Eurockot (converted SS-19).

2.5.2 Calibration/Validation

The refurbishment activities of an already existing Radar calibration transponder have been completed at ESTEC (Noordwijk, NL). It will be shipped to Svalbard , which location maximizes the number of fly0over passes to ensure proper calibration of SIRAL.

2.5.3 Campaigns

The Airborne SAR/Interferometric Radar Altimeter System (ASIRAS) has been operated during the CryoVEx campaign performed during march 2005 in the Gulf of Bothnia (Finland).

ASIRAS is now fully operational for the future CryoVEx campaigns. Scientific evaluation of the results is in progress.

2.6- SMOS

In spite of the fact that both Soil Moisture (SM) and Sea Surface Salinity (SSS) are used in predictive atmospheric, oceanographic, and hydrologic models, to date, no capability exists to measure directly and globally these key variables. The main objective of SMOS is to deliver a crucial variable of the land surface: SM as well as SSS fields.

Over land, water and energy fluxes at the surface/atmosphere interface are strongly dependent upon Soil Moisture (SM). Evaporation, infiltration and runoff are driven by SM while soil moisture in the vadose zone governs the rate of water uptake by vegetation. Soil moisture is thus a key variable in the hydrologic cycle. For the oceans, Sea Surface Salinity (SSS) plays an important role in the northern Atlantic sub polar area where intrusions with a low salinity influence the deep thermohaline circulation and the meridional heat transport. Variations in salinity also influence the oceans near surface dynamics in the tropics where rainfall modifies the buoyancy of the surface layer and the tropical ocean-atmosphere heat fluxes. SSS fields and their seasonal and interannual variabilities are thus tracers and constraints on the water cycle and on the coupled ocean-atmosphere models.

2.6.1 Project status

The SMOS project is conducted in cooperation between ESA, CNES and CDTI under the overall responsibility and leadership of ESA.

The Payload Module (PLM) is developed by an industrial consortium led by EADS-CASA under direct contract from ESA. The PLM development is currently in Phase C/D with it Critical Design Review (CDR) planned end of 2005. Flight model production of subsystems has already started for most units.

The satellite platform and associated satellite operations ground segment are based on the existing PROTEUS bus developed by CNES and ALCATEL. Satellite activities will enter into phase C/D in October.

The Phase C/D of the Data Processing Ground Segment (DPGS) is about to start in full, with industrial work having started already under an "Authorisation to Proceed".

Feasibility analyses have been performed with the Launcher provider, demonstrating the suitability and compatibility of the ROCKOT Launcher for the SMOS Mission.

The SMOS mission implementation phase (C/D,E) has been approved by the ESA Earth Observation Programme Board in September 2003. All activities are being put in place accordingly, with a launch date planned in February 2007.

2.6.2 SMOS Science

Various study and campaign activities were initiated to address the analysis, enhancement and validation of appropriate L-band radiative transfer models accounting for signal perturbing effects such as wind azimuthal dependence, roughness and foam, sea surface temperatures, rain, Faraday rotation for ocean salinity and forests, dew, frost, under-storey, litter, topography for soil moisture and the requirements on the timeliness of collocated observations. In addition, appropriate campaigns had to be organised and conducted to provide suitable data. Once elaborated, the enhanced retrieval schemes together with the system error budget, a vicarious calibration scheme, and a final product definition shall provide insight on the expected usefulness of SMOS data for various science communities. The following paragraphs briefly outline the activities initiated by ESA and their preliminary results. It should be noted that additional study and campaign activities were initiated within national programmes. Activities were coordinated via the SMOS Science Advisory Group and relevant workshops involving the various study and campaign teams.

The *'Soil Moisture Retrieval by a Future Space-borne Earth Observation Mission'* study was aiming at determination of the soil moisture product- and accuracy requirements for a space-borne EO Mission for scientific and semi-operational applications and included the simulation of global brightness temperature maps for subsequent studies.

The main objective of the *'Soil Moisture Retrieval for the SMOS Mission'* study to review existing and to develop and analyse new soil moisture retrieval schemes by accounting for the observation characteristics of the SMOS mission and by taking into account spatial and temporal land surface variability. For this the simulated dataset generated within the previous study was intensively used. Also a software tool based on state-of-the art retrieval techniques including a sophisticated decision tree was developed within this study activity which allows the science community to address open questions and the fine-tune the retrieval concept.

The *'Ocean Salinity Requirement Study'* study addressed the requirements of a future space-borne mission to observe sea surface salinity. The main objective of this study was to analyse the scientific observation requirements and impact assessment on ocean-atmosphere and thermohaline circulation models using different salinity accuracy. State-of-the art ocean

circulation models were used to provide a first qualitative assessment of the expected salinity signal. Characteristic salinity patterns and their temporal and spatial variations have been derived.

The *'Ocean Salinity Retrieval Study'* had the objectives to advance the understanding of the physics for the SMOS characteristics (L-band, range of incidence angle, dual polarisation) for different sea state conditions and to develop retrieval algorithms for ocean salinity from SMOS observations accounting for the spatial resolution (varying footprints), mixed pixels due to wind variability, foam as well as the timeliness and accuracy of ancillary data. Modelling was based on the recently developed small slope approximation (SSA) model.

2.6.3 SMOS Campaigns

EuroSTARRS:

The main objective of the first exploitation of the Salinity Temperature and Roughness Remote Scanner (STARRS) in Europe (EuroSTARRS, 16th – 23rd November 2001) was to acquire SMOS-like observations for addressing a range of critical issues relevant to the soil moisture objectives of the SMOS mission. Additional flights were scheduled for the ocean salinity experiments.

The STARRS sensor is owned by NRL (Naval Research Laboratories, USA) and was operated during the campaign aboard a Dornier 228 by DLR (German Aerospace Center). The instrument, a push-broom scanner with six beams operating in L-band at V polarisation, was mounted perpendicular to the flight direction and tilted to one side by 12 degrees. A mount parallel to the flight direction, necessary to acquire multi-angular observations of the same footprint at almost the same time, was not possible due to technical constraints. However, by overlapping flight lines and accounting for the incidence angles of the different antenna beams, multi-angular observations of up to 50 degrees could be obtained. This required almost perfect flight navigation, which was supported by a new navigation system within the DLR aircraft.

Intensive field-work was carried out by large ground teams providing in-situ information on surface temperature, characterisation of the surface cover (vegetation type, biomass, litter mass, fractional vegetation cover, fractional soil cover, soil texture and roughness, etc.), and soil moisture (gravimetric and TDR measurements) during the overflights.

WISE:

The WInd and Salinity Experiment (WISE) was conducted in 2000 and 2001 on an oil rig (Casablanca tower) about 50 km off the coast of Barcelona. The overall objective of this campaign was to measure and analyse polarimetric L-band emission under varying incidence and azimuthal viewing angles for a wide range of sea state conditions. The LAURA L-band radiometer of the Polytechnic University of Catalonia (UPC), Spain, at the same time prime contractor and responsible for all logistics, was used as the core instrument. Systematic measurements were acquired from Nov. 16th to Dec. 18th, 2000 and continued during Jan., 9th to 15th, 2001. The experiment was repeated from October 23rd to November 22nd in order to cover stronger winds and avoid interferences (RFI problems) encountered during the

first campaign which occurred in certain directions and likely are originated from airport radar systems. Data at wind speed higher than 50 knots (~100km/h) were registered during one of the most severe gale this region ever had. In addition, this experiment was coordinated with the EuroSTARRS campaign, which enabled a contemporaneous data acquisition during an overflight of the STARRS instrument.

LOSAC:

The LOSAC campaign was initiated to address azimuthal dependence of the first two Stokes parameter (Tb,v and Tb,h) with wind speed and direction which is not yet fully understood. The EMIRAD full-polarimetric L-band radiometer was exploited aboard a C130 aircraft operated by the Royal Danish Air Force over the North Sea. The large antenna horn of EMIRAD looked out through the starboard parachute door, an optimised installation for investigating azimuthal signatures by flying circles with the antenna pointing at the sea surface. Changing the roll angle of the aircraft and thus the diameter of the circle, data with different antenna beam incidence angles could be acquired. A first technical test flight was carried out January 16th, 2001, revealing technical problems due to RFI which could be solved by additional shielding. Three science flights were conducted over the North Sea on March 15 and 23, and on October 25.

2.7- Swarm

2.7.1 Objectives

SWARM will provide the best-ever survey of the geomagnetic field and its temporal evolution. SWARM will offer new insights into the composition and processes in the interior and surroundings of the earth, thereby improving our knowledge of the climate. It will provide also supplementary information for studying the interaction of the magnetic field with other physical quantities describing the Earth system. It could also provide data on ocean circulation. Practical applications such as space weather, radiation hazards, navigation and resource exploration will also benefit from SWARM.

2.7.2 Concept

The Swarm concept consists of a constellation of three satellites in three different polar orbits between 400 and 550 km altitude. Two satellites will fly in close tandem at 450 km altitude and one at 530 km altitude, in time drifting orbits, thus sampling the field in varying geometries and at all local times. High-precision and high-resolution measurements of the strength and direction of the magnetic field will be provided by each satellite. In combination, they will provide the necessary observations that are required to model various sources of the geomagnetic field. GPS receivers, an accelerometer and an electric field instrument will provide supplementary information for studying the interaction of the magnetic field with other physical quantities describing the Earth system.

2.7.3 Planning

After selection in 2004, Swarm entered phase B. Launch is planned for 2009. The mission includes contribution from Canada (Electric Field Instrument) and France (Absolute Scalar Magnetometer).

2.8 New call for Earth Explorer Core Missions

A new call for Earth Explorer *Core* ideas was released on 15 March 2005. Twenty-four proposals had been received by the deadline of 15 of August of 2005. Evaluation is ongoing and the selection of candidates for assessment is due for May 2006.

3. - EARTH WATCH

3.1 Initial Actions

These are the operational missions of ESA for partners. Three elements were approved in Edinbourgh in 2001:

- TerraSAR Consolidation, phase B and pre-development of a mission deploying a SAR operating in L-band. The programme has been completed and continuation is to be discussed.

- Fuegosat Consolidation, born as a demonstrator of a constellation of satellites with IR sensors for (Forest) fire monitoring, it has been redirected to be come an element of the EC – ESA initiative on Global Monitoring for Environment and Security (GMES).

- The GMES Service Element (GSE) is ongoing with the consolidation of a number of operational services involving more than 200 users, numerous service providers, developers and strategic partners. They address all areas of the priorities identified by the EC, in particular, ocean monitoring, land management, crisis management, and also potential new services as humanitarian aid and atmospheric composition monitoring. The GSE has been fundamental in identifying the requirements for the GMES Space Component.

3. 2- Operational Meteorology and Climate Monitoring

ESA is co-operating with Eumetsat on the development of new series of meteorological satellites: MSG (Meteosat Second Generation) and MetOp.

Regarding the future generations:

- **Post MSG**: The Phase 0 mission system architecture studies for MTG reached the mid-term review in march 2005. The two contractors have been provided with feed-back, also taken into consideration the Eumetsat users workshop recommendations (Locarno, CH, 13-15 April 2005). Ongoing work will end with a Mission Architecture

Review by ESA in 2005. Phase 0 will be completed with a EUMETSAT led Mission Definition Review (MDR) in spring 2006. This will allow to establish the baseline for phase A studies which should run in 2007 – 2008.

The present concept includes a combined imagery mission, merging the previous high resolution and high spectral contents imaging missions, a lighting imager, and infrared sensor. A sensor operating in the UV-VNIR is being studied in parallel for atmospheric chemistry monitoring. The payload is distributed in two satellites, an imaging satellite and a sounding satellite. The imaging satellite would include the combined imager and the lightning imager and has the highest priority to ensure enhanced continuity to the MSG mission as from 2015. The sounding satellite would carry the infrared sounder.

Coordination is maintained with activities on GMES Sentinel-4, the GMES mission devoted to air quality monitoring from geostationary orbit.

- **Post MetOp**: Four Application experts groups (AEG), including ESA staff, have been nominated to address the six strawman missions identified for post EPS**.** ESA and Eumetsat are also analyzing a potential gap-filler. The AEG should complete the work on time for user workshop in 2006 and timely preparation of documents for phase 0 mission / system architecture studies.

3.3- GMES services element

GMES stand for the Global Monitoring for Environment and Security. GMES is a joint initiative of the European Space Agency and the European Commission to provide Europe with an independent global information system for key strategic parameters in environment and security.

In November 2001, the ESA Ministerial Council approved a new 5-year ESA programme dedicated to GMES, called the GMES Service Element (GSE for short). This is the very first ESA programme dedicated to GMES.

GSE will deliver policy-relevant services to end-users, primarily (but not exclusively) from Earth Observation sources. GSE is a key element of GMES, because it will enable end-users to become key players in the move from present generation Earth Observation satellites to future European systems that will deliver vital information on global environment and security.

The first priority list of services to be delivered by GMES is

• Land use, vegetation and soil management
• Urban and industrial zones management and security
• Coastal zone management and security
• Disaster management

• Atmospheric pollution management
•Water management

The GSE formally started in January 2002. After an ITT, 10 portfolios were selected and the studies started in 2003 for a period of 20 months. The Initial Period Final report was issued . Phase 2 started in March 2004. The GMES implementation period is up to 2008.
Six contracts are starting in September 2005 for the following information services:

- Marine and Coastal Environment
- Polar Environment
- Flood and Fire Risk
- Geohazard risk (Land motion)
- Food security for Africa
- Forest monitoring

Other services are still in the consolidation phase.

3.4- GMES Sapce Component

The ESA proposal for the GMES space component encompasses the development of new "Sentinel" missions and coordination with and access to other national and European missions. Five notional missions, the so called Sentinels are under definition.

- Sentinel-1, a C-band SAR mission to provide continuity to ERS, ENVISAT and maintain the cooperation with Radarsat
- Sentinel-2, a multispectral optical imaging mission to provide continuity to the data so far obtained from SPOT and Landsat
- Sentinel-3, an ocean monitoring mission providing ocean colour, sea surface topography and sea surface temperature, and providing continuity to data as those of MERIS, RA-1 / RA-2, (A)ATSR. It would also provide continuity to the data so far provided by the Vegetation sensors on SPOT-4 and 5.
- Sentinel-4, a geostationary element for monitoring of atmospheric composition
- Sentinel-5, a low-Earth orbit element devoted to the monitoring of atmospheric composition

The IR element defined under the Fuegosat Consolidation, see above, will be part of the payload of selected satellites of the Sentinel families.

A data-gap filler, to meet the most critical data needs, called GMES-1 is envisaged for the 2010/11 time-frame.

The ground segment will include the flight operation segment and the payload ground segment. The latter will provide interface to cooperative missions and the in-situ component. Activities are ongoing for achievement of inter-operability.

Service development is continuing under the GSE introduced above.

The program will be proposed to the ESA Ministerial Conference scheduled in December 2005 and could include a first mission (GMES-1) to cover the most urgent data gaps from 2011 and until the full space component is deployed.

4. - REFERENCES

Further information about the various ESA missions can be found on the following WWW addresses which offers the possibility to download many supporting relevant documentation:

http://www.estec.esa.nl/explorer/

http://earth.esa.int/gmes/