

CEOS Working Group on Cal/Val WGCV #30 ESA Report

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Ilhabela, Brazil

- The ERS-2 satellite will reach 14 years of operational activity in April 2009. Despite its high age the satellite is performing well within specification.
- The second ERS-2 / Envisat SAR Interferometry Tandem campaign initially foreseen for three months was extended until early April 2009. Its objectives is to exploit the 30 minutes difference between Envisat and ERS-2 data acquisition, focusing on the velocity of fast moving glaciers and low relief Digital Elevation Models in the high Northern latitudes.
- The SAR duty cycle increased from 3.5 to 6 minutes per orbit in the last months. This is related to the above SAR Interferometry Tandem campaign but is also due to the increasing SAR NRT demand from application projects like GSE MARISS.
- The experimental “Virtual Archive” is given full satisfaction. Internet download performances of 400 MBit/s were reached and 1 GBit/s will be tested in the coming months. This approach ensures very fast and easy download of archived data and is currently supporting GEO.
- Geohazard initiative through access of large stacks of archived SAR products over selected volcanoes and tectonics areas.

- Though the Envisat mission confirms its remarkable success after 7 years of operations, the first quarter of 2009 provided its share of concerns for the satellite into two different areas: a serious anomaly with the GOMOS instrument, and the impact of the collision between two satellites in February 2009:
 - The GOMOS instrument experienced a series of serious anomalies starting at end of December 2008. The instrument operations were suspended during February 2009 in order to perform a test campaign. Since the resumption of its operations in early March, the GOMOS instrument behaviour has been irregular with periods of satisfactory operations and periods of high occurrence of abnormal events.
 - On 10 February 2009, a defunct Russian telecommunication satellite collided with an operational US telecommunication satellite, at an altitude of about 790 km, therefore endangering both Envisat and ERS-2 satellites which fly at similar altitudes. This event created a considerable concern at ESA and highlighted the European dependence on a suitable Space Surveillance activity.

Earth Explorers


- Cryosat
 - *Are the ice caps shrinking?*
 - Launch planned on December 10th, 2009
- Goce
 - *How does the gravity field affect ocean currents and sea level?*
 - The GOCE satellite was successfully launched on the 17th of March 2009.
 - The Launch and Early Orbit Phase (LEOP) was successfully completed on the 20th of March.
 - Commissioning of the satellite is progressing nominally.
- ADM-Aeolus
 - *How does measuring the wind improve weather forecasting?*
 - Test data gives confidence that the laser in full flight configuration will show much better energy stability in vacuum, the tests on the EM laser clearly demonstrated the potential sensitivity of optical components against LIC in the high-powerultraviolet beam path.
 - Launch planned on April 15th, 2011



- ESA's gravity mission GOCE has achieved a first in the history of satellite technology. The sophisticated electric propulsion system has shown that it is able to keep the satellite completely free from drag as it cuts through the remnants of Earth's atmosphere – paving the way for the best gravity data ever.

Earth Explorers

- SMOS
 - *Is climate change accelerating the water cycle?*
 - Launch planned for July 16th, 2009.
 - The satellite continues to be in storage. The FAR was successfully passed yesterday.
 - The launcher related reviews are successfully completed. After the successful GOCE launch, the project now awaits the formal correspondence from Eurockot / Khrunichev as regards a launch date.
 - Detailed launch campaign preparations have started.
 - The flight operations ground segment is performing dress rehearsals for the LEOP.
 - The data processing ground segment has its delta test, intended to demonstrate the fixes for the numerous problems reported in the on-site acceptance test (OSAT) of version 2.
- SWARM
 - *How fast is the Earth's magnetic shield weakening against solar radiation?*
 - Launched planned between October, 2010 and June, 2011
- Earth Care
 - *To what extent do clouds and aerosols influence global warming?*
 - Launched planned September, 2013

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- **Earth Explorer Core Missions:**
 - **System Studies for three potential missions:**
 - **Biomass**
 - **CoReH2o**
 - **PREMIER**

- **Phase A system study for the BIOMASS mission (two parallel studies after open competition)**
 - The primary scientific objectives of the BIOMASS mission are (1) to determine the distribution of aboveground biomass in the world forests and (2) to measure annual changes in this stock over the period of the mission. The first objective will enable to accurately estimate the sources and sinks of carbon attributable to forest cover change. By measuring changes in aboveground biomass, BIOMASS will measure the changes resulting from forest degradation and growth.
 - The satellite carries a P-Band (435 MHz) SAR providing full-polarimetric measurements in a side-looking geometry at a resolution of about $50\text{ m} \times 50\text{ m}$ with 4 looks. The mission will provide observations with global coverage of forested areas in 27 to 45 days during the Nominal Phase, depending on the concept. Polarimetric-interferometric observations are systematically acquired by ensuring the required interferometric baseline between any two successive orbit cycles through the selection of a non-exact repeating ground track orbit. The local time at equator crossing is 05:00 to minimise the effect of ionospheric disturbances.

- **Phase A system study for the CoReH2o mission (two parallel studies after open competition)**
 - The overall objectives of the CoReH2O mission are to improve the modelling and prediction of water balance and stream flow for basins with snow cover and glaciers, the forecasting of water supply from these regions, the modelling of the water cycle and energy balance at high latitudes, and for improving regional climate models. The mission will provide observations of the water volume stored in the snowpack at high spatial and sufficient temporal resolution.
 - The mission includes a single satellite carrying a dual frequency (X- and Ku-band), dualpolarisation SAR in a near-polar sun-synchronous dawn-dusk orbit to observe snow and ice to high spatial resolution. The mission is split into two distinct operational phases. In a first phase of two year duration, the orbit at 666 km altitude with a 3-day repeat period over selected test areas will allow to match the cycle of synoptic meteorological systems.
 - During the second phase of 3 year duration, the orbit will be changed to one with a 15-day repeat cycle and 645 km altitude, which will allow 95% area coverage above 40° N latitude and below 40° S latitude.
 - The payload is a SAR operating at X- and Ku-band, at 9.6 GHz and 17.2 GHz respectively, transmitting with vertical linear polarisation and receiving backscattered signals from the Earth surface with vertical and horizontal linear polarisation. The dual-frequency SAR will image a swath of 100 km in a side-looking configuration with incidence angles between 30° and 45°. The ScanSAR mode of operation has been selected, with 6 sub-swaths covering the 100 km swath at a spatial resolution of 50 m × 50 m with 5-6 looks.

- **Phase A system study for the PREMIER mission (two parallel studies after open competition)**
 - The main goal of PREMIER is to quantify processes controlling global atmospheric composition in the middle and upper troposphere and lower stratosphere (5–25 km), which is a region of particular importance for climate change and chemistry-climate feedbacks.
 - To sample this region requires high vertical resolution (1-2 km) measurements, which are not obtainable from nadir sounding. For the first time, truly 3D measurements would be performed by combining limb sounding with along-track and across-track sampling.
 - The PREMIER space segment consists of a single satellite flying in formation with MetOp in a sun-synchronous orbit at an altitude of 817 km with 09:30 local time at the descending node. The satellite will fly about 8 minutes ahead of MetOp and observe the limb in a rearward looking geometry in order to exploit synergy with the nadir observations from the MetOp instruments.
 - The mission payload includes an InfraRed Limb Sounder/Cloud Imager (IRLS/IRCI) and a mm-Wave Limb Sounder (STEAMR) provided as a Swedish national contribution to the PREMIER mission. The IRLS/IRCI is a Fourier Transform Spectrometer combining sounding and imaging functions and providing 3D limb observations in two bands covering the spectral range 6.0-9.4 μm and 10.2-13 μm respectively. The instrument operates in two exclusive modes with different spectral and spatial sampling requirements.
 - The high spectral resolution mode (atmospheric chemistry) features a spectral sampling of 0.2 cm^{-1} and a vertical spatial sampling of 2 km, whereas the high spatial resolution mode (atmospheric dynamics) has a spectral sampling of 1.25 cm^{-1} and a vertical spatial sampling of 500 m. Continuous acquisition of high spatial resolution images (vertical sampling 500 m) in the same spectral range but at a reduced spectral sampling (10 cm^{-1}) is performed using the central part of the interferogram. The across track field of view has an extent of 240-320 km and a vertical range of 48 km (15 km for the imaging function). The acquisition is performed at the highest spatial/spectral sampling required by the different modes, the target resolutions being achieved by spectral/spatial processing of the raw samples.

EARTH WATCH EUMETSAT MISSIONS

- **MTG (Meteosat Third Generation)**
 - The MTG will take the relay in 2015 from Meteosat 11, the last of a series of four satellites of the MSG (Meteosat Second Generation).
 - This is a joint project between ESA and EUMETSAT that followed the success of the first generation Meteosat satellites.
 - The first of four MSG satellites was launched in 2002, entering into service with EUMETSAT in early 2004 and now renamed Meteosat-8.
 - The second MSG satellite, renamed Meteosat-9, was launched in December 2005.
- **Future Eumetsat Polar System**
 - Launched in October 2006, MetOp-A is Europe's first polar-orbiting satellite dedicated to operational meteorology.
 - It represents the European contribution to a new co-operative venture with the United States providing data to monitor climate and improve weather forecasting.
 - MetOp is a series of three satellites to be launched sequentially to deliver data until at least 2020 and forms the space segment of EUMETSAT's Polar System (EPS).
 - Preparations have started for the next generation of this EUMETSAT Polar System, the so-called Post-EPS.

CAMPAIGNS

- The objectives of the EO campaigns include the provision of support for the preparation of future EO programmes
- **CEFLES2** - (CarboEurope, FLEX and Sentinel-2) - Combines different activities in support of:
 - the Earth Explorer candidate FLEX (Fluorescence Explorer) mission through the validation of photosynthesis estimates based on airborne fluorescence measurements. The data are used to analyse the performance of fluorescence detection and the definition of space observation techniques and quantitative requirements for effective fluorescence retrieval;
 - the Sentinel-2 project by providing feedback on the definition of acceptable compression ratios for each spectral band of the Sentinel-2 Multispectral Instrument (MSI) and to support the definition of the Level-1 processing algorithms and Level-2 Algorithm Theoretical Basis Documents.
- **BioSAR-2** - The BioSAR-2 supports the candidate Earth Explorer BIOMASS mission through airborne and ground data acquisition to support the evaluation of forest biomass retrieval and forest height retrieval performance. In addition to providing a first dataset representative of northern Boreal forests, the campaign activity aims to quantify the effects of topography on the retrieval of forest biomass at P-Band and investigate mitigation strategies applicable to the Level-2 processing algorithms.

- ***DESIREX2008*** - (Dual-use European Security IR Experiment 2008)
 - The campaign activity took place within the framework of the Reorientation of the Consolidation Phase of the Fuegosat Earth Watch Programme. The reorientation was endorsed by the Participants to the Fuegosat element (Consolidation Phase) and, in addition to fire-related applications, additional work related to infrared observations supporting GMES objectives was identified. This includes activities to support establishing requirements reconsidering previous studies and through Data User Element (DUE) projects relevant to the infrared element development.

New Campaigns initiatives

- **TropiSAR 2009**

The TropiSAR campaign will provide feedbacks on key performance issues of the Earth Explorer 7 candidate mission BIOMASS over tropical forests. The main objectives of the campaign are to

- estimate temporal coherence at P- and L-band for time intervals compatible with spaceborne missions,
- assess the performance of BIOMASS forest parameter retrieval algorithms for tropical forests, and
- derive the complete error budget in Level-2 products over tropical forests and assess product validation methods.

Preparations for the campaign have been initiated.

- **NoSREx**

The SnowEx campaign supports the Earth Explorer 7 candidate mission CoReH2O. Objectives include the application and validation of the dual-frequency retrieval algorithms for the retrieval of geophysical parameters such as snow water equivalent (SWE). The campaign is envisaged to consist of a long-term ground based scatterometer measurements during the 2009/2010 winter period in Northern Finland in order to measure a variety of snow conditions. Preparations for the campaign have been initiated.

- **PremierEx**

The objectives of this campaign are linked to the overall objectives of the Earth Explorer candidate mission PREMIER. The PremierEx campaign will support the inflight testing of the MARSCHALS airborne simulator, and the preparation and execution of flights in 2010 to support the definition of PREMIER capabilities to quantify:

- Horizontal transport/mixing processes in the mid to upper troposphere / lower stratosphere
- Cirrus formation in the Arctic upper troposphere

In addition, the campaign observation shall be used to demonstrate the complementary attributes of IRLS and MWLS in terms of sensitivity to clouds and propagation of observations into the troposphere. Preparations for the campaign have been initiated.

Sentinels

- Each Sentinel mission is based on a constellation of two satellites to fulfil revisit and coverage requirements to provide robust datasets for GMES Services.
- Sentinel-1 is a polar-orbiting, all-weather, day-and-night radar imaging mission for GMES land and ocean services. The first Sentinel-1 satellite is planned for launch at the end of 2011.
- Sentinel-2 is a polar-orbiting, multispectral high-resolution imaging mission for GMES land monitoring to provide, for example, imagery of vegetation, soil and water cover, inland waterways and coastal areas. Sentinel-2 will also provide information for emergency services. The first Sentinel-2 satellite is planned for launch at the end of 2012.
- Sentinel-3 is a multi-instrument mission to determine parameters such as sea-surface topography, sea- and land-surface temperature, ocean colour and land colour with high-end accuracy and reliability. The first Sentinel-3 satellite is planned for launch at the end of 2012.
- Sentinel-4 is a payload that will be embarked upon a Meteosat Third Generation (MTG) satellite in geostationary orbit and launched in 2017. Sentinel-4 is devoted to atmospheric monitoring.
- Sentinel-5 is a payload will be embarked on a post-EUMETSAT Polar System (EPS) spacecraft and launched in 2019. A Sentinel-5 precursor mission is planned to launch in 2014, to avoid data gaps between Envisat (Sciamachy data in particular) and Sentinel-5. This mission will be devoted to atmospheric monitoring.