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STATUS OF THE CURRENT AND FUTURE ESA EARTH OBSERVATION MISSIONS AND PROGRAMMES

CGMS is informed of the status of the current European Space Agency Earth Observation missions. Two of them, MSG and MetOp are in co-operation with EUMETSAT. The Gravity field and steady-state Ocean Circulation Explorer, GOCE, the first Explorer satellite launched on 17 March 2009, completed its nominal mission in April 2011. GOCE continues to provide top-quality gravity field data. The SMOS satellite was launched on 2 November 2009. SMOS Level 2 data products were released at the end of October 2010. All reprocessed Level 1 and 2 data are available from the ESA Cal/Val portal since mid-March 2012. The CryoSat-2 satellite was launched on 8 April 2010. The first CryoSat Arctic sea-ice thickness map was presented in June 2011. Release of systematic CryoSat products (Level 1b and 2) to scientific community is going on. The Proba-V small satellite was launched on 7 May 2013. Its coarse resolution imager continues the data acquisition of the Vegetation payload on-board SPOT-4 and 5. About 4,000 data user projects worldwide use data from the ESA EO missions and this number is increasing further. The total volume of ESA EO mission data exceeds 100 Terabytes per year.
CGMS is further informed of the status of the future European Space Agency Earth Observation missions. Two of them, MTG and Post EPS (now EPS SG) are in co-operation with EUMETSAT. The Living Planet Programme has three lines of implementation: Earth Explorer satellites, Earth Watch satellites plus services and applications demonstration. BIOMASS, the 7th Core Explorer, has now been selected. Progress in the preparation of the forthcoming Explorer missions ADM-AEOLUS, Swarm and EarthCARE is described. GMES represents the major new initiative of European efforts in Earth Observation. The start of the GMES pre-operational services took place in 2008, with the provision of the relevant data. The first GMES dedicated satellites (the “Sentinels”) will be launched in 2014. Related activities are under way at all stages within the Agency, the EC and at Member States level.
CGMS is also informed of the status of the Earthwatch Programme Element, Global Monitoring of Essential Climate Variables (also known as the ‘ESA Climate Change Initiative’ or CCI). The CCI Programme has continued to progress well. The thirteen existing project teams have made significant progress on algorithm development and on specifying a future operational system. The Programme will achieve its phase 1 objectives by end-2013 and continue in Phase 2 starting in early 2014.

Status of the Current and Future ESA Earth Observation Missions and Programmes

1 INTRODUCTION

This paper provides information on the status of the current and future European Space Agency Earth Observation missions. ESA's Living Planet Programme comprises a science and research element, which includes the Earth Explorer missions, and an Earth Watch element, which is designed to facilitate the delivery of Earth observation data for use in operational services. Earth Watch includes the well-established meteorological missions with the European Organisation for the Exploitation of Meteorological Satellites (Eumetsat). These missions (MSG, MTG, MetOp and EPS-SG) are not dealt with in this report.

Current in-flight missions include three R&D satellites from the Earth Explorer series, and two small satellites of the Proba series. The status of future Earth Explorer and Earth Watch missions is presented, as well as the progress in the development of the ESA Climate Change Initiative (CCI).

Although the past ESA ERS-1, ERS-2 and Envisat missions are no longer operating, users can easily access the large ESA archives to get products generated from their respective instrument complements.

2 CURRENT ESA SATELLITE SYSTEMS

Satellites	Equator Crossing Time Altitude	Launch date	Access to data or products	Instruments	Status, applications and other information
PROBA-1	8:30 (D) 615 km	22/10/2001	Earthnet on line	CHRIS, SREM	The orbit is drifting from the original 10:30 desc. ECT.
GOCE	06:00 (A) 260 km	17/03/2009	Earthnet on line	Electrostatic Gravity Gradiometer, LRR, Satellite-to-Satellite Tracking Instrument	(Gravity field and Ocean steady-state Circulation Explorer). End of life planned in 2013
SMOS	06:00 (A) 755 km	2/11/2009	SMOS data centres	MIRAS (Microwave Imaging Radiometer using Aperture Synthesis), GPS, STA	L-band radiometer for salinity & soil moisture observation
PROBA-2	06:00 (A) 730 km	2/11/2009	Earthnet on line	SWAP, LYRA, TPMU, DSLP	2nd flight unit of the PROBA programme. Main mission: space weather
CryoSat-2	717 km (92° incl.)	8/04/2010	Earthnet on line	SIRAL (SAR Interferometric Radar Altimeter), DORIS, LRR	Polar ice monitoring
PROBA-V	10:30 (D)	5/07/2013	Commissioning	VEGETATION-P	2nd flight unit of the PROBA programme. Main mission: vegetation monitoring

2.1 Status of current Earth Explorer satellites

Three ESA Earth Explorer missions are currently in operation, namely GOCE, SMOS (launched in 2009) and CryoSat-2 (launched in 2010). All three missions have provided outstanding results of interest to the meteorological and climate research communities at large.

2.1.1 GOCE

In orbit since March 2009, the Gravity field and steady-state Ocean Explorer (GOCE) is measuring the Earth's gravity field with unprecedented detail to advance our understanding of ocean circulation, sea-level change and Earth-interior processes.

2.1.1.1 Status of spacecraft

Originally due to complete its mission of mapping Earth's gravity in April 2011, GOCE continues to provide top-quality gravity field data. Measurement cycle number 16 was flown at an altitude of 240 km and finished on 2 February 2013. A third step to lower GOCE's orbital altitude by a total of 20 km down to 235 km has been successfully completed on 16 February 2013. GOCE's capability to continue flying at 235 km throughout the upcoming long eclipse period – essentially until end of life – has been assessed and concluded positively. On May 31, 2013, the altitude has been lowered by an additional 10 km, with the aim to further improve the spatial resolution and accuracy of GOCE gravity field products. With this manoeuvre the measurement altitude of GOCE will have been reduced by a total of 30.78 km with respect to the original mapping orbit maintained throughout the first three years of operation. The gravity field products based (in part) on data from this final orbit will be included in Release 5 GOCE field models, expected in mid-2014.

Plans are for continuation of gravity field mapping only interrupted by infrequent calibrations (approximately one day of satellite shaking approximately every two months). Current Xenon gas consumption figures (directly linked to the air density) predict the exhaustion of the tank around November 2013. Thereafter, GOCE will re-enter the Earth's atmosphere within weeks. By that time, GOCE would have acquired more than four times the amount of data foreseen by the nominal mission profile.

2.1.1.2 Performance and results

With the reprocessed and extended mission data set covering the period from November 2009 until end of 2012, the mission goals (with respect to the original GOCE mission proposal) are accomplished based on GOCE data alone.

Adding the lowered orbit data from August 2012 onwards will significantly improve the signal content and spatial resolution of GOCE gravity field models towards the mesoscale (80 km or better). Including other satellite data (e.g. GRACE, LAGEOS) will further improve the GOCE products, in particular in the lower harmonic range.

Fourth-generation gravity field models based on GOCE data were released in March 2013. While the third generation spanned 18 months-worth of data, these fourth

generation solutions span almost three years of mission data, from November 2009 up to July 2012, boosting the effective data volume used from 12 months up to 27.

The First International GOCE Solid Earth Workshop was held on 16-17 October 2012, hosted by the Faculty ITC of the University of Twente (Enschede, The Netherlands) and fully sponsored by ESA. The Workshop was a very successful event, bringing together scientists and professionals working on applications as diverse as global crustal modelling, lithospheric modelling, ice melting, basin and petroleum system modelling. This once more proved the appeal of the unique and high-quality GOCE data to an ever-growing scientific and professional community. All presentations from the First International GOCE Solid Earth Workshop are available through the GOCE portal, on the Proceedings page.

2.1.2 SMOS

Launched on 2 November 2009, SMOS is the second Earth Explorer Opportunity mission to be developed as part of ESA's Living Planet Programme. SMOS carries a novel microwave sensor to capture images of brightness temperature, from which information on soil moisture and ocean salinity is derived. The data acquired from the SMOS mission will lead to better weather and extreme-event forecasting, and contribute to seasonal-climate forecasting.

2.1.2.1 Status of spacecraft

The platform (operated under full CNES responsibility) and payload are operating nominally. No major anomalies have impacted the availability of SMOS science data. Due to the implemented mitigation strategies, the performance of the instrument continues to be excellent, accounting for 99.8% of availability for generating observation data.

2.1.2.2 Performance and results

In general, the RFI situation in particular over Europe and North America continues to improve. The very strong sources over Poland are still present but much weaker since February 2013, not blinding any more the whole of Central Europe but still making the data unusable for scientific applications in affected areas.

The distribution of the NRT light product through EUMETSAT’s EUMETCast system is open since 14 February. This will increase the uptake of SMOS data amongst operational agencies (at present: NOAA NESDIS, CMC Canada, and US Navy).

A first assessment of the quality of the reprocessed data has shown that there is a larger number of successful retrievals, and a much improved stability of salinity when compared to *in situ* measurements such as ARGO. The reprocessed level 2 ocean salinity data has been made available to the user community in April 2013.

Amongst the many outstanding results already achieved by SMOS, of particular interest are: the observation of hurricane Sandy and measurements of surface wind speed in stormy conditions; the monitoring of warm, salty eddies being carried north by the Gulf Stream and colder, less-salty water transported southward along North

America's east coast by the Labrador Current, mixing the water masses off Cape Hatteras; the monitoring of wetlands and their relation with methane emissions; the thinning of ice in marginal, seasonal ice zones; the comparison between SMOS and Aquarius data, the differences in the data yielding even more detail about variations in the salinity of the oceans; the contribution to improving flood forecasts as demonstrated with the extreme floods in Central Europe in June 2013. This variety of results shows off how versatile is the ESA SMOS mission.

2.1.3 CryoSat-2

ESA's Earth Explorer CryoSat-2 mission, launched on 8 April 2010, is dedicated to the precise monitoring of the changes in the thickness of marine ice floating in the polar oceans and variations in the thickness of the vast ice sheets that overlie Greenland and Antarctica.

2.1.3.1 Status of spacecraft

The overall performance of the CryoSat-2 mission was satisfactory during past year. The space segment performed well with no major issues. It is noted that the end-to-end space and ground system's availability was 98.9%. The reprocessing campaign is ongoing as planned; the first reprocessed dataset has been distributed to the user community. Completion of first reprocessing campaign is expected in the second or third quarter of 2013.

2.1.3.2 Performance and results

The first detailed assessment of CryoSat-2 mission objectives in terms of ice mass variation per unit area [cm/y] will be feasible only after the completion of the reprocessing campaign. Release of the CryoSat-2 Ocean Products is expected in the second quarter of 2013. First measurements of sea-ice trend in Arctic are expected in the third quarter of 2013.

The CryoSat-2 Third User Workshop was successfully held at the Technical University of Dresden, Germany, on 12-14 March (see: http://www.cryosat2013.org/). The workshop provided a forum to present and discuss all topics related to the exploitation of the CryoSat-2 mission. The workshop was attended by 128 participants from 18 countries. It provided an opportunity to review the mission status, mission performance and product status, to assess the state of the art in scientific use of the CryoSat-2 data and to identity novel scientific challenges.

The first map of Arctic ice thickness was released in June 2011. Since then, new results have been obtained with CryoSat-2, including the discovery that the volume of Arctic sea ice has declined by 36% during autumn and 9% during winter between 2003 and 2012, confirming, for the first time, that the decline in sea ice coverage in the polar region is accompanied by a substantial decline in ice volume. CryoSat-2 data have also been used to map, for the first time, volume changes of an Antarctic sub-glacial lake in three dimensions. SARIn mode data are shown to track the perimeter and depth changes of a 260 km^2 sub-glacial lake in East Antarctica.

2.2 Small satellites

Operational for more than a decade, Proba-1 was the first in ESA's series of satellites aimed at providing in-orbit testing of new space technologies. Proba-1 was launched in October 2001 as an experimental mission but is still going strong. In November 2009 Proba-1 was joined in orbit by Proba-2, focused on solar monitoring.

Launched on 7 May 2013, Proba-V is tasked with a full-scale mission: to map land cover and vegetation growth across the entire planet every two days. Proba-V is flying a lighter but fully functional redesign of the 'Vegetation' imaging instruments previously flown aboard France's full-sized Spot-4 and Spot-5 satellites, which have been observing Earth since 1998. Proba-V's Vegetation instrument boasts improved spatial resolution from to its Spot predecessors: 350 m resolution compared to 1 km for Spot Vegetation, with 100 m resolution available within its central field of view.

The Spot Vegetation dataset has close to 10 000 registered users around the globe and has contributed to hundreds of scientific papers over 15 years. But with further Spot satellites lacking the capacity to carry Vegetation instruments, Proba-V has been designed to meet the future needs of this group.

Proba-V will provide data to the instrument's worldwide user community of scientists and service providers as soon as its orbital commissioning – including cross-checks with Spot-5's Vegetation instrument – is complete. Uses of Proba-V Vegetation data include day-by-day tracking of extreme weather, alerting authorities to crop failures, monitoring inland water resources and tracing the steady spread of deserts and deforestation.

3 FUTURE ESA SATELLITE SYSTEMS

3.1 Future Earth Explorer missions

The Earth Explorers are research missions designed to address key scientific challenges identified by the science community while demonstrating breakthrough technology in observing techniques. Involving the science community right from the beginning in the definition of new missions and a peer-reviewed selection process ensures that a resulting mission is developed efficiently and provides the exact data required by the user.

3.1.1 SWARM

Swarm is the third Earth Explorer Opportunity Mission of ESA's Earth Observation Envelope Programme. This constellation of three satellites is designed to measure the magnetic signals that stem from Earth's core, mantle, crust, oceans, ionosphere and magnetosphere. The three Swarm satellites are in storage. Due to further delay of the launch, as announced by Eurockot in January and recently in March, the satellites' storage has been extended up to end of July 2013; the new potential date of transport to Plesetsk. The three satellites remain stored within their containers since 11 July 2012. According to Eurockot statements, ESA should maintain plans in order to be ready to take a launch opportunity in October 2013.

3.1.2 EarthCARE

EarthCARE – the largest and most complex Earth Explorer mission to date – is being developed as a joint venture between ESA and the Japan Aerospace Exploration Agency, JAXA. EarthCARE will advance our understanding of the role that clouds and aerosols play in reflecting incident solar radiation back into space and trapping infrared radiation emitted from Earth's surface. By acquiring vertical profiles of clouds and aerosols, as well as the radiances at the top of the atmosphere, EarthCARE aims to address these issues. The mission will employ high-performance lidar and radar technology that has never been flown in space before.

The EarthCARE satellite budgets and system configuration remained stable during the past year. Good progress has been achieved for the Multispectral imager and the Broadband radiometer. In Japan, JAXA has completed successfully the Cloud Profiling Radar mechanical qualification of the instrument. The ATLID instrument schedule remains on the critical path of the spacecraft due to the technologies involved and the complexity of this instrument.

Current plans call for a launch of EarthCARE in November 2016. The mission has a design lifetime of three years, including a six-months commissioning phase.

3.1.3 ADM-AEOLUS

The ADM (Atmospheric Dynamics Mission)-Aeolus satellite will carry a single, but complex, instrument that will probe the atmosphere to profile the world's winds. Reliable and timely wind profiles are urgently needed by meteorologists to improve weather forecasts. In the long term, they will also contribute to climate research. Aeolus will carry a pioneering instrument called ALADIN that uses laser light scattering and the Doppler Effect to gather data on wind.

Developing the laser transmitter has been a very long and difficult undertaking – forging new technologies in many areas such as optics, opto-electronics, precision mechanics and thermo-mechanical design. During recent tests conducted throughout three consecutive weeks in March 2013, the laser transmitter remained perfectly stable at full energy, producing a total of 90 million UV laser shots.

Thanks to the recent successes during these instrument tests and integration, the earliest launch date for ADM-Aeolus is maintained for July 2015, but without any contingency.

3.1.4 BIOMASS

The Biomass mission has been selected in May 2013 as the 7th Earth Explorer mission of its Living Planet programme. The satellite will be designed to provide, for the first time from space, P-band radar measurements that are optimised to determine the amount of biomass and carbon stored in the world's forests with greater accuracy than ever before. This information, which is poorly known in the tropics, is essential to our understanding of the role of forests in Earth's carbon cycle and in climate change. These objectives will be achieved by measuring biomass and forest height at a resolution of 200 m and forest disturbances at a resolution of 50 m.

Reliable knowledge of tropical forest biomass also underpins the implementation of the UN Reducing Emissions from Deforestation and forest Degradation (REDD+) initiative – an international effort to reduce carbon emissions from deforestation and land degradation in developing countries.

In addition, the measurements made by Biomass offer the opportunity to map the elevation of Earth's terrain under dense vegetation, yielding information on subsurface geology and allowing the estimation of glacier and ice-sheet velocities, critical to our understanding of ice-sheet mass loss in a warming Earth. Biomass also has the potential to evolve into an operational system, providing long-term monitoring of forests – one of Earth's most important natural resources. The launch of the mission is foreseen for 2020.

3.2 Future Earth Watch missions

In addition to meteorological satellites, the GMES (Global Monitoring for Environment and Security) Sentinel missions, which form part of the GMES Space Component, will collect robust, long-term climate-relevant datasets. Also ESA has initiated studies on a Jason-CS mission aimed at continuing high-precision altimetry observations of the ocean beyond the current Jason-1, -2 and 3 series.

3.2.1 Sentinel-1

The Sentinel-1 mission is a polar-orbiting satellite system for the continuation of Synthetic Aperture Radar (SAR) operational applications. Sentinel-1 is a C-band imaging radar mission to provide an all-weather day-and-night supply of imagery for GMES user services. The SAR will operate in two main modes: Interferometric Wide Swath and Wave. The first has a swath width of 250 km and a ground resolution of 5×20 m.

The first Sentinel-1 satellite is ready for launch in October 2013 and will be followed by the second satellite a few years later. However, due to the extremely crowded launch manifest of Soyuz from Kourou in the last months of the year and given the priority assigned to the Galileo FOC launches as explicitly required by the European Commission, the Sentinel-1A launch date of end October 2013 can no longer be guaranteed. A suitable alternative date is being discussed with the launch service provider, Arianespace.

The nominal date of the Sentinel-1B Flight Acceptance Review (FAR) is December 2014, with the objective of launching in January 2015. However, the actual launch date will depend upon the availability of the funding from the European Commission for the Phase E1 of Sentinel-1B (not covered by the Programme Declaration).

3.2.2 Sentinel-2

The pair of Sentinel-2 satellites will routinely deliver high-resolution optical images globally, providing enhanced continuity of SPOT- and Landsat-type data. Sentinel-2 will carry an optical payload with visible, near infrared and shortwave infrared sensors comprising 13 spectral bands: 4 bands at 10 m, 6 bands at 20 m and 3

bands at 60 m spatial resolution (the latter is dedicated to atmospheric corrections and cloud screening), with a swath width of 290 km.

The Sentinel-2A launch date has now been set to 30 September 2014, and the Sentinel-2B FAR is scheduled on 30 June 2015.

3.2.3 Sentinel-3

The Sentinel-3 mission's main objective is to measure sea-surface topography, sea- and land-surface temperature and ocean- and land-surface colour with high-accuracy and reliability in support of ocean forecasting systems, and for environmental and climate monitoring. Sentinel-3 builds directly on a proven heritage pioneered by ERS-2 and Envisat. Its innovative instrument package includes:

- A Sea and Land Surface Temperature Radiometer (SLSTR), based on Envisat's Advanced Along Track Scanning Radiometer (AATSR), to determine global sea-surface temperatures to an accuracy of better than 0.3 K.
- An Ocean and Land Colour Instrument (OLCI) based on heritage from Envisat's Medium Resolution Imaging Spectrometer (MERIS). With 21 bands, compared to the 15 on MERIS, a design optimised to minimise sun-glint and, a resolution of 300 m over all surfaces, OLCI marks a new generation of measurements over the ocean and land. The swath of OCLI and nadir SLSTR fully overlap.
- A dual-frequency (Ku and C band) advanced Synthetic Aperture Radar Altimeter (SRAL) based on CryoSat heritage and providing measurements at a resolution of ~300 m in SAR mode along track. SRAL is supported by a microwave radiometer for atmospheric correction and a DORIS receiver for orbit positioning.

The estimated launch date for the Sentinel-3A Satellite is end of November 2014 resulted, with a Sentinel-3B FAR in the 3rd Quarter of 2015.

3.2.4 Sentinels-4/-5

The Sentinel-4 and Sentinel-5 missions are dedicated to monitoring the composition of the atmosphere for GMES Atmosphere Services. Both missions will be carried on meteorological satellites operated by Eumetsat.

To be carried on the geostationary Meteosat Third Generation satellites, the Sentinel-4 mission comprises an Ultraviolet Visible Near-infrared (UVN) spectrometer and data from Eumetsat's thermal InfraRed Sounder (IRS), both embarked on the MTG-Sounder (MTG-S) satellite. After the MTG-S satellite is in orbit, the Sentinel-4 mission also includes data from Eumetsat's Flexible Combined Imager (FCI) embarked on the MTG-Imager (MTG-I) satellite. The first MTG-S satellite is expected to be launched in 2019 and the first MTG-I in 2017.

To be carried on the polar-orbiting MetOp Second Generation satellite, the Sentinel-5 mission comprises an Ultraviolet Visible Near-infrared Shortwave (UVNS) spectrometer and data from Eumetsat's IRS, the Visible Infrared Imager (VII) and the Multi-viewing Multi-channel Multi-polarization Imager (3MI). The first MetOp Second Generation satellite is expected to be launched in 2020.

In addition, a Sentinel-5 Precursor mission is being developed to reduce data gaps between Envisat, in particular the Sciamachy instrument, and the launch of Sentinel-5. Sentinel-5 Precursor is scheduled to be launched in June 2015. As a joint initiative between ESA and the Netherlands, the mission will comprise a satellite and a UVNS instrument called Tropomi.

The Sentinel-4 and -5 missions will provide information on atmospheric variables in support of European policies. Services will include the monitoring of air quality, stratospheric ozone and solar radiation, and climate monitoring.

3.2.5 Jason-CS

The Jason-CS satellites will form the space component of the Jason Continuity of Service mission, within the GMES Space Component Segment 3. Jason-CS will extend high-accuracy ocean topography measurements well into the 2020s. The project is currently in Phase B1. The Satellite Design Review, kicked-off during the last quarter of 2012, was completed during the first quarter of 2013. The review is considered to be very successful, with participation of all of the partner agencies (EUMETSAT, CNES, NOAA and NASA/JPL), as well as many in-house ESA specialists.

The altimeter will employ digital architecture and the simultaneous measurement in the advanced SAR mode as well as in the conventional pulse-width limited mode. The microwave radiometer will be an enhanced version of JPL's instrument used on Jason-2 and Jason-3. This radiometer will be accompanied by a new high-frequency radiometer, whose high spatial resolution will complement the high spatial resolution of the SAR altimeter – this instrument is a new concept and not yet demonstrated to be feasible technically, scientifically and financially, so it remains to be confirmed as a payload element for the C/D Phase.

The GNSS receiver optimised for Precise Orbit Determination will be an instrument derived from the Sentinel-3b GNSS receiver, while the request, by EUMETSAT's member states, for a Radio Occultation (RO) capability will be satisfied by a variant of JPL's TriG Receiver, optimised for RO. Additionally a DORIS Receiver and a Laser Retro-Reflector Array, also from JPL, will be embarked. It should be noted that all of the JPL payload complement are funded by NOAA.

The schedule is under review at present, as the development schedule is in advance of the need date for the mission, given that the preceding Jason-3's launch has been delayed to March 2015.

3.3 The ESA Climate Change Initiative (CCI)

Combined satellite and *in situ* data archives can be used to produce data products for climate monitoring, modelling and prediction. To this end, the ESA Climate Change Initiative (CCI) was launched in 2009. The CCI has been created to address the GCOS Essential Climate Variable (ECV) requirements for satellite datasets and derived products. Its principal objective is "*to realize the full potential of the long-term global Earth Observation archives that ESA together with its Member states have*

established over the last thirty years, as a significant and timely contribution to the ECV databases required by the UNFCCC". The CCI focuses on the exploitation of data records primarily, but not exclusively, from past ESA satellite missions, for the benefit of climate monitoring and climate research. It complements existing efforts in Europe (e.g. led by EUMETSAT through the CM SAF) and internationally (e.g. under the umbrella of SCOPE-CM) which both focus on datasets characterizing meteorological aspects of the climate system.

A competitive tender for proposals to generate climate-quality products addressing a first set of ECVs was released by ESA in the last quarter of 2009. As part of CCI phase 1, between August and December 2010, ten ECV-specific projects were launched (hereafter: ECV_cci projects). The ECV_cci teams are consortia of between six and 15 European partner institutions, including academia, government agencies and system engineering companies.

In addition to the ten ECV_cci teams, a CCI Climate Modelling User Group (CMUG) consisting of major European climate modelling centres has been set up. At all stages of the program, its task is to provide a climate modelling perspective on the CCI, and to test datasets generated in the CCI within their models. CMUG also aims to provide an interface between the CCI and the international climate modelling community. The existence of CMUG emphasizes the important role of climate modelling as a primary user of CCI output. Finally, a CCI project on sea ice was launched in January 2012, together with two other projects dedicated to ice sheets and soil moisture, though funded under a different scheme.

ESA CCI projects, science leaders and corresponding ECV product needs identified in GCOS-107 (2006) and GCOS-154 (2011).

CCI Project	Science Leader	GCOS-107 Product
Cloud	Deutscher Wetterdienst, Germany (*R. Hollmann*)	A.4
Ozone	BIRA-IASB, Belgium (*M. van Roozendael*)	A.7
Aerosol	DLR, Germany / FMI, Finland (*T. Holzer-Popp / G. De Leeuw*)	A.8
GHG	University of Bremen, Germany (*M. Buchwitz*)	A.9
Sea Level	LEGOS-CNES, France (*A. Cazenave*)	O.2
SST	University of Reading, UK (*C. Merchant*)	O.3
Ocean Colour	Plymouth Marine Laboratory, UK (*S. Sathyendranath*)	O.4
Sea Ice*	Nansen Environmental and Remote Sensing Centre, Norway (*S. Sandven*)	O.5
Glaciers	University of Zurich, Switzerland (*F. Paul*)	T.2.1
Ice Sheets*	Danish Technical University, Denmark (*R. Forsberg)*	T.4
Land cover	Université Catholique de Louvain, Belgium (*P. Defourny*)	T.5.1
Fire	University of Alcala, Spain (*E. Chuvieco*)	T.9
Soil Moisture*	Technical University, Wien, Austria (*W. Wagner*)	T.11
Climate Modelling User Group	UK Met Office Hadley Centre (*R. Saunders*)	-

* Shaded boxes denote CCI Projects initiated in January 2012.

Most CCI project teams have now implemented their prototype production chains and are in the process of generating the multi-annual global data ECV sets which are the primary output of this program element. The data products will span the period 1992-2011. Several projects are also progressing on additional option packages which include further validation activities, bring in additional expertise and data sources, and activate cooperative work-packages between different ECV project teams.

The three ECV projects which kicked-off in January 2012 are completing the round robin algorithm inter-comparisons and will start setting up their prototype processing chains in the latter part of 2013.

The CCI project teams are continuing to make scientific publications in high impact scientific journals. These report progress on the retrieval algorithms resulting from the round robin exercise, as well as new results related to climate process and trends, based on analysis of the ECV data sets being generated in CCI.

CCI teams have submitted numerous abstracts, reporting progress made on diverse topics addressed within CCI, to the ESA Living Planet Symposium to be held in September 2013 in Edinburgh.