

## **EUMETSAT CONTRIBUTIONS TO CLIMATE MONITORING INCLUDING PEER REVIEW OF CLIMATE DATA RECORDS**

In response to CGMS action/recommendation 38.03

The document provides information on activities of the EUMETSAT Secretariat for the generation of Climate Data Records (CDRs) within its distributed ground segment. This includes progress in the development of the reprocessing facilities and an update of reprocessed data at the Central Application Facilities (CAF) at its Headquarters. It also highlights EUMETSAT's role in related international Climate Monitoring activities.

Cornerstones in 2010/2011 were the progress in the establishment of dedicated reprocessing facilities at CAF, progress in GSICS and SCOPE-CM, the start of the EU FP7 ERA-CLIM project and the support to ESA-CCI. In addition the EUMETSAT Satellite Application Facilities Network (SAFs) offers an extended commitment with respect to the generation of Climate Data Records (CM SAF and other SAFs).

EUMETSAT also participated in international discussions on data set assessments and acknowledges the importance of those for establishing information on the reliability of existing and upcoming Climate Data Records. EUMETSAT supports assessment work within the SAF network and the CAF and also proposes steps to include data set assessments as mandatory item into the data set release process in SCOPE-CM.

Action/Recommendation proposed:

**Recommendation I:** CGMS members to consider ways to publish Climate Data Records employing unique identifiers such as the DOI or OID systems.

**Recommendation II:** CGMS members to consider contributions to SCOPE-CM activities in particular to surface albedo and AMV data sets.

**Recommendation III:** CGMS members to actively support scientific activities within the framework of data set assessments performed by WCRP, such as the GEWEX RP water vapour assessment.

## **EUMETSAT Contributions to Climate Monitoring including Peer Review of Climate Data Records**

### **1 INTRODUCTION**

For the analysis of climate variability as well as climate and environmental change detection, member state agencies and scientists require reliable data sets collected over decades. Operational meteorological satellites have the capability to provide those long-term measurements from space.

As stated in its convention, EUMETSAT is committed to the contribution to the operational monitoring of the climate and the detection of global climate change.

Noting that a number of important initiatives making use of space data in support to Climate Monitoring, were starting in Europe and globally, EUMETSAT Secretariat started in 2008 a dialogue with its Member States in order to precisely define the role of the organisation in that area.

In 2010, the EUMETSAT Council approved the EUMETSAT Climate Implementation Plan (EUM/C/70/10/41) that contains three implementation phases. Phase I covers the 2010-2011 timeframe and mainly aims at establishing the ongoing climate activities in EUMETSAT in a more structured way, with the necessary level of coordination with Member States and with European and Global initiatives. Within Phase I also an update of the Implementation Plan, involving new activities in the 2012-2017 timeframe will be prepared.

This document provides information on current activities of the EUMETSAT Secretariat that make EUMETSAT more efficient in creating CDRs within its distributed ground segment. The document also describes progress in the development of the reprocessing facilities at the CAF and highlights EUMETSAT's role in international activities.

### **2 ACTIVITIES AT EUMETSAT LEVEL**

The approval of the Climate Monitoring Implementation Plan triggered developments in several areas of the organisation, with the aim to optimise coordination and cooperation at all relevant levels (SAF Network, Central Application Facility (CAF) and Secretariat) and to build up the reprocessing facilities to implement the elements of the Implementation Plan.

#### **2.1 Working Group on Data Set Generation through Reprocessing**

In 2009 a "*Working Group on Data Set Generation through Reprocessing*" was formed with the aim to coordinate the contributions of the SAFs and Central Application Facilities (CAF) as well as to assess the user needs and capabilities.

Additionally, an overall (SAF and CAF) reprocessing plan was established and maintained after the second meeting of this Working Group.

The last meeting of the Working Group was held in October 2010 in the context of the SAF CDOP-2 preparation workshop. The initial EUMETSAT Reprocessing Plan was consolidated allowing support of the planning of related CDOP-2 commitments. The Working group as well further elaborated on a mechanism for registering of produced CDRs by using for instance the digital object identifier (doi) system that is used in science literature. EUMETSAT Secretariat will prepare a draft concept paper for the next WG meeting.

## **2.2 SAF Network**

Through their CDOP-2 proposals, covering the period 2012-2017, the SAF Network is anticipating an extended commitment with respect to the generation of Climate Data Records (CM SAF and other SAFs), The proposal evaluation highlighted the relevance of these SAF contributions as well as the importance to integrate the activities and products into the overall EUMETSAT Climate Monitoring Strategy.

In particular, the following elements are planned by the SAF Network as CDOP-2 activities towards CDR generation:

Processing of data from US missions such as AVHRR, HIRS, MSU, AMSU-A, AMSU-B, MHS, SSM/I, SSMIS, SSM/T2 in addition to EUMETSAT data. (except SSM/I, SSMIS and SSM/T2 all mentioned sensors are part of the Initial Joint Polar System (IJPS) of NOAA and EUMETSAT);

EUMETSAT CAF plans to generate and provide FCDRs for the IJPS instruments in close collaboration with NOAA Climate Data Record Program and the SAF Network during CDOP-2. Related work will be coordinated within the Working Group on Data Set Generation through Reprocessing;

Some SAFs are also planning to use ESA instrument data for climate data records generation, e.g., ERS with ASCAT or GOME/SCIAMACHY with GOME-2.

## **2.3 Central Application Facilities**

In the second half of 2010 a new procedure for the generation of Climate Data Records (CDR) at CAF was developed. The main reasons to do this were:

CDR generation needs to follow GCOS guidelines as close as possible. That includes a peer review mechanism prior to the release of a CDR from the EUMETSAT Data Centre;

The procedures for CDR generation within the distributed ground segment of EUMETSAT should be similar, i.e., the CAF and the SAFs should follow the same principles;

There is a need for a clear product requirements description for a meaningful validation. To achieve this, a document already established in the SAF context, the Product Requirements Document (PRD), has been introduced into the CAF as well;

There is a need for a description of appropriate documentation for users. The new procedure describes what user documents, e.g., ATBDs, validation report and user guide, need to be available before the release of a data set to the public.

Since CGMS-38 the implementation of adequate re-processing facilities for EUMETSAT GEO and LEO spacecrafts has progressed and a reprocessing of SEVIRI image data has been performed.

The Reprocessing Image Processing Facility (RIMPF) was build to reprocess the SEVIRI image data of Meteosat-8 and 9 to consistently apply the new radiance definition introduced in 2008 to all Meteosat Second Generation data. The facility passed the Operational Readiness Review in February 2011 and started the reprocessing of the image data. The reprocessing of the operational SEVIRI image data has been finished in August 2011. Currently, it is explored if also commissioning phase data from the SEVIRI on Meteosat-8 for the year 2003 can be reprocessed. This is in particular interesting because these data cover one of the most severe heat waves over Europe in July 2003.

The Reprocessing Meteorological Product Extraction Facility (RMPEF) was designed to reprocess Meteosat First Generation data and is currently used to produce Geostationary Surface Albedo (GSA) as well as Atmospheric Motion Vector (AMV) and Clear Sky Radiance (CSR) products for the Indian Ocean Data Coverage (IODC) and the two phases of the Meteosat Atlantic Data Coverage (ADC and XADC). The MTP albedo product reprocessing covers the following spacecrafts and observation periods:

Spacecraft	Service	Period	Completion
Meteosat-7	IODC Service	2006- 2010	100%
Meteosat-3	ADC Service	1991-1993	50 %
Meteosat-3	XADC Service	1993-1995	0 %

RMPEF will also be used to reprocess AMVs and CSRs from Meteosat Second Generation based on the reprocessed images from the RIMPF to fulfil the commitments of the EU FP-7 ERA-CLIM project. Current planning includes the implementation of the MSG framework and application software until the end of 2011 and to perform the processing in the first half of 2012.

A new activity introduced after user requests at the GSICS workshop during the EUMETSAT conference in Cordoba 2010 is a re-analysis of the complete MVIRI/SEVIRI IR and WV channel radiance time series (1982-2010).

It was envisaged to use an inter-calibrated time series of HIRS observations to homogenise the Meteosat measurements and to bring them to the HIRS level. The inter-calibrated HIRS data are provided by NOAA-NCDC (in the SCOPE-CM

framework) and cover the time 1979-2010. This re-analysis utilises the collocation methodology developed within GSICS for IASI and SEVIRI.

The consistency of the inter-calibrated Meteosat level-1.5 product will be proven by employing the ARSA radiosonde data base from LMD, France, satellite overlaps from 0° and IODC Meteosat coverage, and potentially at a later stage results from the observation feedback archive of the ERA-CLIM reanalysis project. The development and implementation started in 2011 and the production of the data set is envisaged for the end of 2012.

For the EU FP-7 ERA-CLIM project on the preparation of the next European Reanalysis at ECMWF a reprocessing facility for EPS Metop data (R-EPS) has been built up in the first half of 2011 and was declared operational in August 2011.

The first reprocessing activity on the facility will be a second release of the GOME-2 level 1 data (GOME-2-R2) for the period 2007-present. The main purposes of the GOME-2 reprocessing are:

- Removal of any spurious effects on the level 1B data quality, of processor and auxiliary-data changes during January 2009 to January 2011.

- Consistent evaluation of the long-term degradation of the Metop-A GOME-2 instrument.

- Development of an offline radiance and irradiance degradation correction matrix from a consistent data-set to be used to correct level-1B data for the long-term instrument degradation observed.

- Provision of a consistent data-set of the GOME-2 Metop-A mission to the users with the actual product format, which includes the updated versions of cloud parameters FRESCO (FRESCO+), as well as additional polarisation measurement device (PMD) data and geo-location reference data for PMD read-outs. The latter will significantly improve the information content of reprocessed GOME-2 data products on atmospheric scattering (e.g. for aerosol optical properties retrievals) for the years 2007 to 2010.

The GOME-2 reprocessing has been started in the last week of August 2011 and will be finalised at the end of 2011.

Further implementations of application software on the REPS system for the ERA-CLIM project (see section 5.6) committed products AVHRR polar winds, Radio Occultation bending angles from CHAMP, GRACE, GRAS and COSMIC satellites as well as ASCAT Level-1b and soil moisture are under preparation.

### **3 EUMETSAT Activities at International Level**

#### **3.1 Global Climate Observing System (GCOS)**

EUMETSAT further supported GCOS by participation in the update of the satellite supplement of the GCOS Implementation Plan in January 2011. The updated document GCOS-107 will contain for the first time tabulated quantitative requirements for the Essential Climate Variables. In addition, ECVs such as water vapour and cloud properties are better described due the use of sub-products, e.g,

for water vapour three instances; total column, profiles and upper tropospheric humidity were chosen.

### **3.2 Global Satellite Inter-calibration System (GSICS)**

EUMETSAT supports the international efforts to coordinate inter-calibration activities within the WMO Global Satellite Inter-calibration System (GSICS) with the overall goal to create an operational system that monitors, evaluates and corrects the calibration of the global meteorological satellite observing system in a coherent and systematic manner. This is an essential pre-requisite for reliable long-term, global climate monitoring.

During 2010 GSICS continued to develop and grow. By the time of the GSICS User's Workshop in September, four products had been released in "Demonstration Mode", allowing feedback from beta-testers. These include GSICS Bias Monitoring, Near-Real-Time and Re-Analysis Corrections for the infrared channels of three GEO imagers (using IASI/AIRS as inter-calibration references), as well as the PATMOS-X calibration products for the AVHRR series on LEO satellites. Members of the GSICS Research Working Group are currently reviewing various methods for the inter-calibration of the solar channels of GEO imagers to complement these products, and aim to integrate several of these to develop GSICS products during 2011, while pursuing others for validation purposes.

A microwave sub-group has also been formed to coordinate the activities of various groups involved in the inter-calibration of microwave instruments, aligning them with the requirements of users, and encouraging and assisting them in submitting products to be certified as GSICS compliant. GSICS have also welcomed new members from JAXA, ISRO, Roshydromet, USGS and official observers from ESA and CEOS WGCV.

The above described re-analysis of the MVIRI/SEVIRI IR and WV channel radiance time series has been introduced in 2010 to GSICS as a new activity. First results and further needs towards GSICS will be presented at the EUMETSAT Meteorological Satellite Conference in Oslo, Norway in early September 2011.

### **3.3 Sustained and Coordinated Processing of Environmental Satellite Data for Climate Monitoring (SCOPE-CM)**

The WMO network for Sustained and Coordinated Processing of Environmental Satellite Data for Climate Monitoring (SCOPE-CM) provides an international basis for the provision of high quality long-term data sets of what GCOS has defined as Essential Climate Variables using observations from space.

EUMETSAT is hosting the secretariat of this WMO initiative and is actively involved in all five SCOPE-CM pilot projects through its CAF and CM SAF.

At the fifth SCOPE-CM Executive Panel meeting in Asheville, USA, in October 2010 the SCOPE-CM members developed the latest version of the so called Climate Information Flow Diagram (shown below), which is fully aligned with the main conceptual elements of the EUMETSAT Climate resolution. This facilitates a smooth integration of EUMETSAT’s climate activities into SCOPE-CM.

As a new term, the “Interim Climate Data Record (ICDR)” has been introduced, which allows the notification of data records with shorter temporal length, that don’t fulfil yet the requirements for climate variability and trend detection. The ICDRs have significant higher quality as the related NRT data products. The higher quality is induced by corrections, e.g. from GSICS, that can be introduced to radiance data with low or medium latency or by applying the same algorithm over a complete time period.

As an important progress, the implementation of the EUMETSAT/JRC algorithm for surface albedo from geostationary satellites (GSA) at NOAA/NCDC for GOES has to be highlighted. With this milestone, this EUMETSAT led pilot project now includes processing of satellite data at three operational agencies (EUMETSAT, JMA and NOAA) and 5 geostationary orbits. The development of a quasi-global long-term Level 3 climate data set based on these processing activities will be the next major milestone for this SCOPE-CM activity.

SCOPE-CM was further strengthening its partnership with the GEWEX Radiation Panel in a second joint meeting in Tokyo, in late August 2011.

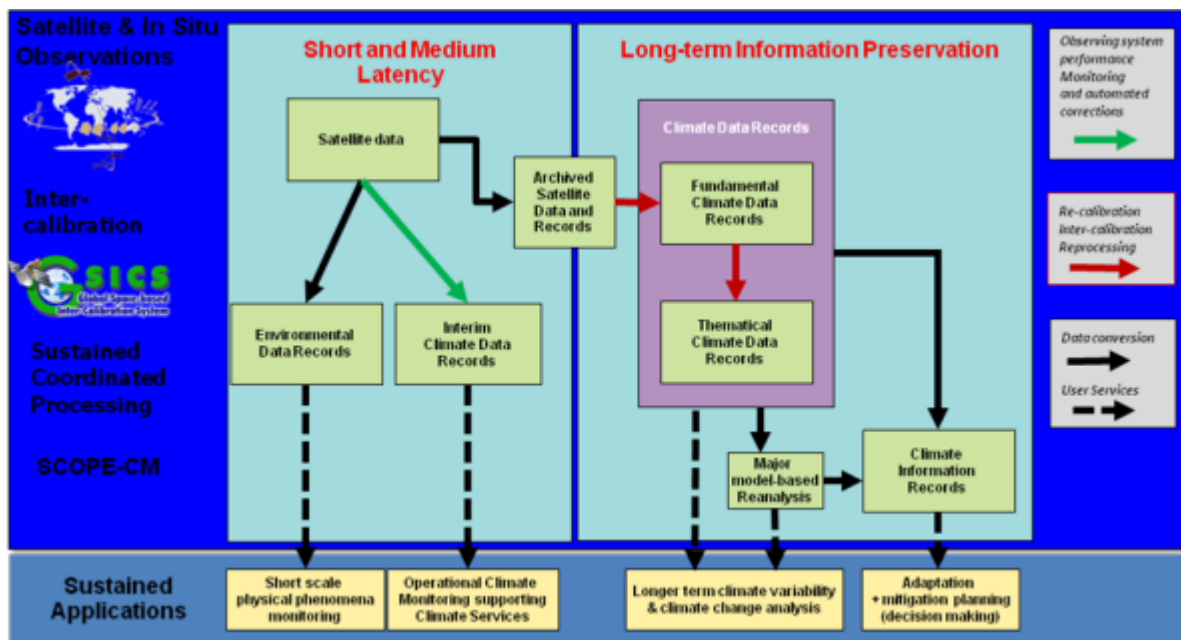


Figure 1 – Climate Information Flow Diagram

### 3.4 World Climate Research Programme (WCRP)

EUMETSAT supported the organisation of two workshops in collaboration with the GEWEX Radiation Panel (GRP) and the WCRP Observation and Assimilation Panel (WOAP). The first entitled GEWEX workshop on long term water vapour data sets and their quality assessment took place at ESA/ESRIN, 8-10 March 2011 ([http://earth.eo.esa.int/workshops/WVP\\_Assessment2011](http://earth.eo.esa.int/workshops/WVP_Assessment2011)). It has structured an assessment of water vapour data sets covering the GCOS ECVs total column content, temperature and humidity profiles and Upper/Free Tropospheric Humidity. High ranked specialists mainly from the US and Europe including many scientists from various SAFs participated in this workshop. It is planned that the CM-SAF forms a technical centre for this assessment using resources within the SAF CDOP-2 phase. Strong support for this assessment is also provided by NOAA/NCDC and ESA.

The WOAP workshop entitled Evaluation of Satellite-Related Global Climate Datasets was held at ESA/ESRIN, 18-20 April 2011. It assessed how existing data sets for the ECVs cloud properties, radiation budget, sea surface temperature, sea ice, near-surface ocean wind, FAPAR and soil moisture followed the GCOS guidelines, provide suitable uncertainty estimates, e.g., for global climate modellers, and look into methodologies to assess the maturity of CDRs. EUMETSAT was part of the Scientific Committee and many SAF scientists working in the field of climate monitoring participated.

### 3.5 CEOS Working Group Climate

In 2010, at the 25th Committee on Earth Observation Satellites (CEOS) Strategic Implementation Team (SIT) meeting members have agreed to create a working group on climate at CEOS level. An ad hoc group met first on 22 and 23 July 2010 at ESA's Climate Office at the Harwell Centre, Didcot, UK to discuss its Terms of Reference and its future work. The group shall have the responsibility to keep a high level overview on the generation of Climate Data Records in satellite agencies.

Recent developments include:

The group was formally established at the 24th Plenary meeting of CEOS, in Rio de Janeiro, Brazil, on 13-14 October 2010 with EUMETSAT as full member. Mark Dowell, EU-JRC and John Bates, NOAA-NCDC were nominated as working group Co-Chairs.

The group had a first meeting in May 2011 at ESA in Frascati, Italy where it discussed its contributions to the sans logo document on architecture for space-based climate monitoring, started a discussion on how best an inventory of existing GCOS ECV generation activities and underlying satellite data could be done and established links to the other initiatives such as GSICS and SCOPE-CM.



### **3.6 Support To Specific Projects**

#### **a. EU FP7 European Re-Analysis of Global CLIMate Observation (ERA-CLIM) Project**

In support to global re-analyses EUMETSAT participates in the ECMWF led European Union FP7 ERA-CLIM project. EUMETSATs contribution to this project will mainly be the reprocessing of existing EUMETSAT satellite data, in particular Meteosat Second Generation (MSG), radio occultation and the derivation of a consistent total ozone data record with GOME-2 and IASI data. The reprocessing of the GRAS radio-occultation data will further be supported by reprocessing data from other radio-occultation missions, where possible. In addition other Metop-A as well as Meteosat First Generation data will be reprocessed as required and allowed by available resources.

The project started officially at 1 January 2011 and the kick-off meeting was successfully held at ECMWF on 16 February 2011. For EUMETSAT activities see section 2 of this report.

#### **b. EU FP7 EUGENE Project**

The main objective of the EU FP7-funded project EUGENE is to foster collaboration between pan-European organisations in the field of earth observation, with a particular focus on Climate, Water and Disasters. DLR leads the project and EUMETSAT is responsible for the Climate Work packages.

Following the climate experts workshop, held in April 2010 at EUMETSAT HQ (involving also EUMETNET and scientists from EUMETSAT member states), a Status Quo Report was finalised together with a Workshop Report (available at <http://www.eugenefp7.eu/documents.htm>). From this source documentation, a first draft of the main climate strategic issues (findings and recommendations) was generated. These climate strategic issues will ultimately be combined within an overall EUGENE Strategic Issues Document that will cover Climate, Water and Disasters.

In terms of outreach, EUMETSAT presented the main interim climate strategic outcomes at an EC seminar in Brussels in September 2010 and at the GEO European Projects Workshop in London in February 2011. A presentation was also delivered to the GEO High-Level Working Group in Brussels on 16 March 2011.

The vast majority of the EUMETSAT activities in this project have now been completed and this 2-year project is due to finish in October 2011.

### **c. ESA Climate Change Initiative (CCI)**

Several projects of the ESA Climate Change Initiative (all started in 2010) are in need of EUMETSAT satellite data, in particular, from those sensors where EUMETSAT provides operational continuity for ESA instruments such as GOME and the ERS scatterometer. In addition, the AVHRR as precursor for MERIS and Sentinel 3 satellites, IASI for trace constituents, temperature, humidity, surface emission and cloud parameters as well as the geostationary MVIRI and SEVIRI data for diurnal cycle analysis of clouds are of high interest for ESA CCI.

EUMETSAT is committed to re-process and document its data that will enter the CCI according to the needs of the CCI. In particular the above described reprocessing of the GOME-2 level 1 data is a key contribution to the ESA CCI Ozone project. EUMETSAT expects feedback on the quality and usability of FCDRs from the ESA CCI consortia.

EUMETSAT regularly liaise with ESA on the mutual support of its climate activities, the last meeting took place in October 2010 at ESA Harwell Centre.

## **4 Peer Review Process and Data Set Assessment**

The quality assessment of Climate Data Records was one of the top discussion themes at many meetings of WCRP bodies such as WOAP and also at the CDR generation activities such as SCOPE-CM. Assessments are very important to find out and communicate which existing CDRs are reliable for the use in climate science and

for tasks of public administrations. The WOAP workshop mentioned in section 3.4 took this matter up and discussed it with leading experts in all GCOS ECV domains (atmosphere, oceanic and terrestrial).

It is important to note the respective roles of peer review and data set assessment. A peer review process is used during the publication of a journal article on a produced data set and in review procedures as performed by EUMETSAT prior to the public availability of a data set. Such a peer review assesses the correctness of the provided article or user documentation and occasionally also the quality of the data set through an own examination by the reviewer.

An assessment of a data set in the sense of the GEWEX Radiation Panel is more an expert opinion on existing data sets derived from a description, fair comparison of data sets and analysis of the comparison results. The assessment of data sets can be supported by the application of standard measures as the Maturity Index developed at NOAA. However, this cannot substitute a thorough scientific analysis of data sets by experts.

EUMETSAT sees the need of assessment work and strongly supported the WOAP workshop earlier this year. It also participates and supports ongoing assessments in the framework of the WCRP GEWEX RP. The EUMETSAT Secretariat has encouraged in particular the Climate Monitoring SAF to play a leading role in the support of assessments and this is now planned for e.g., the assessment of water vapour products.

SCOPE-CM is also fully acknowledging the role of data set assessments and included them in its updated structure for the second phase as a mandatory element before a SCOPE-CM CDR can become an internationally accepted data set. Discussions with scientific WCRP bodies on how assessments can be performed in the future will be continued at the next joint SCOPE-CM/GEWEX-RP meeting in Tokyo in August 2011.

## **5 CONCLUSIONS**

Following the Council Resolution on EUMETSATs support to Climate Monitoring in 2009 and the approval of the Climate Implementation Plan in 2010(EUM/C/70/10/DOC/41), the EUMETSAT Secretariat continued its activities to further shape its profile in climate and to maintain and improve its related involvement at various levels.

Cornerstones in 2010/2011 were the progress in the establishment of dedicated reprocessing facilities at CAF, progress in GSICS and SCOPE-CM, the start of the ERA-CLIM project and the support to ESA-CCI.

In addition, through their CDOP-2 proposals, the SAF Network is offering an extended commitment with respect to the generation of Climate Data Records (CM SAF and other SAFs).

EUMETSAT participated in international discussions on data set assessments and acknowledges the importance of those for establishing information on the reliability of existing and upcoming Climate Data Records. EUMETSAT supports assessment work within the SAF network and the CAF and also proposes steps to include data set assessments as mandatory item into the data set release process in SCOPE-CM.