

## **EUMETSAT Activities on Climate Monitoring**

In response to CGMS action A37.08/recommendation R37.05

The document provides information on the formal establishment of an Implementation Plan for the generation of Climate Data Records (CDRs) and on organisational activities of the EUMETSAT Secretariat that make EUMETSAT more efficient in creating CDRs within its distributed ground segment. The document also gives comments on the maturity index for climate data records under development by NOAA, as well as on the Guideline for the Generation of Satellite-based Datasets and Products Meeting GCOS Requirements (GCOS-128). The document also highlights EUMETSAT involvement in international activities helping to reach GCOS goals. It also gives further information on the development of the reprocessing facilities at the Central Application Facility as well as a very brief outlook into the future.

Cornerstones in 2010 were the decisions on the MTG program that brought the Meteosat observation potentially to a time series of 50 years for those observations that were already available on the First Generation satellites and on the EUMETSAT Implementation Plan in Support to Climate Monitoring that provides a formal framework of coordination for the generation of Climate Data Records in the near future. The establishment of this and the organisational changes went hand in hand with progress in the establishment of dedicated reprocessing facilities at EUMETSAT that will now be used to support the EUMETSAT SAFs, SCOPE-CM, ESA-CCI and the ERA-CLIM project. In particular the latter project once again highlights the importance of EUMETSAT data for global NWP model-based reanalysis.

## **EUMETSAT Activities on Climate Monitoring**

### **1 INTRODUCTION**

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. GCOS requires reliable data sets collected over decades that are suitable for the analysis of climate variability as well as climate and environmental change detection. Operational meteorological satellites have the capability to provide those long-term measurements from space.

The 2010 EUMETSAT Council decision on the establishment of the MTG satellite program (see EUM/C/70/10/LOD) has enlarged the horizon for climate scale observations from geostationary orbit up to 50 years for those observations that already were part of the Meteosat First Generation satellites. In addition the Metop instruments shared with NOAA also establish climate scale series that will reach 40 years within EUMETSAT's EPS program.

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.

The document provides information on the formal establishment of an Implementation Plan for the generation of Climate Data Records (CDRs) and on organisational activities of the EUMETSAT Secretariat that make EUMETSAT more efficient in creating CDRs within its distributed ground segment. The document also gives comments on the maturity index for climate data records under development by NOAA, as well as on the Guideline for the Generation of Satellite-based Datasets and Products Meeting GCOS Requirements (GCOS-128 and the update GCOS-143). In addition the document also highlights international activities and gives further information on the development of the reprocessing facilities at the EUMETSAT Central Application Facility as well as a very brief outlook into the near future.

### **2 ESTABLISHMENT OF A CLIMATE MONITORING RESOLUTION AND IMPLEMENTATION PLAN**

After several iterations with Member States, the EUMETSAT Council, at its 67th Meeting on 30 June – 1 July 2009, adopted a Resolution (EUM/C/67/09/Res. VIII) on EUMETSAT's activities in support to Climate Monitoring. With this resolution EUMETSAT's remits in the context of climate monitoring, were substantiated, recalling that the focus should be:

Taking into account the climate specific requirements in the operations of the current EUMETSAT satellites and the planning for the future programs, and on the generation of Fundamental and Thematic Climate Data Records (long-term homogeneous data sets), both through the EUMETSAT Central Application Facility and the EUMETSAT Satellite Application Facility (SAF) network.

In that Resolution, Council tasked the EUMETSAT Secretariat with the elaboration of an Implementation Plan and recommended to develop it in close coordination with Member

States. This coordination was to be achieved through the creation of a Working Group involving Member States.

This Implementation Plan (EUM/PPS/DOC/09/0168, V5) with dedicated tasks addressing the targets set by the Council Resolution was established and agreed by the EUMETSAT Council in June 2010 (EUM/C/70/10/LOD).

## 2.1 Implementation Plan Elements

Major elements of the Implementation Plan with respect to activities and tasks of EUMETSAT to support the necessary monitoring and research activities are:

The existing instruments that can be used to derive information on the climate system;

A definition process for new EUMETSAT programs that seriously takes into account specific needs for climate monitoring following the GCOS climate monitoring principles;

An application ground segment - consisting of its Central Application Facilities and the SAFs – that continuously generates on an operational basis products of climate relevant parameters and has the capability for the generation and preservation of homogeneous long-term data sets from satellites. It already provides for more than two decades data in support to the International Satellite Cloud Climatology Project (ISCCP) and the Global Precipitation Climatology Project (GPCP). Furthermore, reanalysis projects of ECMWF and JMA have been and will be successfully supported.

Participation in 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.

Support and contributions to the recently established WMO network for Sustained and Coordinated Processing of Environmental Satellite Data for Climate Monitoring (SCOPE-CM) that 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.

Support and contributions to the ESA Climate Change Initiative program.

## 2.2 Implementation Plan Phasing

The tasks and activities are structured in three phases:

**Phase I** will cover the **2010-2011** timeframe. This build-up phase will mainly aim 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. This phase will mostly rely on existing activities and limited additional resources will be sought. If this is the case, these additional resources will mainly come from third-parties. Phase I will also be used to prepare an update of the Implementation Plan, involving new activities in the 2012-2017 timeframe.

**Phase II** will cover the **2012-2017** timeframe. In this timeframe, the Implementation Plan will ensure that activities identified during Phase I are consolidated and sustained. In this phase, EUMETSAT will also prepare for the optimal use of MTG data in Climate-related areas. Finally, this period will embrace the implementation of the Second Continuous Development and Operations Phase of the SAF Network (CDOP-2), thus ensuring optimal coordination between EUMETSAT and its SAF network on Climate-related issues and enabling the mobilisation of dedicated financial resources to support these activities.

**Phase III, beyond 2017**, will correspond to the time where data from all new EUMETSAT mandatory programmes (MTG and EPS-Second Generation) should be available. At this time, the objective is to have a portfolio of sustained Climate-related activities in EUMETSAT with their corresponding funding arrangements.

### **2.3 Implementation Plan Monitoring and Evolution**

The progress of the committed tasks in the Climate Monitoring Implementation plan will be regularly monitored and the reported to EUMETSAT Delegate Bodies on a annual basis, beginning with Spring 2011.

Updates of the Implementation Plan will be proposed by the Secretariat for endorsement by EUMETSAT Council when necessary. The first major update is expected in second half of 2011, when the CDOP-2 proposals of the SAFs will be approved.

## **3 ORGANISATIONAL ACTIVITIES**

The discussions and results of the interactions with Member States on EUMETSAT Climate Monitoring activities 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 and Secretariat).

Among other things the “*Working Group on Data Set Generation through Reprocessing*” elaborates on mechanisms for registering of produced CDRs by using for instance the digital object identifier (doi) system that is used in science literature. The big advantage of using such a system is that it helps to increase the acceptance of the data sets as legitimate, citable contributions to the scientific record. It makes it easier to identify, find, access, verify, cite, reuse and track impact of data sets in a global environment. A prerequisite to the success of this system is a high level of quality assurance for the data and the associated metadata. Thus, a peer review process for the CDRs created at the SAFs and the CAF and cross comparisons with other agencies data sets are mandatory elements.

### **3.1 EUMETSAT SAF Network**

A SAF Network Workshop was held 14-15 May 2009 in Darmstadt dedicated to the reprocessing of satellite data. The meeting was attended by representatives from the concerned SAFs, EUMETSAT Secretariat as well as ECMWF. As a consequence of the workshop 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.

During 2010 the SAF network is planning for the second Continuous Development Operations Phase (CDOP-2). The EUMETSAT Council has encouraged all SAFs to consider contributions to the climate theme in this new SAF phase. Preparation workshops with representatives from the SAFs revealed the wish of the SAFs to collaborate much closer with the CAF on the generation of Fundamental and Thematic Climate Data records as well as on the provision of timely climate information for NMSs. A consequence of this might be an increased number of organisational and processing tasks within the EUMETSAT Secretariat.

### **3.2 EUMETSAT Central Application Facilities**

The restructuring of the Meteorological Operations Division in EUMETSAT's Operations Department resulted in the creation of a new section dedicated to the generation of Climate Monitoring products. Within this section the CAF data set generation activities are coordinated.

### **3.3 EUMETSAT Secretariat**

To achieve an optimal level of planning and realisation of as well as public awareness for EUMETSAT climate data products and activities in connection to an efficient use of resources, the work of the "*Steering Group on the Effective Exploitation of Climate Data*" at EUMETSAT Secretariat, initially established in 2006, will be continued with updated Terms of References reflecting the newest developments of climate activities within the EUMETSAT ground segment. The Steering Group ensures the cross-departmental coordination and information exchange and also coordinates the coherent presentation/visibility of EUMETSAT towards its users and the general public.

## **4 MATURITY INDEX**

The maturity index holds a great potential for the data set producers to quickly analyse the status of a produced data set. It also has a great potential to function as a support tool for climate scientists and environmental agencies that are in search of a product for a specific application. It is easy to apply and tests of its application have been successfully done within the SCOPE-CM initiative.

The maturity index needs further development, in particular, a clearer formulation of some of the matrix entries and the addition of categories can be imagined. For instance a self assessment should include an assessment of how a data set production followed the GCOS guidelines.

A maturity index is one measure, but other indices (such as time series of the uncertainty in the global mean of each ECV) that can be readily communicated to the broad user community should also be considered. A maturity index is an effective measure of how well quality assurance processes (such as the GCOS guidelines) have been followed in the production of a dataset, but it does not give information on the actual quality of the dataset. Indicators, such as a time series of the uncertainty of the global mean, should be established to standardise the characterisation of dataset quality. A workshop initiated by the WCRP WOAP (see 6.1) is targeting to apply the maturity index to a variety of ECV products and to develop a kind of standard metric for data sets that can easily communicate progress in the data set quality.

## 5 GCOS GUIDELINE ON THE GENERATION OF DATASETS AND PRODUCTS

The GCOS guidelines lay the foundation for an international more homogeneous understanding of what is required to successfully produce a CDR that is widely accepted by the user community. The 12 needs given can clearly be understood and followed as well. At EUMETSAT many of those guidelines have already been followed in setting up complete lifecycles for climate data records including a peer review process and a comprehensive documentation. EUMETSAT will continue to adhere to those guidelines as much as feasible in the future. In particular the assessment of data sets by internationally recognised groups is seen as a mandatory task.

Critical appears the need number 9 on the timeliness of data release to enable monitoring. It is not ad hoc clear if this related to climate change monitoring with results presented in IPCC assessment reports or if it is referencing to the monthly climate bulletins of the National Weather Services. The current experience with satellite data is that the quality needed for climate change monitoring can only be reached through carefully performed reprocessing activities. Thus, the first interpretation of monitoring can be met and it would be very desirable if international CDR improvements could be done in the phases of IPCC assessment reports. The second interpretation seems to be very difficult to meet as long as there is no absolute reference in space.

## 6 INTERNATIONAL ACTIVITIES

This section highlights recent relevant international developments in which EUMETSAT took part.

### 6.1 GCOS and WCRP

Following a letter from the GCOS secretariat in May 2010 asking for agency support for a systematic international approach to ensure transparency, traceability and sound scientific judgement in the generation of climate data records, EUMETSAT personnel is supporting the organisation of two workshops in collaboration with the WCRP Observation and Assimilation Panel (WOAP) and the GEWEX Radiation Panel (GRP). The first entitled *Evaluation of Satellite-Related Global Climate Datasets* will assess how existing data sets followed the GCOS guidelines for the generation of datasets and look into methodologies to assess the maturity of CDRs. A few example datasets will be analysed at the workshop with the aim to further encourage dataset producers to perform a self assessment and to also educate users to apply it when searching a data set. The second entitled *GEWEX workshop on long term water vapour data sets and their quality assessment* will be looking at the specific topic of water vapour data set assessment in the GRP context. Both workshops will be held in the first 3 months of 2011 at ESA/ESRIN in Frascati.

### 6.2 GSICS and SCOPE-CM

EUMETSAT supports the international efforts to coordinate intercalibration activities within the WMO Global Satellite Intercalibration 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.

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 fourth SCOPE-CM Executive Panel meeting, EUMETSAT presented a model for SCOPE-CM and GSICS cooperation that described the distributed areas of activities and responsibilities of the two organisations, to ensure the generation of long-term homogeneous climate data records. SCOPE-CM would benefit largely from the corrections (and/or correction methodologies) that GSICS is able to offer. In very general terms, the SCOPE-CM needs would comprise corrections a) applicable to recent/current data, b) applicable to historic data, and c) the most appropriate corrections to be applied for a sustained extension of FCDRs into the future. GSICSs responsibility would be the construction and maintenance of the corrections (pillars and cables) which would be applied by SCOPE-CM to generate FCDRs, serving as the basis for TCDR generation (in SCOPE-CM or elsewhere).

### **6.3 CEOS ad-hoc Climate Group**

At the CEOS Strategic Implementation Team (SIT) 25th meeting in 2009, members have agreed to create a working group on climate at CEOS level. This 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 CEOS member space agencies.

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

The EUMETSAT Council accepted the EUMETSAT participation of EUMETSAT in the ECMWF led European Union FP7 ERA-CLIM project (see EUM/C/70/10/DOC/40 for details). 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 has been favourably evaluated by the EU commission services and was invited for contract negotiations on 11 May 2010. It is expected that the project will start at 1 January 2011 and runs three years.

Currently, EUMETSAT's commitment at this stage is independent of the SAFs, however it is recognised that they can provide significant value-added inputs. ERA-CLIM and the CDOP-2 overlap for about 18 months at the beginning of the CDOP-2. An appropriate involvement of SAFs in this project is possible by introducing specific work packages to support ERA-CLIM in the CDOP-2 proposals, coherent with other planned reprocessing activities by the SAFs.

### **6.5 EU FP7 EUGENE Project**

Since October 2010 EUMETSAT participates on the EU FP7 project EUGENE. The main objective of the EUGENE project is to foster collaboration between pan-European

organisations in the field of earth observation and to strengthen the coordination of national and regional programmes and organisations in their work towards GEO. The EUGENE projects initially works on the three Societal Benefit Areas Climate, Disasters and Water where EUMETSAT took responsibility for the climate area.

The activities undertaken in EUGENE's Climate work package aim at analysing the contribution of different actors in the field of climate monitoring and related issues in Europe. It will bring together relevant European actors and programmes, analyse their current plans and contributions, and discuss the way forward for a more effective, visible, sustained and structured European GEO contribution to the SBA on Climate.

In order to prepare for this discussion, the work package leader, EUMETSAT, has conducted a study, inclusive of a workshop in April 2010, of the Status Quo of relevant European activities in climate monitoring and presented workshop and study results in a report (available at <http://www.eugene-fp7.eu/documents.htm>). The results will be used to prepare a coherent European position for the GEO initiative with special attention to the preparation of the GEO Ministerial Summit taking place in Beijing in November 2010.

## **6.6 ESA Climate Change Initiative (CCI)**

Several ESA CCI projects 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 reprocess and document its data that will enter the CCI according to the needs of the CCI. EUMETSAT expects feedback on the quality and usability of FCDRs from the ESA CCI consortia. A coordination mechanism with ESA is in place, the next meeting is scheduled for October 2010. The scheduling of reprocessing requests coming from ESA CCI, the SAF network and the ERA-CLIM project will be optimised to make most efficient use of the available resources.

## **7 TECHNICAL SYSTEM ACTIVITIES IN SUPPORT OF CLIMATE MONITORING**

The implementation of adequate and dedicated re-processing facilities for EUMETSAT GEO and LEO spacecrafts has progressed.

The GEO Reprocessing facility was migrated from a HP environment onto a SUN environment which is much more capable of performing reprocessing. Within the SUN environment the calibration, clear sky radiance, and geostationary albedo suites have been verified against the processing on the old environment. Some requirements for the new reprocessing facility were pointing at the ability to include third party software into the system. This was successfully tested in collaboration with EUMETSAT CM-SAF Heliosat algorithm that produces cloud information and subsequently solar irradiation at the surface. In this test only the intermediate product cloud index was produced and shipped to the CM-SAF for validation. During the installation process a few lessons on how to do this best were

learned that will now positively influence any potential transfer of third party software into the reprocessing facilities at EUMETSAT CAF.

The build up of a reprocessing environment for LEO instruments has also progressed during the last 6 months. A formal readiness review was held in Q-II 2010 on the basis of an operational verification for the reprocessing of GOME-2 data. In 2011 and 2012 software suites for other Metop instruments will be implemented to fulfil the targets of the ERA-CLIM project and for the support of the ESA CCI.

## **8 PLANNED ACTIVITIES IN SUPPORT TO CLIMATE MONITORING**

The list of data sets to be produced at the CAF has not changed since the last meeting and includes most of the operational products from GEO and LEO systems. However, during the SAF network CDOP-2 preparation workshops discussions with the SAFs on a more general approach towards the generation of CDRs within the EUMETSAT ground segment took place. This includes a better collaboration in the utilisation of GSICS results for the creation of improved radiance data sets for many sensors. In this context also approaches to long time series using the US AVHRR and all TOVS/ATOVS instruments were discussed. This included a discussion with the CM-SAF on new ideas for the generation of an ATOVS Level 2 TCDR where the distributed ground segment has two different retrieval systems available that might be used to construct a data record ensemble that allows for a better characterisation of uncertainties.

## **9 CONCLUSIONS**

Following the Council Resolution on EUMETSAT's support to Climate Monitoring, EUMETSAT continues its activities to further shape its profile in climate and to maintain and improve its related involvement at various levels.

Cornerstones in 2010 were the decisions on the MTG program that brought the Meteosat observation potential to a time series of 50 years for those observations that were already available on the First Generation satellites and on the Implementation Plan in Support to Climate Monitoring that provides a formal framework of coordination for the generation of Climate Data Records in the near future. The establishment of this and the organisational changes went hand in hand with progress in the establishment of dedicated reprocessing facilities that will now be used to serve SAF support, SCOPE-CM, ESA-CCI and the ERA-CLIM project. In particular the latter once again highlights the importance of EUMETSAT data for global NWP model-based reanalysis.