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EUMETSAT ACTIVITIES IN CLIMATE MONITORING

In response to CGMS action/recommendation: None

Working Paper Abstract (corresponding to ca ½ a page)

This document summarises the EUMETSAT activities in support to Climate Monitoring. It starts with a review of the current EUMETSAT contributions to CM through international activities (i.e. in the WMO, CGMS or CEOS context). The document then lists all dedicated internal EUMETSAT activities contributing to CM, i.e. in the EUMETSAT Central Facility or in the EUMETSAT SAF Network. Finally, the document briefly report on the discussion of the 67th EUMETSAT Council of June 2009, during which EUMETSAT Member States agreed on a precise definition of the role of EUMETSAT and its SAFs in support to CM. This Council statement should lead to the development of an Implementation Plan. This will take place in the course of 2010 and a report will be submitted to CGMS-38.

Action/Recommendation proposed: CGMS is invited to take note.

EUMETSAT activities in climate monitoring

1 INTRODUCTION

This document aims at presenting EUMETSAT activities in support to Climate Monitoring.

2 INTERNATIONAL ACTIVITIES

EUMETSAT is involved in the following international activities related to Climate Monitoring.

2.1 Regional / Specialized Satellite Centres – Climate Monitoring R/SSC-CM

The aim of the WMO Global Network of Regional / Specialized Satellite Centres for Climate Monitoring (R/SSC-CM) is to address the requirements of GCOS in a cost-effective, coordinated manner, capitalising upon the existing expertise and infrastructures. The overall objective is the continuous and sustained provision of high-quality Essential Climate Variables satellite products on a global scale.

The Implementation Plan for the R/SSC-CM was finalized by EUMETSAT in November 2007 and agreed with the initial participating organizations: EUMETSAT, the China Meteorological Administration (CMA), National Oceanic and Atmospheric Administration (NOAA), Japan Meteorological Agency (JMA), the Committee on Earth Observation Satellites (CEOS), the United States Geological Survey (USGS), the WMO Space Programme, and GCOS.

EUMETSAT's contribution to the R/SSC-CM Network includes the committed activities of the CM-SAF and other SAFs as well as the activities of its Central Facilities in Darmstadt. Furthermore, EUMETSAT acts as the interim R/SSC-CM Secretariat. In a planning meeting which took place in April 2008, the participating organisations have proposed five TCDRs of interest to focus the initial activities onto:

1. AVHRR based data set of cloud and aerosol properties
2. SSM/I total column water vapour, precipitation and liquid water path
3. Surface albedo, clouds and aerosols from geostationary satellites
4. Atmospheric motion vectors and clear sky radiances
5. Upper tropospheric humidity.

The first Executive Panel Meeting will take place in January 2009.

2.2 Global Space-Based Intercalibration System GSICS

The WMO Global Space-Based Intercalibration System (GSICS) has been established by leading satellite operating agencies with the overarching goal of creating an operational system that monitors and evaluates the calibration of the global meteorological satellite observing system in a coherent and systematic manner. EUMETSAT is one of the founding members of GSICS and very actively pursues the realisation of such an operational system. Implementation plans are reviewed and updated by the GSICS Executive Panel and the implementation activities are now underway. The operational EUMETSAT intercalibration activities have concentrated on the calibration of the EUMETSAT geostationary satellites (Meteosat First and Second Generation, MVIRI and SEVIRI instruments, respectively). So far this has been based on intercalibration with the HIRS instruments on NOAA satellites. A major recent step has been the intercalibration with the IASI instrument on Metop; IASI is considered as a reference for the thermal infrared inter-calibration because of the excellent on-board calibration. It is also noteworthy that a longer term (> 1 month) comparison with Meteosat First Generation (M-7) has been done, which is important for a re-calibration of first generation Meteosat satellites; this is in turn important for the re-processing in support of re-analysis activities at NWP centres.

2.3 International Satellite Cloud Climatology Project ISCCP

Since 1986 EUMETSAT has supported the International Satellite Cloud Climatology Project (ISCCP) as part of the world climate research project (WCRP) by providing data from the first and second generation Meteosat satellites. This project routinely extracts sampled images from geostationary satellites on a 3-hourly basis to enable the detection of global cloud coverage and associated changes of these quantities. It also performs a satellite intercalibration, or rather a normalisation, to AVHRR radiances which can be considered the first “satellite intercalibration” ever.

2.4 Global Precipitation Climatology Project GPCP

Similarly to EUMETSAT’s contribution to the ISCCP project, EUMETSAT has, since 1987, extracted from its Meteosat image data so called precipitation indices on a routine basis as a contribution to the Global Precipitation Climatology Project (GPCP). This is also an activity which contributes to the World Climate Research Project as a contribution in the context of GEWEX (Global Energy and Water Cycle Experiment). With the advent of Metop, EUMETSAT Contribution now extends also to the provision of ATOVS and AVHRR data.

2.5 Committee on Earth Observation Satellites CEOS

In the context of the Committee on Earth Observation Satellites (CEOS), strategic positions are generally prepared first at the working/organisational level (Societal Benefit Area Teams, Constellations and Working Groups, CEOS SEC) before becoming progressively endorsed at the various policy-making levels (mainly CEOS Strategic Implementation Team SIT and CEOS Plenary).

EUMETSAT's representation in all the relevant CEOS fora means that it is well-positioned to push its climate monitoring agenda within CEOS. In particular, EUMETSAT's involvement in the recently formed CEOS Climate SBA team (Coordinator: Mitch Goldberg from NOAA) together with its participation in the OST and ACC Constellations are anticipated to be the primary vehicles to pursue EUMETSAT's positions and plans at the CEOS working level.

2.6 Group on Earth Observations GEO

In the domain of climate monitoring, EUMETSAT has one direct and one indirect relationship with the Group on Earth Observations (GEO):

- as a GEO Participating Organisation and
- as an active member of CEOS which is charged with fulfilling GEO's climate SBA tasks concerned with satellite observations.

3 EUMETSAT ACTIVITIES IN RELATION WITH CLIMATE MONITORING

This section gives a brief overview of the current internal activities of EUMETSAT related to climate monitoring. The related activities and plans are reported in two categories: EUMETSAT Programmes and the Network of Satellite Application Facilities.

3.1 EUMETSAT Programmes

3.1.1 Meteosat (1st and 2nd Generation)

The Meteosat programme is the well-established European contribution to the ring of operational geostationary satellites. The first Meteosat satellite was launched more than 30 years ago by ESA in 1977. In 1995 EUMETSAT took over the operations of the Meteosat satellites. Nowadays EUMETSAT still operates one Meteosat satellite of the first generation (Meteosat-7) and two (Meteosat-8 and Meteosat-9) of the second generation. The latter has much higher capabilities in terms of temporal repeat cycle (15 minutes compared to 30 minutes of the first generation) and twelve spectral bands as compared to only three spectral bands for the first generation Meteosats. The larger number of spectral bands enables a better observation of important climate variables, especially those undergoing diurnal cycles. An additional improvement of vital importance to climate observations is the improved on-board calibration of the thermal IR channels of the Meteosat Second Generation Satellites.

3.1.2 EUMETSAT Polar System EPS

With the launch of Metop-A in October 2006 EUMETSAT operates a polar orbiting satellite system with a long-term operational perspective. Through its innovative payload, the Metop satellites can provide information on a large number of key climate variables over at least 14 years of operations on a global scale.

The hyper spectral sounding Infrared Atmospheric Sounding Interferometer (IASI) allows the retrieval of temperature and moisture profiles at high accuracy (1K, 15 %, respectively) over 1km layers. IASI also allows the observation of trace gases

relevant for the greenhouse effect and for atmospheric chemistry. The Global Ozone Monitoring Experiment -2 (GOME-2) will continue the capability to measure Ozone profiles and related trace gases with high accuracy. An instrument like the GNSS Radio-occultation Atmospheric Sounder (GRAS) also provides information on temperature and humidity profiles, with the advantage that no adaptation of calibration between subsequent satellites is required for the creation of a long-term dataset.
From the other instruments on Metop (AVHRR, ATOVS, ASCAT) long-term climate records can be derived as well, especially with regard to AVHRR and ATOVS which provide continuity of climate records from NOAA satellites.

In summary, the measurements of EPS/Metop System provide a wealth of new and continued climate monitoring information.

3.1.3 Jason

OSTM/Jason-2 will provide essential observational data on the mean sea level ECV. IPCC reports on acceleration of global mean sea level rise beyond 1993 are essentially based on satellite altimetry. Polar orbiting satellite altimetry missions are unique instruments for addressing the spatial requirements on mean sea level observations. A particular goal of OSTM/Jason-2 is to extend the existing mean sea level ECV data-set beyond TOPEX/Poseidon and Jason-1 to complete the first two decades of high-precision altimetry observations. For the future, NOAA and EUMETSAT lead the CEOS study to establish the basis for an Ocean Surface Topography Constellation that satisfies the threshold requirements for the sea level ECV (and also those of the sea state ECV). These studies will also include considerations to improve the spatial resolution and to extend observations over lakes and rivers for the lakes ECV.

3.1.4 Meteosat Third Generation MTG

The uniqueness of geostationary measurements and their high temporal frequency provide the capability to observe sub-synoptic atmospheric and surface events, particularly precipitating cloud systems and to characterize the diurnal cycles of the atmosphere-surface system. Characterization of the annual cycle and diurnal cycles is crucial for an understanding of the physical processes determining the status of the climate system and its potential change. The extended observation capabilities of MTG which are expected to provide hyper-spectral sounding and lightning data in addition to an improved imager will deliver unprecedented information which will provide new insights into the forcing and feedback mechanisms that determine the energy and water cycle of the climate system.

3.1.5 Post-EPS

The continued contribution of observing Essential Climate Variables (ECVs) with satellites data hinges upon the observations from operational meteorological satellites in a polar orbit, because such satellites provide the required continuity in time and the global coverage. The Post-EPS satellite series (i.e. the series planned after EPS/Metop) will provide such continuity for atmospheric ECVs as well as for some terrestrial and oceanic ECVs. Currently, the Post-EPS preparation is in Phase-0; high-level user requirements, including climate, have been established. It is also important

that the current work towards a Joint Polar System with NOAA provides the basis for truly concerted observing systems and their deployment in a coordinated fashion. It is expected that Post-EPS, as part of a Joint Polar System with NOAA, will address and cover all ECVs currently measured with better quality and will potentially go beyond the fulfilment of these requirements by providing additional monitoring capabilities (e.g. on aerosol, clouds, trace gases, wind fields and also improved observations for a better understanding of the climate processes).

3.1.6 Reprocessing of EUMETSAT Geostationary Data

EUMETSAT has continuous activities related to the reprocessing of its image data and Meteorological Products from the first and second generation of its Meteosat satellites. Past activities included the reprocessing of Meteosat-2 image data for the ECMWF ERA-40 Re-analysis and the reprocessing of Meteosat-3 to Meteosat-7 image data for the ECMWF ERA-Interim Re-analysis for the years 1989 to 2000. This data set included image data from the Meteosat-3 Atlantic Data Coverage and the Meteosat-3 Extended Atlantic Data Coverage. The reprocessed data for the ERA-40 and ERA-Interim Re-analysis are used also by JMA Re-analysis.

The relevant FCDR from the above mentioned activities is the re-calibration of the both the visible and infrared image data. The TCDRs created include the clear sky radiances and the Atmospheric Motion Vectors.

A current TCDR activity is the processing of the Meteosat Surface Albedo (MSA) product using Meteosat First Generation imagery. About 60% of the archive has been processed for the zero degree mission and the processing of the Indian Ocean Data Coverage mission has started. The algorithm derives the surface albedo within the VIS band accounting for the surface anisotropy and the performed advanced atmospheric corrections. These data need to be analysed to determine the temporal consistency of the time series based on six different Meteosat first generation radiometers.

In addition several months of Multi-Sensor Precipitation Estimates from Meteosat-7 have been reprocessed for an international precipitation comparison study under the auspices of the WMO International Precipitation Working Group.

3.1.7 Reprocessing of EUMETSAT Polar Orbiting Data

The reprocessing of the data from the Metop-satellites has also been started. The first FCDR generated was the complete available GOME-2 data set from January 2007 until June 2008. This will now be followed by the reprocessing of ASCAT data for the period January 2007 until December 2008. In addition the first TCDR to be reprocessed using Metop data is the global soil moisture derived from ASCAT data, covering the same period as used for the ASCAT FCDR.

3.2 Satellite Application Facilities Network (SAFs)

3.2.1 Climate Monitoring SAF

The Satellite Application Facility on Climate Monitoring (CM-SAF) operationally retrieves geophysical parameters from meteorological satellites that are considered

suitable for climate monitoring. With its current list of products (cloud parameters, surface and top of atmosphere radiation fluxes, surface albedo as well as atmospheric humidity and temperature), the CM-SAF already covers part of the variables that are classified as "GCOS Essential Climate Variables". (http://www.cmsaf.eu)

The establishment of high quality long term series with known error characteristics and high temporal stability is a significant committed activity of the CM-SAF in its Continuous Development and Operations Phase (CDOP) which started 2007 and will be completed in 2012. Plans are in place to produce, during CDOP, the following datasets:

Cloud and surface radiation flux products from NOAA/AVHRR GAG dataset Patmos-X, global coverage, 1982-2002 in collaboration with NOAA,
Cloud, top of atmosphere, surface radiation and humidity products from homogeneous radiance data set (VIS+IR) from SEVIRI+GERB, 2004-2010,
Temperature and humidity products from ATOVS (1998-2010), IASI (2006-2010), GRAS (2006-2010), and GOME-2 (2006-2010) with contributions from the GRAS SAF and O3M SAF,
Free Troposphere Humidity (FTH) from Meteosat 2-10, 1983-2011 in collaboration with LMD, France and EUMETSAT central facility,
Surface radiation fluxes from Meteosat, 1983-2004 (associated activity to FTH),
Total column water vapour content and liquid water path over ocean from SSM/I and SSMIS, 1987-2011,
Turbulent Heat Fluxes over ocean from SSM/I, SSMIS and AVHRR, 1987-2011,
Precipitation and Evaporation over ocean from SSM/I, SSMIS and AVHRR1987-2011.

3.2.2 Ocean and Sea Ice SAF

The Ocean and Sea Ice SAF generates in near-real time a set of products with high relevance for climate monitoring, such as Sea Surface Radiation parameters, Sea Surface Temperature and Sea Ice Coverage and Characteristics.

The OSI SAF is currently developing a reprocessing environment for the sea ice algorithms in order to generate a re-analysis of global (Arctic and Antarctic) sea ice from 1987/1995 to 2005 from SSM/I data. (http://www.osi-saf.org/)

3.2.3 Other SAFs

GRAS SAF: Through its precision and stability, the Radio Occultation Technique provides an excellent opportunity for the monitoring of atmospheric profiles for climate monitoring purposes. The GRAS SAF is dedicated to the operational derivation of such parameters in Near Real Time and offline, as well as the provision of climate data derived from the initial products. The GRAS SAF is also involved in a federated activity with the CM SAF, targeting the generation of the long-term homogeneous water vapour data set. (http://www.grassaf.org)

LSA SAF: The Satellite Application Facility on Land Surface Analysis generates, disseminates and archives on an operational basis a set of parameters involved in

the surface radiation budget, snow and vegetation cover. The LSA SAF addresses a wide user community including climate modelling and seasonal forecast and as such is a provider of products and services for international programmes. (http://landsaf.meteo.pt)

O3M SAF: The SAF on Ozone and Atmospheric Chemistry Monitoring produces, archives, validates and disseminates ozone and atmospheric chemistry products to support the services of the EUMETSAT Member States in weather forecasting as well as monitoring of ozone depletion, air quality and surface UV radiation. The O3M SAF is also involved in a federated activity with the CM SAF and the GRAS SAF to produce long term data sets of atmospheric water vapour derived from GOME-1 and GOME-2 data. (http://o3msaf.fmi.fi)

H-SAF: The SAF on Support to Operational Hydrology and Water Management will generate and archive high-quality data sets and products for operational hydrological applications. The retrieval of products will use data from microwave and infrared instruments and will aim at reaching the best possible accuracy from satellite systems available now or in the near future. The H-SAF, currently in its Development and Validation Phase, is focusing on the generation of products, that are considered essential climate variables covering precipitation, soil moisture and snow parameters. The planned start of the dissemination of the first operational products is currently in 2010.

NWP SAF: The continuous improvement of the Fast Radiative Transfer Code RTTOV and adaptation to new instruments is a major task of the NWP SAF and is recognized as a significant contribution to the reanalysis activities at ECMWF. (http://www.metoffice.gov.uk/research/interproj/nwpsaf/).

NWC SAF: The development of retrieval software, its continuous validation and improvement is provides the scientific community with valuable tools for generating climate products from EUMETSAT data. A large part of the CM-SAF processing is based on NWC SAF developments.

4 EUMETSAT MANDATE IN SUPPORT TO CM ACTIVITIES

On the basis of the above, the 67th Meeting of the EUMETSAT Council, meeting in July 2009, agreed on the following definiation of EUMETSAT activities in support to CM:

"E*UMETSAT will provide and maintain satellite-based Climate Data Records over decades with the highest possible level of accuracy, homogeneity, reliability and stability.*

As a first priority, EUMETSAT, at its Central Facility and through its Satellite Application Facilities, will generate Fundamental Climate Data Records (FCDR).

As a second priority, EUMETSAT will generate Thematic Climate Data Records (TCDR), making best use of the expertise available in the EUMETSAT SAFs.

In order to fulfil the above objectives, EUMETSAT will rely on GCOS guidance and extensively build on international cooperation schemes, such as the WMO GSICS and SCOPE-CM activities."

That Statement by the EUMETSAT Council triggered the development of an Implementation Plan, to be prepared by the Secretariat in the first half of 2010. This Implementation Plan will list specific activities that will be undertaken by EUMETSAT to support Climate Monitoring.

An updated report will be provided to CGMS-38.

5 CONCLUSION

CGMS is invited to take note.