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Status of the EUMETSAT Satellite Applications Facilities

The development of the Network of approved Satellite Application Facilities (SAF) has progressed well in 2005, with 5 SAFs in Initial Operations, 2 still under development, and with the approval of a new SAF on "Support to Operational Hydrology and Water Management". This paper presents the status of the SAF Projects.

1 INTRODUCTION

Since CGMS-XXXII, SAF activities have further evolved. The purpose of this paper is to report on the status of the approved network of SAF projects and to present an updated list of the SAF products.

As major achievement to be highlighted, 5 SAFs are currently in their Initial Operations Phase and started distribution of their products based on NOAA and MSG data. The remaining 3 SAFs are still under development.

Full SAF operational activities will start in 2007, at conclusion of the validation of the EPS/Metop based products.

2 SAF NETWORK DEVELOPMENT AND OPERATIONS STATUS

In November 1992 EUMETSAT adopted the concept of a distributed Applications Ground Segment, including the central Meteorological Products Extraction Facilities (MPEF) and the Unified Meteorological Archive and Retrieval Facility (U-MARF), both located in Darmstadt, Germany, and a network of elements known as Satellite Applications Facilities (SAF). The MPEF produces an agreed set of basic meteorological products, while the Satellite Applications Facilities (SAF) are more specialised development and processing centres, which, based on specific expertise in Member States, will deliver additional meteorological and geophysical products and related services, as an integral part of the overall EUMETSAT service.

The SAFs are developed by consortia of organisations from the Member States, based in National Meteorological Services or other agreed entities, and responsible for research, development and operational activities. EUMETSAT contributes up to 50% of the development cost of each SAF, and the EUMETSAT Secretariat coordinates and manages the SAF Network level activities and all activities necessary to integrate the SAFs and the central services into coherent end-to-end systems providing the operational services expected by the end users. It provides also managerial, technical and scientific support to the SAFs, including the organisation of reviews, interface and planning meetings. A SAF Network Management Scheme has been established and agreed for this purpose.

Eight SAFs are currently funded and address the following topics:

- Support to Nowcasting and Very Short Range Forecasting;
- Ocean and Sea Ice;
- Ozone Monitoring;
- Climate Monitoring;
- Numerical Weather Prediction;
- GRAS Meteorology;
- Land Surface Analysis;
- Support to Operational Hydrology and Water Management.

SAFs will use data from Meteosat, MSG, NOAA, and EPS, or other satellites, where appropriate. Until relevant data become available, information from current satellites are used for development.

The partnership of each SAF project is presented in the following table.

SAF on	Date of kick-off	Hosting Institute	Consortium members
Support to Nowcasting & VSRF	February 1997	INM (Spain)	NMSs of France, Austria and Sweden.
Ocean & Sea Ice	April 1997	Météo France (France)	NMSs of The Netherlands, Denmark, Norway and Sweden.
Ozone Monitoring	October 1997	FMI (Finland)	NMSs of The Netherlands, Belgium, Denmark, Greece, Germany and France; Deutsches Zentrum für Luft- und Raumfahrt (Germany), University of Thessaloniki (Greece).
Climate Monitoring	Dec. 1998	DWD (Germany)	NMSs of The Netherlands, Belgium, Finland, Sweden and Switzerland.
Numerical Weather Prediction	Feb. 1999	UKMO (UK)	NMSs of The Netherlands and France; ECMWF.
GRAS Meteorology	April 1999	DMI (Denmark)	NMS of United Kingdom; Institut d'Estudis Espacials de Catalunya (Spain).
Land Surface Analysis	Sep. 1999	IM (Portugal)	NMSs of Belgium, France and Finland; Inst. For Applied Science & Technology (Portugal), University of Valencia (Spain).
Support to Operational Hydrology and Water Management	Sep. 2005	UGM (Italy)	NMSs of Austria, Finland, France, Turkey; Four EUMETSAT Cooperating States (Poland, Hungry, Slovakia, Romania) Several Research Institutes

Table 1 – SAF Projects Partnership

The overall status of the SAF Projects development is presented in the following diagram, which shows the development, the Initial Operations Phase (IOP) (when applicable) and following operations phases. The achieved development status is as follows:

- **SAF on Nowcasting and Very Short-Range Forecasting:** the project completed its development phase in February 2002 and entered into its Initial Operations Phase (IOP). System Testing activities were successfully completed in 2003 and validation of MSG related software packages was finalised. This SAF routinely distributes the NWC Software Packages (limited to NMSs of EUMETSAT Member and Cooperating States). Delta-development for EPS-related software also proceeds in line with plans and will continue during the IOP;
- **SAF on Ocean and Sea Ice:** the project completed as well its development phase in June 2002 and entered its IOP in July 2002. An operational chain has been set-up and tested at system level at Météo-France in Lannion, and validation activities started in summer 2003, aiming at incrementally achieving the operational readiness in 2004-2005 for

NOAA and MSG-based products, whose distribution is now performed using EUMETCast;

- **SAF on Ozone Monitoring:** the development phase has been extended to February 2007, for reconciliation with the EPS development logic and schedule. The Project prepared their infrastructure to proceed with verification testing and integrated tests with the EPS Ground Segment;
- **SAF on Climate Monitoring:** the development phase was completed in December 2003 and the IOP was kicked-off in January 2004. First validated products are already available;
- **SAF on Numerical Weather Prediction:** the development phase was completed in February 2004 and the IOP started in March 2004. Software packages are routinely and world-wide distributed;
- **SAF on GRAS Meteorology:** the project development phase has been extended to February 2007, for reconciliation with the EPS development logic and schedule. The Project prepared their infrastructure to proceed with verification testing and integrated tests with the EPS Ground Segment;
- **SAF on Land Surface Analysis:** after conclusion of the development phase, the project started in January 2005 the IOP and is preparing for distribution of the first set of products using EUMETCast;
- The EUMETSAT Council approved the proposal for the Development Phase of the **SAF on Support to Operational Hydrology and Water Management** (H-SAF) in July 2005, and activities of this new SAF started already in September 2005.

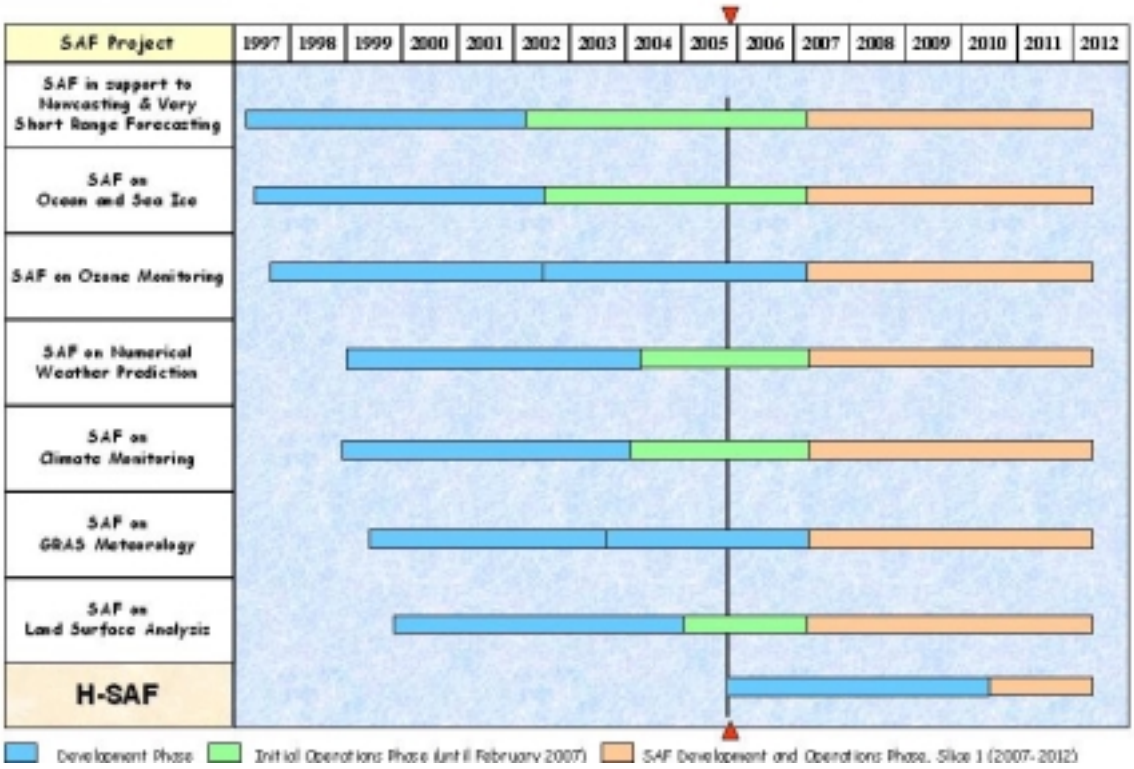

Figure 1 - SAF Projects Overall Schedule

To be highlighted that a GCOS/WMO/EUMETSAT Workshop on the SAF Network contribution to the Climate Monitoring was organised on 1-2 September 2005 in Nuremberg. This workshop followed the first organised in July 2004 in Hamburg.

The purpose of the meeting, that was co-organised with WMO/GCOS, the CM SAF and DWD, was to review the progress made since the first meeting held in Hamburg in July 2004, including the results of the pilot experiments that have been identified in previous workshops and sessions.

Furthermore this Meeting gave the opportunity to discuss the evolution of the SAF Network in the upcoming phase (2007-2012) with respect to global climate monitoring and to foster the cooperation of satellite operators on relevant topics.

Representatives from EUMETSAT, the SAF Projects, and other satellite operators, as well as from climate research experts attended the meeting

Specific recommendations and actions were agreed in particular for the re-calibration and intercalibration of satellite data. Satellite Operators are requested by WMO/GCOS to make an effort to re-calibrate archived satellite data, in order to make the data worthy for climate studies.

3 THE SAF PRODUCTS

The following SAFs will deliver MSG Products or SW Packages to generate these products:

- SAF in support to Nowcasting and VSRF;
- SAF on Ocean and Sea Ice;
- SAF on Climate Monitoring;
- SAF on Land Surface Analysis;

as presented in the next Tables.

Nowcasting SAF	
Product Name	**Product Characteristics**
Cloud Mask and Cloud Amount	Information on the presence of clouds
Cloud Type (including fog)	Major cloud types, fractional clouds, semi-transparency, fog & stratus identification, snow or sea-ice occurrence
Cloud Top Temperature/Height	Vertical extension of clouds, cloud top temperature
Precipitating Clouds	Identification of clouds likely to produce precipitation within predefined precipitation intensity classes
Convective Rainfall Rate	Precipitation intensities for convective clouds
Total Precipitable Water	Total amounts of precipitable water in clear areas
Layer Precipitable Water	Distribution of precipitable water and relative humidity per layer
Stability Analysis Imagery	Stability classes in clear air
High resolution Winds from HRVIS	Winds at high spatial resolution (25 km or better) from HRVIS
Aut. Satellite Image Interpretation	Cloud images with text and objective attributes overlays

Rapidly Developing Thunderstorms	Semi-quantitative image product showing features related to the evolution of convective systems
Air Mass Analysis	Combination of basic quantities that describe air masses into one integrated classification of the air mass. Detection of air mass boundaries

Table 2 – NWC SAF provided MSG Products

Ocean & Sea Ice SAF	
Product Name	**Product Characteristics**
Atlantic Low and Mid Latitude SST	Composite SST field (skin and bulk temperature averages over 3 hours) on a regular geographic grid from MSG SEVIRI and GOES Imager. Cloudy areas will be masked.
Merged Atlantic SST	Composite SST field (skin and bulk temperature averages over 12 hours) on a regular geographic grid from MSG SEVIRI, GOES Imager and NOAA/EPS AVHRR. Cloudy areas will be masked.
Atlantic Low and Mid Latitude Surface Radiative Fluxes	Downward short-wave surface flux (DSSF), net short-wave surface flux (NSSF) and downward long-wave surface flux (DLSF) in W/m^2 on a regular geographic grid from MSG SEVIRI and GOES imager.
Merged Atlantic Surface Radiative Fluxes	Downward short-wave surface flux (DSSF), net short-wave surface flux (NSSF) and downward long-wave surface flux (DLSF) in W/m^2 on a regular geographic grid from MSG SEVIRI, GOES imager and METOP/NOAA AVHRR.

Table 3 – OSI SAF provided MSG Products

Climate Monitoring SAF	
Product Name	**Product Characteristics**
Cloud Parameters	Cloud information for climatological applications from MSG SEVIRI, METOP/NOAA AVHRR. The products are fractional cloud covers, cloud classification, cloud top temperature, cloud top height, cloud phase, cloud optical thickness and cloud liquid water path. Output includes daily and monthly values, mean diurnal cycles and frequency distributions.
Components of the Surface Radiation Budget (SRB)	Components of the SRB for climatological applications from MSG SEVIRI and METOP/NOAA AVHRR. The core product will be the solar irradiance. Output includes daily and monthly values, mean diurnal cycles for some components.
Components of the Radiation Budget at the Top Of the Atmosphere (TOA)	Homogeneous earth reflected and emitted radiation field at TOA for climate applications from MSG GERB and SEVIRI, CERES, ERBE and SCARAB. Albedo and solar absorbed flux will also be derived. Output will be daily and monthly values and mean diurnal cycle.

Table 4 – Climate Monitoring SAF provided MSG Products

Land Surface Analysis SAF

Product Name	Product Characteristics
Short-wave Radiation Parameters	Maps of Surface Albedo, Downwelling Surface Short-wave Fluxes (DSSF) on a geographical grid from MSG SEVIRI and METOP/NOAA AVHRR.
Long-wave Radiation Parameters	Maps of Land Surface Temperature (LST) and Downward Surface Long-wave Fluxes (DSLF) on a geographical grid from MSG SEVIRI and METOP/NOAA AVHRR.
Soil Moisture Indices	Surface Soil Moisture (SSM) over more densely vegetated surfaces derived from the Land Surface Temperature product.
Snow Cover	Information on the possible occurrence of snow and the related snow albedo from METOP/NOAA AVHRR and MSG SEVIRI.
Evapotranspiration	Evapotranspiration maps on a geographical grid derived from MSG SEVIRI and METOP/NOAA AVHRR and from the Vegetation Parameters.
Vegetation Parameters	Daily and decade data sets of vegetation parameters derived from MSG SEVIRI and METOP/NOAA AVHRR. The following vegetation parameters will be derived: SEVIRI Vegetation Index and the Leaf Area Index (LAI).

Table 5 – LSA SAF provided MSG Products

SAF on support to operational Hydrology and Water Management	
Product Name	**Product Characteristics**
Instantaneous precipitation rate	Precipitation intensity at ground observed in Microwave and Infrared spectral region with indication of the phase (solid or liquid)
Cumulative precipitation	Precipitation intensity cumulated over 3, 6, 12, and 24 hours observed in Microwave and Infrared spectral region

The following SAFs will deliver EPS Products as described in the following tables, where these products are identified in relation with to the relevant EPS instruments.

	SAF in Support to Nowcasting & Very Short Range Forecasting	**SAF on Ocean & Sea Ice**	**SAF on Ozone Monitoring**
AVHRR	Cloud Mask and Amount Cloud Type Cloud Top Temp. & Height Precipitating Clouds	Sea Surface Temperature Surface Radiative Fluxes Sea Ice Edge, Cover & Type	
HIRS			Total Ozone UV fields (clear sky) UV fields with clouds
AMSU-A	Precipitating Clouds		
ASCAT		Ocean Surface Winds Sea Ice Edge & Type	
GOME-2			Total Ozone Ozone Profiles Trace Gases (BrO, OClO, NO2, SO2, HCHO) Aerosols UV fields (clear sky) UV fields with clouds

Table 6 – NWC, OSI and O3M SAF provided EPS Products

	SAF on Operational Hydrology and Water Management	SAF on Climate Monitoring	SAF on Numerical Weather Prediction	SAF on Land Surface Analysis	SAF on GRAS Meteorology
AVHRR	**Snow detection**	Fractional Cloud Cover Cloud Type Cloud Top Temp. & Height Cloud Phase Cloud Optic. Thickness Surface Radiative Fluxes	ATOVS: Improved RTMs Observation Operators Improved AAPP processing package Monitoring of data quality	Surface Albedo Surface SW Fluxes Land Surface Temp. Surface LW Fluxes Vegetation Parameters Evapo-transpitation Snow Cover	
MHS	**Instantaneous precipitation rate Cumulative Precipitation rate**	Cloud Water Path			
IASI			Fast RTM Observation Operators IASI Processing Package		
ASCAT	**Instantaneous precipiation rate Soil moisture Snow water equivalent**		Observation Operators		
GOME-2/ OMI					
GRAS					Refractivity profile Temperature Profile Humidity Profile Pressure Profile Observation Operators

Table 7 – H-SAF, CLM, NWP, LSA, and GRAS SAF provided EPS Products

4 SAF OPERATION SCENARIOS

The overall objective of a SAF is the provision of operational services, in the context of a cost-effective and synergetic balance between the central and distributed services. The SAF services will be an integral part of the overall EUMETSAT operational services.

In this context, the establishment of a SAF is to undertake on a distributed basis such necessary research, development and operational activities that can be carried out in a more effective way than at the EUMETSAT central facility. The primary role the SAFs is to develop and deliver services and products aimed at enhancing the value and use of data for

applications considered being a common need of all, or the least a majority, of Member States.

The following strategic elements have been set-up for the SAF operations.

Distribution of user software packages
For the distribution of user software packages developed by a SAF for operational applications or local data processing, the baseline policy will be implementation under the responsibility of a SAF operations leading entity supported by a network involving the development and other partners.

Off-line product service
Considering the specific development undertaken by SAFs and their assumed re-use of existing infrastructure, the current baseline is to deploy local end-to-end services at selected SAFs for off line products. This will include production, archiving and distribution, with catalogues to be included in, or linked to, the EUMETSAT catalogue using standard interfaces.

Near-Real time product services
SAFs responsible for near-real-time data services are expected to minimise internal distribution of operational services, operational complexity and costs, whilst maintaining their distributed expertise base.

5 CONCLUSION

The SAF Network development proceeds in line with plans for all approved SAF Projects, with 5 SAFs (NWC, OSI, CM, NWP, and LSA) already in their Initial Operations Phase. The IOP gives a major opportunity for users to initiate/conduct their activities based on SAF Products and Services. A new SAF on Support to Operational Hydrology and Water Management has been approved in July 2005.