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STATUS OF THE EUMETSAT SATELLITE APPLICATION FACILITIES

The development of the Network of approved Satellite Application Facilities (SAF) has progressed well in 2002, with the SAFs *on "Nowcasting and Very Short Range Forecasting*" and "*Ocean and Sea Ice*" entering their Initial Operations Phase. This paper describes the status of the 7 active SAF Projects and provides the updated list of their planned products.

NETWORK OF EUMETSAT SATELLITE APPLICATION FACILITIES

1 INTRODUCTION

Since CGMS-XXX, 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.

2 THE SAF NETWORK DEVELOPMENT CONTEXT

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.

Seven SAFs are currently under development 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.

SAFs will use data from Meteosat, MSG and EPS, or other meteorological satellites, where appropriate. Until relevant data become available, information from current satellites will be 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 and Sweden.
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 Sweden; Inst. Of Meteorology & Climate Research (Germany), University of Bonn (Germany), Federal Inst. Of Hydrology (Germany), University of the Aegean (Greece), Inst. of Agrometeorology & Environmental Analysis Applied in Agriculture (Italy), Applied Meteorology Foundation (Italy), Inst. For Applied Science & Technology (Portugal), University of Evora (Portugal), University of Valencia (Spain).

Table 1 – SAF Projects Partnership

The overall status of the SAF Projects development is presented in the following diagram, which shows the development, initial operations (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 and validation of MSG related software packages is progressing, with involvement of selected beta-users. The Operations Readiness Review for the MSG-based products will be conducted in early 2004. The 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. A pre-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 achieving operational readiness in April 2004 for MSG-based products.
- **SAF on Ozone Monitoring:** the development phase has been extended to end of 2006, for reconciliation with the EPS development logic and schedule. It has completed its Critical Design Review process.
- **SAF on Climate Monitoring:** the project is currently testing the first version for the system configuration and will enter an Initial Operations Phase in January 2004.
- **SAF on Numerical Weather Prediction:** the project had the Mid term Review in the first

part of 2002, and released in summer 2004 the Version 4 of the AAPP Software. The NWP SAF will enter its Initial Operations Phase in March 2004.

- **SAF on GRAS Meteorology:** the project development phase has been up to end of 2006, similarly to the approach taken for the SAF on Ozone Monitoring. The Critical Design Review (CDR) was successfully conducted in early 2003.
- **SAF on Land Surface Analysis:** after conclusion of the Requirements and Architectural Design Review in 2001, the project proceeded with detailed design and pre-development/prototyping, and is completing for the Mid Term Review process. The development phase will be completed by end of 2004 and followed by an Initial Operations Phase.

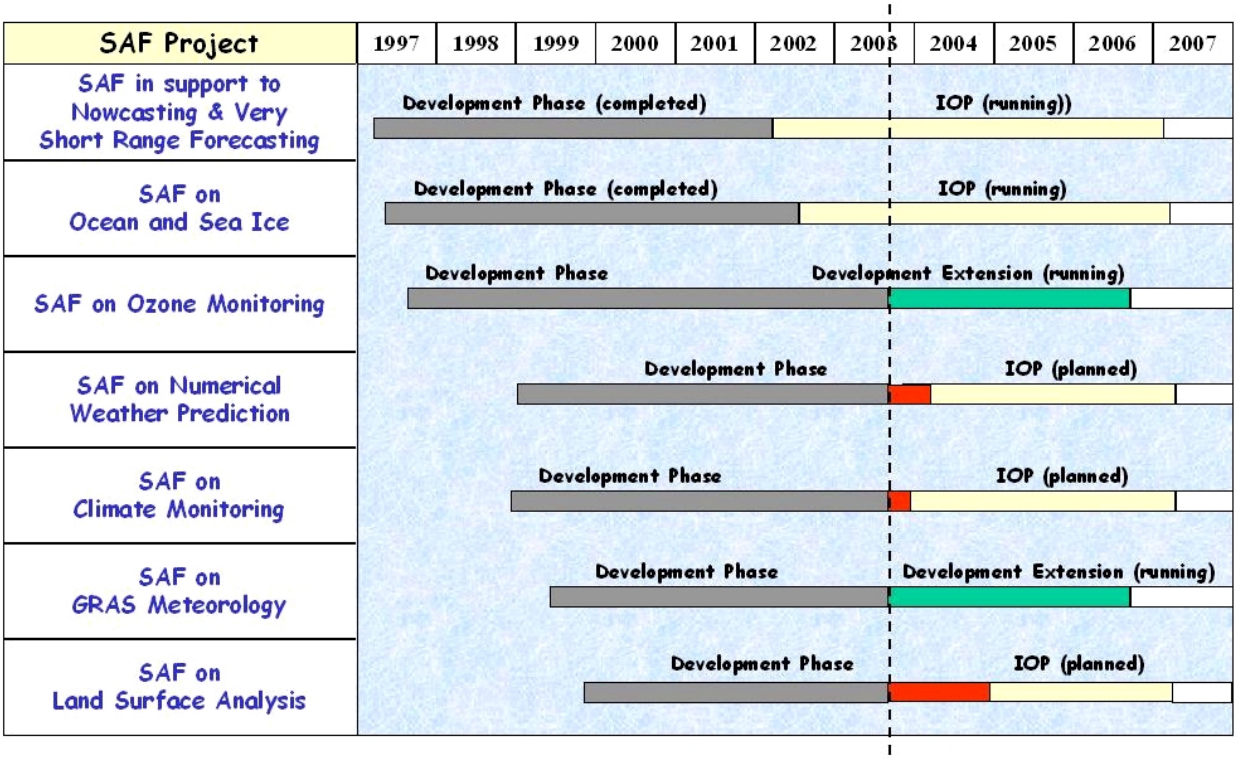

Figure 1 - SAF Projects Overall Schedule

In consideration of the phasing needs with the MSG and EPS commissioning, the **NWC and OSI SAFs** entered an **Initial Operational Phase** (IOP) respectively in March and July 2002. During IOP, the development for the EPS related products will be finalised, while MSG products will be put into operations after their validation using the real data provided by the MSG instruments. Continuous research and development will take place during IOP to sustain the needs for product improvements and innovation.

To ensure phasing with the EPS commissioning, the **Ozone Monitoring SAF** development phase was also **extended**. A similar conceptual approach was applied to the SAF on GRAS meteorology.

For all SAFs, the full **Operational Phase** will aim to:

- Put into operations the accepted SAF Products and Services;
- Maintain these products;
- Improve the Products, based on the results of the continuous research and development effort as well as on the users feedback.

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 liquid 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 shortwave surface flux (DSSF), net shortwave surface flux (NSSF) and downward longwave surface flux (DLSF) in W/m^2 on a regular geographic grid from MSG SEVIRI and GOES imager.
Merged Atlantic Surface Radiative Fluxes	Downward shortwave surface flux (DSSF), net shortwave surface flux (NSSF) and downward longwave 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 and MHS. The products are fractional cloud covers, cloud classification, cloud top temperature, cloud top height, cloud phase, cloud optical thickness and cloud 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

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 Climate Monitoring	SAF on Numerical Weather Prediction	SAF on Land Surface Analysis	SAF on GRAS Meteorology
AVHRR	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	Cloud Water Path			
IASI		Fast RTM Observation Operators IASI Processing Package		
ASCAT		Observation Operators		
GOME-2/ OMI				
GRAS				Refractivity profile Temperature Profile Humidity Profile Pressure Profile Observation Operators

Table 7 – 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.

Real time product services

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

5 DISCUSSION ON A POTENTAIL NEW 8th SAF ON HYDROLOGY

In November 2002, the EUMETSAT Council recognised the potential need of a new SAF and approved a new SAF Theme on 'Support to Operational Hydrology and Water Management'.

The EUMETSAT Policy Advisory Committee approved a way forward in Spring 2003, based on the set-up of a SAF Hydrology Framework Working Group (SHFWG) made up of leading scientists and application experts.

The Working Group is required to:

- Establish a vision on how operational catchment hydrology and its relationship to numerical weather prediction models will evolve in the five and 10 next years, and on how the relevance of ground-based and satellite observations will evolve accordingly;
- Prioritise the type of services and products expected from this new potential SAF;
- Determine the expertise that should be combined in a potential SAF targeting, after its development, a first operational phase of five years in 2009.

A roadmap establishing the scientific framework was agreed at the first SHFWG meeting in Rome in July 2003, which was hosted by the Italian Meteorological and chaired by Dr Anthony Hollingsworth.

The Central Institute for Meteorology and Geodynamics (ZentralAnstalt für Meteorologie und Geodynamik - ZAMG) will host the Working Group's second meeting in Vienna in November 2003, and the Group aims to deliver a report to EUMETSAT Delegate Bodies by Spring 2004.

6 CONCLUSION

The SAF Network development proceeds in line with plans for all approved SAF Projects, with the two pilots SAF (NWC and OSI) already in their Initial Operations Phase. The IOP will give a major opportunity for users to initiate their activities based on SAF Products and Services. Lessons learnt will benefit the validation process of all other SAFs Projects Validation processes and will support optimisation of the Operational Phase.