CGMS-XXVII EUM-WP-29
Prepared by EUMETSAT
Agenda Item: III.4

RAPID SCANS FROM METEOSAT IN SUPPORT OF MAP

This document reports on EUMETSAT's activities to support the Special Observing Period of the Mesoscale Alpine Programme. The novel feature of this support is the use of the standby spacecraft, Meteosat-6, to provide rapid scan (5-minute) imagery of the Alpine region.

RAPID SCANS FROM METEOSAT IN SUPPORT OF MAP

1 INTRODUCTION

The Mesoscale Alpine Programme (**MAP**) is an international project conceived to co-ordinate and integrate top-quality basic research on mountain meteorology with direct practical applications for numerical weather predictions. The programme aims at obtaining further insights into the physical and dynamical processes that rule precipitation mechanisms over major complex orography, and determining three-dimensional circulation patterns in the proximity of large mountain ranges (Levizzani, 1998).

The MAP strategy (Levizzani, 1998) is to focus on key orographic-related mesoscale effects exemplified in the Alpine region. In this sense flow patterns and precipitation formation and evolution mechanisms in the Alps are considered as prototypical of similar processes determined by other major mountain ranges around the world.

MAP is designed as a multi-year programme structured in three phases:

1. An extended preparatory period (1995-1998);
2. A 13-month field phase (1998-1999), including a shorter intensive Special Observing Period (**SOP**) that runs from September 7th - November 15th 1999;
3. An evaluation period.

During Phase I the climatology of Alpine mesoscale weather systems is investigated together with a detailed and systematic evaluation of current forecast model performances and testing of new observing systems. Phase II involves the acquisition of specific, high-resolution and detailed data sets by means of state-of-the-art instrumentation. Phase III covers the assembly and analysis of the observational field data.

All data gathered or used by MAP will be stored in and made available by the MAP Data Centre, located at the Eidgenossische Technische Hochschule (**ETH**) in Zurich.

Additional information on the Mesoscale Alpine Programme can be found at http://www.map.ethz.ch.

2 THE NEED FOR HIGH FREQUENCY METEOSAT DATA

It is foreseen that the normal half-hour IR, WV and visible image data from Meteosat will play an important role in MAP. However, in addition to the half-hour full Earth disk images, it has been suggested that, for the duration of the SOP, a Meteosat spacecraft is made available for special rapid scan imaging operations whenever potentially interesting weather features are developing. The scientific needs for a Meteosat rapid scan strategy during MAP are described by

Levizzani (1998) and are summarised below.

2.1 Deep Convection

The benefits of very rapid scan imagery (1-minute interval) from GOES-8 for the study of explosive convection has been discussed by Purdom (1996a). Purdom (1996b) has also demonstrated the significant impact of rapid scan imagery down to a 30-second repetition rate for the analysis of the formation and evolution of squall lines and their fine structure. Although Meteosat spacecraft cannot match the 30-second repetition rate of GOES-8/9, Meteosat rapid scan image data with a period of a several minutes should greatly improve the monitoring of deep convective cloud formation and evolution within the MAP area.

2.2 Winds

Purdom (1996c) has conducted tests using special high-resolution image sequences from GOES-8 at 30-second, 1- and 3-minute image repetition rates. The sequences included severe thunderstorms and hurricanes, as well as more common situations such as winter storms with multiple cloud layers and trade wind flows over the ocean. The results show that such high-frequency imagery is very good for deriving cloud motion. It is therefore highly likely that high temporal resolution Meteosat imagery over the MAP area can significantly contribute to wind derivation tests for ingestion into forecast models.

2.3 Rainfall Estimation

Given the amount of non-conventional meteorological data that is made available, MAP represents an excellent opportunity to test satellite rainfall estimation schemes. Infrared precipitation methods can be tested against an unprecedented data set of rain gauge and radar measurements. High-frequency scanning strategies again give the possibility to obtain rainfall maps more often than the normal 30-minute interval, and at a frequency approaching that of the radar frequency.

2.4 Use for Mesoscale Analysis

High-resolution mesoscale models will benefit from the availability of cloudiness and cloud temperature maps at several minute intervals. The availability of frequent scans in the water vapour channel is also important for the analysis of convergence/divergence upper air structures. PV streamer research and upper level feature studies can also generally benefit from such images.

3 EUMETSAT SUPPORT TO THE MAP SOP

Since the availability of Meteosat rapid scan image data during the SOP would clearly provide both scientific and operational benefits to the MAP project, MAP approached EUMETSAT to discuss the possibilities for performing rapid scanning with Meteosat. Following discussions between EUMETSAT and MAP, and parallel discussions inside the MAP community, a EUMETSAT service scenario for the MAP SOP has been defined. This section provides an overview of the rapid scanning capabilities of the Meteosat spacecraft and ground segment, and describes the rapid scanning support that EUMETSAT will provide during the SOP.

3.1 Rapid Scan Imaging with Meteosat

Meteosat spacecraft allow the setting of the lower and upper scanning thresholds to any value within the permitted scanning range. Normally, these scanning thresholds are set by ground command so that an image will contain 2500 forward scan lines covering the full Earth disk. With the inclusion of radiometer retrace and stabilisation periods at the end of a forward scan the complete *scan cycle* for a full Earth disk scan takes 30 minutes.

To target a specific area on the Earth disk, the scanning limits can be set so that a reduced number of forward scan lines are included in each scan cycle. Since these *reduced* scans can be completed in less time than a full Earth disk scan, reduced scans can provide imagery with a higher temporal resolution than that of the normal half-hourly full Earth disk scans.

For example, a reduced scan that covers 228 forward scan lines requires about 5 minutes per scan cycle, and so allows the region to be scanned at six times the normal half-hourly rate. This mode of scanning is often referred to as *rapid scanning*. It should be noted that in rapid scanning mode the radiometer stepping rate (once per 0.6 second spacecraft revolution), the number of pixels per line of image data and the resolution of the image data are identical to that for normal full Earth disk scans.

Although rapid scanning is a supported mode of operation for Meteosat spacecraft, due to the absence of a firm operational requirement, and the inability of the ground segment to rectify rapid scan data, it has not previously been used operationally.

Following EUMETSAT's agreement with MAP to provide rapid scanning support to the SOP, it was necessary to modify the ground segment so that it could operationally support the rectification and visualisation of rapid scan image data.

With these modifications the ground segment now fully supports rapid scanning operations with up to 6 reduced scans per half-hour.

3.2 The EUMETSAT Service Scenario for the MAP SOP

Following discussions inside the MAP community and between MAP and EUMETSAT Operations, a MAP SOP service scenario has been identified.

According to this scenario, EUMETSAT will make the back-up spacecraft at 9° W (Meteosat-6) available for rapid scan imaging for the duration of the MAP SOP. This solution allows the operational spacecraft at 0° (Meteosat-7) and at 63°E (Meteosat-5) to remain completely unaffected by the MAP support service. The service scenario is based on the utilisation of redundant ground segment equipment to support this additional imaging stream from the standby spacecraft. It should be noted that if this nominally redundant equipment is required to support either the operational 0° or 63°E missions, then the MAP service will be suspended. Similarly, if the standby spacecraft is required to support one of the operational missions, the MAP service will also be suspended.

The agreed operational interface between MAP and EUMETSAT Operations requires that periods of rapid scanning be requested by the MAP forecasting team (located at the MOC, in Innsbruck). The MOC will contact EUMETSAT Operations to request a period of rapid scanning whenever potentially interesting weather features are developing. Requests for rapid scan imaging can be made 24 hours per day, 7 days per week. To facilitate this, the operational interface with the MOC has been designed so that the EUMETSAT Mission Control Centre operators are able to initiate the sequence of activities required to support rapid scanning operations.

When Meteosat-6 is not being used for rapid scanning, it will be configured in the default non-imaging mode that is standard for a standby spacecraft. As a result, the EUMETSAT service scenario for the MAP SOP requires that adequate notice be given to EUMETSAT Operations when a period of rapid scanning is required, so that the spacecraft and ground segment can be prepared for the requested rapid scan operations. It has been agreed that rapid scanning requests will be made at least 12 hours prior to the requested start time, which should be sufficient time to prepare for the rapid scanning. Most of this 12-hour notice period is needed to perform full Earth disk scans to enable the image processing system to stabilise prior to the start of the rapid scanning.

For MAP it has been decided that 6 scans per half-hour is the optimum scan pattern (corresponding to a 5-minute repetition rate). The region to be covered is shown in Figure 1. This region corresponds to a scan of 228 image lines, although after rectification the usable area shrinks to about 170 lines. The rapid scan image data will be rectified to the same projection used for the 0° operational mission and the geometric accuracy will be comparable to that of the normal full Earth disk image data. It will be possible to perform rapid scanning for up to 18 hours without incurring a loss of geometric accuracy in the rectified image data. Runs of up to 48 hours are also possible, but with a gradual loss of geometric accuracy after the first 18 hours or so.

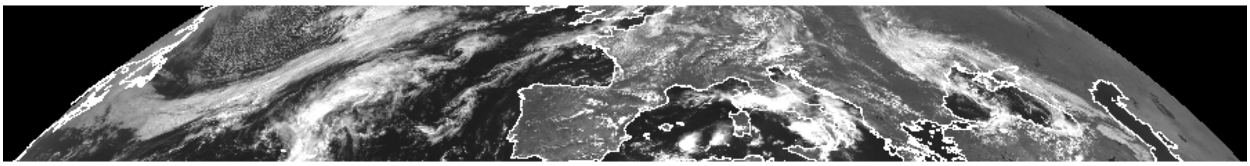

Figure 1. Meteosat rapid scan region for MAP. This region will be scanned at 5-minute intervals.

Meteosat 7, the 0° operational spacecraft, will perform its normal 30-minute scanning schedule so as to ensure the delivery of operational imagery and products to member states NWS. All MAP real-time data needs will be satisfied by the normal services provided by the 0° operational spacecraft.

Rapid scan data will be made available to the MAP Data Centre via the MARF FTP user interface in close to real-time (approximately 15 minutes after the end of each half-hour nominal imaging slot). The MAP rapid scan image data will be archived in the MARF, and as such will be available to other users. However, in order to reduce the scope of ground segment modifications, no modifications to the MARF catalogue structure have been made – so it will not be evident from the catalogue that the entries contain rapid scan data.

Note that EUMETSAT will not calibrate this rapid scan data. Calibration will be performed by MAP using cross-calibration techniques.

4 INVESTIGATIONS ON SHORTER TIME INTERVAL SCANS FOR THE DERIVATION OF SPATIALLY DENSER AND MORE ACCURATE WIND FIELDS

The extraction of Atmospheric Motion Vectors is operationally based on half hourly imagery from MTP. The current FOW of the satellite provides the potential to extract winds with data from shorter time interval scans. Work performed especially at UW/CIMSS has shown that for a satellite having similar characteristics as MTP a reasonable extraction frequency could be 15 or 7.5 min imagery. The advantage of the higher extraction frequency generally manifests itself in better quality displacement vectors and a higher density. It has been realised that the current utilisation of Meteosat-6 in rapid scan mode will provide a unique opportunity to investigate this potential with a European satellite.

As the utilisation of the rapid scans presents several new requirements on the extraction procedure it has currently been decided to perform the first evaluations in an external study. The study 'SATELLITE-DERIVED ATMOSPHERIC MOTION VECTORS: IMPROVED DISPLACEMENT ESTIMATES OF LOW LEVEL CLOUDS OVER LAND' will, in addition to the preparatory research related to the new opportunities provided by the SEVIRI instrument on MSG, include investigations on the impact of shorter time interval scans. The study was awarded to 'Laboratoire de Meterologie Dynamique (LMD)' in France. It commenced 12 May 1999 and is foreseen to last one year.

5 REFERENCES

Levizzani, V., 1998. Mesoscale Alpine Programme Proposal to EUMETSAT. EUMETSAT Support to MAP: Use of Back-up Satellite for Rapid Scan of the MAP Area During SOP.

Purdom, J.F.W., 1996a. One minute interval imaging of atmospheric phenomena using NOAA's new generation of geostationary satellites. Prep. Eight Conf. on Satellite Meteorology and Oceanography, AMS, 164-167.

——————, 1996b. Advanced atmospheric studies using GOES-8/9 multichannel imagery. Proc. 1996 Meteorological Satellite Data Users' Conference, EUMETSAT EUM P 19, 77-86.

——————, 1996c. Detailed cloud motions from satellite imagery taken at thirty second, one and three minute intervals. Proc. Third Int. Winds Workshop, EUMETSAT EUM P 18, 137-146.