

EUCOS – THE EUMETNET COMPOSITE OBSERVING SYSTEM

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Abstract

EUMETNET is a network grouping of 21 National Meteorological Services in Europe that provides a framework to organise operational and developmental co-operative programmes between the Services. EUCOS is the EUMETNET Composite Observing System, a programme to deliver terrestrially based operational observations for the efficient improvement of regional NWP in Europe. In addition EUCOS provides a framework for national observing networks and makes a significant contribution to the WWW. This paper gives a brief background to EUMETNET and EUCOS, describes some of the challenges faced by EUCOS and its operational successes in recent years. A review of the top level observational requirements is undertaken; discussion of how EUCOS is meeting some of these requirements and how the remaining observational requirements are to be met in future years is presented. Some analysis of the strengths and weaknesses of the existing observations systems is also presented and a review of the quality of observations within the EUCOS framework is undertaken. Trends in operational performance, identifying the reasons for the trends and any corrective actions that are in place are discussed. An example of how the EUCOS Programme can help build the capacity of observing systems elsewhere in the world is also given.

1. INTRODUCTION

1.1 EUMETNET – the European Meteorological Network

EUMETNET is a network grouping of 21 National Meteorological Services in Europe that provides a framework to organise co-operative programmes between the Members in the various fields of basic meteorological activities such as observing systems, data processing, basic forecasting products, training, research and development. Through EUMETNET Programmes, the Members intend to develop their collective capability to serve environment management and climate monitoring and to bring to all European users the best available quality of meteorological information. They will use EUMETNET to make more efficient the management of their collective resources. The total budget for 2007 for all the EUMETNET programmes has been set at 6.7M€, with 5.1M€ allocated to the EUCOS Programme and its associated operational programmes for E-AMDAR, E-ASAP and E-SURFMAR. Further details on EUMETNET can be found at: <http://www.eumetnet.eu.org/>



Figure 1: The Members of EUMETNET

1.2 EUCOS – the EUMETNET Composite Observing System

EUCOS is the EUMETNET Composite Observing System, a programme to deliver terrestrially based observations for the efficient improvement of regional NWP in Europe. This is undertaken through resource transfer from the well observed European territorial areas to the poorly observed territorial and predominantly

maritime areas. There is a general expectation that no new money is available for the EUCOS Programme and so a combination of national savings and a re-distribution of funding between Members is the mechanism by which EUCOS is funded. The EUCOS Operational Programme was established on 1 January 2002, based on recommendations resulting from the EUCOS Implementation Programme [Ref:1], which ended in 2001. The EUCOS concept and progress so far is a major achievement for European Meteorological Services. It offers the potential for optimised observing networks, targeted observations and maximum cost-effectiveness, leading to better-quality services and benefits for the whole of Europe.

EUCOS is made up of a number of programme components and it is the combination of these components within a single programme that ensures the overall EUCOS Programme does not stagnate, but remains flexible enough to react to changing requirements with the minimum of delay. The latest definition of the EUCOS Programme for the 2007-11 period has been reviewed and agreed by the EUMETNET Council [Ref:2].

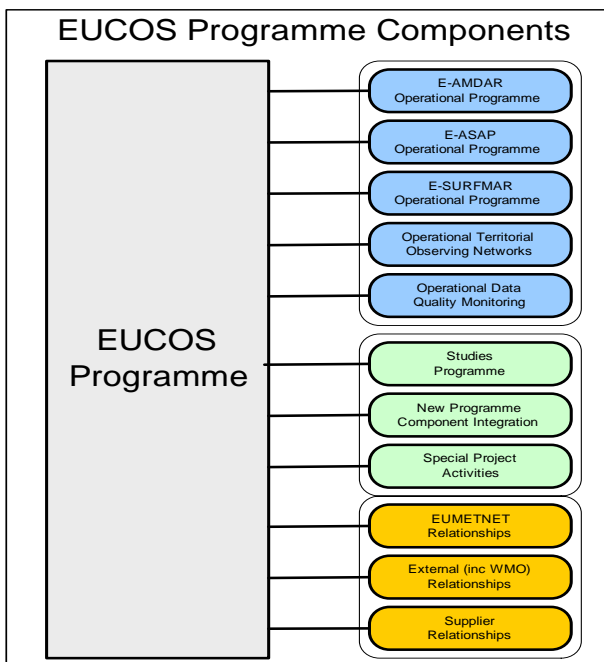


Figure 2: The EUCOS Programme Structure

With the main focus of EUCOS being the provision of observations that will make a cost effective improvement to regional NWP capability for Europe, a domain within which observations are required to improve forecasts on the one to three day scale is needed [Ref:3]. This area is known as the EUCOS Area of Interest and this domain is bound by 70W to 40E and 10N to 90N as shown below.



Figure 3: The EUCOS Area of Interest

2. User Requirements, Operational Targets and Quality Management

With the purpose of the EUCOS Programme clearly defined [Ref:2], the next step is to understand the requirements for the observations, in terms of accuracy, coverage, frequency and latency. Once the requirements have been defined, the targets for the various components of the EUCOS Network are set.

2.1 Top Level Requirements

The general requirements for regional NWP are available from the WMO. It should be noted these requirements are currently under review. http://alto-stratus.wmo.ch/sat/stations/_asp_htx_idc/Requirementsearch.asp. These requirements need to be further modified by the specific needs of NWP in Europe [Ref:4]. Many of these modifications result in a more challenging requirement being set. The tables below show typical differences in requirements for upper air observations between the general WMO statements and the European specific requirements, requirements for other observational data can be found at [Ref:4]. In all cases the common observational cycle for upper air observations is a threshold of twelve hours, a breakthrough of three hours and an optimum of half an hour. The common observational latency for upper air observations is a threshold of two hours and an optimum of half an hours, no breakthrough is stated but is assumed to be one hour.

Table 1: WMO derived Upper Air Observational Requirements for Regional NWP				
Element	Position	Accuracy (o, b, t)	Vertical Resolution (km) (o, b, t)	Horizontal Resolution (km) (o, b, t)
Temperature (K)	Lower Troposphere (Boundary layer)	0.5, -, 3.0	0.3, -, 3	10, -, 500
	Upper Troposphere / Lower Stratosphere		1, -, 3	
Wind Vector (m/s)	Troposphere / Lower Stratosphere	1, -, 5	0.4, -, 5	
Specific Humidity (%)	Troposphere	5, -, 20	0.4, -, 2	10, -, 100

Table 2: European Upper Air Observational Requirements for Regional NWP				
Element	Position	Accuracy (o, b, t)	Vertical Resolution (km) (o, b, t)	Horizontal Resolution (km) (o, b, t)
Temperature (K)	Lower Troposphere (Boundary layer)	0.5, -, 1.5	0.01, 0.3, 0.5	1, 10, 50
	Upper Troposphere / Lower Stratosphere		0.1, 1.0, 2.0	3, 30, 200
Wind Vector (m/s)	Troposphere / Lower Stratosphere	1, -, 3	0.1, 1.0, 2.0	3, 10, 200
Specific Humidity (%)	Troposphere	5, -, 10	0.1, 1.0, 2.0	3, 30, 200

The descriptions optimum (o), breakthrough (b) and threshold (t) levels for observations are stated in the above tables. The definition of each of these three quantities is a function of which element of the parameter is being described. Full details on the definitions can be obtained from the EUMETSAT nowcasting requirements paper [Ref:5]. However the following summaries are appropriate:

- Optimum (o) – the level beyond which additional benefit to forecasting accuracy is not derived;
- Breakthrough (b) – measurable advances in forecasting capability are this level is reached;
- Threshold (t) – the level routine observations must reach before significant benefit can be derived.

2.2 Future changes to requirement

Although the role of EUCOS, in serving the needs of regional NWP is clearly defined, there is an ongoing expectation that the needs of regional NWP for observational data will change as the capabilities of regional NWP change. These changes relate to model physics, assimilation scheme developments and resolution changes (both in terms of spatial and temporal changes). In the longer term, the expectation is regional models will be able to resolve finer detailed weather phenomena and by implication the precursors to these phenomena.

The expectation is the observational requirements will also change to ensure these precursors are adequately described through assimilation of suitable observational data. Generally these changes are expected to include the need to improve the frequency of observation and resolution of measurement, both in the vertical and horizontal. Nevertheless, the fundamental need to measure basic geophysical variables, such as temperature, pressure, wind and humidity will remain.

2.3 Specific Targets for EUCOS Networks

Having discussed the requirements for observations needed to improve regional NWP performance, detailed quality targets for the EUCOS Networks have been established [Ref:6] and are summarised as follows:

Parameter	Land R/S Targets	E-ASAP Targets	E-AMDAR Targets
Temperature (°K)	1.0	1.0	1.5
Wind Vector (m/s)	2.5	2.5	2.5
Specific Humidity (%) (to tropopause)	10	10	10
O-B 100 hPa Geopotential Height Difference (m)	65	65	n/a
Observations received from Network	95 % of schedule	75 % of schedule	12 million pa
Percentage received by HH+100 (All parts)	95%	95%	95%
Percentage received by HH+60 (Parts A&B)	50%	50%	90%
Percentage achieving 100hPa	97%	90%	n/a
Percentage achieving 50hPa	95%	75%	n/a

Table 3: EUCOS Upper Air Observing Targets

Parameter	Land Targets	VOS Targets	Buoy Targets
Pressure (hPa)	1.0	1.0	1.0
Temperature (°K)	1.0	2.0	1.0
Wind Vector (m/s)	2.5	5.0	2.5
Specific Humidity (%)	10	15	10
Sea Surface Temperature (°K)	n/a	1.0	1.0
Observations received from Network	95 %	95 %	90%
Percentage received by HH+100	95%	95%	95%
Percentage received by HH+60	90%	90%	90%

Table 4: EUCOS Surface Observing Targets

2.4 Quality Monitoring Methods Used

Data quality assessments are undertaken using standard 'observations minus background field' assessments with the Met Office Global NWP Model. In addition, to avoid individual model biases affecting the outputs, cross checks are undertaken with other Global NWP Centres such as ECMWF and Meteo-France. Details of the elements assessed for each observing system are available in the EUCOS Annual Quality Monitoring Report

Routine reports on the level of performance of the components of the EUCOS Network are made available to the relevant Programme Managers and EUMETNET Members on a regular basis. Daily checks are automatically posted on the web each day. Monthly, quarterly and annual performance reports are produced and distributed. These reports act as the basis for identifying areas of weakness, applying corrective actions and improving the observing networks on a continual basis. All the reports are available at: www.eucos.net and the annual report is also available at www.wmo.ch/web/www/ois/monitor/monitor-home.htm

2.5 Fault Reporting and Follow up

One key element of the Quality Management System for the EUCOS Network is the fault reporting and correction process. Merely monitoring and reporting on the outputs is not adequate if significant improvements to operational performance are expected. Fault reporting and follow up ensures that problems are resolved in a timely fashion.

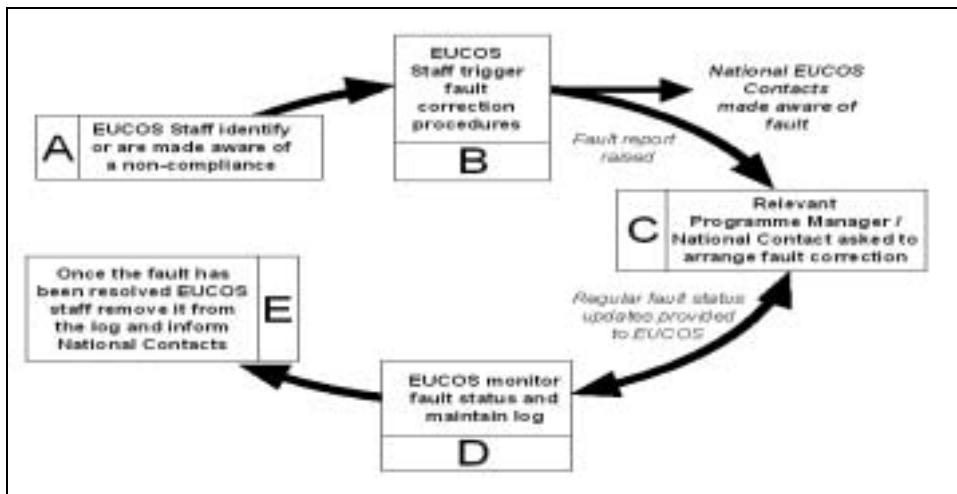


Figure 4: EUCOS Fault Correction Process

3. Operational Experiences with EUCOS

Having established the purpose for EUCOS, identified the user requirements, set operational targets and implemented monitoring and recovery mechanisms, one can now assess the performance of the Network. The operational elements of EUCOS are delivered through the EUMETNET Members and operational programmes for AMDAR data (E-AMDAR Programme), ship borne radiosonde data (E-ASAP Programme) and surface marine data (E-SURFMAR Programme). These operational programmes are key to the operational success of the EUCOS Programme and demonstrate the overall ethos of EUCOS, success through collaboration.

3.1 How well is the EUCOS network meeting user needs

Considering the requirements identified for EUCOS Programme a straightforward analysis of the current compliance to the requirements is possible. Areas of particular strength include the volume of E-AMDAR data, the timeliness of the E-ASAP fleet, the quality of the territorial upper air network and coverage of the drifting buoys within the E-SURFMAR Programme.

EUCOS Component	Network Coverage	Data Amount	Data Timeliness	Data Quality
AMDAR	Close to Target	Meets Target	Meets Target	Meets Target
ASAP	Not Meeting Target	Close to Target	Meets Target	Close to Target
Territorial Radiosonde Network	Meets Target	Close to Target	Close to Target	Meets Target
Drifting Buoys	Meets Target	N/A	Not Meeting Target	Meets Target

Figure 5: EUCOS Programme Performance

3.2 Improvement actions to overcome shortfalls

The following actions are being implemented to improve Programme performance:

- E- AMDAR network coverage will be improved by recruiting more airlines;
- E-ASAP distribution will be improved by reporting in areas where satellite observations are not available;
- E-ASAP data volumes and data quality will be improved by the further training of ships crews;
- Territorial Radiosonde Network coverage will be improved by jointly funded procurement exercises;
- Territorial Radiosonde Network timeliness will be improved by reducing telecoms routing latency;
- The E-SURFMAR Drifting Buoy volume target will be set once the network grows to the agreed density;
- Drifting Buoy data timeliness targets will be met by moving to alternative satellite telecoms systems.

3.3 EUCOS Studies Programme

To ensure the EUCOS Programme evolves and continues to meet customer needs for regional NWP a Studies Programme has been established. This programme includes the commissioning and analysis of Observing

System Experiments (OSEs) commissioned from a selection of European NWP centres, undertaking Special Observing Periods (SOPs) and reviewing the capabilities of new observing systems within the overall EUCOS Network. The results of the Studies Programme are reviewed by the EUCOS Scientific Advisory Team, chaired by Horst Boettger. If the results are considered statistically significant and changes to the networks are affordable then these changes are implemented to the operational networks. Details of the EUCOS Studies Programme results can be found at www.eucos.net

3.4 Examples of trends in Operational Performance

The E-ASAP Programme is tasked with delivering a radiosonde profiles in the North Atlantic and Mediterranean, with a focus on the areas considered as climatologically sensitive for the development of high impact weather in Europe. Although there are monthly variations in the performance of E-ASAP one can see a trend of improvement over the last four years. This improvement is mostly due to the careful efforts of the Programme Manager in training the crews, improving the reliability of the hardware and identifying and sharing best practice across the fleet.

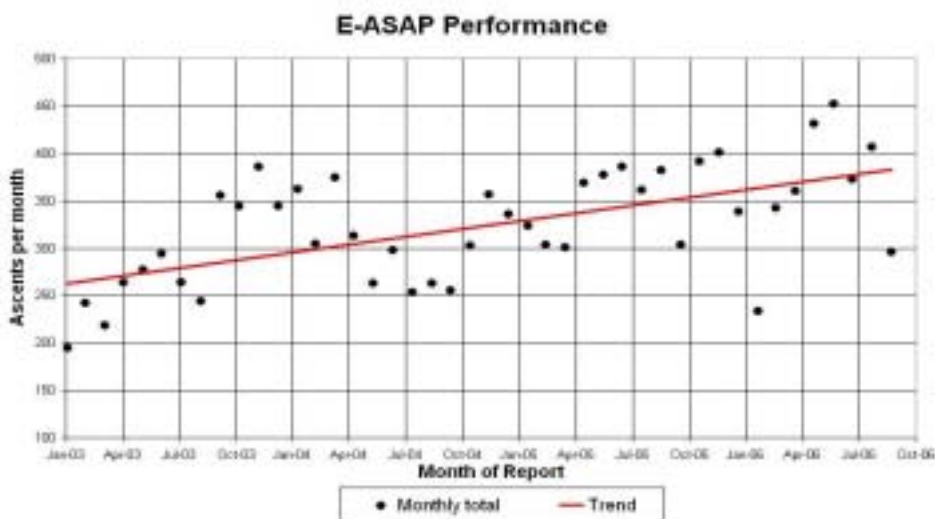


Figure 6: Trend in E-ASAP Performance

Not all trends within the EUCOS Programme are positive. There is a worrying trend in the mean burst height for the 49 EUCOS designated land based radiosonde stations. Many individual reasons can be cited for this gradual decline in operational performance. However there is no single dominant cause unless one considers the implicit impact of the economic pressure on the EUMETNET Members to reduce their operating costs.

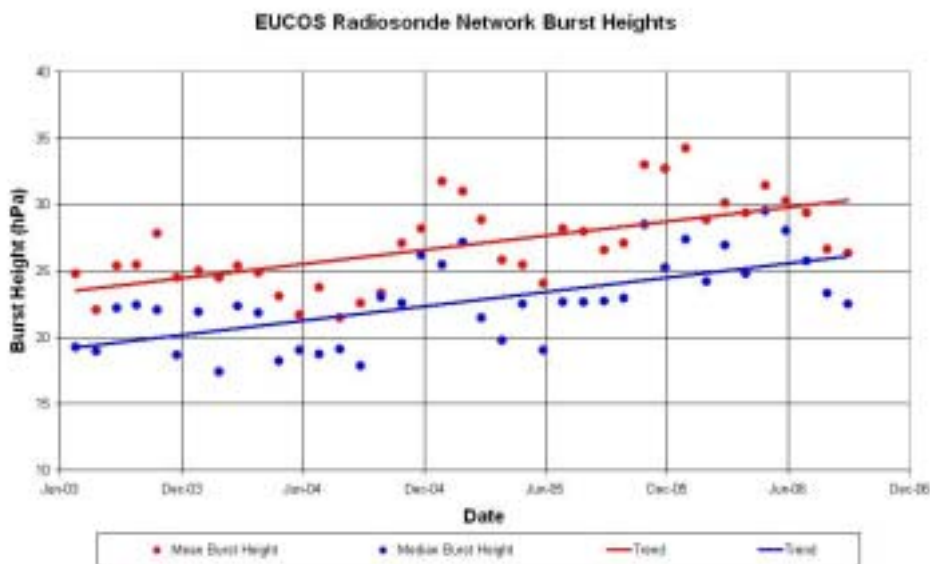


Figure 7: Trend in Radiosonde Network Burst Height

3.5 Long term plans for EUCOS Network Development

EUCOS is an ongoing operational programme where the deliverables evolve as a function of the needs of the European NWP centres. In the next five years the following activities have been identified as an important part of the evolution of EUCOS:

E-AMDAR Programme

- The further expansion of the E-AMDAR Programme to more airlines within the Membership;
- The co-ordination of the introduction of humidity measurement capability on AMDAR equipped aircraft;
- The development of a fully automated data targeting capability to enable the refined distribution of observations captured to reflect the needs of the user community for high impact weather forecasting.

E-ASAP Programme

- Further training of crews to reduce the radiosonde losses at launch, currently approximately 25% of total;
- Implementation of a reduced cost satellite telecoms system to enable data transmission costs to be reduced;
- Introduction of a data targeting system to allow radiosondes to be launched in sensitive areas for forecasts.

E-SURFMAR Programme

- Deploy sufficient drifting buoys to allow density requirement to be met at the 125% of threshold level;
- Implement a reduced cost satellite telecoms service;
- Implement spectral wave measurement capability on moored buoys for satellite measurement verification.

Territorial Observing Programme

- Redistribute investment in radiosonde networks into data sparse areas;
- Encourage the hourly exchange of surface data in line with Evolution of the GOS recommendations;
- Initiate a common procurement exercise to reduce costs to the Members with low volume usage.

Further details can be found in the Definition of EUCOS Programme 2007-11 Paper [Ref:2].

4. Opportunities for Capacity Building within WMO

AMDAR data has shown itself to have significant value for forecasting. Within Europe and North America the programmes in these areas can be considered to be mature. Within Europe the E-AMDAR programme has made significant investments in the infrastructure necessary to maintain a dynamic and responsive network. The National Met Services have worked closely with their national carriers to build strong relationships. This investment in infrastructure and relationships can be utilised by other Met Services by making the most of the AMDAR data that could be made available from the long haul fleets that are operated by the European Airlines.

SAWS, the South African Weather Service, are a very good example of this utilisation of the E-AMDAR infrastructure. They have established an agreement with E-AMDAR to enable additional AMDAR data to be made available in southern Africa, from both within South Africa and neighbouring countries. This capability, to switch on AMDAR data from the long haul fleets when they are outside the EUCOS Area of Interest is possible in other areas of the world. Thus AMDAR data can be made available in countries where no national AMDAR programme exists, assuming these countries airports are routinely visited by European AMDAR equipped airlines. Details of how this provision of data can be arranged can be obtained from the E-AMDAR Programme Manager, contact details available via www.eucos.net.

5. References

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