The EUCOS operational programme

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Abstract

EUCOS (EUMETNET Composite Observing System) is an initiative to improve Numerical Weather Prediction (NWP) products on the regional (European) scale. An outline is provided of the development and structure of the programme, which is expected to lead to progressively improved observational data sets by 2006. It is intended that EUCOS will evolve to form an optimised component of the total space-terrestrial observing system. In addition the contribution of targeted observations in sensitive areas (predicted by NWP schemes) is being investigated.

1 Introduction

EUMETNET is an informal grouping of 18 National Met Services, which provides a framework for collaboration and co-operation. EUCOS is a EUMETNET programme in the field of observing systems aimed at improving numerical weather predictions on the regional scale for 1-3 days ahead and introducing (where appropriate) integrated management and joint funding of programme elements. The EUCOS area of interest is, broadly speaking, the area from which observations impact on NWP, in the short range (Fig. 1).

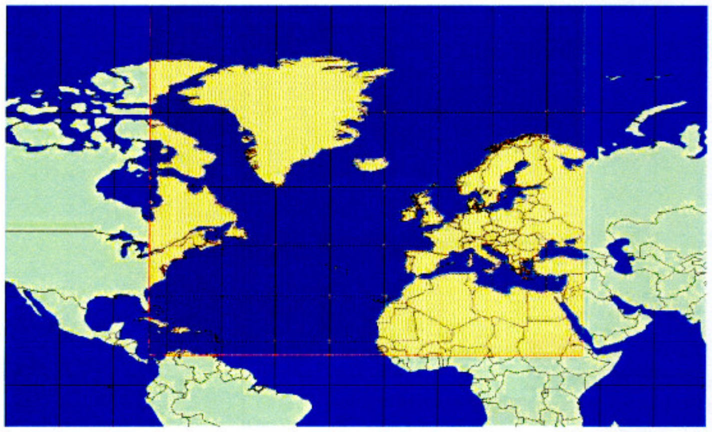


Fig. 1 The EUCOS area of interest (70W-40N, 10N-90N)

The challenge for EUCOS is to improve the quality and make more cost-effective regional NWP at European scale:

- through resource transfer from the mainly well observed territorial areas to the poorly observed maritime regions that exert a crucial influence on European weather at the 12 to 48 hour timescale.
- achieved by EUMETNET Members committing themselves to co-funding the new optimised facilities through a fair (GNI) cost sharing system.

EUCOS can also be regarded as a larger scale network across Europe and the surrounding sea areas that provides a framework for smaller scale networks (designed for very short range forecasting and nowcasting over national territories) and also contributes to medium range weather prediction over the globe. It can also be considered as an optimised regional component of the World Weather Watch of the WMO.

2 Programme structure

It was clear at the outset that more upper air observations were needed upstream if the goal of improved NWP was to be realised. The Atlantic and Mediterranean areas are data sparse but generate damaging cyclones across Europe. On the other hand, observational coverage across mainland Europe on the larger scale is in general fairly good. This implies that some resource transfer may be justified – from rather well to poorly observed areas. During the Implementation Phase of the programme (1999-2002) design studies were conducted leading to overall development strategies for the various components. These were then finalised taking into account issues of affordability. The current EUCOS operational design Ref (1) is summarised in (Fig. 2). Most effort at the present time is involved in implementing this design and completing definitions where necessary as the system evolves and develops out to 2006.

		2001 (RBSN, COSNA)	2006 (EUCOS)
Oceanic Segment	Ocean platforms	OWS "M" (4 RW/day) and Ekofisk rig (2RW/day) (2190 TEMP/yr)	
	ASAP units	10 operated by Members and E-ASAP, producing 3000 TEMPSHIP/yr	18 units operated by E-ASAP producing a minimum of 6300 TEMPSHIP/ year
	Data Buoys	Yearly deployment of approx. 50 drifting buoys operated under EGOS	To be defined pending Assessment under stage 1 of EUCOS Surface Marine Programme
	Moored buoys	EGOS buoys off the Continental shelf	
	Ships	Approximately 1700 VOS	
Aeronautic Segment	AMDAR units	140 aircraft operated by Members 8,000,000 msgs/yr	13,000,000 AMDAR observations/yr. Profiles from 140 European Airports and level flight data throughout the EUCOS area
Territorial Segment	Radiosonde Stations	69 stations, 19 with 4 RW/day 63,510 TEMP/yr	46 stations, 34 with 4 RW/day 59,130 TEMP/yr
	Surface Stations	359 RBSN stations	Selected surface synoptic stations (list currently subject to approval)
Observation Targeting	ASAP, AMDAR, BUOYS		Season and area variable Deployment and activation
	Other systems		To be defined according to the results from the studies programme

Fig. 2 The EUCOS Operational Design

The programme consists of a series of elements as outlined in (Fig. 3). A brief review is now given of the main programme components and the expected evolution out to 2006.

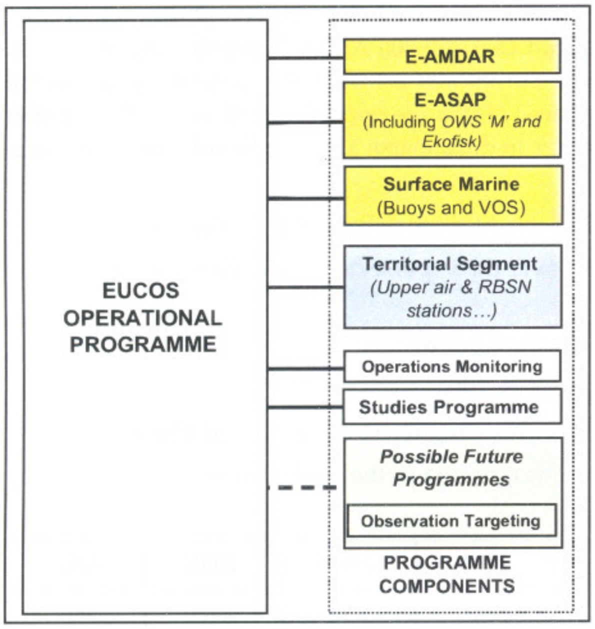


Fig. 3 The EUCOS Programme Components

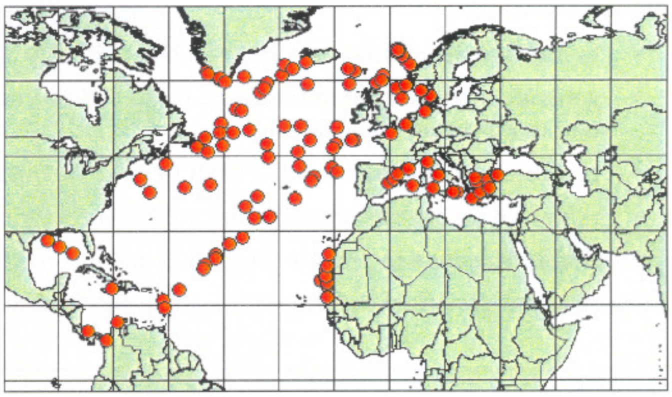


Fig. 4 ASAP Soundings, Feb 2003

3 Oceanic upper air segment (E-ASAP)

This encompasses upper air data from both commercial shipping and Ocean Weather Ship 'Mike' together with the Ekofisk platform in the North Sea. It forms an 'integrated' element of EUCOS which means that Members contribute on a GNI basis to the programme costs. The main programme objectives can be summarised as follows:

- reach a total of 18 ASAP ships providing 6,300 soundings per year by 2006.
- optimise the overall system – to provide homogeneous coverage (as far as possible) and appropriate temporal sampling.
- reduce the average cost of each profile through efficiency measures.

- maintain and (if necessary) replace major equipment components
- contribute to the WWW of the WMO through the ASAP Panel

A typical coverage map from the ASAP programme is shown in Fig (4) for Feb 2003. A total of around 3000 ascents are expected to be generated in 2003.

The expected deployment of the 18 ASAP units by 2006 is set out in the Table below:

Number of ASAP Ships	Route
2	Europe - Greenland
3	Channel - French West Indies / Caribbean
1	Between the Canary Islands - Spain
1	Iceland - Eastern seaboard of Canada / US
1	Greece/Turkey - NW Europe
1	Egypt - Italy
3	Channel - Charleston
3	Malta (mid. & west Mediterranean) - Newark
2	Channel - Montreal
1	Research vessel (WWW contribution)

4 Aeronautical segment (E-AMDAR)

This element provides profiles of wind and temperature data from aircraft from the ascent and descent phase as well as en-route observations (as desired). Data costs are a fraction of those from traditional radiosondes and although humidity measurements are not yet available they provide a lower cost alternative. During the implementation phase EUCOS conducted an upper air OSE that showed that 700-800 AMDAR profiles per day could largely offset a significant reduction in radiosonde ascents across Europe Ref (2). This work enabled a less dense more uniform EUCOS radiosonde network to be defined and offered NMSs the opportunity to re-design national networks to release resources for investment in improving coverage in data sparse areas. In broad terms the objectives are:

- to increase the number of airports where 3-hourly AMDAR profiles are delivered over Europe
- generate increasing numbers of en-route and profile data over data sparse/sensitive areas that are important to European weather forecasts
- procure data in support of the WMO World Weather Watch Programme
- achieve data capture of around 13 million messages per year by 2006.
- enable Members to procure additional data for national purposes beyond the EUCOS requirement.

The expected growth of the programme between 2003 and 2006 is outlined in the Table below.

Description	2003	2004	2005	2006
Number of airports observed daily (within EUCOS area)	100	110	125	140
'3 hourly' locations (Configured to complement EUCOS radiosonde stations)	25	28	32	35
Number of Profiles (within EUCOS area)	560	620	680	740
Data over sensitive EUCOS areas (Percentage of resources devoted)	15%	19%	24%	30%
WWW contribution (Resources devoted to data acquisition outside of the EUCOS area)	5%	7%	9%	10%
AMDAR observations (annual total)	8 million	9.5 million	11 million	13 million

The network has developed rapidly in recent years. Figures (5a) and (5b) show a comparison between the coverage in October 1999 and June 2003. It is hoped to improve coverage in data sparse areas and achieve better coverage during the period 00-06 UTC when currently few AMDAR aircraft operate.

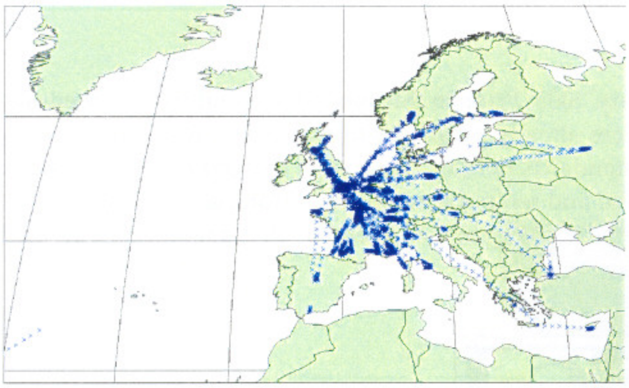


Fig. 5a European AMDAR coverage Oct 1999

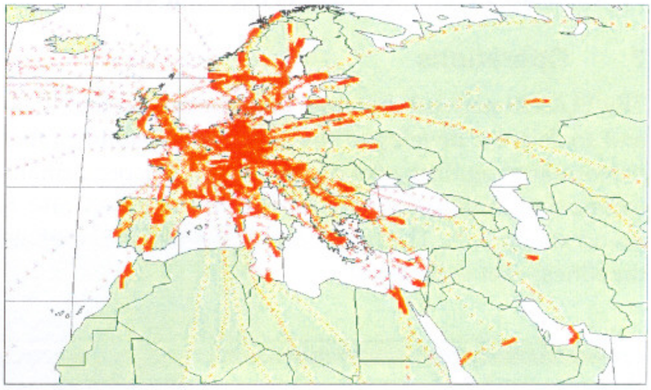


Fig. 5b European AMDAR coverage June 2003

The programme has established data optimisation and quality control procedures that enable selection of particular aircraft and routes as required. Further automation and development is envisaged to give greater flexibility to commission the data required on a day-to-day basis by selection across the entire 600 aircraft fleet. At the beginning of 2003 responsibility for this programme transferred to the Swedish Meteorological and Hydrological Institute.

5 Surface marine programme (E-SURFMAR)

This is a relatively new activity within the EUCOS framework and is currently supported by 15[2] of the 18 NMSs. It seeks to establish the EUCOS requirement for surface marine data from Voluntary Observing Ships, drifting buoys and moored buoys in the context of the other elements of the total system (especially space data). A study will be conducted across the next two years to develop an optimised design, following which is envisaged a period of progressive implementation as resources allow. This work proceeds in close co-operation with the European Group on Ocean Stations (EGOS). Météo-France has been given responsibility for this programme.

6 Territorial networks

As noted earlier the EUCOS upper air design relates closely to the expected growth of AMDAR data across Europe. A relatively homogeneous network of stations about 500 km apart was chosen as illustrated in Fig. 6. (The shaded areas indicate the 500 km region around the station)

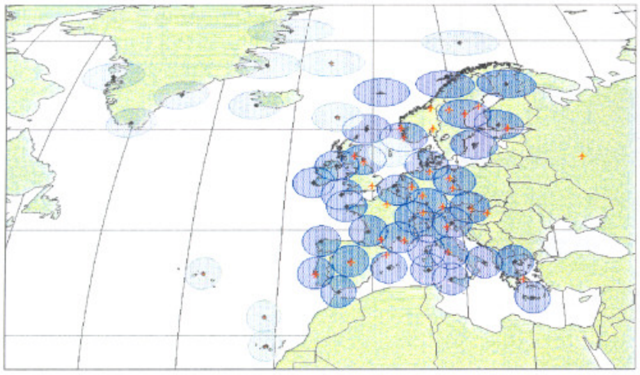


Fig. 6 EUCOS Upper Air Design

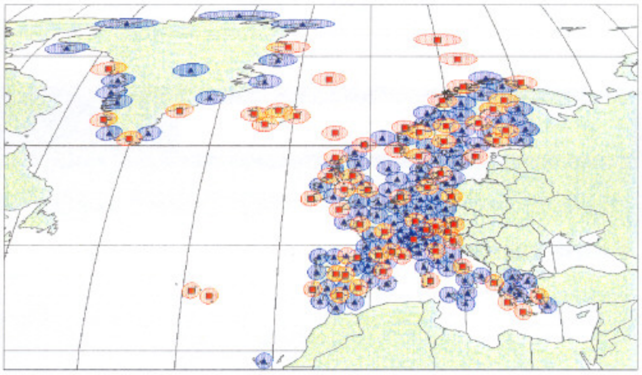


Fig. 7 Preliminary Surface Network

Most of these stations are expected to eventually perform 4 soundings per day (shown in blue, grey indicates 2 soundings per day). However, this network is now under review to take into account

- wider availability of AMDAR data than originally envisaged
- availability of new technology such as GPS, profilers and Doppler radar

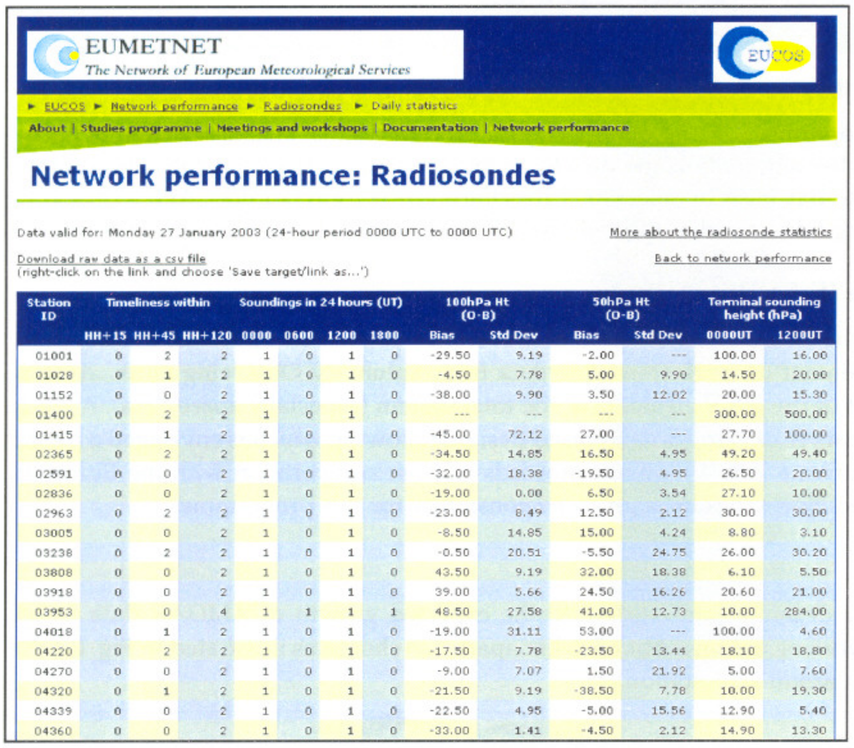
During the next year EUCOS will seek to develop a revised design taking these additional data sources into account.

2 SurfMar Participants: Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Netherlands, Norway, Portugal, Spain, Sweden and the United Kingdom.

A preliminary surface network design, Fig. 7, has been developed using WMO recommendations for surface observations in regional NWP (the red circles denote GCOS Surface Network Stations). A 250-km spacing has been used and a requirement for hourly observations agreed. Individual station lists for the national territories of the 18 NMSs are in the process of being finalised.

7 Operations

The EUCOS network became 'operational' on the 1st January 2003. Prior to this, network monitoring procedures and tools were developed (building on capabilities that were already available) to measure end-to-end network performance against a set of agreed EUCOS performance standards Ref (3). These were defined for each network component in terms of data availability, accuracy and spatial and temporal resolution (examples of which can be found at annex 1). The initial priority when operational monitoring began was to ensure that data availability and timeliness met expectations.



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Network performance: Radiosondes

Data valid for: Monday 27 January 2003 (24-hour period 0000 UTC to 0000 UTC)

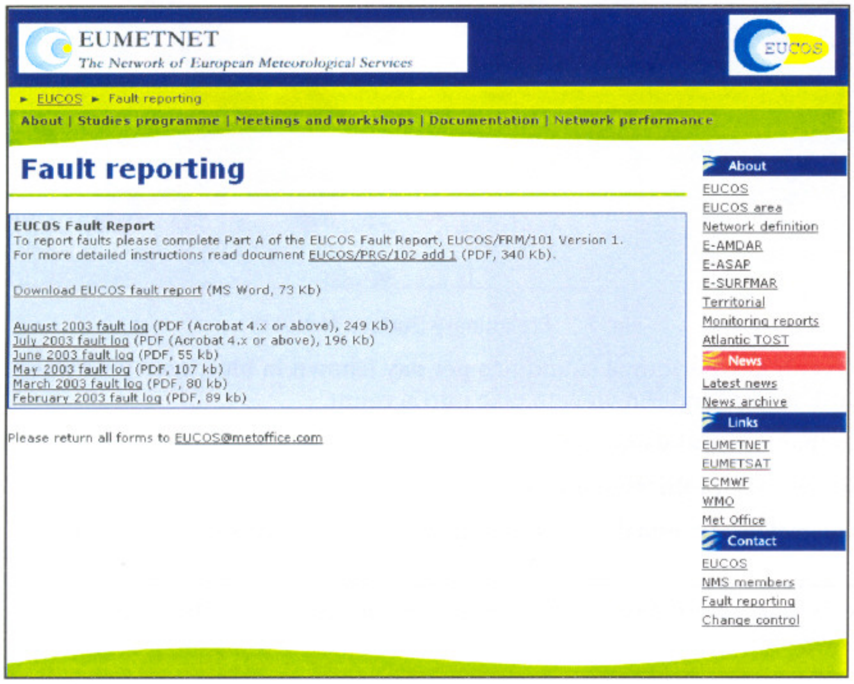
More about the radiosonde statistics

Download raw data as a csv file
(right-click on the link and choose 'Save target/link as...')

Back to network performance

Station ID	Timeliness within			Soundings in 24 hours (UT)				100hPa Ht (O-B)		50hPa Ht (O-B)		Terminal sounding height (hPa)	
	HH+15	HH+45	HH+120	0000	0600	1200	1800	Bias	Std Dev	Bias	Std Dev	0000UT	1200UT
01001	0	2	2	1	0	1	0	-29.50	9.19	-2.00	---	100.00	16.00
01028	0	1	2	1	0	1	0	-4.50	7.78	5.00	9.90	14.50	20.00
01152	0	0	2	1	0	1	0	-38.00	9.90	3.50	12.02	20.00	15.30
01400	0	2	2	1	0	1	0	---	---	---	---	300.00	500.00
01415	0	1	2	1	0	1	0	-45.00	72.12	27.00	---	27.70	100.00
02365	0	2	2	1	0	1	0	-34.50	14.85	16.50	4.95	49.20	49.40
02591	0	0	2	1	0	1	0	-32.00	18.38	-19.50	4.95	26.50	20.00
02836	0	0	2	1	0	1	0	-19.00	0.00	6.50	3.54	27.10	10.00
02963	0	2	2	1	0	1	0	-23.00	8.49	12.50	2.12	30.00	30.00
03005	0	0	2	1	0	1	0	-8.50	14.85	15.00	4.24	8.80	3.10
03238	0	2	2	1	0	1	0	-0.50	20.51	-5.50	24.75	26.00	30.20
03808	0	0	2	1	0	1	0	43.50	9.19	32.00	18.38	6.10	5.50
03918	0	0	2	1	0	1	0	39.00	5.66	24.50	16.26	20.60	21.00
03953	0	0	4	1	1	1	1	48.50	27.58	41.00	12.73	10.00	284.00
04018	0	1	2	1	0	1	0	-19.00	31.11	53.00	---	100.00	4.60
04220	0	2	2	1	0	1	0	-17.50	7.78	-23.50	13.44	18.10	18.80
04270	0	0	2	1	0	1	0	-9.00	7.07	1.50	21.92	5.00	7.60
04320	0	1	2	1	0	1	0	-21.50	9.19	-38.50	7.78	10.00	19.30
04339	0	0	2	1	0	1	0	-22.50	4.95	-5.00	15.56	12.90	5.40
04360	0	0	2	1	0	1	0	-33.00	1.41	-4.50	2.12	14.90	13.30

Fig. 8 EUCOS radiosonde station performance Web page. Web pages provide access to daily, and monthly, summary statistics for each EUCOS component



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Fault reporting

EUCOS Fault Report
To report faults please complete Part A of the EUCOS Fault Report, EUCOS/FRM/101 Version 1.
For more detailed instructions read document EUCOS/PRG/102 add 1 (PDF, 340 Kb).

Download EUCOS fault report (MS Word, 73 Kb)

August 2003 fault log (PDF (Acrobat 4.x or above), 249 Kb)
July 2003 fault log (PDF (Acrobat 4.x or above), 196 Kb)
June 2003 fault log (PDF, 55 kb)
May 2003 fault log (PDF, 107 kb)
March 2003 fault log (PDF, 80 kb)
February 2003 fault log (PDF, 89 kb)

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Fig. 9 EUCOS fault report web page. Providing access to fault logs and fault reporting instructions.

Routine data monitoring is carried out on a daily basis by the EUCOS Technical Co-ordinator, Jacqui Rogers (jacqui.rogers@metoffice.com), who is based within the Met Office, Exeter. She examines automatically generated performance statistics, raises and tracks fault reports and provides quarterly and annual network performance summaries to interested parties. All of this information is available on the EUCOS website. Figures 8 and 9 show some example pages.

Fault Correction Procedures have been established to encourage rapid rectification of problems. Network Change Control Procedures have also been developed to ensure that adjustments can be made to the EUCOS network in a controlled, co-ordinated manner if and when necessary.

The broad aim is to ensure that the components of the system perform in an increasingly effective way as time progresses. The success of this approach is demonstrated by the decision by COSNA in August 2003 to disband and entrust their observational data monitoring responsibility to EUCOS.

8 The studies programme

As noted earlier the evolution of EUCOS is guided by a Studies Programme – overseen by a Scientific Advisory Team chaired by ECMWF and comprising representatives from the main NWP centres in Europe. The 2003 activities include

- Observing System Experiments (OSEs)
- Technology demonstrations
- Network reviews

The three OSEs given priority in 2003 were:

- high-frequency AMDAR data: testing the benefit of more frequent AMDAR profiles from European airports (hourly as opposed to 3-hourly)
- additional surface marine data from climatologically sensitive areas in the Atlantic Ref (4)
- targeted observations (in conjunction with THORPEX - the 2003 Atlantic THORPEX Regional Campaign or A-TReC) Ref (5).

The most ambitious of these is the A-TReC. This is a field campaign whose special observing period (SOP) took place during October-December 2003. During the SOP a number of supplementary sources of remote and in situ meteorological observations were made available by European, US and Canadian meteorological organisations, in addition to the routine observing system. These included:

- dropsondes from up to four European and American research aircraft
- additional land-based radio-sonde ascents
- additional AMDAR reports from commercial aircraft
- additional radiosonde ascents from ASAP ships
- rapid-scan winds from geostationary satellites

All of these additional resources could be used adaptively (or targeted) by specifying the time and/or location of deployment. The aim was to test the benefit of targeting additional observations within regions and at times that were predicted to be particular sensitive.

In order to do this it was necessary for those taking part to:

- Collectively identify suitable cases to target (in terms of a forecast verification region and time)
- For each case, compare several predictions of the location of sensitive areas (provided by ECMWF, Météo-France, Met Office, NCAR and NCEP) and decide on the observation target regions. Figure 10 provides an example of a sensitivity prediction provided by ECMWF.
- Have in place mechanisms to deliver extra observations in these areas at short notice.

A-TReC was the first time that the real-time adaptive control of such a complex set of observing platforms had been attempted. It is considered to be an essential preparation and 'proof of concept' for future targeting field campaigns. In total some 30 cases were successfully targeted.

Now that the field phase of the A-TReC is complete, attention is focused on evaluating all aspects of the experiment. The results will provide guidance for future THORPEX campaigns and the evolution of the composite observing system. The assessment will cover:

- the operational decision-making process and the control of the observing system;
- predictions of sensitive areas;

- the impact of additional observations on forecasts.

These studies, if successful, may lead to progressively greater dynamic interaction between NWP schemes and observing networks.

Other aspects of the studies programme involve evaluation of new technologies including:

- TAMDAR (Tropospheric AMDAR): being developed by NASA, these may provide an inexpensive AMDAR solution including a humidity sensor. This system may be suitable for installation on small, regional aircraft.
- Driftsonde: a semi-targeted observing technology developed by NCAR that involves release of dropsondes from a gondola attached to a stratospheric balloon.

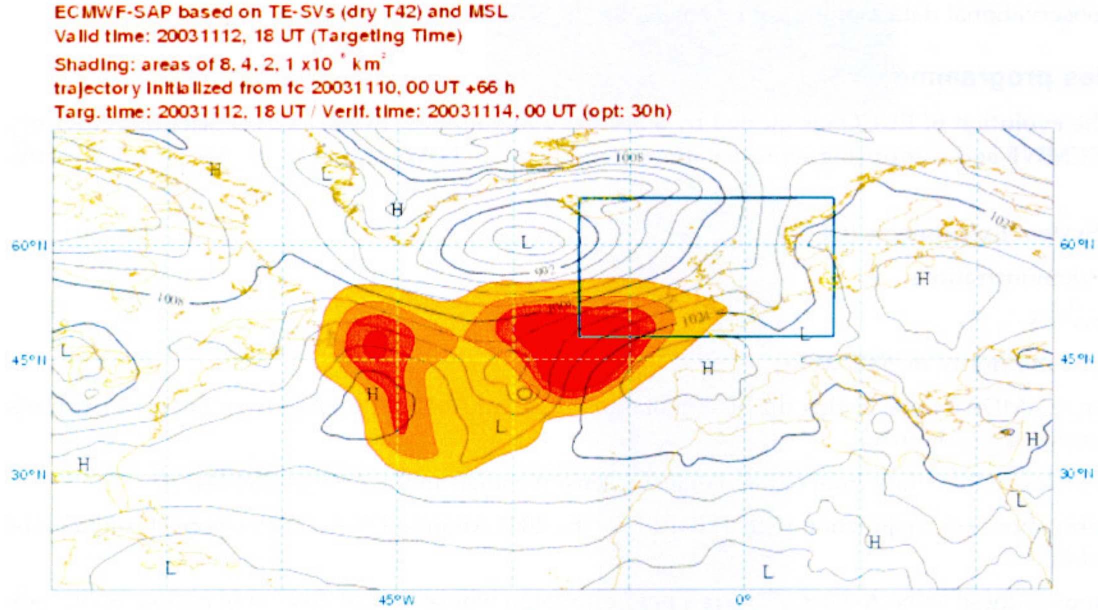

Fig. 10 An example of an A-TReC sensitivity prediction. The verification area (illustrated by the box) is predicted to be particularly sensitive to observations within the shaded region. The darker the shading, the more sensitive the region. The observation target time is 18 UTC 12/11/03 and verification time 00 UTC 14/11/03.

Annex 1: Examples of Performance Standards

AMDAR Aircraft

Observation cycle and horizontal resolution: As defined in the EUCOS Detailed Design [ref 1].

Whilst the network will be configured to generate soundings over airports with a maximum frequency of one every 3-hours from each location, inefficiencies within the optimisation systems are expected to result in greater numbers of profiles over some airports.

<table>
<tr><th>Data</th><th>Quality
(Ob – Model daily mean difference)</th><th>Availability of data</th><th>Timeliness
Of data</th></tr>
<tr><td>Temperature</td><td>1.0°K</td><td rowspan="3">21,500 Observations / day
(Based on 2003 target)</td><td rowspan="3">85%
of data received by Observation Time
+ 45 minutes
95 %
of data received by Observation time
+ 120 minutes</td></tr>
<tr><td>Wind vector</td><td>2.5 m/s</td></tr>
<tr><td>Spec Humidity</td><td>N/A</td></tr>
<tr><td colspan="4">Performance statistics based on those already adopted by E-AMDAR</td></tr>
</table>

ASAP Ships

Observation cycle and horizontal resolution: As defined in the EUCOS Detailed Design [ref. 1].

The current operating procedure requires each ASAP ship, when en-route, to provide 2 soundings per day, at 00 and 12UTC when at least 75nm away from land stations. When within coastal areas close to land stations taking soundings at 00 and 12 UTC the ships are asked to observe at 06 and 18UTC.

Data Element	**Quality** (Ob – Model daily mean difference)	**Availability of data**	**Timeliness Of data**
Temperature	1.0°K	**300 soundings per year / ship** (currently equates to 9 soundings per day from 11 ships)	85% of soundings (Parts A,B,C and D) received by Observation time +120 minutes
Wind vector	2.5 m/s		
Spec Humidity	10%		
O-M 100hPa Geopotential Ht difference	**65 m**		
% Achieving 100hPa	**90%**		
% Achieving 50hPa	**75%**		

References

1 EUCOS Detailed Design by **Francois Gerard**. EUCOS-PRG-010. September 2001

2 EUCOS Impact Study by **Carla Cardinali.** EUCOS-REP-029. September 2000

3 EUCOS Operational Report and Performance Target Review, **B.S. Truscott**, EUCOS Operations Manager, EUCOS/PRG/108, 17th May 2003

4 EUCOS Sensitivity Study by **Gert-Jan Marseille** and **Francois Boultier**. EUCOS-REP-30. September 2000

5 Atlantic-THORPEX Observing System Test, Atlantic-TOST Planning Team (**D. Manfield, D. Richardson, B. Truscott**), EUCOS/SP/105. 22nd August 2003.