J7.1 THE 2003 ATLANTIC THORPEX REGIONAL CAMPAIGN (TReC)

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SUMMARY

The Atlantic THORPEX Regional Campaign (A-TReC) is a field campaign whose 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, in addition to the routine observing system. These included:

- dropsondes from up to five European and American research aircraft
- additional land-based radio-sonde ascents
- additional (high frequency) AMDAR reports from commercial aircraft
- additional radiosonde ascents from ASAP ships
- driftsondes launched from east-coast North America
- rapid-scan winds from geostationary satellites

All of these additional resources can be used adaptively (or targeted) by specifying the time and/or location of deployment. This flexibility is important if these limited and in some cases expensive resources are to be used optimally. To do this it is necessary to identify in advance sensitive areas in which extra observations will have a significant impact on the skill of subsequent forecasts. A number of objective methods were used to do this.

During A-TReC is was necessary to identify suitable cases to target, provide information on the location of sensitive areas and have mechanisms in place 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.

Now that the field phase of the A-TReC is complete, attention is focused on evaluation of all aspects of the experiment. The results will provide guidance for future THORPEX campaigns and the evolution of the composite observing system. The assessment should cover the operational decision-making and control of the observing system, predictions of sensitive areas, and the impact of additional observations on forecasts.

The results of this TReC will be of significant interest to many within the meteorological and academic communities and the aim is to engage wide involvement in the assessment phase. The aim is to make TReC data widely available for this purpose.

1. INTRODUCTION

1.1 Overview

The EUMETNET Composite Observing System (EUCOS) Programme and THORPEX share a common goal of testing the hypothesis that the number and size of significant weather forecast errors over Europe and Eastern seaboard of the USA can be reduced by targeting extra observations over oceanic storm-tracks and other remote areas, determined each day from the forecast flow patterns. The Atlantic-THORPEX Regional Campaign (A-TReC) is planned as a field campaign to make a significant contribution towards this common goal. The primary aim of the A-TReC is to test the real-time quasi-operational targeting of observations using a number of platforms (including AMDAR, ASAP ships, extra radiosonde ascents and research aircraft). To do this, it is necessary to identify suitable cases for targeting, provide information on the location of sensitive areas, and have the facilities to control each observing system at short notice. A-TReC will be the first time that the real-time adaptive control of such a complex set of observing platforms has been attempted. It is considered to be an essential preparation or 'proof of concept' for future targeting field campaigns. Additional scientific objectives of the A-TReC will contribute to the understanding of the location and predictability of sensitive areas and the impact of targeted observations on forecast performance [and the benefit of potential new observing platforms].

1.2 BACKGROUND

The EUCOS Programme has been established under EUMETNET, a network grouping 18 Western European National Meteorological Services (http://www.eumetnet.eu.org). It has the following primary objectives:

- Define an integrated, ground-based composite observing system optimised at European scale with a view to improve short range forecast over Europe without increasing the overall cost.
- Provide a framework for co-ordinating observing system design studies -aiming at the definition mentioned above - and pilot projects to develop the necessary collective

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infrastructure for the future implementation of this network.
- Co-ordinate the implementation of the system, in line with EUMETNET Council's decisions concerning its definition.

A more detailed description of EUCOS can be found on the EUCOS web site, www.eucos.net.

THORPEX: a Global Atmospheric Research Programme is an international research programme to accelerate improvements in the accuracy of 1 to 14-day weather forecasts for the benefit of society and the economy. The programme builds upon ongoing advances within the basic-research and operational-forecasting communities, and will make progress by enhancing international collaboration between these communities and with users of forecast products. More information about THORPEX can be found on the THORPEX web site, www.mmm.ucar.edu/uswrp/programs/thorpex.html (see also paper J1.2, by M Shapiro in this Symposium)

The Atlantic-TReC will be the first THORPEX Regional Campaign to take place and will be the most significant THORPEX experiment so far. It follows on from the Pacific THORPEX Observing System Test (TOST) held earlier in 2003.

The Atlantic-TReC will also represent the largest of three OSEs planned as part of the EUCOS Studies Programme during the period 2002-2004. It consists of a two month Special Observing Period (SOP) which is likely to be followed by a short period of data processing before NWP Centres can start their impact assessment studies. The SOP is scheduled to start in **early to mid-October** and end by **mid-December 2003**. It is hoped that assessments will be completed by the **end of 2004**.

Three primary activities can be identified:
- Case identification, sensitive area prediction and target area selection;
- Delivery of additional observations;
- Impact assessment.

Each of these are discussed in more detail under section 3 of this document.

2. OBJECTIVES

The overall long-term objective of a fully adaptive observing system network is to optimise the use of costly and limited observational resources as well as to improve forecasts of high-impact weather events (as measured by their economic and societal benefits). The new concept of targeting uses information from numerical weather forecasts to identify when and where to make future observations in order to give the greatest benefit to subsequent forecasts. This feedback from forecasts to observations and then back through data assimilation to later forecasts is part of an envisaged interactive forecast system that eventually will see the two-way flow of information interactively from observations, through data assimilation and forecasts to end users and back. The development of such an integrated and interactive forecast system is one of the key long-term goals of EUCOS and THORPEX.

Previous trials of observation targeting include the FASTEX research campaign and the operational US Winter Storms Reconnaissance (WSR) program. In both of these campaigns targeting was used to direct dropsonde equipped research aircraft to appropriate locations. The Atlantic TOST will be the first time that the real-time adaptive control of a more complex and representative set of observing platforms (including AMDAR, ASAP ships, extra radiosonde ascents, driftsondes, research aircraft and Met Satellites) has been attempted. It is considered to be essential preparation for future targeting field campaigns, leading towards the THORPEX Global Prediction Campaign. EUCOS has already conducted initial trials of targeting obs through Special Observing Periods (SOPs) for the ASAP ships and Robotic Aircraft.

The Atlantic TReC is primarily a proof of concept experiment. It aims to test the ability to adaptively control the observing system network by directing where and when (and for what period) to make additional observations to supplement the routine observations. The experiment will also test and evaluate experimental observing systems [driftsondes, wind lidar, … *if these are confirmed].* The overall long-term objective of improving forecasts of high-impact weather events will guide the selection of appropriate cases for targeting during the Atlantic TReC. Attention will be focussed on short range (**24 to 72 hours**), **regional scale** numerical weather prediction over Europe and the eastern seaboard of the USA. Specific high-impact weather events of interest include extra-tropical cyclones and extra-tropical transition of tropical cyclones over these regions. A further guide to case selection will be forecast uncertainty. Higher priority will be given to situations where available ensemble predictions indicate a potential high-impact event, but with a large degree of associated uncertainty.

The benefits of the additional targeted observations for weather forecasts will be assessed so far as is feasible, in line with the overall EUCOS and THORPEX goals. However it is recognised that a full evaluation of the benefits of targeted observations is likely to require a substantial effort using a large database of events accumulated over a number of experimental campaigns. The data gathered during the Atlantic TReC will contribute to this database, and it is hoped that results of studies using the TReC data will be able to guide the planning of future experiments.

2.1 Real-time adaptive control of observations

The primary aim of the Atlantic TReC is to test the real-time quasi-operational targeting of observations using a number of platforms. To do this, it is necessary to identify suitable cases for targeting, provide information on the location of sensitive areas, and have the facilities to control each observing system at short notice. The Atlantic TReC will be the first time that the real-time adaptive control of such a complex set of observing platforms has been attempted.

The Atlantic TReC will be an 'operational' demonstration of the current capability for targeting. This will be carried out in a realistic international context, where:

- different sensitive area prediction methods may indicate different target regions for observations;
- targeting will be needed for more than one observation type
- there may be varying user requirements (different users may be interested in different forecast weather events).

Real-time decision-making processes necessary for the selection of target areas and deployment of observational resources will be developed and used in the Atlantic TReC. This it is hoped will provide a benchmark for future developments. Evaluation of the performance during the TReC and results of subsequent research on the impacts from the experiment will highlight key aspects where development is needed and guide future studies.

3. CASE IDENTIFICATION

The following guidelines were used to select suitable cases during A-TReC.

Definition of an interesting case:

A high (societal) impact weather event with large degree of uncertainty in the event taking place or in the regions affected. The main verification regions of interest are shown in Fig 1. Cases need to be identified 72-144 hours ahead. [The TReC will focus on taking observations to improve 24-72 hour forecasts; in addition 24-48 hours is needed to request additional observations.]

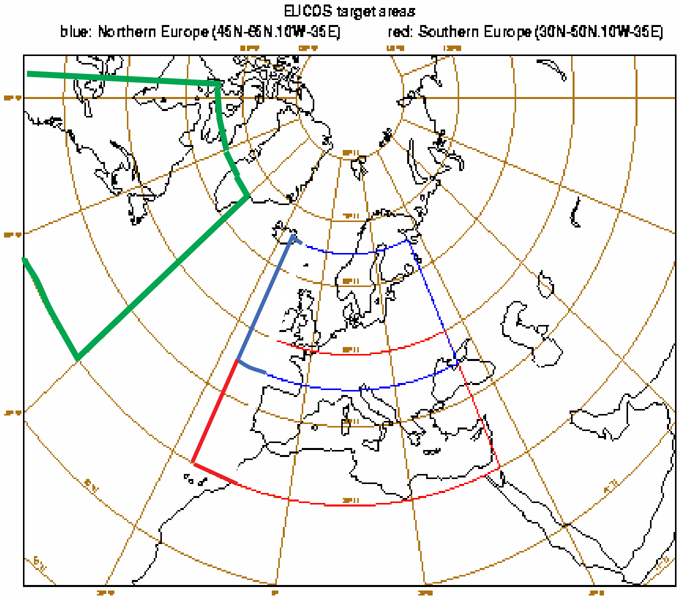

Figure 1: Verification regions for the Atlantic TOST. Northern Europe (15W-35E, 45N-65N), Southern Europe (15W-35E, 30N-50N) Western Atlantic (40W-85W, 30N-65N)

Lead times suggest that cases of interest will be restricted to Atlantic cyclogenesis threatening severe winds and possibly widespread heavy rain over the European verification areas, or east coast cyclogenesis leading to severe winds and/or snow storms over the eastern U S or Canada. (Snow over parts of Western Europe, especially British Isles, would have high impact, but unlikely this early in the season)

The decision on what constitutes a high impact event will be subjective and depend on the area threatened, but some guidelines for forecasters may useful. For wind over northern Europe we suggest 10m gusts ≥ 25m/s (~60kt) over highly populated areas. For rain the impact is less predictable and will depend on other factors such as rainfall over previous days. For the western Atlantic similar wind speeds may be appropriate –need idea of snowfall – is snow alone a problem or does there need to be enough wind for drifting? However, note that case selection will be based on forecasts with lead times of 72-144 hours, so it is not appropriate to give detailed specification of relevant high impact events to be identified in the forecast fields. Rather, the aim is to identify cases which (taking into account the forecast range) indicate the potential for high impact weather events.

The desired degree of uncertainty is even more difficult to define, and will usually decrease with decreasing lead time so that a case looking very unpredictable at t+120, may look much less so even before the extra targeted observations are due to be made. The most promising cases are likely to be those where a cyclogenesis event is reasonably probable, but the intensity and areas at risk are uncertain. However events such as the October `87 storm and the Christmas'99 storms were not strongly signalled by the EPS and though improvements have been made to the EPS since then, we should also consider cases where cyclogenesis appears in only a few members, especially if other members or deterministic models suggest a large scale environment where major cyclogenesis is possible. Any such high impact storms should be included as possible cases at least as far as calculating the sensitive areas. The cases could be dropped before the stage of requesting targeted observations if the result of the sensitive area calculations or subsequent forecast runs look unpromising.

4. SENSITIVE AREA PREDICTIONS

A number of methods were used to predict areas where additional observations are expected to be particularly beneficial. These were run in parallel throughout the TReC. This will provide a substantial sample over which to compare the predictions made using the different methods.

It should be stressed that some of the sensitive area predictions have a significant subjective component, requiring forecasters to identify features and regions of interest. Such a system can only be properly tested in a real-time, 'operational' situation. This is generally difficult to achieve, but was made possible as part of the TReC by specifically committing forecaster resources. Thus the TReC dataset of sensitive area predictions will be a valuable resource that would not otherwise be available.

As well as providing for comparison of sensitive area prediction methods, the dataset will be used to study the sensitive areas themselves. Where are they and how do they vary from day to day? What are the implications for the observing system (e.g. problems with satellite data in cloudy regions)? It will also provide an opportunity to compile more information about the climatology of sensitive areas based on different methods.

For A-TReC sensitive area predictions were made by ECMWF, the Met Office, Meteo-France, NCEP and NRL. Brief descriptions of the difference methods are given below; example plots from one of the early TReC cases – trec_007 – are shown in Annex 1. Investigation of the similarities and differences between the methods will form part of the post-TReC assessment. Where possible, targeted observations were taken in all locations identified as potentially important by any of the methods. This will allow comparison of the utility of each technique and will also provide 'null' cases to test for a single method, the relative benefits of observations taken inside and outside sensitive areas.

ECMWF sensitivities were made using three different version of the singular vector (SV) method. The total energy singular vectors (TESVs) use a dry version of the ECMWF tangent-linear model (T42 resolution) with total energy metric at initial and final time (Buizza and Montani, 1999). For the Hessian SVs, the initial norm is replaced by an approximation of the Hessian of the analysis error covariance matrix (Barkmeijer et al., 1999). Moist singular vectors (MSVs) include moist processes in the forward and adjoint models (Mahfouf, 1999), run at TL95 resolution with total energy initial and final norms.

Meteo-France also use the singular vector method (dry, with total energy norms) using the Meteo-France model. Practical considerations limited the forecast range for which computations could be made. Hence in the case trec_007 for example the verification time was set to 06 UTC on 30 October rather than the assigned 12 UTC.

The Met Office and NCEP both used the Ensemble Transform Kalman Filter (ETKF, Bishop et al. 2001, Majumdar et al. 2002). Met Office calculations are based on the ECMWF Ensemble Prediction System (EPS, Buizza et al. 2003) with a targeted observation time of 18UTC. The NCEP calculations also use members of the NCEP ensemble, but are only available for targeting times of 12 UTC or 0 UTC (see wwwt.emc.ncep.noaa.gov/gmb/targobs/ATOST/).

The NRL sensitivities are made using the adjoint of both the forecast model (NOGAPS) and the Navy data assimilation scheme (NAVDAS). For further details see Langland and Baker (paper J7.9 in this Symposium) and www.nrlmry.navy.mil/shared-bin/adap/adap.cgi.

5. OBSERVATIONAL PLATFORMS

The following observing systems were used during the Atlantic TReC to take additional observations to supplement the routing observing network.

5.1 AMDAR Aircraft

This fleet of more than 600 European aircraft are operated by the EUMETNET-AMDAR Programme (a component of EUCOS). They are controlled using ground based 'Optimisation Systems' developed by airlines. These systems activate the aircraft automatically to satisfy a predefined observing programme over Europe (in terms of the frequency at which profiles are required over

European airports) and to deliver data when the aircraft fly to/from selected long-haul destinations. Although relatively few observations will be available over many parts of the poorly observed Atlantic, the aim will be to deliver the greatest number possible within the defined target areas.

5.2 ASAP Ships

Approximately 13 European ASAP ships will be operating in the Atlantic at the time of the SOP. These will be co-ordinated under the EUMETNET-ASAP Programme, another component of the EUCOS Programme. They will routinely conduct up to four soundings each day but will be asked to make additional launches when required. No US or Canadian ASAP units will be available.

5.3 Additional radiosonde ascents

Additional launches will be provided on request from European and eastern US and Canadian stations. The stations able to provide this service will be identified in advance as it is understood that local constraints (such as staff availability) will mean that not all sites can make additional launches. These stations will be expected to conduct their normal observing programme and carry out additional soundings when requested.

5.4 Research aircraft

The availability of research aircraft during the TReC is shown in the table in Annex 2.

5.5 Driftsonde Flights

Support for continued development and testing of driftsondes may be possible from NSF. NCAR would operate this system, which has recently moved into the proof-of-concept phase. It is hoped that Driftsondes will be operated from Bangor, Maine. The deployment of four gondolas is currently planned, each having a capability of releasing 20 dropsondes on demand. This is considered an interesting emerging technology that has the potential to make a useful contribution towards the experiment.

5.6 Satallite Rapid Scan Winds

EUMETSAT operated Meteosat-6 to provide rapid scan winds (10 minute interval). It was not possible to redefine the scan region during the SOP, so a single, large area will be adopted covering a large part of the Northern Atlantic. Some early products from MSG may also be available.

Special GOES scanning strategies were set up for the TReC. Due to operational requirements, it will not be possible to achieve a continuous rapid-scan cycle, instead an SRSO (Super Rapid Scan Operations) will be triggered when we have an observation target area within the GOES footprint. This special scan will provide rapid imaging for 8-minute periods, one period every hour, for 6-8 consecutive hours (routine duration of an SRSO).

6. OPERATIONAL ASPECTS

The Atlantic-TReC is a large international field campaign depending on the joint activities of many centres and countries, spread over several time zones. As such, success will rely on close co-ordination with a clear command structure and effective communications between all collaborators.

Central to the process is the Operations Centre which assumed the lead during the SOP, working on a 24/7 basis to control the decision making and co-ordinate the TReC on a daily basis. The daily schedule was based on the following considerations:

- Nominal **18UTC observation time** (daylight flights over Atlantic)
- Time required for calculation of sensitive areas (after identification of suitable cases)
- Involvement of N.American centres in discussion of target area selection
- Approx. 48 and 24 hour notice required to observation systems operators

The Operations Centre leads activities for the whole of the SOP, issuing instructions and guidance to be followed by all other TReC groups such as the Sensitive Area Prediction Centres (SAPCs), Observation Command Centres (OCCs) and observing system operators. The Operations Centre consisted of a small team located within the Met Office’s National Meteorological Centre, Exeter who communicated on a daily basis with other international teams. Twice-daily telephone conferences were used to discuss case selection and the results of the sensitivity calculations. The Ops Centre had overall responsibility for case selection, target area selection, and requesting observation deployment.

While the Operations Centre took overall command of the field campaign, the OCCs had the responsibility of co-ordinating all aspects of the observation systems and reporting back daily to the Operations Centre on the status and availability of the observation systems. The role of the OCCs was to co-ordinate commissioning of the additional observations requested by the Operations Centre and to ensure the observations were gathered, communicated and archived.

7. ASSESSMENT / IMPACT STUDIES

The outcomes of the Atlantic TReC need full and careful evaluation to provide guidance for future THORPEX campaigns and the evolution of the composite observing system. The assessment should cover the operational decision-making and control of the observing system, predictions of sensitive areas, and the impact of additional observations on forecasts.

The choice of impact study is dependent on the type and number of cases that occur during the SOP. Given this uncertainty, it was not appropriate to give precise objectives for impact study experiments in advance of the SOP. Rather, a number of options will be considered and final decisions will be made depending on what data and cases occur. These will be documented within the Science Assessment Plan, which will be prepared shortly after the SOP. The basic objective will be to provide guidance on the value of additional observations over the N Atlantic region. If there are a number of significant cases then further more detailed information may be possible.

Full details of each TReC case have been recorded in case history files. The information includes the reasoning behind the selection of cases, and the forecasters expectation of the benefit of the additional observations. The actual weather outcomes are also recorded. It is hoped that these records will be useful during the evaluation, especially in the difficult process of assessing the potential 'real-world' benefit of the targeted observations. A sample case history file for trec_007 is included at Annex 3 (not complete at this stage).

An outline of possible impact study experiments is given in Annex 2 of the Project Plan; information on centres that plan to contribute to these studies is given in Section 5 of the same document

Assessment of the benefit of the additional observations will as far as possible follow the guidance given in the THORPEX Science Plan. However it is recognised that the Atlantic TReC campaign alone is unlikely to provide sufficient data for a full evaluation of for example the economic benefit of targeted observations. Despite these limitations it is hoped that the Atlantic TReC data will be a useful test-bed for the development of evaluation tools, again providing a basis for future studies.

Atlantic-TReC cases will also be used, together with the FASTEX data and that from other (and future) experiments to build up a database containing a large number of data targeting cases. This it is hoped will provide a valuable resource leading to conclusive results and thus providing the guidance necessary to inform the future evolution of the observing systems

8. FURTHER INFORMATION

The full Project and Operations plans for the Atalntic TReC can be obtained from the WMO THORPEX website at
www.wmo.int/web/arep/wwrp/THORPEX/atlantic_ob_system.htm

Sensitivity calculations from ECMWF, Met Office and Meteo-France were placed on the TReC website at

http://nwmstest.ecmwf.int/products/forecasts/d/charts/tost/

The NCEP sensitivities and additional TreC information are available at

http://wwwt.emc.ncep.noaa.gov/gmb/targobs/ATOST/

NRL sensitivities and additional information are at

http://www.nrlmry.navy.mil/shared-bin/adap/adap.cgi

9. REFERENCES

Barkmeijer, J., Buizza, R. and Palmer, T. N., 1999. 3D-Var Hessian singular vectors and their potential use in the ECMWF Ensemble Prediction System. *Q. J. R. Meteorol. Soc.*, **125**, 2333-2351.

Bishop, C.H., Etherton, B.J., and Majumdar, S.J., 2001: Adaptive sampling with the ensemble transform Kalman filter. Part I: Theoretical aspects. *Mon. Wea. Rev.*, **129**, 420-436.

Buizza, R., Richardson, D.S. and Palmer, T.N., 2003: Benefits of increased resolution in the ECMWF ensemble system and comparison with poor-man's ensembles. *Q. J. R. Meteorol. Soc.*, **129**, 1269-1288.

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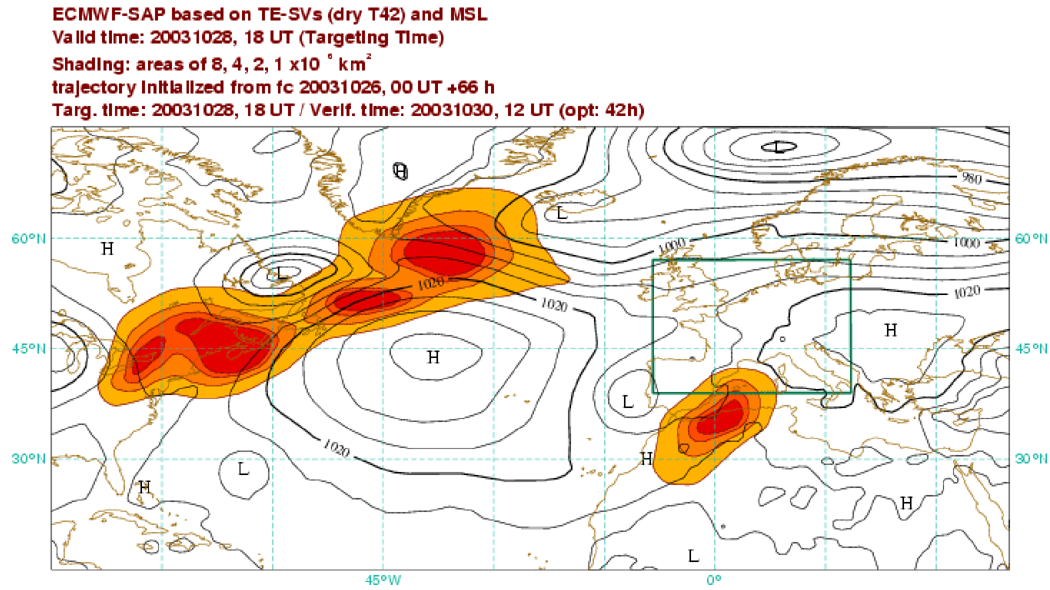
Majumdar, S.J., Bishop, C.H. and Etherton, B.J., 2002: Adaptive sampling with the ensemble transform Kalman filter. Part II: Field program implementation. *Mon. Wea. Rev.*, **130**, 1356-1369.

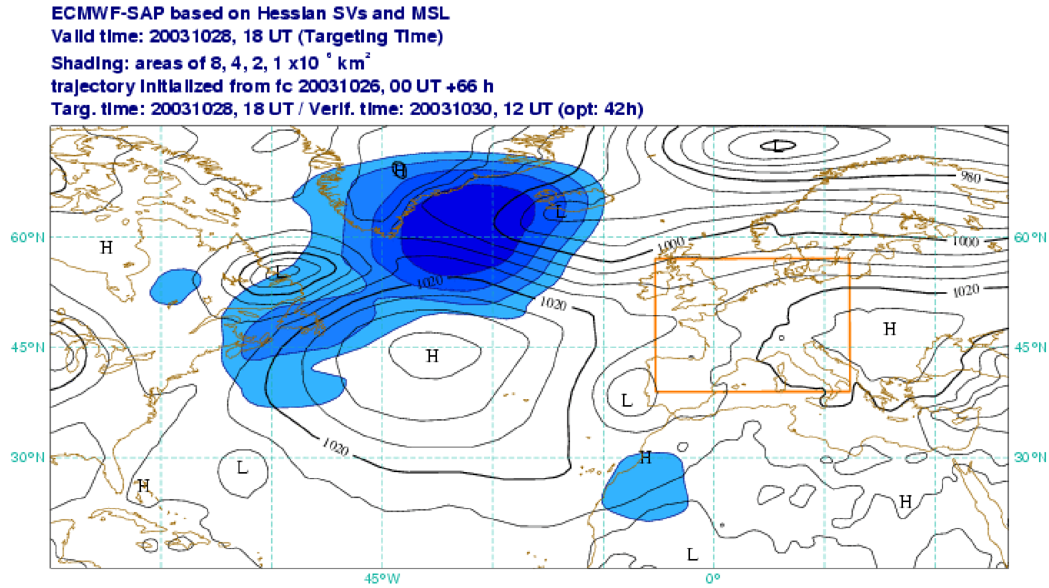
Mahfouf, J.-F., 1999: Influence of physical processes on the tangent-linear approximation. Tellus, 51A, 147-166.

Annex 1. Example sensitive area predictions for TReC 007

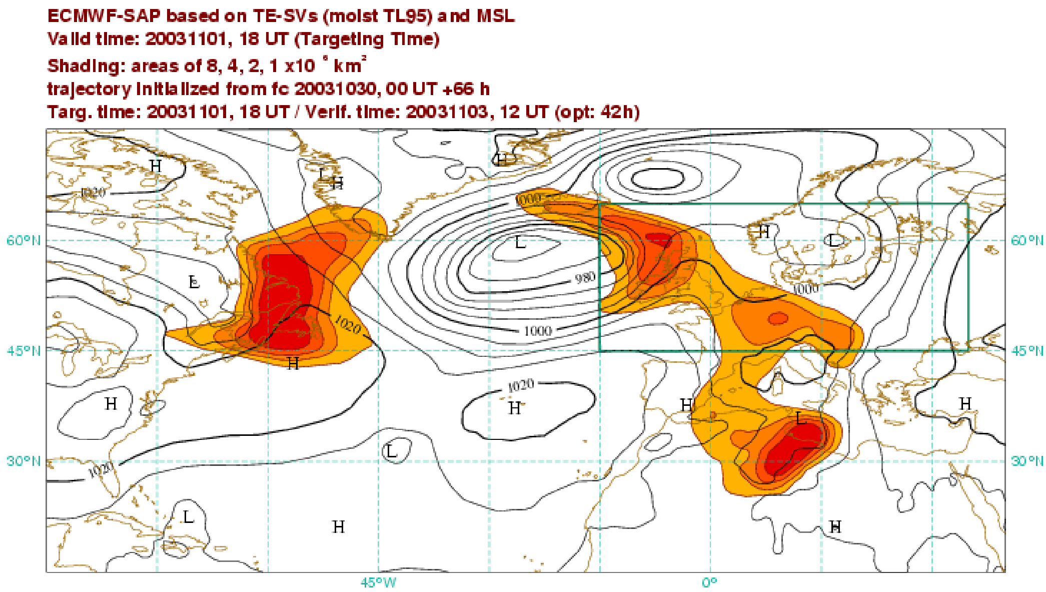
The selected verification time was 12 UTC on 30 October 2003 and the chosen observation target time was 18 UTC on 28 October 2003. The chosen verification area is shown on the plots. The mean sea-level pressure fields (where shown) are from the ECMWF deterministic forecast started from the initial time given in the figure title; these fields give helpful guidance in orientation and relating the sensitivity fields to the meteorological situation, although, particularly in the case of the Met Office sensitivities, it should be remembered that the field shown is only one of the various possible situations and that the ensemble forecasts can show significant variations from this. For further details on the contents of each plot see the references (and websites given in the Further Information Section)



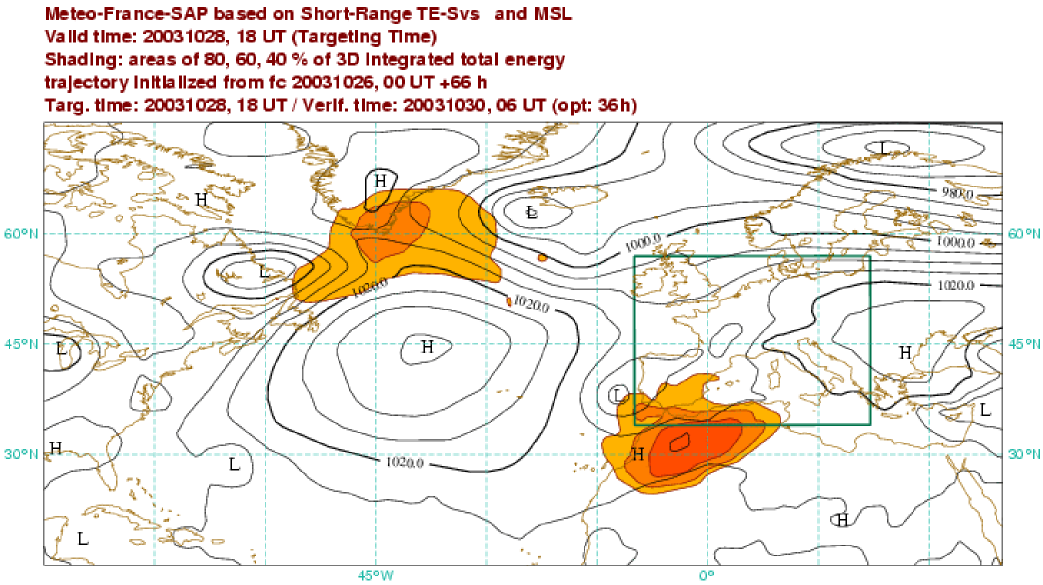
a. ECMWF Total Energy singular vector summary map.



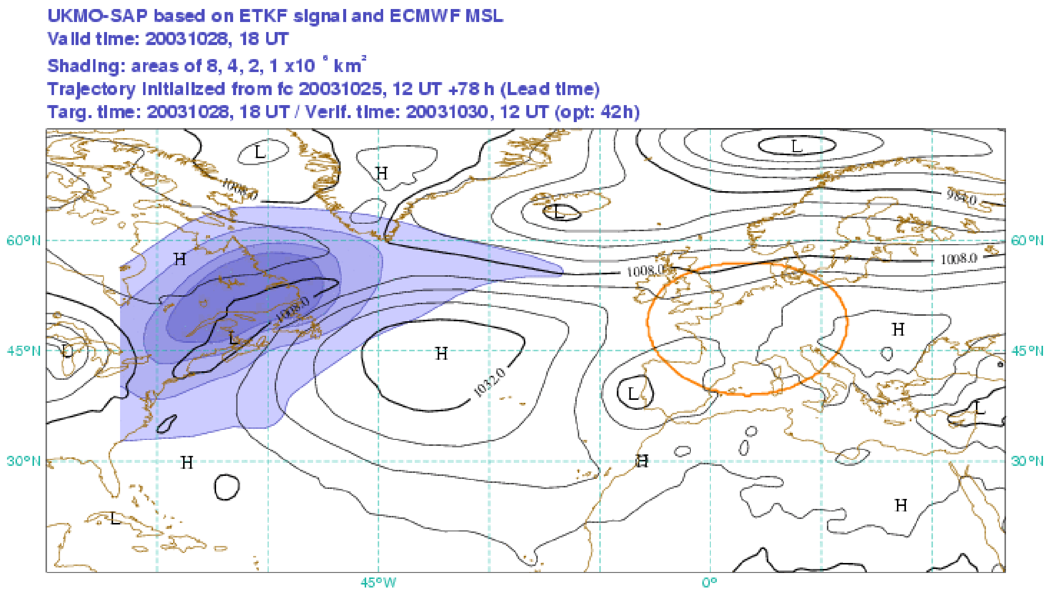
b. ECMWF Hessian singular vector summary map



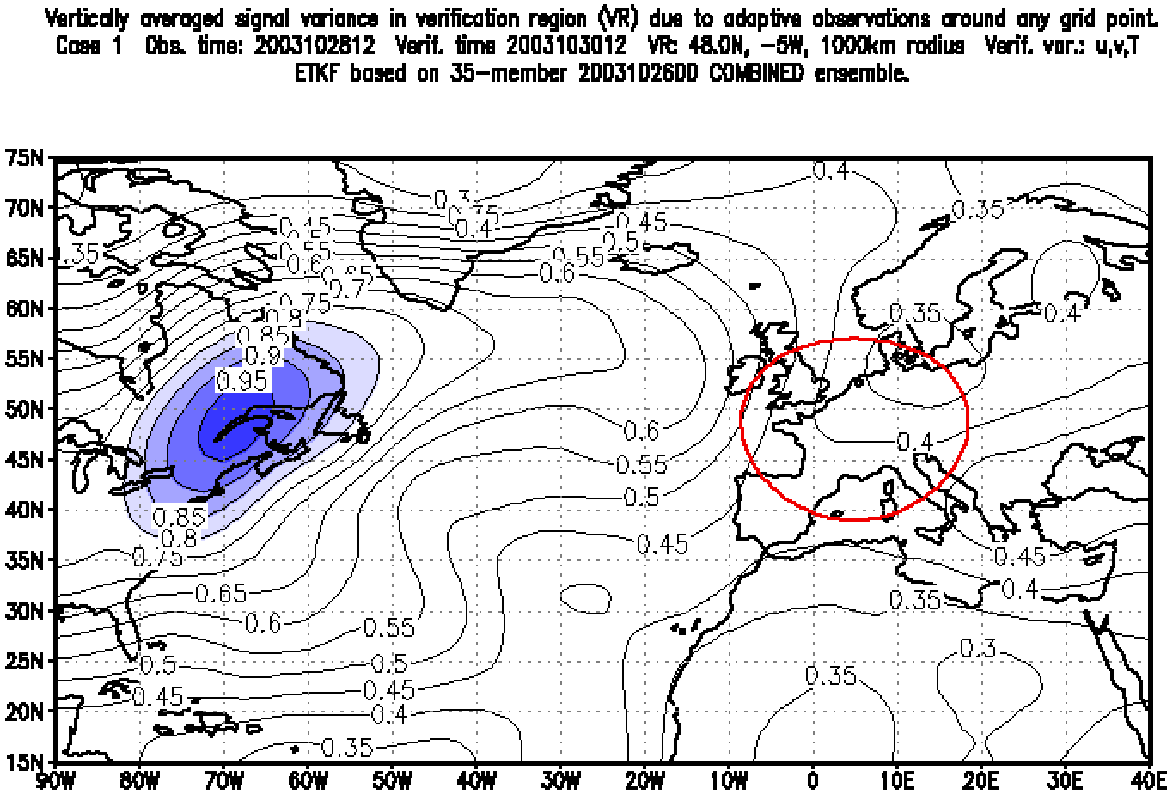
c. ECMWF moist singular vector summary map (total energy)



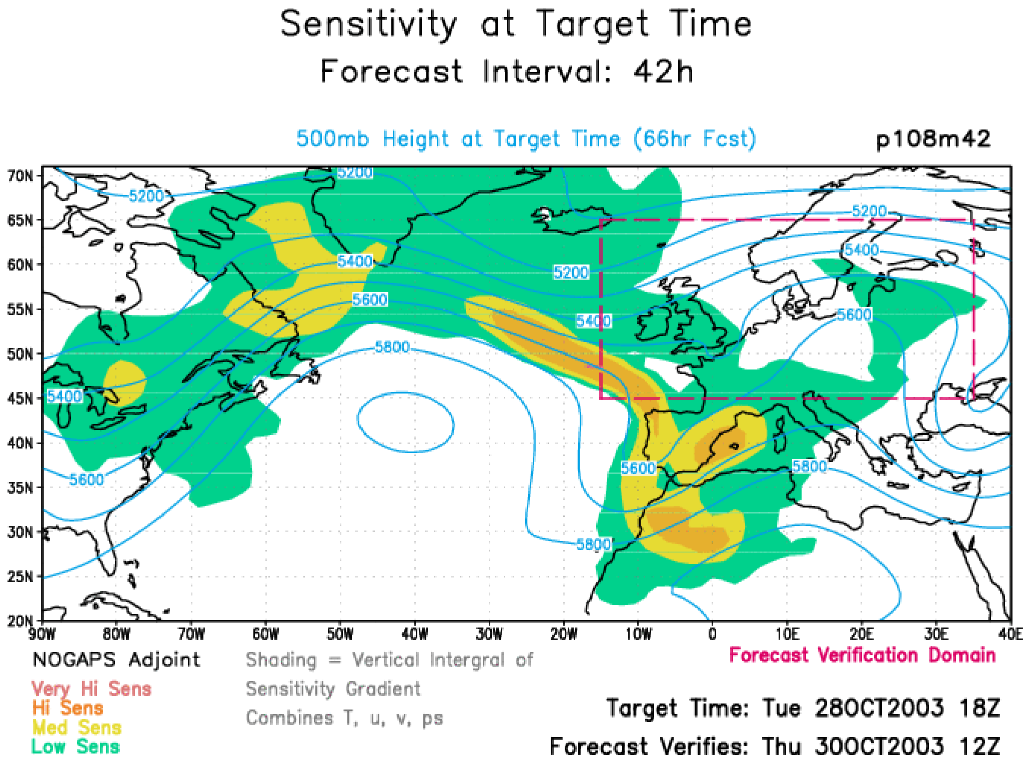
d. Meteo-France total energy summary map



e. Met Office ETKF summary map (using ECMWF ensemble)



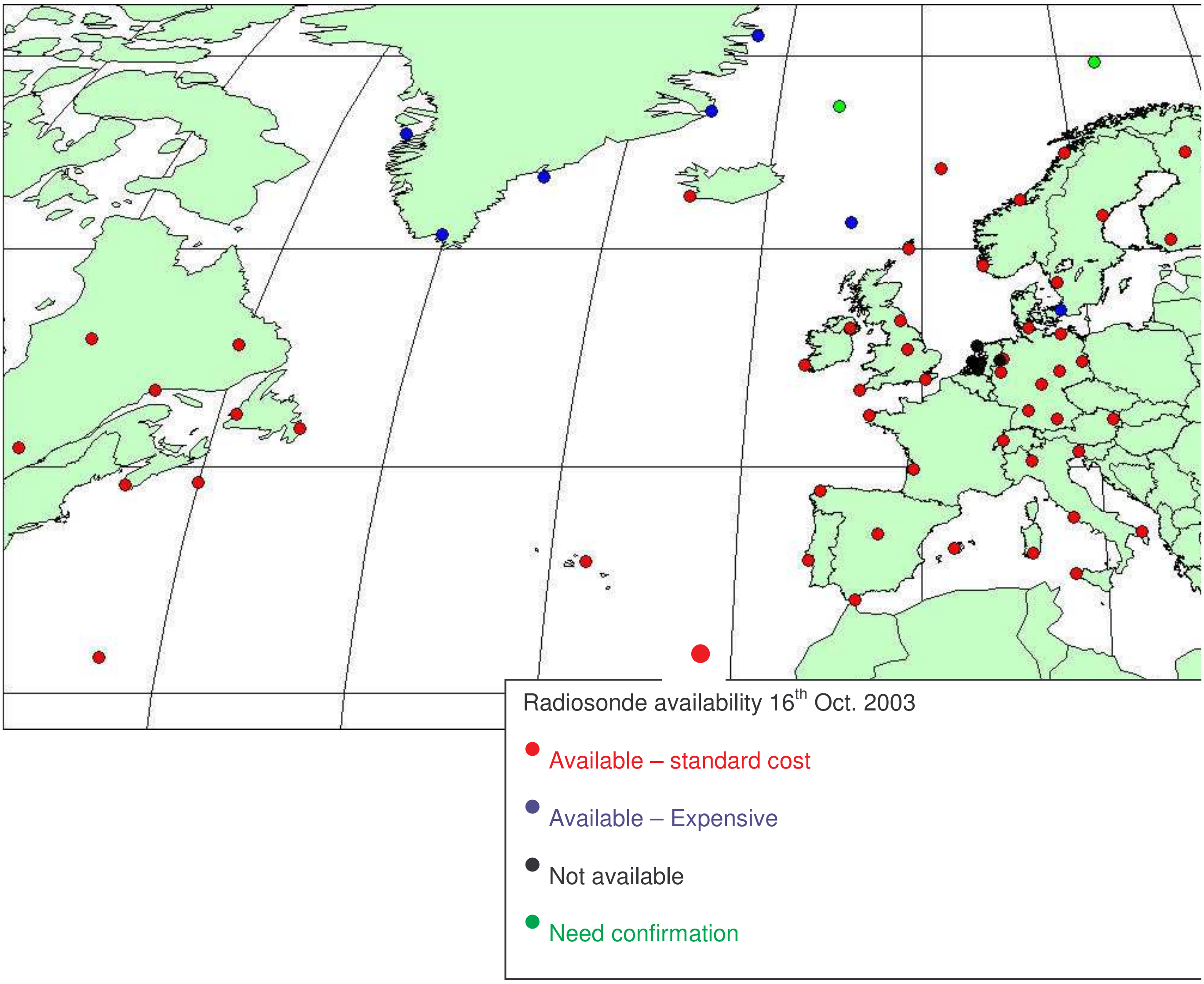
f. NCEP Office ETKF summary map (using ECMWF and NCEP ensembles)



g. NRL adjoint sensitivity summary map

Annex 2. Radiosonde locations and research aircraft availability

Chart shows locations of radiosondes (for example case of 16 October) that can be targeted in TReC. Additional launches can be requested at up to 3-hourly intervals to supplement the routine 0 and 12 UTC ascents.



The research aircraft listed in the table below will, it is hoped, provide dropsonde and other measurements (such as wind lidar from the DLR Falcon).

Aircraft	Operator	Targeted Dropsonde capability?	Operating Base	Available Flying Time (directly in support of the NA-TOST)	Availability		
					Duration	Start Date	End Date
DLR Falcon	DLR	Yes	Iceland (Kevflavik) (with the possibility of deploying to other locations)	30 hours (5 flights: 50 dropsondes in total)	2 weeks	6th Nov	21 Nov
NOAA G-4	NOAA	Yes	St Johns (with the possibility of deploying to other locations)	To be defined	1 month	15th Nov	12th Dec
Citation	UND	Yes	Bangor, Maine	30-40 hours	1 month	18 Nov	18 Dec
ER-2	NASA	No	Bangor, Maine	30-40 hours	1 month	18 Nov	18 Dec
Convair 580	Canada	Yes	Halifax / St Johns	4 flights – 150 dropsondes	TBD	Early Oct	Late Oct
C-130 (J and H models)	US Air-force	To be confirmed #	To be confirmed	To be confirmed	To be confirmed	tbc	tbc
# Some preliminary discussions have also begun with the US Air Force to investigate whether they could alter their training schedule to include some dropsonde missions in support of the Atlantic-TOST.							

Annex 3. Example TReC Case history file (trec_007)

Case history file for TReC

Case number	Trec_007
Case description	Upper trough swings southeast from Denmark strait over northwest Europe. Potential for several developments, baroclinic cyclogenesis on the forward side of the trough, cold air low in the base of the trough or lee cyclogenesis over the Mediterranean. Difficult to pick a surface feature to verify so instead we aim at the upper trough itself. Surface low over northwest France became verification feature by Monday 27th conference

Case parameters:

Parameter	Conference date (UTC)			
	20031026 0900	20031027 0900	20031028 0900	
Verification region	Northern and southern Europe, centre 48N 05E	Northern Europe Centre 49N 02W	Northern Europe Centre 49N 02W	
Verification time (UTC) -	20031030 1200	20031031 0000	20031031 0000	
Observation time (UTC) -	20031028 1800	20031028 1800	20031028 1800	
Priority	medium	medium	medium	

Observation deployment requested: Yes.

Reason for deployment request/non request:

The case was considered to be medium priority because of the uncertainty about the strength of the winds over western Europe and precipitation over the Mediterranean. Additionally, the sensitive areas were found to be over the radiosonde networks of north-east Canada and Greenland/Iceland and southern Europe. Given that observation resources were available from these stations, observation requests were issued.

Observation deployment plan:

28th October 2003

System
Request

Canadian radionsonde
71600, 71603, 71801, 71811, 71815 & 71816: 18 UTC

Portugese radiosonde

08522, 08579: 18 UTC

Uk radiosonde

08495: 18UTC

Spanish radiosonde

60018, 08302, 08221: 18UTC

AMDAR

Data with target area:

1. 40N-60N, 75W-50W
2. 50N-70N, 50W-20W
3. 25N-40N, 17W-15E

ASAP

Data within any of the above target regions
(unlikely to be any available)

GOES-12

Centred 48N, 55W

29th October 2003

System Request

Canadian radionsonde

71811, 71815 & 71816: 06 UTC

Icelandic radiosonde

04018: 18 UTC

Greenland radiosonde

04270, 04360 & 04339: 18 UTC

Spanish radiosonde

08302: 06 UTC

AMDAR

Data within target area:
2. 50N-70N, 50W-20W

GOES-12

Centred 48N, 45W (Informed on 28th Oct unavailable)

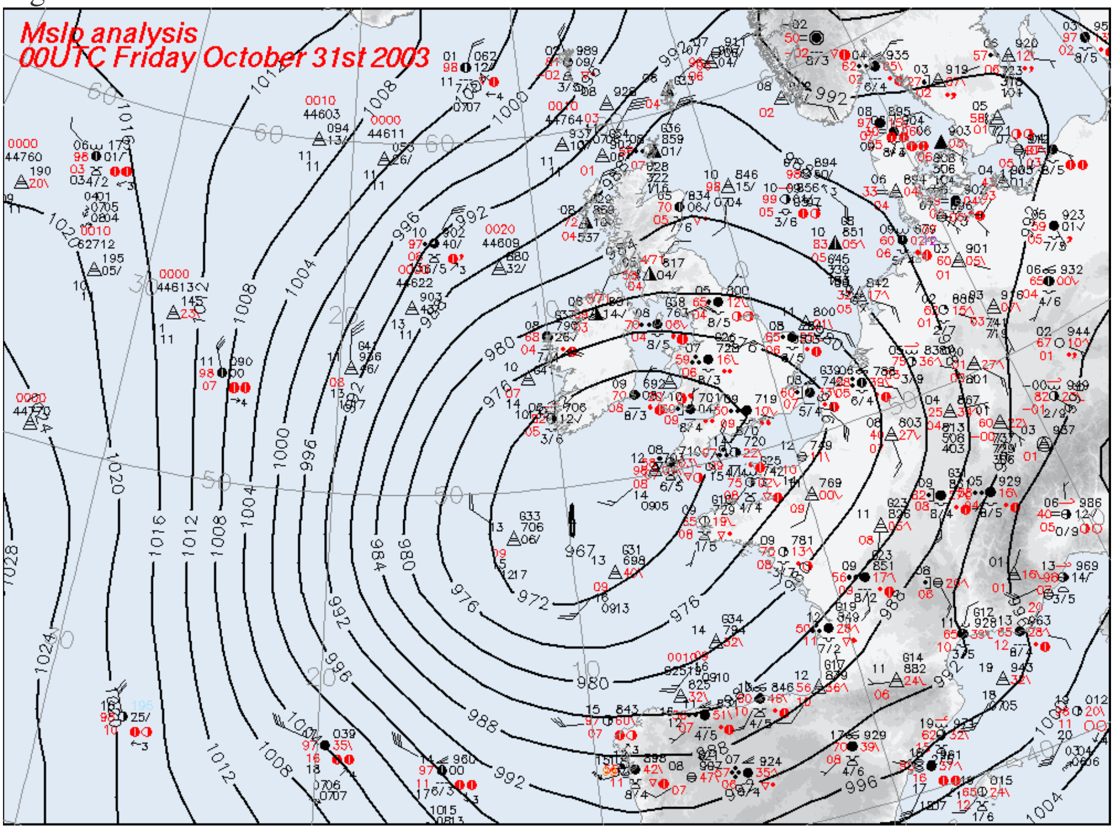
Observations deployed:

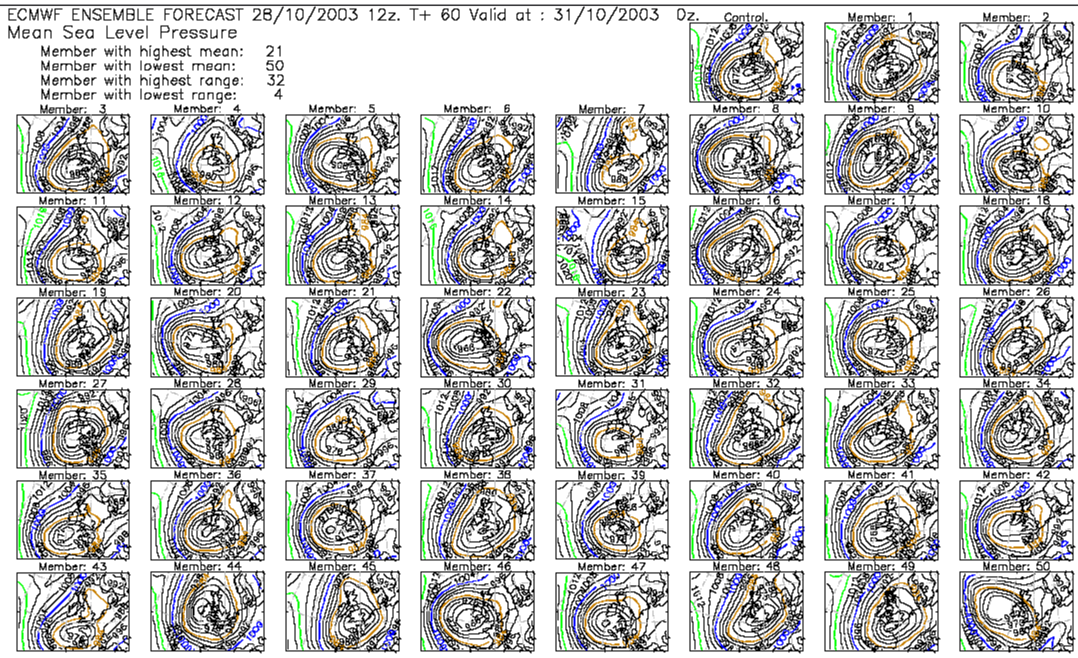
All observations requested for the 28th and 29th were taken with the exception of GOES RSW on the 29th. All Radiosonde were transmitted in real time via the GTS and received at Exeter. The GOES RWS data for 28th was captured but not transferred to ECMWF yet. No ASAP ships were in the area but one, KHRH, launched at 18UTC on 28th out of area.
AMDAR ??

Weather over verification region at verification time:

The low deepened a little earlier than predicted at the time the case was confirmed, but the verification time of 00UTC Friday 31st was best for impact (fig. 1) as the low began to fill as it moved into northern Biscay during Friday. The weather was significant but not exceptional. Severe gales were widespread over the sea areas west of Ireland southwards towards Portugal, with gales overnight in Lisbon, but the strong winds were confined more to these sea areas than was forecast early on. There was heavy rain across southern and central England and northwest France. 25-30mm in 12hrs in places from Cornwall to Birmingham, and 46mm in 24hrs at Bordeaux. By the time the extra obs were made the uncertainty was fairly low, with only detailed differences between ensemble members (fig. 2) but the targeted obs may prove to have pin-pointed the areas of severe gales and heaviest rain.

Fig 1





Impact of targeted observations:

Case being investigated.