Atlantic TreC

A first experiment in the operational interactive combination of the observing and forecasting systems

Introduction

The Atlantic TReC (**T**horpex **Re**gional **C**ampaign) was part of the **EU**METNET **C**omposite **O**bserving **S**ystem (EUCOS) programme with the aim of testing the hypothesis that short term forecasts errors over Europe and the Eastern seaboard of the USA can be reduced by targeting extra observations over sensitive areas determined each day by the forecast flow patterns. The intention was to concentrate on cases where either severe weather or high uncertainty in the forecast meant that an improvement in the forecast would have high societal or economic impact.
Several experiments have already been carried out attempting to improve short-range weather forecasts by inserting additional observations in those areas found from the NWP models to be most sensitive to small perturbations in the analysis (e.g. FASTEX 1997, and the ongoing American Winter Storms project). Atlantic TReC was the first attempt at real time adaptive control of the whole operational observing system rather than using only research aircraft to supply additional observations.

The observations available for targeting were
1. Radio-sondes – extra 18UTC or 06UTC ascents from European countries, Greenland, Nova Scotia and Newfoundland and up to 3 hourly ascents from ASAP ships.
2. AMDAR - extra observations from European carriers at flight level and ascent and descent.
3. Satellite rapid scan winds from METEOSAT and GOES.
4. Drop-sondes from NOAA G-IV, the Univ. of North Dakota aircraft 'Citation' and the DLR Falcon (available for part of the experiment).

A virtual operations centre was set up at the new Met Office headquarters in Exeter to select cases for targeting, co-ordinate the calculation of the sensitive areas, agree sensitive areas and request and monitor the targeted observations.

Case selection

Every morning forecasters from ECMWF, Météo-France and the Met Office separately scanned overnight NWP output for potential cases of high impact or high uncertainty or both within 3-5 day forecasts for Europe and the Eastern seaboard of America. Although the aim was to improve 1-3 day forecasts, it was necessary to look this far ahead in order to be able to give 48 hours notice to observation providers, particularly necessary for aircraft operations. Suggested cases were posted

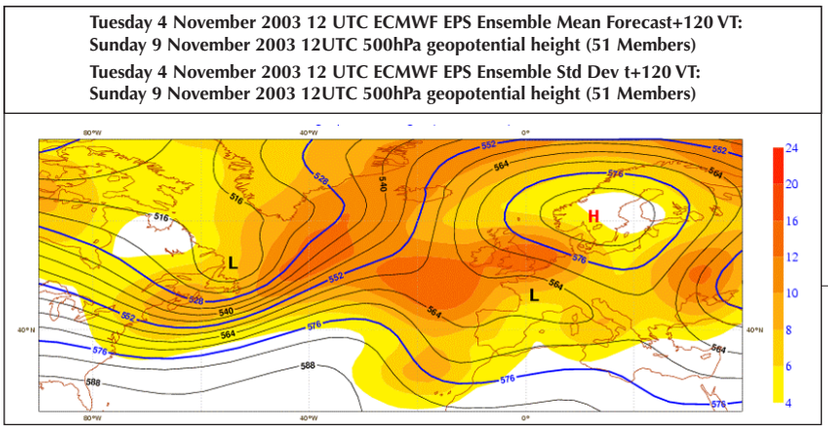

Figure 1: Example of ECMWF ensemble mean and spread used as an indication of forecast uncertainty

Figure 2: Example of interactive ensemble probabilities, in this case for total rainfall exceeding 150mm in 3 days

on a FTP site provided by ECMWF and then discussed at a telephone conference at 0900UTC. Unfortunately the time difference precluded the active participation of participants in the United States. Different model diagnostics were available in the different centres and it was instructive to compare techniques, especially for interpreting output from the ECMWF ensembles. Two diagnostics were particularly useful – a measure of the ensemble spread (fig. 1) made available on the ECMWF web site for the duration of the experiment, and the ability at ECMWF to interactively calculate probabilities of weather events with thresholds and time periods chosen by the forecaster (see for example fig. 2).

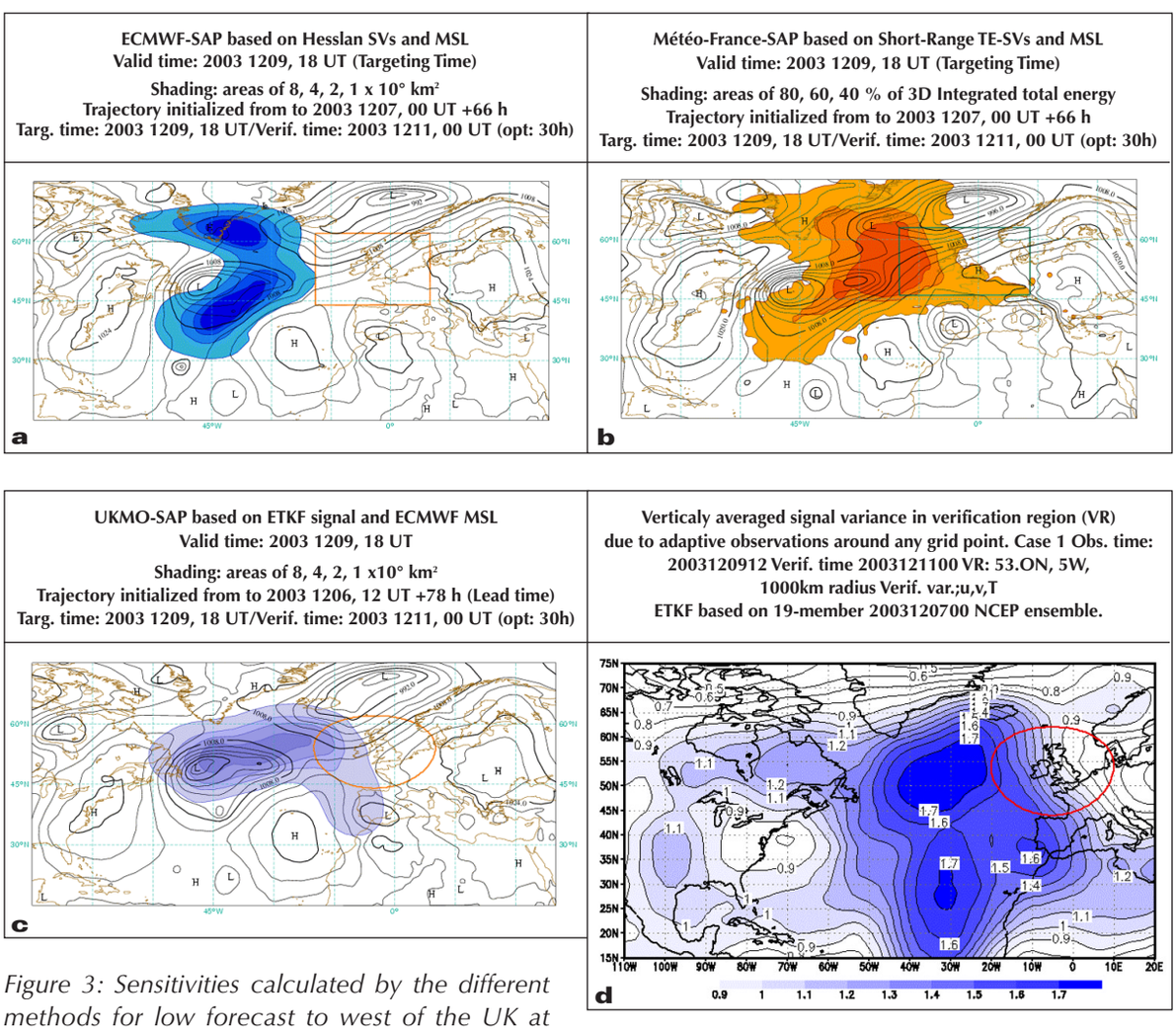

Figure 3: Sensitivities calculated by the different methods for low forecast to west of the UK at 00Z 11Dec 2003. Shading indicates the areas most sensitive to insertion of additional obs. (a) ECMWF singular vector method, (b) Meteo France singular vector method (c) ETKF method using ECMWF ensembles (compu-ted by Met Office) and (d) ETKF method using NCEP ensembles.

In spite of the different approaches used at the three centres it proved relatively easy to agree on potential cases both of high impact weather and high uncertainty (though the former were relatively few during the period). Case selection included defining the verification area and date and time and the observation date and time when additional targeted data would be provided. (The latter was normally centred on 18UTC to give daytime flights for aircraft based on the western side of the Atlantic and because there are few routine radio-sonde ascents at this time.)

Target area selection

Once a case was chosen ECMWF, Meteo-France, Met Office and NCEP independently computed the sensitive areas based on the relevant parameters. The singular vector technique used by Meteo-France and ECMWF took some hours to run so results were not available until early afternoon. These were also posted on an ECMWF web site and discussed by forecasters, NWP experts and where appropriate the aircraft scientists at a 1600UTC conference. At this conference it was decided which if any targeted observations should be requested. This was a more difficult process as it was necessary to consider the availability of the different observation systems while the different techniques and models used by the various centres often gave rise to rather different estimates of the sensitive areas (fig. 3).

Data delivery

After the second conference the various observation providers were contacted by e-mail requesting the additional observations. Usually this was in the form of a 48 hour warning followed by a confirmation of the request the next day.

The vast majority of the additional observations were made available in real time on the GTS and used in the operation runs of the NWP models.

Results

Scientific results on the impact of the targeted observations await re-runs of the NWP data assimilation and subsequent forecasts without the additional data. Many experiments are planned for re-runs without all or part of the additional observations. In this way it will be possible to examine the relative impacts of the different observation types and to investigate the effectiveness of the different techniques for calculating the sensitive areas.

The experiment, however has already been deemed a success as it demonstrated that it is possible to adaptively control the combined observing system accordingly to target apparent areas of greatest sensitivity. Several lessons have been learnt. To be fully operational some of the tasks will need to be streamlined and automated as the whole process often involved 24 or more man hours work per day from the team of forecasters, data managers, and NWP experts at the Exeter Operations Centre alone. The small number (13) of ASAP ships available meant that there were only occasionally ships within the target areas. This is a potentially highly important form of targetable data, providing observations in the lower and middle troposphere under cloudy conditions when satellite soundings are not available.

From a forecasting point of view, NWP guidance made it relatively easy to select the few cases of really severe weather, but often the apparent uncertainly in the forecast at days 3-5 was much reduced by the time the additional observations were made 1-3 days before verification time. It remains a challenge to the human forecaster to select those occasions on which the forecast uncertainty will persist until close to the event.

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