SUBJECTIVE EVALUATION AND OBJECTIVE VERIFICATION OF ECMWF PRODUCTS NEAR AND OVER IRELAND.

G. Scully,
W. Campbell and,
Michael R. Walsh.
Meteorological Service,
Dublin, Ireland.

Abstract

The performance of the ECMWF model is examined in 3 short case studies concerned with weather events which affected Ireland in 1990 and 1991 ;

1) In the case of four severe storms in early 1990, a detailed subjective comparison of the relevant ECMWF forecasts suites and the verifying analyses lead to the **main conclusion** that, **fast moving and rapidly deepening Atlantic depessions are more often than not poorly forecast in the vicinity of Ireland.**

2) In the presentation on some information on the objective verification of ECMWF forecast rainfall over Ireland, rainfall amounts at a particular synoptic station were compared with the amounts forecast by the model and it was found that, for the spring period, **the model showed positive skill scores against persistence out to D+3.** It also captured the climatology of the period quite well. In the summer period, scores are generally lower and there was a significant mismatch between the forecast and observed climatologies.

3) In the case of the blocking anticyclone which affected Ireland in late August/ early September 1991, the surface pressure patterns for each 10 day suite of forecasts, for the period, were compared subjectively with the analyses and it was found that for, advance indication of development, persistence and breakdown, **the medium range forecasts were quite valuable.**

1. AN ASSESSMENT OF THE PERFORMANCE OF ECMWF FORECASTS IN RESPECT OF FOUR SEVERE STORMS, EXPERIENCED IN IRELAND DURING EARLY 1990.

1.1 Storm of January 25th 1990.

An Atlantic depression continued to deepen rapidly as it crossed eastwards over the northern half of the country. Central pressure fell as low as 955hPa and gusts as high as 86kts were reported in a westerly airflow.

The Centre's forecasts gave several days advance warning of the storm. The T+120hr (Fig.1) was particularly good in this regard. This, together with the rest of the sequence of forecast charts based on the midday analysis of Jan.20th, were very impressive in picking up the shallow wave disturbance in the Southwest North Atlantic and deepening it rapidly as it moved in an northeasterly track towards Ireland. Subsequent forecasts continued to show the explosive deepening of the approaching depression but they differed in both the track and the intensity.

1.2 Storm of February 1st.

On February 1st a depression moved northeastwards close to the west coast of Ireland, generating strong gale to storm force winds. A maximum gust of 78kts was recorded on the North coast and a central pressure of 946hPa was recorded.

The only ECMWF forecast, prior to the T+24hr that showed any similarity with the actual situation that existed on the 1st was the T+144hr based on the analysis of Jan.26th). However, with the exception of the T+24hr issued on the 31st, all the subsequent forecasts received from ECMWF were of little use. Most of them persisted with the idea of an open wave passing harmlessly to the south of Ireland with little deepening.

1.3 Storm of February 11th.

By midday on the 11th this was just west of Belmullet and had deepened to 960hPa, bringing gale to storm force winds. Mean winds of 45kts were recorded with gusts to 75kts. As it cleared eastwards a very strong and blustery west to northwest airflow developed in its

wake. Ten minute mean winds in excess of 50kts were reported in places with gusts as high as 81kts.
The medium term forecasts of 72 to 144hrs failed completely to predict the storm. It was not until the T+48hr, based on the analysis of the 9th, that the development of a depression in the vicinity of Ireland was first suggested. The forecast position was quite good but the actual depression was a more well defined cut-off low and 14hPa deeper.

1.4 Storm of 26th February.

This storm moved rapidly northeastwards across the Atlantic on the 25th. By 0000UTC on the 26th it was just off the north coast with a central pressure of 956hPa. Southwesterly gales or strong gales were widespread over Ireland during the early hours of the 26th. Winds later veered west to northwest and became even stronger, reaching storm force in many areas. A record, monthly, gust of 81 kts was recorded at Clones (Station 03974).
Most of the forecasts predicted the very tight west to nortwest gradient over Ireland on the 26th. However, they did not show the small scale but very intense depression that passed close to the north coast of Ireland early on the 26th. It was only the forecasts based on the midday data of the 24th that gave the first hint of any such development but not the intensity and they gave no suggestion of the record breaking winds recorded in the northern half of Ireland around this time.

1.5 CONCLUSIONS

a) The short term forecasts, out to T+48hrs were only of little use in 3 of the 4 cases and in the 4th case they completely undermined the value of a fairly good set of medium forecasts.
b) The medium term forecasts were of some guidance in 3 of the 4 cases but this guidance was reduced in the short range and in one case, Jan 25th., it was undermined completely.
c) The **main conclusion** is, that **fast moving and rapidly deepening Atlantic depessions are more often than not poorly forecast in the vicinity of Ireland.** The forecasts are often more useful for Great Britain and mainland Europe.

2. VERIFICATION OF ECMWF DMO RAINFALL AMOUNTS IN IRELAND DURING THE SPRING AND SUMMER OF 1991.

2.1 Introduction

The Irish Meteorological Service supplies weather forecasts to the peat harvesting industry during the late spring, summer and early autumn months. Among the parameters forecast are temperature, humidity, wind, and rainfall amount. Forecast values are interpolated from the gaussian grid of the ECMWF model, and passed to the operational forecaster for appraisal and possible amendment before being issued.

The most critical meteorological factor in peat harvesting operations is the rainfall amount. During the spring and summer of 1991, a study was conducted to ascertain the quality of the directly-interpolated ECMWF rainfall forecasts. The synoptic station at Mullingar (03971), which is close to the main peat harvesting areas, was selected as a test site, and the forecast rainfall amounts checked against observations. Three categories * of rainfall were used.

2.2 Results

Each morning, forecasts are issued for the current day and for each succeeding three days. The day 1 forecast of rainfall corresponds to the accumulated rainfall (large-scale + convective) from 12 hours to 36 hours of the ECMWF forecast, the day 2 forecast corresponds to the accumulation from 36 hrs to 60 hours of the forecast etc. Forecast values are checked against the corresponding accumulated rainfall amount at the site.

Data were evaluated seperately for two periods - a spring period from 14/2/1991 to 14/5/1991, and a summer period from from 15/5/1991 to 14/8/1991. For the spring period the percent correct decreases from 77% at D+1 to 65%, 64% and 57% on D+2, D+3 and D+4. During the summer period the trend in the scores from D+1 to D+4 is somewhat more erratic, with the percent correct increasing from 66% to 67% from D+1 to D+2, and then decreasing to 63% and 55% on D+3 and D+4.

Rather than looking simply at the percent correct, the quality of the forecast can perhaps be better assessed by means of the Heidke Skill Score. This effectively measures the percentage of forecasts which are correct after those forecasts have been eliminated from consideration which would have been correct on the basis of chance.

The skill score ranges from 1.0 for a perfect forecast to 0.0 for a forecast which is no better than chance. (The score can also become negative if the forecast is worse than chance).

		Spring	Summer
	Percent Correct	= 77%	= 66%
D+1	Heidke Skill Score	= 0.60	= 0.32
	Persistence Skill Score	= 0.45	= 0.23
	Percent Correct	= 65%	= 67%
D+2	Heidke Skill Score	= 0.41	= 0.34
	Persistence Skill Score	= 0.24	= 0.28
	Percent Correct	= 64%	= 63%
D+3	Heidke Skill Score	= 0.38	= 0.28
	Persistence Skill Score	= 0.20	0.13
	Percent Correct	= 57%	= 55%
D+4	Heidke Skill Score	= 0.22	= 0.13
	Persistence Skill Score	= -0.03	= -0.02

One drawback of the Heidke Skill Score is that, since 'chance' is the most unskilled standard of comparison, it is relatively easy for the forecast to show a positive score. Accordingly, a second skill score was calculated, this time using persistence as the standard comparison. As expected, these persistence scores are systematically lower than the Heidke scores.

2.3 Conclusions

For the spring period, the model showed positive skill scores against persistence out to D+3. It also captured the climatology of the period quite well, with the number of cases forecast quite close to the number of cases observed in each of the three categories*.
In the summer period, scores are generally lower and there was a significant mismatch between the forecast and observed climatologies.

* (Category 1 < 1mm.
Category 2 1-5 mm.
Category 3 > 5mm.)

3. A SUBJECTIVE ASSESSMENT OF THE PERFORMANCE OF THE ECMWF MODEL IN FORECASTING A BLOCKING ANTICYCLONE WHICH AFFECTED IRELAND IN THE LATE SUMMER AND VERY EARLY AUTUMN OF 1991.

3.1 Introduction

In a prolonged unsettled spell of summer weather any indication of anticyclonic conditions becomes more and more critical and once an anticyclonic spell becomes established a reliable indication of its breakdown becomes critical (a 72hr + indication is most desirable). This situation arose in Ireland during 1991.

3.2 The Three Principal Factors Looked At Were;

a) How far in advance were the anticyclonic conditions reliably forecast?

b) How reliably was its persistence forecast?

c) How far in advance was its breakdown signalled?

3.3 Method

Each suite of 10 day ECMWF forecasts was examined, from August 18th to September 12th inclusive. The surface pressure pattern for each day from D+1 to D+10 was compared with each actual.

3.4 A Description Of The Main Weather Patterns As They Affected Ireland During The Period August 18th To September 13th 1991

August 18-20th: High pressure over the SE of Ireland moved SE into Europe followed by a weak trough. A shallow ridge followed, as the Azores anticyclone extended into Northern France .

August 21-22nd: An Atlantic trough off the West Coast began to deepen as high pressure moved into Central and Eastern Europe .

August 23-24th: Depression moved across Ireland and began to fill as high pressure over the SE of France began to extend Northwestwards towards the British Isles (fig.2).

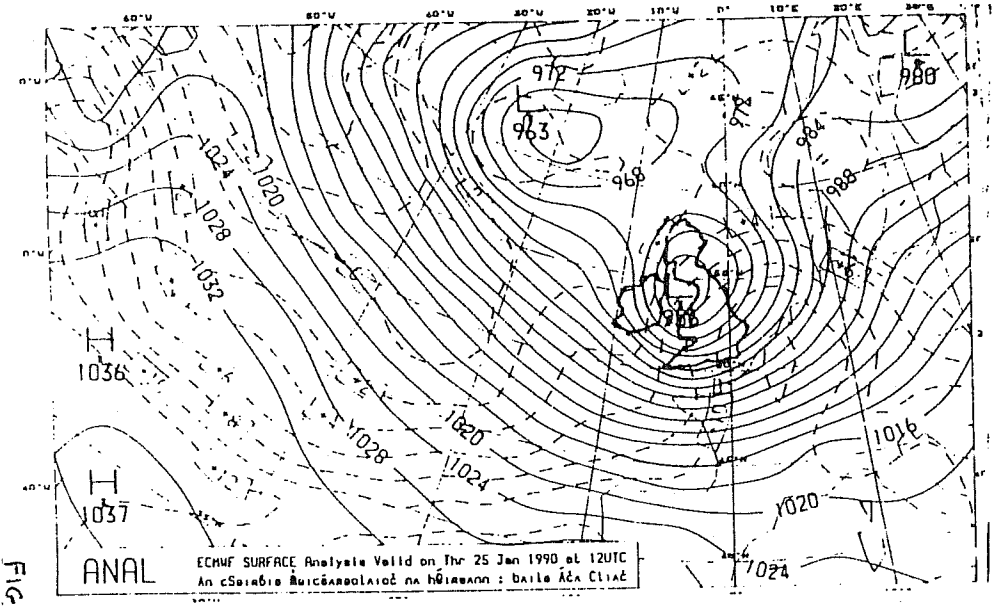
By **Aug.27th** (fig.2) a large anticyclone had become established close to the NW coast and then moved ESE to lie close to the Dutch coast by the **30th**, giving a slack SE'ly flow over Ireland.

By **Sept.1st** the high pressure had moved into the Baltic and a shallow trough lay east/west close to the south coast. Subsequently the high

pressure in the Baltic joined with high pressure near the Azores to give a NE'ly flow over Ireland. This high pressure continued to intensify, especially to the WNW of Ireland, producing an E'ly flow over Ireland by the **Sept.3rd** and squeezed the low pressure centre down over Iberia.
Over the next 6 days this high pressure drifted very gradually SE' wards over the NE of Ireland and then down over the UK, so that by **Sept.9th** it was centred in the North Sea. By this time also a new depression was forming off Newfoundland and another area of high pressure was edging SE' wards from the Denmark Straits/Iceland area. Between **Sept.9th and 12th** the Icelandic anticyclone moved to the east coast of Britain and the West Atlantic low had moved out to 35W, 56N and its associated frontal zone was nearing the SW coast of Ireland. By **Sept.13th** a SW'ly airflow had set in and the settled spell of weather had ended.

3.5 Conclusions

a) Despite the poor handling of the low pressure system, of **Aug.21st to 24th**, by all of the forecast suites from **Aug.18th** onwards, they **all gave some indication of high pressure developing in the vicinity of Ireland subsequently**, though there were significant variations in the forecast position of the high pressure.
b) Each daily suite of forecasts, from **Aug.24th** onwards indicated persisting high pressure in the general vicinity of Ireland, though again the positioning varied .
c) From **Sept.1st** onwards there were indications of a low pressure system developing in the West Atlantic and each successive days suite showed the breakdown at, as should be, an earlier date. But, at the end of the period, while the breakdown was correctly forecast to continue, its actual pattern was poorly forecast.
d) So, on the basis of the very basic questions which were asked i.e., advance indication of development, breakdown and persistence, **it is considered that the medium range forecasts were quite valuable.** However, for **the finer details**, particularly and most importantly - given Ireland's maritime geographical location, the forecasting of the positioning of the high pressure systems **could have been better.**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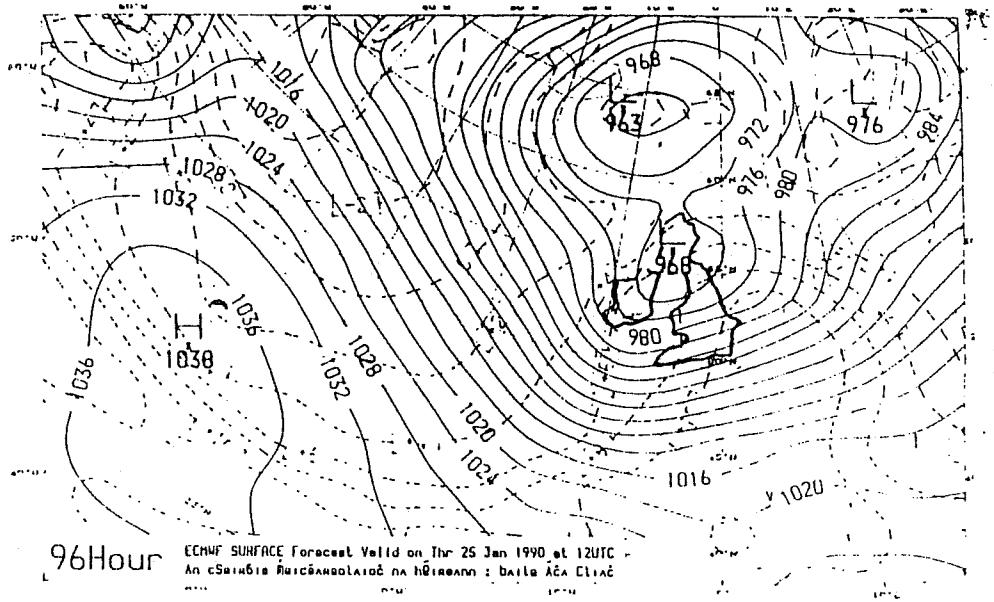
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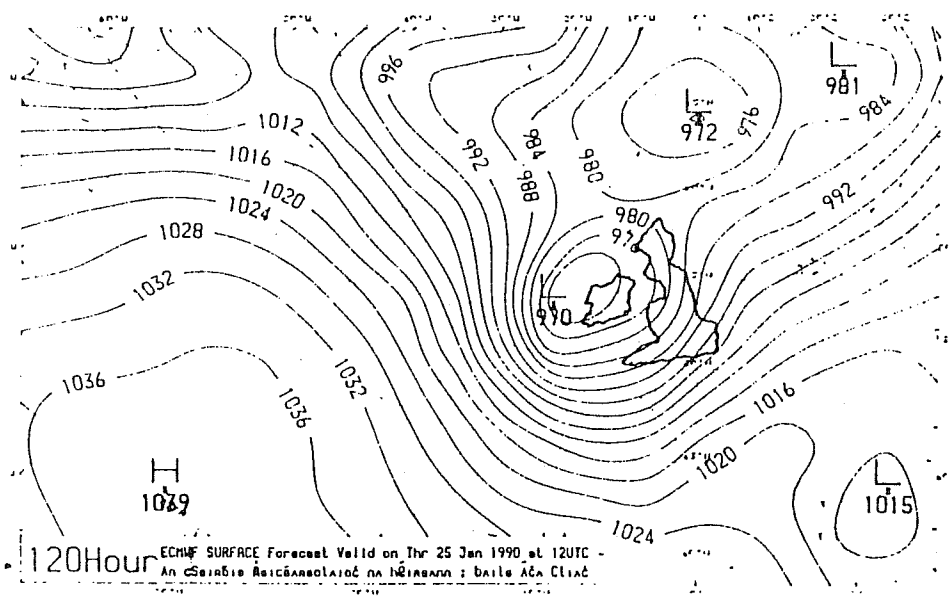
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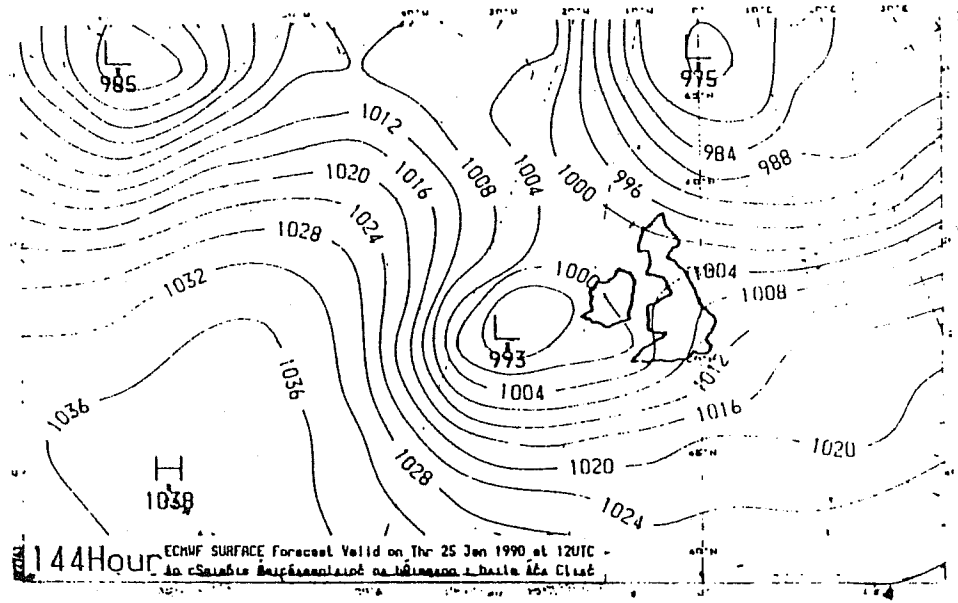
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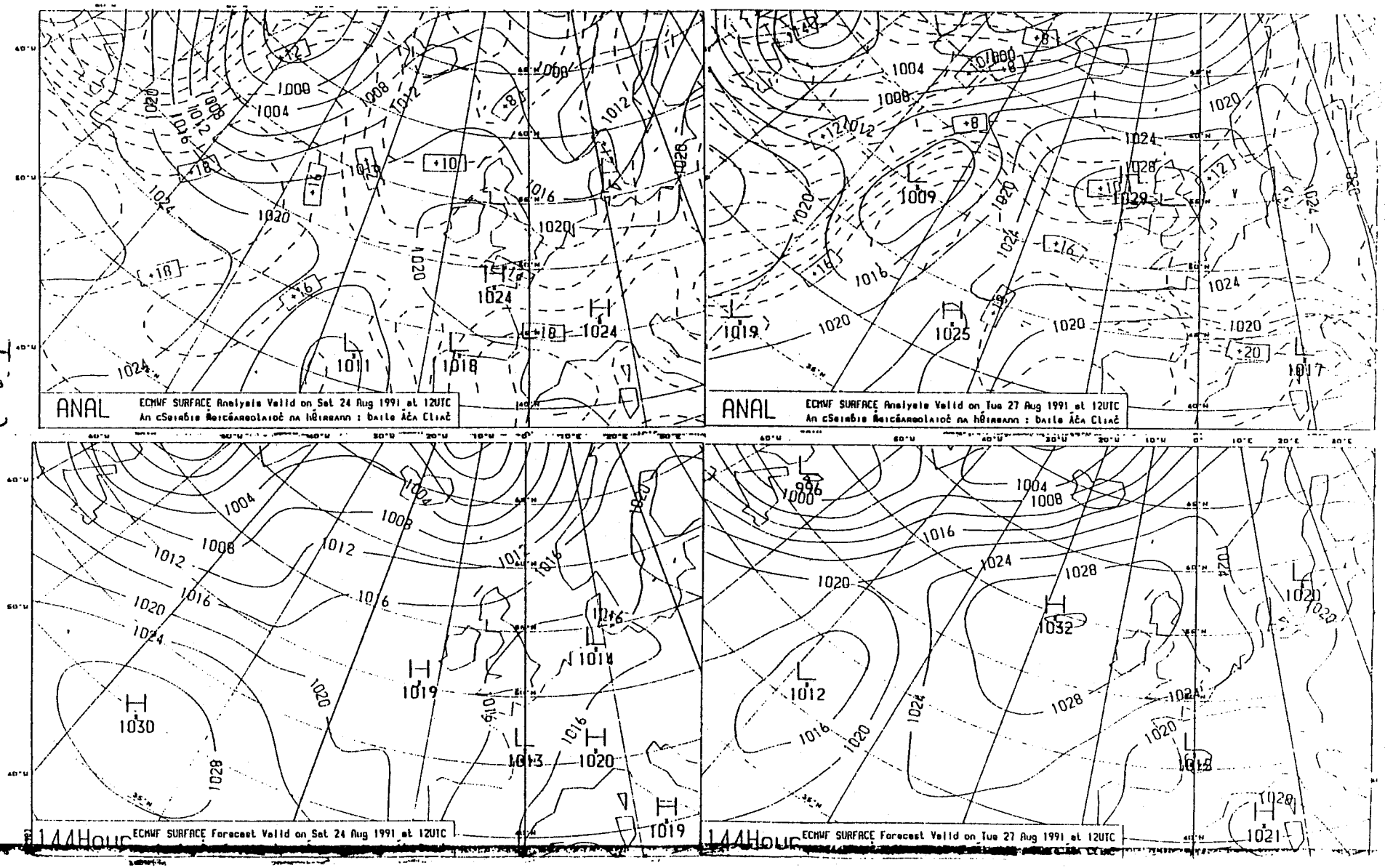
FIG 1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ANAL
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144Hour
ECMWF SURFACE Forecast Valid on Sat 24 Aug 1991 at 12UTC
144Hour
ECMWF SURFACE Forecast Valid on Tue 27 Aug 1991 at 12UTC

Fig. 2