Forecasting Research

Met O 11 Technical Note No. 12

The 5-day forecast trial of the AC scheme

by

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1. INTRODUCTION

During the trial of the AC scheme over Christmas 1987 (Bell, 1988) there occurred a case (on 26th December) in which the 5-day forecast from the AC scheme was found to be notably worse than the corresponding forecast from the operational system (Macpherson and Downton, 1988). Another outcome of this trial (and other, earlier trials) was the suggestion that, when started from an analysis produced by the AC scheme, the behaviour of the UK forecasting system is shifted towards that of the ECMWF system.

A new trial has been undertaken to assess the performance of the forecast starting from the AC analysis in six selected cases. Three cases were chosen from occasions when the verification against observations showed that the rms errors over Area 2 (see Figure 7) for the operational five-day forecast for both pmsl and 500mb height were 20% better (smaller) than those for the corresponding ECMWF forecast, and three more were chosen from occasions when the ECMWF five-day forecast was 20% better than the operational forecast according to the same criteria. During the search for these cases, occasions when EC forecasts were 20% better than the UK forecast were found about four times more often than occasions when the UK forecast was 20% better than the EC. The cases when the EC forecast was better frequently occurred in sequences when blocking situations affected Western Europe, especially January 1987, when the UK forecasts performed much worse than usual.

The cases chosen were for starting analyses at the following times:-

A) ECMWF 5-day forecast better than Operational

Case 1. 12Z, 30th March 1987
Case 2. 12Z, 19th May 1987
Case 3. 12Z, 17th Dec 1987

B) Operational 5-day forecast better than ECMWF

Case 4. 12Z, 14th April 1987
Case 5. 12Z, 20th Nov 1987
Case 6. 12Z, 15th Feb 1988

The rms errors of the EC forecast for these cases are shown as a percentage of the errors of the UK forecast in Table 1.

Starting analyses were obtained using the same version of the AC scheme as was used in the Christmas trial. Forecasts were then produced by running the UK operational forecast model to five days. Subjective verification of pmsl and the height at 500mb was undertaken for the Northern Hemisphere north of 30°. Comparisons were also been made with the corresponding ECMWF forecasts. Five of the six cases have also been rerun using the interpolated ECMWF analysis. Objective assessment has been carried out by verifying the forecasts and analyses from the AC scheme against observations and comparing the results with those already available from the UK and EC forecasts. Some consideration has also been given to the geostrophic balance of the fields in different versions of the forecast.

2. SUBJECTIVE ASSESSMENT OF THE AC FORECASTS

In describing the six cases, emphasis is placed on the area covering the North Atlantic and Western Europe, but mention is also made of significant differences or synoptic features in other areas of the Northern Hemisphere.

2.1 Case 1. Formation of deep Low over Biscay, DT 12Z 30 March 1987 (Fig 1)

A ridge over the UK declined southwards as an upper trough extended south across Ireland into Biscay on 1st April, forming a deep upper low which drifted slowly southwest to be at 45°N 15°W at midday on the 4th. An Atlantic ridge developed northeast towards Iceland, linking with a ridge that had developed northwestwards from Central Europe. Over the Mid-Pacific intense cyclogenesis took place between 1st and 2nd, and the resulting vortex filled rapidly on 3rd.

Surface developments reflected the 500mb pattern as an eastward-moving trough became slow-moving over the UK with the formation of a low on 1st. This deepened rapidly and moved southwest into Biscay on 2nd, so that much of Northwest Europe was under a very strong easterly flow on 3rd and 4th, as pressure rose across Scandinavia and Iceland. A very deep low (939mb) had developed over the Pacific by 2nd, filling quickly on 3rd. An intense high (1056mb) became established close to the North Pole.

The forecast from the operational analysis produced the trough extension over the UK, but both the upper and surface lows were positioned 5-10° too far to the east on days 4 and 5, producing a northeasterly flow across the UK. This error had a much greater effect over Western France, Portugal and Spain, where the forecast predicted a flow from the west or northwest instead of from the southeast. The forecast from the AC scheme was very similar, although the position of the surface low over the UK on day 2 and over France on days 4 and 5 was marginally improved. Further afield, differences were very small although the operational forecast had a better surface low southwest of Newfoundland on day 5. All runs correctly forecast the deep low over the Pacific on 2nd, but failed to fill it quickly enough. The high over the Arctic was not developed strongly enough and declined far too quickly in the UK runs, but it was maintained in the ECMWF forecast.

An analysis error may have occurred over Northwest Canada, as a significant difference in the shape of a 500mb trough over the Labrador Sea is evident by Day 1. This trough, which is deeper in the ECMWF forecast, moved southeast across southern Greenland, and then turned south over the Eastern Atlantic to create the extension just west of the UK, eventually cutting off to leave the deep low over Biscay. Both the operational and AC forecasts have this trough weaker at day 1. On moving southeast it took a more easterly track, with the result that the cut-off was displaced too far to the northeast. Unlike the ECMWF forecast, the operational and AC forecasts did not predict the northward development of the upper ridge over the Mid-Atlantic as strongly as in reality and so they failed to unite it with the ridge over Eastern Europe.

2.2 Case 2. Movement of Trough from Scandinavia to Biscay, DT 12Z 19/5/87 (Fig 2)

An upper ridge in Mid-Atlantic moved northeastwards to form a large high cell to the north of Scotland by 22nd, while a low formed within a trough over Denmark and moved southwest across northern France into Biscay by the 23rd. This low was reinforced on 24th by a disrupting upper trough that had moved east across the Atlantic. At the surface the Mid-Atlantic high moved northeast to the Faeroes, with a small low over Norway moving south and then southwest into France to form a complex, as a shallow low drifted north from Spain.

Differences between the operational and AC forecasts were very small except over the Pacific where at T+96 the operational run had a deeper 500mb trough at 170°E which verifies better than the AC. By day 5 the forecast position of this trough was still better in the operational run, although both forecasts have moved it too quickly.

As in Case 1, the UK model forecasts failed to extend the Atlantic high northeast with an upper low being turned east towards the USSR instead of being moved southwest. ECMWF forecast the correct development for western Europe but produced an inferior forecast over the United States by having an upper low at 90°W 75°N instead of over the Labrador sea where it was correctly forecast by the UK forecasts.

2.3 Case 3. Strong Westerly Flow over the Atlantic, DT 12Z 17/12/87 (Fig 3)

A strong zonal flow existed between 40-60°N around the Northern Hemisphere with a series of troughs and ridges moving quickly east across the UK. Although the rms error of the ECMWF forecast at T+96 and T+120 was 20% better than the UK, the UK forecast was generally good with the main error occuring in Mid-Atlantic, where an upper trough and, in particular, the associated surface low were not deep enough. Using the AC analysis has slightly degraded the operational forecast of this trough by having it shallower and slightly further east. Its origins appear to be over the east Pacific near 150°W as a trough at 125°W is evident by T+24 in the operational run, which has it slightly deeper than in the AC run. This trough remained deeper as it moved east to extend southeast from the Hudson Bay by T+120. This created a sharper ridge over the west Atlantic, a deeper trough at 25-30°W and a stronger ridge just west of the British Isles.

Phase errors appeared over the Pacific with the operational run having a better position of a trough 145°W at T+96. However, by T+120 the position of this trough seems to be better on the AC forecast. The AC is also significantly better with the position of a surface low near Alaska.

2.4 Case 4. Ridge moving east into Western Europe, DT 12Z 14/4/87 (Fig 4)

The main differences at T+96 and T+120 between the ECMWF and UK forecasts were on the western boundary of Area 2 where the ECMWF forecast developed a phase error. Further east the forecasts were similar.

An upper ridge moved east across the UK during 16th and 17th to be over the North Sea on 18th and 19th. This was followed by a trough moving east across the Atlantic to reach the UK by 19th. At the surface an anticyclone over the UK gradually moved east and declined as Atlantic troughs progressed into western parts of the UK on 19th. Further west, a deep upper vortex moved slowly east across southern parts of the United States while a trough, near Japan at T+0, moved steadily east and intensified, leading to the formation of a deep surface low that moved northeast to be just south of Alaska by T+120.

Although the forecasts were very similar over the eastern Atlantic and western Europe, there were marked differences from the eastern Pacific across the United States into the Western Atlantic. Here the forecast from the operational run appeared significantly better than the AC. It developed more amplitude in the troughs and ridges that moved east from the west Pacific. By T+48 it produced a deeper trough at 150°W. At T+72 the trough was still deeper at 135°W with a sharper ridge developing over the Rockies. A trough forward of this, at 80°W, was also deeper. By T+96 the effect of the sharper ridge over the Rockies had produced a slightly deeper trough at 75°W. This trough deepened further as it moved East to 55°W by T+120. Upstream troughs at 110°W and 150°W were also deeper, especially at 150°W where the AC failed to forecast an upper low. This is reflected at the surface where the operational run produced an exceptionally accurate forecast of the highs and lows over the Pacific.

The ECMWF forecast was poor over most of the northern Hemisphere. It became too zonal, particularly over the Pacific and United States where a phase error developed. The errors in the forecast from the AC analysis showed some similarity to those in the ECMWF forecast in this case.

2.5 Case 5. Southward Extension of Upper Trough over W. Europe, DT 12Z 20/11/87 (Fig 5)

A trough developing near Iceland on 21st extended south across the UK with a low forming near NE Scotland. This low transferred southwards to the base of the trough over Southern France on 24th and then moved northeast to central France by 25th. As the trough extended, a strong ridge developed northwards to Iceland and toppled southeast into north Scotland on the 25th. A high persisted over northeast USSR while a deep trough over central United States moved east and then relaxed away northeast. A surface low moved southeast to the Shetland Isles by 22nd. It then developed a trough southwards, with a deep low forming over southern France and moving northeast to Germany by 25th.

The forecasts over the Atlantic, Europe and Asia were very similar. From T+72 the AC run produced significantly better positions, shapes and depths of the surface and upper troughs and lows over the Pacific and Western United States with an upper trough at 60°W on day 5 having a better shape than the operational run but poorer position. This is reflectd at the surface by a low over the Labrador sea 10mb deeper that does not verify as well as the operational forecast.

2.6 Case 6. Development of a High over the U.K., DT 12Z 15/02/88

A sharp upper trough moved East across the UK on 16th, eventually extending southeast to reinforce a broad upper trough over the eastern Mediterranean. This was followed by a steady increase in contour heights with a strong ridge developing across England and Scotland. Shallow lows between 30-45°N extended eastwards from mid Atlantic through the Mediterranean, whilst a deep vortex moved slowly southeast from northwest Canada to the Hudson Bay.

At the surface a low over northwest Scotland transferred southeast while an anticyclone near 45°N 15°W slowly intensified and moved east to Southern England by 20th.

Forecast differences were small. The AC 500 mb height field at T+120 was slightly worse over Europe, due to the ridge and trough over Europe being displaced a little further east than inthe operational run. This difference was not significantly reflected in the surface pattern. Both runs were a little slow with the movement of the Canadian vortex although the AC was slighly better than the operational.

3. EC ANALYSIS/UK FORECASTS

Five of the six cases were also rerun using the an analysis interpolated from the uninitialized ECMWF analysis. For these cases any differences between the UK/UK (UK operational analysis /UK forecast) and the EC/UK (EC analysis /UK forecast) were generally small: improvements in some forecasts were countered by deteriorations in others. Significant differences are mentioned below.

In the case starting from 30th March, on using the EC analysis the trough extension took place 2-3° further west to produce a much better surface flow over the UK from T+72 to T+120. For the case verifying on 24th May a better surface low was produced near the southwest tip of Alaska, An improvement of 10° in the position of the trough over the east Pacific was evident for the December case verifying on the 22nd. In the November case, the use of the EC analysis produced a significantly poorer result over the Pacific, especially at the surface.

4. OBJECTIVE ASSESSMENT OF THE TRIAL

Objective assessment of the results of the trial has been performed in two ways. An examination has been made of the geostrophic balance of the analyses and forecasts from the available model fields. A comparison of the model forecasts, judged by their agreement with the verifying observations, has also been made.

4.1 Ageostrophic winds.

Only four of the six cases have been investigated, two where EC had performed better (March and May) and two where the UK had performed better (April and November) over Area 2. The geostrophic winds in the area north of 22½N were computed from the height fields at 500 and 250mb in each case. The ageostrophic winds were then obtained by subtracting the computed geostrophic wind from the actual model wind on the same level. The results from the May case have rather less strength than the other three but otherwise the individual cases show the same behaviour. The results have been averaged over all four cases to obtain the mean ageostrophic wind: this is shown as a function of forecast time in Figure 8. Results for the 48-hour forecasts were not computed. Appropriate fields from the UK forecast were available from the archive only as far as the 72-hour forecast.

It can be seen from Figure 8 that the behaviour is similar at 500mb and 250mb. The verifying UK analysis has a high level of ageostrophic activity. Forecasts from the UK analysis start off at this level but decline over the period of the forecast. Similarly, the forecasts starting from the uninitialized EC analyses but using the UK forecast model (EC/UK) show a similar decline from a high starting level. However, both the EC forecast (from the initialized EC analysis) and the forecast from the AC analysis start at a lower level of ageostrophic activity and decline only slowly.

An independent verification of the ageostrophic wind is not possible. However, the results indicate that there are differences in character between the analyses from the AC scheme and those from the current operational system, with the former coming much closer to geostrophic balance. The forecast models appear to have their own balance, not necessarily the same as in their starting analyses, and they adjust towards it as the forecast progresses. This adjustment may affect a model's ability to make correct forecasts in the medium term.

4.2 Verification against Observations, Area 2.

A selection of up to 15 model fields has been verified against surface and radiosonde observations at 24-hour intervals through the analyses and subsequent forecasts in all six cases. The magnitude of the model rms error varies considerably from case to case: for example the rms error of the height at 250mb is over 200m in the December case, but in the April case it is less than 90m. Rather than quote the raw results for all cases, it is more helpful to present the verification results by evaluating an rms error from an AC run as a percentage of the corresponding rms error from the UK operational run for the same case. These percentages are set out in Tables 2 to 8 with the two sets of runs grouped together. Where the AC run has a smaller error than the UK run, the percentage is less than 100: where the AC run has the larger error, the percentage is greater than 100.

Tables 2 to 7 show the results over Area 2 (Figure 7) for each day of the forecast from Day 0 to Day 5. Results for the analysis could not be obtained in the December case because of problems with the set of verifying observations. Humidity results are treated only up to Day 1. The results of wind verification for three of the cases - March, April, May - have suffered from the effects of a fault in the operational verification during these three months in 1987 which has certainly damaged the verification figures for Day 0: however, the effect is less important as the forecast proceeds. This makes the figures for the percentage performance of the forecast from the AC scheme extremely doubtful in these cases and so they not have been presented for forecasts out to Day 2.

The results suggest that in the analysis and the early stages of the forecast, up to Day 2 (Tables 2 to 4), the AC scheme performed better than the operational scheme in two of the three cases where verification results are available. Results for Day 3 (Table 5) are shown for completeness, but there is little to choose between the two schemes at this stage.

By Day 4, however, a pattern emerges (Table 6): the AC scheme performs better than the UK system in the set of cases where the EC forecast was better than the UK forecast; and the AC scheme performs worse than the UK system in the set of cases where the UK forecast was better than the EC forecast. This pattern is repeated at Day 5 (Table 7). The pattern is not found in all fields (for example, the low-level temperatures on 3rd and 4th April), but it holds good for the two fields, pmsl and 500mb height, which were originally used to choose these cases. On the whole the AC scheme shows a performance in between that of the UK system and that of the EC system. This is true even for the mid-April case where, although the AC scheme was up to 31% worse in its forecast of the height at 500mb, the EC forecast was more than 40% worse for the same field (Table 1).

Mean percentages have been computed over each set for all fields and are presented in Tables 6 and 7. They confirm that, in the forecasts for Days 4 and 5, the performance of the AC scheme in relation to the UK system is qualitatively the same as that of the EC system. Overall figures, taken as the mean over all 13 fields in the Tables, suggest that the AC scheme is 6% better in the cases where EC was 20% better; and that the AC scheme is 9% worse in cases where EC was 20% worse.

4.3 Verification against Observations, Other Areas.

The rms errors of the AC scheme's forecast against observations have been expressed as a percentage of the rms errors of the UK forecast for Day 5 in the verification areas 200, 300 and 400 (Figure 7). Results for Area 200 (90°N - 30°N) are given in Table 8. The percentages tend to be closer to 100 but they conform broadly to the pattern shown by the Area 2 results. However, it now appears that the AC scheme performed better than the UK system in the February case. Both these effects may be explained as the result of a reversal in the relative performance of the forecast on moving outside Area 2 into the rest of Area 200. The forecast charts (Figures 1 to 6) have already shown such behaviour over the Pacific Ocean.

Relative performance figures for the EC system have also been computed for pmsl and the height at 500mb over Area 200 (Table 9). They confirm that the relative behaviour over Area 2 is not necessarily maintained over the rest of the northern hemisphere, since in the November case the EC system seems to have more than made up for its faults in Area 2 by making a better forecast of the pair of depressions over the North Pacific.

On inspection of the results for Area 300 (30°N - 30°S), it has been found that the AC scheme gave better forecasts certainly in three out of the six cases and perhaps in two further cases. The UK system gave a better forecast for the May case. In Area 400 (30°S - 90°S) the two forecasts were about equal in two cases, and the UK system gave slightly better forecasts in three further cases. As in Area 300, the UK forecast was clearly better for the May case.

5. SUMMARY

5.1 Main Differences between Forecasts using Operational and AC analyses

Case 1. DT 12Z 30/03/87.

a. Surface low over France at T+96 and T+120 marginally better on AC.
b. Operational better with surface low southwest of Newfoundland at T+120.

Case 2. DT 12Z 19/05/87.

a. Operational better with Pacific trough at T+96 and T+120.

Case 3. DT 12Z 17/12/87.

a. Operational better with trough that moves east across the United States to the mid Atlantic.
b. Operational slightly better over the Pacific at T+96.
c. AC slightly better at T+120 with a surface low southwest of Alaska.

Case 4. DT 12Z 14/04/87.

a. Operational significantly better from the Mid Pacific across the United States to west Atlantic. Differences evident from T+48.

Case 5. DT 12Z 20/11/87.

a. AC better from T+72 over Pacific and western United States.
b. AC better with shape of trough at 60°W. OP has better position.

Case 6. DT 12Z 15/02/88.

a. AC marginally better with a slow moving vortex over Canada.

5.2 Conclusions from the Objective Assessment

Two main conclusions may be drawn:-

a. The performance of the forecast from the AC scheme for Days 4 and 5 over Area 2 falls in between that of the UK system and that of the EC system. In general, when the EC system performed better than the UK system, the AC scheme also performed better: and when the UK system was better than the EC system, it was also better than the AC scheme.

b. The balance achieved by the AC scheme gives it an ageostrophic wind which has about the same strength as that found in the EC system.

6. ACKNOWLEDGEMENTS

The trial was conducted as a cooperative exercise within Met O 11 with contributions of interest, advice and effort from several people, notably R.S.Bell, D.Robinson and B.Macpherson.

7. REFERENCES

R.S.Bell, 'A Further Trial of the Global Analysis Correction Scheme - Christmas, 1987', Met O 11 Technical Note No 14, 1988.

B.Macpherson & R.Downton, 'Sensitivity of a Medium-Range Forecast with the Analysis Correction Scheme to Data Selection in the Horizontal', Met O 11 Technical Note No 15, 1988.

TABLES OF ERRORS OF AC & EC FORECASTS AS PERCENTAGE OF ERROR IN UK FORECAST

The fields to which these percentages refer are identified by a four-character code, XLLL where X is H for height, T for temperature, W for vector wind, or Q for relative humidity, and LLL is the pressure in millibars. pmsl is pressure at mean-sea-level.

	----- EC better -----			----- UK better -----		
DAY 4	3 Apr	23 May	21 Dec	18 Apr	24 Nov	19 Feb
pmsl	60	70	61	125	147	124
H500	71	49	58	154	143	121
DAY 5	4 Apr	24 May	22 Dec	19 Apr	25 Nov	20 Feb
pmsl	63	82	78	147	130	126
H500	73	63	66	183	123	136

TABLE 1 Area 2, Days 4 & 5: EC rms error as percentage of UK rms error

	----- EC better -----			----- UK better -----		
DAY 0	30 Mar	19 May	17 Dec	14 Apr	20 Nov	15 Feb
pmsl	*	*	*	*	100	106
H850	*	*	*	*	100	92
H700	*	*	*	*	109	93
H500	*	*	*	*	106	100
H250	*	*	*	*	106	100
T850	*	*	*	*	115	111
T700	*	*	*	*	120	120
T500	*	*	*	*	120	130
T250	*	*	*	*	115	117
W850	*	*	*	*	100	100
W700	*	*	*	*	100	100
W500	*	*	*	*	114	100
W250	*	*	*	*	110	100
Q850	*	*	*	*	107	113
Q700	*	*	*	*	113	107

TABLE 2 Area 2, Day 0: AC rms error as percentage of UK rms error
Asterisks indicate results not available or unreliable: see section 4.2

DAY 1	----- EC better ----- 31 Mar	20 May	18 Dec	----- UK better ----- 15 Apr	21 Nov	16 Feb
pmsl	*	*	97	*	112	94
H850	*	*	90	*	118	81
H700	*	*	82	*	117	84
H500	*	*	83	*	115	91
H250	*	*	100	*	112	100
T850	*	*	94	*	105	104
T700	*	*	100	*	100	104
T500	*	*	100	*	105	94
T250	*	*	90	*	109	96
W850	*	*	100	*	110	100
W700	*	*	100	*	110	100
W500	*	*	92	*	107	94
W250	*	*	95	*	105	100
Q850	*	*	95	*	100	100
Q700	*	*	71	*	104	95

TABLE 3 Area 2, Day 1: AC rms error as percentage of UK rms error Asterisks indicate results not available or unreliable: see section 4.2

DAY 2	----- EC better ----- 1 Apr	21 May	19 Dec	----- UK better ----- 16 Apr	22 Nov	17 Feb
pmsl	*	*	93	*	113	94
H850	*	*	92	*	105	84
H700	*	*	90	*	108	86
H500	*	*	91	*	106	92
H250	*	*	87	*	105	92
T850	*	*	97	*	96	100
T700	*	*	100	*	104	104
T500	*	*	96	*	104	96
T250	*	*	100	*	100	100
W850	*	*	100	*	100	100
W700	*	*	94	*	100	100
W500	*	*	90	*	100	100
W250	*	*	93	*	100	100

TABLE 4 Area 2, Day 2: AC rms error as percentage of UK rms error Asterisks indicate results not available or unreliable: see section 4.2

DAY 3	----- EC better ----- 2 Apr	22 May	20 Dec	----- UK better ----- 17 Apr	23 Nov	18 Feb
pmsl	105	87	101	109	103	105
H850	105	88	100	107	102	100
H700	102	89	100	100	108	103
H500	100	92	98	92	106	108
H250	102	100	98	89	105	105
T850	103	93	97	97	103	97
T700	103	97	97	94	103	103
T500	103	100	103	100	104	104
T250	109	95	110	104	103	110
W850	100	83	106	100	100	108
W700	100	86	100	100	100	107
W500	95	93	92	95	105	125
W250	97	94	92	89	108	108

TABLE 5 Area 2, Day 3: AC rms error as percentage of UK rms error

DAY 4	-------- EC better -------- 3 Apr	23 May	21 Dec	Mean	-------- UK better -------- 18 Apr	24 Nov	19 Feb	Mean
pmsl	95	90	89	91	110	109	100	106
H850	98	83	83	88	121	109	105	112
H700	97	84	84	88	123	107	107	113
H500	99	89	86	91	118	111	110	113
H250	99	94	84	92	116	112	111	113
T850	105	92	100	99	103	100	108	104
T700	107	100	91	99	100	108	103	104
T500	103	100	88	97	112	106	119	112
T250	100	84	100	95	121	103	122	115
W850	100	94	100	98	107	100	100	102
W700	100	91	91	94	113	107	107	109
W500	104	87	88	93	115	105	105	108
W250	98	92	87	92	104	110	113	109
		Overall Mean		94%		Overall Mean		109%

TABLE 6 Area 2, Day 4: AEC rms error as percentage of UK rms error

DAY 5	-------- EC better -------- 4 Apr	24 May	22 Dec	Mean	-------- UK better -------- 19 Apr	25 Nov	20 Feb	Mean
pmsl	93	92	91	92	118	114	100	111
H850	92	90	88	90	124	109	98	110
H700	92	88	87	89	126	103	102	110
H500	94	89	87	90	131	103	104	113
H250	98	98	84	93	128	111	106	115
T850	102	93	91	94	118	100	109	109
T700	102	100	88	97	117	105	105	109
T500	98	100	85	94	121	106	111	113
T250	89	91	98	93	131	103	97	110
W850	96	89	100	95	106	111	100	106
W700	96	90	96	94	107	105	100	104
W500	100	93	96	96	116	104	100	107
W250	100	100	98	99	108	103	109	107
		Overall Mean		94%		Overall Mean		109%

TABLE 7 Area 2, Day 5: AC rms error as percentage of UK rms error

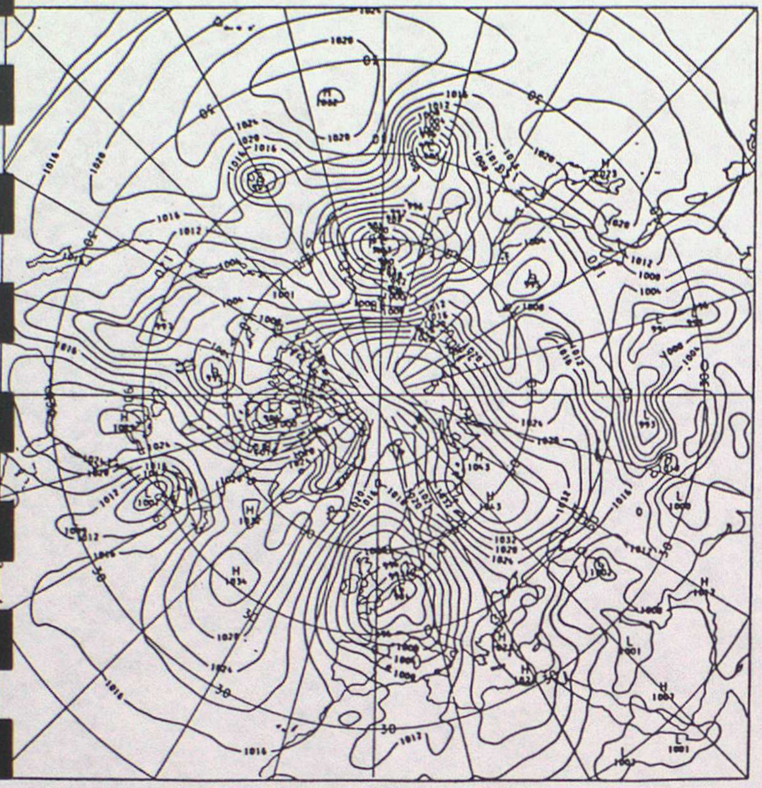
DAY 5	-------- EC better -------- 4 Apr	24 May	22 Dec	Mean	-------- UK better -------- 19 Apr	25 Nov	20 Feb	Mean
pmsl	95	94	95	95	112	110	96	106
H850	93	94	94	94	115	107	94	105
H700	95	92	92	93	112	108	96	105
H500	96	92	90	93	111	113	99	109
H250	99	96	87	94	118	117	101	112
T850	102	98	96	99	107	127	98	111
T700	102	105	93	100	112	116	98	109
T500	100	97	90	96	117	109	97	108
T250	96	98	100	93	110	103	100	104
W850	100	95	100	98	100	111	100	104
W700	96	90	100	95	106	105	100	104
W500	100	96	97	96	109	104	100	104
W250	100	92	98	97	103	103	100	102
		Overall Mean		95%		Overall Mean		107%

TABLE 8 Area 200, Day 5: AC rms error as percentage of UK rms error

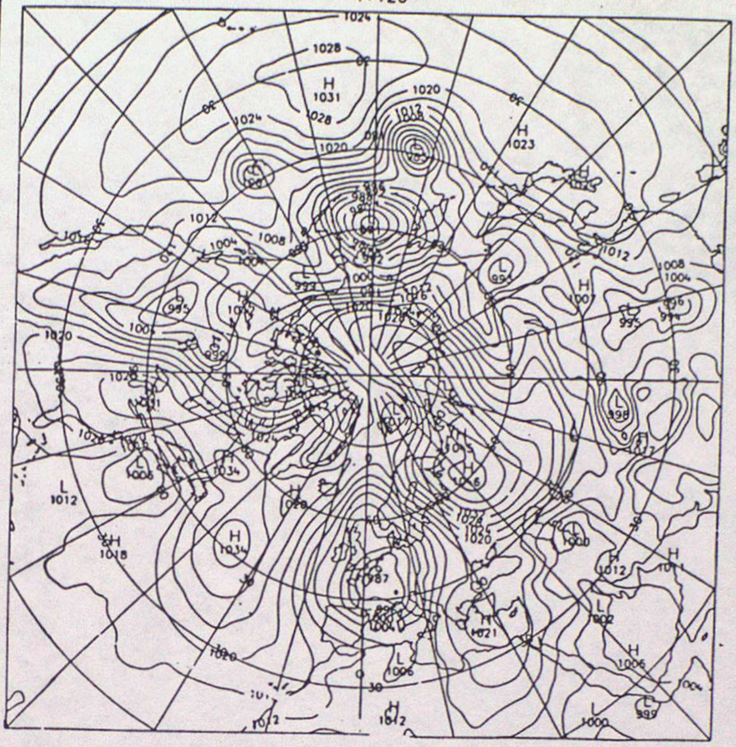
DAY 4	----- EC better -----			----- UK better -----		
	3 Apr	23 May	21 Dec	18 Apr	24 Nov	19 Feb
pmsl	70	76	66	110	94	116
H500	76	61	63	117	98	119
DAY 5	4 Apr	24 May	22 Dec	19 Apr	25 Nov	20 Feb
pmsl	70	81	83	129	81	119
H500	83	74	71	150	95	129

TABLE 9 Area 200, Days 4 & 5: EC rms error as percentage of UK rms error

UK ANALYSIS / UK FORECAST
MEAN SEA LEVEL PRESSURE
VALID AT 12Z ON 4/4/1987
SEA LEVEL



A.C. CASE FOR 04/04/87 (T+120)
MEAN SEA LEVEL PRESSURE
VALID AT 12Z ON 4/4/1987 DATA TIME 12Z ON 30/3/1987
SEA LEVEL T+120

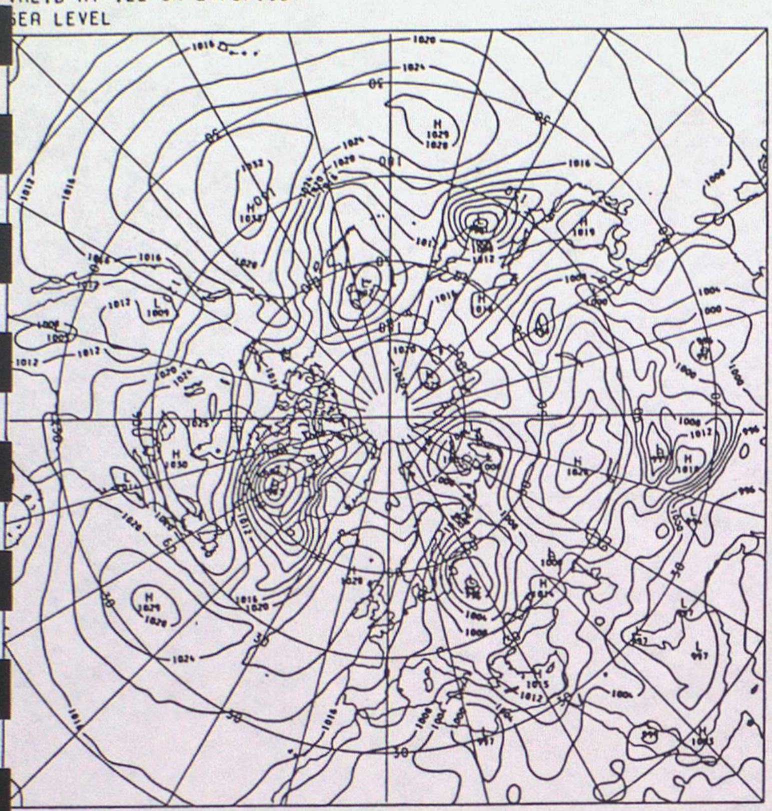


UK ANALYSIS
MEAN SEA LEVEL PRESSURE
VALID AT 12Z ON 4/4/1987
SEA LEVEL

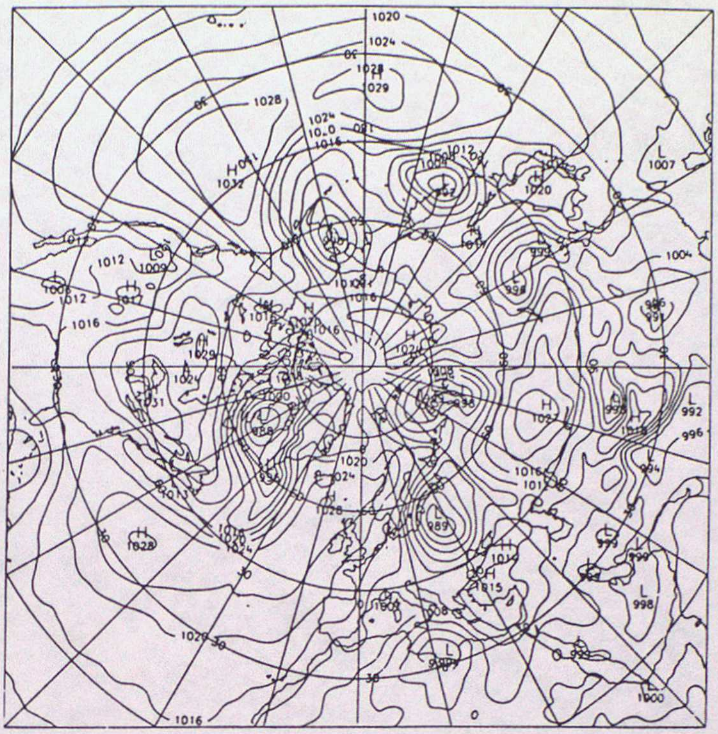
oper f/c T+120	trial f/c T+120
verif analysis	fig. 1 VT 04 April

AC better position of low over N.France.
OP better shape and depth of low near Nova Scotia.

UK ANALYSIS / UK FORECAST
MEAN SEA LEVEL PRESSURE
VALID AT 12Z ON 24/5/1987
SEA LEVEL



A.C. CASE FOR 24/05/87 (T+120)
MEAN SEA LEVEL PRESSURE
VALID AT 12Z ON 24/5/1987 DATA TIME 12Z ON 19/5/1987
SEA LEVEL T+120

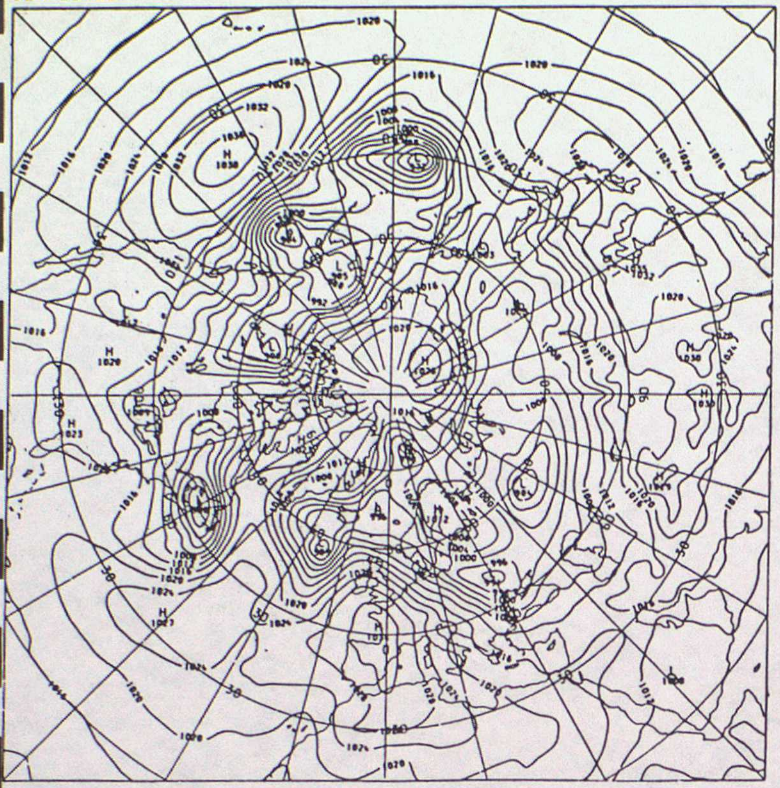


UK ANALYSIS
MEAN SEA LEVEL PRESSURE
VALID AT 12Z ON 24/5/1987
SEA LEVEL

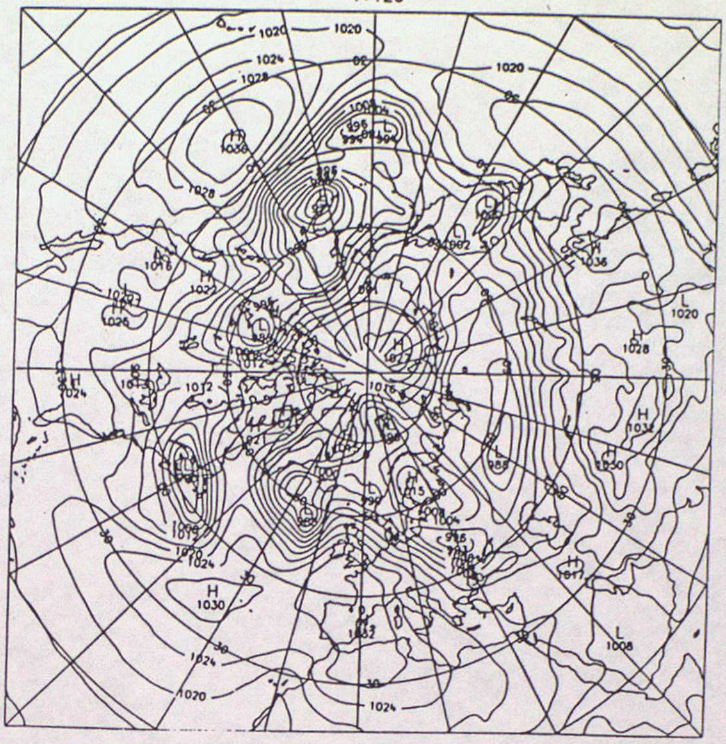
oper f/c T+120	trial f/c T+120
verif analysis	fig. 2 VT 24 May

OP slightly better with surface flow across Alaska.

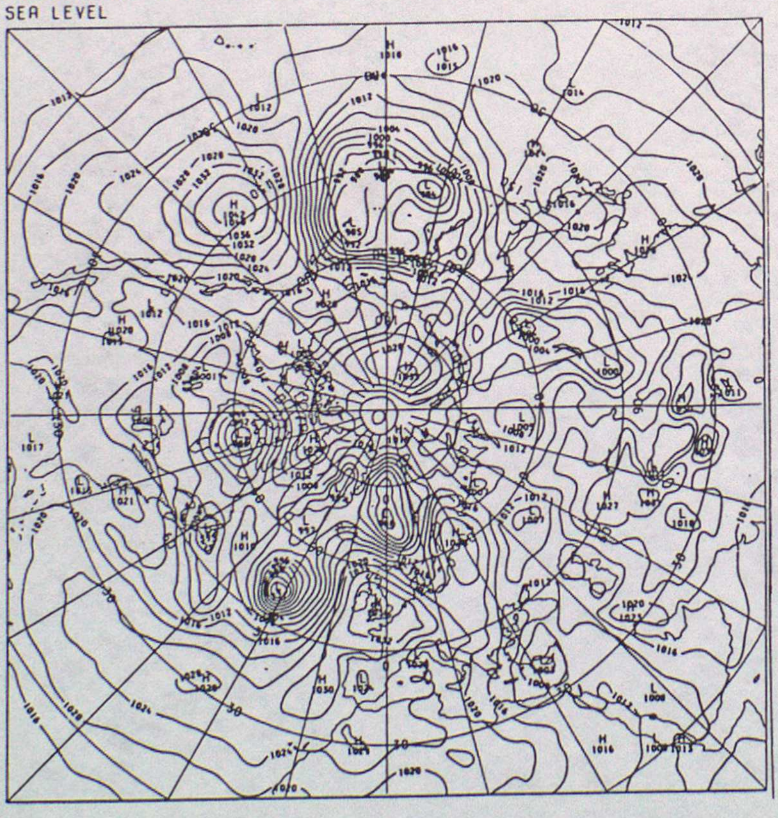
UK ANALYSIS / UK FORECAST
MEAN SEA LEVEL PRESSURE
VALID AT 12Z ON 22/12/1987
SEA LEVEL



A.C. CASE FOR 22/12/87 (T+120)
MEAN SEA LEVEL PRESSURE
VALID AT 12Z ON 22/12/1987 DATA TIME 12Z ON 17/12/1987
SEA LEVEL T+120



UK ANALYSIS
MEAN SEA LEVEL PRESSURE
VALID AT 12Z ON 22/12/1987
SEA LEVEL

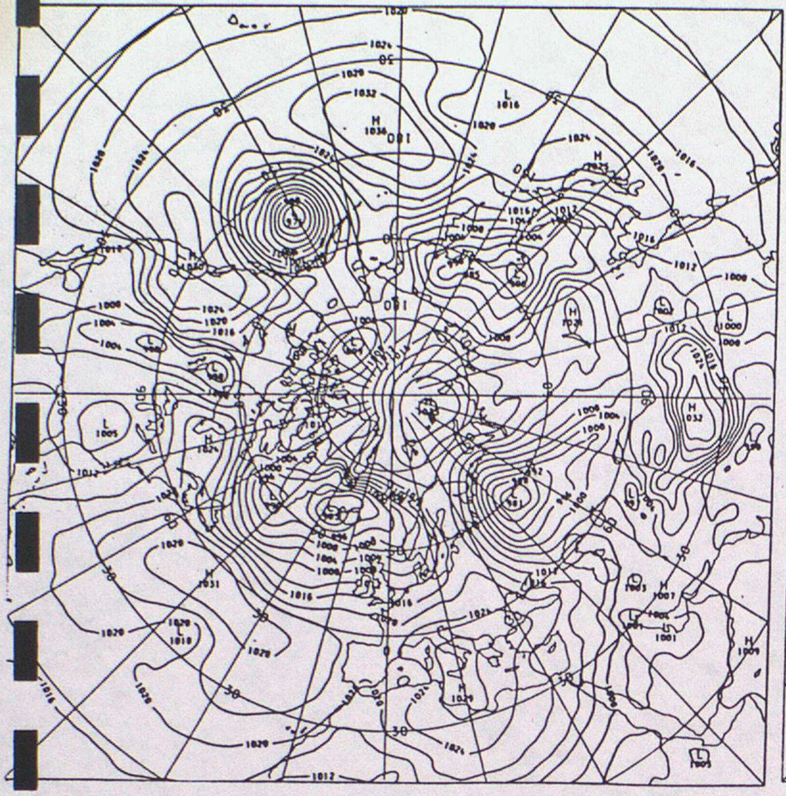


oper f/c T+120	trial f/c T+120
verif analysis	fig. 3 VT 22 Dec

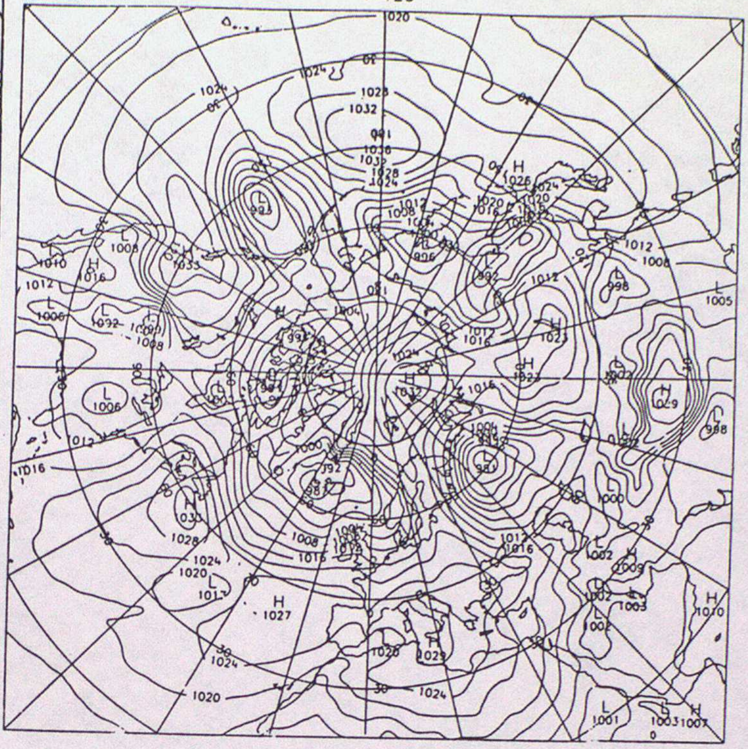
AC better position of low to the southwest of Alaska.

OP better position of Trough at 25°W.

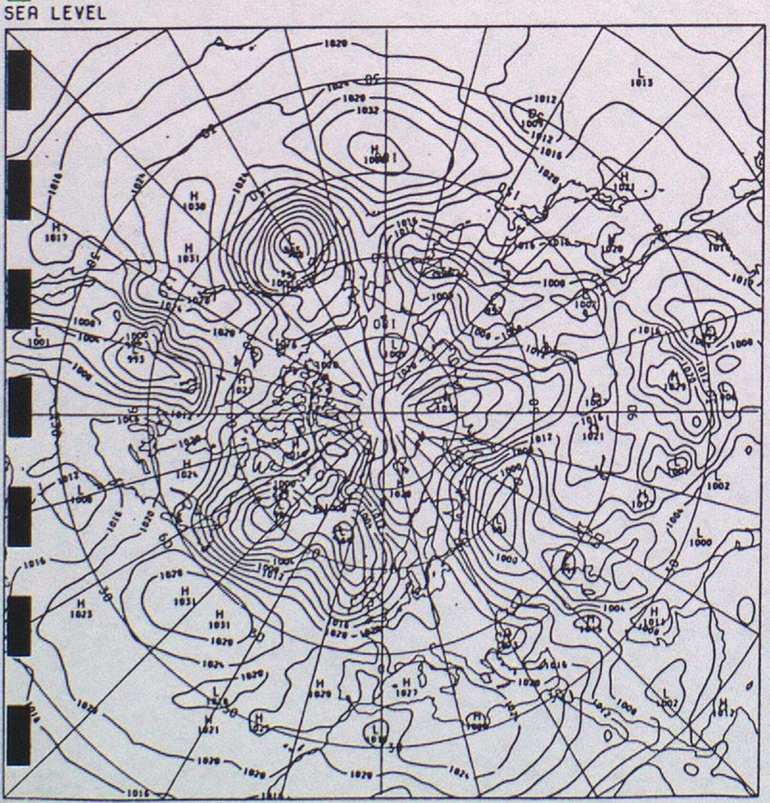
UK ANALYSIS / UK FORECAST
MEAN SEA LEVEL PRESSURE
VALID AT 12Z ON 19/4/1987
SEA LEVEL



A.C. CASE FOR 19/04/87 (T+120)
MEAN SEA LEVEL PRESSURE
VALID AT 12Z ON 19/4/1987 DATA TIME 12Z ON 14/4/1987
SEA LEVEL T+120



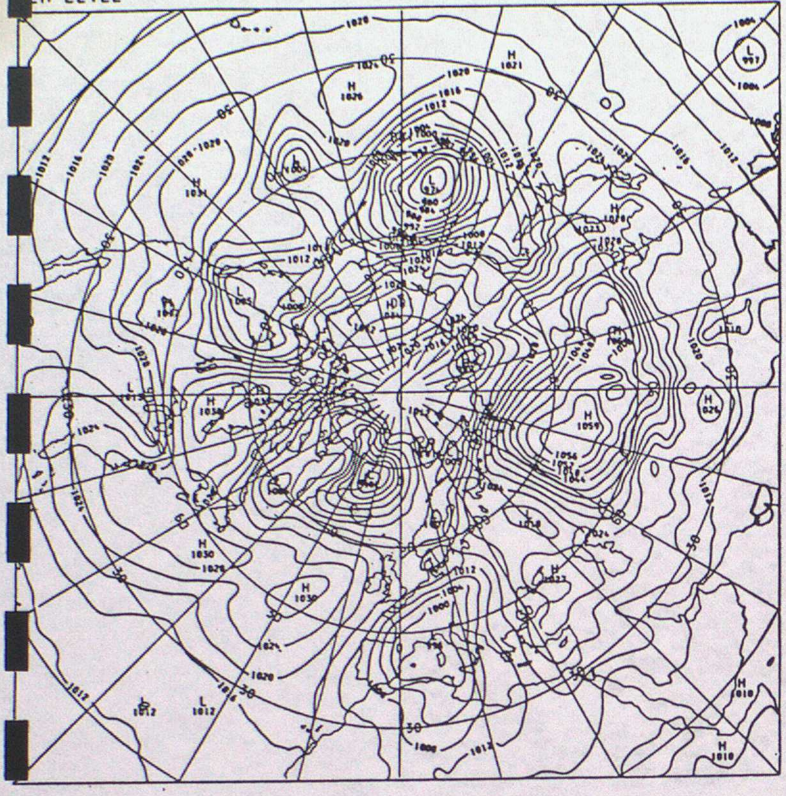
UK ANALYSIS
MEAN SEA LEVEL PRESSURE
VALID AT 12Z ON 19/4/1987
SEA LEVEL



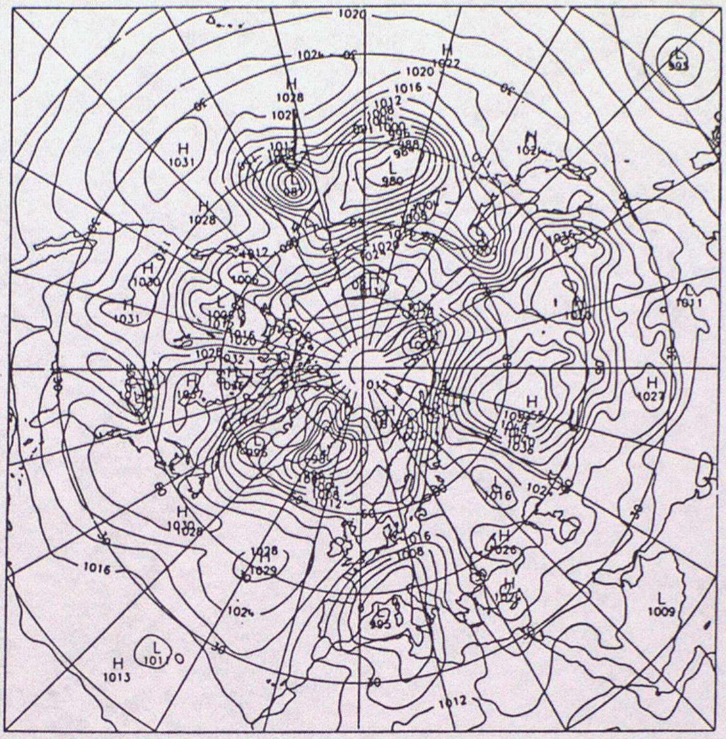
oper f/c T+120	trial f/c T+120
verif analysis	fig. 4 VT 19 April

OP significantly better from mid Pacific across the United States to West Atlantic.

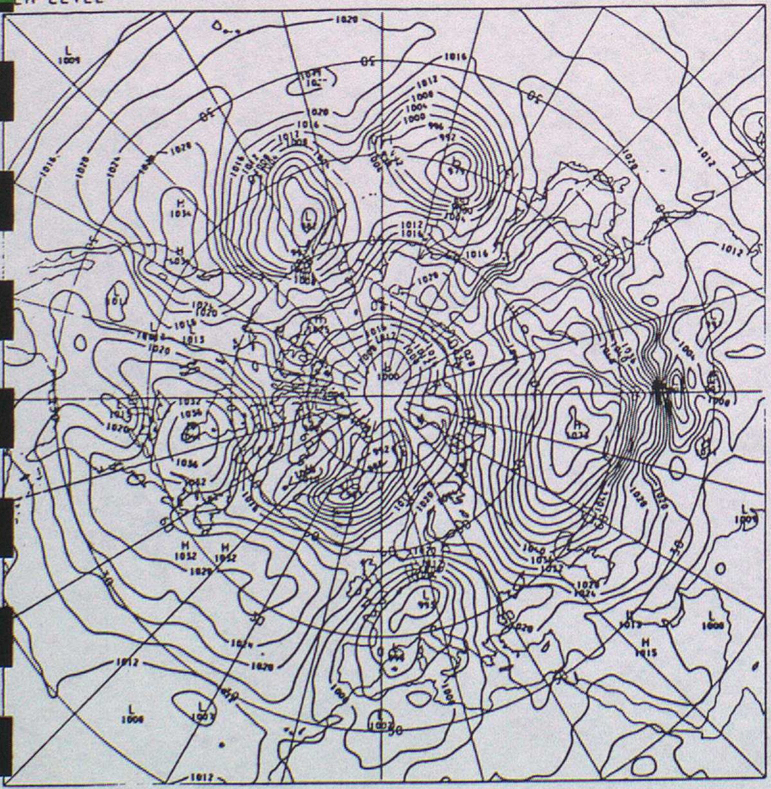
UK ANALYSIS / UK FORECAST
MEAN SEA LEVEL PRESSURE
VALID AT 12Z ON 25/11/1987
SEA LEVEL



A.C. CASE FOR 25/11/87 (T+120)
MEAN SEA LEVEL PRESSURE
VALID AT 12Z ON 25/11/1987 DATA TIME 16Z ON 20/11/1987
SEA LEVEL T+120



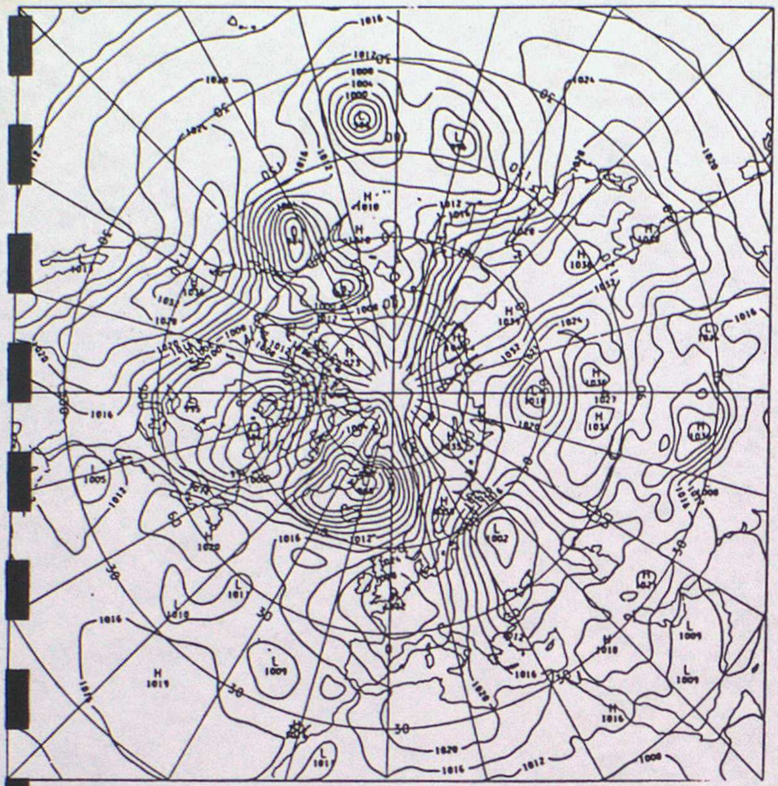
UK ANALYSIS
MEAN SEA LEVEL PRESSURE
VALID AT 12Z ON 25/11/1987
SEA LEVEL



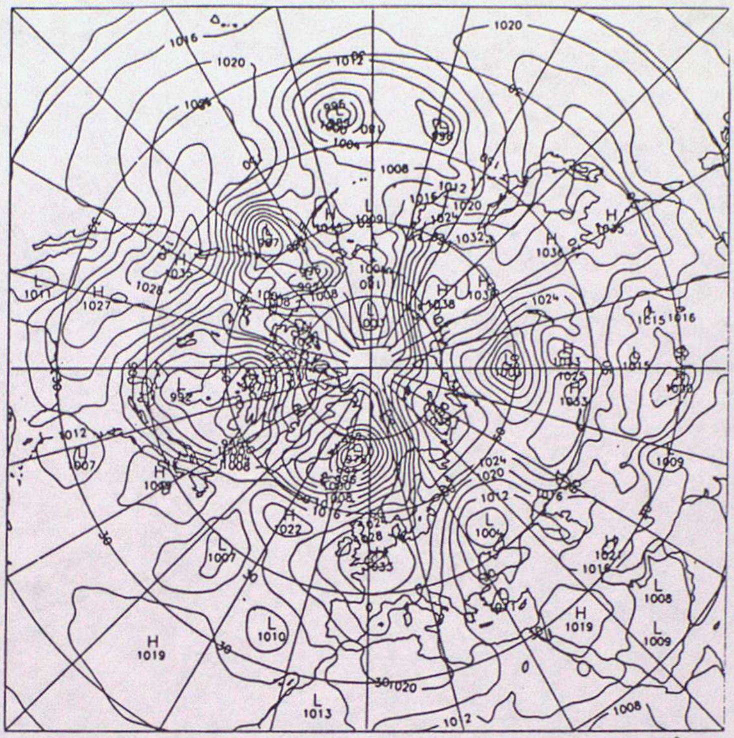
oper f/c T+120	trial f/c T+120
verif analysis	fig. 5 VT 25 Nov

AC Very good with position and depth of low at 160°W.

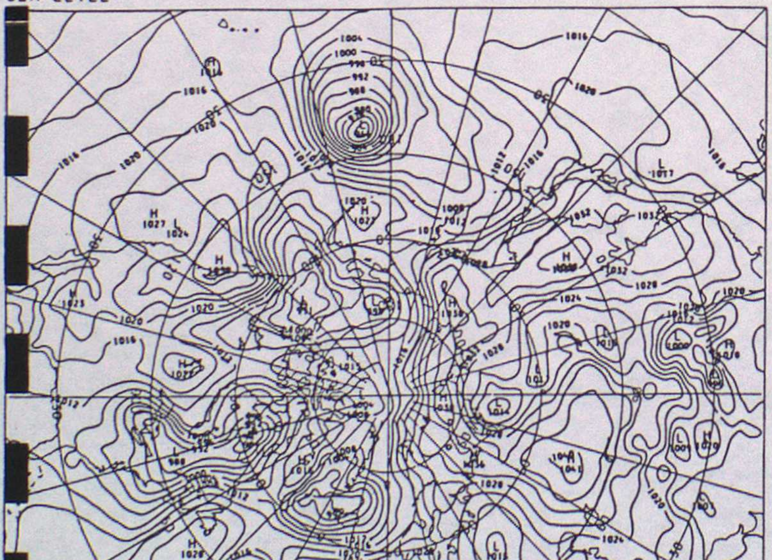
K ANALYSIS / UK FORECAST
EAN SEA LEVEL PRESSURE
ALID AT 12Z ON 20/2/1988
SEA LEVEL



A.C. CASE FOR 20/02/88 (T+120)
MEAN SEA LEVEL PRESSURE
VALID AT 12Z ON 20/2/1988 DATA TIME 12Z ON 15/2/1988
SEA LEVEL T+120



ANALYSIS
AN SEA LEVEL PRESSURE
VALID AT 12Z ON 20/2/1988
SEA LEVEL



oper f/c T+120	trial f/c T+120
verif analysis	fig. 6 VT 20 Feb

AC Slightly better with low
Mid Atlantic.
OP better with low over NW Russia.

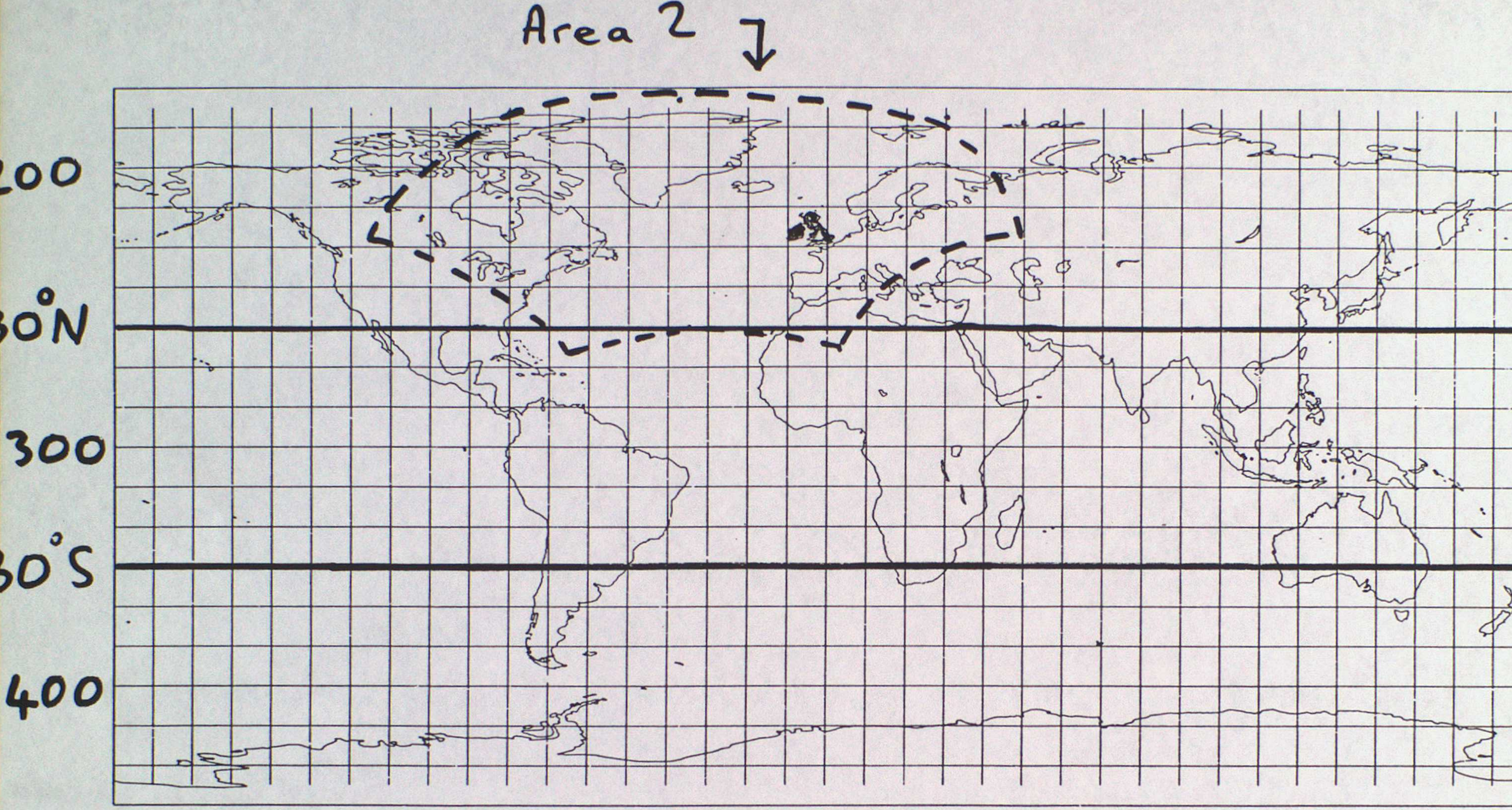
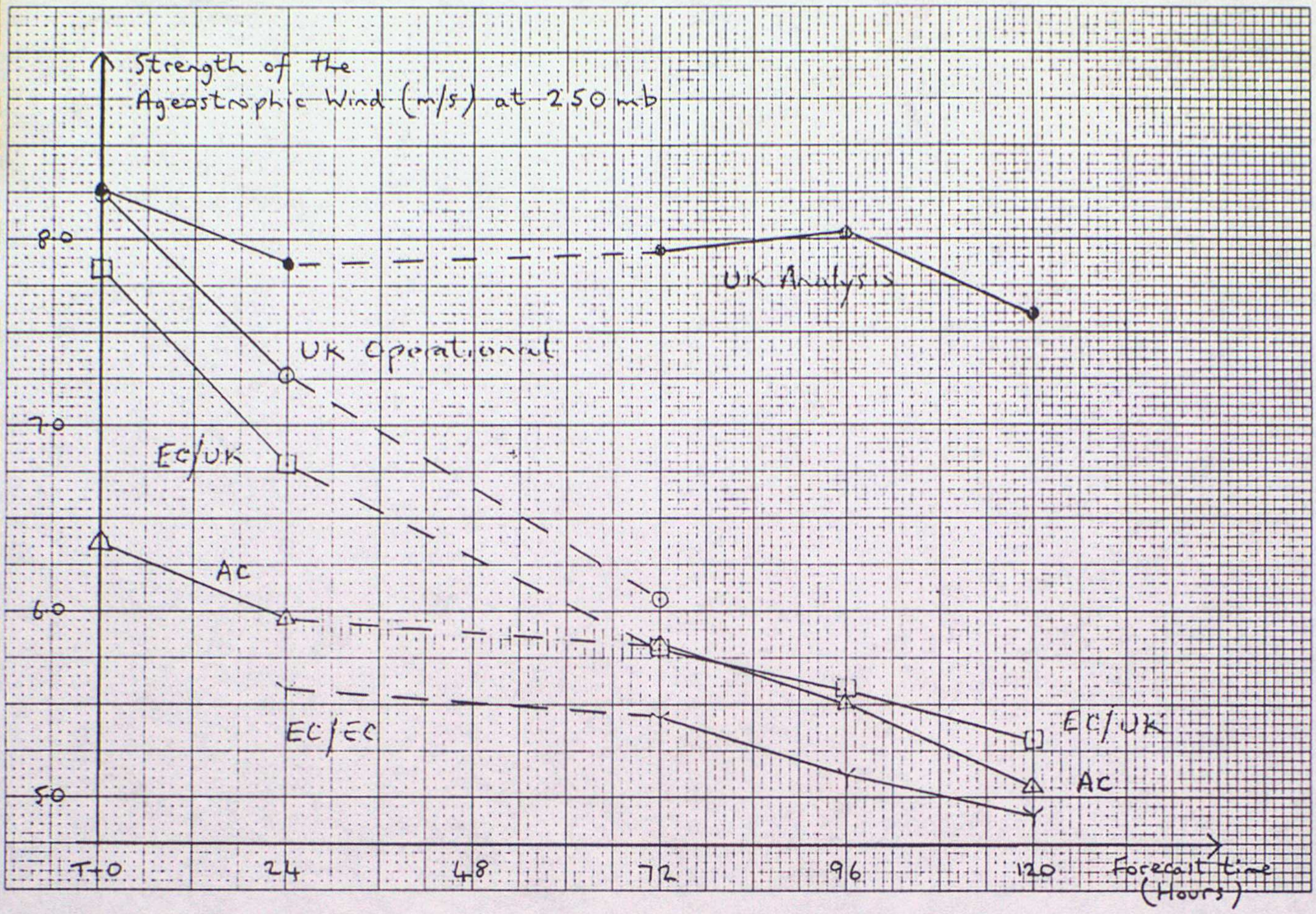


FIG 7: VERIFICATION AREAS



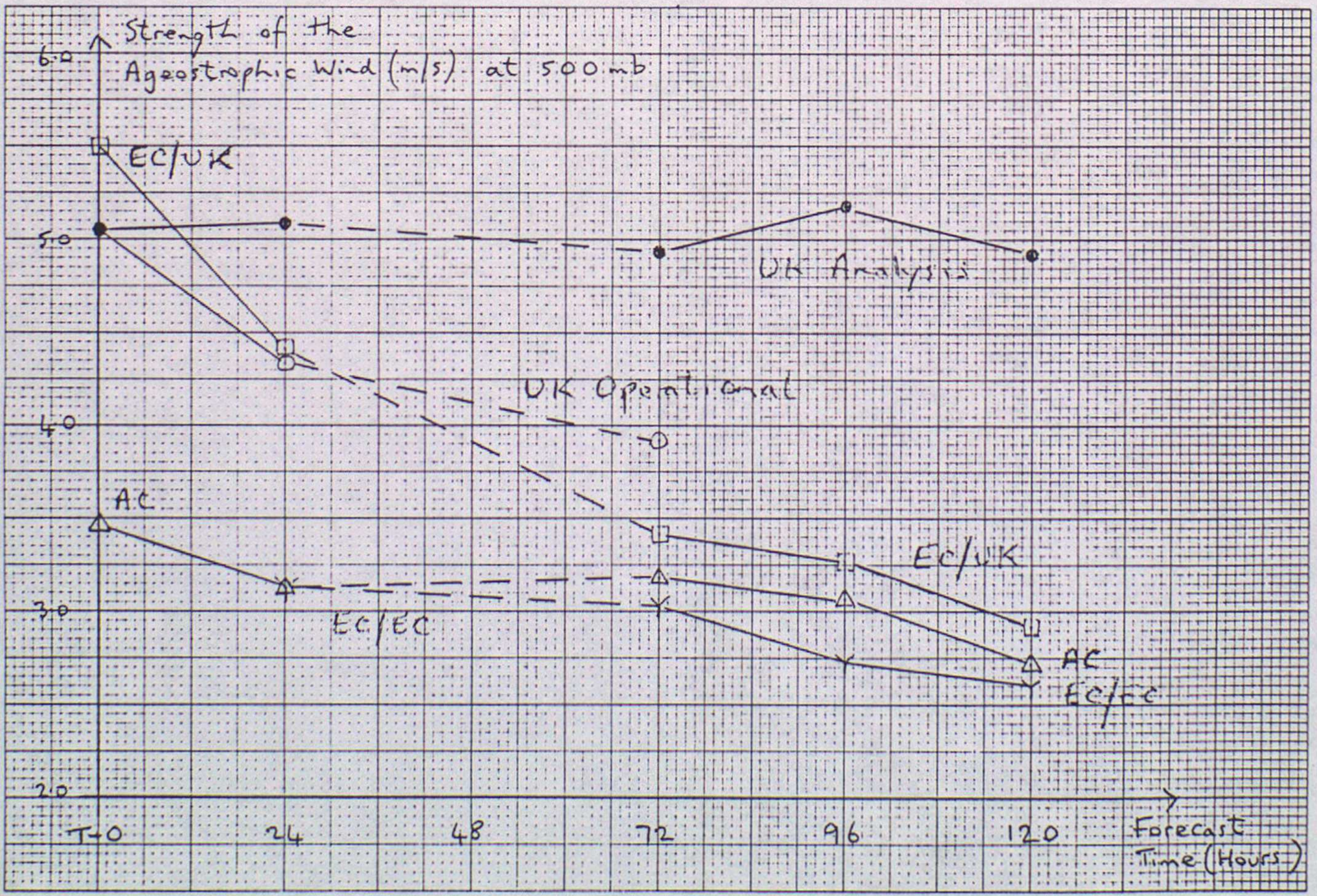


Fig 8. Strength of Ageostrophic Wind as a function of Forecast Time.