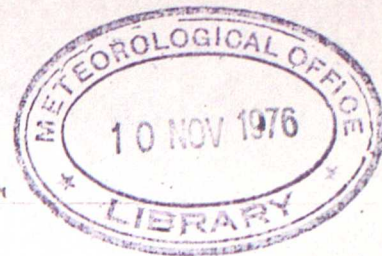


MET O 11 TECHNICAL NOTE No. 75

For Appendix see Tech. Note No. 75a



Report on variable level forecasts on the octagon area

by

123391

Nguyen Ngoc Anh

FH33

NOTE: This paper has not been published. Permission to quote from it should be obtained from the Assistant Director of the above Meteorological Office Branch.

16 September 1976

Acknowledgement

I would like to express my sincere gratitude to Professor R.P. Pearce of Reading University, Mr D.E. Jones of Meteorological Office College and Mr P. Graystone of Met O 11, Bracknell Meteorological Office for arranging for me to have this project work in Met O 11.

My thanks are due to the staff of Met O 11 for their kind assistance and helpful cooperation throughout my stay, otherwise this work could never have been complete.

Nguyen Ngoc Anh

1. Introduction

The 10-level model was converted to the variable level one so that forecasts could be obtained from experiments with different vertical distributions of pressure levels. Both the 10-level and the variable level model used the split semi-implicit integration scheme described by Burridge (1975) and were run with a time step of 15 minutes. The initial data for the variable level version was obtained from the initialised 10-level data using orthogonal polynomial interpolation described by Forsythe (1957). A diagnostic program was written to compute RMS errors at 10 pressure levels between 100 mb and 1000 mb at intervals of 100 mb.

From July to September 1976 6 day forecasts on the octagon area were obtained from variable level experiments for a particular synoptic situation on 20/6/1976. The forecasts were assessed subjectively and the numerical results were used for the purpose of comparison between the 10-level and variable level model performance.

2. Experiments

Extra pressure levels were put in the middle of the basic 10-level 100 mb layer from the top of the atmospheric column in Experiment A and from the middle of the atmospheric column in Experiment B. Experiment C was aimed for the problem of high concentration of pressure levels in the layer of jet streams.

At the time of this report being done progress is still being made so that experiments on the surface boundary layer and aspects about a model containing less than 10 levels can be considered.

Table A provides a list of the successful runs of the experiments described above.

3. Results

Subjectively the variable level surface forecasts were rather disappointing since they generally produced the same gross errors as the 10-level surface forecasts. An illustrated example is given in Figs 1-4 which show the initial analysis at 12z 20/6/76, the final analysis at 12z 26/6/76 and the 10-level and run A17 6 day forecasts. The 10-level forecast failed to predict the existence of the depression over the Pacific Ocean and so did all variable level forecasts. Minor differences

between the 10-level and the variable level forecasts resulted in the fact that the variable level forecasts usually described lows and highs slightly better or slightly worse than the 10-level forecasts. There was no significantly improved synoptic development to be recorded.

Tables B.1-10 show RMS errors for all forecasts at 10 pressure levels between 100 mb and 1000 mb at intervals of 100 mb over the complete octagon area and a 20 x 20 area surrounding the British Isles. According to White (1976) one of the disadvantages of the semi-implicit scheme is its tendency to produce intense cold pools and since the cold pools arose mainly in central Asia, in polar regions or in Canada, the 20 x 20 area was largely uncontaminated by them. Tables C.1-10 show RMS error difference between the 10-level and variable level forecasts for each of 10 pressure levels.

Basically all variable level forecasts did not perform well in the lowest layers of the troposphere. Since there were no experiments on the surface boundary layer no preliminary conclusion on the performance of the variable level model on the lowest tropospheric layers could be made. Considering the jet stream layers, however, the variable level model produced forecasts with better accuracy than the 10-level model. This feature is well illustrated in numerical results given by Experiment A, which was designed to improve the upper layer forecasts. Figs 5-7 provide an opportunity to make a 6 day 200mb height field forecast comparison for run A17. The patterns suggest that there was no significantly improved synoptic development although the RMS error of run A17 was much less than the 10-level one. Experiment B, which was designed to improve the middle troposphere forecast, did show some slight improvement in the considered layer. In Experiment C the high concentration of pressure levels about the 300 mb level was established so that the 300 mb forecasts could be improved. Its numerical results indeed proved the above suggestion.

An example of RMS error distribution with pressure levels and with forecast time is illustrated in Fig 8 using the numerical results of run A17.

4. Conclusion

It can be concluded that the vertical distribution of pressure levels is able

to have an effect on the quality of forecasts.

It would be desirable to use initialised variable level data for performing experiments. Future experiments can be aimed at the surface boundary layer to measure the quality of surface forecasts. Considering the problem of CPU time, it is also useful to use less than 10 levels in the vertical to see whether forecast accuracy is maintained in comparison with the 10-level performance.

REFERENCES

- | | | |
|-------------------------------|------|---|
| Burridge, D.M. | 1975 | "A split semi-implicit reformulation of the Bushby - Timpson 10 - level model". Quart.J.R.Met.Soc. <u>101</u> pp 777-792 |
| Burridge, D.M. and Gadd, A.J, | 1975 | "The Meteorological Office operational 10 level numerical weather prediction model (December 1975)". Met O 2b Technical Note No 12 Version 2. |
| Forsythe, G.E. | 1957 | "Generation and use of orthogonal polynomials for data-fitting with a digital computer". J.Soc.Indust.Appl.Math <u>5</u> pp 74-88. |
| White, P.W. | 1976 | "Report on fine mesh forecasts on the octagon area". Met O 11 Technical Note No 70. |

SURFACE PRESSURE FIELD
 0 HR. FORECAST. DATA TIME 12 Z 20 / 6 / 76. VERIFICATION TIME 12 Z 20 / 6 / 76

10 LEVELS

100
 200
 300
 400
 500
 600
 700
 800
 900
 1000

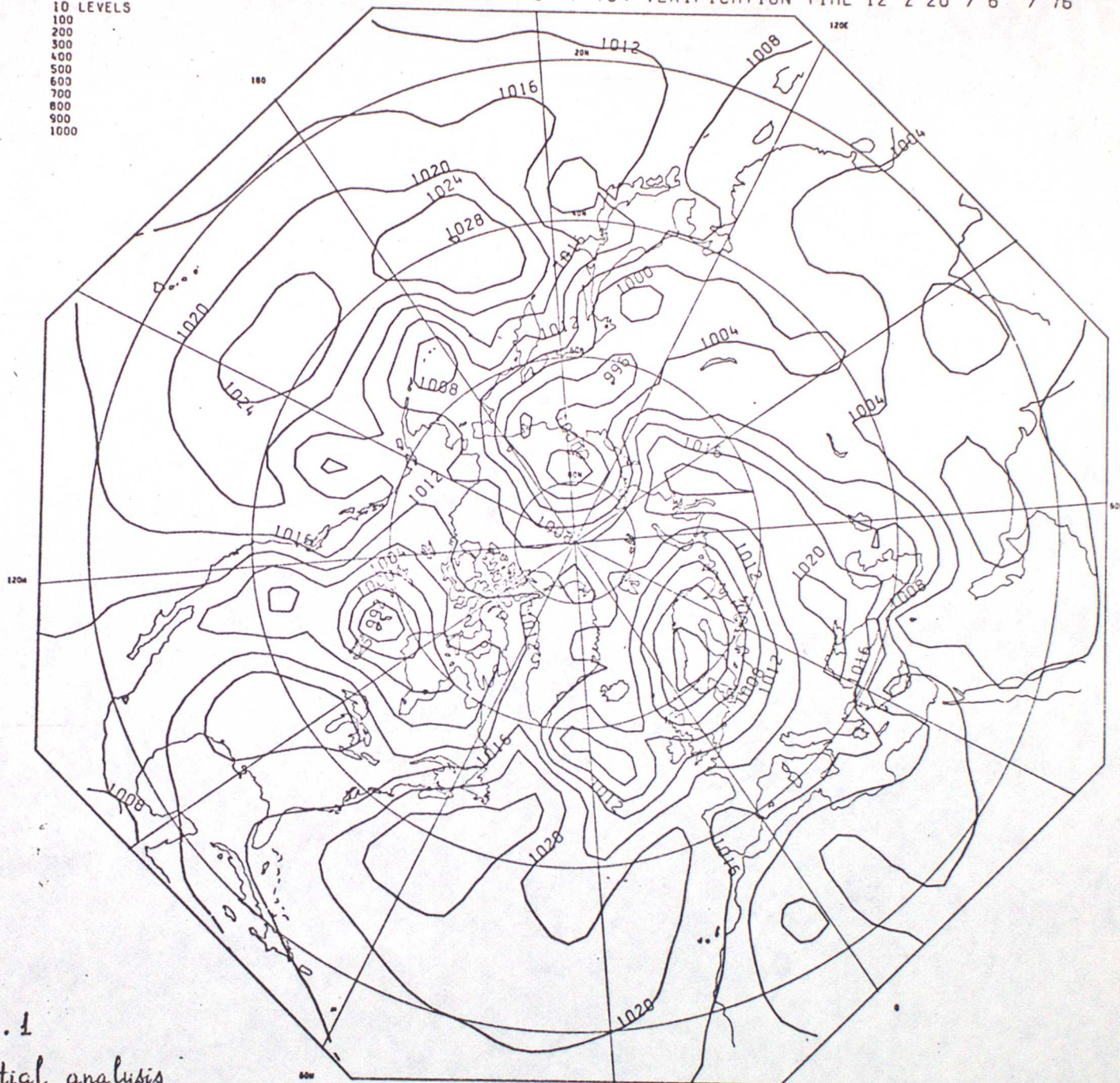


Fig. 1
 Initial analysis
 12Z 20.6.76

300 KM OCTAGON

0 HR.FORECAST. DATA TIME 12 Z 26 / 6 / 76. VERIFICATION TIME 12 Z 26 / 6 / 76

Fig. 2
Final analysis
12x 26.6.76

SURFACE PRESSURE FIELD

144HR.FORECAST. DATA TIME 12 Z 20 / 6 / 76. VERIFICATION TIME 12 Z 26 / 6 / 76

10 LEVELS
100
200
300
400
500
600
700
800
900
1000

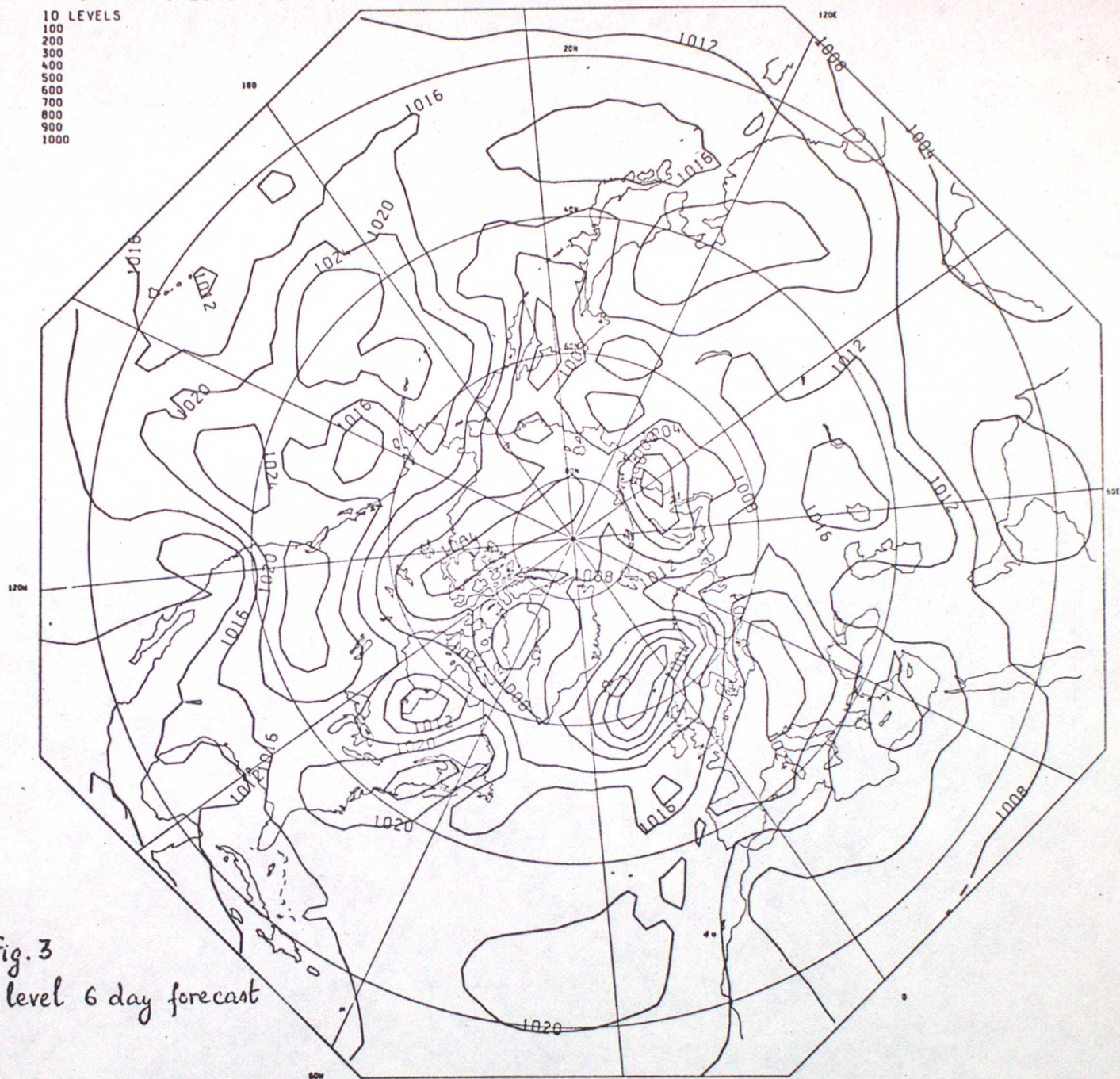


Fig. 3
10-level 6 day forecast

300 KM OCTAGON

SURFACE PRESSURE FIELD

144HR.FORECAST. DATA TIME 12 Z 20 / 6 / 76. VERIFICATION TIME 12 Z 26 / 6 / 76

17 LEVELS

100
150
200
250
300
350
400
450
500
550
600
650
700
750
800
900
1000

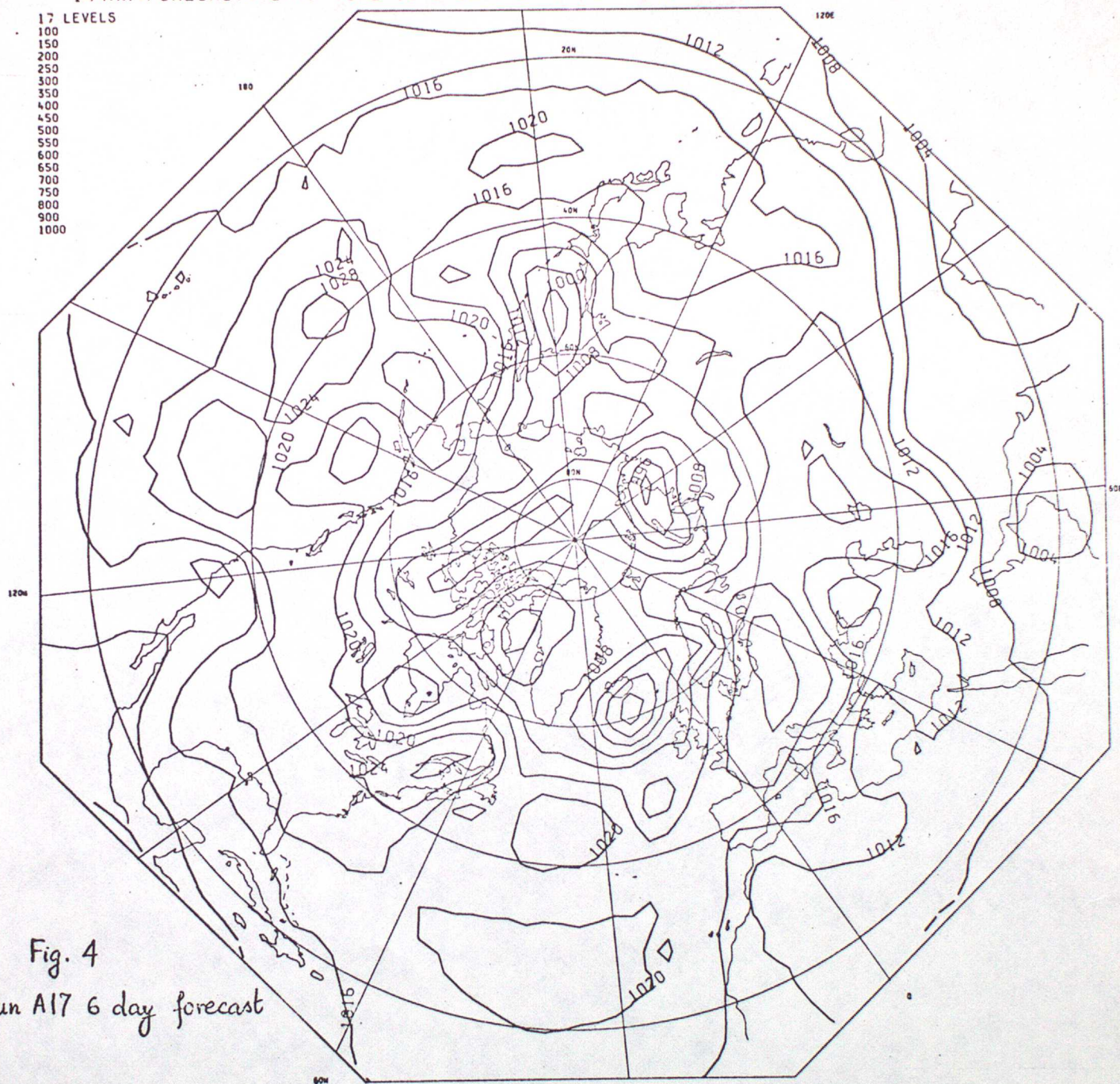


Fig. 4

Run A17 6 day forecast

300 KM OCTAGON

200 MB HEIGHT FIELD

0 HR.FORECAST. DATA TIME 12 Z 26 / 6 / 76. VERIFICATION TIME 12 Z 26 / 6 / 76

10 LEVELS
100
200
300
400
500
600
700
800
900
1000

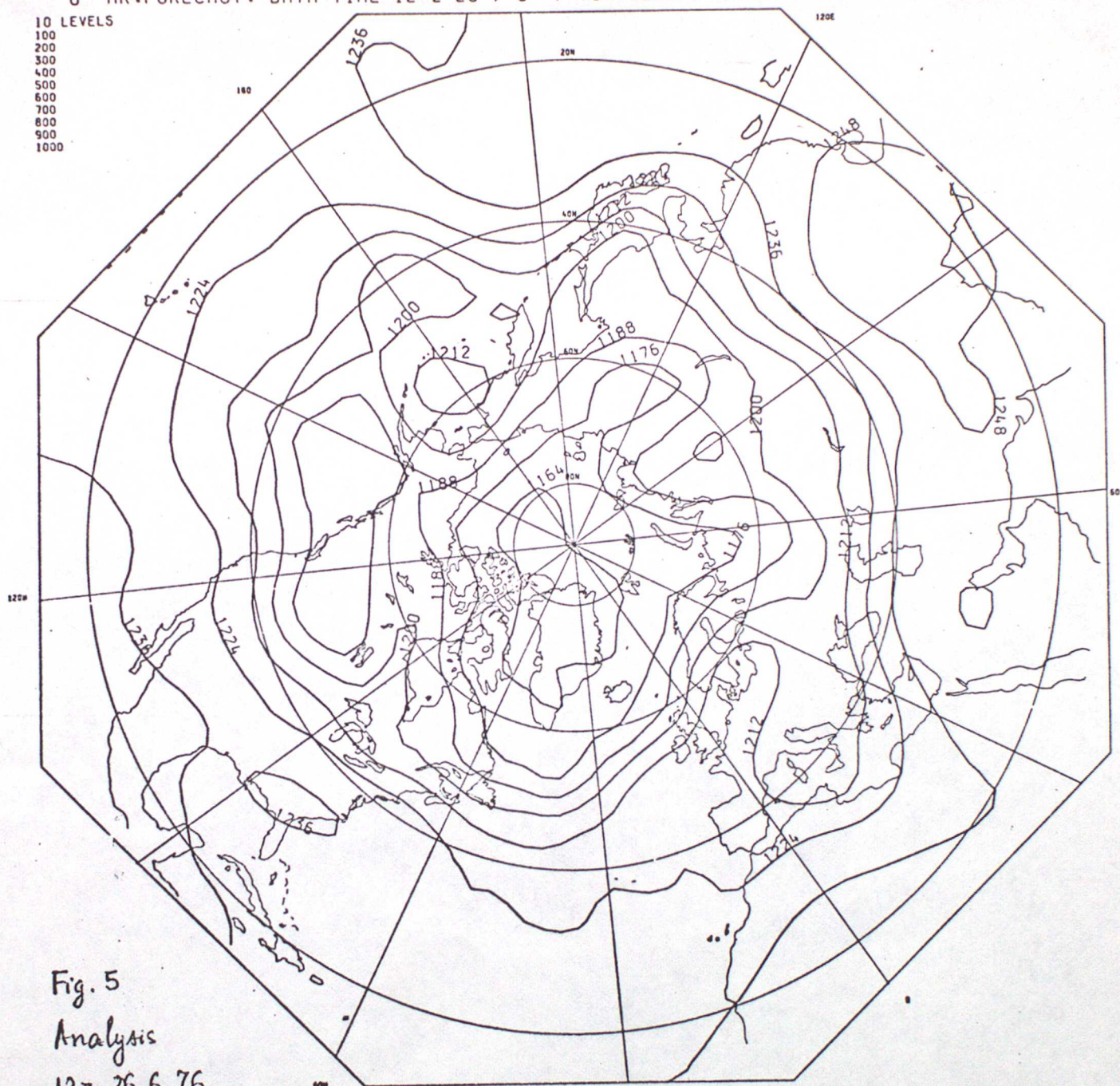


Fig. 5

Analysis

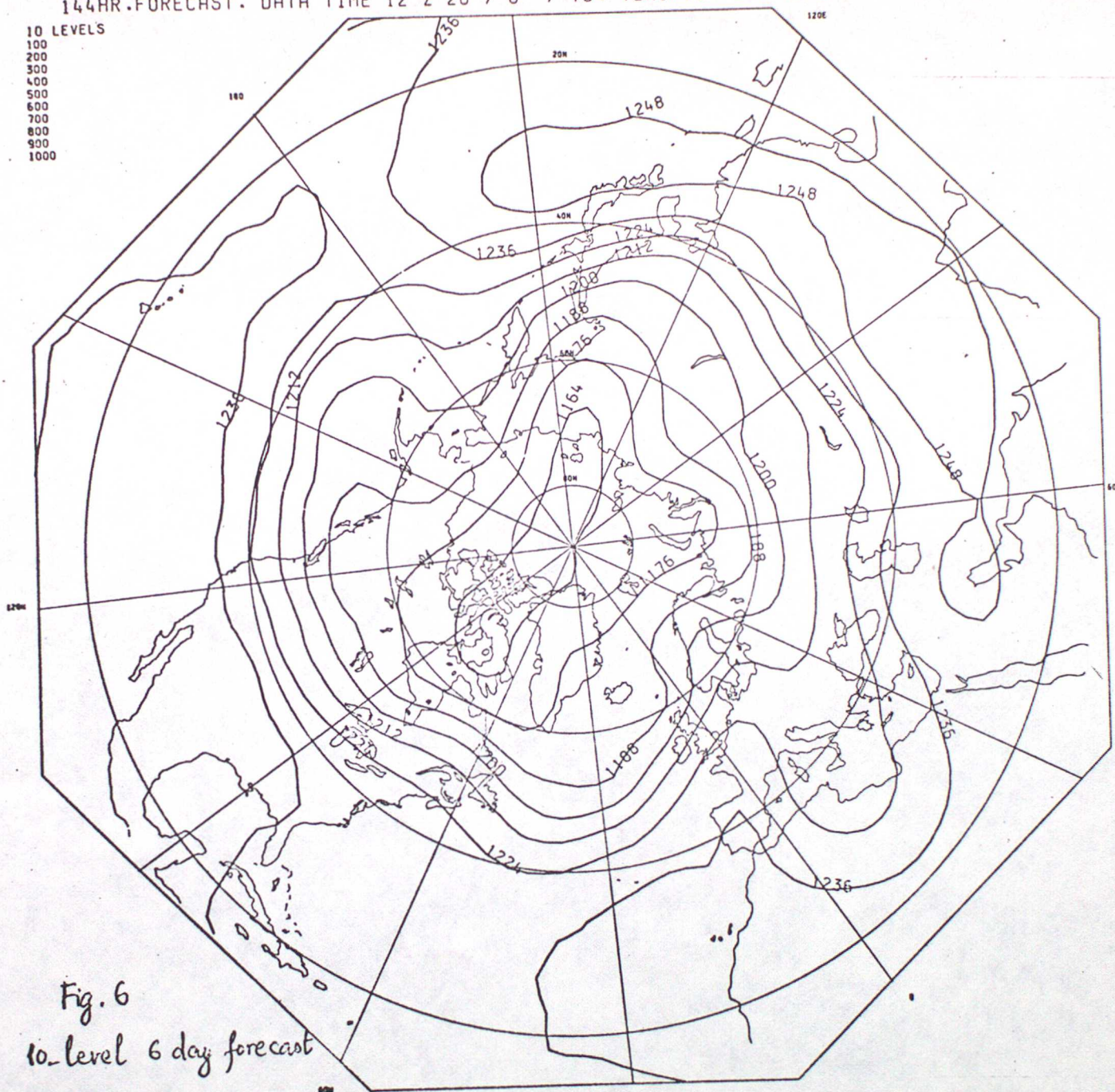
12z 26.6.76

300 KM OCTAGON

200 MB HEIGHT FIELD

144HR.FORECAST. DATA TIME 12 Z 20 / 6 / 76. VERIFICATION TIME 12 Z 26 / 6 / 76

10 LEVELS
100
200
300
400
500
600
700
800
900
1000



300 KM OCTAGON

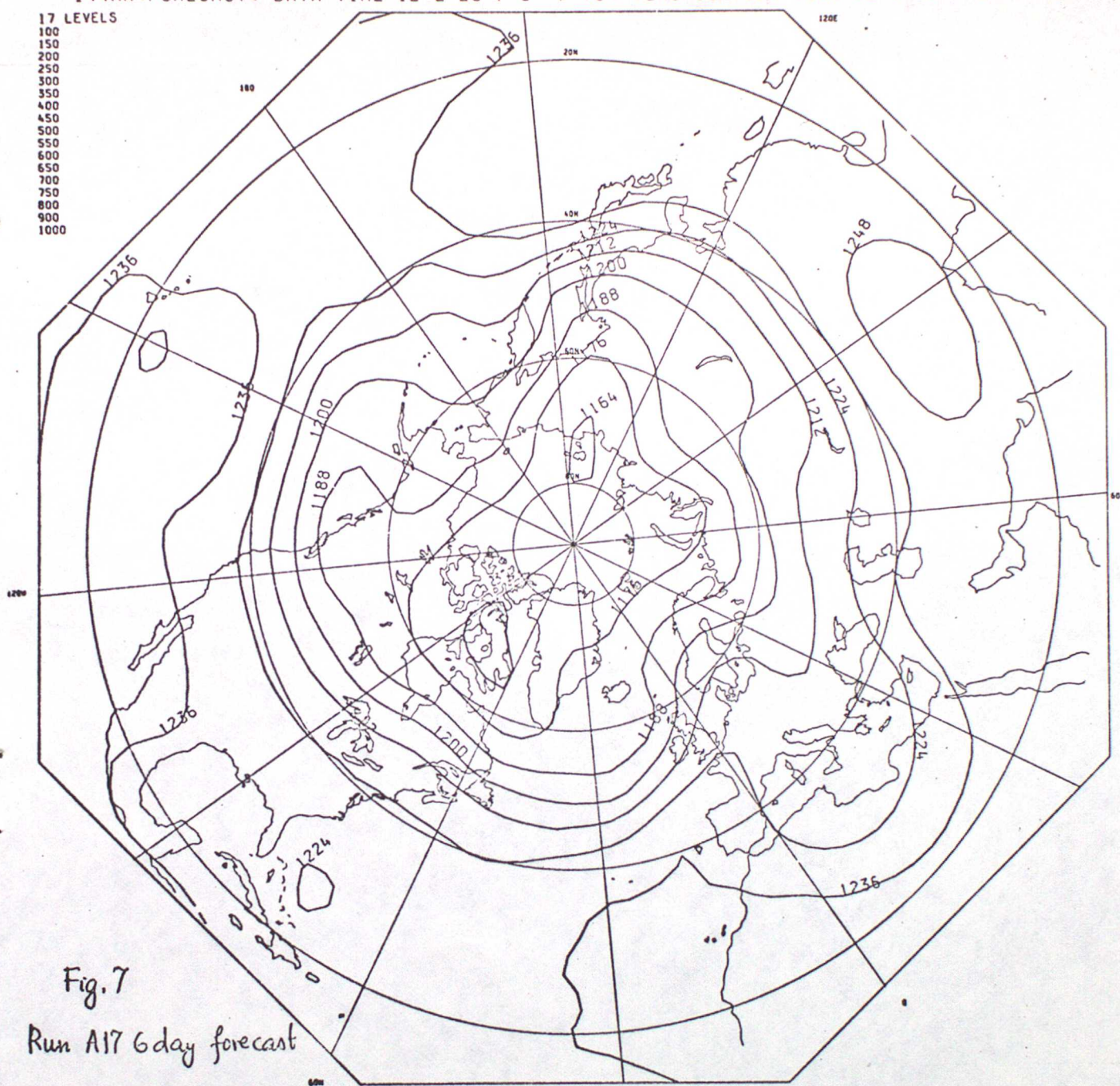
Fig. 6
10-level 6 day forecast

200 MB HEIGHT FIELD

144HR.FORECAST. DATA TIME 12 Z 20 / 6 / 76. VERIFICATION TIME 12 Z 26 / 6 / 76

17 LEVELS

100
150
200
250
300
350
400
450
500
550
600
650
700
750
800
900
1000



300 KM OCTAGON

Fig. 7
Run A17 6 day forecast

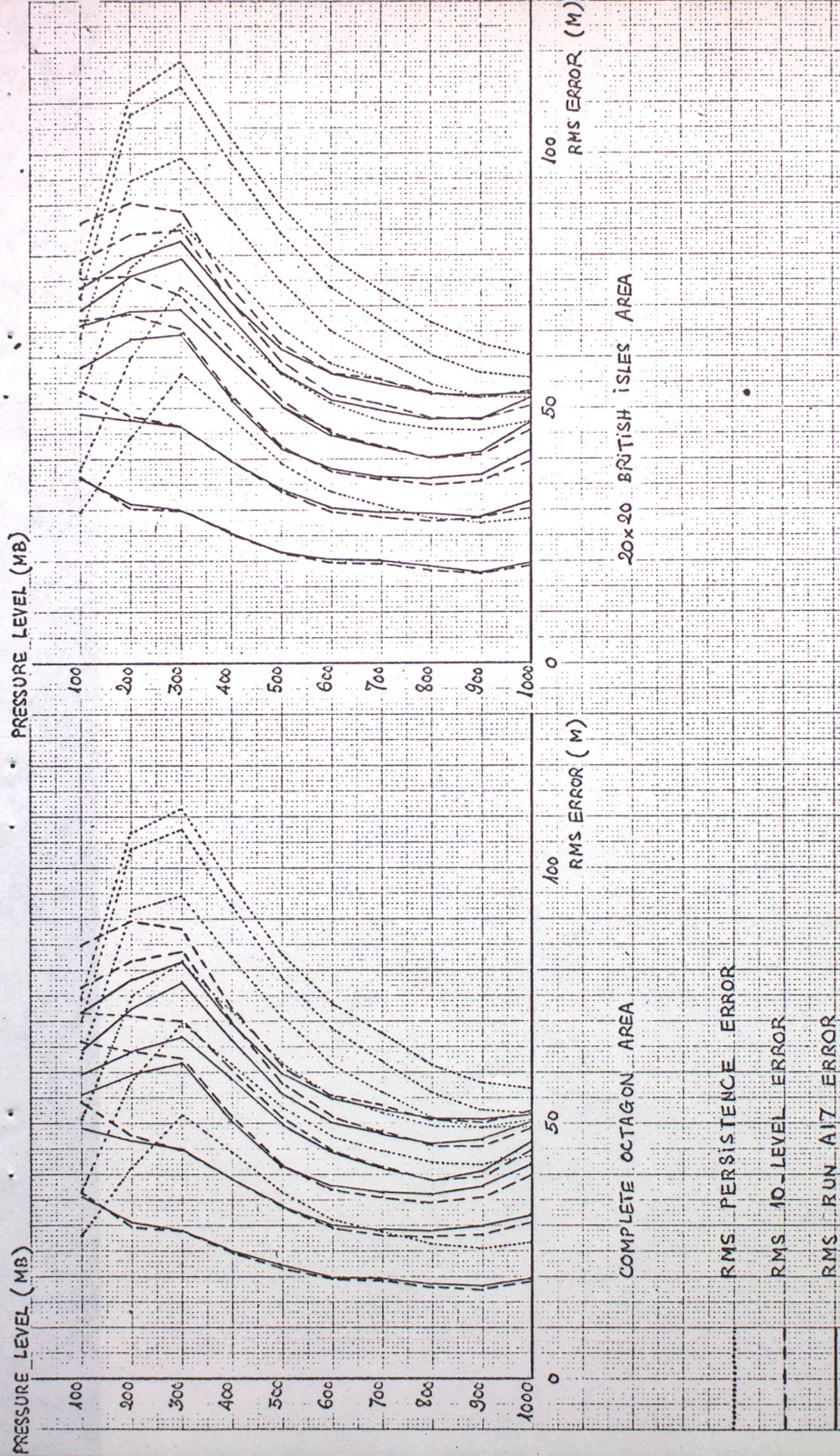


FIG. 8 RMS ERROR DISTRIBUTION WITH PRESSURE LEVELS AND WITH FORECAST TIME

LIST OF PRESSURE LEVELS																			
EXPERIMENTS	RUNS	NUMBER OF PRESSURE LEVELS	100	150	200	300	400	500	600	700	800	900	1000						
A	A11	11	100	150	200	300	400	500	600	700	800	900	1000						
	A12	12	100	150	200	250	300	400	500	600	700	800	900	1000					
	A13	13	100	150	200	250	300	350	400	500	600	700	800	900	1000				
	A14	14	100	150	200	250	300	350	400	450	500	600	700	800	900	1000			
	A15	15	100	150	200	250	300	350	400	450	500	550	600	700	800	900	1000		
	A16	16	100	150	200	250	300	350	400	450	500	550	600	650	700	800	900	1000	
	A17	17	100	150	200	250	300	350	400	450	500	550	600	650	700	750	800	900	1000
B	B11	11	100	200	300	400	500	550	600	700	800	900	1000						
	B13	13	100	200	300	400	450	500	550	600	650	700	800	900	1000				
	B15	15	100	200	300	350	400	450	500	550	600	650	700	750	800	900	1000		
	B17	17	100	200	250	300	350	400	450	500	550	600	650	700	750	800	850	900	1000
C	C14	14	100	200	250	280	300	320	350	400	500	600	700	800	900	1000			

TABLE A

COMPLETE OCTAGON AREA

20x20 BRITISH ISLES AREA

EXPERIMENT	RUNS	T+24	T+48	T+72	T+96	T+120	T+144
A	PERSISTENCE	27.92	36.34	50.77	62.84	69.30	74.21
	10 LEVEL	36.47	53.95	66.17	71.54	76.74	84.85
	A11	34.75	48.28	55.23	60.35	68.01	77.01
	A12	35.83	49.64	56.50	61.93	69.42	79.02
	A13	35.40	49.04	55.39	59.97	66.13	74.33
	A14	35.33	48.69	54.81	59.11	64.59	71.65
	A15	35.48	48.77	54.91	59.06	63.87	70.73
	A16	35.48	48.95	55.34	59.59	64.37	71.39
	A17	35.44	48.98	55.50	59.55	64.28	71.45
	B11	37.80	55.16	67.43	72.44	76.28	84.24
B	B13	36.99	53.91	66.06	70.79	74.29	81.57
	B15	35.76	52.61	64.53	69.68	72.85	79.40
	B17	35.32	52.57	64.12	68.88	72.69	79.93
	C14	35.11	52.43	63.25	68.36	71.76	79.30
C		T+24	T+48	T+72	T+96	T+120	T+144
		29.78	37.82	52.41	63.78	71.37	76.86
		36.25	53.21	67.18	75.52	79.15	86.20
		34.96	48.07	56.97	66.22	72.29	78.87
		36.44	49.55	58.63	68.05	74.00	81.20
		36.05	48.93	57.54	66.19	70.61	76.48
		36.01	48.62	57.09	65.28	69.05	73.60
		36.16	48.68	57.19	65.27	69.47	72.62
		36.16	48.85	57.59	65.84	69.13	73.39
		36.10	48.88	57.85	65.99	69.21	73.58
C		37.82	54.65	68.54	76.92	78.99	85.27
		36.93	53.32	67.18	75.45	77.14	82.61
		35.60	51.84	65.49	74.09	75.56	80.36
		35.26	51.93	65.11	73.49	75.86	81.53
		35.03	51.67	63.93	72.43	74.37	80.44

TABLE B.1

EXPERIMENT	RUNS
A	PERSISTENCE
	10 LEVEL
	A11
	A12
	A13
	A14
	A15
	A16
	A17
	B11
B	B13
	B15
	B17
	C14

T+24	T+48	T+72	T+96	T+120	T+144
41.23	58.14	74.83	91.58	103.86	106.92
29.78	47.55	64.09	70.99	81.71	89.60
30.07	47.96	62.64	68.77	81.12	88.52
30.57	47.17	60.75	67.18	79.99	88.92
30.29	46.28	58.81	62.99	74.01	81.53
30.33	46.02	58.64	63.22	73.26	79.66
30.48	46.13	58.77	63.15	72.40	78.37
30.49	46.35	59.31	63.57	72.29	78.24
30.47	46.47	59.48	63.81	72.53	78.12
32.40	50.20	66.93	73.33	82.40	88.71
31.32	49.21	65.63	71.50	78.85	85.22
29.39	46.37	61.97	66.99	73.20	78.27
30.03	46.81	61.27	65.95	73.42	79.91
29.94	46.19	59.00	63.59	71.42	78.39

T+24	T+48	T+72	T+96	T+120	T+144
44.05	59.82	77.63	94.59	107.62	111.59
30.24	48.44	68.33	75.82	84.11	90.30
30.54	49.03	66.60	73.84	83.60	89.04
31.21	48.16	64.34	71.63	82.110	89.50
30.93	47.26	62.48	67.77	76.71	82.37
31.02	47.11	62.61	68.02	76.08	80.48
31.15	47.19	62.74	68.06	75.44	79.32
31.14	47.37	63.27	68.54	75.54	79.32
31.10	47.48	63.49	68.90	75.95	79.33
32.92	51.09	70.81	78.18	85.04	89.31
31.81	50.02	69.75	76.68	82.02	86.11
29.84	47.24	66.56	72.47	76.72	79.32
30.46	47.58	65.22	70.52	76.56	80.87
30.36	46.89	62.60	67.59	74.08	79.15

TABLE B.2

EXPERIMENT	RUNS	T+24	T+48	T+72	T+96	T+120	T+144
A	PERSISTENCE	51.46	69.06	81.61	94.31	107.45	111.78
	10 LEVEL	28.97	44.87	62.78	70.15	83.46	87.90
	A11	28.76	44.39	61.64	69.00	82.93	87.34
	A12	29.04	45.02	62.66	70.98	85.78	91.24
	A13	28.93	44.94	61.31	67.25	79.82	85.31
	A14	28.95	44.93	61.34	67.32	79.18	83.89
	A15	29.01	44.67	61.16	66.80	78.24	82.69
P	A16	29.03	44.84	61.35	66.79	77.60	81.87
	A17	29.07	44.97	61.51	66.89	77.64	81.45
	B11	30.52	45.97	63.76	71.03	83.39	86.51
	B13	29.79	45.58	62.53	68.96	80.16	83.37
	B15	29.42	45.68	62.47	68.18	78.44	81.15
	B17	29.16	46.15	63.37	68.96	79.43	82.83
	C14	28.37	44.68	60.27	66.06	75.94	80.64
C							

TABLE B.3

COMPLETE OCTAGON AREA

20x20 BRITISH ISLES AREA

EXPERIMENT	RUNS	T+24	T+48	T+72	T+96	T+120	T+144
A	PERSISTENCE	44.25	61.66	72.12	82.41	92.50	96.49
	10 LEVEL	24.76	38.90	51.28	60.50	69.69	72.53
	A11	24.47	38.31	50.23	59.90	69.51	72.56
	A12	24.36	38.38	50.48	60.85	71.03	75.00
	A13	24.93	39.05	50.45	59.34	68.30	72.76
	A14	24.86	39.04	50.34	59.02	67.55	71.46
	A15	24.91	38.82	50.13	58.37	66.68	70.47
B	A16	24.97	38.94	50.23	58.46	66.22	69.80
	A17	25.01	39.02	50.26	58.52	66.22	69.41
	B11	25.02	38.61	50.00	59.21	67.73	70.52
	B13	25.73	39.33	49.94	58.17	65.76	68.43
	B15	25.45	39.94	51.49	59.57	66.96	69.05
	B17	25.22	40.10	51.70	59.47	66.79	69.25
	C14	24.96	39.51	50.91	58.94	66.16	69.57
C		T+24	T+48	T+72	T+96	T+120	T+144
		48.34	66.17	76.37	86.93	98.06	103.12
		25.27	39.66	52.71	61.35	70.99	73.78
		24.94	39.04	51.71	60.70	70.32	73.51
		24.82	39.12	51.77	61.53	71.57	75.34
		25.46	39.71	51.71	60.01	68.94	73.25
		25.42	39.78	51.82	59.83	68.47	72.36
D		25.47	39.59	51.70	59.35	67.80	71.75
		25.53	39.69	51.83	59.51	67.48	71.29
		25.58	39.77	51.83	59.68	67.65	71.08
		25.80	39.43	51.20	59.84	68.88	71.97
		26.64	40.19	51.44	59.04	67.22	70.38
		26.09	40.68	53.16	60.88	68.85	71.28
		25.83	40.75	53.25	60.80	68.63	70.95
E		25.55	40.18	52.31	59.82	67.66	70.70

TABLE B.4

EXPERIMENT	RUNS	T+24	T+48	T+72	T+96	T+120	T+144
A	PERSISTENCE	36.19	52.96	61.86	70.68	78.55	83.06
	10 LEVEL	21.45	33.28	41.78	50.99	57.83	61.06
	A11	21.35	32.78	40.79	50.52	57.90	61.61
	A12	21.15	32.54	40.57	50.65	58.15	62.79
	A13	21.78	33.35	41.24	49.94	56.53	61.54
	A14	21.85	33.55	41.28	50.01	56.46	61.01
	A15	21.92	33.59	41.21	49.58	55.90	60.39
	A16	22.00	33.70	41.38	49.81	55.78	60.03
	A17	22.06	33.77	41.31	49.73	55.72	59.67
	B11	21.90	33.39	41.46	50.47	56.54	60.47
	B13	22.02	33.67	41.47	49.96	55.70	58.70
	B15	22.40	34.63	42.66	50.79	56.54	59.16
	B17	22.23	34.63	42.41	50.02	55.53	58.46
	C14	22.03	33.93	42.02	49.78	55.34	59.19
B	T+24	39.64	56.73	65.66	74.71	83.91	89.72
	T+48	21.82	33.61	42.47	51.60	59.06	62.65
	T+72	21.73	33.06	41.51	51.04	58.71	62.93
	T+96	21.56	32.83	41.19	51.02	58.61	63.45
	T+120	22.23	33.61	41.81	50.26	57.09	62.35
	T+144	22.31	33.84	41.93	50.48	57.31	62.28
	T+24	22.38	33.89	41.92	50.17	56.95	62.06
	T+48	22.46	33.98	42.10	50.45	56.91	61.87
	T+72	22.54	34.05	42.01	50.44	56.96	61.68
	T+96	22.69	33.90	42.09	51.00	57.82	62.46
	T+120	22.76	34.15	42.24	50.66	57.25	61.11
	T+144	22.89	34.96	43.45	51.70	58.27	61.78
	T+24	22.76	34.90	43.16	50.93	57.09	60.51
	T+48	22.47	34.21	42.68	50.36	56.62	60.63
	T+72						
C	T+24	39.64	56.73	65.66	74.71	83.91	89.72
	T+48	21.82	33.61	42.47	51.60	59.06	62.65
	T+72	21.73	33.06	41.51	51.04	58.71	62.93
	T+96	21.56	32.83	41.19	51.02	58.61	63.45
	T+120	22.23	33.61	41.81	50.26	57.09	62.35
	T+144	22.31	33.84	41.93	50.48	57.31	62.28
	T+24	22.38	33.89	41.92	50.17	56.95	62.06
	T+48	22.46	33.98	42.10	50.45	56.91	61.87
	T+72	22.54	34.05	42.01	50.44	56.96	61.68
	T+96	22.69	33.90	42.09	51.00	57.82	62.46
	T+120	22.76	34.15	42.24	50.66	57.25	61.11
	T+144	22.89	34.96	43.45	51.70	58.27	61.78
	T+24	22.76	34.90	43.16	50.93	57.09	60.51
	T+48	22.47	34.21	42.68	50.36	56.62	60.63
	T+72						

TABLE B.5

COMPLETE OCTAGON AREA

20x20 BRITISH ISLES AREA

EXPERIMENT	RUNS
A	PERSISTENCE
	10 LEVEL
	A11
	A12
	A13
	A14
	A15
B	A16
	A17
	B11
	B13
	B15
C	B17
	C14

T+24	T+48	T+72	T+96	T+120	T+144
31.15	47.31	55.28	61.45	68.35	73.20
19.41	29.34	37.13	44.39	51.25	55.22
19.34	28.88	36.56	44.33	51.81	56.19
19.18	28.66	36.33	44.27	51.72	56.89
19.72	29.41	37.17	44.67	50.59	56.04
19.85	29.74	37.40	44.07	50.46	55.54
19.92	29.95	37.39	43.75	50.10	54.99
20.04	30.16	37.87	44.27	50.27	54.97
20.06	30.17	37.71	44.05	50.21	54.74
19.34	29.20	37.49	44.39	50.37	55.08
19.75	29.71	37.77	44.18	49.97	53.34
20.42	30.88	38.85	44.79	50.71	53.81
20.27	30.82	38.47	43.91	49.41	52.80
20.16	30.07	37.94	43.71	49.43	53.39

T+24	T+48	T+72	T+96	T+120	T+144
33.57	51.04	58.80	65.17	73.45	79.46
19.75	29.62	37.50	45.10	52.69	56.92
19.65	29.12	36.95	44.98	52.97	57.72
19.53	28.92	36.65	44.73	52.47	57.49
20.05	29.63	37.41	44.43	51.35	56.92
20.17	29.94	37.65	44.54	51.46	56.86
20.24	30.15	37.68	44.29	51.27	56.63
20.36	30.36	38.14	44.85	51.48	56.77
20.42	30.35	37.97	44.66	51.51	56.67
19.87	29.59	37.77	45.01	51.96	57.21
20.15	30.06	38.10	44.88	51.70	55.85
20.73	31.11	39.17	45.54	52.41	56.38
20.63	31.01	38.79	44.63	50.85	54.76
20.41	30.27	38.17	44.20	50.58	54.66

TABLE B.6

EXPERIMENT	RUNS	T+24	T+48	T+72	T+96	T+120	T+144
A	PERSISTENCE	28.70	44.60	52.16	56.04	62.12	67.47
	10 LEVEL	19.19	28.21	35.67	41.51	48.76	53.32
	A11	19.13	27.93	35.25	41.45	49.40	54.24
	A12	18.98	27.73	34.99	41.25	49.24	54.67
	A13	19.43	28.43	35.81	41.19	48.32	53.90
	A14	19.58	28.77	35.99	41.05	48.13	53.32
	A15	19.72	29.08	36.12	40.88	47.92	53.12
B	A16	19.76	29.21	36.56	41.35	47.96	52.74
	A17	19.82	29.24	36.45	41.10	48.01	52.80
	B11	19.17	28.23	36.37	41.53	48.19	53.65
	B13	19.47	28.61	36.35	41.09	47.56	51.19
	B15	20.06	29.71	37.28	41.48	48.10	51.73
	B17	19.98	29.63	36.95	40.61	46.81	50.57
	C14	19.76	28.90	36.35	40.58	47.01	51.12
C	PERSISTENCE	T+24	T+48	T+72	T+96	T+120	T+144
		30.90	48.42	55.46	59.60	67.00	73.29
		19.54	28.62	36.04	42.53	50.70	55.43
		19.50	28.32	35.71	42.54	51.26	56.35
		19.39	28.17	35.41	42.16	50.68	56.00
		19.81	28.83	36.16	41.96	49.64	55.23
		19.95	29.13	36.29	41.89	49.64	55.01
		20.08	29.44	36.43	41.76	49.56	55.04
		20.10	29.55	36.85	42.21	49.59	54.74
		20.19	29.57	36.73	41.99	49.71	54.89
		19.62	28.75	36.64	42.49	50.27	56.13
		19.93	29.03	36.67	42.06	49.65	53.93
		20.38	30.06	37.56	42.45	50.12	54.48
		20.36	29.98	37.25	41.53	48.51	52.74
		20.05	29.25	36.58	41.29	48.37	52.60

TABLE B.7

COMPLETE OCTAGON AREA

20x20 BRITISH ISLES AREA

EXPERIMENT	RUNS	T+24	T+48	T+72	T+96	T+120	T+144
A	PERSISTENCE	26.32	42.36	49.74	51.14	55.93	61.49
	10 LEVEL	17.94	27.67	34.54	38.87	45.82	50.73
	A11	17.90	27.50	34.33	39.09	46.84	51.91
	A12	17.75	27.47	34.24	39.20	46.95	52.51
	A13	18.15	28.09	35.06	39.28	46.19	51.78
	A14	18.36	28.45	35.25	39.00	46.03	51.14
	A15	18.57	28.82	35.46	38.99	45.89	51.22
	A16	18.64	29.06	36.06	39.44	45.92	50.70
	A17	18.71	29.09	35.98	39.15	45.98	50.95
	B11	17.94	27.83	35.56	39.24	45.53	51.26
B	B13	18.39	28.27	35.64	39.03	45.22	48.94
	B15	18.85	29.30	36.53	39.30	45.62	49.58
	B17	18.84	29.35	36.39	38.55	44.73	48.72
	C14	18.53	28.52	35.65	38.60	44.87	48.85
C		T+24	T+48	T+72	T+96	T+120	T+144
		28.33	46.09	52.74	54.45	60.44	66.83
		18.26	27.99	34.95	40.22	48.12	53.08
		18.30	27.88	34.90	40.59	49.14	54.36
		18.17	27.90	34.82	40.48	48.82	54.13
		18.52	28.46	35.50	40.33	47.81	53.26
		18.71	28.76	35.61	40.08	47.74	52.89
		18.90	29.10	35.78	40.03	47.67	53.08
		18.96	29.31	36.34	40.46	47.70	52.69
		19.04	29.34	36.24	40.21	47.82	52.99
C		18.32	28.18	35.85	40.48	47.86	53.84
		18.68	28.55	35.91	40.19	47.47	51.71
		19.11	29.51	36.73	40.39	47.74	52.29
		19.15	29.57	36.60	39.58	46.47	50.84
		18.76	28.75	35.84	39.42	46.19	50.22

TABLE B.8

PERIMENT	RUNS	T+24	T+48	T+72	T+96	T+120	T+144
A	PERSISTENCE	25.53	42.11	49.35	48.97	52.69	58.15
	10 LEVEL	17.37	28.24	35.59	39.56	45.60	50.08
	A11	17.22	27.95	35.37	39.73	46.72	51.38
	A12	17.12	28.08	35.56	40.33	47.28	52.42
	A13	17.54	28.63	36.34	40.66	46.83	51.98
	A14	17.82	29.13	36.64	40.43	46.75	51.27
	A15	18.06	29.54	36.98	40.62	46.77	51.62
B	A16	18.13	29.82	37.59	40.99	46.82	50.93
	A17	18.20	29.90	37.48	40.62	46.81	51.30
	B11	17.48	28.49	36.87	40.20	45.54	50.54
	B13	18.00	29.03	37.10	40.41	45.78	48.59
	B15	18.33	30.00	37.90	40.67	46.10	49.32
	B17	18.34	30.10	37.90	40.22	45.67	49.01
	C14	18.13	29.22	37.09	40.20	45.79	49.01
C	T+24	27.41	45.79	52.02	52.02	56.90	62.78
	T+48	17.55	28.35	35.85	40.83	47.80	51.97
	T+72	17.51	28.16	35.83	41.19	48.94	53.44
	T+96	17.40	28.32	36.00	41.56	49.07	53.70
	T+120	17.76	28.79	36.63	41.57	48.28	52.99
	T+144	18.01	29.21	36.85	41.31	48.17	52.42
	T+168	18.23	29.59	37.13	41.43	48.22	52.80
D	T+192	18.29	29.84	37.71	41.76	48.24	52.23
	T+216	18.37	29.91	37.58	41.46	48.26	52.62
	T+240	17.65	28.59	37.02	41.33	47.68	52.54
	T+264	18.11	29.07	37.21	41.36	47.67	50.68
	T+288	18.43	29.98	37.93	41.55	47.83	51.31
	T+312	18.48	30.09	37.96	41.02	47.02	50.46
	T+336	18.18	29.21	37.12	40.82	46.79	49.78

TABLE B.9

EXPERIMENT	RUNS	T+24	T+48	T+72	T+96	T+120	T+144
A	PERSISTENCE	26.41	43.62	50.53	49.25	52.13	56.90
	10 LEVEL	19.11	30.77	39.77	44.79	49.06	52.58
	A11	18.76	30.37	39.48	44.84	50.00	53.75
	A12	18.71	30.54	39.92	45.76	50.91	55.09
	A13	19.11	31.02	40.66	46.39	50.93	55.16
	A14	19.44	31.75	41.12	46.43	51.06	54.58
	A15	19.69	32.22	41.67	46.94	51.29	55.10
B	A16	19.71	32.54	42.32	47.31	51.65	54.43
	A17	19.89	32.73	42.21	46.97	51.63	54.93
	B11	19.42	31.24	41.34	45.83	49.43	52.96
	B13	19.86	31.92	41.83	46.63	50.40	51.67
	B15	20.05	32.84	42.55	46.90	50.73	52.49
	B17	20.19	32.97	42.58	46.65	50.51	52.56
	C14	19.93	31.92	41.66	46.44	50.48	52.65

EXPERIMENT	RUNS	T+24	T+48	T+72	T+96	T+120	T+144
A	PERSISTENCE	28.22	47.26	52.91	52.14	56.10	60.71
	10 LEVEL	19.02	30.58	39.61	45.49	50.62	53.39
	A11	18.77	30.28	39.52	45.66	51.56	54.73
	A12	18.70	30.45	39.92	46.37	52.09	55.45
	A13	19.04	30.86	40.54	46.68	51.75	55.20
	A14	19.34	31.51	40.93	46.69	51.80	54.72
	A15	19.59	31.95	41.43	47.11	52.01	55.21
B	A16	19.62	32.26	42.04	47.45	52.33	54.64
	A17	19.80	32.43	41.91	47.18	52.27	55.12
	B11	19.30	31.04	41.08	46.36	50.86	53.81
	B13	19.73	31.69	41.52	46.97	51.49	52.50
	B15	19.92	32.54	42.18	47.20	51.62	53.21
	B17	20.06	32.65	42.23	46.88	51.14	52.92
	C14	19.71	31.60	41.29	46.54	50.89	52.47

TABLE B.10

COMPLETE OCTAGON AREA

20x20 BRITISH ISLES AREA

EXPERIMENT	RUNS	T+24	T+48	T+72	T+96	T+120	T+144
A	A11	1.72	5.67	10.94	11.19	8.73	7.84
	A12	0.64	4.31	9.67	9.56	7.32	5.83
	A13	1.07	4.91	10.78	11.57	10.61	10.52
	A14	1.14	5.26	11.36	12.43	12.15	13.20
	A15	0.99	5.18	11.26	12.48	12.87	14.12
	A16	0.99	5.00	10.83	11.95	12.37	13.46
	A17	1.03	4.97	10.67	11.99	12.46	13.40
B	B11	-1.33	-1.21	-1.26	-0.90	0.46	0.61
	B13	-0.52	0.04	0.11	0.75	2.45	3.28
	B15	0.71	1.34	1.64	1.26	3.89	5.45
	B17	1.15	1.38	2.05	2.66	4.05	4.92
C	C14	1.36	1.52	2.92	3.18	4.98	5.55

TABLE C.1

200 MB RMS ERROR DIFFERENCE BETWEEN 10 LEVEL AND VARIABLE LEVEL FORECASTS (METRE)

COMPLETE OCTAGON AREA

20x20 BRITISH ISLES AREA

EXPERIMENT	RUNS	T+24	T+48	T+72	T+96	T+120	T+144	T+24	T+48	T+72	T+96	T+120	T+144
A	A11	-0.29	-0.41	1.45	2.22	0.59	1.08	-0.30	-0.59	1.73	1.98	0.51	1.26
	A12	-0.79	0.38	3.34	3.81	1.72	0.68	-0.97	0.28	3.19	4.19	1.71	0.80
	A13	-0.51	1.27	5.28	8.00	7.70	8.07	-0.69	0.18	5.85	8.05	7.40	7.93
	A14	-0.55	1.53	5.45	7.77	8.45	9.94	-0.78	1.38	5.72	7.80	8.05	9.82
	A15	-0.70	4.42	5.32	7.84	9.31	11.23	-0.91	1.25	5.59	7.76	8.67	10.98
B	A16	-0.71	1.20	4.78	7.42	9.42	11.36	-0.90	1.07	5.06	7.28	8.57	10.98
	A17	-0.69	1.08	4.61	7.18	9.18	11.48	-0.86	0.96	4.84	6.92	8.16	10.97
	B11	-2.62	-2.65	-2.84	-2.34	-0.69	0.29	-2.68	-2.65	-2.48	-2.36	-0.93	0.99
	B13	-1.54	-1.66	-1.54	-0.51	2.86	4.38	-1.57	-1.58	-1.42	-0.86	2.09	4.19
	B15	0.39	1.18	2.12	4.00	8.51	11.33	0.40	1.20	1.77	3.35	7.39	10.98
C	B17	-0.25	0.74	2.82	5.04	8.29	9.69	-0.22	0.86	3.11	5.30	7.55	9.43
	C14	-0.16	1.36	5.09	7.40	10.29	11.21	-0.12	1.55	5.73	8.23	10.03	11.15

TABLE C.2

COMPLETE OCTAGON AREA

20x20 BRITISH ISLES AREA

EXPERIMENT	RUNS	T+24	T+48	T+72	T+96	T+120	T+144
A	A11	0.21	0.48	1.14	1.15	0.53	0.56
	A12	-0.07	-0.15	0.12	-0.83	-2.32	-3.34
	A13	0.04	-0.07	1.47	2.90	3.64	2.59
	A14	0.02	-0.06	1.44	2.83	4.28	4.01
	A15	-0.04	0.20	1.62	3.35	5.22	5.21
	A16	-0.06	0.03	1.43	3.36	5.86	6.03
	A17	-0.10	-0.10	1.27	3.26	5.82	6.45
B	B11	-1.55	-1.10	-0.98	-0.88	0.07	1.39
	B13	-0.82	-0.71	0.25	1.19	3.30	4.53
	B15	-0.45	-0.81	0.31	1.97	5.02	6.75
	B17	-0.19	-1.28	-0.59	1.19	4.03	5.07
C	C14	0.60	0.19	2.51	4.09	7.52	7.26

	T+24	T+48	T+72	T+96	T+120	T+144
T+24	0.26	0.48	1.15	1.04	1.02	0.79
T+48	0.03	-0.14	0.42	-0.69	-1.64	-2.59
T+72	0.09	0.02	1.70	2.87	4.17	3.14
T+96	0.02	-0.07	1.37	2.69	4.58	4.36
T+120	-0.03	0.18	1.46	3.03	5.28	5.27
T+144	-0.05	0.03	1.24	2.93	5.70	5.89
T+168	-0.08	-0.08	1.08	2.69	5.44	6.13
T+192	-1.51	-1.05	-0.86	-1.10	-0.04	1.30
T+216	-0.88	-0.62	0.10	0.71	2.80	3.98
T+240	-0.51	-0.75	-0.11	1.23	4.22	6.00
T+264	-0.16	-1.12	-0.79	0.54	3.30	4.78
T+288	0.62	0.38	2.66	4.26	7.33	7.35

TABLE C.3

COMPLETE OCTAGON AREA

20x20 BRITISH ISLES AREA

EXPERIMENT	RUNS	T+24	T+48	T+72	T+96	T+120	T+144
A	A11	0.29	0.59	1.05	0.60	0.18	-0.03
	A12	0.40	0.52	0.80	-0.35	-1.34	-2.47
	A13	-0.17	-0.15	0.83	1.16	1.39	-0.23
	A14	-0.10	-0.14	0.94	1.48	2.14	1.07
	A15	-0.15	0.08	1.15	2.13	3.01	2.06
B	A16	-0.21	-0.04	1.05	2.04	3.47	2.73
	A17	-0.25	-0.12	1.02	1.98	3.47	3.12
	B11	-0.26	0.29	1.28	1.29	1.96	2.01
	B13	-0.97	-0.43	1.34	2.33	3.93	4.10
	B15	-0.69	-0.04	-0.21	0.93	2.73	3.48
C	B17	-0.46	-1.20	-0.42	1.03	2.90	3.28
	C14	-0.20	-0.61	0.37	1.56	3.53	2.96
		T+24	T+48	T+72	T+96	T+120	T+144
		0.33	0.62	1.00	0.65	0.67	0.27
		0.45	0.54	0.94	-0.18	-0.58	-1.56
		-0.19	-0.05	1.00	1.34	2.05	0.53
		-0.15	-0.12	0.89	1.52	2.52	1.42
		-0.20	0.07	1.01	2.00	3.19	2.03
		-0.26	-0.03	0.88	1.84	3.51	2.49
		-0.31	-0.11	0.88	1.67	3.34	2.70
		-0.53	0.23	1.51	1.51	2.11	1.81
		-1.37	-0.53	1.27	2.31	3.77	3.40
		-0.82	-1.02	-0.45	0.47	2.14	2.50
		-0.56	-1.09	-0.54	0.55	2.36	2.83
		-0.28	-0.52	0.40	1.53	3.33	3.08

TABLE C.4

100 MB RMS ERROR DIFFERENCE BETWEEN 10-LEVEL AND VARIABLE LEVEL FORECASTS (METRE)

COMPLETE OCTAGON AREA

20x20 BRITISH ISLES AREA

PERIMENT	RUNS
A	A11
	A12
	A13
	A14
	A15
B	A16
	A17
	B11
	B13
	B15
C	B17
	C14

T+24	T+48	T+72	T+96	T+120	T+144
0.10	0.50	0.99	0.47	-0.07	-0.55
0.30	0.74	1.21	0.34	-0.32	-1.73
-0.33	-0.07	0.54	1.05	1.30	-0.48
-0.40	-0.27	0.50	0.98	1.37	0.05
-0.47	-0.31	0.57	1.41	1.93	0.67
-0.55	-0.42	0.40	1.18	2.05	1.03
-0.61	-0.49	0.47	1.26	2.11	1.39
-0.45	-0.11	0.32	0.52	1.29	0.59
-0.57	-0.39	0.31	1.03	2.13	2.36
-0.95	-1.35	-0.88	0.20	1.29	1.90
-0.78	-1.35	-0.63	0.97	2.30	2.60
-0.58	-0.65	-0.24	1.21	2.49	1.87

T+24	T+48	T+72	T+96	T+120	T+144
0.09	0.55	0.96	0.56	0.35	-0.28
0.26	0.78	1.28	0.58	0.45	-0.80
-0.41	0.00	0.66	1.34	1.97	0.30
-0.49	-0.23	0.54	1.12	1.75	0.37
-0.56	-0.28	0.55	1.43	2.11	0.59
-0.64	-0.37	0.37	1.15	2.15	0.78
-0.72	-0.44	0.46	1.16	2.10	0.97
-0.87	-0.29	0.38	0.60	1.24	0.19
-0.94	-0.54	0.23	0.94	1.81	1.54
-1.07	-1.35	-0.98	-0.10	0.79	0.87
-0.94	-1.29	-0.69	0.67	1.97	2.14
-0.65	-0.60	-0.21	1.24	2.64	2.02

TABLE C.5

EXPERIMENT	RUNS	T+24	T+48	T+72	T+96	T+120	T+144
A	A11	0.07	0.46	0.57	0.06	-0.56	-0.97
	A12	0.23	0.68	0.80	0.12	-0.47	-1.67
	A13	-0.31	-0.07	-0.04	0.32	0.66	-0.82
	A14	-0.44	-0.40	-0.27	0.32	0.79	-0.32
	A15	-0.51	-0.61	-0.26	0.64	1.15	0.23
B	A16	-0.63	-0.82	-0.74	0.12	0.98	0.25
	A17	-0.65	-0.83	-0.58	0.34	1.04	0.48
	B11	0.07	0.14	-0.36	0.00	0.88	0.14
	B13	-0.34	-0.37	-0.64	0.21	1.28	1.88
	B15	-1.01	-1.54	-1.72	-0.40	0.54	1.41
C	B17	-0.86	-1.48	-1.34	0.48	1.84	2.42
	C14	-0.75	-0.73	-0.81	0.68	1.82	1.83
		T+24	T+48	T+72	T+96	T+120	T+144
		0.10	0.50	0.55	0.12	-0.28	-0.80
		0.22	0.70	0.85	0.37	0.22	-0.77
		-0.30	-0.01	0.09	0.67	1.34	0.00
		-0.42	-0.32	-0.15	0.56	1.23	0.06
		-0.49	-0.53	-0.18	0.81	1.42	0.29
		-0.61	-0.74	-0.64	0.25	1.21	0.15
		-0.67	-0.73	-0.47	0.44	1.18	0.25
		-0.12	+0.03	-0.27	0.09	0.73	-0.29
		-0.40	-0.44	-0.60	0.22	0.99	1.07
		-0.98	-1.49	-1.67	-0.44	0.28	0.54
		-0.88	-1.39	-1.29	0.47	1.84	2.16
		-0.66	-0.65	-0.67	0.90	2.11	2.26

TABLE C.6

700 MB RMS ERROR DIFFERENCE BETWEEN 10-LEVEL AND VARIABLE LEVEL FORECASTS (METRE)

COMPLETE OCTAGON AREA

20x20 BRITISH ISLES AREA

EXPERIMENT	RUNS	T+24	T+48	T+72	T+96	T+120	T+144
A	A11	0.06	0.28	0.42	0.06	-0.64	-0.92
	A12	0.21	0.48	0.68	0.26	-0.48	-1.35
	A13	-0.24	-0.22	-0.14	0.32	0.44	-0.58
	A14	-0.39	-0.56	-0.32	0.46	0.63	0.00
	A15	-0.53	-0.87	-0.45	0.63	0.84	0.20
	A16	-0.57	-1.00	-0.89	0.16	0.80	0.58
	A17	-0.63	-1.03	-0.78	0.41	0.75	0.52
B	B11	0.02	-0.07	-0.70	-0.02	0.57	-0.33
	B13	-0.28	-0.40	-0.68	0.42	1.20	2.13
	B15	-0.87	-1.50	-1.61	0.03	0.66	1.59
	B17	-0.79	-1.42	-1.28	0.90	1.95	2.75
C	C14	-0.57	-0.69	-0.68	-0.93	1.75	2.20

TABLE C.7

800 MB RMS ERROR DIFFERENCE BETWEEN 10-LEVEL AND VARIABLE LEVEL FORECASTS (METRE)

COMPLETE OCTAGON AREA

20x20 BRITISH ISLES AREA

EXPERIMENT	RUNS	T+24	T+48	T+72	T+96	T+120	T+144
A	A11	0.04	0.17	0.21	-0.22	-1.02	-1.18
	A12	0.19	0.20	0.30	-0.33	-1.13	-1.78
	A13	-0.21	-0.42	-0.52	-0.41	-0.37	-1.05
	A14	-0.42	-0.78	-0.71	-0.13	-0.21	-0.41
	A15	-0.63	-1.15	-0.92	-0.12	-0.07	-0.49
B	A16	-0.70	-1.39	-1.52	-0.57	-0.10	0.03
	A17	-0.77	-1.42	-1.44	-0.28	-0.16	-0.22
	B11	0.00	-0.16	-1.02	-0.37	0.29	-0.53
	B13	-0.45	-0.60	-1.10	-0.16	0.60	1.79
	B15	-0.91	-1.63	-1.99	-0.43	0.20	1.15
C	B17	-0.90	-1.68	-1.85	0.32	1.09	2.01
	C14	-0.59	-0.85	-1.11	0.27	0.95	1.88
	T+24	-0.04	0.11	0.05	-0.37	-1.02	-1.28
	T+48	0.09	0.09	0.13	-0.26	-0.70	-1.05
	T+72	-0.26	-0.47	-0.55	-0.11	0.31	-0.18
	T+96	-0.45	-0.77	-0.66	0.14	0.38	0.19
	T+120	-0.64	-1.11	-0.83	0.19	0.45	0.00
	T+24	-0.70	-1.32	-1.39	-0.24	0.42	0.39
	T+48	-0.78	-1.35	-1.29	0.01	0.30	0.09
	T+72	-0.06	-0.19	-0.90	-0.26	0.26	-0.76
	T+96	-0.42	-0.56	-0.96	0.03	0.65	1.37
	T+120	-0.85	-1.52	-1.78	-0.17	0.38	0.79
	T+24	-0.89	-1.58	-1.65	0.64	1.65	2.24
	T+48	-0.50	-0.76	-0.89	0.80	1.93	2.86

TABLE C.8

PERIMENT	RUNS	T+24	T+48	T+72	T+96	T+120	T+144
A	A11	0.15	0.29	0.22	-0.77	-1.12	-1.30
	A12	0.25	0.16	0.03	-0.77	-1.68	-2.34
	A13	-0.17	-0.39	-0.75	-1.10	-1.23	-1.90
	A14	-0.45	-0.89	-1.05	-0.87	-1.15	-1.19
	A15	-0.69	-1.30	-1.39	-1.06	-1.17	-1.54
	A16	-0.76	-1.58	-2.00	-1.43	-1.22	-0.85
B	A17	-0.83	-1.66	-1.89	-1.06	-1.21	-1.22
	B11	-0.11	-0.25	-1.28	-0.64	0.06	-0.46
	B13	-0.63	-0.79	-2.51	-0.85	-0.18	1.49
	B15	-0.96	-1.76	-2.31	-1.11	-0.50	0.76
C	B17	-0.97	-1.86	-2.31	-0.66	-0.07	1.07
	C14	-0.76	-0.98	-1.50	-0.64	-0.19	1.07
		T+24	T+48	T+72	T+96	T+120	T+144
		0.04	0.19	0.02	-0.26	-1.14	-1.47
		0.15	0.03	-0.15	-0.73	-1.27	-1.73
		-0.21	-0.44	-0.78	-0.74	-0.48	-1.02
		-0.46	-0.86	-1.00	-0.48	-0.37	-0.45
		-0.68	-1.24	-1.28	-0.60	-0.42	-0.83
		-0.74	-1.19	-1.86	-0.93	-0.44	-0.26
		-0.82	-1.56	-1.73	-0.63	-0.46	-0.65
		-0.10	-0.24	-1.17	-0.50	0.12	-0.57
		-0.56	-0.72	-1.36	-0.53	0.13	1.29
		-0.88	-1.63	-2.08	-0.72	-0.03	0.66
		-0.93	-1.74	-2.11	-0.19	0.78	1.51
		-0.63	-0.86	-1.27	0.01	1.01	2.19

TABLE C.9

	T+24	T+48	T+72	T+96	T+120	T+144
	0.25	0.30	0.09	-0.17	-0.94	-1.34
	0.32	0.13	-0.31	-0.88	-1.47	-2.06
	-0.02	-0.28	-0.93	-1.19	-1.13	-1.81
	-0.32	-0.93	-1.32	-1.20	-1.18	-1.33
	-0.57	-1.37	-1.82	-1.62	-1.39	-1.82
	-0.60	-1.68	-2.43	-1.96	-1.71	-1.25
	-0.78	-1.85	-2.30	-1.69	-1.65	-1.73
	-0.28	-0.46	-1.47	-0.87	-0.24	-0.42
	-0.71	-1.11	-1.91	-1.48	-0.87	0.89
	-0.90	-1.96	-2.57	-1.71	-1.00	0.18
	-1.04	-2.07	-2.62	-1.39	-0.52	0.47
	-0.69	-1.02	-1.68	-1.05	-0.27	0.92

	T+24	T+48	T+72	T+96	T+120	T+144
	0.35	0.40	0.29	-0.05	-0.94	-1.17
	0.40	0.23	-0.15	-0.97	-1.85	-2.51
	0.00	-0.25	-0.89	-1.60	-1.87	-2.58
	-0.33	-0.98	-1.35	-1.64	-2.00	-2.00
	-0.58	-1.45	-1.90	-2.15	-2.23	-2.52
	-0.60	-1.77	-2.55	-2.52	-2.59	-1.85
	-0.78	-1.96	-2.44	-2.18	-2.57	-2.35
	-0.31	-0.47	-1.57	-1.04	-0.37	-0.38
	-0.75	-1.15	-2.06	-1.84	-1.34	0.91
	-0.94	-2.07	-2.78	-2.11	-1.67	0.09
	-1.08	-2.20	-2.81	-1.86	-1.45	0.02
	-0.82	-1.15	-1.89	-1.65	-1.42	-0.07

EXPERIMENT	RUNS
A	A11
	A12
	A13
	A14
	A15
B	A16
	A17
	B11
	B13
	B15
C	B17
	C14

TABLE C.10