METEOROLOGICAL OFFICE

Forecasting Research

Forecasting Research Division
Technical Report No. 112

TRIAL OF A LONGER TIMESTEP FOR PHYSICS IN THE GLOBAL MODEL

by

C.A. Wilson and O. Hammon

February 1995

Meteorological Office
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CONTENTS

1. INTRODUCTION

This technical report contains the results of the subjective and objective assessment of a parallel suite trial of a longer timestep (20 minutes) for the physics in the global model. The parallel suite ran from 16/06/94 to 03/07/94. **Technical Report 111** (Wilson, Hammon and Barnes 1994) described the impact of a longer physics timestep for the limited area model. These longer timesteps for both the global and limited area model were implemented in the operational suite on 13 December 1994, along with the superadiabat lapse rate corrections (see **Technical Report 125** ,Wilson, Rawlins and Hammon, 1994) .

The timestep chosen for the unified model is based on numerical stability considerations for the solution of the dynamics equations on a finite grid (see Cullen et al, UMDP 10) . The timestep conventionally refers to that for the advection step (with the adjustment step repeated a number of times, normally 3, for each advection timestep). Until now, the physical parametrizations have been called with the same timestep as the advection, except for the full radiation calculations which are performed less frequently (currently every 3h for both global and LAM). For the global version this has meant physics calculations every 10 min, at a cost of ~30% of the run time. Given the highly parametrised nature of the physics schemes and the relatively slow scale of many of the processes it is questionable whether such a high frequency of physics calls is necessary; (although the ice-fallout process of the precipitation scheme is much faster and already known to be rather sensitive to the timestep) . There is no stability restriction on using a longer physics timestep since the boundary layer calculations are implicit as are some of the precipitation scheme's. Following the relatively small impact in the limited area model of using a 15 minute timestep for physics, it was decided to test the impact of using a 20 minute timestep in the global model, i.e called half as frequently as the dynamics scheme. The saving would be around 10-15% of total run time. Like the limited area trial the impact was small and overall assessed as being a neutral change.

2. OBJECTIVE VERIFICATION

The analyses and forecasts were verified against observations (sondes and synops) for the period 16/06/94 to 03/07/94. Verification was also performed against analyses, each suite was verified against its own analyses for the same period. Time-mean results will mostly be discussed here . Results for forecast times T+0, T+24, T+48, T+72, T+120 and for areas

%RMS	CHANGE (TRIAL -OPERATIONAL)												
VERIFICATION AGAINST OBSERVATIONS													
	T+0	T+24	T+48	T+72	T+96	T+120		T+0	T+24	T+48	T+72	T+96	T+120
AREA	2						AREA	200, N Hem to 30N					
HEIGHTS							HEIGHTS						
850	-1.3	-3	-0.6	0.1	0.9	1.1	850	-0.5	-1.5	-0.7	-0.1	-0.4	0.2
700	-1.2	-2.5	0.1	-0.3	0.6	0.9	700	0.8	-0.8	-0.1	0.4	0	0.2
500	-1.9	-1.9	0.7	-0.3	-0.2	0.9	500	0.8	-0.8	0.1	0.3	0	0.5
300	-1.2	-1.5	0	-2.7	-1.1	0.2	300	0.4	-1.3	-0.5	-1.7	-0.8	-0.2
250	-2.5	-1.5	-0.4	-3.9	-1.2	0.1	250	0	-1.5	-1	-2.6	-0.9	-0.4
200	-2.2	-2.5	-0.4	-5.3	-1.4	-0.1	200	-0.5	-1.9	-1.4	-3.8	-1.2	-0.9
100	-0.9	-0.7	-1	-3	-1	-0.8	100	-0.8	-0.8	-1	-2.5	-1.4	-1.8
50	0.3	-0.1	-0.3	-1	-0.5	0.3	50	-0.3	0	-0.1	-0.7	0	-0.1
Mean	-1.4	-1.7	-0.2	-2	-0.5	0.3	Mean	0	-1.1	-0.6	-1.3	-0.6	-0.3
TEMPERATURES							TEMPERATURES						
850	0.6	2.2	2.6	1.8	2.1	1.2	850	2.1	3.4	4.6	3.6	2.9	3.3
700	1.3	-0.1	1.1	1.1	0.8	2.9	700	2.4	1.7	1.9	2	0.5	2.5
500	2.7	0	0.1	-3.3	0.1	0.3	500	1.7	-0.1	-0.3	-0.8	-0.1	0.3
300	0.4	-0.6	-0.1	-4.4	-0.8	-0.7	300	1.1	-1.2	-0.7	-1.8	-0.9	-1.9
250	1.9	1.5	-1.3	-0.7	-0.8	0	250	1.4	0.3	-1.2	-1.3	-0.9	-0.9
200	-0.4	-0.1	-1.3	-0.6	-0.2	0.3	200	0.4	0	-0.7	-0.6	-0.9	-0.3
100	-0.5	-1	0.5	-2	0.2	1.5	100	-0.3	-0.4	0	1.3	1	0.8
50	0.5	-0.1	0.8	1.2	0.2	0.2	50	-0.1	-0.7	1.2	0.5	1.4	1
Mean	0.8	0.2	0.3	-0.9	0.2	0.7	Mean	1.1	0.4	0.6	0.4	0.4	0.6
WINDS							WINDS						
850	1.7	-0.5	-0.7	0.4	0	1.5	850	2.1	-0.4	-0.5	0.3	-0.5	0.4
700	1.6	-0.2	-0.1	-1	0.2	2.2	700	2.5	0.6	-0.1	0.2	-0.1	1.1
500	2.6	-0.1	0.2	-0.9	0.2	1.6	500	3.1	0.5	0	0.1	-0.2	0.9
400	2.7	0.4	-0.1	-0.9	0	1.5	400	3.3	1	0	0.6	-0.2	1.1
300	2.7	-0.2	0.3	-0.6	-0.2	1.5	300	2	-0.5	0.1	0.1	-0.3	0.6
250	1.6	-0.3	0.3	-0.9	0.1	1.5	250	1.6	-0.8	-0.2	-0.4	-0.3	-0.1
200	0.1	-1.2	0.2	-2.3	-0.4	1	200	2.3	-0.9	-0.4	-0.5	0.3	-1.1
100	-0.1	-2.1	-0.3	-1.4	1.6	0.8	100	0.7	-0.5	-0.7	1.3	1.9	0.9
Mean	1.6	-0.5	0	-0.9	0.2	1.4	Mean	2.2	-0.1	-0.2	0.2	0.1	0.5
RH							RH						
850	1.6	1.9	3.5	2.7	3.7	2.1	850	2.9	4.1	4.8	4.8	3.8	3.1
700	1.9	-0.2	1	-1	0.8	0.4	700	2.9	0.9	0.7	0.1	0.5	0.6
500	3.5	0.3	-0.3	-0.5	0.5	-0.1	500	3.3	0.1	-0.4	0.1	0.5	-0.2
Mean	2.3	0.7	1.4	0.4	1.7	0.8	Mean	3	1.7	1.7	1.7	1.6	1.2
SURF							SURF						
press	-0.9	-0.7	0.9	0.3	1.7	2.2	press	-0.6	-0.9	-0.8	0.9	1	1.6
temp	-0.4	-0.2	-0.6	-1	-0.6	-0.1	temp	2.8	2.9	1.3	2.1	1.1	1.5
wind	1.3	0	-0.1	0.6	1.1	1.8	wind	0.7	0.1	-0.2	0.5	0.6	1.1
Mean	0	-0.3	0.1	0	0.7	1.3	Mean	1	0.7	0.1	1.2	0.9	1.4
Mean all	0.5	-0.5	0.2	-1	0.2	0.9	Mean all	1.3	0	0.1	0.1	0.2	0.5

TABLE 2.1

%RMS CHANGE (TRIAL -OPERATIONAL)

VERIFICATION AGAINST OBSERVATIONS

	T+0	T+24	T+48	T+72	T+96	T+120
AREA	300, Tropics 30N-30S					
HEIGHTS						
850	1.1	-3.2	-1.9	-2.9	-0.6	2.2
700	1.1	-1.9	-1	-1.2	-0.1	0.9
500	-0.2	-1.5	-0.5	-0.9	-0.9	-1.2
300	-0.1	-1.2	-2	-1.8	-1.9	-2.2
250	-0.6	-1.7	-2	-2.6	-2.2	-2.5
200	-0.6	-1.6	-2.1	-2.3	-2.8	-2.1
100	-0.2	-1.6	-1.9	-2.4	-2.1	-2.1
50	-1.4	-0.6	-0.7	-0.7	-1.2	-1.4
Mean	-0.1	-1.7	-1.5	-1.8	-1.5	-1
TEMPERATURES						
850	0.2	0.7	0.1	-0.5	-0.4	-1.6
700	0.3	-0.3	-0.5	-0.2	-3	-2.7
500	0.9	0	-1.5	-2.4	-1.4	-1.4
300	0.6	0.8	-1	-1.6	-1	-1.1
250	2	0.8	-2.1	-2	-4.1	-2.6
200	1	-1	-0.2	-2.3	-2.5	-2.1
100	1	0.5	0.2	0.3	0.2	0.3
50	1.3	1.6	0.7	2.6	1.3	1
Mean	0.9	0.4	-0.5	-0.8	-1.4	-1.3
WINDS						
850	1.4	-1.4	-1.5	-2.7	-0.8	0
700	2.1	-1.5	-0.6	-2.3	-0.8	0.3
500	1.9	-0.9	-0.4	-1.6	-1.2	-3
400	2.1	-1.2	-0.6	-2.3	-0.5	-3.9
300	2.5	-1.4	-0.6	-1	0.5	-3
250	1.7	-2.3	-1.5	-3.6	-0.6	-1.2
200	1.7	-1.9	-1	-2.4	0.8	-1.6
100	0.6	-1.3	-0.5	-0.4	-1	-1.4
Mean	1.7	-1.5	-0.8	-2	-0.4	-1.7
RH						
850	2.1	-0.7	-0.3	0.2	0.1	0.8
700	3.2	0.4	-0.3	0.6	0.4	0.3
500	1.8	-1.4	-1.6	-0.8	-0.9	-0.4
Mean	2.4	-0.6	-0.7	0	-0.1	0.2
SURF						
press	0	-1.3	-0.4	-2.2	-0.4	-0.7
temp	0.9	2.1	2.6	2.1	2.3	1.6
wind	0.4	-0.3	-0.3	-0.2	0	0.1
Mean	0.4	0.2	0.6	-0.1	0.6	0.3
Mean all	1	-0.8	-0.8	-1.2	-0.8	-1

	T+0	T+24	T+48	T+72	T+96	T+120
AREA	400, S Hem from 30S					
HEIGHTS						
850	1	0.1	-0.1	-1.4	-0.5	-2.4
700	-1.3	-0.9	-0.2	-1.4	-1	-1.8
500	0.9	0.2	-0.1	-1.8	-2.1	-2.5
300	1.5	1.8	-0.2	-2.9	-2.2	-3.7
250	0.3	0.9	-0.4	-3.2	-1.9	-3.2
200	-0.9	-0.5	0.1	-2.9	-2	-3
100	0.1	-2	1.2	-2.1	-1.9	-0.6
50	0	-2.1	1.1	-2.5	-1.1	0.3
Mean	0.2	-0.3	0.2	-2.3	-1.6	-2.1
TEMPERATURES						
850	0.5	-2.5	-2	-1.5	-4.2	0.2
700	0.4	1.7	-0.9	-3.5	-2.6	-4.1
500	2.8	1.7	0.6	-0.5	-1.5	-3.6
300	1.4	0.3	2	3.1	-1.4	-0.5
250	0.8	1.7	1.7	1.7	0.6	0
200	1.4	0.4	0.3	-0.3	-1.2	-1.7
100	0	0.5	0.4	-0.1	-0.7	-0.2
50	0.8	-0.6	-0.1	0.3	0.2	-0.8
Mean	1	0.4	0.2	-0.1	-1.3	-1.3
WINDS						
850	0.5	0.5	-1.2	1.3	0.9	2.3
700	0.4	0	-2.6	-0.2	-1.9	0
500	3.2	0.2	-0.6	-0.6	-2.2	-2.4
400	1.6	-0.1	-1.3	-2	-1.7	-3.7
300	1.4	0.3	-2.1	-1.8	0.1	-2.8
250	1.2	0	-0.7	-2.6	-0.8	-1.4
200	3.2	0.3	0.6	-2.6	0	-2.2
100	-1.8	-2	-0.6	-2.8	-1.1	-1.1
Mean	1.2	-0.1	-1.1	-1.4	-0.8	-1.4
RH						
850	1.9	-2.3	-2.4	-1	-0.5	0.5
700	3.1	-0.5	1	0.8	1.8	0.7
500	0.6	1.1	-3.3	-0.3	-2.4	-1.1
Mean	1.9	-0.6	-1.6	-0.2	-0.4	0
SURF						
press	2.9	0.6	-0.9	-1.1	-1.3	-3.2
temp	0.1	-1.2	-1.1	-3.6	-3.4	-3
wind	-1	-1.1	-0.3	-1.2	0.4	-0.6
Mean	0.7	-0.6	-0.8	-2	-1.4	-2.3
Mean all	0.9	-0.1	-0.4	-1.2	-1.2	-1.5

TABLE 2.2

"2", N. Hemisphere to 30N ("200"), Tropics 30N-30S ("300") and S. Hemisphere from 30S ("400") will be given.

2. 1 RMS ERRORS -OVERALL SUMMARY

TABLE 2.1 summarises the objective scores for the N. Atlantic region (area 2) and extratropical N. Hemisphere. It shows the percentage changes in rms errors for heights, temperatures , vector winds (8 levels each) , relative humidity (3 levels) and 3 surface fields. A negative value shows the trial to be an improvement. Column and surface-means are also shown. **TABLE 2.2** summarises the objective scores for the Tropics and extratropical S. Hemisphere.

Overall there are generally small differences in rms errors for most parameters. Taking changes greater than 1%, the number of scores from **TABLES 2.1 AND 2.2** for which the trial was better are given in **TABLE 2.3**. For changes less than 1% operational and trial were deemed equal. The impact of the longer timestep is generally neutral, as expected. The N. Atlantic and N. Hemisphere figures marginally favour the operational version whilst the trial version is better for the Tropics and S. Hemisphere. The largest degradation is seen for the rms vector wind errors at T+0 which are ~1.5-2% worse (**TABLES 2.1 AND 2.2**). However, at T+24, the errors are similar to the operational for all areas except the Tropics which show an *improvement* of ~1-2%. The likely impact of the longer timestep on aviation wind forecasts is discussed further below.

TABLE 2.3 : Summary of objective verification scores from verification against observations (**TABLES 2.1 AND 2.2**)

Area	Trial better	equal	operational better
N Atlantic ("2")	28	111	41
N Hemisphere	18	118	44
Tropics	72	85	23
S Hemisphere	71	83	26

TOTAL SCORE FOR EACH AREA=180

TABLES 2.4, AND 2.5. summarise the percentage changes in rms errors for verification against analyses. NB each version is verified against its own analyses. There is a clear reduction in error at T+24 in all areas for all levels and parameters.This is also generally true at T+72 but by T+120 the reduction is less and for area2 and N. Hemisphere there is a degradation at T+120. The reduced wind errors are exaggerated by the degradation of ~2% in the quality of the wind analyses (see **TABLES 2.1 AND 2.2**); even allowing for this the wind scores are still better. It may be that the extra adjustment steps for each physics increment has resulted in a better balanced model with fewer spurious noisy increments and

RMSE	%CHANGE(TRIAL-OPER) PERIOD 16/06/94-03/07/94							
	T+24	T+72	T+120			T+24	T+72	T+120
VERIFICATION AGAINST ANALYSES								
AREA 2					N.HEM			
HEIGHT					HEIGHT			
850	-2.4	-1.2	2.4		850	-3.8	-1.4	2.0
700	-3.1	-0.6	2.2		700	-4.1	-1.0	2.0
500	-3.2	0.0	3.1		500	-4.2	-0.3	1.9
300	-3.0	-0.2	3.2		300	-4.1	-0.9	1.2
250	-3.3	-0.3	3.3		250	-3.8	-0.9	1.3
200	-2.6	-0.9	3.0		200	-3.9	-1.6	1.1
100	-4.3	-2.4	1.9		100	-4.4	-2.9	-0.5
50	-5.2	-3.6	0.7		50	-3.7	-1.9	-1.9
mean	-3.4	-1.2	2.5		mean	-4.0	-1.4	0.9
TEMP					TEMP			
850	-3.4	1.7	3.2		850	-3.1	0.8	2.4
700	-2.1	0.0	4.9		700	-2.0	0.0	1.5
500	-4.3	-0.5	3.0		500	-5.6	-1.1	0.4
300	-5.3	-1.8	-1.4		300	-5.5	-2.4	-2.2
250	-5.0	-1.1	0.8		250	-5.2	-2.0	-1.2
200	-4.5	0.7	3.3		200	-5.6	-1.2	0.5
100	-4.7	0.7	4.0		100	-4.1	0.7	1.9
50	-5.3	0.9	1.7		50	-4.6	-1.3	0.0
mean	-4.3	0.1	2.4		mean	-4.5	-0.8	0.4
WIND					WIND			
850	-6.1	-0.5	3.6		850	-6.4	-2.0	1.3
700	-6.3	-0.4	3.8		700	-6.9	-1.9	1.4
500	-5.6	-0.1	3.3		500	-6.5	-1.4	0.9
300	-4.2	0.0	2.5		300	-5.6	-0.8	0.3
250	-4.2	-0.1	2.9		250	-5.8	-1.1	0.0
200	-4.9	-0.1	3.0		200	-6.3	-1.5	-0.5
100	-8.8	-1.6	2.4		100	-7.9	-2.0	1.2
mean	-5.7	-0.4	3.1		mean	-6.5	-1.5	0.7
RELHUM					RELHUM			
950	-5.2	-0.8	1.3		950	-4.7	-0.3	0.6
850	-3.0	-0.3	2.0		850	-1.5	-0.1	1.5
700	-5.1	-0.6	1.6		700	-5.1	-1.0	0.8
500	-5.1	-0.1	0.2		500	-5.7	-0.9	-0.2
mean	-5.4	-0.6	1.9		mean	-5.4	-1.0	0.6
PMSL					PMSL			
	-1.8	-0.5	3.1			-3.9	-1.4	2.0
				TABLE 2.4				

RMSE	%CHANGE(TRIAL-OPER) PERIOD 16/06/94-03/07/94							
	T+24	T+72	T+120			T+24	T+72	T+120
VERIFICATION AGAINST ANALYSES								
TROPICS					S.HEM			
HEIGHT					HEIGHT			
850	-5.3	-3.9	-4.2		850	-2.7	-1.5	-0.9
700	-5.6	-2.4	-1.8		700	-3.1	-2.4	-1.4
500	-5.5	-1.4	-0.5		500	-3.3	-1.8	-1.4
300	-4.5	-1.5	-0.7		300	-2.5	-1.0	-0.7
250	-4.7	-2.9	-1.6		250	-2.4	-1.1	-0.8
200	-4.7	-4.2	-3.0		200	-2.3	-1.1	-0.9
100	-5.2	-5.1	-5.3		100	-2.3	-1.5	0.6
50	-5.2	-3.9	-3.0		50	-2.1	-2.0	2.1
mean	-5.1	-3.2	-2.5		mean	-2.6	-1.6	-0.4
TEMP					TEMP			
850	-4.8	-2.8	-2.3		850	-4.8	-2.2	-1.2
700	-5.0	-1.3	0.5		700	-1.7	-0.6	0.0
500	-4.9	-1.7	-0.7		500	-2.6	0.6	0.2
300	-4.2	-3.8	-3.8		300	-3.7	-1.1	0.0
250	-4.7	-4.7	-4.1		250	-3.4	-0.3	0.3
200	-4.8	-2.6	-2.1		200	-3.6	-1.2	0.4
100	-6.3	-0.8	0.6		100	-2.8	-1.3	0.6
50	-5.6	-0.8	-0.7		50	-2.7	0.0	0.0
mean	-5.0	-2.3	-1.6		mean	-3.2	-0.8	0.0
WIND					WIND			
850	-6.7	-2.8	-0.9		850	-4.3	-0.4	-0.3
700	-6.9	-3.0	-1.5		700	-4.7	-0.8	-0.2
500	-6.5	-1.0	0.5		500	-4.3	-0.8	-0.1
300	-5.9	-0.8	0.0		300	-3.8	-0.8	0.8
250	-5.6	-1.1	-0.4		250	-4.2	-0.7	0.8
200	-5.7	-1.4	-0.3		200	-4.9	-1.3	0.7
100	-6.6	-3.9	-1.6		100	-6.0	-2.3	1.7
mean	-6.3	-2.0	-0.6		mean	-4.6	-1.0	0.5
RELHUM					RELHUM			
950	-6.0	-3.9	-1.4		950	-6.6	-2.0	-1.5
850	-5.9	-3.6	-2.7		850	-5.5	-1.6	-0.7
700	-6.9	-3.3	-1.8		700	-3.0	-0.8	-0.4
500	-7.2	-4.1	-3.6		500	-4.0	-1.4	-1.2
mean	-6.4	-3.2	-1.7		mean	-4.9	-1.5	-0.1
PMSL					PMSL			
	-4.0	-3.4	-4.3			-2.6	-1.0	-0.5
				TABLE 2.5				

so generally smoother fields.[1]

TABLE 2.6 summarises the overall performance of the trial based on the scores in **TABLES 2.4, AND 2.5**. It shows the number of scores for which the rms changed by greater than 1% to decide whether the trial or operational were better in each area,with changes less than 1% deemed equal. The trial version is favoured in all regions ,including the N. Atlantic and N. Hemisphere in distinction from the verification against observations. The tropics and S. hemisphere clearly shows improved scores with the longer physics timestep. On this assessment the change is better than neutral and so justified on more grounds than economy.

TABLE 2.6 : Summary of objective verification scores from verification against analyses (**TABLES 2.4 AND 2.5**)

Area	Trial better	equal	operational better
N Atlantic ("2")	35	24	25
N Hemisphere	48	22	14
Tropics	69	15	0
S Hemisphere	49	33	2

TOTAL SCORE FOR EACH AREA=84

2.2 BIASES AND VERTICAL DISTRIBUTION OF ERROR

The verifications against surface observations and sondes will mostly be shown since the pattern from verification against analyses is very similar.

PMSL

FIGURE 2.1 shows the bias and rms errors (in hPa) ,verified against observations, from T+0 to T+120 for mean sea-level pressure for N Atlantic , N Hemisphere, Tropics and S. Hemisphere. The negative biases in the N. Hemisphere areas are reduced whilst the bias is little changed in the other 2 areas.

HEIGHT

FIGURE 2.2 shows the bias (left) and rms (right) height error profiles for T+120 for area 2 (top) and N Hemisphere (bottom). **FIGURE 2.3** shows the same for the tropics and S Hemisphere. It is quite apparent that the longer timestep has almost no impact on the height biases except for the slightest reductions to the negative biases at upper levels.

[1]The 500hPa rms height errors at T+24 against analyses for December 1994 show a 1% reduction in the N. Hemisphere extratropics and 7% reductions in the Tropics and S. Hemisphere for the period after the operational implementation (14-31 December) compared to the period before the change (1-13 December). This may be influenced by synoptic variability between the periods and the other changes made to reduce superadiabtic lapse rate frequency.

TEMPERATURE

FIGURE 2.4 shows the bias (left) and rms (right) temperature error profiles for T+120 for area 2 (top) and N Hemisphere (bottom). **FIGURE 2.5** shows the same for the tropics and S Hemisphere. As with the height biases there are few differences between the trial and operational confirming the neutral nature of the longer timestep. There is a little degradation in the cold bias in the N. Hemispheric regions and a slight improvement in the S. Hemisphere.

WINDS

FIGURE 2.6 shows the bias (left) and rms (right) wind error profiles for T+0 for area 2 (top) and N Hemisphere (bottom). **FIGURE 2.7** shows the same for the tropics and S Hemisphere. The worsening of ~2% rms has already been commented upon. It is also seen that the wind speed biases are generally a few tenths of a knot lighter. Whilst this is still true in the N. Hemisphere at T+24, the rms scores are practically identical for the trial and operational in all regions (**FIGURES 2.8 AND 2.9**). The worse fit to standard level winds at T+0 does not appear to be affecting the quality of the T+24 forecasts when sonde winds are used for verification. The impact of the longer timestep on winds using aviation reports is investigated further below in section 2.3.

The picture obtained from verification against analyses is very much the same except for the improvement at T+24 noted above. For example, there is a slight reduction to the negative height bias (**FIGURE 2.10**) despite the analyses from the trial and operational verifying against sondes almost exactly the same (not shown).

2.3 OBSERVATION-BACKGROUND WIND ERRORS AGAINST AIREPS

To investigate further the apparent deficiency of the fit to wind observations revealed by the verification against sondes, the observation processing database (opd) from both trial and operational was used to look at background (T+6) errors against aireps. Ranking the O-B differences by speed bands there is a greater underestimate of observed wind speed for the global region with the longer timestep (**FIGURE 2.11, AND TABLE 2.7**), although the background rms vector wind errors are similar, except for winds in excess of $80ms^{-1}$ (for which there are few observations) . The results from individual latitude bands for the N. Hemisphere (**FIGURE 2.12**),tropics (**FIGURE 2.13**) and S. Hemisphere (**FIGURE 2.14**) are broadly the same, except the wind speed errors are generally lower in the tropics compared to the higher latitudes for both trial and operational versions.

2.4 OBJECTIVE VERIFICATION - SUMMARY

From the verification scores there is little to suggest a significant degradation in forecast skill through the use of a longer timestep for the physics. The exceptions are the wind analyses and forecast wind speeds. Since the latter are enhanced for aviation users recalculation of the scaling factors could be considered if necessary.

Background errors (against aireps)									
Jun 15-	Jul 03								
400-101hPa									
Operational					Long t/step				
MEAN O&B	MEAN O-B	RMS O-B	No. OBS		MEAN O-B	RMS O-B	No. OBS	%mean diff	%rms diff
SPEED m/s	SPEED m/s	VECTOR m/s			SPEED m/s	VECTOR m/s			
90-30S									
Total no. Observations			1807		Total no. Observations		1807		
0-3	-1.65	2.98	4		-1.50	2.89	4	-9.1	-3.0
3-20	0.21	5.31	387		0.24	5.33	387	14.3	0.4
20-40	0.89	7.85	815		0.90	7.78	816	1.1	-0.9
40-60	1.72	8.13	467		1.76	8.10	466	2.3	-0.4
60-80	4.14	9.00	120		4.18	8.87	121	1.0	-1.4
>80	4.72	7.47	14		4.78	7.58	13	1.3	1.5
ALL	1.20	7.53	1807		1.22	7.49	1807	1.7	-0.5
30N-30S									
Total no. Observations			11693		Total no. Observations		11693		
0-3	-1.10	2.97	276		-1.02	2.97	272	-7.3	0.0
3-20	0.87	5.19	7658		0.93	5.25	7670	6.9	1.2
20-40	1.21	6.39	2611		1.25	6.52	2610	3.3	2.0
40-60	1.18	7.04	904		1.25	7.04	898	5.9	0.0
60-80	2.27	8.66	229		2.35	8.64	230	3.5	-0.2
>80	1.68	6.93	15		1.68	7.26	13	0.0	4.8
ALL	0.95	5.68	11693		1.01	5.75	11693	6.3	1.2
30N-90N									
Total no. Observations			35919		Total no. Observations		35917		
0-3	-1.09	3.19	387		-1.05	3.20	382	-3.7	0.3
3-20	0.21	5.53	16569		0.22	5.57	16606	4.8	0.7
20-40	0.84	7.05	14302		0.87	7.05	14286	3.6	0.0
40-60	2.20	8.44	4160		2.36	8.45	4148	7.3	0.1
60-80	3.56	8.68	484		3.68	8.69	478	3.4	0.1
>80	8.39	12.79	17		8.73	13.23	17	4.1	3.4
ALL	0.73	6.59	35919		0.76	6.60	35917	4.1	0.2
Global					Global				
Total no. Observations			49419		Total no. Observations		49417		
0-3	-1.10	3.10	667		-1.04	3.11	658	-5.5	0.3
3-20	0.42	5.42	24614		0.44	5.47	24663	4.8	0.9
20-40	0.90	7.00	17728		0.93	7.01	17712	3.3	0.1
40-60	1.99	8.20	5531		2.13	8.21	5512	7.0	0.1
60-80	3.29	8.72	833		3.39	8.70	829	3.0	-0.2
>80	5.09	9.65	46		5.41	10.12	43	6.3	4.9
ALL	0.80	6.42	49419		0.84	6.45	49417	5.0	0.5

TABLE 2.7

3. SUBJECTIVE ASSESSMENT -Parallel Suite Trial 16/06/94 - 3/07/94

3.1 NORTHERN HEMISPHERE (NORTH OF 30N)

Comparing the trial and operational forecasts subjectively, it was apparent that running with the 20 minute timestep for the physics had little impact in the Northern Hemisphere. Most differences in mean sea level pressure and 500mb forecasts were fairly insignificant, even at T+120, with no evolution changes. There was a very slight impact upon 250mb polar jet maxima at T+120 with approximately two differences exceeding 5 knots per forecast but the differences were not systematic and most verified in favour of the trial forecasts.

Nearly all the impact upon the precipitation forecasts resulted from minor variations in the distribution of showers and differences in dynamic rainfall were difficult to spot subjectively. The overall impression was that running with the longer timestep tended to produce more showers overland at 12Z. Rainfall statistics for the Northern Hemisphere (north of 30N) and for Area 2 supported this impression by showing a slight overall increase in precipitation, mostly convective, of 1-4%.

The only noticeable impact on dynamic rainfall over the U.K. was seen in the T+72 forecasts verifying at 12Z 22/06/94. The comparison in **FIGURE 3.1** shows that the trial forecast (**FIGURE 3.1a**) was slightly faster with the clearance of rain from Eastern England. The analysis for 12Z 22/06/94 (**FIGURE 3.2**) shows the cold front to be well clear of Eastern England so the faster timing was an improvement although neither forecast handled the wave on the cold front well.

A good example of the impact on convective rainfall can be seen by comparing the T+24 forecasts verifying at 12Z 26/06/94, shown in **FIGURE 3.3**. The verifying analysis, (see **FIGURE 3.4**) , shows a slow moving cold front over Germany with hot, humid and potentially unstable air to the east. The position of the cold front was well predicted by the trial T+24 forecast (**FIGURE 3.3a**) but the extent of the heavy showers was over-predicted at this time. The tendency for the trial to predict slightly more showers at 12Z can also be seen by comparing the forecasts over Russia between 40E and 70E.

3.2 THE TROPICS (30N - 30S)

A comparison of trial and operational subtropical jets showed that running with the 20 minute timestep for the physics had a slight impact , but the differences were variable rather than systematic and the verification was 50% in favour of the trial and 50% against.

The main impact in the tropics resulted from differences in the convective precipitation. There was a slight tendency for the shower distribution in the trial forecasts to be jerkier, with fewer but heavier showers, in comparison with the smoother, more widespread shower distribution in the operational forecasts. This difference can be seen by comparing the trial (**FIGURE 3.5**) and operational (**FIGURE 3.6**) precipitation forecasts for

T+72 for South America , the South Atlantic and Africa. The trial precipitation is slightly spottier, especially over the Ocean in the ITCZ and around the Azores anticyclone. Overall, the difference in accumulations was small with a small average mean increase of about 1% in total rainfall accumulation at T+72.

3.3 The Southern Hemisphere (south of 30S)

The largest differences between operational and trial forecasts could be seen in the Southern Hemisphere at T+72 onwards. Occasional big differences were noted in the forecast detail of small scale features plus some changes in forecast evolution especially at T+120.

(i) Levels 18 and 19.

Noise differences in mean sea level pressure and 500mb analyses around the south Pole indicated possible instability problems in the top levels. Conditions during this period were rather extreme, with the forecast polar night jet exceeding 300 knots and the temperature of the polar vortex -110C.

The trial, using version 3.3, contained the automatic half-timestep dynamics option, which was frequently used during the period of the trial. This meant that the two versions were not strictly comparable in the top levels. The operational forecast, still using version 3.2, ran with the full timestep until 16th when CFO switched fully to the half timestep.

(ii) Precipitation

Differences in the precipitation were difficult to identify subjectively from the charts, but most appeared to be due to differences in shower distribution. Statistics from all the individual forecasts showed a small increase in convective precipitation with a smaller decrease in dynamic precipitation. The overall mean increase in precipitation was 1-3%.

(iii) Mean sea level pressure and 500mb

Forecasts at T+120 were starting to diverge, with on average 4/5 significant differences per forecast. The differences were variable, mainly ranging between +/- 10-15mb, rather than any systematic deepening or filling of depressions. The verification of these differences was slightly in favour of the trial. There were a few differences as large as 20mb between depressions.

The largest difference in evolution seen during the trial is illustrated in **Figure 3.7c** by the 40mb difference at T+120 over the Southern Ocean to the south of South Africa and Madagascar. The trial T+120 forecast (**Figure 3.7b**) ,verifying at 12Z 25/06/94, predicted a deep depression of 953mb in this area. In contrast, the operational T+120 forecast (**Figure 3.7a**) predicted only a shallow depression of 971mb. The verifying operational analysis (**Figure 3.8a**), with a depression of 957mb, favoured the trial forecast for the depth of the low, although the operational forecast position was better.

Comparing the same forecasts, another large difference of 28mb (shown in **Figure 3.9c**) occurred to the south of Tierra del Fuego and the Falkland Islands. This time the operational T+120 forecast (**FIGURE 3.9a**) predicted the lower pressure with a depression of 978mb at 60S 65W. The trial forecast (**FIGURE 3.9b**) just predicted a northerly airstream with pressure 1004mb in this position. The verifying operational analysis (**FIGURE 3.8b**) shows that the operational forecast predicted the better pressure pattern but over-deepened the low at 60S 65W by 16mb. The trial forecast, on the other hand, was closer to the analysed pressure at this point but the predicted surface winds were too strong.

(iv) 250mb jets

There was a slight impact on the 250mb jets at T+24 used by aviation but most differences were less than 5 ms^{-1}. The largest difference seen in the trial at T+24 can be seen in the difference chart, **FIGURE 3.10b**, showing a difference of 5-8 ms^{-1} in the forecast 250mb jet over South America. A comparison of the individual trial and operational T+24 forecasts, **FIGURES 3.11a and 11b** respectively, show that even this difference was fairly insignificant.

Larger differences were noticed between trial and operational at jets T+72 / 120 with some evolution changes but overall assessment was slightly in favour of the trial.

3.4 OVERALL SUBJECTIVE ASSESSMENT OF SIGNIFICANT FORECAST DIFFERENCES AT T+120

Northern Hemisphere	**Trial**	**Operational**
250mb jet maxima	**9**	4
Southern Hemisphere		
mean sea level pressure	**26**	11
500mb	**9**	3
250mb jet maxima	**15**	12

TABLE 1. Subjective assessment of significant differences between trial and operational forecasts at T+120. (Definition of significant forecast difference at T+120; >6mb mslp, >6dm 500mb, >5ms^{-1} 250mb wind speed).

3.5 CONCLUSIONS FROM THE SUBJECTIVE ASSESSMENT

1. In the Northern Hemisphere, most differences in mean sea level pressure and 500mb forecasts were fairly insignificant, even at T+120, with no evolution changes.

2. Most of the impact upon the precipitation forecasts resulted from minor variations in the distribution of showers. Running with the longer timestep tended to produce more showers overland at 12Z.

3. Occasional big differences were noted in the forecast detail of small scale features in the Southern Hemisphere at T+72 onwards, plus some changes in forecast evolution.

Assessment slightly favoured the trial.

4. Conclusions

The conclusion from the subjective assessment, and verification against analyses and observations, is that running with a 20 minute timestep for the physics in the global model does not significantly affect the forecasts. The assimilation also used the longer timestep. The quality of the analyses (T+0) was not degraded because of this except for the winds which showed a 1.5-2% worsening in rms vector wind errors. However the T+24 rms vector wind error from verification against sonde observations was the same as for the operational version. The underestimation of wind speeds was also very slightly worse according to the objective verification. However the subjective verification could not really detect this and for the 250hPa jets came out slightly in favour of the trial. Overall the assessment, both subjective and objective, is that the use of the longer timestep is generally neutral. There is a little evidence, from the T+24 verification against analyses, that the extra adjustment steps per physics increment may result in slightly smoother fields. As with the limited area model trial, it does not appear necessary for the assimilation to be performed at the shorter (dynamics) timestep. Implementing the change would save approximately 10-15% of the run time, which could be used for other model enhancements, such as increased vertical resolution or improved treatment of orographic drag and gravity wave drag.

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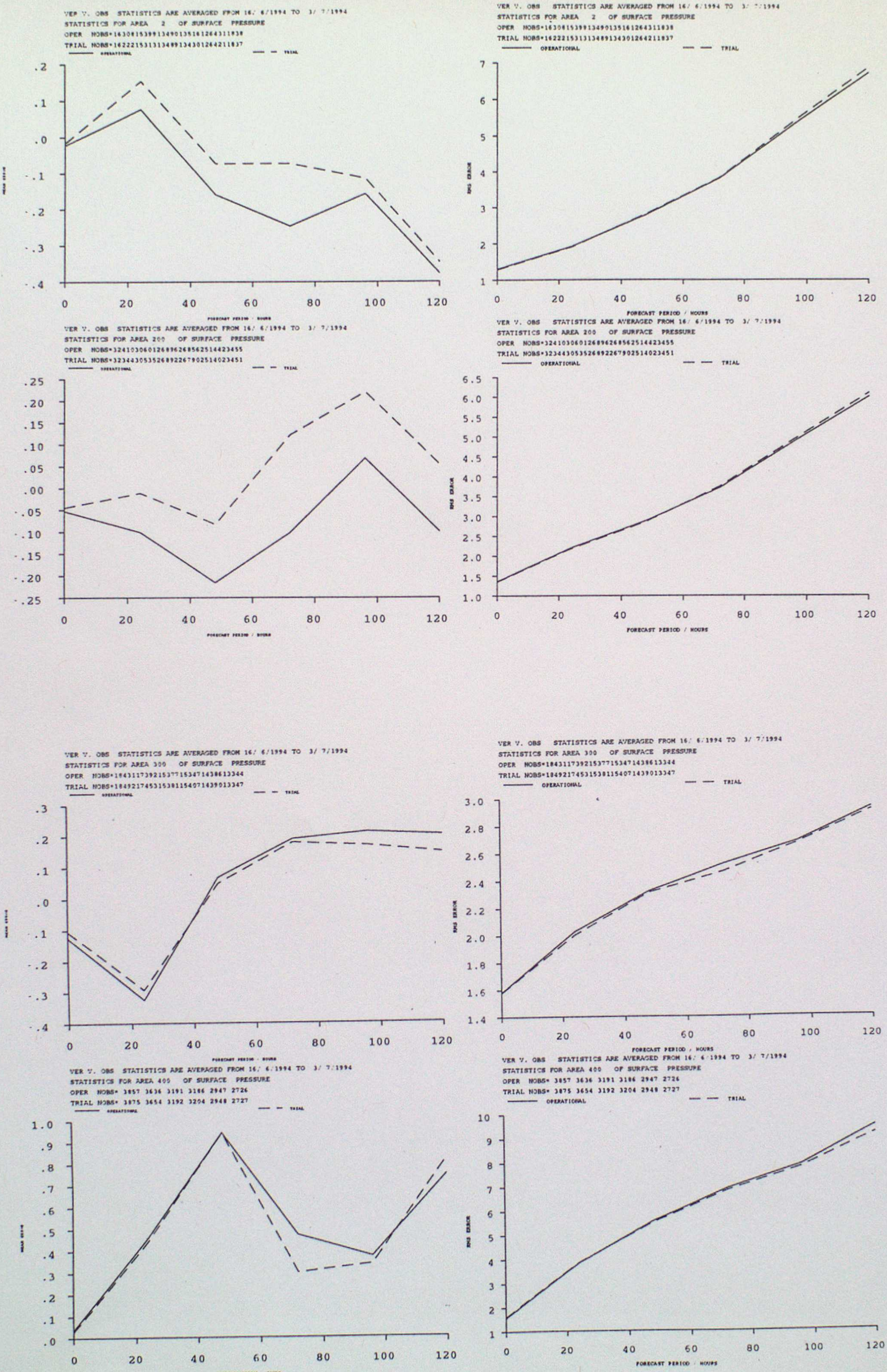
Wilson C A , O M Hammon and R T H Barnes, 1994:
Trials of a longer timestep for physics in the limited area model. *FR Technical Report* ***111***

Wilson C A , F Rawlins and O M Hammon, 1994:
Cause and cure of the superadiabatic lapse rate in the limited area and global models. *FR Technical Report* ***125***


VER V. OBS STATISTICS ARE AVERAGED FROM 16/ 6/1994 TO 3/ 7/1994
STATISTICS FOR AREA 2 OF SURFACE PRESSURE
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TRIAL NOBS=162221531313489134301264211837
OPERATIONAL
TRIAL
RMS ERROR
FORECAST PERIOD / HOURS
VER V. OBS STATISTICS ARE AVERAGED FROM 16/ 6/1994 TO 3/ 7/1994
STATISTICS FOR AREA 200 OF SURFACE PRESSURE
OPER NOBS=324103060126896268562514423455
TRIAL NOBS=323443053526892267902514023451
OPERATIONAL
TRIAL
RMS ERROR
FORECAST PERIOD / HOURS
VER V. OBS STATISTICS ARE AVERAGED FROM 16/ 6/1994 TO 3/ 7/1994
STATISTICS FOR AREA 300 OF SURFACE PRESSURE
OPER NOBS=184311739215377153471438613344
TRIAL NOBS=184921745315381154071439013347
OPERATIONAL
TRIAL
RMS ERROR
FORECAST PERIOD / HOURS
VER V. OBS STATISTICS ARE AVERAGED FROM 16/ 6/1994 TO 3/ 7/1994
STATISTICS FOR AREA 400 OF SURFACE PRESSURE
OPER NOBS= 3857 3636 3191 3186 2947 2726
TRIAL NOBS= 3875 3654 3192 3204 2948 2727
OPERATIONAL
TRIAL
RMS ERROR
FORECAST PERIOD / HOURS

FIGURE 2.1

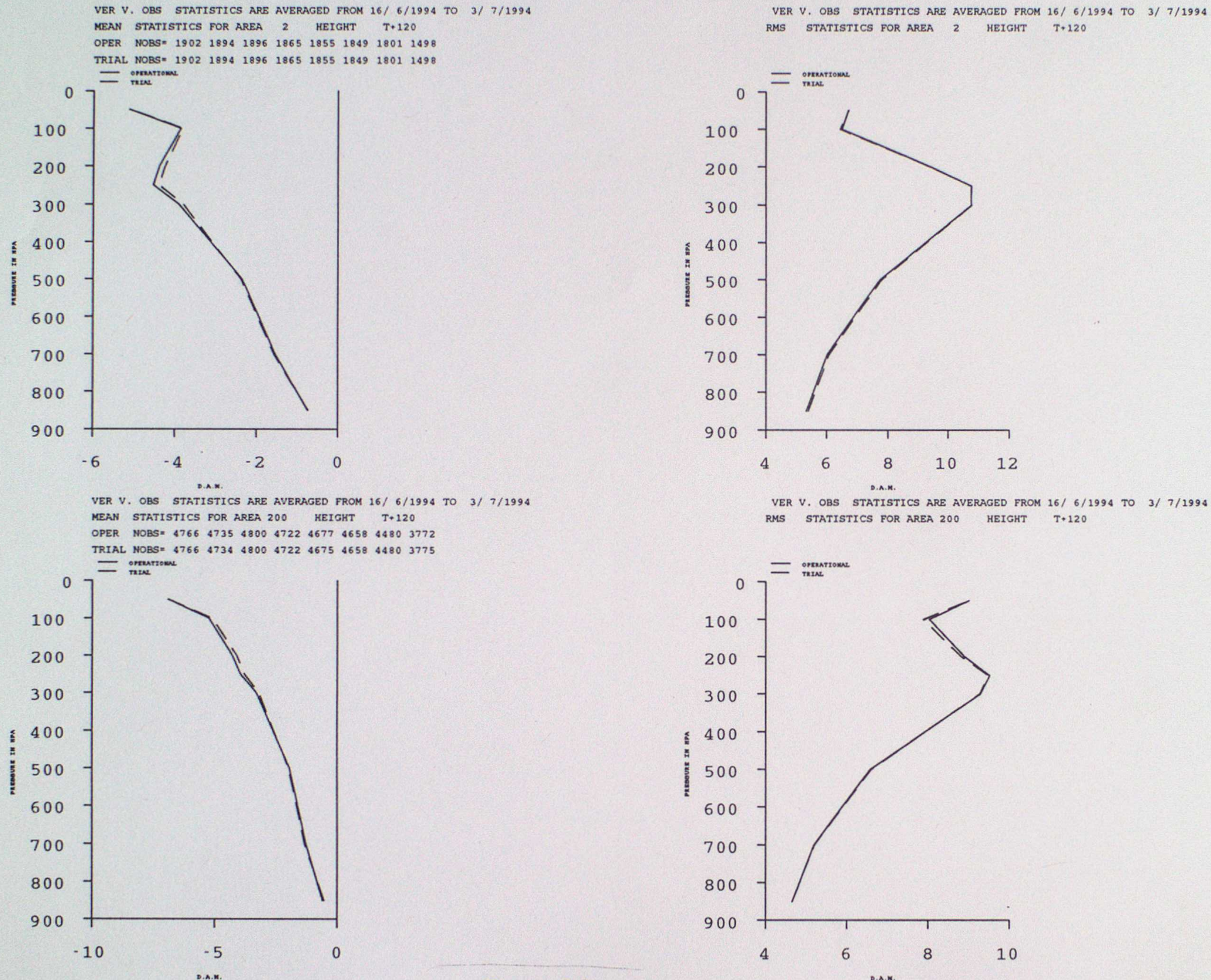

VER V. OBS STATISTICS ARE AVERAGED FROM 16/ 6/1994 TO 3/ 7/1994
MEAN STATISTICS FOR AREA 2 HEIGHT T+120
OPER NOBS= 1902 1894 1896 1865 1855 1849 1801 1498
TRIAL NOBS= 1902 1894 1896 1865 1855 1849 1801 1498
OPERATIONAL
TRIAL
PRESSURE IN HPA
D.A.M.
VER V. OBS STATISTICS ARE AVERAGED FROM 16/ 6/1994 TO 3/ 7/1994
RMS STATISTICS FOR AREA 2 HEIGHT T+120
OPERATIONAL
TRIAL
PRESSURE IN HPA
D.A.M.
VER V. OBS STATISTICS ARE AVERAGED FROM 16/ 6/1994 TO 3/ 7/1994
MEAN STATISTICS FOR AREA 200 HEIGHT T+120
OPER NOBS= 4766 4735 4800 4722 4677 4658 4480 3772
TRIAL NOBS= 4766 4734 4800 4722 4675 4658 4480 3775
OPERATIONAL
TRIAL
PRESSURE IN HPA
D.A.M.
VER V. OBS STATISTICS ARE AVERAGED FROM 16/ 6/1994 TO 3/ 7/1994
RMS STATISTICS FOR AREA 200 HEIGHT T+120
OPERATIONAL
TRIAL
PRESSURE IN HPA
D.A.M.

Figure 2.2

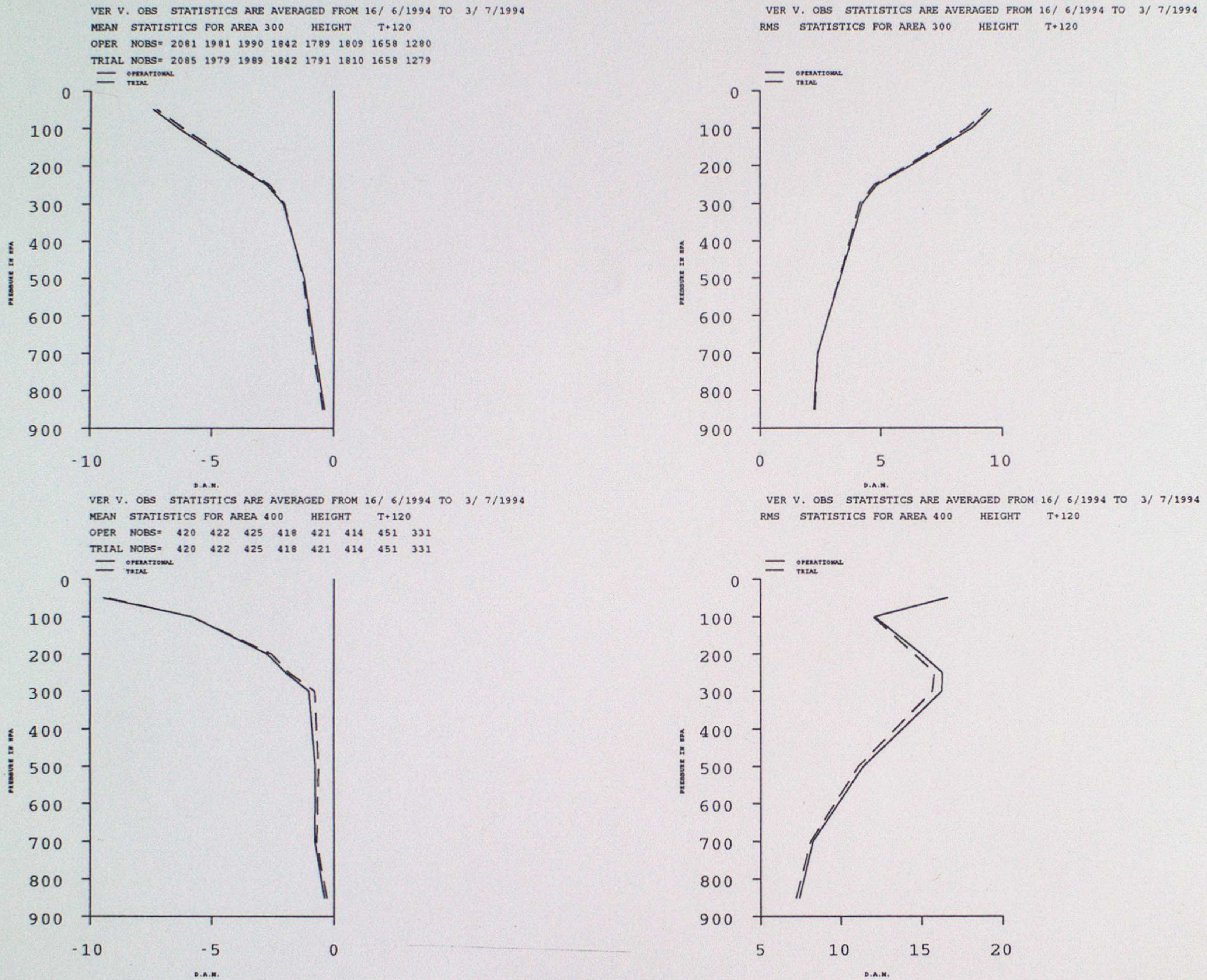

VER V. OBS STATISTICS ARE AVERAGED FROM 16/ 6/1994 TO 3/ 7/1994
MEAN STATISTICS FOR AREA 300 HEIGHT T+120
OPER NOBS= 2081 1981 1990 1842 1789 1809 1658 1280
TRIAL NOBS= 2085 1979 1989 1842 1791 1810 1658 1279
OPERATIONAL
TRIAL
PRESSURE IN HPA
D.A.M.
VER V. OBS STATISTICS ARE AVERAGED FROM 16/ 6/1994 TO 3/ 7/1994
RMS STATISTICS FOR AREA 300 HEIGHT T+120
OPERATIONAL
TRIAL
PRESSURE IN HPA
D.A.M.
VER V. OBS STATISTICS ARE AVERAGED FROM 16/ 6/1994 TO 3/ 7/1994
MEAN STATISTICS FOR AREA 400 HEIGHT T+120
OPER NOBS= 420 422 425 418 421 414 451 331
TRIAL NOBS= 420 422 425 418 421 414 451 331
OPERATIONAL
TRIAL
PRESSURE IN HPA
D.A.M.
VER V. OBS STATISTICS ARE AVERAGED FROM 16/ 6/1994 TO 3/ 7/1994
RMS STATISTICS FOR AREA 400 HEIGHT T+120
OPERATIONAL
TRIAL
PRESSURE IN HPA
D.A.M.

FIGURE 2.3

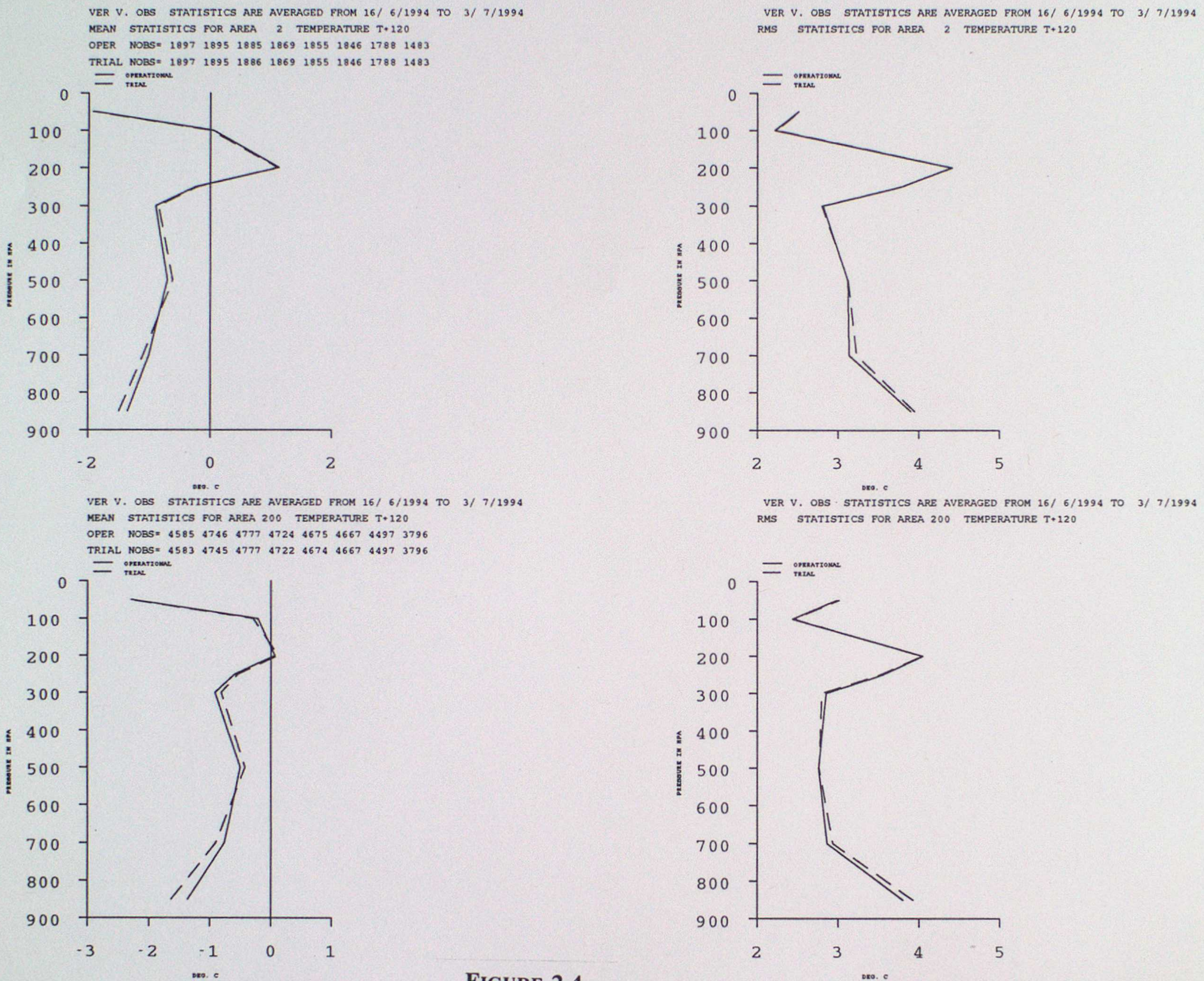

VER V. OBS STATISTICS ARE AVERAGED FROM 16/ 6/1994 TO 3/ 7/1994
MEAN STATISTICS FOR AREA 2 TEMPERATURE T+120
OPER NOBS= 1897 1895 1885 1869 1855 1846 1788 1483
TRIAL NOBS= 1897 1895 1886 1869 1855 1846 1788 1483
OPERATIONAL
TRIAL
PRESSURE IN HPA
DEG. C
VER V. OBS STATISTICS ARE AVERAGED FROM 16/ 6/1994 TO 3/ 7/1994
RMS STATISTICS FOR AREA 2 TEMPERATURE T+120
OPERATIONAL
TRIAL
PRESSURE IN HPA
DEG. C
VER V. OBS STATISTICS ARE AVERAGED FROM 16/ 6/1994 TO 3/ 7/1994
MEAN STATISTICS FOR AREA 200 TEMPERATURE T+120
OPER NOBS= 4585 4746 4777 4724 4675 4667 4497 3796
TRIAL NOBS= 4583 4745 4777 4722 4674 4667 4497 3796
OPERATIONAL
TRIAL
PRESSURE IN HPA
DEG. C
VER V. OBS STATISTICS ARE AVERAGED FROM 16/ 6/1994 TO 3/ 7/1994
RMS STATISTICS FOR AREA 200 TEMPERATURE T+120
OPERATIONAL
TRIAL
PRESSURE IN HPA
DEG. C

FIGURE 2.4

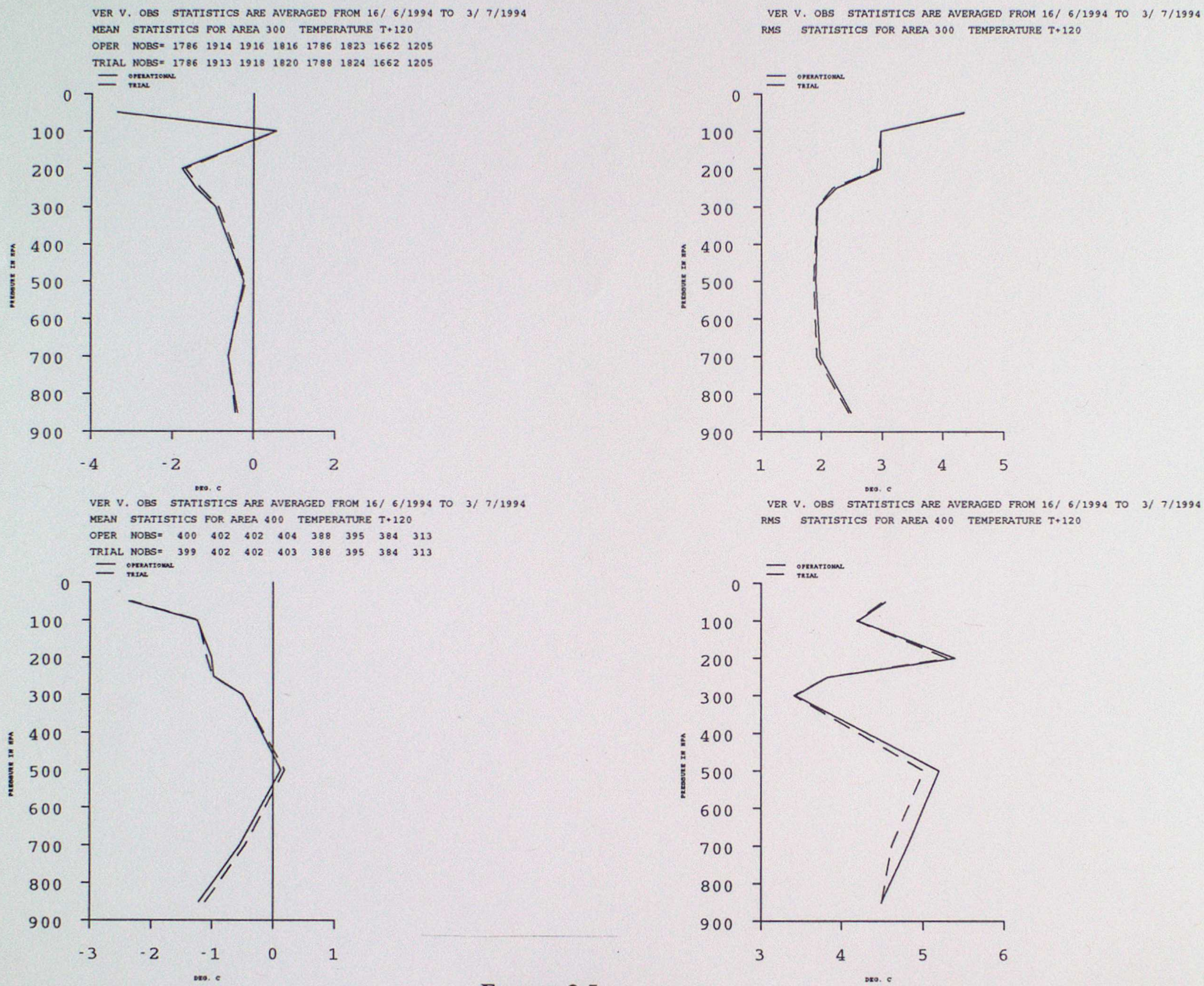

VER V. OBS STATISTICS ARE AVERAGED FROM 16/ 6/1994 TO 3/ 7/1994
MEAN STATISTICS FOR AREA 300 TEMPERATURE T+120
OPER NOBS= 1786 1914 1916 1816 1786 1823 1662 1205
TRIAL NOBS= 1786 1913 1918 1820 1788 1824 1662 1205
OPERATIONAL
TRIAL
0
100
200
300
400
500
600
700
800
900
-4
-2
0
2
DEG. C
VER V. OBS STATISTICS ARE AVERAGED FROM 16/ 6/1994 TO 3/ 7/1994
RMS STATISTICS FOR AREA 300 TEMPERATURE T+120
1
2
3
4
5
VER V. OBS STATISTICS ARE AVERAGED FROM 16/ 6/1994 TO 3/ 7/1994
MEAN STATISTICS FOR AREA 400 TEMPERATURE T+120
OPER NOBS= 400 402 402 404 388 395 384 313
TRIAL NOBS= 399 402 402 403 388 395 384 313
-3
-2
-1
0
1
VER V. OBS STATISTICS ARE AVERAGED FROM 16/ 6/1994 TO 3/ 7/1994
RMS STATISTICS FOR AREA 400 TEMPERATURE T+120
3
4
5
6

FIGURE 2.5

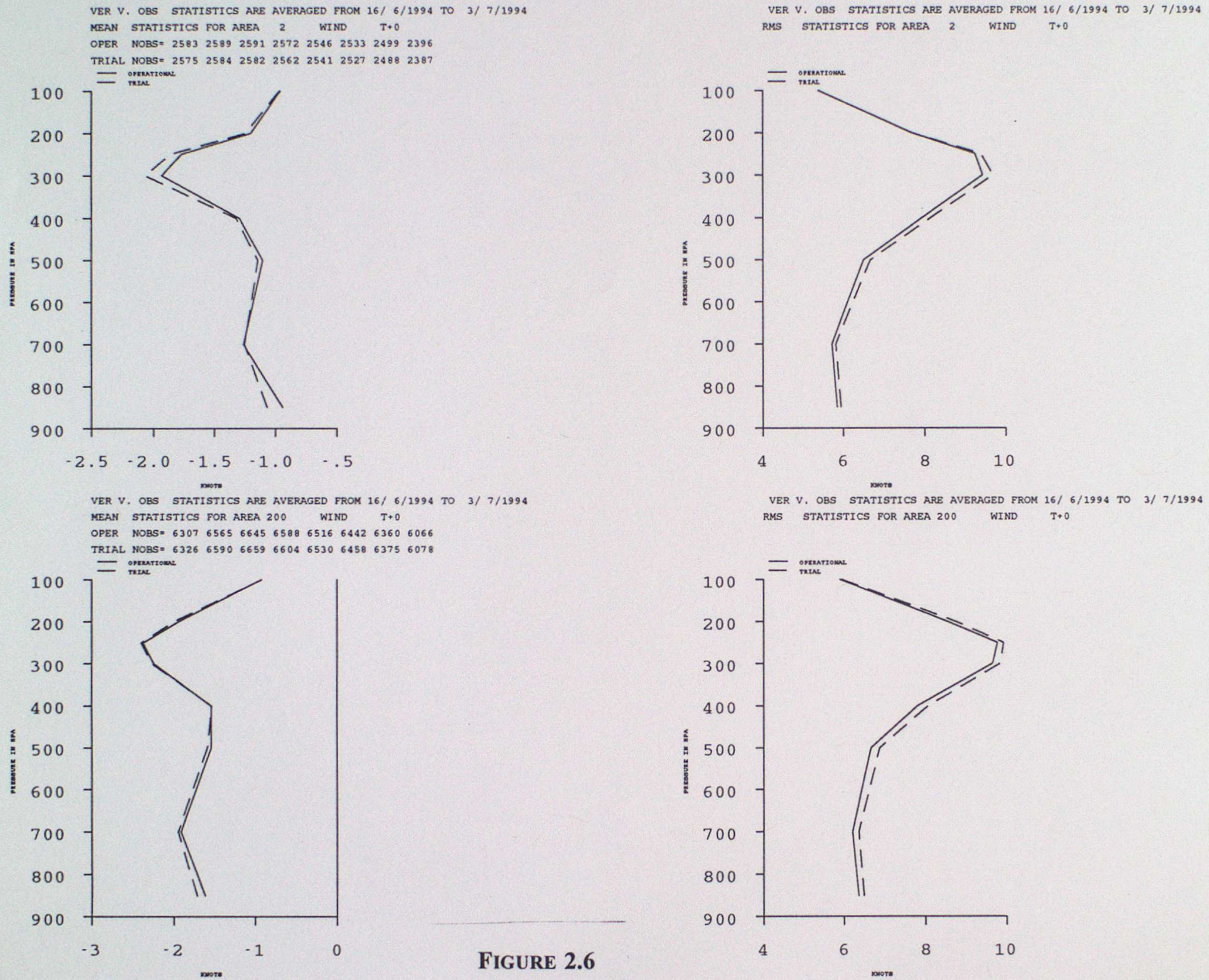

VER V. OBS STATISTICS ARE AVERAGED FROM 16/ 6/1994 TO 3/ 7/1994
MEAN STATISTICS FOR AREA 2 WIND T+0
OPER NOBS= 2583 2589 2591 2572 2546 2533 2499 2396
TRIAL NOBS= 2575 2584 2582 2562 2541 2527 2488 2387
OPERATIONAL
TRIAL
100 200 300 400 500 600 700 800 900
-2.5 -2.0 -1.5 -1.0 -.5
VER V. OBS STATISTICS ARE AVERAGED FROM 16/ 6/1994 TO 3/ 7/1994
RMS STATISTICS FOR AREA 2 WIND T+0
OPERATIONAL
TRIAL
100 200 300 400 500 600 700 800 900
4 6 8 10
VER V. OBS STATISTICS ARE AVERAGED FROM 16/ 6/1994 TO 3/ 7/1994
MEAN STATISTICS FOR AREA 200 WIND T+0
OPER NOBS= 6307 6565 6645 6588 6516 6442 6360 6066
TRIAL NOBS= 6326 6590 6659 6604 6530 6458 6375 6078
OPERATIONAL
TRIAL
100 200 300 400 500 600 700 800 900
-3 -2 -1 0
VER V. OBS STATISTICS ARE AVERAGED FROM 16/ 6/1994 TO 3/ 7/1994
RMS STATISTICS FOR AREA 200 WIND T+0
OPERATIONAL
TRIAL
100 200 300 400 500 600 700 800 900
4 6 8 10

FIGURE 2.6

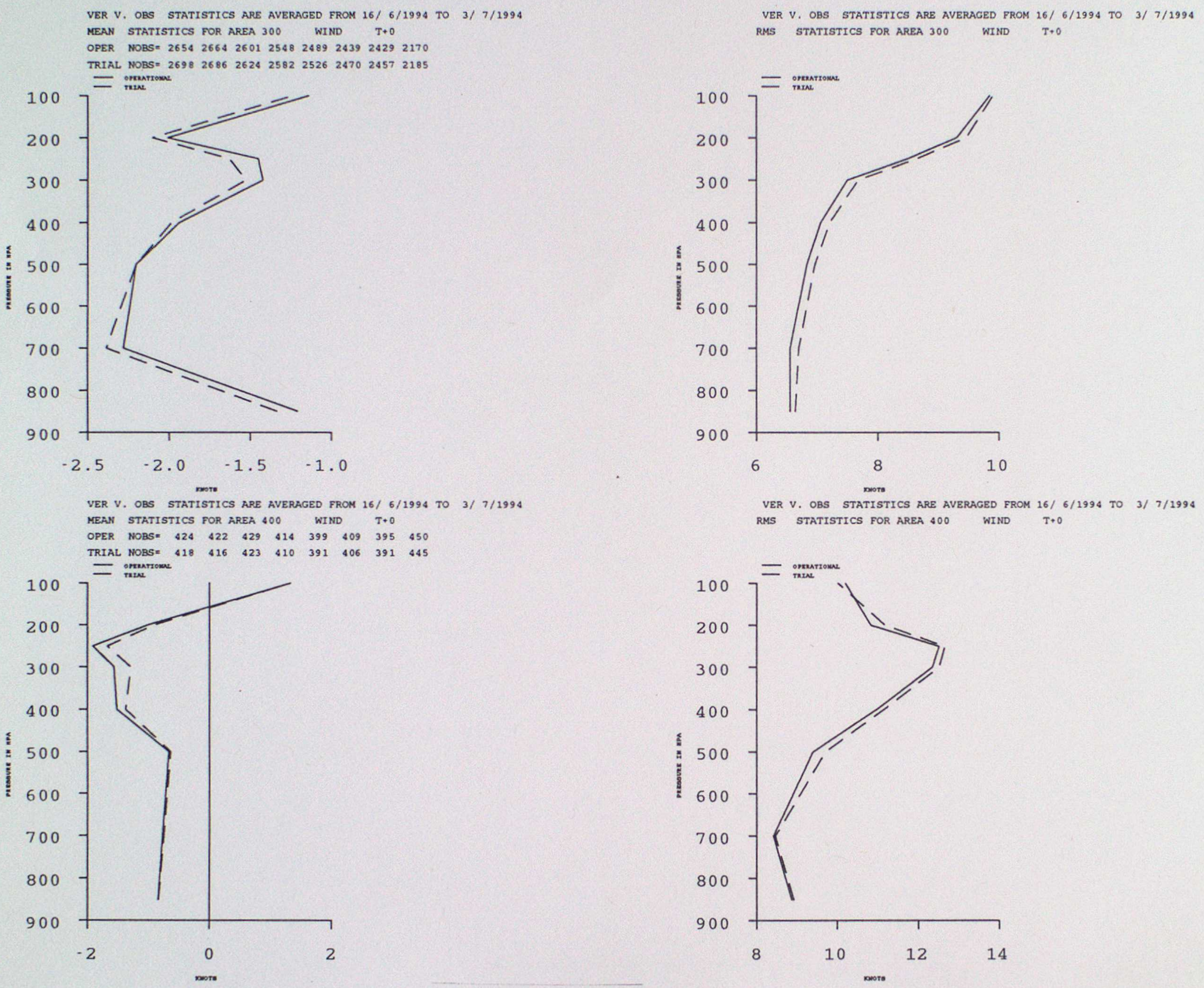

VER V. OBS STATISTICS ARE AVERAGED FROM 16/ 6/1994 TO 3/ 7/1994
MEAN STATISTICS FOR AREA 300 WIND T+0
OPER NOBS= 2654 2664 2601 2548 2489 2439 2429 2170
TRIAL NOBS= 2698 2686 2624 2582 2526 2470 2457 2185
OPERATIONAL
TRIAL
100 200 300 400 500 600 700 800 900
PRESSURE IN HPA
-2.5 -2.0 -1.5 -1.0
KNOTS
VER V. OBS STATISTICS ARE AVERAGED FROM 16/ 6/1994 TO 3/ 7/1994
RMS STATISTICS FOR AREA 300 WIND T+0
OPERATIONAL
TRIAL
100 200 300 400 500 600 700 800 900
PRESSURE IN HPA
6 8 10
KNOTS
VER V. OBS STATISTICS ARE AVERAGED FROM 16/ 6/1994 TO 3/ 7/1994
MEAN STATISTICS FOR AREA 400 WIND T+0
OPER NOBS= 424 422 429 414 399 409 395 450
TRIAL NOBS= 418 416 423 410 391 406 391 445
OPERATIONAL
TRIAL
100 200 300 400 500 600 700 800 900
PRESSURE IN HPA
-2 0 2
KNOTS
VER V. OBS STATISTICS ARE AVERAGED FROM 16/ 6/1994 TO 3/ 7/1994
RMS STATISTICS FOR AREA 400 WIND T+0
OPERATIONAL
TRIAL
100 200 300 400 500 600 700 800 900
PRESSURE IN HPA
8 10 12 14
KNOTS

FIGURE 2.7

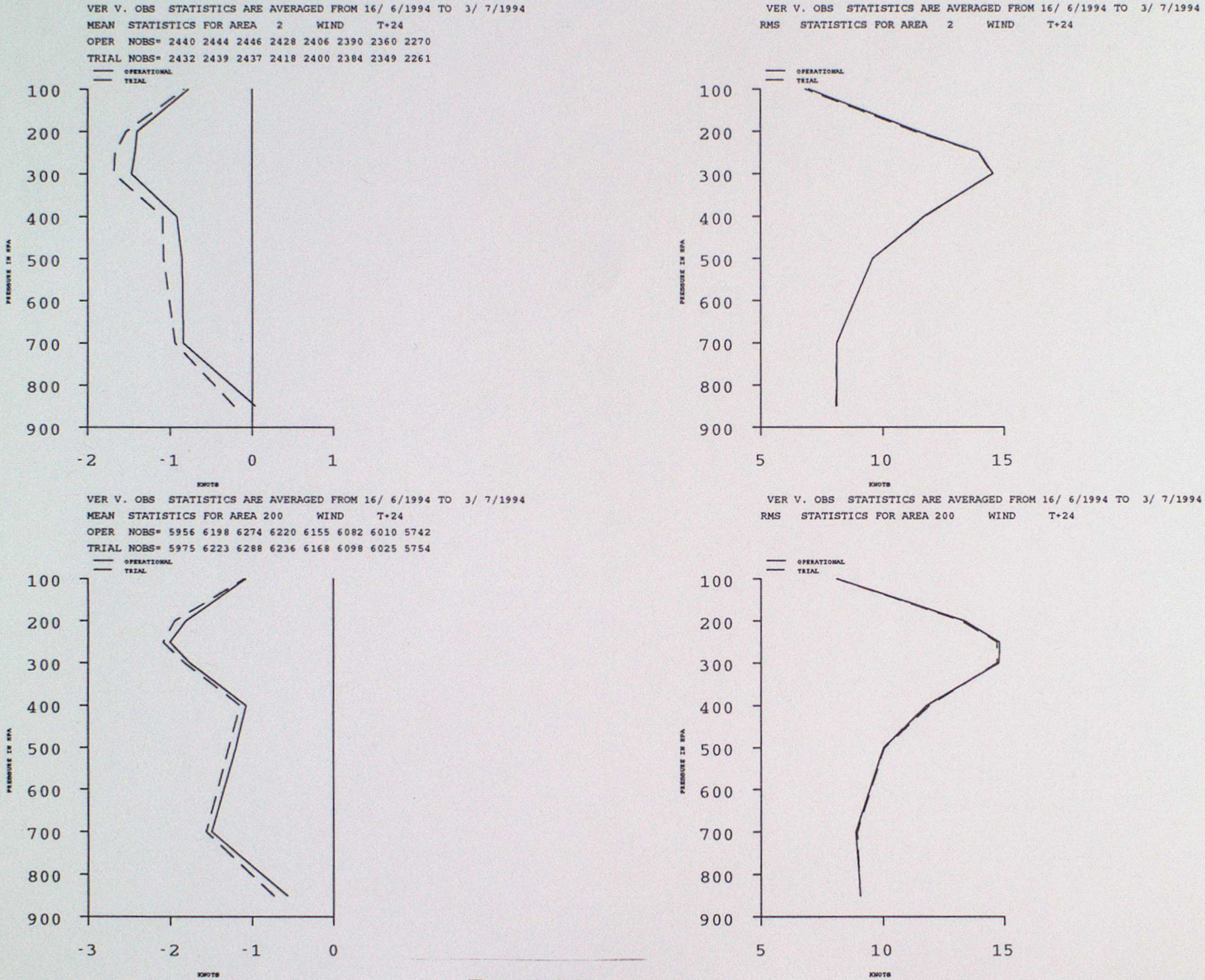

VER V. OBS STATISTICS ARE AVERAGED FROM 16/ 6/1994 TO 3/ 7/1994
MEAN STATISTICS FOR AREA 2 WIND T+24
OPER NOBS= 2440 2444 2446 2428 2406 2390 2360 2270
TRIAL NOBS= 2432 2439 2437 2418 2400 2384 2349 2261
OPERATIONAL
TRIAL
PRESSURE IN HPA
KNOTS
VER V. OBS STATISTICS ARE AVERAGED FROM 16/ 6/1994 TO 3/ 7/1994
RMS STATISTICS FOR AREA 2 WIND T+24
OPERATIONAL
TRIAL
PRESSURE IN HPA
KNOTS
VER V. OBS STATISTICS ARE AVERAGED FROM 16/ 6/1994 TO 3/ 7/1994
MEAN STATISTICS FOR AREA 200 WIND T+24
OPER NOBS= 5956 6198 6274 6220 6155 6082 6010 5742
TRIAL NOBS= 5975 6223 6288 6236 6168 6098 6025 5754
OPERATIONAL
TRIAL
PRESSURE IN HPA
KNOTS
VER V. OBS STATISTICS ARE AVERAGED FROM 16/ 6/1994 TO 3/ 7/1994
RMS STATISTICS FOR AREA 200 WIND T+24
OPERATIONAL
TRIAL
PRESSURE IN HPA
KNOTS

FIGURE 2.8

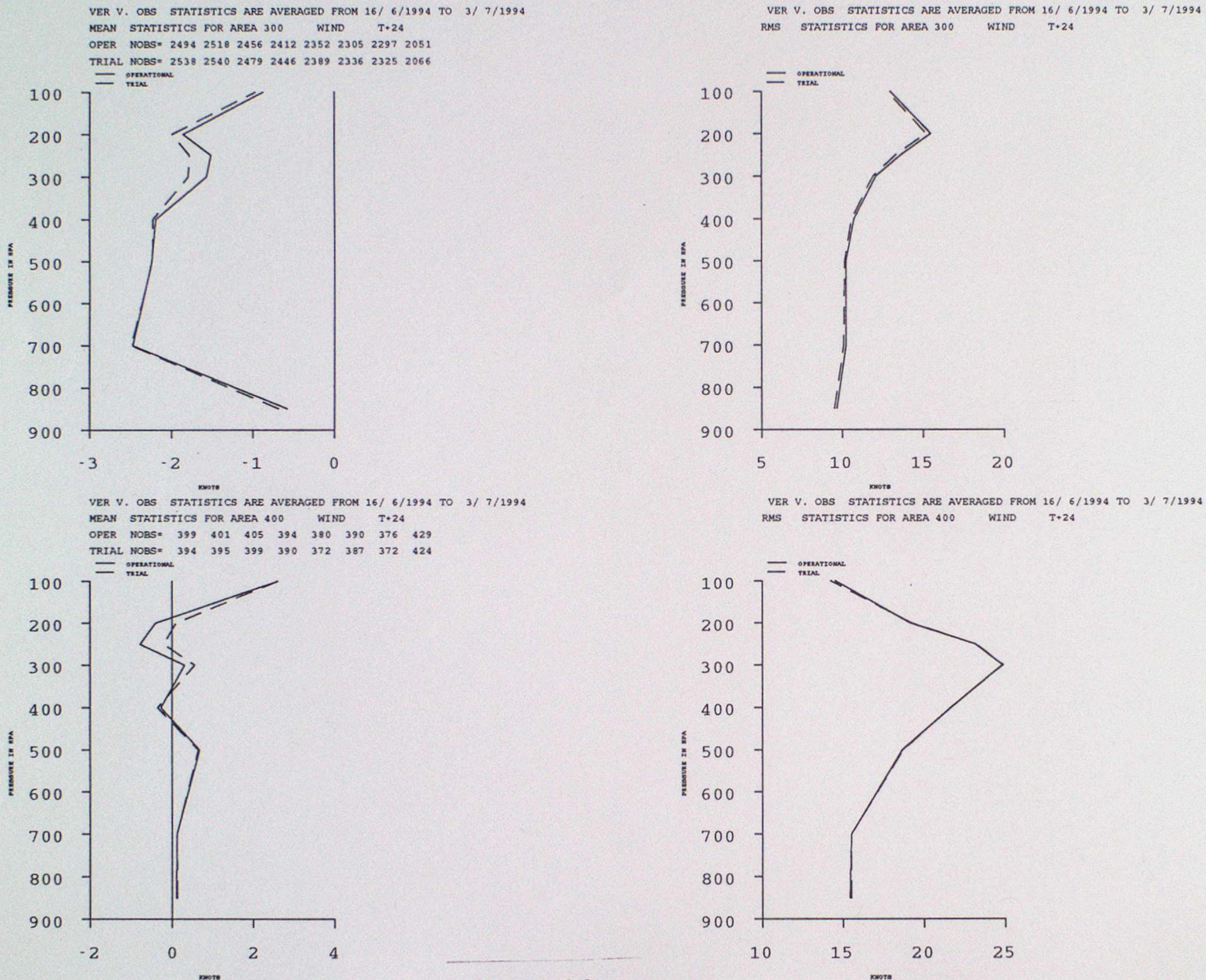

VER V. OBS STATISTICS ARE AVERAGED FROM 16/ 6/1994 TO 3/ 7/1994
MEAN STATISTICS FOR AREA 300 WIND T+24
OPER NOBS= 2494 2518 2456 2412 2352 2305 2297 2051
TRIAL NOBS= 2538 2540 2479 2446 2389 2336 2325 2066
OPERATIONAL
TRIAL
PRESSURE IN HPA
100
200
300
400
500
600
700
800
900
-3
-2
-1
0
KNOTS
VER V. OBS STATISTICS ARE AVERAGED FROM 16/ 6/1994 TO 3/ 7/1994
RMS STATISTICS FOR AREA 300 WIND T+24
OPERATIONAL
TRIAL
PRESSURE IN HPA
100
200
300
400
500
600
700
800
900
5
10
15
20
KNOTS
VER V. OBS STATISTICS ARE AVERAGED FROM 16/ 6/1994 TO 3/ 7/1994
MEAN STATISTICS FOR AREA 400 WIND T+24
OPER NOBS= 399 401 405 394 380 390 376 429
TRIAL NOBS= 394 395 399 390 372 387 372 424
OPERATIONAL
TRIAL
PRESSURE IN HPA
100
200
300
400
500
600
700
800
900
-2
0
2
4
KNOTS
VER V. OBS STATISTICS ARE AVERAGED FROM 16/ 6/1994 TO 3/ 7/1994
RMS STATISTICS FOR AREA 400 WIND T+24
OPERATIONAL
TRIAL
PRESSURE IN HPA
100
200
300
400
500
600
700
800
900
10
15
20
25
KNOTS

FIGURE 2.9

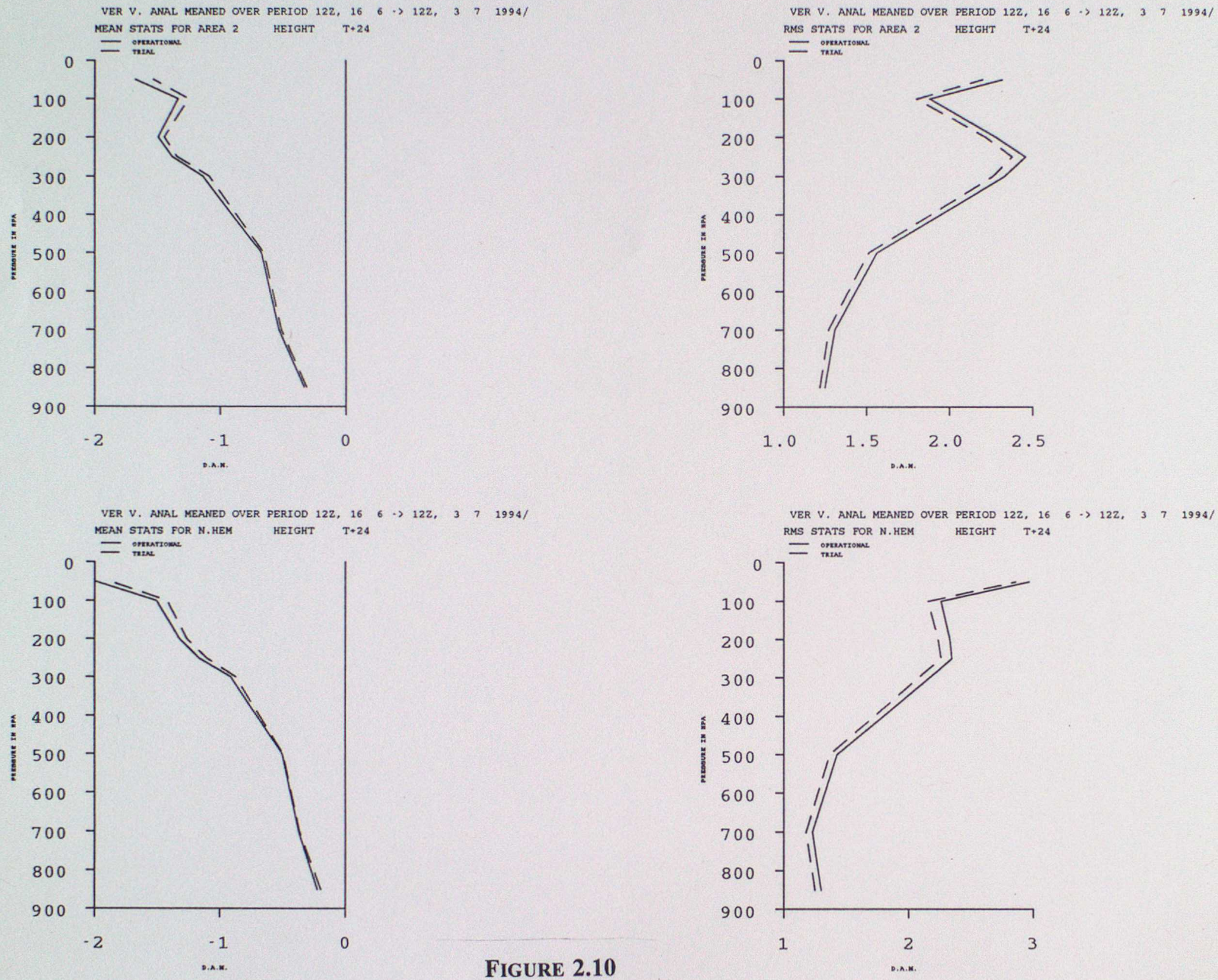

VER V. ANAL MEANED OVER PERIOD 12Z, 16 6 -> 12Z, 3 7 1994/
MEAN STATS FOR AREA 2 HEIGHT T+24
OPERATIONAL
TRIAL
PRESSURE IN HPA
0
100
200
300
400
500
600
700
800
900
-2
-1
0
D.A.M.
VER V. ANAL MEANED OVER PERIOD 12Z, 16 6 -> 12Z, 3 7 1994/
RMS STATS FOR AREA 2 HEIGHT T+24
OPERATIONAL
TRIAL
PRESSURE IN HPA
0
100
200
300
400
500
600
700
800
900
1.0
1.5
2.0
2.5
D.A.M.
VER V. ANAL MEANED OVER PERIOD 12Z, 16 6 -> 12Z, 3 7 1994/
MEAN STATS FOR N.HEM HEIGHT T+24
OPERATIONAL
TRIAL
PRESSURE IN HPA
0
100
200
300
400
500
600
700
800
900
-2
-1
0
D.A.M.
VER V. ANAL MEANED OVER PERIOD 12Z, 16 6 -> 12Z, 3 7 1994/
RMS STATS FOR N.HEM HEIGHT T+24
OPERATIONAL
TRIAL
PRESSURE IN HPA
0
100
200
300
400
500
600
700
800
900
1
2
3
D.A.M.

FIGURE 2.10

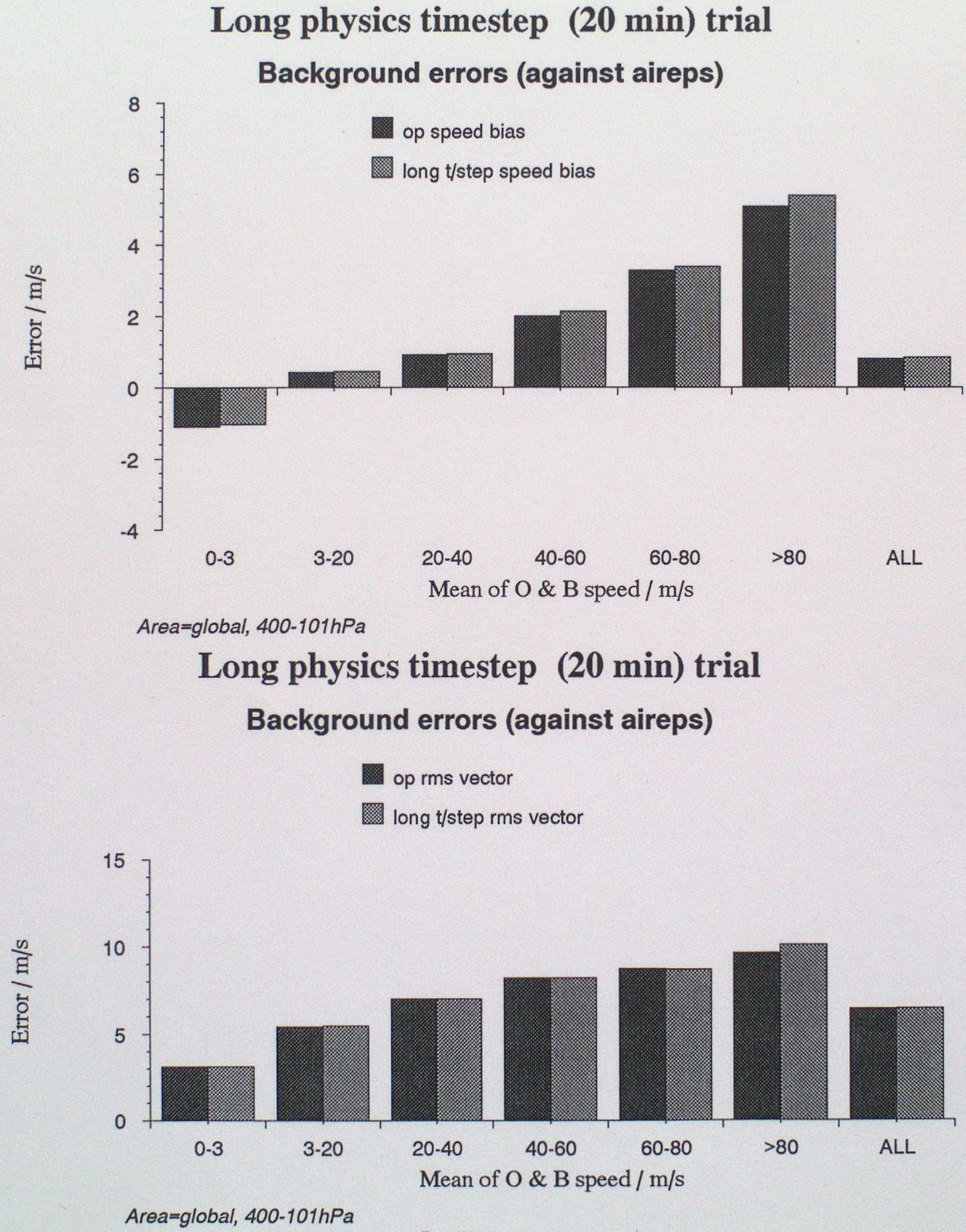
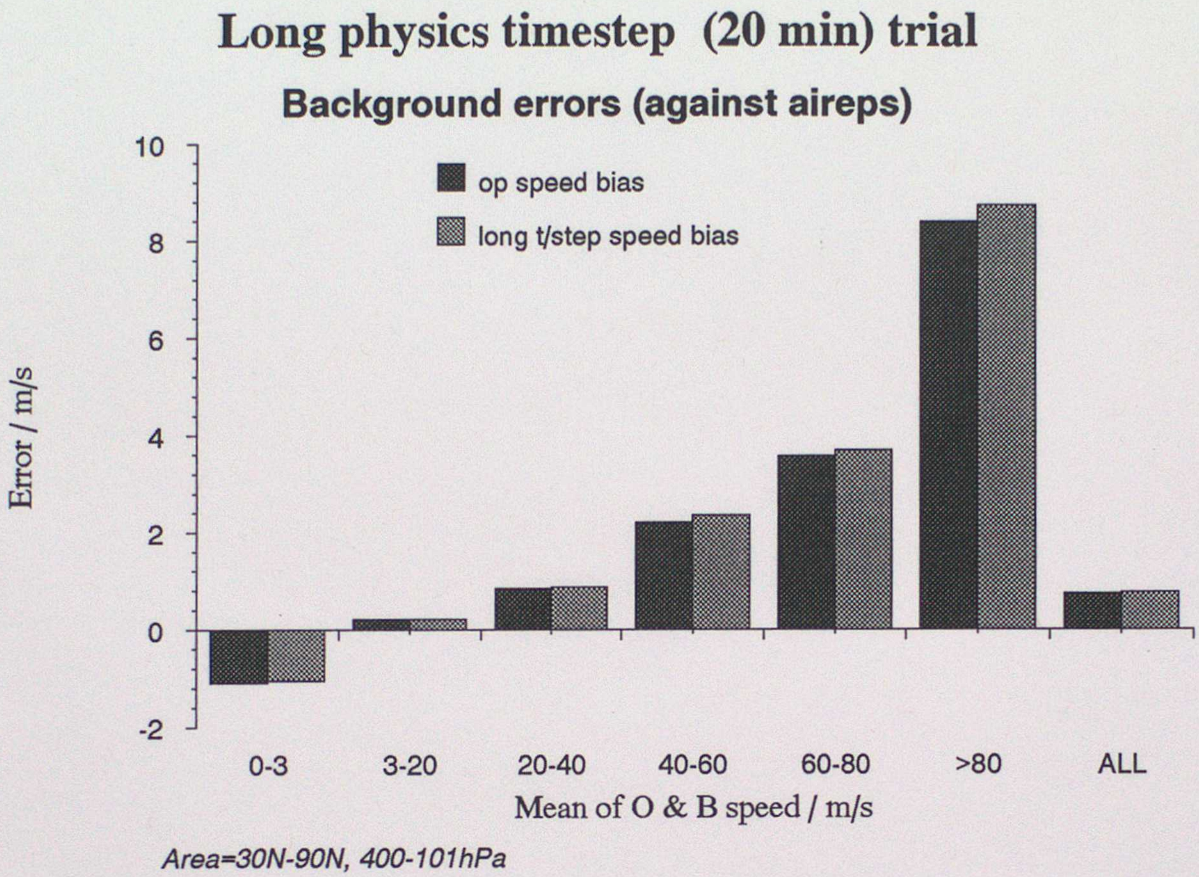
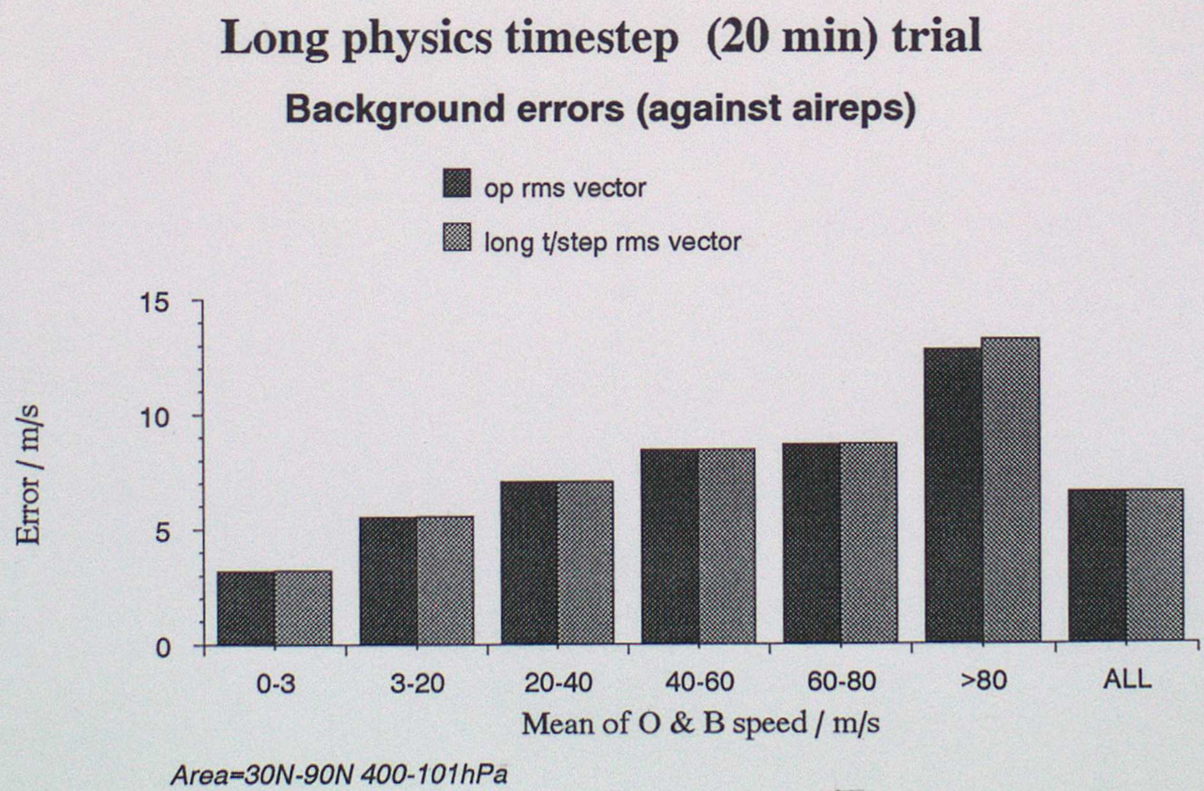

Long physics timestep (20 min) trial
Background errors (against aireps)
op speed bias
long t/step speed bias
Error / m/s
8
6
4
2
0
-2
-4
0-3
3-20
20-40
40-60
60-80
>80
ALL
Mean of O & B speed / m/s
Area=global, 400-101hPa
Long physics timestep (20 min) trial
Background errors (against aireps)
op rms vector
long t/step rms vector
Error / m/s
15
10
5
0
0-3
3-20
20-40
40-60
60-80
>80
ALL
Mean of O & B speed / m/s
Area=global, 400-101hPa

FIGURE 2.11

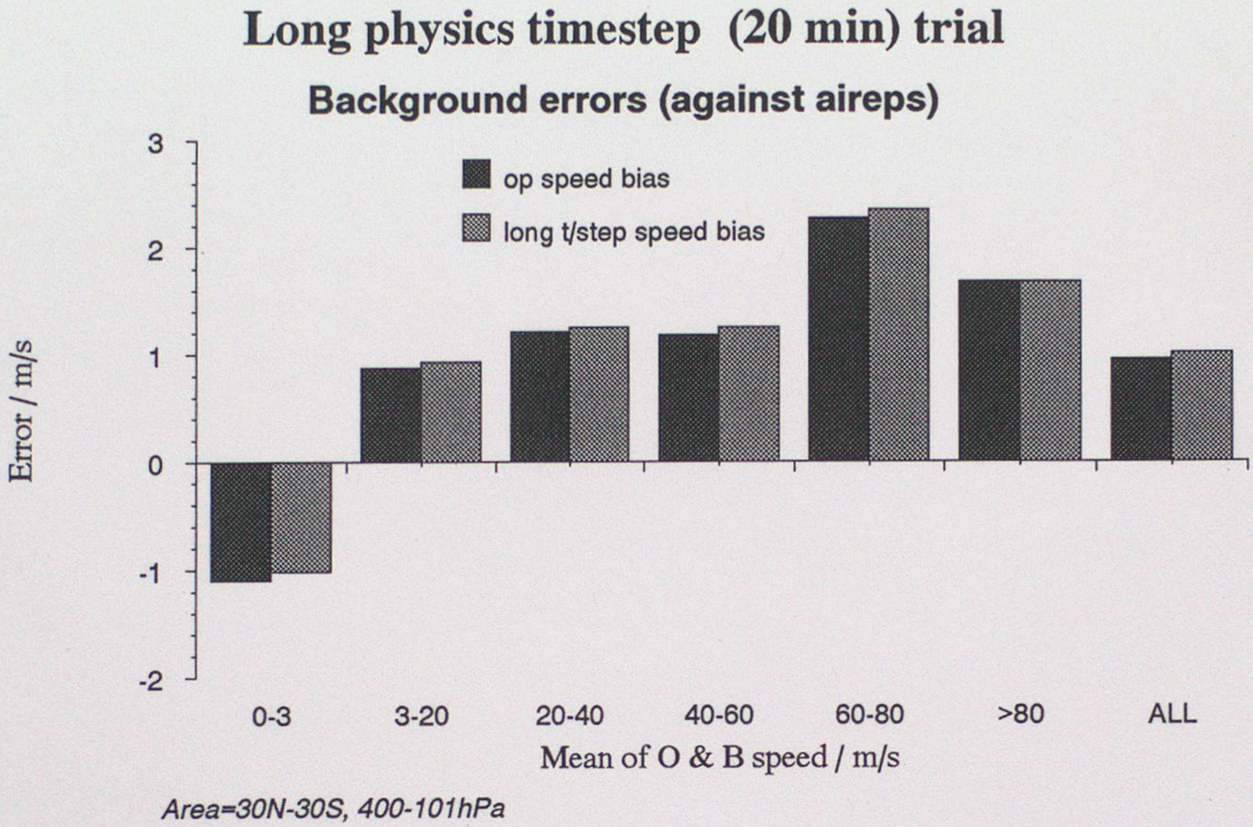


Long physics timestep (20 min) trial
Background errors (against aireps)
op speed bias
long t/step speed bias
Error / m/s
10
8
6
4
2
0
-2
0-3
3-20
20-40
40-60
60-80
>80
ALL
Mean of O & B speed / m/s
Area=30N-90N, 400-101hPa



Long physics timestep (20 min) trial
Background errors (against aireps)
op rms vector
long t/step rms vector
Error / m/s
15
10
5
0
0-3
3-20
20-40
40-60
60-80
>80
ALL
Mean of O & B speed / m/s
Area=30N-90N 400-101hPa

FIGURE 2.12


Long physics timestep (20 min) trial
Background errors (against aireps)
op speed bias
long t/step speed bias
Error / m/s
3
2
1
0
-1
-2
0-3
3-20
20-40
40-60
60-80
>80
ALL
Mean of O & B speed / m/s
Area=30N-30S, 400-101hPa

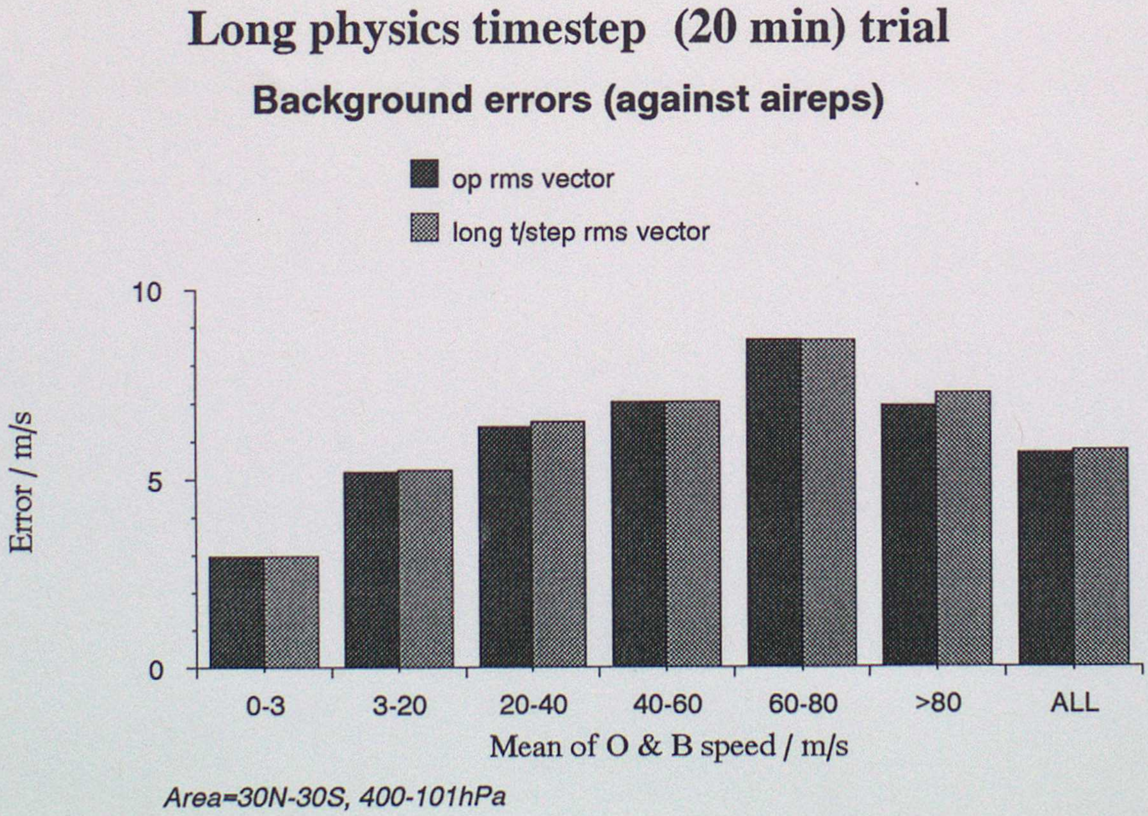
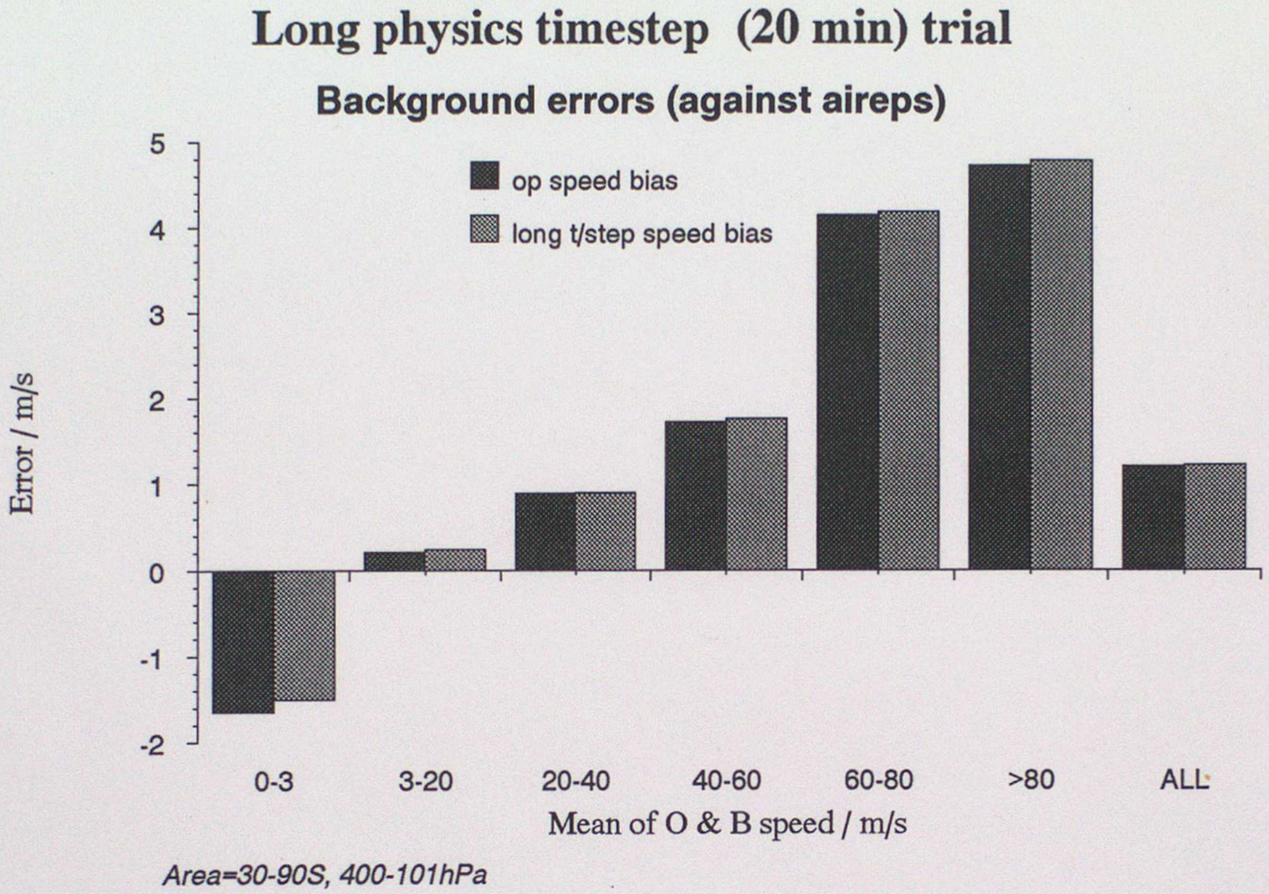

Long physics timestep (20 min) trial
Background errors (against aireps)
op rms vector
long t/step rms vector
Error / m/s
10
5
0
0-3
3-20
20-40
40-60
60-80
>80
ALL
Mean of O & B speed / m/s
Area=30N-30S, 400-101hPa

FIGURE 2.13


Long physics timestep (20 min) trial
Background errors (against aireps)
op speed bias
long t/step speed bias
Error / m/s
5
4
3
2
1
0
-1
-2
0-3
3-20
20-40
40-60
60-80
>80
ALL
Mean of O & B speed / m/s
Area=30-90S, 400-101hPa

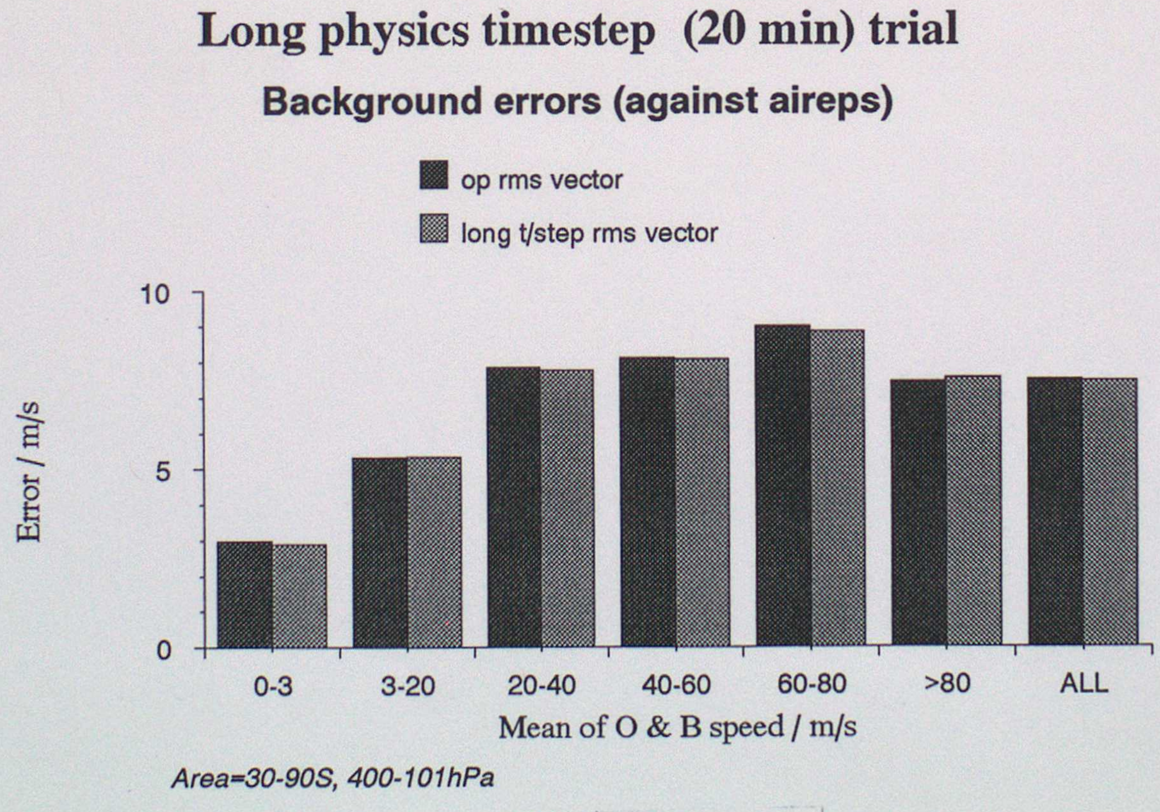

Long physics timestep (20 min) trial
Background errors (against aireps)
op rms vector
long t/step rms vector
Error / m/s
10
5
0
0-3
3-20
20-40
40-60
60-80
>80
ALL
Mean of O & B speed / m/s
Area=30-90S, 400-101hPa

FIGURE 2.14

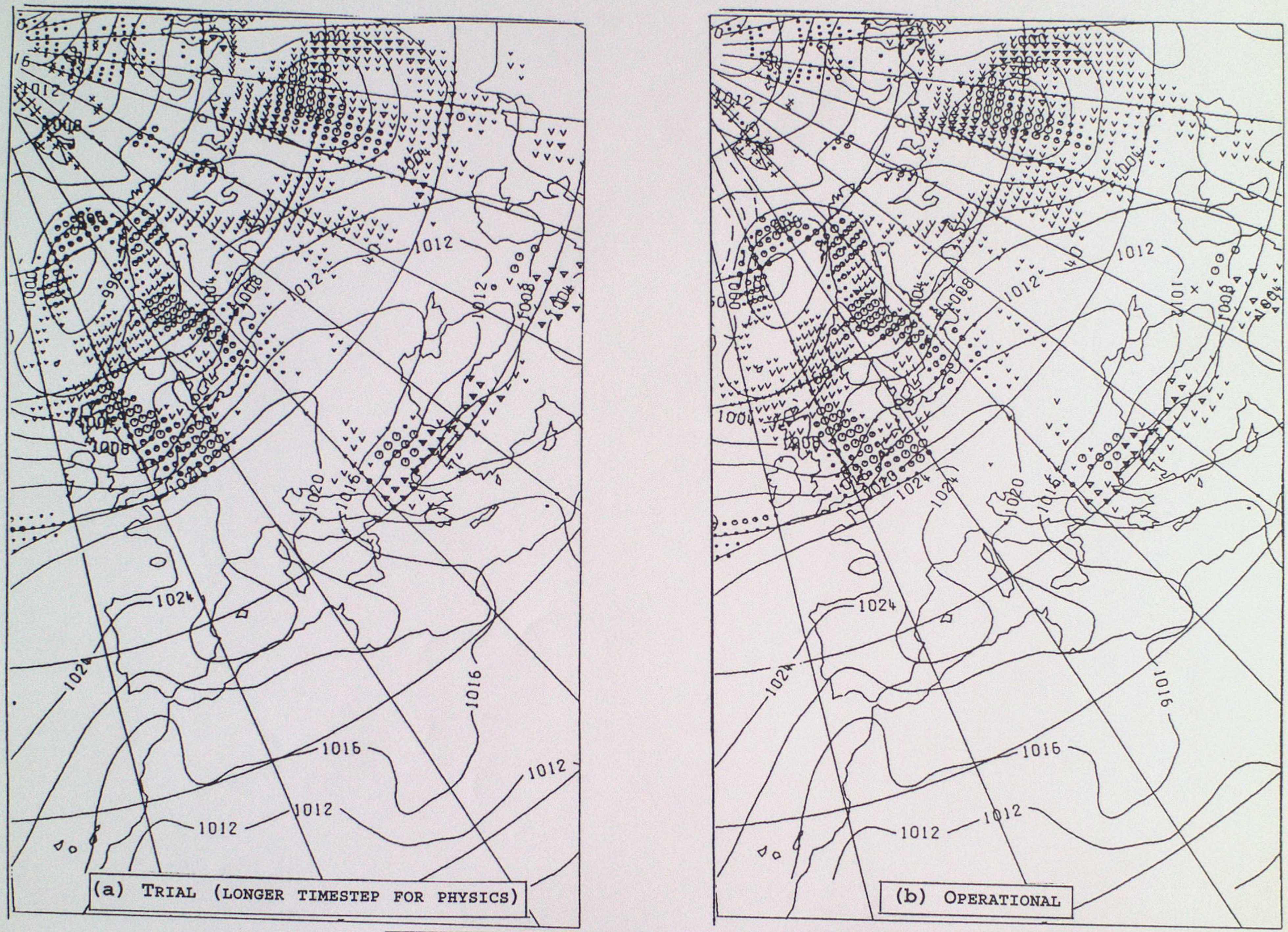
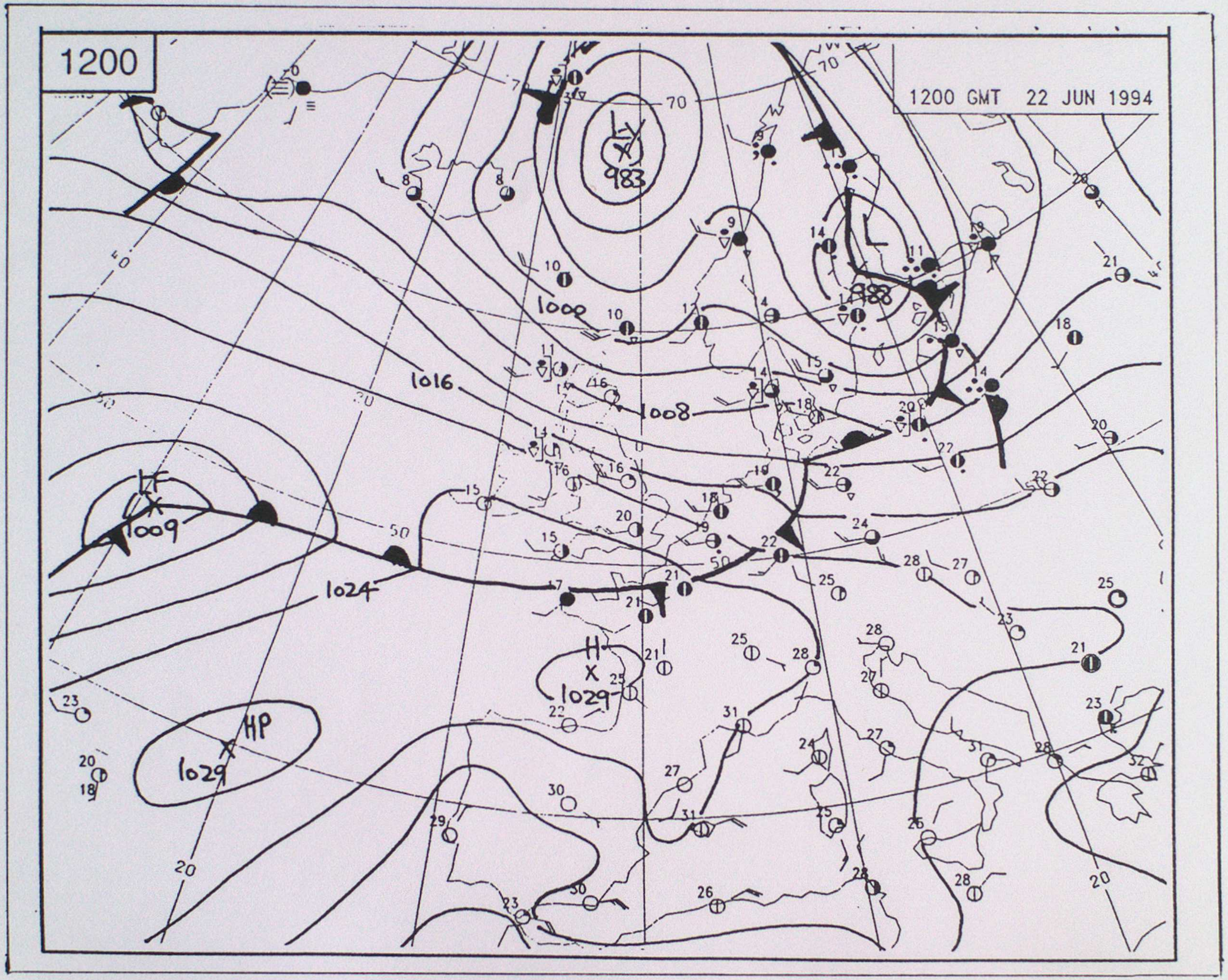


FIGURE 3.1 T+72 FORECASTS OF MEAN SEA LEVEL PRESSURE AND TOTAL PRECIPITION RATE
DT12Z 19/06/94 VT 12Z 22/06/94

FIGURE 3.2 ANALYSIS FOR 12Z 22/06/94



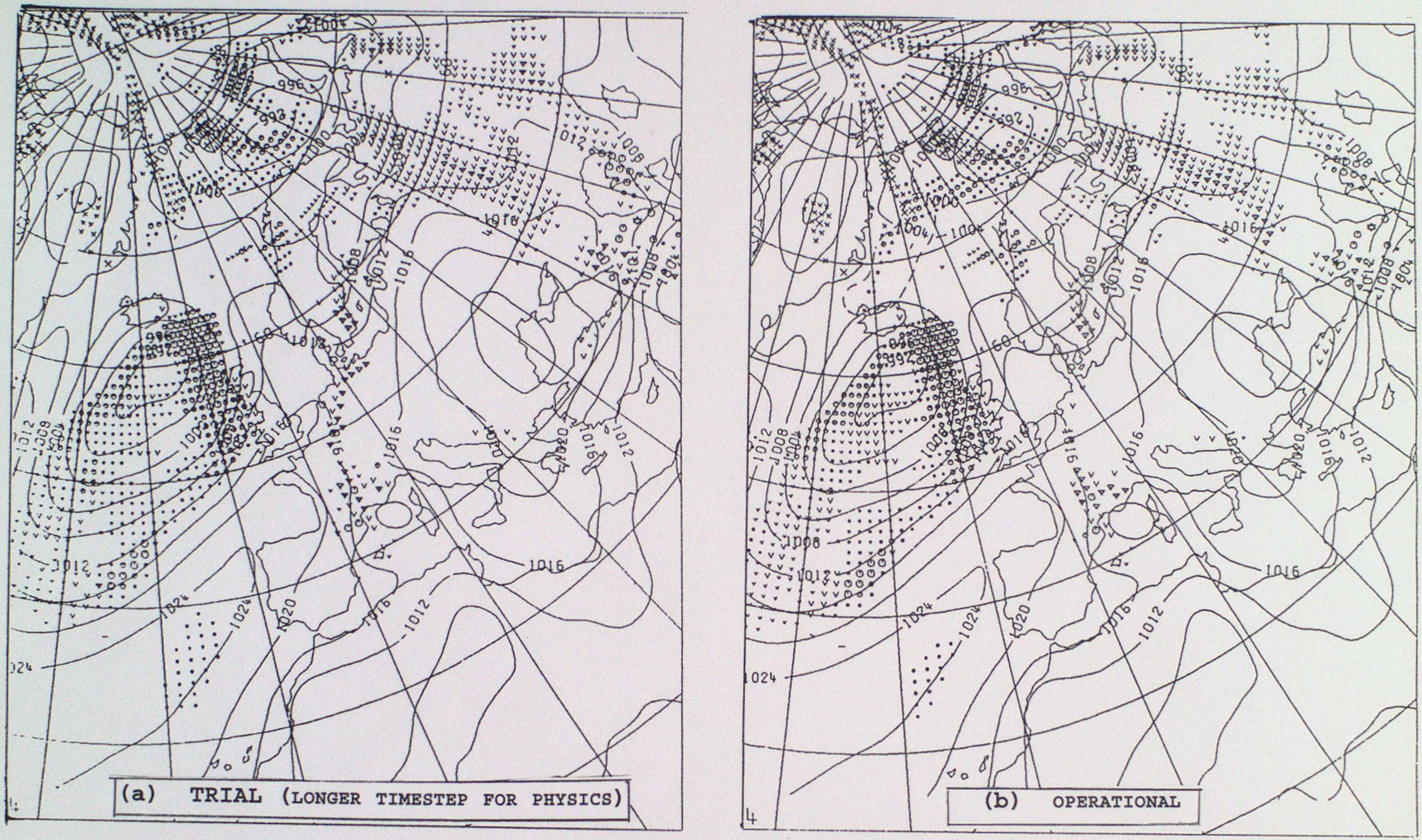


FIGURE 3.3 T+24 FORECAST OF MEAN SEA LEVEL PRESSURE AND TOTAL PRECIPITATION RATES
DT 12Z 25/06/94 VT 12Z 26/06/94

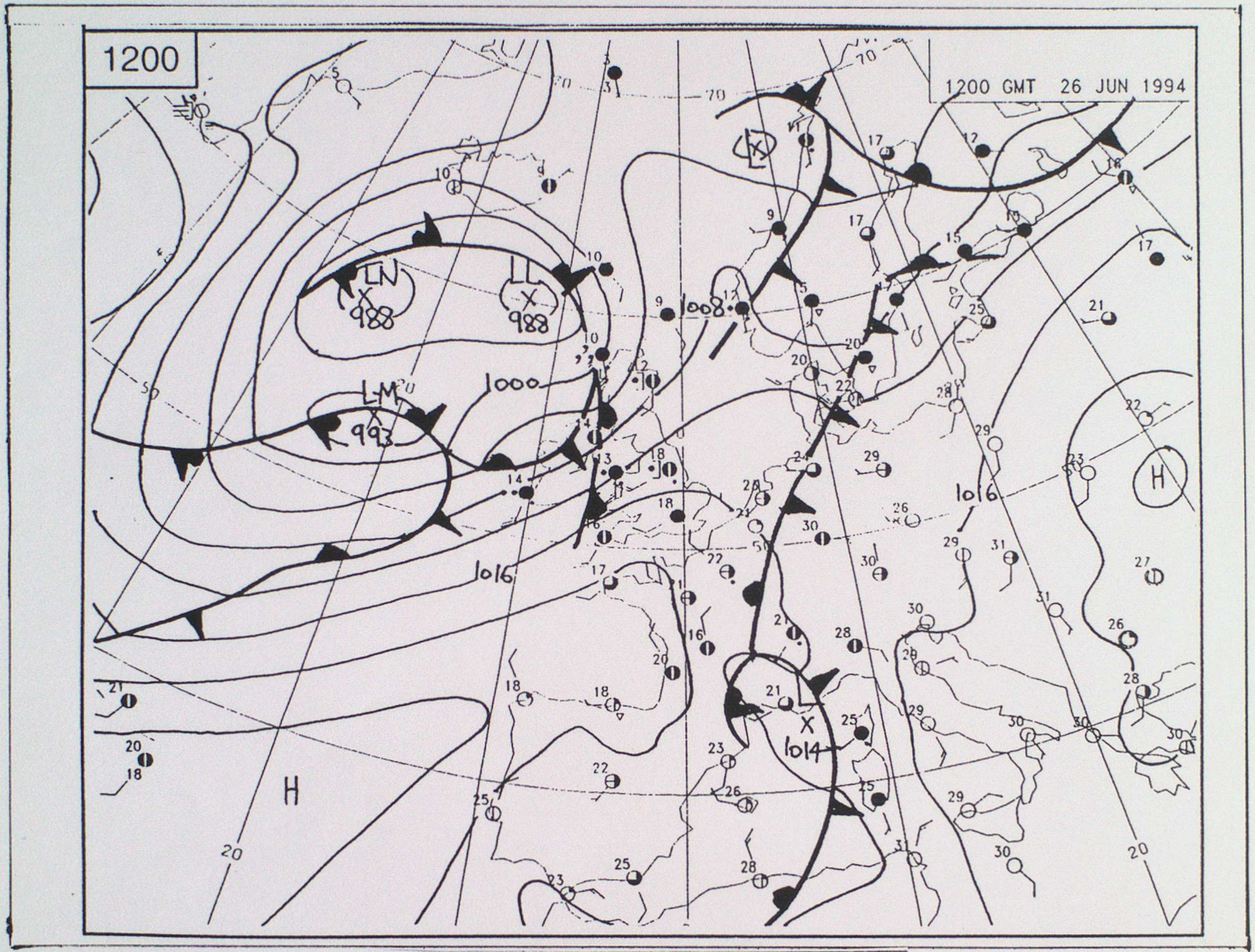
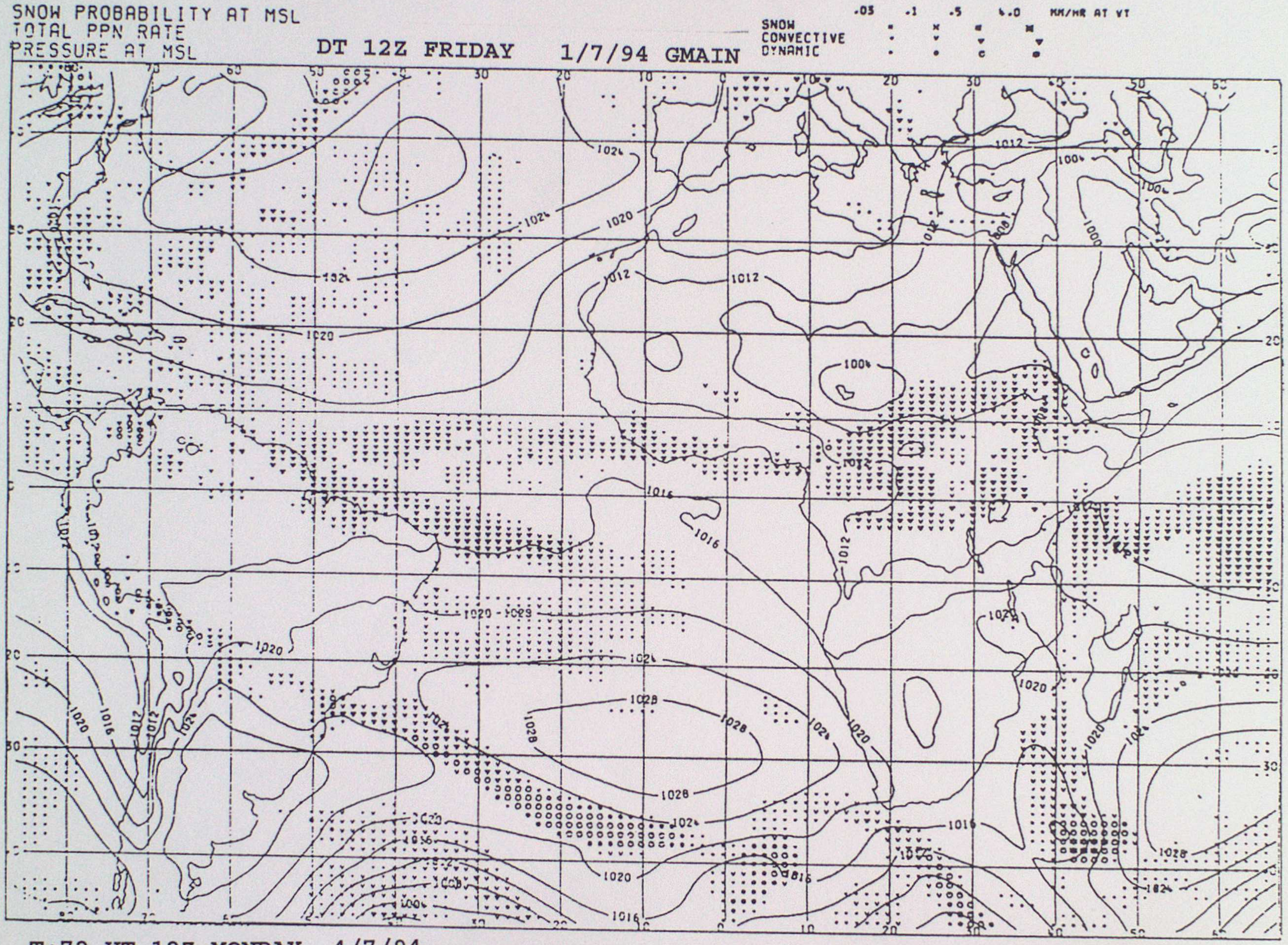


FIGURE 3.4 ANALYSIS FOR 12z 26/06/94

FIGURE 3.5 T+72 FORECAST OF MEAN SEA LEVEL PRESSURE AND TOTAL PRECIPITATION RATES
DT 12Z 1/07/94 VT 12Z 4/07/94
TRIAL (longer timestep for physics)

SNOW PROBABILITY AT MSL
TOTAL PPN RATE
PRESSURE AT MSL

DT 12Z FRIDAY 1/7/94 GMAIN



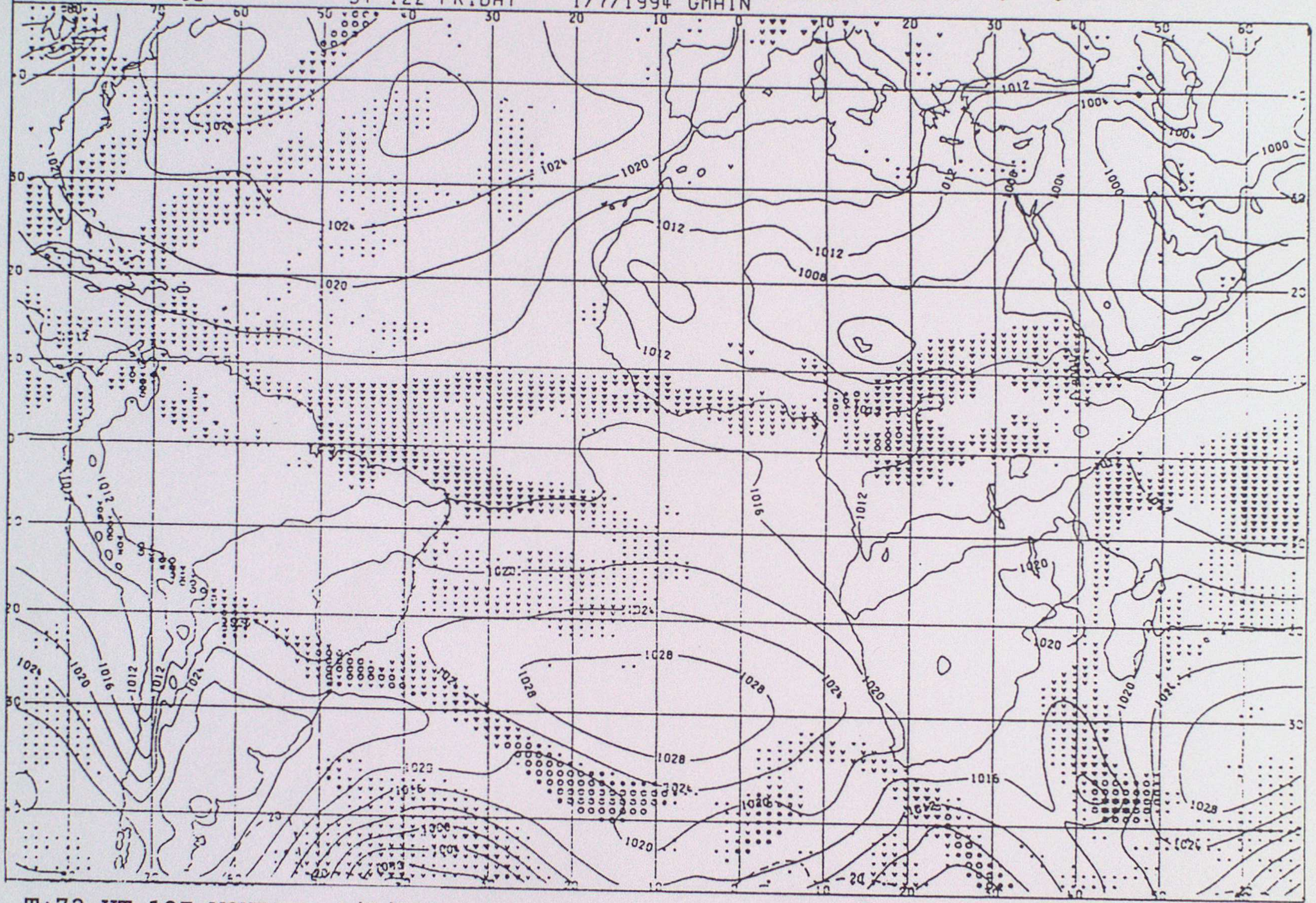
T+72 VT 12Z MONDAY 4/7/94

FIGURE 3.6 T+72 FORECAST OF MEAN SEA LEVEL PRESSURE AND TOTAL PRECIPITATION RATES
DT 12Z 1/07/94 VT 12Z 4/07/94
OPERATIONAL

SNOW PROBABILITY AT MSL
TOTAL PPN RATE
PRESSURE AT MSL

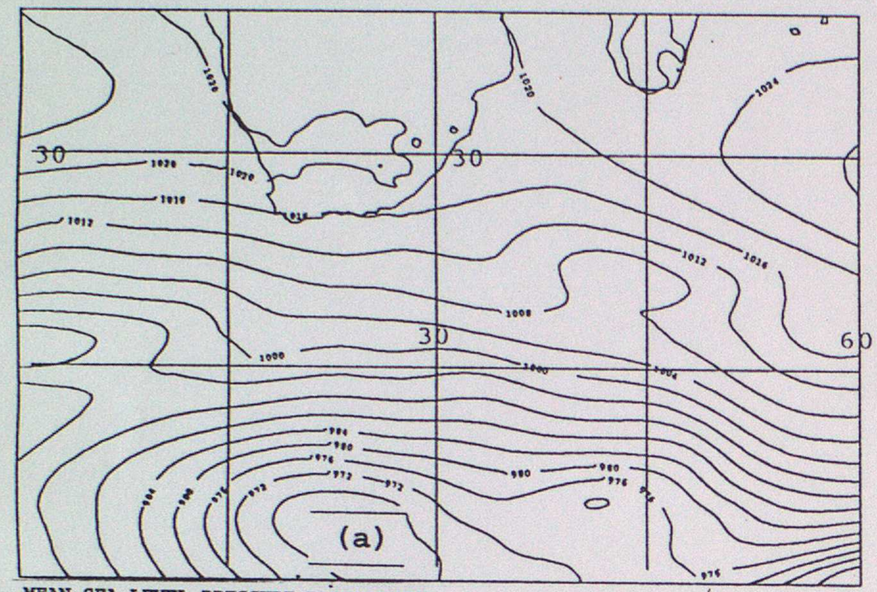
DT 12Z FRIDAY 1/7/1994 GMAIN

	.03	.1	.5	4.0	MM/HR AT VT
SNOW					
CONVECTIVE					
DYNAMIC					

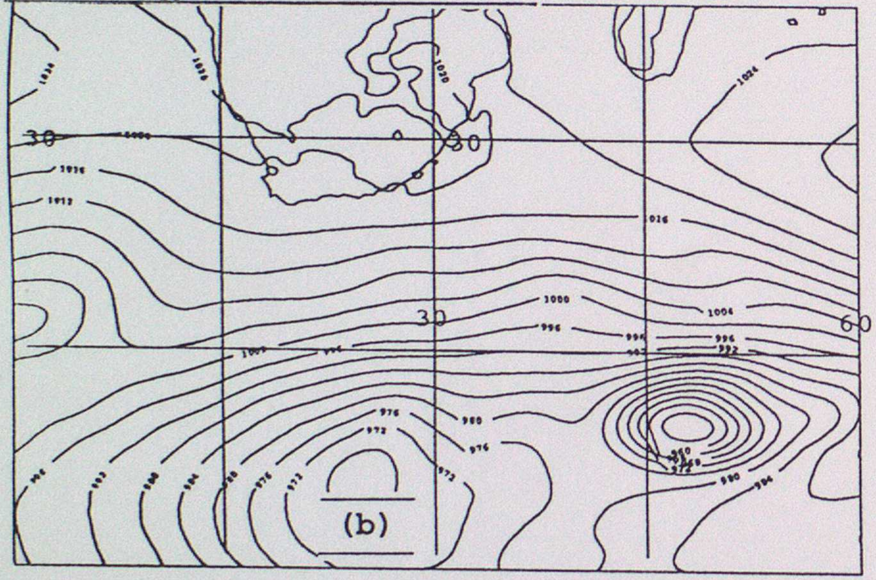


T+72 VT 12Z MONDAY 4/7/94

MEAN SEA LEVEL PRESSURE
OPERATIONAL
DT 12Z 20/06/94 VT 12Z 25/06/94
T+120 FORECAST



MEAN SEA LEVEL PRESSURE DIFFERENCES
TRIAL (LONG PHYSICS TIMESTEP) - OPERATIONAL
DT 12Z 20/06/94 VT 12Z 25/06/94
T+120 FORECAST



MEAN SEA LEVEL PRESSURE DIFFERENCES
TRIAL (LONG PHYSICS TIMESTEP)- OPERATIONAL
DT 12Z 20/06/94 VT 12Z 25/06/94
T+120 FORECAST

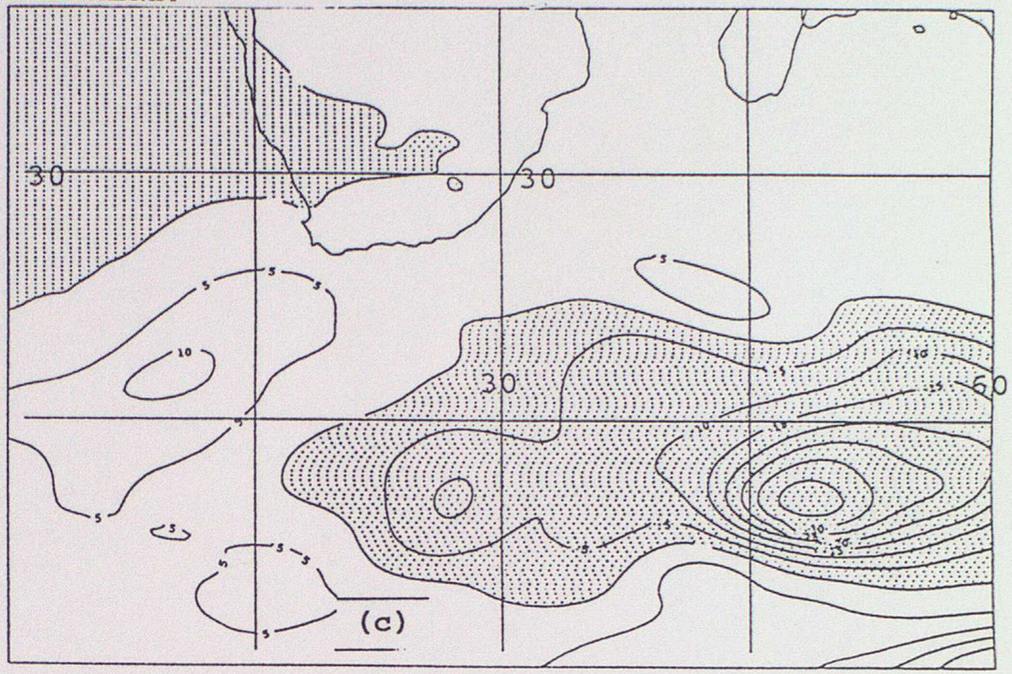
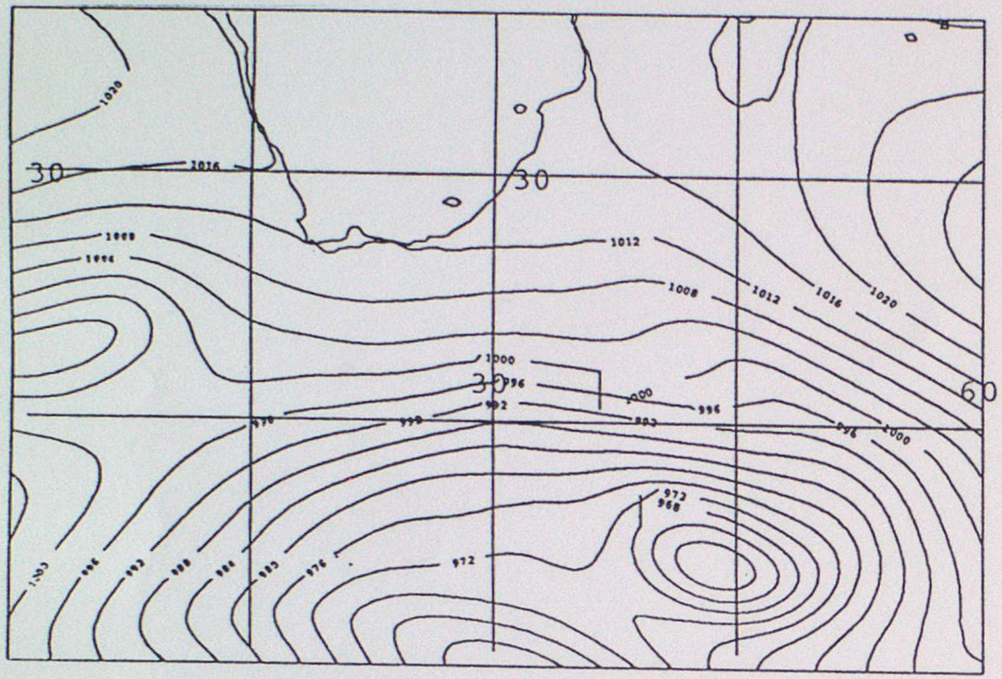


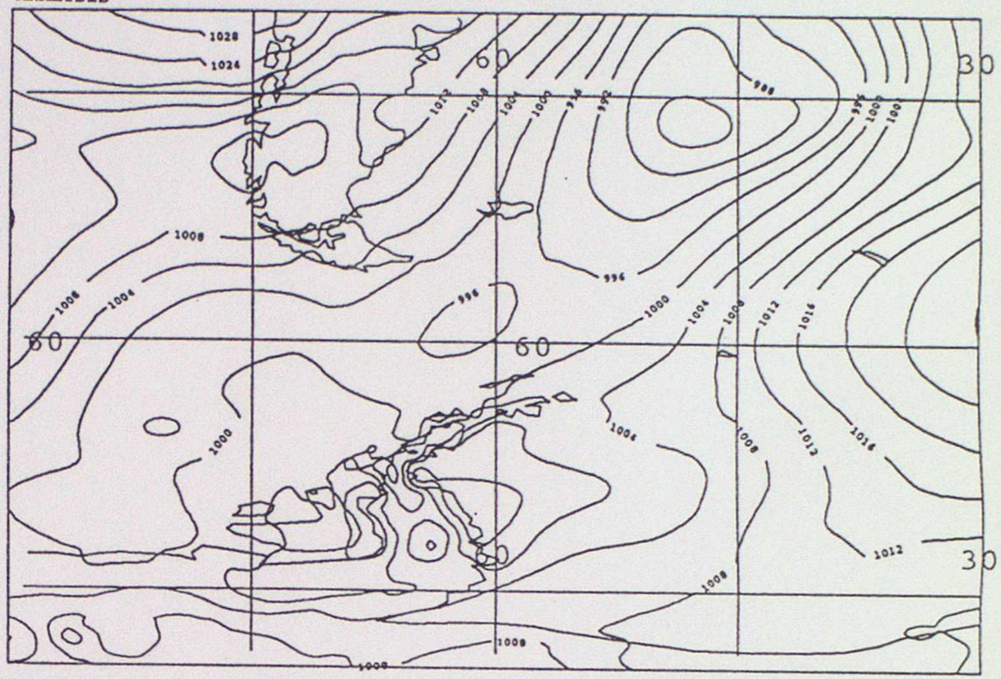
FIGURE 3.7
T+120 FORECAST DT 12Z 20/06/94 VT 12Z 25/06/94
(a) OPERATIONAL MEAN SEA LEVEL PRESSURE FORECAST
(b) TRIAL (LONGER TIMESTEP FOR PHYSICS)
MEAN SEA LEVEL PRESSURE FORECAST
(c) MEAN SEA LEVEL PRESSURE DIFFERENCES
(TRIAL - OPERATIONAL)

MEAN SEA LEVEL PRESSRE
OPERATIONAL
DT 12Z 25/06/94
ANALYSIS



(a)

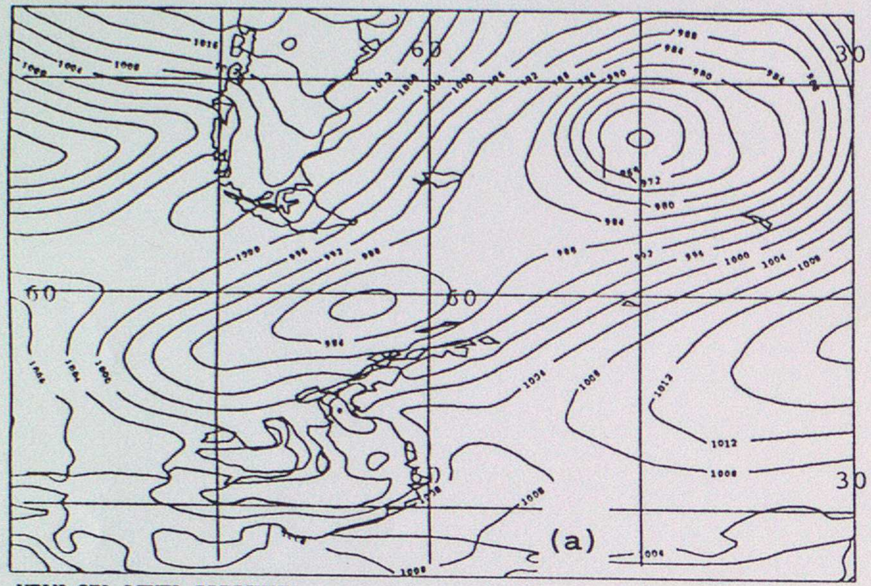
MEAN SEA LEVEL PRESSRE
OPERATIONAL
DT 12Z 25/06/94
ANALYSIS



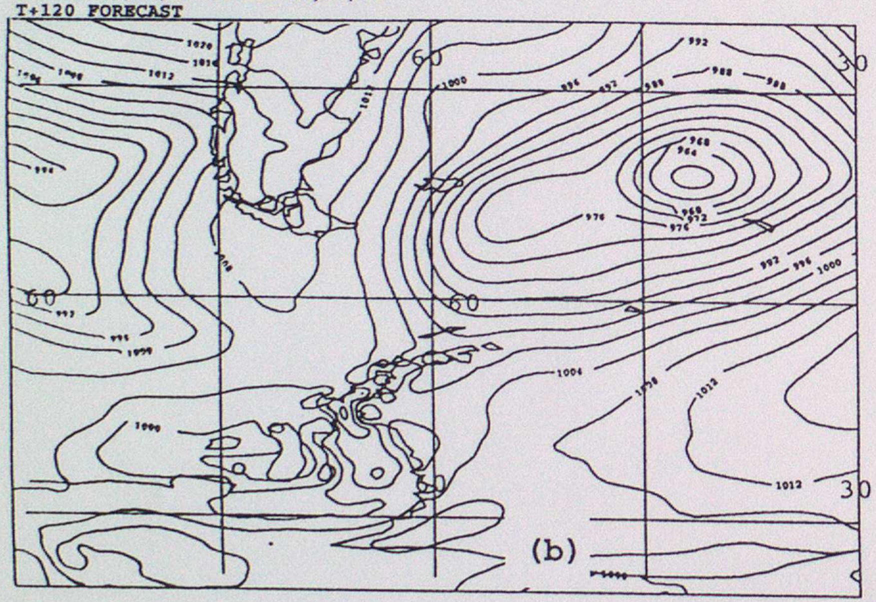
(b)

FIGURE 3.8
MEAN SEA LEVEL PRESSURE OPERATIONAL ANALYSIS
DT 12Z 25/06/94
(a) SOUTHERN HEMISPHERE - SOUTH AFRICA
(b) SOUTHERN HEMISPHERE - SOUTH AMERICA

MEAN SEA LEVEL PRESSRE
OPERATIONAL
DT 12Z 20/06/94 VT 12Z 25/06/94
T+120 FORECAST



MEAN SEA LEVEL PRESSURE
TRIAL (LONG PHYSICS TIMESTEP)
DT 12Z 20/06/94 VT 12Z 25/06/94
T+120 FORECAST



MEAN SEA LEVEL PRESSURE DIFFERENCES
TRIAL (LONG PHYSICS TIMESTEP)- OPERATIONAL
DT 12Z 20/06/94 VT 12Z 25/06/94
T+120 FORECAST

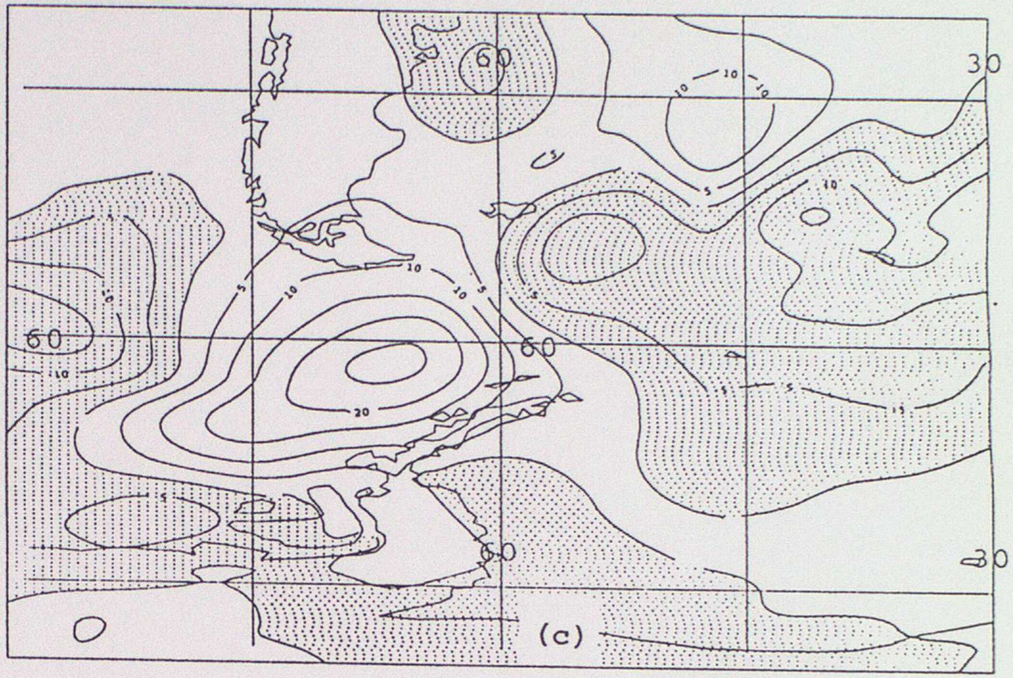
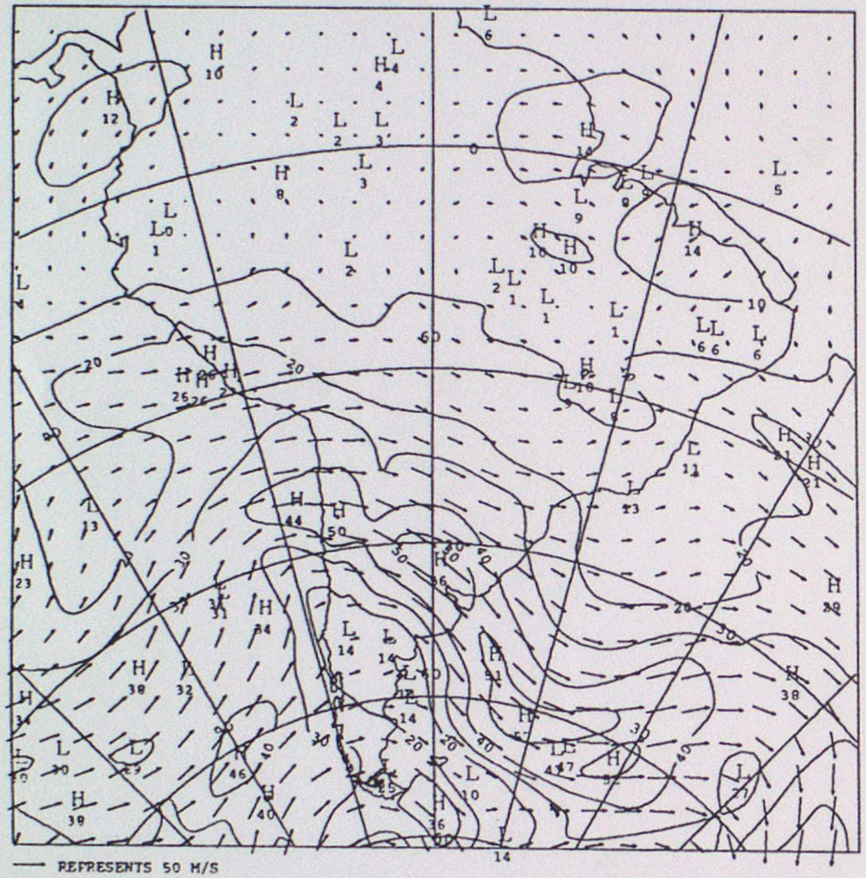


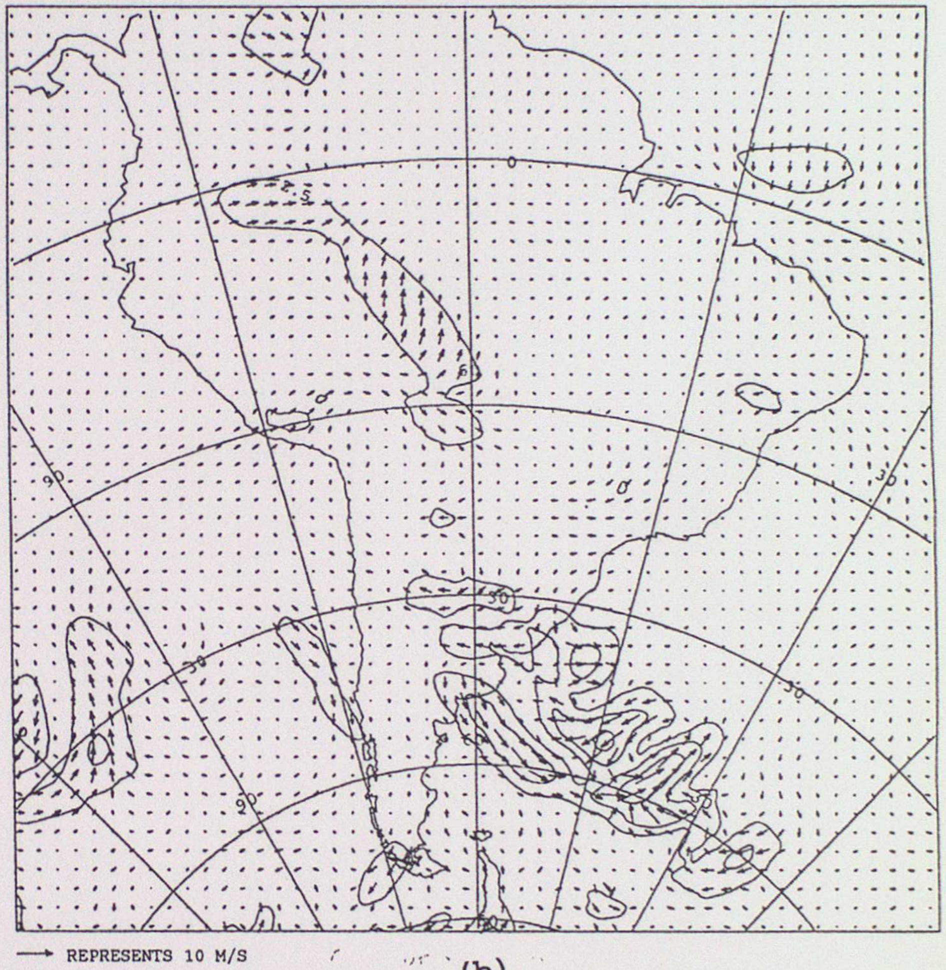
FIGURE 3.9
T+120 FORECAST DT 12Z 20/06/94 VT 12Z 25/06/94
(a) OPERATIONAL MEAN SEA LEVEL PRESSURE FORECAST
(b) TRIAL (LONGER TIMESTEP FOR PHYSICS)
MEAN SEA LEVEL PRESSURE FORECAST
(c) MEAN SEA LEVEL PRESSURE DIFFERENCES
(TRIAL - OPERATIONAL)

250hPa WIND SPEED AND DIRECTION
OPERATIONAL
DT 12Z 30/06/94
ANALYSIS



(a)

250hPa WIND DIFFERENCES
TRIAL (LONG PHYSICS TIMESTEP)- OPERATIONAL
DT 12Z 29/06/94 VT 12Z 30/06/94
T+24 FORECAST



(b)

FIGURE 3.10
(a) 250hPa WIND OPERATIONAL ANALYSIS DT12Z 30/06/94
(b) 250hPa WIND DIFFERENCES (TRIAL-OPERATIONAL)
T+24 FORECAST DT 12Z 29/06/94 VT 12Z 30/06/94

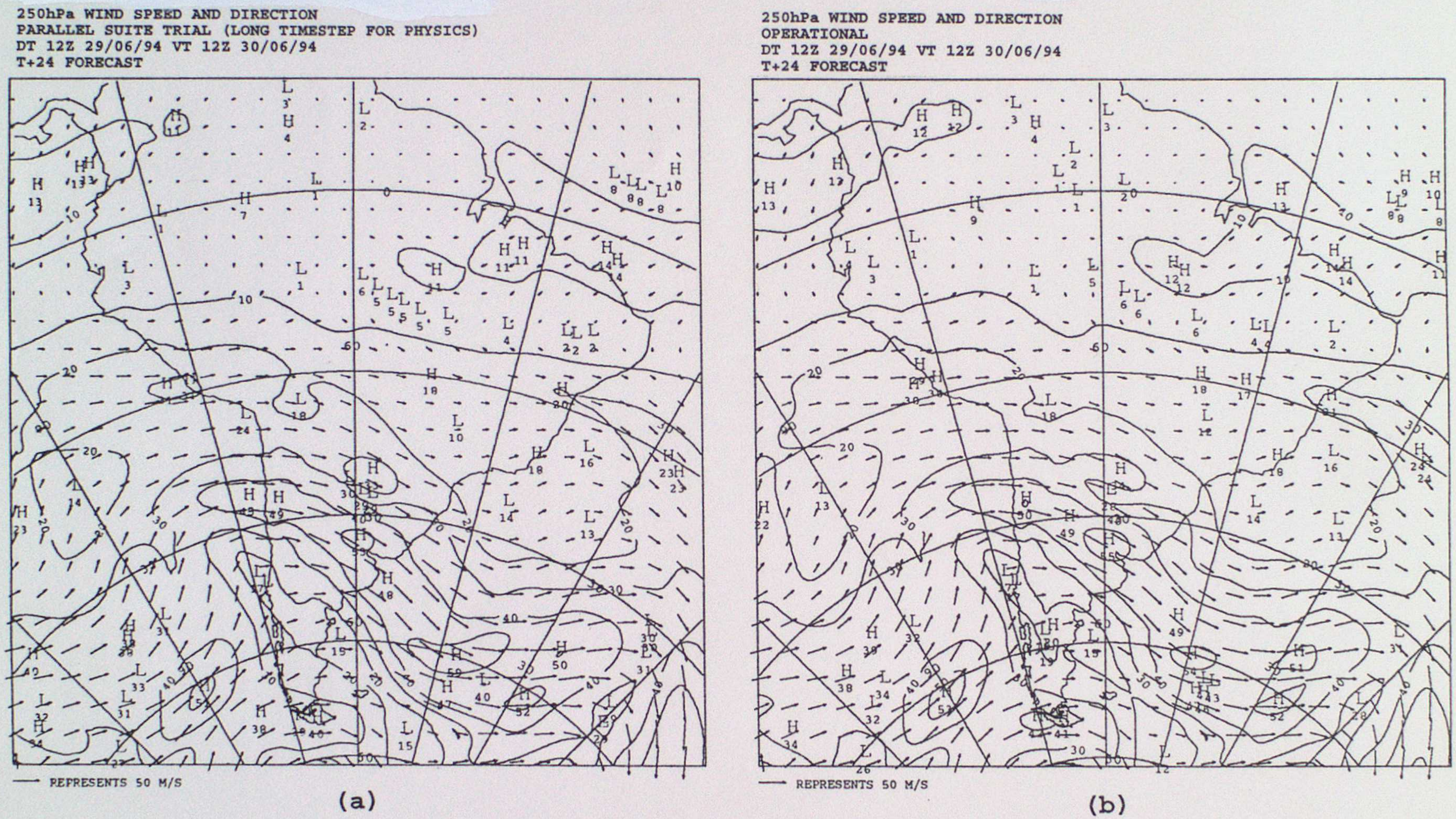


FIGURE 3.11
250hPa WIND T+24 FORECAST DT 12Z 29/06/94 VT 12Z 30/06/94
(a) TRIAL (LONGER TIMESTEP FOR PHYSICS)
(b) OPERATIONAL