TECHNICAL MEMORANDUM

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N48-15 level assimilation

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RESEARCH DEPARTMENT TECHNICAL MEMORANDUM

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N48-15 Level Assimilations

By R. Seaman

1. Introduction

This note summarises a repetition of the data assimilation experiments reported in Technical Report No. 12, using refined analysis and prediction models, at a higher resolution. Time has not permitted a detailed study of the results, and the conclusions expressed below should be regarded as tentative.

2. Major differences between components in the N48 and N24 experiments

(i) Analysis

Humidity was analysed, and was used in the prediction model physics.
The data selection scheme was refined.
Guess fields of geopotential at 30,20 and 10 mb were weighted towards climatology, and the corresponding wind guesses were obtained geostrophically.

(ii) Forecast

The prediction model used for producing guess fields, including the physical parameterizations described in ECMWF Technical Report No. 10.

(iii) Grid transformations

For vertical interpolations between pressure and sigma surfaces, cubic spline interpolation was always used, and pressure surfaces below the topography were used in the pressure to sigma interpolations.

3. Observational data and experimental method

The data base was the same as that used in the N24 CONTROL experiment, namely the DST observational data for February 1976, with the difference that constant level balloon observations were included in the N48 but not in the N24.

The experimental method was identical to that employed in the N24. Starting from a climatological guess at 00 GMT, 4 February 1976, six-hour analysis-forecast cycles were performed up to 00 GMT, 10 February.

4. Results

Charts at six-hourly intervals are contained in folders together with the corresponding N24 analyses.
Post-processing files are archived on magnetic tape.
Outlet listings of the analysis (AV), initialisation (IV), forecast (FJ), and events (EV) runs, for each cycle, have been kept.
Plots from K. Arpe's diagnostic program have been kept. On the abscissae, day 0 corresponds to 12 GMT 4 February (not 00 GMT).
Listings of global and latitude band means of geopotential, at 12 hour intervals, have been kept.

5. Discussion

It is emphasised that the following remarks are based upon a very hurried first look.

The N48 analyses, and corresponding diagnostics, up to 00 GMT 5 February are suspect, because up to this time there was an error in the analysis program which resulted in an incorrect correlation of observational errors under some conditions.

In general, the N48 analyses agreed closely with the N24, and the differences were much as expected with higher resolution, namely (i) more detail, much of which appeared synoptically realistic, and (ii) more concentrated jetstreams and slightly stronger winds.

New problems in the N48, which were not present, or not so severe in the N24, were (i) box boundary discontinuities (especially when the guess field was poor), (ii) development of small scale noise in guess fields of geopotential, and (iii) pressure reduction below high topography which progressively lowered the 1000 mb geopotential in these areas. However, this last effect did not spread outwards from the affected areas.

Apart from areas with high topography, the guess field biases in the N48 were less than in the N24. In particular, global mean surface pressures and 1000 mb geopotentials did not decrease with time, as they did in the N24 (Table 1, Table 3a). However, small but systematic biases (order of 5 m) did exist in geopotential guess fields at most levels (Table 2b). These were partially corrected by observations during the analysis , but were somehow reintroduced (by interpolation, initialisation, or prediction) into the subsequent guess field.

The geopotential fields were changed during initialisation in such a way that global means, and large area means, were usually adjusted back towards the first guess means. It is not known whether this was the case in the N24.

The analyses at levels above 100 mb appeared to be unrealistically cellular, especially in the tropics and subtropics. This may have been due to the use of covariances inappropriate to the guess fields, which were weighted towards climatology at the highest levels. However, the stratospheric deficiencies did not appear to contaminate the lower levels.

The evolution with time, of the global integrals (over all levels) of PE and KE, was similar to the N24,namely an increase during the first three days, then a levelling out (Table 1).

The N48 analyses had 10 to 15 percent higher eddy KE than the N24, but the zonal KE was about the same in both runs (Fig. 2b).

The AE (both zonal and eddy) was about 4 percent lower in the N48 than in the N24 (Fig.2a).

The N48 analyses had slightly more KE than either the corresponding first guesses, or the initialised fields. The analyses and the initialised fields had about the same AE, and both had slightly more AE than did the first guesses. In both the KE and AE comparisons, the margin was comparatively widest in the high wave numbers.

A c k n o w l e d g e m e n t s

I gratefully acknowledge the willing cooperation of my colleagues in the Data Assimmlation Section, and especially thank C. Little for his efforts during the final days of my visit, to obtain vital diagnostic results.

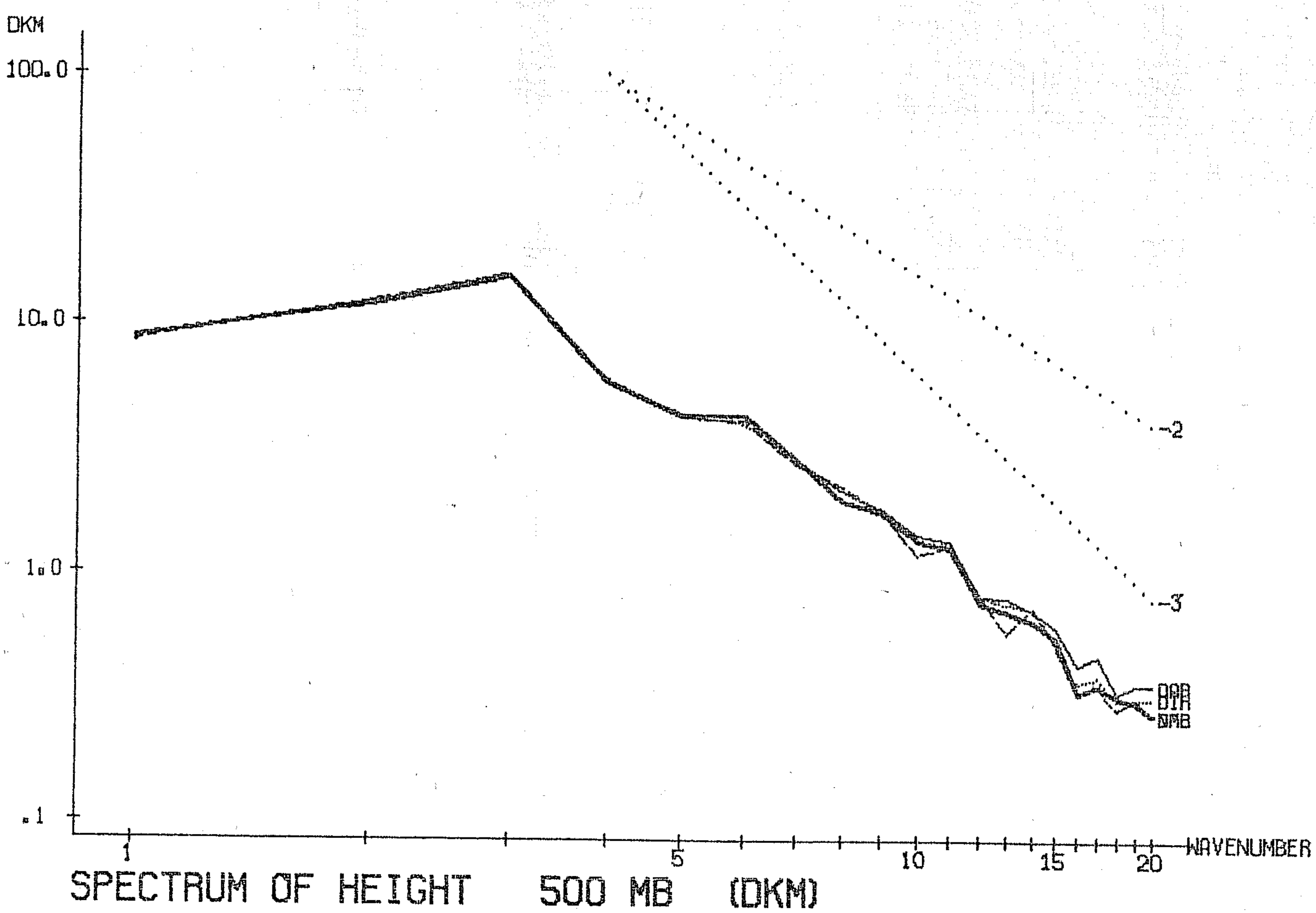

Figure 1: Spectrum of 500 mb geopotential height, between 40 and 60 degrees North, for the period from 12Z, 7 Feb. to 00Z, 10 Feb.

(Compare with Fig. 16, Technical Report No.12).

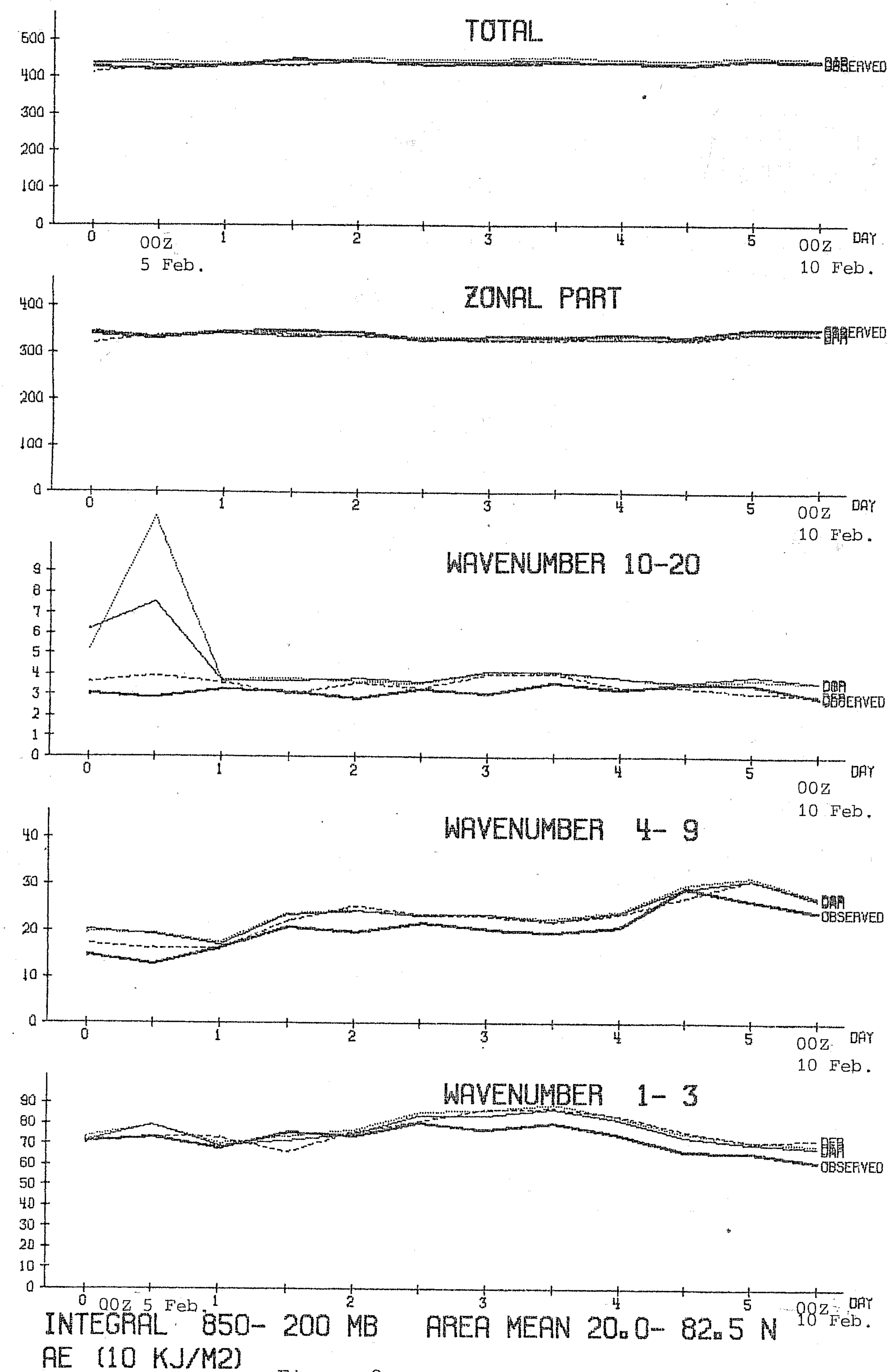

Figure 2a (refer to separate sheet for legend)

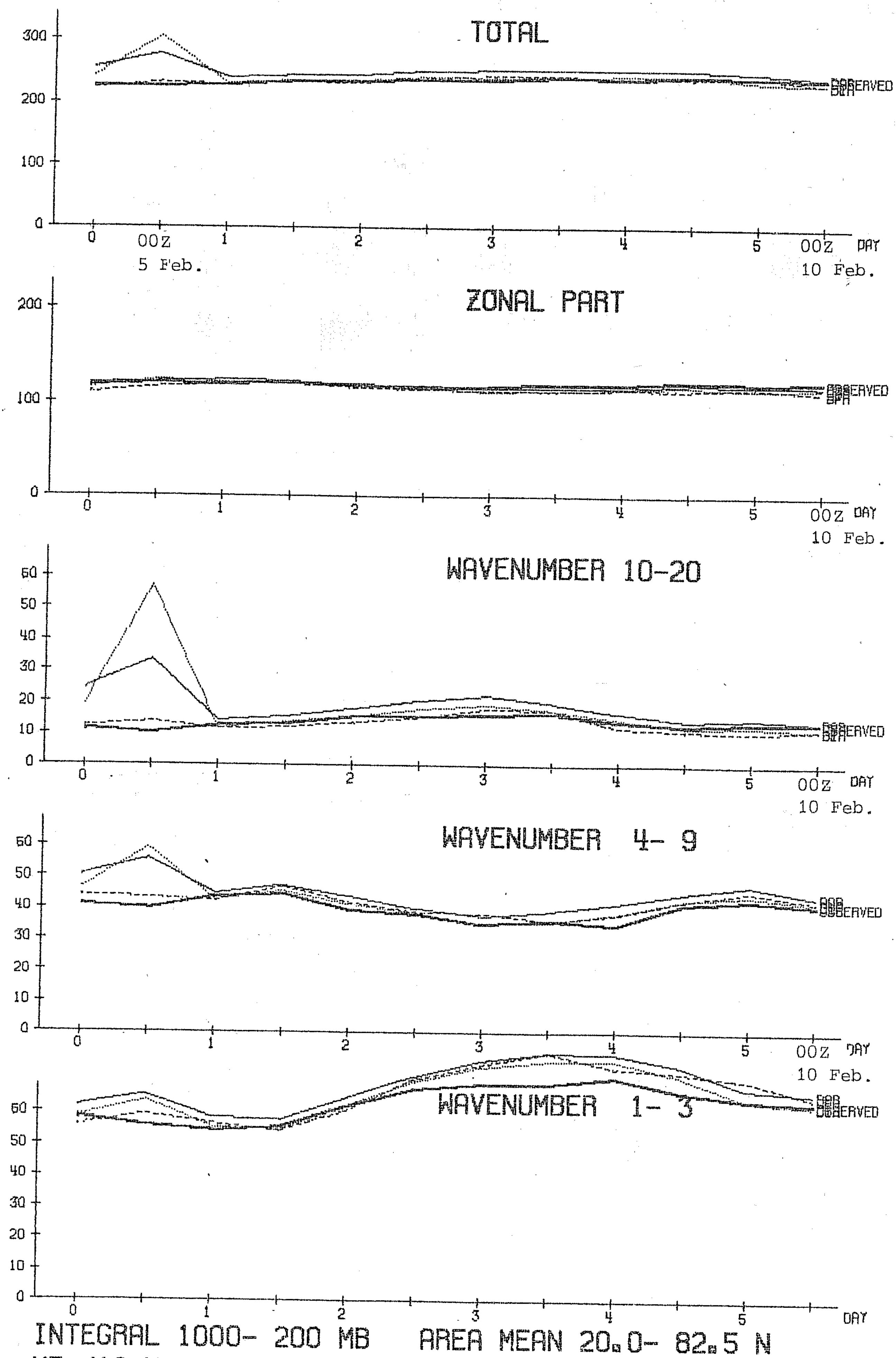

Figure 2b (refer to separate sheet for legend)

Figure Legends :

Figure 2a : Time variation, in spectral bands, of the available potential energy. The energy was computed between 850 mb and 200 mb, from 20 to 85 degrees North. (Compare with Fig. 21a, Technical Report No. 12. The CONTROL (thick line) is the N24 analysis to be compared witg DAR (thin line) N48 analysis).

Note : Day 0 is 12Z 4 Feb., whereas Technical Report No. 12 Day 4 is 00Z 4 February.

Figure 2b : As for Fig. 2a, but kinetic energy, computed from the geostrophic wind. (Compare with Fig. 21b, Technical Report No.12. The CONTROL (thick line) is the N24 analysis to be compared with DAR (thin line) N48 analysis.

Note : Day 0 is 12Z, 4 February, whereas in Technical Report No. 12, Day 4 is 00Z 4 February.

KEY

NMC	NMC analysis	DIR	ECMWF analysis after initialisation
DAR	ECMWF analysis	DFR	ECMWF 6 hour forecast.

ENERGY AND GLOBAL $\overline{P_S}$ (Pascals)

TIME & DATE	BEFORE INITIALISATION PE	KE	PS	AFTER INITIALISATION PE	KE	PS
00Z 4.2.76	250836	153	98496	250829	152	98497
06Z	250813	152	98506	250809	153	98505
12Z	250733	162	98532	250731	161	98531
18Z	250732	161	98535	250730	160	98534
00Z 5.2.76	250697	167	98542	250696	166	98541
06Z	250744	162	98543	250746	161	98543
12Z	250742	164	98558	250743	164	98558
18Z	250793	164	98560	250794	163	98560
00Z 6.2.76	250782	167	98561	250781	166	98561
06Z	250837	165	98561	250838	165	98561
12Z	unavailable			unavailable		
18Z	unavailable			unavailable		
00Z 7.2.76	250915	173	98598	250913	174	98598
06Z	250952	174	98596	250952	174	98596
12Z	250939	175	98603	250937	175	98602
18Z	250954	176	98591	250957	176	98591
00Z 8.2.76	250964	177	98597	250960	177	98596
06Z	251016	172	98591	251018	172	98591
12Z	251055	175	98607	251052	175	98606
18Z	251088	174	98601	251087	174	98600
00Z 9.2.76	251008	178	98602	251005	178	98601
06Z	251056	176	98595	251058	175	98595
12Z	251061	171	98609	251055	171	98608
18Z	251043	169	98601	251043	169	98601
00Z 10.2.76	251074	174	98616	251071	171	98615

Table 1 : Global potential energy, global kinetic energy and global mean surface pressure of analysis, before and after initialisation.

Geopotential Global MS difference from observations (m^2)

TIME & DATE	Mean square (observation - first guess) 1000 mb	500 mb	200 mb	Mean square (observation - analysis) 1000 mb	500 mb	200 mb
00Z 4.2.76	5137	10840	22780	1166	964	1634
12Z	unavailable			unavailable		
00Z 5.2.76	1410	1581	8051	1106	1341	7031
12Z	1769	1119	14100	1499	757	12350
00Z 6.2.76	1832	2562	4206	1489	2214	2965
12Z	unavailable			unavailable		
00Z 7.2.76	1067	2076	2399	812	1730	1304
12Z	1729	899	4944	1497	443	4235
00Z 8.2.76	1785	660	3642	1447	234	3034
12Z	1943	144	3588	1645	993	2186
00Z 9.2.76	1481	1131	6900	1171	593	6386
12Z	2083	870	5027	1761	365	3790
00Z 10.2.76	1729	1659	2482	1481	1372	1230

Table 2a : Global Mean Square difference of geopotential height (in m^2) between all observations and first guess and between all observations and the analysis. Rejected observations are included.

Geopotential Global Mean difference from observations (m)

TIME & DATE	Mean (observation - first guess) 1000 mb	500 mb	200 mb	Mean (observation - analysis) 1000 mb	500 mb	200 mb
00Z 4.2.76	-6.4	-40.4	-95.5	-1.0	-3.4	-3.6
12Z	unavailable			unavailable		
00Z 5.2.76	2.6	-5.4	- 8.5	-0.7	-2.4	-2.4
12Z	3.5	-0.6	-11.5	-1.2	-0.1	-9.1
00Z 6.2.76	5.5	-4.9	- 6.1	-0.7	-1.7	-1.1
12Z	unavailable			unavailable		
00Z 7.2.76	5.4	-5.2	-9.4	-1.4	-2.2	-2.8
12Z	3.7	-4.0	-9.8	-0.5	-1.0	-3.6
00Z 8.2.76	5.2	-0.9	-5.8	-1.0	-0.1	-0.9
12Z	4.3	2.9	-12.8	-1.7	1.6	-5.6
00Z 9.2.76	5.1	-6.2	-16.4	-0.5	-2.2	-8.0
12Z	5.7	1.7	-7.5	-1.5	-0.3	-3.0
00Z 10.2.76	6.4	-3.6	-7.5	-0.9	-2.8	-3.3

Table 2b: Global mean differences of geopotential height (m) between all observations and the first guess and between all observations and the analysis. Rejected observations are included.

Global $\overline{Z}$ (m)

	1000 mb			500 mb			200 mb		
TIME & DATE	F	A	I	F	A	I	F	A	I
00Z 4.2.76	-	85	83	-	5625	5625	-	11947	11949
12Z	86	87	87	5629	5628	5628	11956	11953	11955
00Z 5.2.76	88	88	87	5629	5628	5629	11958	11956	11958
12Z	88	89	88	5632	5630	5631	11962	11958	11960
00Z 6.2.76	89	89	88	5634	5631	5632	11967	11961	11963
12Z	89	90	89	5635	5632	5634	11969	11963	11965
00Z 7.2.76	91	92	91	5637	5634	5636	11973	11967	11970
12Z	92	92	91	5638	5636	5638	11976	11969	11972
00Z 8.2.76	91	91	90	5639	5635	5637	11978	11972	11974
12Z	91	92	91	5640	5638	5640	11982	11976	11978
00Z 9.2.76	92	92	91	5642	5636	5638	11985	11975	11978
12Z	92	92	91	5640	5638	5640	11983	11976	11978
00Z 10.2.76	93	93	92	5641	5637	5639	11983	11978	11980

Table 3a) : Global mean geopotential height for 1000, 500 and 200 mb for analysis (A), analysis after initialisation (I) and 6 hour forecast (F).

The means are weighted to take into account the differing area of earth's surface represented by each grid point.

TROPICS $\overline{Z}$ (m) 22.5°S - 22.5°N

	1000 mb			500 mb		200 mb			
TIME & DATE	F	A	I	F	A	I	F	A	I
00Z 4.2.76	-	92	81	-	5840	5828	-	12332	12319
12Z	90	94	91	5834	5838	5835	12324	12328	12326
00Z 5.2.76	94	95	94	5837	5837	5839	12328	12330	12332
12Z	98	98	95	5842	5842	5842	12336	12335	12336
00Z 6.2.76	100	100	98	5846	5843	5845	12341	12338	12341
12Z	102	104	102	5847	5846	5846	12344	12341	12341
00Z 7.2.76	104	105	103	5848	5846	5847	12345	12342	12343
12Z	106	108	105	5849	5848	5847	12346	123545	12344
00Z 8.2.76	104	107	104	5847	5846	5846	12347	12346	12347
12Z	107	109	106	5849	5849	5849	12352	12351	12351
00Z 9.2.76	107	109	108	5848	5847	5849	12353	12349	12352
12Z	111	110	106	5852	5850	5848	12357	12354	12352
00Z 10.2.76	106	109	108	5847	5847	5849	12353	12353	12356

Table 3b) : As for table 3a, but for the tropical regions, 22.5°S to 22.5°N

Northern Hemisphere $\overline{Z}$ (m)

0° - $90^{\circ}N$

	1000 mb			500 mb		200 mb			
TIME & DATE	F	A	I	F	A	I	F	A	I
00Z 4.2.76	-	119	131	-	5479	5495	-	11631	11653
12Z	123	123	122	5495	5486	5488	11659	11641	11645
00Z 5.2.76	121	122	120	5489	5484	5485	11650	11643	11645
12Z	118	120	120	5488	5481	5485	11650	11639	11644
00Z 6.2.76	115	117	117	5485	5479	5481	11650	11641	11644
12Z	116	116	115	5487	5479	5481	11657	11645	11648
00Z 7.2.76	113	116	116	5484	5479	5482	11659	11648	11663
12Z	114	114	114	5485	5480	5485	11666	11654	11663
00Z 8.2.76	112	114	115	5485	5480	5485	11666	11657	11663
12Z	114	117	118	5491	5486	5490	11677	11664	11670
00Z 9.2.76	118	121	119	5494	5487	5489	11678	11664	11667
12Z	121	125	128	5497	5495	5502	11679	11670	11679
00Z 10.2.76	128	131	128	5407	5502	5502	11687	11677	11678

Table 3c) : As for table 3a, but for the northern hemisphere.

Antarctic $\overline{Z}$ (m) 67.5°S - 90°S

	1000 mb			500 mb		200 mb			
TIME & DATE	F	A	I	F	A	I	F	A	I
00Z 4.2.76	–			–			–		
12Z	-77	-100	-97	5118	5113	5116	11284	11278	11282
00Z 5.2.76	-94	-100	-99	5125	5128	5129	11292	11296	11298
12Z	-90	-106	-106	5141	5131	5132	11312	11292	11294
00Z 6.2.76	-95	-116	-113	5145	5138	5140	11308	11294	11298
12Z	-103	-118	-116	5150	5151	5156	11311	11303	11309
00Z 7.2.76	-98	-112	-114	5167	5162	5163	11325	11326	11329
12Z	-104	-121	-118	5169	5163	5169	11336	11319	11329
00Z 8.2.76	-113	-135	-134	5160	5147	5150	11328	11304	11310
12Z	-129	-151	-150	5144	5133	5138	11313	11293	11301
00Z 9.2.76	-142	-155	-156	5130	5119	5120	11302	11287	11291
12Z	-147	-164	-165	5119	5110	5113	11293	11274	11280
00Z 10.2.76	-149	-162	-165	5113	5100	5101	11284	11271	11274

Table 3d) : As for Table 3a, but for the Antarctic Region, 67.5°S to 90°S.