MCR/6

MET O 11 TECHNICAL NOTE NO. 195

ASSESSMENT OF HERMES DATA: A CASE STUDY COMPARISON WITH THE OPERATIONAL ANALYSIS FOR 2ND MARCH 1984.

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1. INTRODUCTION

High resolution satellite temperature soundings, calculated from direct readout radiance data from the TIROS-N operation vertical sounder, are now available in the Met Office and known as HERMES data. There are several methods in which the accuracy and potential impact of these data for NWP can be assessed:

a. By analyses and forecasts with and without the data.

b. By collocating the data with nearby radiosondes.

c. By comparison of the data with model analyses and forecasts made not using them.

The first method is being attempted in Met O 11 and Met O 2b. However it is likely that until the characteristics of Hermes data have been assessed, and appropriate analysis techniques devised, the analysis system will be unable to make full use of the data.

The second method is being done routinely in Met O 19, but cannot assess the potential impact of Hermes data for NWP.

This paper presents, in section 3, a case study using the third method.

2. DESCRIPTION OF HERMES SYSTEM

The Hermes system receives real-time data from the TIROS-N series of satellites. After processing and cloud-clearing, the radiances are inverted to temperature and relative humidity profiles by means of a minimum variance regression scheme. The maximum resolution of such profiles after cloud-clearing is 80 km (but is reduced to approximately 150 km in areas of significant cloud contamination).

3. CASE STUDY: 2nd MARCH 1984

Figure [1] shows the main surface fronts at 12Z on 2nd March 1984, together with the 1000-500 mb thickess field. The case-study concerns the development of the 1000-500 mb cold trough behind the surface cold front.

The Hermes pass closest in time to 12Z over the area of interest was at 1430.

Figure [2] demonstrates that the 12Z analysis fitted the conventional observations quite closely, with the rms errors from the three observation types (ships, sondes and satems) less than three decametres. The maximum observation - field difference was from a satem over the central UK.

In contrast, figure [3] shows the [Hermes - model] 1000-500 mb thickness field. Clearly, the differences were much greater (with an rms difference of 4 decametres and a maximum of 10 decametres over north

Wales). It was also possible to draw a 'zero difference' line showing the Hermes thicknesses to be warmer than the model to the west and cooler to the east.

STATISTICS

	HERMES - MODEL (TIME DIFFERENCE 2 1/2 HOURS)		CONVENTIONAL OBS - MODEL (SHIPS/SATEMS ± 3 HOURS)	
	MEAN	RMS	MEAN	RMS
1000-850 mb	-4.2	16.2	1.2	6.2
1000-500 mb	11.8	39.6	12.9	19.5
1000-250 mb	-23.4	4.4	26.4	33.2
1000-100 mb	61.0	71.8	44.7	57.3

UNITS = METRES

These results would appear to indicate either a problem with the Hermes data or significant development in the pattern between 12Z and 1430. To test the second possibility, a coarse mesh forecast was run forward 10 timesteps from the 12Z update analysis, and the fields replotted. [To test the model evolution, a 12 hour forecast was run forward from 12Z 2nd March and shown to be in reasonable agreement with conventional observations.]

Figure [4] shows the 1430 1000-500 mb thickness field with Hermes data overplotted. Comparing the pattern with figure [1], it is clear that development did occur in the region, with the 522 line becoming cut off over the northern UK and a slight easterly displacement of the associated cold pool. The corresponding (Hermes-forecast) difference field (figure [5]) showed improvements in some areas eg Northern Ireland (8 → 5 dcm), the North Sea (-9 → -4 dcm) and Germany (-7 → -3 dcm).

However, over Wales, there were still maximum differences of up to 9 decametres. This slight improvement was reflected in the rms errors for most other layers (except 1000-100 mb).

STATISTICS

HERMES - MODEL FORECAST FIELD

	MEAN	RMS	(METRES)
1000-850 mb	-5.5	15.9	(16.2) ( ) 12Z cf 1430 Hermes
1000-500 mb	7.2	32.2	(39.6)
1000-250 mb	17.2	35.4	(4.4)
1000-100 mb	72.2	81.0	(71.8)

These results would suggest that development was not the main factor.

To investigate this, the vertical structure of the Hermes data was then examined, using both cross-sections and single profiles. 1430 model profiles at the nearest (fine-mesh) grid-point positions to UK radiosonde stations were overplotted with collocated Hermes retrievals. Examples are shown in Figures (6-9). The model profiles were characterised by

a. very low tropopause heights at stations close to the centre of the cold pool: 480 mb at Crawley, 485 at Hemsby.

b. strong subsidence inversions (eg Camborne) between 600 and 800 mb associated with a high pressure region to the west of Ireland.

c. dry adiabatic lapse rates at medium levels (eg Hemsby).

In contrast to the variation between model profiles, all the Hermes profiles were similar in shape, rounded, with a tropopause height of 300 mb and without subsidence inversions or steep lapse rates. Some stations (eg Shanwell) also had isothermal layers below 850 mb, suggestive of cloud-clearing problems.

Figure [10] shows an east-west cross-section at 57°N. This would appear to suggest that the zero difference line roughly followed the axis of the 1000-500 mb trough, reflecting the change in shape of the model profiles - but not the Hermes profiles - across the trough axis.

4. CONCLUSIONS

In this particular case, the retrievals produced by the Hermes system over the UK area were unrealistic. Their similarity to a climatological average would tend to suggest that the statistical inversion step was the main source of error. However, contributions from the cloud-clearing step may also have been significant.

General conclusions cannot be drawn from one case. However, clearly, when considering how Hermes data should be used in the assimilation scheme, care must be taken to avoid a negative impact on the model's vertical structure.

FIG. 1

12Z UPDATE ANALYSIS 2/3/84
THICKNESS(DAM). WIND SHEAR(M/S) & VERIFYING OBSERVATIONS
VALID AT 12Z ON 2/3/1984 DAY 62
LEVEL: 500 MB - 1000 MB

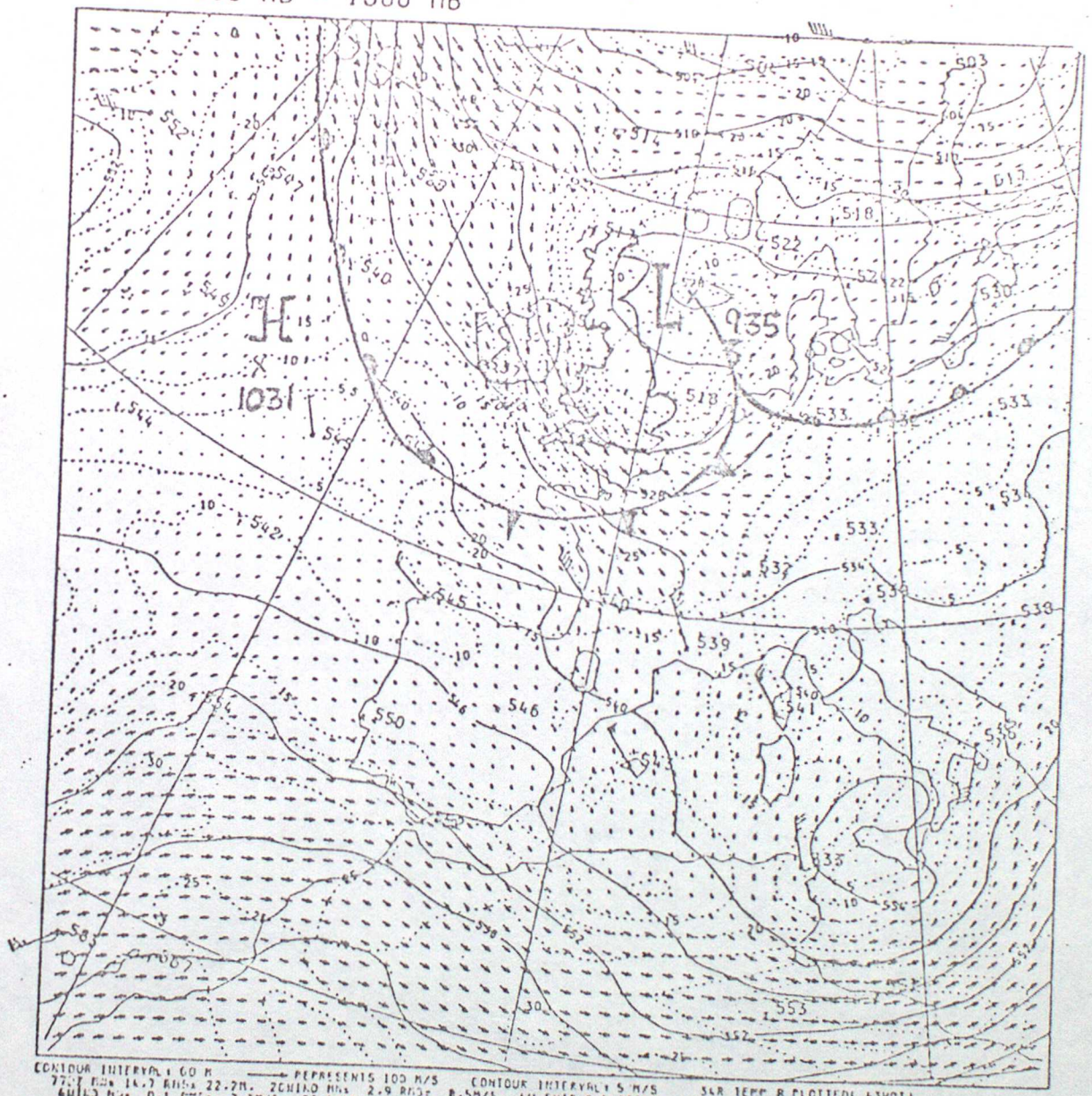
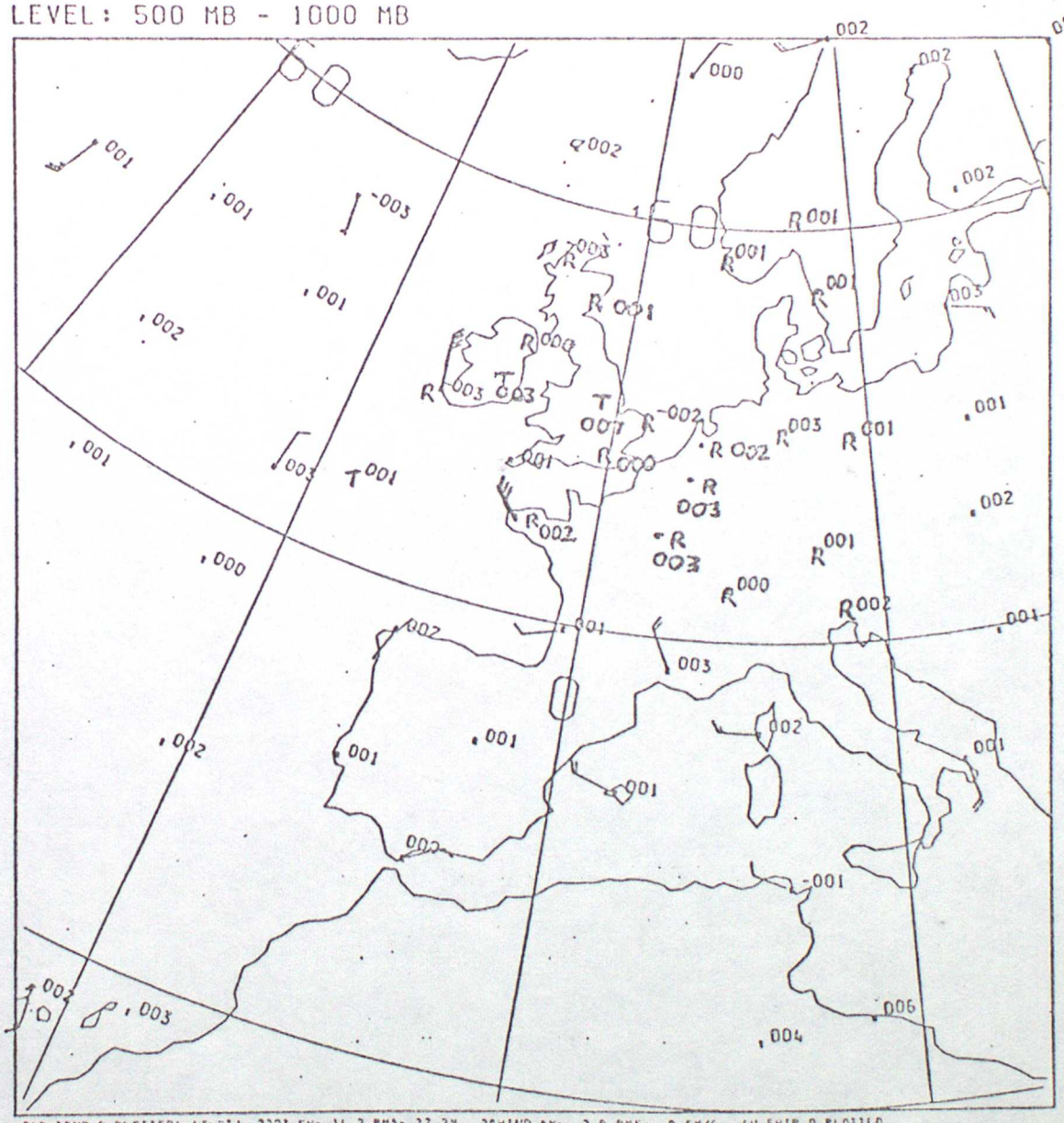


FIG 2.

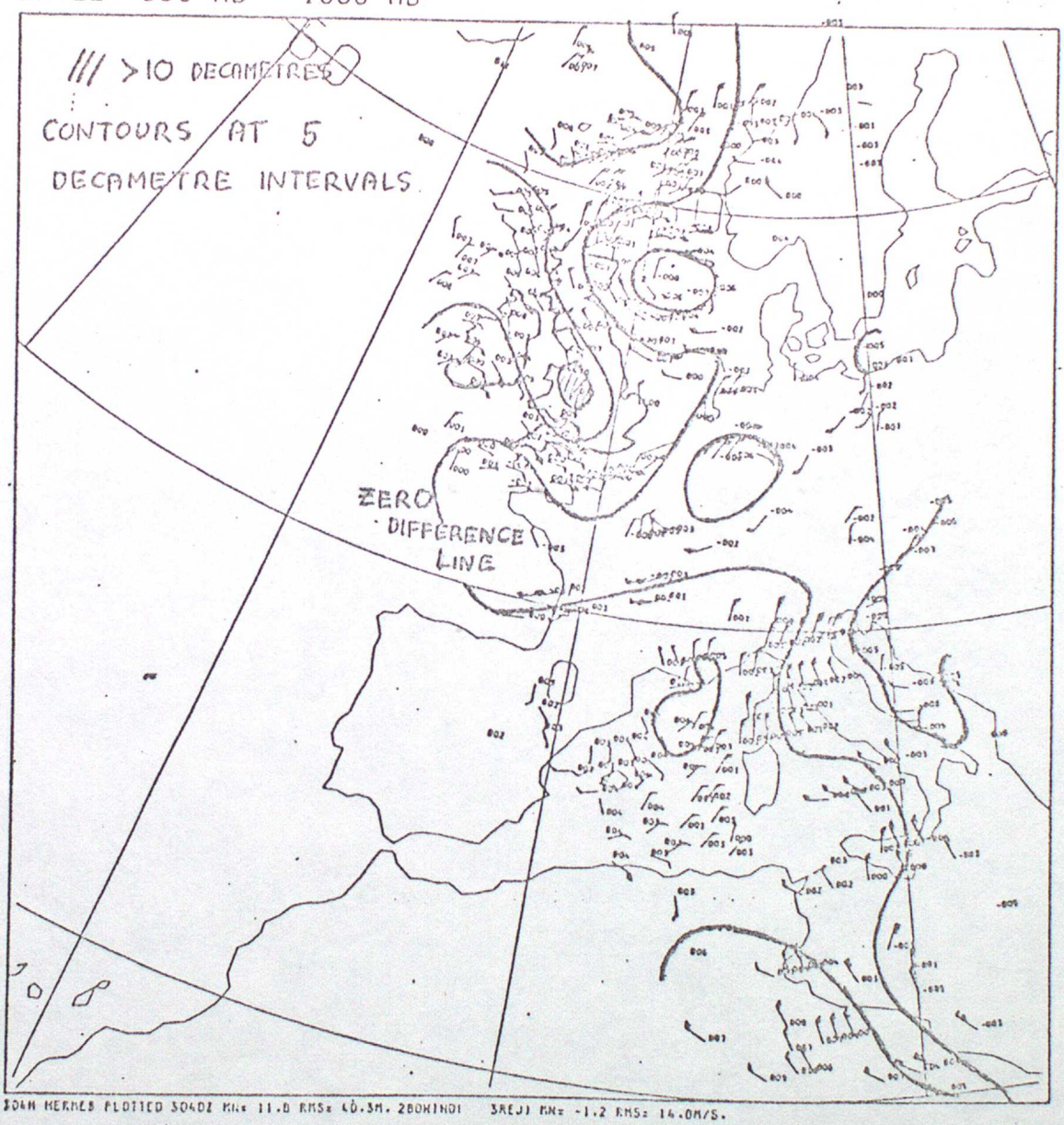
12Z UPDATE ANALYSIS 2/3/84
OBSERVED - FIELD VALUES
VALID AT 12Z ON 2/3/1984 DAY 62
LEVEL: 500 MB - 1000 MB



BAR TEMP A PLOTTED ASSIMI 7702 BIAS 14.7 RMS= 22.2M. 20KIND BIAS 2.9 RMS= 8.5M/S. 40 SHIP A PLOTTED
402 BIAS 3.0 RMS= 21.6M. 4KIND BIAS 0.1 RMS= 7.3M/S. 91 SAIEM PLOTTED(22HOT) 5102 BIAS= 21.5 RMS= 27.7M.

FIG. 3

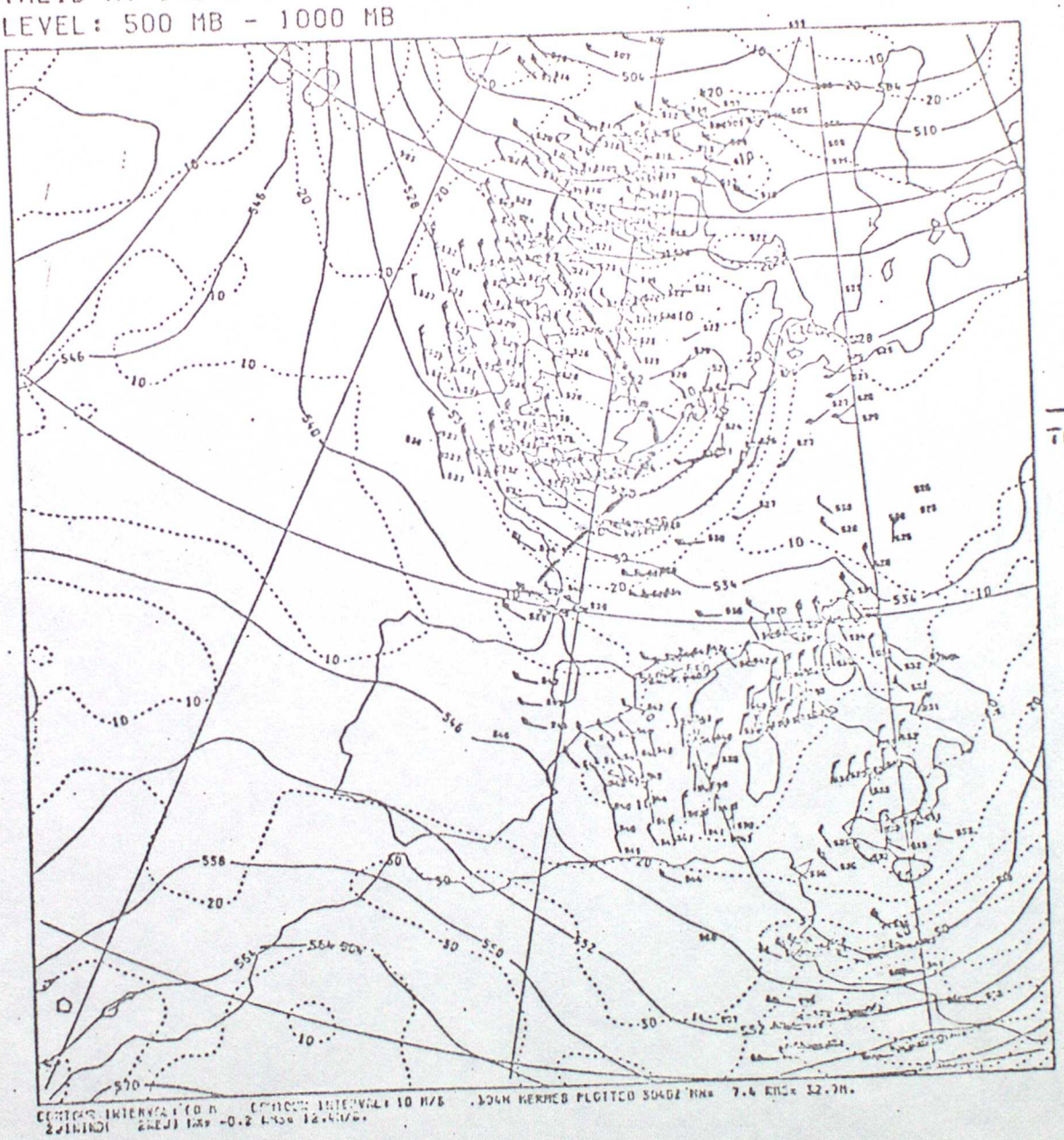
12Z UPDATE ANALYSIS 2/3/84
OBSERVED - FIELD VALUES
VALID AT 12Z ON 2/3/1984 DAY 62
LEVEL: 500 MB - 1000 MB



304M HERMES PLOTTED 304DI MN= 11.8 RMS= 40.3M. 2BOKINDI 3REJI MN= -1.2 RMS= 14.0M/S.

FIG. 4

1430 COARSE-MESH FORECAST(2/3/84)
THICKNESS(DAM). GEOSTROPHIC THERMAL WIND ISOTACHS(& VERIFYING OBSERVATIONS
VALID AT 14Z ON 2/3/1984 DAY 62 DATA TIME 12Z ON 2/3/1984 DAY 62
LEVEL: 500 MB - 1000 MB



CONTOUR INTERVAL 6 DAM CONTOUR INTERVAL 10 M/S .504M KERMES PLOTTED SCALE FAC= 7.4 ERR= 12.7M.
ZONTAL SHEAR FAC= -0.2 ERR= 12.4M/S.

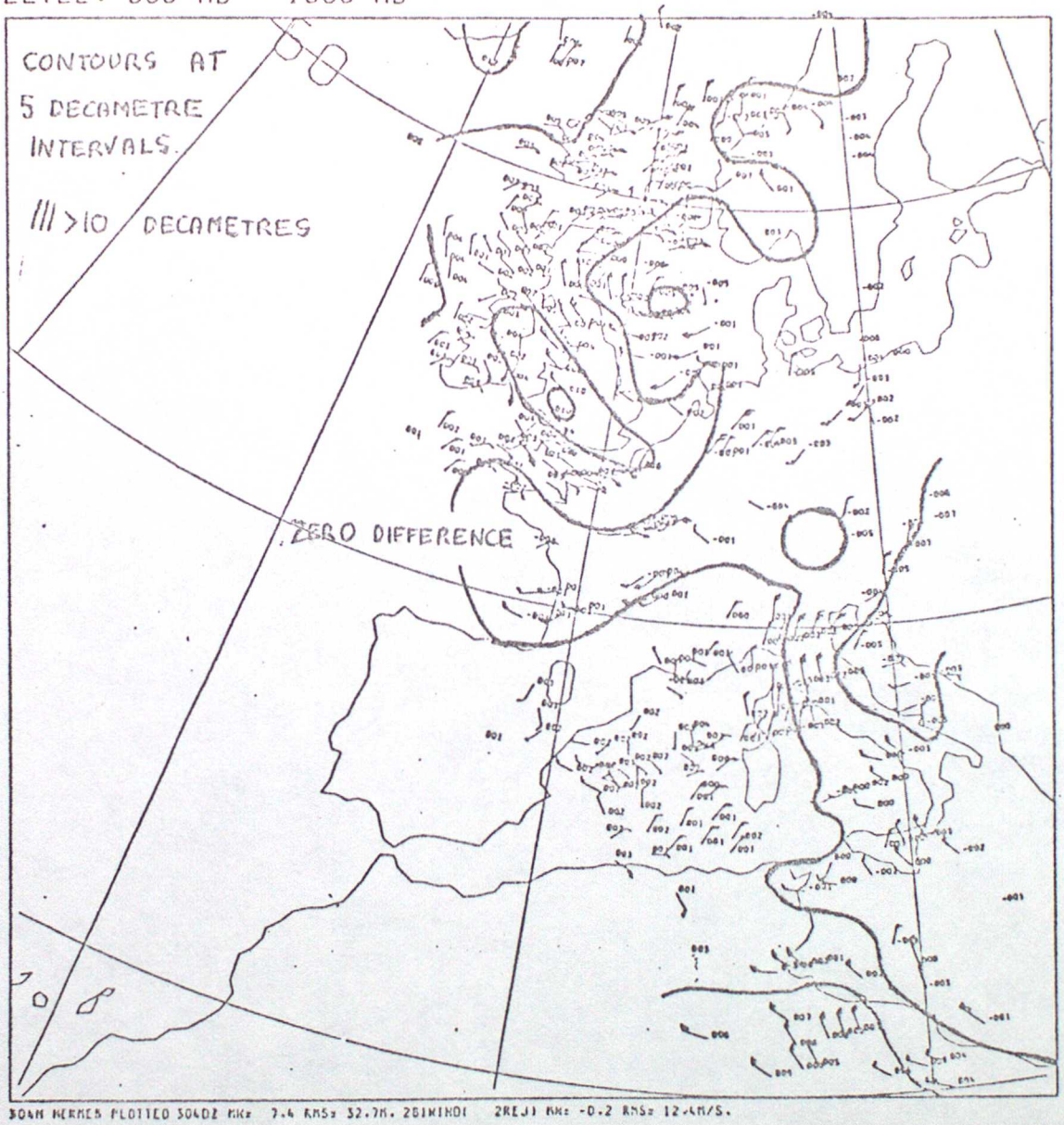
FIG. 5

1430 COARSE-MESH FORECAST 2/3/84)

OBSERVED - FIELD VALUES

VALID AT 14Z ON 2/3/1984 DAY 62 DATA TIME 12Z ON 2/3/1984 DAY 62

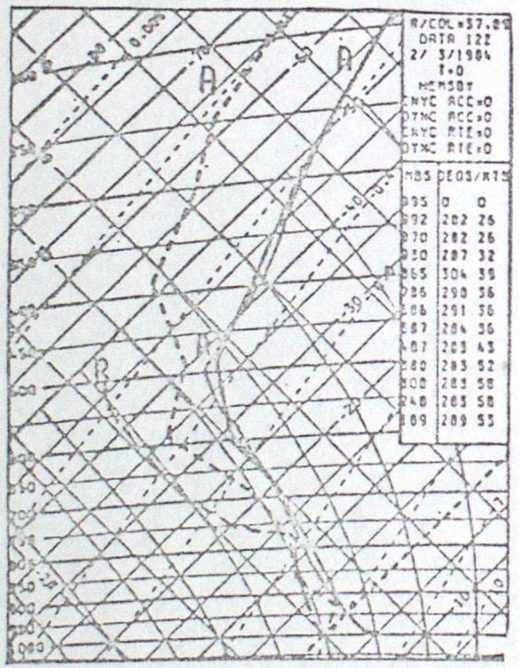
LEVEL: 500 MB - 1000 MB



3OAH HERMES PLOTTED 50402 RMS= 7.4 RMS= 32.7M. 2BIMIND1 2REJ1 RMS= -0.2 RMS= 12.4M/S.

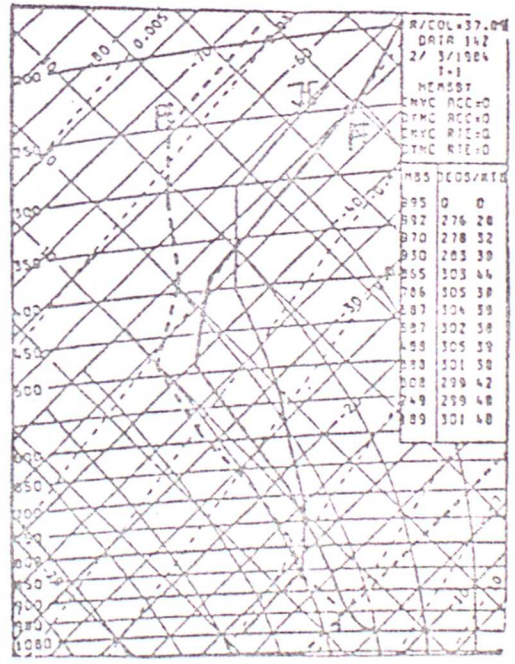
HEMSBY (MSU ONLY)

UPDATE ANALYSIS 12Z (A)



12Z COLLOCATED RADIOSONDE(R)

CORRSE-MESH FORECAST 1430 (F)

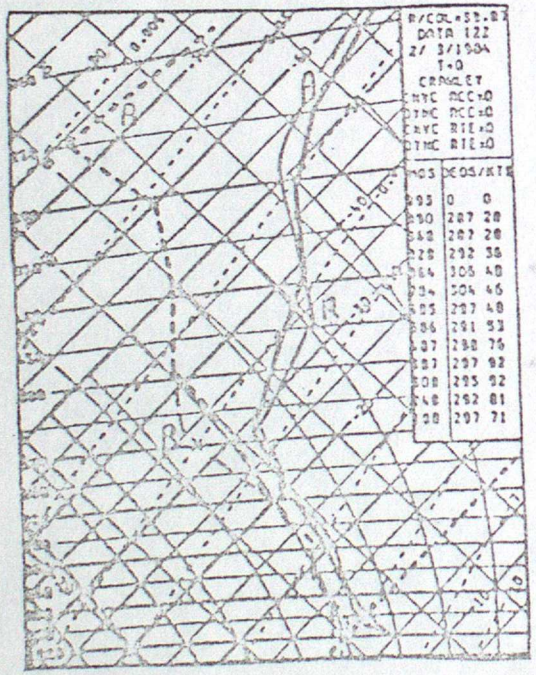


1430 HERMES DATA (H)

FIG. 6

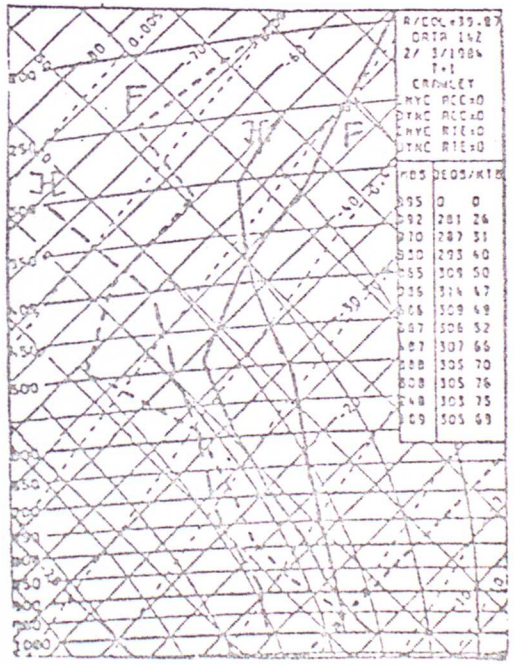
CRAWLEY

UPDATE ANALYSIS 12Z (A)



12Z: COLLOCATED RADIOSONDE (R)

COARSE-MESH FORECAST 1430 (F)

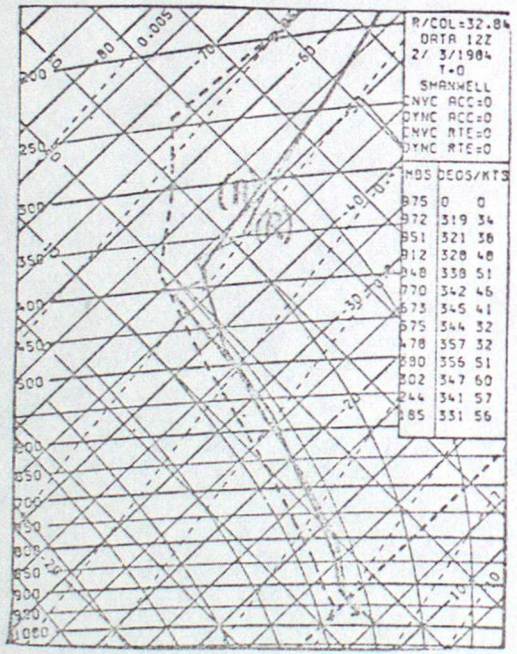


1430 HERMES DATA (H)

FIG 7

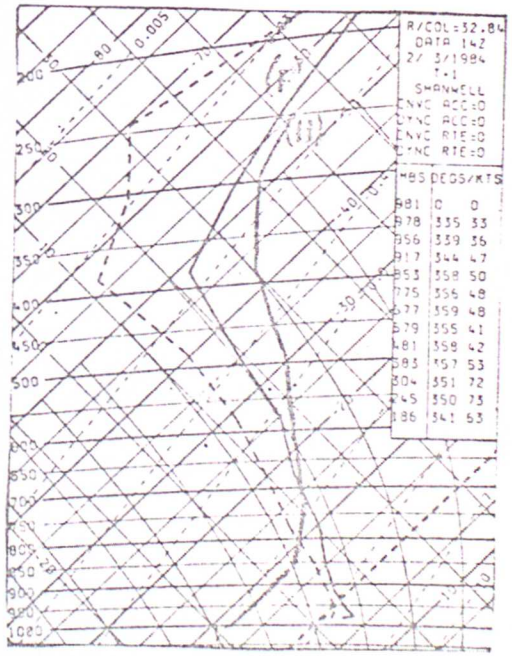
SHANWELL

UPDATE ANALYSIS 12Z (A)



12Z COLLOCATED RADIOSONDE (R)

COARSE-MESH FORECAST 1430 (F)

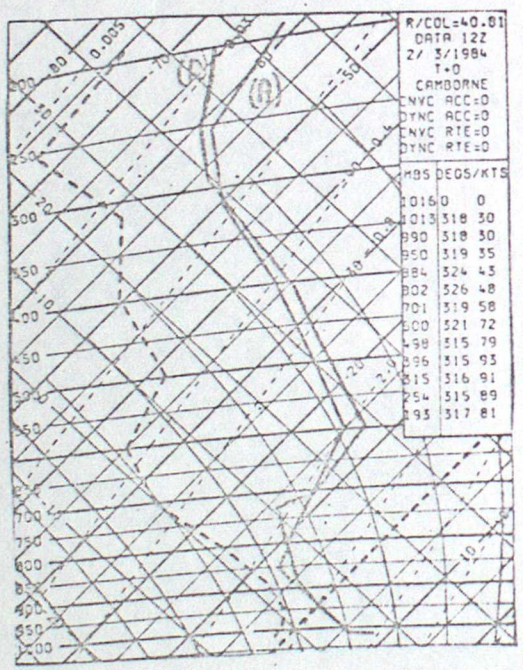


1430 HERMES PROFILE (H)

FIG. 8

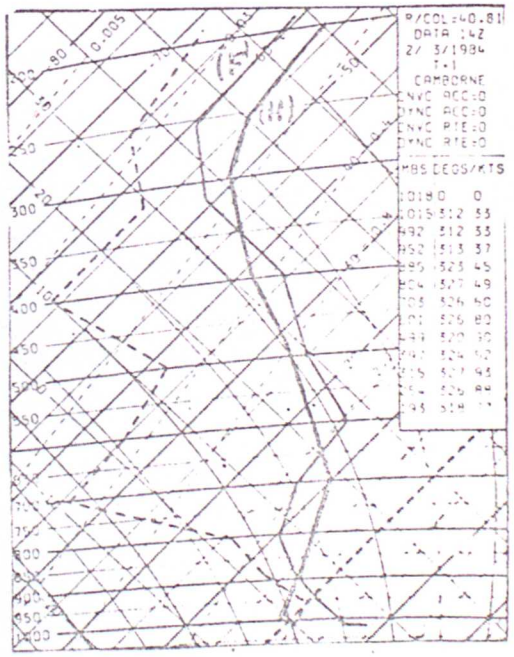
CAMBOURNE

UPDATE ANALYSIS 12Z (A)



12Z COLLOCATED RADIOSONDE (R)

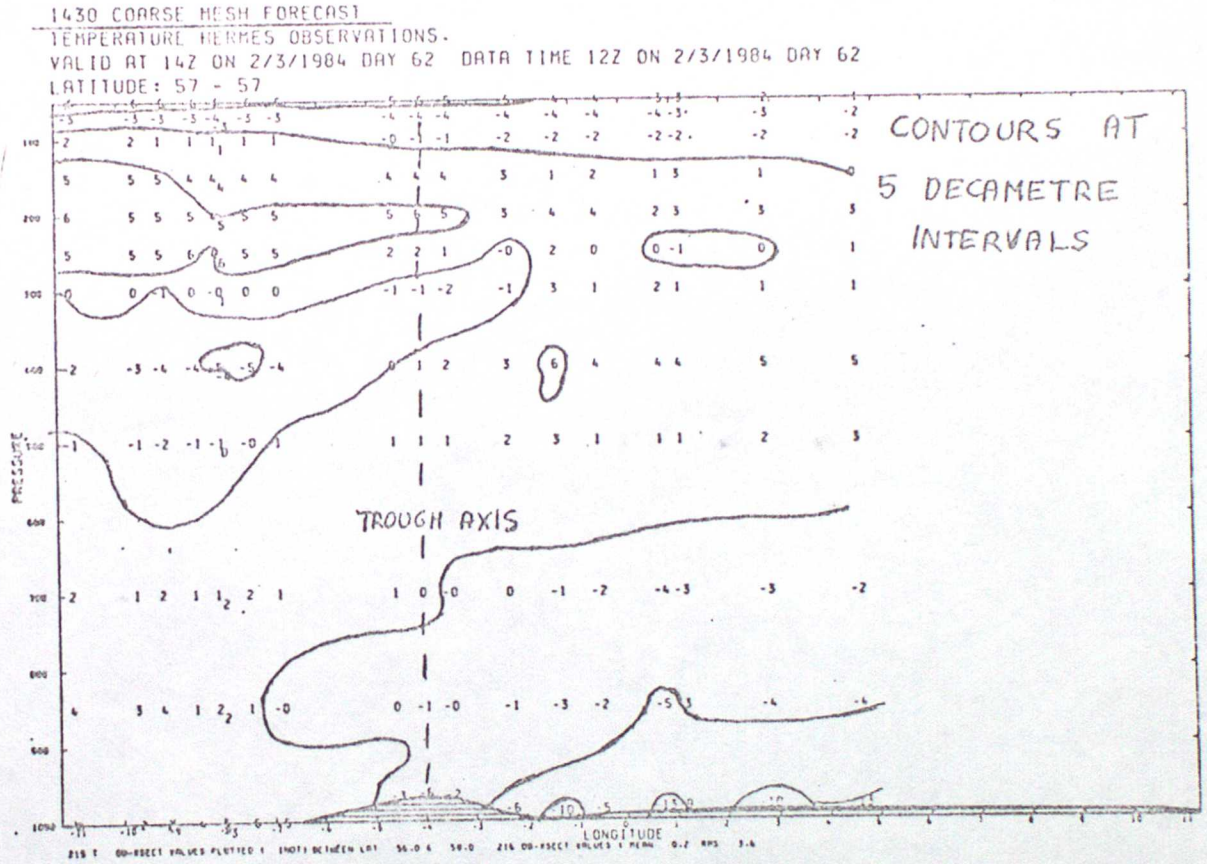
COARSE-MESH FORECAST 1430 (F)



1430 HERMES DATA (H)

FIG. 9

FIG. 10


1430 COARSE MESH FORECAST
TEMPERATURE HERMES OBSERVATIONS.
VALID AT 14Z ON 2/3/1984 DAY 62 DATA TIME 12Z ON 2/3/1984 DAY 62
LATITUDE: 57 - 57
CONTOURS AT
5 DECAMETRE
INTERVALS
TROUGH AXIS
PRESSURE
LONGITUDE