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METEOROLOGICAL OFFICE

FORECASTING TECHNIQUES BRANCH MEMORANDUM No. 4

OPERATIONAL NUMERICAL FORECASTING

by

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April, 1965

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OPERATIONAL NUMERICAL FORECASTS

Area

The area analysed covers 47 x 41 grid points. The forecast covers the same area, though output is limited to a smaller 'forecast area'. Details regarding projection, grid size etc. are given in Appendix 1.

Procedure

Forecasts are computed twice daily, based on 00Z and 12Z data. Timing below refers to the 00Z forecast. In each case a preliminary analysis and forecast are made, the latter running to 24 hours only, using data received by a specified cut-off time, viz 0625Z. This is followed by a final analysis and forecast based on a later cut-off time, viz 0810Z for upper air and surface land data, and 0830Z for ship reports. The forecast normally runs to 48 hours. The preliminary forecast is completed about 0710Z, the final about 0900Z.

Data

1. Magnetic tapes

The following magnetic tapes are required. Full details regarding their contents are given in Appendix 2.

- a. Programme tape
- b. Data tape. Used to store data which have been partially processed from broadcast teleprinter tapes
- c. Results tape. Carries results from each programme, and hence enables a restart to be made from any point.
- d. Initial Forecast tape. Contains the required forecast field, together with ship observations six hours previous to datum time, and seasonal mean height fields.
- e. Constants tape. Contains station lists, and various additional parameters required.
- f. Master tapes. Comprise results of forecasts and analyses.

2. Paper-tape - 5-hole Murray Code

The following broadcast tapes are processed:

T/P	-	Bracknell
		Paris 1 (Paris & Rome)
		Paris 2 (Prague & Moscow)
		De Bilt (Offenbach & Stockholm)
		Brussels (New York)
		Montreal
RTP		Moscow
		Offenbach

Tapes are separated into a maximum of about 3 hours broadcast time. Each length of tape is preceded by a heading as follows:

(CR) (LF) (LF) (LF) GJKLJG (SP) n (SP) tt (CR) (LF) (LF)

Correct punching, in Murray code, of these 18 characters is essential to the data extraction programme. tt is the time of broadcast, to the nearest

three hours (00, 03 etc) n is the broadcast identifier, and other characters are fixed. The code for n is as follows:

0	-	Moscow RTP
1	-	Montreal
2	-	Brussels (8)
3	-	Offenbach RTP
4	-	De Bilt (2 + 4)
5	-	Bracknell (1)
6	-	Paris 1 (3 + 6)
7	-	Paris 2 (5 + 7)
8	-	Special ship tape

The last item refers to a special tape of surface ship observations compiled by Met.O.5.

3. Paper tape - 8-hole, KDF9 code

Special tapes of corrected observations etc. are required for some programmes. These are prepared by Met.O.2 and Met.O.12. The format is shown in Appendix 3.

Programmes

There are 10 main programmes, some of which are themselves subdivided. 000 - 002 comprise the preliminary run and 003 - 008 the final version, while 009 is a 'clearing-up' set of programmes.

Preliminary Run

000 - Preliminary Data Extraction

The Murray-code broadcasts are processed for the period 00Z - 0625Z approx. The programme is in three parts:-

000Z. This sorts the broadcast data into groups, plants appropriate indicators, and writes the information on to the Data Tape.

000A. The information on the Data Tape is processed and the following reports extracted:

Upper Air observations - 00Z

Surface land observations - 00Z, 03Z, 06Z.

Surface ship observations - 18Z, 21Z, 00Z, 03Z, 06Z.

The lists of surface and upper air land stations extracted are given in Appendix 4. All upper air ship reports are extracted. Surface ships are classified into three regions, (see Appendix 2, Results Tape), up to 256 ships being extracted for any one region.

This part of the programme also carries out some checks on the processed reports, printing some of the results.

000B. This completes the checking, and deals with storage on to the results tape and output on the line printer.

Observations are checked in 000 as follows:

Upper Air Land:

a. Heights and temperatures are inspected for hydrostatic consistency. Where possible, incorrect heights and/or temps are amended. Reports at any levels which cannot be so corrected are rejected. Wind observations are roughly checked for consistency in the vertical.

- b. If an observation is repeated, the second report is ignored if the whole of the first has been accepted. Otherwise the whole observation is replaced by the second version.

Upper Air Ships: As for upper air land stations. The position is also checked against the reported Marsden Square.

Surface Land:

- a. Tendency. 00Z & 06Z observations are checked against that at 03Z. Reports are rejected when the discrepancy exceeds 1 mb.
- b. Tropical check. Pressure observations are rejected if they lie outside the limits:
 $1024 + 125 (\sin \phi)^2$ and $996 - 125 (\sin \phi)^2$
- c. Forecast field. A crude check is applied against the 1000 mb forecast field, viz. height difference is allowed to be up to 200 metres, and geostrophic wind up to 200 knots.
- d. Repeated reports. The first observation is used only if it passes the above tests. Otherwise the second report is normally accepted. In the case of 00Z reports only, when no tendency check is possible, the report nearest to the forecast value is used.

Surface Ships:

- a. Tendency. 18Z & 00Z pressures and tendencies are examined, and a weighted tendency derived, equal to $\frac{1}{2}$ the 18Z value and $1\frac{1}{2}$ times the 00Z value. A discrepancy of up to 5 mb is allowed, otherwise the 00Z report is rejected. Where 03Z or 21Z reports are available, a direct check is made, though a tolerance of 5 mb is still allowed.
- b. Tropical check. Pressure observations are rejected if they lie outside the limits:
 $1024 + .0375 (\phi)^2$ & $996 - .0375 (\phi)^2$
- c. Forecast field. As for land stations.
- d. Repeated reports. As for land stations.
- e. Position. When an 18Z observation is available, the distance travelled is compared with that derived from the dsvs groups, using $\frac{1}{2}$ the initial values and $1\frac{1}{2}$ times the final ones. Ships lying more than 60 nautical miles from the computed position are rejected.
- f. Land check. Observations from locations over land are rejected. A location is assumed to be over land only if there is no sea within that particular grid square.

Line-Printer Output

The following items are printed while the data is being processed:

1. Details of different observations extracted for surface land stations, under the same station number.
2. Alterations made to upper air data by the hydrostatic check.

The following are printed when processing is complete:

1. Upper Air (Land).

a. Print of 1000, 500 & 200 mb data. R is printed beside any data rejected, and also beside the appropriate station number.

b. List of stations for which some data are rejected.

c. List of missing stations.

2. Upper Air (Ships)

Print of 1000, 500 & 200 mb data, with Reference Nos. where appropriate.

R is printed beside any rejected data, including ship's position.

3. Surface Land

a. List of rejected reports, with reason for rejection.

b. List of accepted reports for 00Z, 03Z, 06Z.

4. Surface Ships

a. List of rejected reports, with reason for rejection.

b. List of accepted reports for 00Z.

OC1 - Preliminary 00Z Analysis

An analysis is made of the 500 mb and 200 mb heights, and the 1000-500 mb thickness. This makes use of the previous forecast field (or, if not available, of the seasonal mean field), and up to 10 upper air observations within 6 grid-lengths of each grid point. After the first analysis, observations failing to satisfy the following tolerances are rejected:

500 mb & Thickness: Height 16 dkm. Wind Vector 75 km/hr
200 mb: Height 12 dkm. Wind Vector 75 km/hr

The wind comparison is made against the analysed geostrophic gradient over one grid length. A second analysis of the three fields is then made, omitting the rejected observations.

A separate 1000 mb analysis is made, using the field implied by the computed 500 mb & thickness fields, and up to 12 surface reports within 6 grid-lengths of each grid point. Following this, observations failing to satisfy the following tolerances are rejected:

1000 mb height. 10 dkm. Wind Vector 65 km/hr

A second analysis is then made, omitting the rejected observations. The 1000 mb analysis is then used to 'correct' the previous 500 mb & thickness fields, each being altered by one half of the difference between the new, and the previously implied values.

Output: 1) Lists of upper air and surface reports rejected following the first analysis.

2) Analyses of 1000 mb, 500 mb, 200 mb & 1000-500 thickness. Grid-point values are printed as near as possible to their correct geographic positions on special stationery.

OC2 - Preliminary Forecast

A three-parameter forecast is run for 24 hours. Provision is made for varying the times of output. Standard output is as follows:

Surface, 500 mb, 200 mb, 1000-500 mb thickness - 12-hour & 24-hour forecasts
Vertical velocity, 1000-600 mb - 00, 12 & 24 hours

Output is confined to the smaller 'forecast area' and is on preprinted stationery. The values printed are not those at grid-points, but are interpolated so as to correspond with their geographic location.

Final Run

OC3 - Final Data Extraction

The Murray code broadcasts are processed from the cut-off time in OC0 to 0810 approx. The programme is as OC0, data extracted being added to those previously processed. Additionally, a special 8-hole data tape is read, consisting of two sections:

- a. Lists of station nos. & reference nos. indicating data previously extracted by OC0, which are now to be rejected.
- b. New or corrected 00Z observations. These overwrite any data previously extracted and are not subject to any checks in the extraction programme.

Checks are made of the reports extracted from the broadcasts as in OC0, with the following exceptions.

- a. 06Z observations are not checked against the forecast field.
- b. 06Z land observations are checked in respect of tendency against 03Z reports. If the discrepancy exceeds 1 mb, the 06Z report is rejected provided the 00Z & 03Z reports are consistent in respect of pressure & tendency. If the latter does not apply, the 06Z report is classed as 'suspect', but retained by the computer. If no 03Z report is available, 06 & 00Z reports are compared, as for surface ships in OC0.
- c. 06Z ship observations are not checked at this stage.

Output: As in OC0 with the following additions.

Surface Land: An additional list of 06Z 'suspect' reports is printed.

Upper Air Data: In addition to the items listed in OC0, a complete list of upper air data extracted for all levels is printed. A is printed beside rejected items.

OC4 - Final 00Z Analysis

A special 8-hole data tape is first read. This contains a list of station nos., or of reference numbers printed by OC1 as rejected data. The reports listed on this special tape are now 'starred', and cannot be rejected in the subsequent analysis.

A final 00Z analysis is made, in a fashion identical with OC1. Observations rejected after the first analysis are now finally erased.

- Output:
- 1) Lists of 00Z observations rejected following first analysis.
 - 2) Analyses of 1000, 500, 200 mb & 1000-500 mb thickness as in OC1.

OC5 - 6-hour Forecast

A forecast to 0600 is made, as in OC2, but omitting smoothing.

Output: Surface, 500 mb, 200 mb & 1000-500 mb - 6-hour forecasts.
Vertical velocity - 00 & 06 hours

OC6 - Final Ship extraction

A Murray-code data tape prepared by Met.0.5., containing 06Z surface ship reports is read & processed. These reports are added to those previously extracted in OC3, and checks are made as follows:

- a. Tendency. 06Z reports are checked against those for 00Z & 03Z, and are classified as follows:

Discrepancy 0-5 mb	-	accepted
5-10 mb	-	suspect
> 10 mb	-	rejected

- b. Tropical check. As in OCØ.

- c. Forecast field. Reports are checked against the 06Z forecast produced by OC5, and are classified as follows.

1000 mb height discrepancy 0-100 metres	-	accepted
100-200 metres	-	suspect
> 200 metres	-	rejected
Geostrophic wind discrepancy 0-40 knots	-	accepted
40-200 knots	-	suspect
> 200 knots	-	rejected

- d. Repeated observations. As in OCØ.

- e. Position. As OCØ.

- f. Land check. As OCØ.

Output

Lists are printed of ships accepted, rejected & suspect, the first and third of these being accompanied by reference numbers for use in preparing the OC7 data tape. Accepted & suspect data are retained in the computer.

OC7 - Final 06Z Analysis

A special 8-hole tape is read, containing additional 06Z reports, and details of 06Z observations to be rejected. A surface analysis is then made for 06Z. No observations are rejected, though those failing to satisfy the tolerances given under OC1 are printed out. The 500 mb and 1000-500 mb thickness fields are then adjusted as in OC1.

Output 1) Lists of surface stations failing to fit analysis.
2) 1000 mb, 500 mb & 1000-500 mb 06Z analyses.

OC8 - Final Forecast

The three-parameter forecast is continued from 06Z to the stipulated time - normally 48 hours.

Output The 'forecast area' is printed as in OC3 for the following times:

/Surface

Surface	30, 36 & 48 hours
500 mb, 200 mb, 1000-500 mb thickness,	24, 36, 48 hours
Vertical velocity	00, 30, 36, 48 hours

OC9 - Additional programmes

Three 'clearing up' programmes are run:

- a. Initial Forecast Tape. The 12-hour forecast is copied from the results tape, together with surface ship observations for 06Z. These are used in the following preliminary run.
- b. Master Analysis Tape. The analyses for 00Z & 06Z are transferred to a master tape.
- c. Master Forecast Tape. All forecast fields are transferred to a master tape.

Appendices

- Appendix 1. Numerical Forecasting Grid.
- Appendix 2. Magnetic Tapes.
- Appendix 3. Proformae, giving layout of information punched on 8-hole data tapes.
 - 3a. OC3 input tape. OOZ lists of reports to be rejected, and additional or corrected observations.
 - 3b. OC4 input tape. Lists of 'starred' observations, which will not be rejected in the OC4 analysis.
 - 3c. OC7 input tape. Additional reports, and lists of rejected reports for O6Z.
- Appendix 4. Lists of surface and upper air stations, with coordinates and sonde-corrections.

Appendix 1

Numerical Forecasting Grid

The grid is derived by stereographic projection from the south pole, on to a plane tangential to the north pole. On this plane the grid is a rectangular array, the origin being at the pole, the y-axis positive along 145°E, and the x-axis positive along 55°E.

The latitude ϕ and the longitude σ of the grid points are then derived from the formulae:

$$(1 + \sin \phi)^{-1} = 0.5 + \frac{a^2(x^2 + y^2)}{8R^2}$$

$$\tan(\sigma - 55^\circ) = \frac{y}{x}$$

where σ is positive eastwards. a is the grid length at the pole and R the earth's radius.

The magnification factor $\beta = 2(1 + \sin \phi)^{-1}$

Constants:

$$\begin{aligned} a &= 326.683635 \text{ km} \\ &= 202.992 \text{ statute miles} \\ &= 176.2842 \text{ nautical miles} \\ R &= 6367.3 \text{ km} \end{aligned}$$

$$\frac{a^2}{8R^2} = 3.2901007 \times 10^{-4}$$

$$\frac{2R}{a} = 38.983$$

$$\frac{\beta g}{af} = \frac{1486.5}{\sin \phi (1 + \sin \phi)} \text{ hr}^{-1}$$

Grid area, 47 x 41 grid points,

$$x = -21 \text{ to } +25$$

$$y = -25 \text{ to } +15$$

Appendix 2 - Magnetic Tapes

1. Programme Tape

All programmes are recorded on a single magnetic tape. In some cases, the programmes are subdivided: viz OCØ, OC2, OC3, OC5, OC8 are each divided into an A and B programme, the latter part being called in by OUT 1. Otherwise the programmes are independent.

2. Data Tape

Title block

- 1 Reel No.
- 2 MFMØØYMD - (last character input by flexowriter)
- 3 CRLF CN MURRAY
- 4 L Tape L L L
- 5 DD/MM/YY
- 6 GG L GMT L L L Datum time. d-day of week.

The following blocks comprise up to 1024 words, of which the first is an indicator word as follows:

Broadcast No.	-	1 character
Time of B/C	-	2 characters
Reason for termination	-	1 character (Ø = Normal, 1 = change of B/C 2 = end of B/C tapes)
Data & Time (binary)	-	1 character (Twice day of month, adding one if datum time is 12Z)
No. of words in block	-	3 characters (In binary; indicator word is excluded)

The remaining words of the block consist of an integral number of lines of processed Murray code - details in OCØZ programme. The last block of OCØZ data carries a last block marker, and OC3Z data follows. The last block of OC3Z data has a LBM; followed by a single zero word with LBM.

3. Results Tape

Title Block

- 1 Reel No.
- 2 MFRØØYMD - Identifier
- 3 CRLF CN RESULT
- 4 S TAPE L L
- 5 DD/MM/YY
- 6 GG L GMT L L L

This tape contains the accumulated results from each programme. At the end of each programme a single word block is written, viz.

CN OCn L END

The single word following OC8 carries a last block marker. In the event of data on the results tape being incomplete, the one-word block following the last completed programme is repeated, with a last-block marker.

A standard title block precedes each item stored on the results tape. It consists of four words as follows:

CRLF CN 00Ø/3¹/4²/56 78IIT+tt DD/MM/YY t't'Z-Q₁Q₂Q₃n

All items are in character form.

Any programme numbers not required in the first two words are replaced by spaces.

The indicators II are for internal use in programmes; t't' represents datum time (00 or 12).

Q1Q2Q3 identify the type of information following & n the number of blocks of such information, in character form. Q1 is either P (preliminary) or F (final). Q2Q3 are defined below.

DATA

Most blocks begin with a single 48 - bit binary number N, denoting the number of reports in the block.

UL Upper air land data.

N, followed by sets of 5 words for each station extracted, (Stn. No.) (h, d, f)1000 (h, d, f)500 (h, d, f)200, each as $\frac{1}{2}$ length words. Station numbers are stored as the full 5-figure numbers in binary form, the remainder as binary numbers, fixed point. h is in metres and f in knots.

US Upper air Ship data.

N, followed by sets of 7 words per ship.
As UL, adding two words, zero, ϕ + 350, ϕ , blank after each report.
 ϕ is longitude in tenths of degrees and ϕ latitude in tenths of degrees, fixed point. Following the initial N, the first half of the next word repeats the number of ships in the block (24-bit, binary).

LA Upper air land - additional data.

N, followed by 24 words per station, viz.
(Stn. No.) and (T, T - T_d), h, d, f for 10 levels, followed by 2 words of spare space, and one word, containing nos. of missing items, in Q-store format, of h/t/V.
Station Nos. are 1-word, character form, and remainder are $\frac{1}{2}$ -word, fixed point.

SA Upper air ships - additional data.

As LA, substituting QLLLLL for station number.

LC Surface land data - complete.

N, followed by 6 words per station.
(Stn. No. h₀ u₀ v₀ (PPPTTapp)₀ (PPPTT app)₃ (PPPTTapp)₆ (adff0dfff₆). The suffixes refer to the datum time t't' and to 3 and 6 hours later.
h, u, v floating point and last four winds in binary coded decimal characters.
Stn. No. is in binary but first 6 digits contain indicators for starred observations or for result of tendency check.

LS Surface land data - short

N, followed by 2 words per station.
(Stn. No.), h, u, v with Stn. No. in binary form and h, u, v floating point. Time is given by t't'. u, v are in km/hr.

LT As LS, with time given by t't' + 6.

RS Rejected Surface Ships

N, followed by Ref. Nos. ($\frac{1}{2}$ word, binary) of ships rejected by OC4 analysis.

/SE

SE Surface ship data - early.

N, followed by 4 words per ship.
(YQLLLLL) (GGdsvsddff) (PPTTapp) (Call sign)
Time is t't' -3 or -6 as indicated by GG.
Time in 2nd word of title block indicated as t't' -6.

SL Surface ship data - late.

As SE. Time given by GG, may be t + 3 or t + 6.
2nd word of title block contains t't' + 6.

SC Surface ship data - complete

As SE; time given by t't'.

SF Surface ship data (T + 3)

As SE; time given by t't' + 3.

SG Surface ship data - late

As SE; time given by t't' + 6.

SS Surface ship data - short

N, followed by 4 words per ship.
-, h, u, v, x, y, β g/af, $(\beta$ g/af)².
All half-word floating point, except x, y, 11 i.p. fixed point.
u, v are in km/hr & β g/f in hr.⁻¹
The first - after N contains a repeat of
N as $\frac{1}{2}$ -word, fixed point
Surface ships are divided into three
blocks, according to position;
A. All ships with positive y - co-ordinate
B. All other than A & C
C. Ships S of 50°N & between 0° & 90°W.

SM Surface ship data, late - short

Data derived from SL (t't' + 6) in form
given under SS.

UN Repeat of Block 2 on constants tape, inserting 1
in most significant digit of each station already
received, completely.

ANALYSIS

AH Analysis - height fields

n = 1 (1000mb) n = 3 (1000, 500 and 200mb).
47 x 41 $\frac{1}{2}$ -words, floating point, with 500mb heights
as h -5000 and 200mb h -11,000 metres.

FORECAST

FH Forecast height fields

As AH.

FV Forecast vertical velocity 1000 - 600 mb

Fields of 43 x 37, $\frac{1}{2}$ -word, floating point.

Items stored on the results tape may not be in any particular order
within any programme.

/Information

Information stored by each programme is given below, with the estimated number of blocks in brackets.

OC0; PLA(8) PSA(1) PUL(2) PUS(1) FUN(1) PLC(5) PLS(2) FSE(2)
PSC(3) PSS(3) PSL(1)

OC1; PAH(3)

OC2; PFH(3) (t = 6, 12, 24) PFV1 (t = 0, 6, 12, 24)

OC3; FLA(8) FSA(1) FUL(2) FUS(1) PLC(5) FLS(2) PSC(3)
FSS(3) FSE(2) PSL(2)

OC4; FAH3 FRS1

OC5; FFH3 (t = 6)

OC6; FSM(3) FSC(3) FSF(2) PSG(3)

OC7; FLC(5) FSG(3) FAH3

OC8; FFV1 t = 0, 6, 12, 24, 30, 36, 48
FFH3 t = 6, 12, 24, 30, 36, 48
FFH1 t = 30

4. INITIAL FORECAST TAPE

1. Title Block
 1. Reel No.
 2. Identifier MFI00YMD
 3. ☒ CR ☒ CN INITIA
LF
 4. L < FORECA
 5. ST < TAPE <
 6. DD/MM/YY
 7. GG < GMT < <
2. Blocks 2 - 13 - Fields of seasonal mean heights, 1000, 500 and 200mb for January, April, July, October; $\frac{1}{2}$ -word floating point.
3. (a) Copy of FSG data from previous results tape i.e. surface ship reports for 0600Z (1800Z) in form N (YQLLL111) (GGdsvsapp) (PPPTTapp) (Call sign) etc.
(b) Copy of appropriate forecast (FFH3) from earlier results tape.

Items 3(a) and (b) may occur in either order; either or both may be omitted.

The last block on the tape ends with a last block marker.

5. CONSTANTS TAPE

Block No.

1. Title block.
 1. Reel No.
 2. Identifier MFCNST00.
 3. ☒ CR ☒ CN CONSTA
LF
 4. NTS < TAPE
 5. DD/MM/YY - Date from which valid.

2. (a) List of 101 numbers, $n_{00}, n_{01}, \dots, n_{00}$, in binary, $\frac{1}{2}$ -words, fixed point. n_{II} is the $\frac{1}{2}$ -word relative address of the beginning of the list of upper air station nos. in W.M.O. Block II; e.g. $n_{00} = 0, n_{01} = 0, n_{02} = 6$ etc. Total $50\frac{1}{2}$ words + $\frac{1}{2}$ -word gap.
- (b) List of upper air station nos., omitting block number, beginning with those in block 01. Stored in $\frac{1}{2}$ -words, with each numeric character in binary form; e.g. station 159 is octal 00 01 05 11. 1 special station, DY4 in block 04, is stored as octal 00, 57, 46, 04.
3. (a) x, y for each station in order given in 2(b) stored as $\frac{1}{2}$ -words, fixed point, 11 integral places.
- (b) $\beta g/af$ for each station, in hr^{-1} , stored as $\frac{1}{2}$ -words, floating point.
4. (a) As 2(a), substituting list of land stations.
- (b) As 2(b) (land stations)
5. (a) As 3(a) for land stations
- (b) As 3(b) for land stations
6. 1 word title-block - U/A CONS
7. Values of $S_{00}, S_{12} \oplus + 350$, for each upper air station in order given in 2(b). S represents 200mb sonde-correction in metres, 12 bits each, fixed point and \oplus longitude in tenths of degrees, fixed point, $\frac{1}{2}$ -word.
8. One word title block REF LIST
- 9 - 49. For each grid point, list of 10 nearest upper air stations identified by reference nos. (0,1,2 etc, where 0 refers to first station in list at 2(b)), with other parameters as follows:-

(Ref No.), $p, \bar{x}, \bar{y}, \beta g/af$, all as half-words, the reference number being fixed point (binary) and the remainder floating point. p represents distance weighting factor, x and y are co-ordinates relative to the grid-point in units of grid-lengths and $\beta g/af$ is in hr^{-1} .
If there are less than 10 stations within grid-lengths, the last station ends with -1 (fixed point, $\frac{1}{2}$ -word) and parameters for the next point follow immediately. There are 41 blocks, with one row of grid points per block.
50. Repeat of 3.
51. One word title-block SURF CON
52. List of $\oplus + 350$ for surface stations, $\frac{1}{2}$ -word fixed point \oplus is in tenths of degrees.
53. One word title block SURF REF.

- 54 - 94. List of 12 nearest surface stations, with appropriate parameters, per grid-point, as in 9 - 49.
95. Repeat of 5.
96. One-word title block OCF CNST
97. Topographic heights (metres), floating point, $\frac{1}{2}$ -word for a 45 - 39 grid.
- 98 - 109. Mean thicknesses, as derived from mean sea temps, stored as 1000 - 600mb thickness in metres, less 4000, floating-point, $\frac{1}{2}$ -words. Values are stored for a 43 x 37 grid, with one block for each of the 12 months. Over land, value is stored as -4000.
- 110 One-word block END with last block marker.

Total:- 146,000 words ~ 245 feet.

6. Master Tapes

Title Blocks

Analysis		Forecast
1.	Reel No.	
2.	MFAQ/YMD	MFFQ/YMD - Identifiers
3.	<div> <div>CR</div> <div>LE</div> </div> CN ANALYS	<div> <div>CR</div> <div>LE</div> </div> CN FORECA
4.	IS MASTE	ST MASTE
5.	R TAPE	R TAPE
6.	DD/MM/YY	Dates & Times of first & last entries on tape.
7.	GG GMT	
8.	DD/MM/YY	
9.	GG GMT	

The remaining blocks comprise analysis or forecast fields, with 4-word block indicators, as extracted from the results tape. The identifier letters will be FAH, PAH, FTH, PTH. The last block carries a last block marker.

Time and Date
GGZ; DD/MM/YY

Reject Upper Land
Station Nos.
Additional Upper Land

Station Nos.

1000 ht (dm)

*850 wind

500 ht (dm)

*500 wind

200 ht (dm)

*200 wind

Reject Upper Ships

Reference Nos.

Additional Upper Ships

Latitude degs. and tenths

Longitude degs. and tenths

1000 ht (dm)

*850 wind

500 ht (dm)

*500 wind

200 ht (dm)

*200 wind

Reject Surface I and

Station Nos.

Additional Surface Land

Station Nos.

Pressure and Temp

Reject Surface Ships

Reference Nos.

Additional Surface Ships

Latitude degs. and tenths

Longitude degs. and tenths

*Wind

Pressure and Temp

CN

$$z; \quad / \quad /$$

RUL;

AUL;

RUS;

AUS;

RSL;

ASL;

RSS;

ASS;

INSTRUCTIONS FOR COMPLETION

1. All characters are mandatory, except those indicated by round brackets (), which may be replaced by spaces.
2. A single X should be written for any missing group; missing data indicators within a group are not permissible.
- *3. Wind directions are in tens of degrees, and speeds in knots. Speeds over 100 knots are indicated by adding 50 to dd.
4. Unwanted headings must be deleted.
5. Additional land stations must be on the computer's station list.
6. Reference Nos. refer to those printed by OC 6.

INSTRUCTIONS FOR PUNCHING

1. Punch only characters within the full lines.
2. Each line should terminate with $\begin{pmatrix} CR \\ LF \end{pmatrix}$ after the semi-colon, following the last group entered.
3. All characters should be in case normal. TAB and space are ignored throughout.
4. If no items are required, the date-time group and final end message alone should be punched.

C.F.O. INPUT TAPE - OC4 (STARRED DATA)

Time and Date GGZ; DD/MM/YY	(CR LF)	(CN)	Z;	/	/										
Upper Land Station Nos.	[Iiii]	SUL;													
Upper Ships Reference Nos.	[Unn]	SUS;													
Surface Land Station Nos.	[Iiii]	SSL;													
Surface Ships Reference Nos.	^A [Bnnn] C	SSS;													

→

INSTRUCTIONS FOR COMPLETION

1. All characters are mandatory, except those indicated by round brackets (), which may be replaced by spaces.
2. Unwanted headings must be deleted.
3. Reference Nos. refer to those printed by O.C.1.

INSTRUCTIONS FOR PUNCHING

1. Punch only characters within the full lines.
2. Each line should terminate with (CR
LF) after the semi-colon following the last group entered.
3. All characters should be in case normal. TAB and space are ignored throughout.
4. If no items are required, the date-time group and final end message alone should be punched.


C.F.O. INPUT TAPE - 0C7

[illegible]

INSTRUCTIONS FOR COMPLETION

1. All characters are mandatory, except those indicated by round brackets (), which may be replaced by spaces.
2. A single X should be written for any missing group; missing data indicators within a group are not permissible.
- *3. Wind directions are in tens of degrees, and speeds in knots. Speeds over 100 knots are indicated by adding 50 to dd.
4. Unwanted headings must be deleted.
5. Additional land stations must be on the computer's station list.
6. Reference Nos. refer to those printed by OC 6

INSTRUCTIONS FOR PUNCHING

1. Punch only characters within the full lines.
2. Each line should terminate with  after the semi-colon. following the last group entered.
3. All characters should be in case normal. TAB and space are ignored throughout.
4. If no items are required, the date-time group and final end message alone should be punched.

Appendix 4 a.

List of Surface Stations

Block and Stn.No.	Latitude	Longitude East + West -	Block and Stn. No.	Latitude	Longitude East + West -
01001	7057	-0840	02052	6657	1745
01005	7804	1338	02057	6533	2208
01028	7431	1901	02062	6311	1430
01030	6942	1901	02069	6116	1706
01055	7106	2359	02077	5921	1757
01062	7630	2504	02084	5743	1147
01098	7022	3106	02090	5740	1821
01105	6725	1153	02095	5641	1618
01203	6202	0459	02836	6722	2639
01262	6448	1033	02897	6417	2741
01415	5853	0538	02911	6303	2146
01482	5902	1032	02935	6224	2540
03005	6008	-0111	04005	6610	-2334
03026	5813	-0620	04018	6358	-2236
03075	5827	-0305	04063	6541	-1805
03091	5712	-0212	04077	6627	-1557
03100	5630	-0553	04082	6418	-1512
03171	5623	-0253	04202	7631	-6850
03263	5431	-0125	04210	7247	-5610
03302	5315	-0432	04212	7041	-5207
03334	5321	-0216	04220	6842	-5252
03395	5324	0005	04230	6656	-5342
03497	5235	0143	04231	6700	-5048
03590	5207	0059	04000	6624	-3706
03628	5131	-0235	04250	6410	-5145
03772	5129	-0027	04260	6200	-4943
03827	5021	-0407	04280	6054	-4600
03804	4956	-0618	04310	8136	-1640
03917	5439	-0613	04320	7646	-1846
03953	5156	-1015	04330	7418	-2014
03957	5215	-0620	04340	7025	-2158
03976	5414	-1000	04350	6748	-3216
03980	5522	-0720	04360	6537	-3739
			04380	6232	-4208
			04390	6003	-4312
06005	6206	-0740	07015	5034	0306
06011	6203	-0645	07021	4939	-0138
06030	5706	0952	07110	4827	-0425
06081	5533	0805	07130	4804	-0143
06180	5538	1240	07149	4844	0224
06230	5258	0445	07150	4858	0227
06400	5107	0240	07180	4841	0613
06447	5048	0421	07190	4833	0738
06620	4657	0726	07207	4718	-0313
			07240	4727	0043
			07460	4548	0309
			07480	4543	0457
			07510	4450	-0042
			07630	4337	0122
			07650	4327	0513
			07690	4339	0712
			07747	4244	0252
			07761	4155	0848
			07790	4233	0929

08001	4322	-0825	16059	4511	0739
08023	4328	-0349	16105	4530	1209
08160	4140	-0101	16120	4425	0851
08181	4117	0205	16158	4341	1024
08221	4028	-0334	16190	4337	1331
08261	3929	-0622	16239	4148	1236
08284	3929	-0029	16261	4132	1543
08306	3933	0244	16310	4001	1517
08314	3952	0416	16320	4040	1757
08373	3852	0122	16350	3900	1705
08391	3725	-0554	16405	3811	1305
08488	3650	-0228	16420	3812	1533
08495	3609	-0521	16470	3649	1157
08503	3940	-0307 -3107	16520	4038	0817
08506	3831	-2838	16560	3915	0903
08509	3845	-2705	16597	3551	1429
08515	3658	-2510	16620	4033	2301
08521	3238	-1654	16622	4031	2258
08536	3846	-0908	16641	3937	1955
08538	3659	-0857	16687	3810	2125
08545	4114	-0841	16716	3754	2344
08554	3701	-0755	16743	3648	2300
08575	4149	-0640	16749	3622	2807
08583	1653	-2500	16754	3520	2511
08589	1455	-2331			
08594	1644	-2257			
			17026	4202	3510
			17038	4100	3943
10147	5338	1000	17060	4058	2849
10185	5406	1327	17112	4008	2624
10203	5320	0712	17124	3946	3031
10202	5322	0713	17128	4007	3300
10338	5228	0942	17196	3843	3529
10384	5228	1326	17200	3821	3818
10438	5119	0929	17219	3820	2713
10866	4808	1142	17244	3752	3230
			17300	3653	3042
			17350	3659	3518
11036	4807	1633	17606	3509	3317
11518	5006	1417	17022	4127	3148
11782	4947	1816			
			20046	8037	5803
12295	5307	2311	20069	7930	7659
12330	5225	1651	20087	7933	9037
12375	5211	2058	20274	7730	8214
12695	4948	2246	20292	7743	10417
12840	4731	1902	20353	7657	6835
12882	4729	2139	20667	7320	7002
			20674	7330	8014
			20744	7223	5244
			20891	7159	10228
13128	4544	1604			
13274	4449	2018			
13333	4331	1646			
13462	4226	1917			
13483	4159	2128			
13615	4120	1947			
15120	4647	2342			
15310	4527	2802			
15420	4429	2608			
15552	4312	2755			
15614	4249	2323			

21358	7609	15250	25123	6848	16117
21432	7600	13754	25173	6855	-17929
21504	7440	11256	25248	6720	16814
21647	7311	14356	25399	6610	-16950
21802	7158	11405	25400	6544	15054
21824	7135	12855	25551	6441	17025
21946	7037	14753	25563	6447	17734
21965	7038	16224	25594	6426	-17314
21982	7058	-17832	25621	6400	15855
22113	6858	3303	25677	6303	17919
22165	6839	4318	25703	6255	15225
22235	6722	3702	25821	6155	15859
22522	6459	3447	25913	5935	15047
22550	6435	4030	25954	6021	16600
22583	6445	4739	25956	6027	16935
22768	6206	4254			
22802	6143	3043			
22820	6149	3416			
22887	6114	4638			
			26038	5925	2448
			26063	5958	3018
			26258	5750	2821
			26298	5754	3403
			26422	5558	2404
			26629	5453	2353
			26702	5442	2037
			26781	5445	3204
			26850	5352	2732
			27037	5917	3952
			27196	5839	4937
			27271	5822	4533
			27553	5613	4349
			27595	5547	4911
			27612	5545	3734
			27703	5434	3622
			27947	5244	4128
			28064	5937	6547
			28225	5801	5618
			28275	5809	6811
			28440	5648	6038
			28493	5654	7423
			28661	5528	6524
			28679	5450	6909
			28698	5456	7324
			28722	5445	5600
			28900	5315	5027
			28952	5313	6337
			29231	5818	8254
			29263	5827	9209
			29282	5825	9724
			29574	5600	9253
			29612	5522	7824
			29634	5502	8254
			29698	5453	9902
			29838	5320	8342
			29865	5345	9124
23022	6946	6141			
23074	6924	8610			
23146	6828	7336			
23205	6739	5301			
23219	6705	5923			
23256	6728	7844			
23330	6632	6632			
23383	6653	9328			
23418	6507	5706			
23472	6547	8757			
23552	6455	7749			
23585	6423	9307			
23631	6356	6503			
23711	6242	5612			
23804	6140	5051			
23849	6115	7330			
23884	6136	9000			
23891	6140	9622			
23921	6041	6026			
23933	6058	6904			
23955	6026	7752			
23966	6021	8405			
24105	6828	10222			
24125	6830	11226			
24143	6844	12400			
24266	6733	13323			
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24343	6646	12324			
24382	6627	14314			
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24641	6346	12137			
24671	6357	13552			
24688	6316	14309			
24738	6209	11739			
24817	6116	10801			
24908	6020	10216			
24944	6024	12025			
24959	6205	12945			
24966	6023	13427			

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38062	4446	6532	40980	3137	6548
38178	4309	6420			
38198	4316	6813			
38232	4258	5407			
38262	4257	5949	41530	3401	7135
38341	4251	7123	41598	3256	7343
38388	4102	5746	41640	3133	7420
38392	4150	5959	41675	3012	7126
38457	4116	6916	41715	2818	6828
38507	4002	5259	41756	2504	6148
38613	4055	7257	41765	2523	6825
38656	3919	5836	41768	2531	6947
38687	3905	6336	41780	2455	6709
38696	3934	6657	41858	2451	8923
38750	3728	5358	41917	2346	9023
38836	3835	6847	41941	2216	9149
38880	3758	5820			
38895	3736	6211			
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38954	3730	7130	42111	3019	7802
38974	3632	6113	42165	2800	7318
			42182	2835	7712
			42189	2822	7924
			42314	2729	9501
40001	3703	4113	42339	2618	7301
40007	3611	3713	42348	2649	7548
40045	3520	4009	42361	2614	7815
40100	3349	3529	42379	2645	8322
40180	3200	3454	42398	2638	8819
40191	3114	3447	42410	2605	9143
40199	2933	3457	42475	2527	8144
40356	3141	3839	42543	2435	7342
40357	3059	4059	42559	2439	7719
40362	2938	4330	42591	2445	8457
40373	2819	4605	42623	2446	9354
40395	2728	4828	42634	2315	6948
40427	2616	5037	42647	2304	7238
40449	2521	5523	42704	2341	8659
40477	2130	3912	42754	2243	7548
40564	2041	5854	42779	2246	8154
40575	1703	5406	42809	2239	8827
40586	1439	4920	42840	2112	7250
40597	1250	4502	42867	2106	7903
40621	3528	4424	42875	2114	8139
40642	3302	4017	42886	2155	8405
40648	3322	4334	42909	2054	7022
40676	3101	4614	42971	2015	8550
40688	3025	4739	42977	2051	8815
40706	3808	4615			
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40718	3728	4928			
40738	3651	5428			
40745	3616	5938			
40754	3541	5119			
40767	3447	4830			
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40841	3015	5658			
40845	2916	5020			
40848	2932	5238			
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40875	2711	5617			

43003	1907	7251	48008	2522	9724
43014	1951	7524	48042	2159	9606
43041	1905	8202	48062	2008	9253
43063	1832	7351	48074	1943	9613
43128	1727	7828	48078	1855	9628
43149	1743	8314	48080	1828	9421
43181	1632	8048	48094	1646	9446
43193	1552	7338	48096	1654	9611
43201	1525	7538	48108	1406	9813
43237	1441	7737	48112	0958	9835
43279	1300	8011	48327	1847	9859
43296	1257	7738	48351	1737	10008
43314	1115	7547	48400	1548	10010
43329	1146	7946	48407	1515	10453
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43344	1046	7843	48565	0808	9819
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43371	0829	7657	48601	0518	10016
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43418	0835	8115	48620	0413	10042
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			48665	0216	10215
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46761	2306	12122	48860	1633	11137
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			48930	1953	10208
47008	4147	12949	48940	1757	10234
47014	4147	12653	48948	1640	10500
47041	3954	12731	48966	1322	10351
47058	3901	12549	48985	1037	10413
47105	3745	12854			
47108	3734	12658			
47115	3729	13054	50527	4913	11945
47146	3549	12709	50557	4910	12513
47159	3506	12902	50632	4846	12155
47184	3331	12632	50727	4713	11958
47401	4525	14141	50745	4720	12356
47406	4357	14138	50756	4726	12658
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47430	4149	14045	50949	4501	12458
47582	3943	14006	50953	4545	12638
47585	3939	14158	50963	4558	12844
47598	3657	14054	50978	4517	13057
47600	3723	13654			
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47744	3526	13321	51463	4346	8737
47750	3528	13523	51644	4145	8304
47778	3327	13546	51777	3905	8803
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47898	3243	13301			
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			52533	3950	9815
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53276	4237	11250	58102	3353	11547
53336	4128	10857	58221	3256	11722
53463	4049	11141	58238	3205	11845
53502	3949	10530	58251	3251	12019
53673	3849	11247	58367	3112	12126
53698	3802	11428	58424	3032	11702
53723	3743	10727	58457	3016	12010
53845	3636	10932	58472	3051	12240
53863	3658	11154	58477	3000	12206
			58527	2910	11715
			58633	2858	11853
			58715	2733	11636
			58921	2558	11721
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54094	4435	12936			
54102	4351	11605			
54135	4340	12215			
54151	4352	12520	59023	2448	10800
54208	4215	11613	59293	2345	11450
54218	4216	11854	59316	2321	11640
54324	4133	12027	59431	2251	10819
54342	4147	12324			
54423	4058	11750			
54471	4040	12214			
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54534	3940	11807	60030	2756	-1523
54616	3820	11655	60096	2342	-1552
54662	3854	12138	60115	3447	-0157
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54857	3604	12019	60230	3137	-0802
			60250	3023	-0934
			60360	3650	0749
			60390	3643	0315
			60490	3538	-0037
			60580	3155	0524
			60590	3034	0254
			60611	2803	0938
			60715	3650	1014
			60735	3540	1006
			60765	3353	1006
56294	3040	10404			
56964	2233	10102			
56985	2320	10323			
57006	3430	10550			
57036	3415	10855			
57083	3443	11343			
57237	3205	10805			
57265	3225	11140			
57297	3207	11405			
57447	3016	10922			
57461	3042	11115			
57494	3025	11417			
57515	2930	10633			
57679	2815	11250			
57745	2727	10938			
57799	2705	11455			
57816	2634	10642			
57866	2622	11131			
57902	2525	10515			
57957	2515	11010			
57993	2550	11452			

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61049	1415	1307	62880	0742	2801
61052	1329	0210			
61075	1348	0515			
61090	1348	0900			
61096	1314	1159	63021	1517	3855
61202	2012	0059	63043	1301	4243
61223	1646	-0301	53331	1232	3726
61230	1514	-0922			
61240	1520	-0141			
61257	1426	-1126	64005	0003	1816
61265	1431	-0406	64015	0338	1848
61290	1238	-0802	64040	0031	2511
61297	1121	-0541	64459	0137	1804
61401	2514	-1137	64460	0204	1403
61415	2056	-1703	64500	0027	0925
61421	2031	-1304	64510	0205	1129
61442	1807	-1556	64556	0034	1252
61450	1833	-1126	64600	0413	1547
61600	1603	-1627	64610	0629	1726
61630	1538	-1313	64654	0824	2039
61641	1444	-1730	64656	0444	2250
61687	1346	-1341	64658	1017	2247
61695	1235	-1616	64660	0546	2040
61809	1119	-1218	64661	0630	2316
61816	1056	-1419	64700	1208	1502
61820	1022	-1205	64701	1407	1519
61866	0732	-1230	64705	1029	1643
61886	0935	-1133	64706	0837	1604
61891	0759	-1051	64750	0908	1823
61931	0023	0643	64751	1313	1819
61934	0140	0725	64753	1800	1910
			64754	1102	2017
			64756	1351	2051
			64860	0920	1323
			64901	0536	1404
			64910	0401	0943
62010	3241	1310			
62016	3225	1506			
62019	3112	1635			
62053	3205	2016			
62055	3043	2010			
62063	3151	2355	65001	1053	0445
62131	2908	1557	65019	1036	0727
62161	2902	2134	65073	1142	1102
62271	2413	2318	65082	1151	1305
62306	3120	2713	65145	0811	0945
62318	3112	2957	65229	0619	0536
62333	3117	3214	65243	0748	0644
62366	3008	3134	65250	0451	0701
62387	2805	3044	65257	0628	0733
62405	2540	3242	65306	1108	0256
62414	2358	3247	65333	0852	0236
62417	2912	2529	65335	0759	0226
62420	2820	2854	65387	0610	0115
62432	2529	2900	65404	1004	-0230
62462	2717	3346	65418	0925	-0053
62600	2150	3118	65432	0745	-0206
62640	1932	3319	65467	0453	-0146
62641	1935	3713	65503	1221	-0131
62660	1833	3151	65539	0935	-0512
62680	1742	3358	65548	0723	-0731
62721	1536	3233	65555	0744	-0504
62730	1528	3624	65578	0515	-0356
62760	1337	2520	65592	0425	-0722
62770	1329	2227			
62771	1310	3014			

70026	7118	-15647
70086	7008	-14338
70133	6652	-16238
70200	6430	-15526
70218	6023	-16612
70219	6047	-16148
70222	6444	-15656
70231	6258	-15537
70261	6449	-14752
70273	6110	-14959
70296	6030	-14530
70308	5709	-17013
70316	5512	-15243
70326	5841	-15639
70350	5745	-15231
70360	5948	-14436
70361	5931	-13940
70365	5812	-13638
70381	5822	-13435
70388	5600	-13408
70398	5502	-13134
70414	5243	17406
70454	5153	-17639

72201	2433	-8145
72202	2548	-8016
72205	2833	-8120
72206	3025	-8139
72208	3254	-8002
72211	2758	-8232
72217	3242	-8339
72220	2944	-8459
72222	3028	-8712
72226	3218	-8624
72232	2858	-8922
72235	3219	-9005
72240	3007	-9313
72242	2918	-9448
72248	3228	-9349
72250	2554	-9726
72253	2932	-9828
72259	3250	-9703
72265	3156	-10212
72270	3148	-10624
72274	3207	-11056
72278	3326	-11201
72290	3244	-11710

72304	3516	-7533
72308	3653	-7612
72310	3357	-8107
72317	3605	-7957
72326	3549	-8359
72327	3607	-8641
72334	3503	-8959
72340	3444	-9214
72344	3520	-9422
72353	3524	-9736
72363	3514	-10142
72365	3503	-10637
72374	3501	-11044
72386	3605	-11510
72394	3454	-12027

72405	3851	-7702
72408	3953	-7515
72414	3822	-8136
72423	3811	-8544
72429	3954	-8413
72440	3714	-9323
72445	3858	-9222
72451	3746	-9958
72458	3933	-9739
72460	3946	-10453
72476	3907	-10832
72486	3917	-11451
72488	3930	-11947
72494	3737	-12223

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72506	4.115	-7004
72518	4.245	-7348
72519	4.307	-7607
72520	4.030	-8013
72528	4.256	-7844
72532	4.040	-8941
72537	4.224	-8300
72547	4.224	-9042
72553	4.122	-9601
72562	4.108	-10041
72572	4.046	-11158
72576	4.249	-10844
72578	4.255	-11236
72583	4.054	-11748
72597	4.222	-12252

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72603	4350	-6605
72606	4339	-7019
72623	4302	-8109
72624	4341	-7938
72627	4528	-7345
72630	4458	-7918
72635	4253	-8531
72639	4504	-8334
72645	4429	-8808
72654	4423	-9813
72655	4535	-9411
72662	4403	-10304
72677	4548	-10832
72681	4334	-11613
72693	4407	-12313
72705	4607	-6441
72707	4610	-6003
72709	4723	-6152
72712	4652	-6801
72714	4648	-7123
72718	4836	-6812
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72734	4628	-8422
72735	4742	-7951
72738	4835	-8517
72743	4634	-8724
72745	4650	-9211
72747	4834	-9323
72749	4822	-8919
72753	4654	-9648
72764	4646	-10045
72768	4813	-10637
72773	4655	-11405
72775	4729	-11121
72785	4737	-11731
72793	4727	-12218
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72801	4737	-5245
72803	4857	-5434
72805	4647	-5611
72811	5013	-6616
72813	5012	-6149
72815	4832	-5833
72816	5319	-6025
72817	5215	-5536
72818	5342	-5702
72819	5122	-5535
72822	4947	-7452
72825	5256	-6653
72826	5312	-7054
72828	5448	-6649
72831	4925	-8228
72836	5116	-8039
72840	5011	-8642
72842	5007	-9154
72846	5214	-8753
72848	5350	-8952
72852	4954	-9714
72860	5001	-10019
72863	5026	-10440

72867	5358	-10106
72869	5313	-10541
72870	5017	-10741
72872	5001	-11043
72877	5106	-11401
72891	5014	-12134
72895	5055	-12757
72896	5353	-12241
72898	5418	-13026
72900	5527	-6014
72903	6135	-6439
72904	6105	-6933
72905	5517	-7746
72906	5806	-6826
72907	5827	-7808
72908	6307	-7756
72909	6345	-6833
72910	5514	-8507
72913	5845	-9404
72915	6412	-8322
72916	6320	-9043
72917	8000	-8556
72918	7300	-8518
72919	6826	-8939
72920	5532	-10221
72921	5753	-10140
72923	6108	-10055
72924	7443	-9459
72925	6906	-10507
72926	6418	-9600
72927	6840	-9748
72932	5639	-11113
72934	6001	-11158
72936	6228	-11427
72938	6749	-11505
72940	5511	-11853
72945	5850	-12235
72946	6145	-12114
72953	6007	-12849
72959	6927	-13300
72964	6043	-13504
72965	6336	-13553
74043	6517	-12648
74051	7157	-12444
74053	6935	-12045
74062	6529	-11022
74072	7614	-11920
74073	6243	-10906
74074	7847	-10332
74081	6847	-8115
74082	8230	-6220
74090	7027	-6833
74091	6857	-7518
74093	6826	-6647
74094	6635	-6137
74098	5614	-6444
74107	5156	-13101
74123	5319	-11335
74188	5041	-6848
74189	4901	-6424

76050	3151	-11638	80022	1028	-7530
76151	2910	-11819	80062	0807	-7643
76160	2905	-11057			
76225	2838	-10604	80308	0227	-7640
76255	2755	-11053	80336	0149	-7845
76342	2654	-10125	80402	1039	-7136
76382	2532	-10327	80405	0809	-6333
76405	2410	-11021			
76412	2449	-10724	80409	0754	-6725
76458	2312	-10625	80410	0751	-7227
76499	2346	-9812	80412	1035	-6218
76548	2213	-9751	80413	0718	-6127
76556	2131	-10454	80414	1007	-6441
76644	2059	-8939			
76648	2031	-8657			
76679	1924	-9912	91066	2813	-17722
76692	1912	-9608	91155	2352	-16617
76695	1951	-9032	91165	2159	-15921
76741	1809	-9425	91182	2121	-15756
76805	1650	-9955	91190	2054	-15626
76833	1610	-9512	91275	1644	-16931
76903	1455	-9216	91285	1943	-15504
78016	3222	-6441			
78073	2503	-7728			
78095	2306	-7459			
78109	2222	-7258			
78325	2309	-8221			
78355	2124	-7755			
78367	1954	-7509			
78383	1915	-8125			
78397	1756	-7647			
78439	1833	-7221			
78486	1828	-6953			
78501	1724	-8356			
78526	1826	-6600			
78663	1342	-8907			
78730	1402	-8324			
78741	1207	-8611			
78762	0959	-8413			
78806	0858	-7936			
78894	1754	-6252			
78897	1616	-6131			
78954	1304	-5930			
78970	1037	-6121			
78988	1211	-6859			

Appendix 4b
List of Upper Air Stations

Block and Stn. No.	Latitude	Longitude East + West -	200 mb Sonde Corrections (in decametres)	
			00Z	12Z
01001	7057	-0840	-2	-4
01028	7430	1900	-2	-4
01152	6716	1424	-2	-4
01241	6342	0924	-2	-4
01384	6012	1106	-2	-4
01415	5853	0539	-2	-4
02057	6533	2208	-2	-4
02062	6311	1437	-2	-4
02077	5921	1757	-2	-4
02084	5743	1147	-2	-4
02160	5744	1836	-2	-4
02836	6722	2639	-2	-4
02935	6224	2540	-2	-4
02963	6049	2329	-2	-4
03005	6008	-0111	0	0
03026	5813	-0619	0	0
03170	5626	-0252	0	0
03322	5333	-0255	0	0
03496	5241	0141	0	0
03774	5105	-0013	0	0
03808	5013	-0519	0	0
03920	5429	-0606	0	0
03953	5156	-1015	0	0
04018	6358	-2236	0	-2
04202	7631	-6850	0	0
04220	6842	-5252	-2	-3
04270	6111	-4525	0	-2
04310	8136	-1640	-2	-3
04320	7646	-1846	-2	-3
04340	7025	-2158	-2	-3
04360	6537	-3739	-2	-3
06011	6203	-0645	-2	-3
06030	5706	0952	-2	-3
06181	5546	1231	-2	-3
06260	5206	0511	-1	-8
06447	5048	0421	-1	-8
06476	5002	0524	-1	-8
06610	4649	0657	0	0
07110	4827	-0425	-2	-6
07145	4846	0201	-2	-6
07180	4841	0613	-2	-6
07480	4543	0457	-2	-6
07510	4450	-0042	-2	-6
07645	4352	0424	-2	-6
07761	4155	0848	-2	-6

08001	4322	-0825	0	-3
08159	4141	-0104	0	-2
08221	4028	-0334	0	-3
08302	3936	0242	0	-3
08495	3609	-0521	0	2
08509	3845	-2705	0	-2
08521	3238	-1654	8	7
08536	3846	-0908	8	7
08594	1644	-2257	8	7
10035	5432	0933	-3	-4
10184	5406	1323	-2	-3
10202	5322	0713	-3	-4
10338	5228	0942	-3	-4
10393	5213	1407	-2	-3
10454	5151	1046	-2	-3
10486	5107	1341	-3	-3
10513	5052	0708	-3	-4
10739	4850	0912	-3	-4
10866	4808	1142	-3	-4
11035	4815	1622	0	-2
11518	5006	1417	-3	-6
11934	4904	2015	-3	-6
12105	5412	1611	-3	-6
12330	5225	1651	-3	-6
12374	5225	2058	-3	-6
12425	5108	1659	-3	-6
12577	5018	2127	-3	-6
12843	4726	1911	-3	-6
12982	4615	2006	-3	-6
13130	4549	1602	0	-2
13276	4447	2032	0	-2
15120	4647	2342	-3	-6
15420	4429	2608	-3	-6
15480	4411	2840	-3	-6
15614	4249	2323	-3	-6
15730	4138	2524	-3	-6
16044	4602	1311	0	-2
16080	4526	0917	0	-2
16242	4148	1214	0	-2
16320	4040	1757	0	-2
16420	3812	1533	0	-2
16560	3915	0903	0	-2
16596	3550	1427	0	1
16622	4031	2258	0	-2
16716	3754	2344	0	-2
16754	3520	2511		
17030	4117	3620	0	-2
17062	4058	2905	0	-2
17130	3957	3253	0	-2
17220	3826	2710	0	-2
17280	3755	4012	0	-2
17606	3509	3317	0	0

20046	8037	5803	-3	-6
20069	7930	7659	-3	-6
20107	7804	1413	-3	-6
20274	7730	8214	-3	-6
20292	7743	10417	-3	-6
20353	7657	6835	-3	-6
20667	7320	7002		
20674	7330	8014	-3	-6
20891	7159	10228	-3	-6

21358	7609	15250	-3	-6
21432	7600	13754	-3	-6
21504	7440	11256	-3	-6
21647	7311	14356	-3	-6
21824	7135	12855	-3	-6
21946	7037	14753		
21965	7038	16224	-3	-6
21982	7058	-17832	-3	-6

22113	6858	3303	-3	-6
22165	6839	4318	-3	-6
22217	6708	3226	-3	-6
22271	6753	4408	-3	-6
22522	6459	3447	-3	-6
22550	6435	4030	-3	-6
22802	6143	3043	-3	-6
22820	6149	3416	-3	-6
22845	6130	3856	-3	-6

23022	6946	6141	-3	-6
23146	6828	7336	-3	-6
23205	6739	5301	-3	-6
23274	6728	8634	-3	-6
23330	6632	6632	-3	-6
23418	6507	5706	-3	-6
23472	6547	8757	-3	-6
23552	6455	7749	-3	-6
23804	6140	5051	-3	-6
23884	6136	9000	-3	-6
23921	6041	6026	-3	-6
23933	6058	6904	-3	-6
23955	6026	7752	-3	-6

24125	6830	11226	-3	-6
24266	6733	13323	-3	-6
24343	6646	12324	-3	-6
24507	6410	10004	-3	-6
24641	6346	12137	-3	-6
24688	6316	14309	-3	-6
24817	6116	10801	-3	-6
24908	6020	10216	-3	-6
24944	6024	12025	-3	-6
24959	6205	12945	-3	-6

25173	6855	-17929	-3	-6
25399	6610	-16950	-3	-6
25551	6441	17025	-3	-6
25563	6447	17734	-3	-6
25594	6426	-17314	-3	-6
25677	6303	17919	-3	-6
25703	6255	15225	-3	-6
25913	5935	15047	-3	-6
25954	6021	16600	-3	-6

26038	5925	2448	-3	-6
26063	5958	3018	-3	-6
26258	5750	2821	-3	-6
26298	5754	3403	-3	-6
26406	5633	2101	-3	-6
26422	5658	2404	-3	-6
26477	5623	3036	-3	-6
26629	5453	2353	-3	-6
26702	5442	2037	-3	-6
26781	5445	3204	-3	-6
26850	5352	2732	-3	-6

27037	5917	3952	-3	-6
27196	5839	4937	-3	-6
27553	5613	4349	-3	-6
27595	5547	4911	-3	-6
27612	5545	3734	-3	-6
27707	5407	3520	-3	-6
27731	5437	3943	-3	-6
27947	5244	4128	-3	-6
27962	5308	4501	-3	-6

28225	5801	5618	-3	-6
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28440	5648	6038	-3	-6
28661	5528	6524	-3	-6
28698	5456	7324	-3	-6
28722	5445	5600	-3	-6
28900	5315	5027	-3	-6
28952	5313	6337	-3	-6

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29263	5827	9209		
29282	5825	9724	-3	-6
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29634	5502	8254	-3	-6
29698	5453	9902	-3	-6
29838	5320	8342		
29865	5345	9124		

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30710	5216	10421	-3	-6
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30935	5022	10845	-3	-6

31004	5837	12522	-3	-6
31088	5922	14312	-3	-6
31168	5627	13809	-3	-6
31329	5304	13256	-3	-6
31369	5309	14042	-3	-6
31510	5016	12730	-3	-6
31735	4831	13510	-3	-6
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32061	5054	14210	-3	-6
32150	4655	14244	-3	-6
32165	4401	14549		
32186	4612	15030	-3	-6
32217	5000	15523	-3	-6
32389	5619	16050	-3	-6
32540	5258	15845	-3	-6
32618	5512	16559	-3	-6
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33317	5010	2703	-3	-6
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33393	4949	2357	-3	-6
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33791	4756	3320	-3	-6
33815	4701	2852	-3	-6
33837	4629	3038	-3	-6
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34247	5025	4103	-3	-6
34300	4956	3617	-3	-6
34560	4841	4421	-3	-6
34731	4715	3949	-3	-6
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35121	5145	5506	-3	-6
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36870	4314	7656	-3	-6
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37472	4301	4726	-3	-6
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38750	3728	5358	-3	-6
38836	3835	6847	-3	-6
38880	3758	5820	-3	-6
38927	3714	6716	-3	-6
38954	3730	7130	-3	-6

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40100	3349	3529	0	2
40179	3200	3449	0	4
40427	2616	5037	0	2
40597	1249	4502	0	2
40650	3320	4424	0	2
40689	3034	4747	0	2
40754	3541	5119	0	2
40841	3015	5658	0	2
40948	3433	6912	0	0
41530	3401	7135	0	0
41640	3133	7420	0	0
41661	3011	6657	0	0
41756	2504	6148	0	2
41780	2455	6709	0	4
41917	2346	9023	0	2
41941	2216	9149	0	2

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42339	2618	7301	0	0
42410	2605	9143	0	0
42475	2527	8144	0	0
42647	2304	7238	0	0
42809	2239	8827	0	0
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43295	1258	7735		
43296	1257	7738	0	0
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43371	0829	7657	0	0
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47122	3706	12702	0	0
47187	3312	12613	0	0
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47582	3943	14006	-3	-3
47590	3816	14054	-3	-3
47600	3723	13654	-3	-3
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48327	1847	9859	1	0
48407	1515	10453	0	0

50527	4913	11945	0	0
50557	4910	12513	0	0
50953	4545	12638	0	0

51076	4752	8806	0	0
51431	4355	8117	0	0
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