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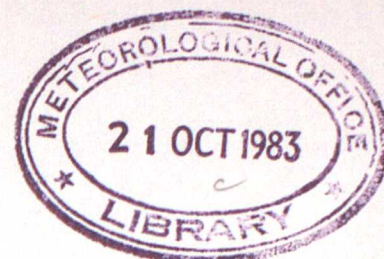
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ACCUMULATION OF A SET OF RADIOSONDE PROFILES
FOR USE WITH SATELLITE SOUNDING DATA FROM
THE EUROPEAN AND NORTH ATLANTIC AREAS.

by

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NOTE:

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1. INTRODUCTION.

The Met.0.19 HERMES project provides real-time retrieval of temperature profiles from TIROS Operational Vertical Sounder (TOVS) data using direct broadcasts from TIROS-N series satellites. These data are received at Lasham in Hampshire (51.19N, 1.03W) giving coverage over an area within about 3000 km. of Lasham, which includes Europe, the Mediterranean and the eastern North Atlantic. (This is known as our "local area".)

The present retrieval method uses a statistical regression between measured satellite radiances and collocated radiosondes. The regression coefficients are generated and supplied by NOAA/NESDIS in Washington D.C. These retrieval coefficient are based on a world wide set of radiosonde-radiance collocations which are updated weekly. It is expected that the accuracy of the retrievals could be improved by tuning the regression coefficients for our local area (e.g. coefficients generated using synthetic radiances calculated from a representative set of radiosondes for our local area). This paper describes an attempt to select a representative set of radiosonde profiles suitable for this purpose.

24 data sets of radiosonde profiles have been assembled, one "land" set and one "oceanic" set for each month. Each set contains 400 profiles which have been randomly selected from a seven year period and checked to eliminate "roques". Further selection has been made to ensure representativeness of geographical distribution and night/day ascent time distribution.

Although the impetus for this work has been provided by the need to assist research and development on TOVS retrievals, it is hoped that the data sets will prove useful in other applications.

2. SELECTION PROCESS.

It was decided at the outset to generate monthly data sets and that for each month there should be one data set for "oceanic" stations and another for "land" stations. "Oceanic" stations include weather ships, islands and coastal sites, whereas "land" stations are mainly distant from the coast. However for stations in the intermediate region a somewhat arbitrary assignment has been made. A suitable source of data was found to be the Monthly Regional Upper Air archive maintained by Met.0.22.

2.1 Radiosonde stations in Lasham local area.

A list of radiosonde station numbers within about 3000 km of Lasham was compiled. A map showing the location of these stations and their ocean/sea classification is given in figure 1.

2.2 Time period of data.

A set of profiles was required from each month over a number of years. Seven years was thought to be adequate. The Met.0.22 archive was found to contain consecutive months of data from 1975 so the following years were chosen.

MONTH	75	76	77	78	79	80	81	82
JAN		*	*	*	*	*	*	*
FEB		*	*	*	*	*	*	*
MAR		*	*	*	*	*	*	*
APR		*	*	*	*	*	*	*
MAY		*	*	*	*	*	*	*
JUN		*	*	*	*	*	*	*
JUL		*	*	*	*	*	*	*
AUG		*	*	*	*	*	*	*
SEP		*	*	*	*	*	*	*
OCT		*	*	*	*	*	*	*
NOV		*	*	*	*	*	*	*
DEC	*	*	*	*	*	*	*	

2.3 Accumulation of sondes as candidates for selection.

For each month of the year over the seven year period candidates for selection were extracted from the Met.0.22 archive and accumulated in either an oceanic data set or a land data set. For each month the seven yearly oceanic data sets were merged to make one data set which typically contained 4000 ascents. Also for each month the seven land data sets were merged to make one land data set which typically contained 6500 ascents.

2.4 Random selection of sondes.

500 ascents were selected at random from each of the merged data sets for land and sea.

2.5 Rogue elimination.

Upon examination of the resulting ascents it was found that some of the profiles contained gross errors. In order to eliminate these, the sonde data were filtered to select (from each data set of 500) 400 free from such errors, using the method outlined in section 4.3.

3. SELECTION CRITERIA.

Selection criteria are employed in different parts of the scheme but are described together below.

Number of levels.

- * Part A of the radiosonde report (i.e. standard levels) must have 2 - 25 levels reported.
- * Part B of the radiosonde report (i.e. special levels) must have 5 - 45 levels reported, with at least one of the bottom 5 levels being greater than 1000 mb.

Pressure.

- * pressure at all levels must be greater than zero mb.
- * each level must have a lower pressure than the preceeding level, with the first level at the surface.
- * pressure of level 1 (surface) in part A of the message must be greater than 850 mb and the top level must be 50 mb or less.
- * pressure of level 1 (surface) in part B of the message must be greater than or equal to 1000 mb and the top level must be 15 mb or less.

Temperature.

- * temperature at all levels must be in the range -100 deg C to +100 deg C.
- * when the profile is interpolated/extrapolated to 40 fixed levels, each temperature must lie within three standard deviations of the ensemble mean for that level.

Humidity.

- * there must be valid dew point at all special levels from the surface to 600 mb.
- * temperature must be greater than or equal to dew point at all levels.
- * if a level temperature is greater than -40 deg C the dew point must be greater than -100 deg C.
- * when the profile is interpolated/extrapolated to 40 fixed levels, each log(mixing ratio) value must lie within three standard deviations of the ensemble mean for that level.

4. PROGRAM STRUCTURE

The following computer programs were used in the selection process, which is illustrated in figure 2. These programs are on COSMOS library M19.SRCELIB and the documentation for most of these programs is kept in the Met.0.19 HERMES documentation folders.

4.1 Accumulation of sondes from archive.

TSNDS - Creates two data sets of radiosonde profiles, one for oceanic stations and one for land stations for one month of one year. Let the number of sondes written to the oceanic data set be NSY, and the number of sondes written to the land data set be NLV. The source of data is the Met.0.22 Monthly Regional Upper Air archive.

TMOD - Makes one file of sondes for one month, oceanic or land. The number of sondes, NS7Y or NL7Y, in the oceanic or land data set respectively is the sum of all the sondes for each of the seven years. 24 data sets are created in all, oceanic and land for each month.

4.2 Random selection.

TRND - Generates a set of 500 random numbers in the range 1 to NS7Y or NL7Y as appropriate for each of the 24 data sets generated by TMOD.

TDAUA - Reads all sondes on a file created by TMOD and writes them to disk as a direct access data set.

TT500 - Selects 500 sondes, using the random numbers generated by TRND as record numbers, from the direct access data set created by TDAUA. Sonde data are examined and various selection criteria employed to ensure the quality of the ascents selected. These criteria are given in section 3.

The end result is an oceanic and a land set for each month each month containing data from 500 radiosonde ascents based on data from seven years.

4.3 Rogue detection.

The data sets created by TT500 above were examined and some of the sondes in them found to contain gross errors (e.g. coding errors). In an attempt to eliminate these errors it was decided to filter the data further.

TFSPRF - Based on the variance of the set of 500, this program filters to eliminate gross errors and select 400 good profiles. Sondes are interpolated to 40 fixed pressure levels, and means and standard deviations of temperature and log(mixing ratio) at each level are calculated. The sondes are then passed through a three standard deviation filter.

If any level in a sonde fails to pass through the filter it is discarded and the first 400 to pass the filter are saved. New level statistics on the 400 sondes are then compiled.

4.4 Ancillary programs.

INVUA - Provides an inventory showing number of ascents from each station in a merged data set.

TALLY - A diagnostic program which lists selected sonde data sets.

TOVSRAD - Program which calculates synthetic radiances for TOVS channels given an atmospheric profile.

Note. All selected sondes have been processed through TOVSRAD, in which some strict quality control checks are applied, and have been found acceptable.

LSFIX - Makes small corrections and amends minor errors in order to tidy up the final data sets.

MNPRF - Calculates statistics on a set of radiosonde ascents.

5. OUTPUT DATA SETS

The final output data sets are on a 9 track IBM standard label, 1600 bpi tape. The records are written in EBCDIC with a logical record length of 1344 bytes (format=224I6), and they are blocked with a physical blocksize of 13440 bytes. The details of the record format are given in table 1.

The tape contains 24 files: 12 for oceanic and 12 for land sondes. Each file contains 400 profiles. The data set names of the files are given in table 2.

6. STATISTICS OF OUTPUT DATA SETS

As a further check on the 400 radiosonde ascents in each of the 24 output data sets, the mean and standard deviation of temperature were calculated at the 40 fixed levels. Graphs of the resulting statistics were plotted. These take the form of plots of monthly mean level temperature against month for a particular fixed pressure level. Included here are 4 such graphs, showing the monthly values for of both land and oceanic stations for the 1000, 500, 250 and 100 mb levels (figures 3, 4, 5 and 6 respectively).

These graphs confirm that the gross characteristics of the data sets generated generally conform with expectations. At all levels the expected annual cycle in mean temperature is found. At 1000 mb the amplitude of the annual cycle is larger over "land" than "sea", reflecting the effect of the surface temperature characteristics. As expected this effect is not significant at other levels. One unforeseen result is the larger variance at all levels in the "sea" data set. This is probably caused by the larger latitudinal range of the stations from which the "sea" data were selected.

Table 1

F050

F050 SONDE RECORD FORMATS.

EACH RECORD IS COMPOSED OF 224 6-BYTE WORDS.
RECORD FORMAT IS (224I6). EACH BLOCK CONTAINS 10 RECORDS.

RECFM =FB RECORD FORMAT.
LRECL =1344 LOGICAL RECORD LENGTH.
BLKSIZE=13440 BLOCKSIZE.

WORD

1	IWMO	BLOCK NUMBER
2	ISTN	STATION NUMBER
3	ILAT	LATITUDE * 100
4	ILON	LONGITUDE * 100
5	IYRMN	YEAR * 100 + MONTH
6	IDYHR	DAY * 100 + HOUR
7	NAL	NUMBER OF LEVELS IN PART A OF MESSAGE
8	NBL	NUMBER OF LEVELS IN PART B OF MESSAGE

CLOUD GROUP

9	ICLD(1) }	NL	AMOUNT OF LOW CLOUD. (OCTAS)
10	ICLD(2) }	CL	TYPE OF LOW CLOUD.
11	ICLD(3) }	HH	HEIGHT OF LOW CLOUD, IN DECAMETERS.
12	ICLD(4) }	CM	TYPE OF MEDIUM CLOUD.
13	ICLD(5) }	CH	TYPE OF HEIGH CLOUD.
14	ITGRND		GROUND TEMPERATURE * 100 deg C ,NOT USED

PART A - STANDARD LEVELS

15	ITTA(1,1) }		PRESSURE mb * 10
16	ITTA(2,1) }	LEVEL 1	TEMPERATURE deg C *10
17	ITTA(3,1) }		DEW POINT deg C *10
18	ITTA(1,2) }		PRESSURE mb * 10
19	ITTA(2,2) }	LEVEL 2	TEMPERATURE deg C * 10
20	ITTA(3,2) }		DEW POINT deg C * 10

ETC. NAL LEVELS OF VALID DATA.
EACH LEVEL CONTAINS THREE DATA ITEMS. P,T AND TD
MAXIMUM NUMBER OF LEVELS IS 25.

89	ITTA(3,25)	LEVEL 25	DEW POINT deg C * 10
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PART B - SPECIAL LEVELS

90	ITTB(1,1) }		PRESSURE mb * 10
91	ITTB(2,1) }	LEVEL 1	TEMPERATURE deg C * 10
92	ITTB(3,1) }		DEW POINT deg C * 10
93	ITTB(1,2) }		PRESSURE mb * 10
94	ITTB(2,2) }	LEVEL 2	TEMPERATURE deg C * 10
95	ITTB(3,2) }		DEW POINT deg C * 10

ETC. NBL LEVELS OF VALID DATA.
EACH LEVEL CONTAINS THREE DATA ITEMS. P,T AND TD
MAXIMUM NUMBER OF LEVELS IS 45.

224	ITTB(3,45)	LEVEL 45	DEW POINT deg C * 10
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Table 1 (continued)

NOTES.

- 1/ Latitude in degrees *100 with positive values indicating North.
- 2/ Longitude in degrees *100 with positive values indicating east of Greenwich, negative west.
- 3/ The station numbers for Weather Ships are on the form 100xxx , where xxx is the number of the letter of the alphabet of the ship.
e.g Ship 'C' is 100003
e.g. Ship 'L' is 100012
- 4/ The missing data indicator is -32768.

Table 2

Data Set Names

DSNAME	CREDAT	RFM	LRECL	BLKSZ	DEN	BLOCKS	LNG	FT	ACC	LENG	VOLSER	SEQ
M19.TUASEA.JAN	83216	FB	1344	13440	3	40	30.32	30.32	30.32	1900950001	1	
M19.TUASEA.FEB	83216	FB	1344	13440	3	40	30.32	30.32	60.64	1900950002	2	
M19.TUASEA.MAR	83216	FB	1344	13440	3	40	30.32	30.32	90.95	1900950003	3	
M19.TUASEA.APL	83216	FB	1344	13440	3	40	30.32	30.32	121.27	1900950004	4	
M19.TUASEA.MAY	83216	FB	1344	13440	3	40	30.32	30.32	151.59	1900950005	5	
M19.TUASEA.JUN	83216	FB	1344	13440	3	40	30.32	30.32	181.91	1900950006	6	
M19.TUASEA.JUL	83216	FB	1344	13440	3	40	30.32	30.32	212.22	1900950007	7	
M19.TUASEA.AUG	83216	FB	1344	13440	3	40	30.32	30.32	242.54	1900950008	8	
M19.TUASEA.SEP	83216	FB	1344	13440	3	40	30.32	30.32	272.86	1900950009	9	
M19.TUASEA.OCT	83216	FB	1344	13440	3	40	30.32	30.32	303.18	1900950010	10	
M19.TUASEA.NOV	83216	FB	1344	13440	3	40	30.32	30.32	333.49	1900950011	11	
M19.TUASEA.DEC	83216	FB	1344	13440	3	40	30.32	30.32	363.81	1900950012	12	
M19.TUALND.JAN	83217	FB	1344	13440	3	40	30.32	30.32	394.13	1900950013	13	
M19.TUALND.FEB	83217	FB	1344	13440	3	40	30.32	30.32	424.45	1900950014	14	
M19.TUALND.MAR	83217	FB	1344	13440	3	40	30.32	30.32	454.76	1900950015	15	
M19.TUALND.APL	83217	FB	1344	13440	3	40	30.32	30.32	485.08	1900950016	16	
M19.TUALND.MAY	83217	FB	1344	13440	3	40	30.32	30.32	515.40	1900950017	17	
M19.TUALND.JUN	83217	FB	1344	13440	3	40	30.32	30.32	545.72	1900950018	18	
M19.TUALND.JUL	83217	FB	1344	13440	3	40	30.32	30.32	576.04	1900950019	19	
M19.TUALND.AUG	83217	FB	1344	13440	3	40	30.32	30.32	606.35	1900950020	20	
M19.TUALND.SEP	83217	FB	1344	13440	3	40	30.32	30.32	636.67	1900950021	21	
M19.TUALND.OCT	83217	FB	1344	13440	3	40	30.32	30.32	666.99	1900950022	22	
M19.TUALND.NOV	83217	FB	1344	13440	3	40	30.32	30.32	697.31	1900950023	23	
M19.TUALND.DEC	83217	FB	1344	13440	3	40	30.32	30.32	727.62	1900950024	24	
FINISHED	TOTAL RECORDS					9576	TOTAL BLKS					960

Figure 1

SONDE STATIONS IN THE LASHAM LOCAL AREA.
O = OCEANIC STATIONS . L = LAND STATIONS

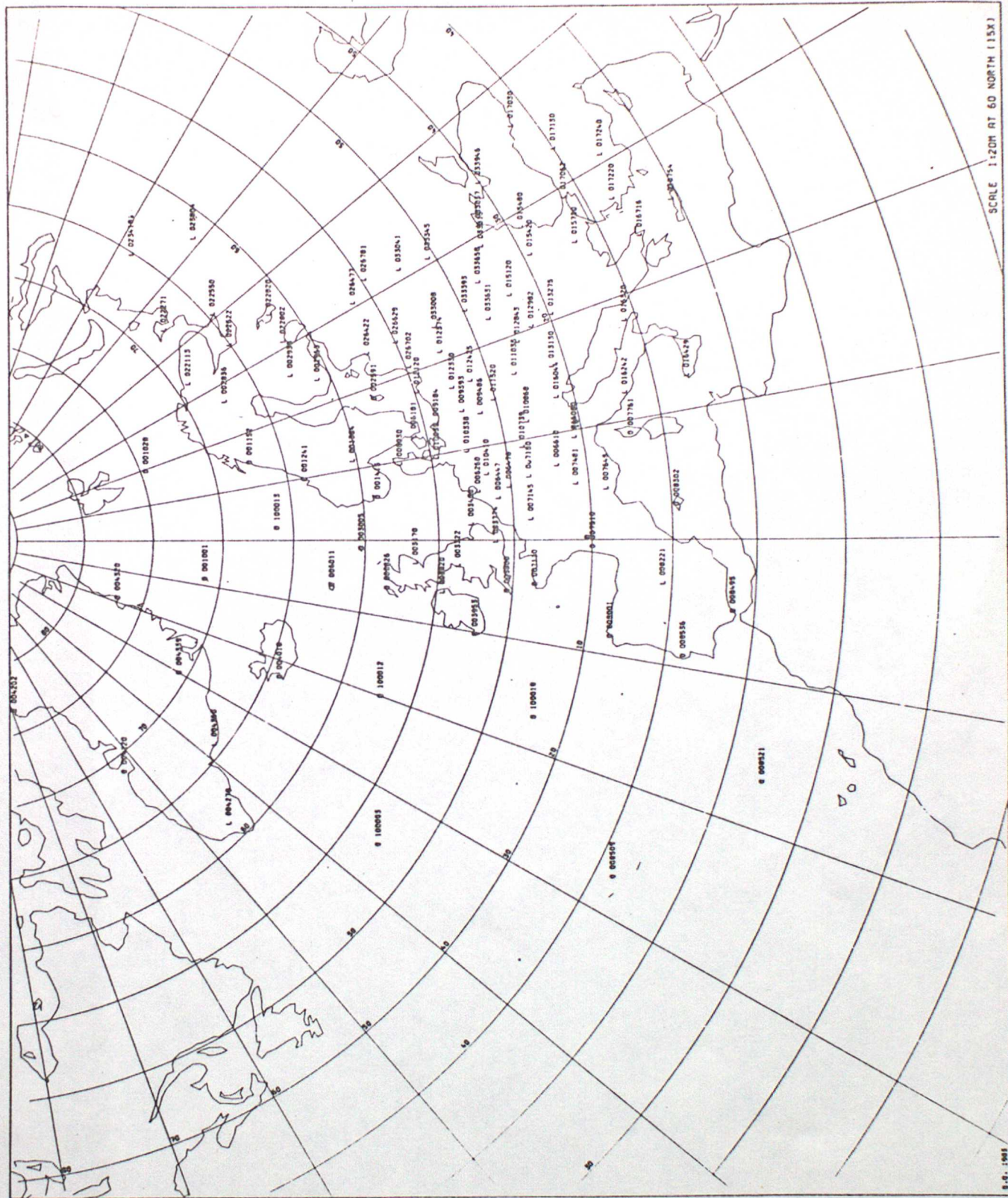


Figure 2

SCHEMATIC DIAGRAM OF PROFILE SELECTION PROCESS.

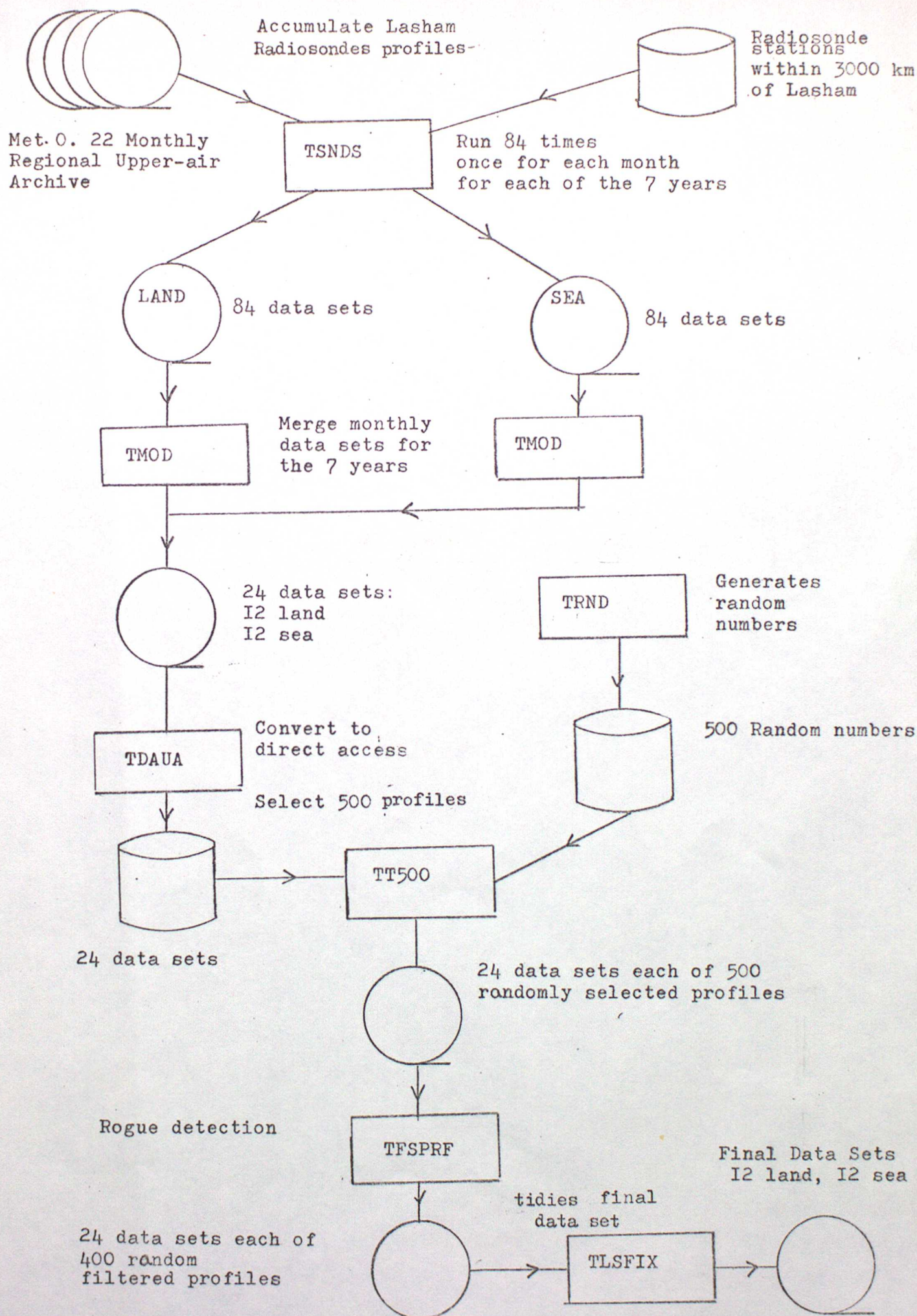


Figure 3

Statistics of 400 radiosonde ascents within 3000 km of Lasham
selected from 7 years of data.

1000m TEMPERATURES

standard deviation

— Land stations
--- Oceanic stations

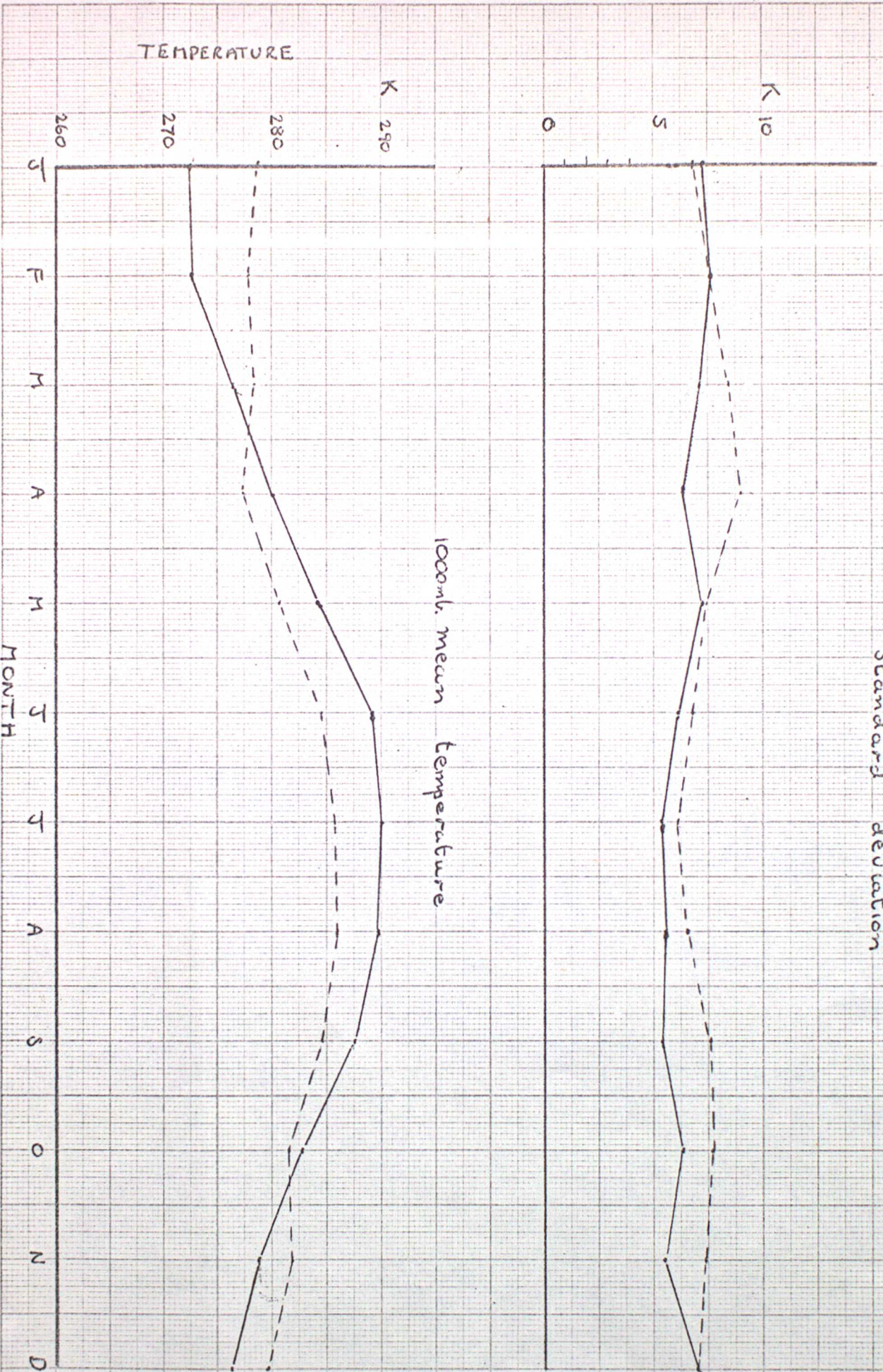


Figure 4 Statistics of 400 radiosonde ascents within 3000 km of Lasham

selected from 7 years of data.

500 MB TEMPERATURES

standard deviation

— Land stations
--- Oceanic stations

500mb mean temperature

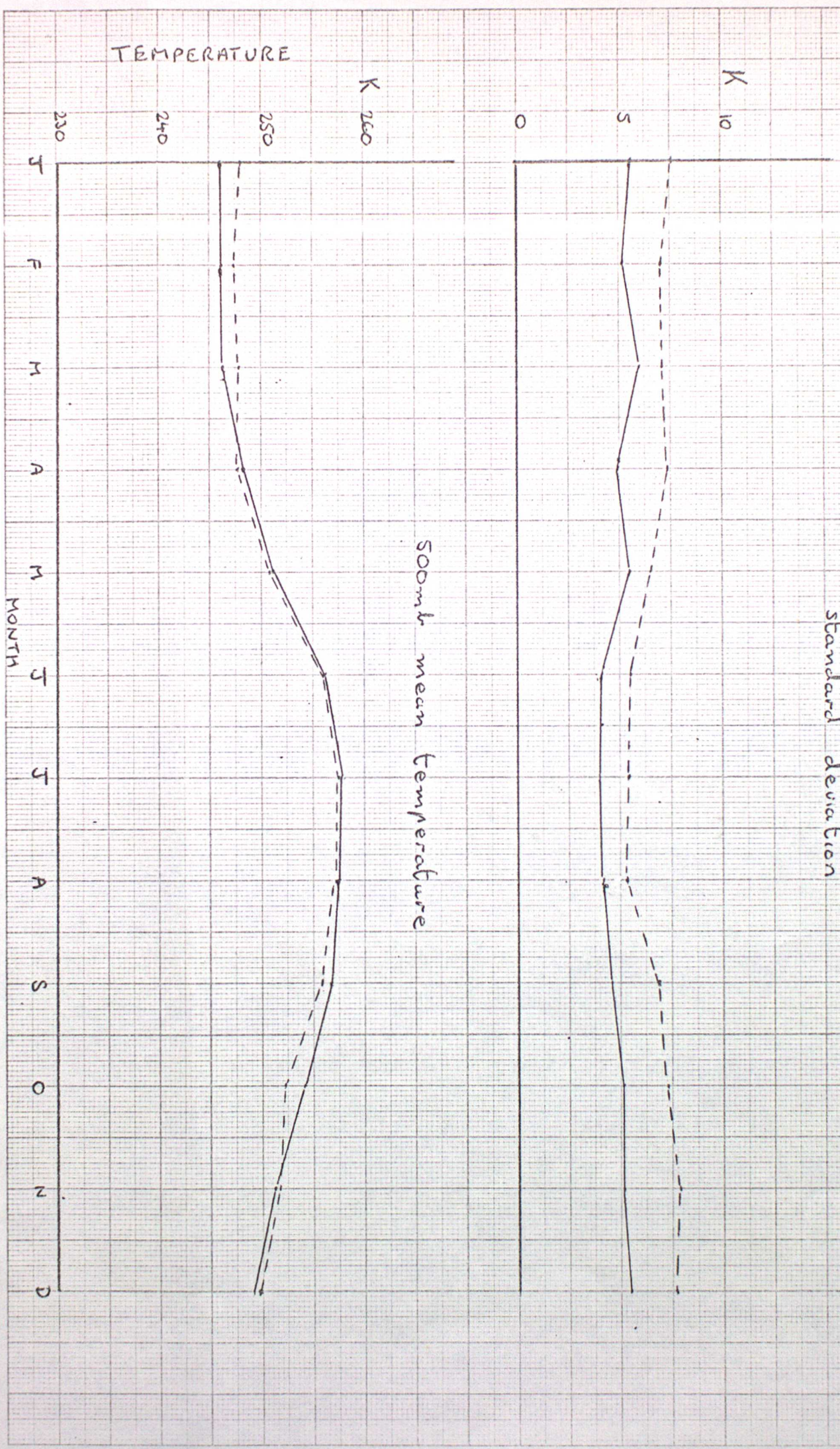


Figure 5 Statistics of 400 radiosonde ascents within 3000km. of Lasham

250 mb TEMPERATURES

selected from 7 years of data

standard deviation

— Land stations
 --- Oceanic stations

250mb mean temperature

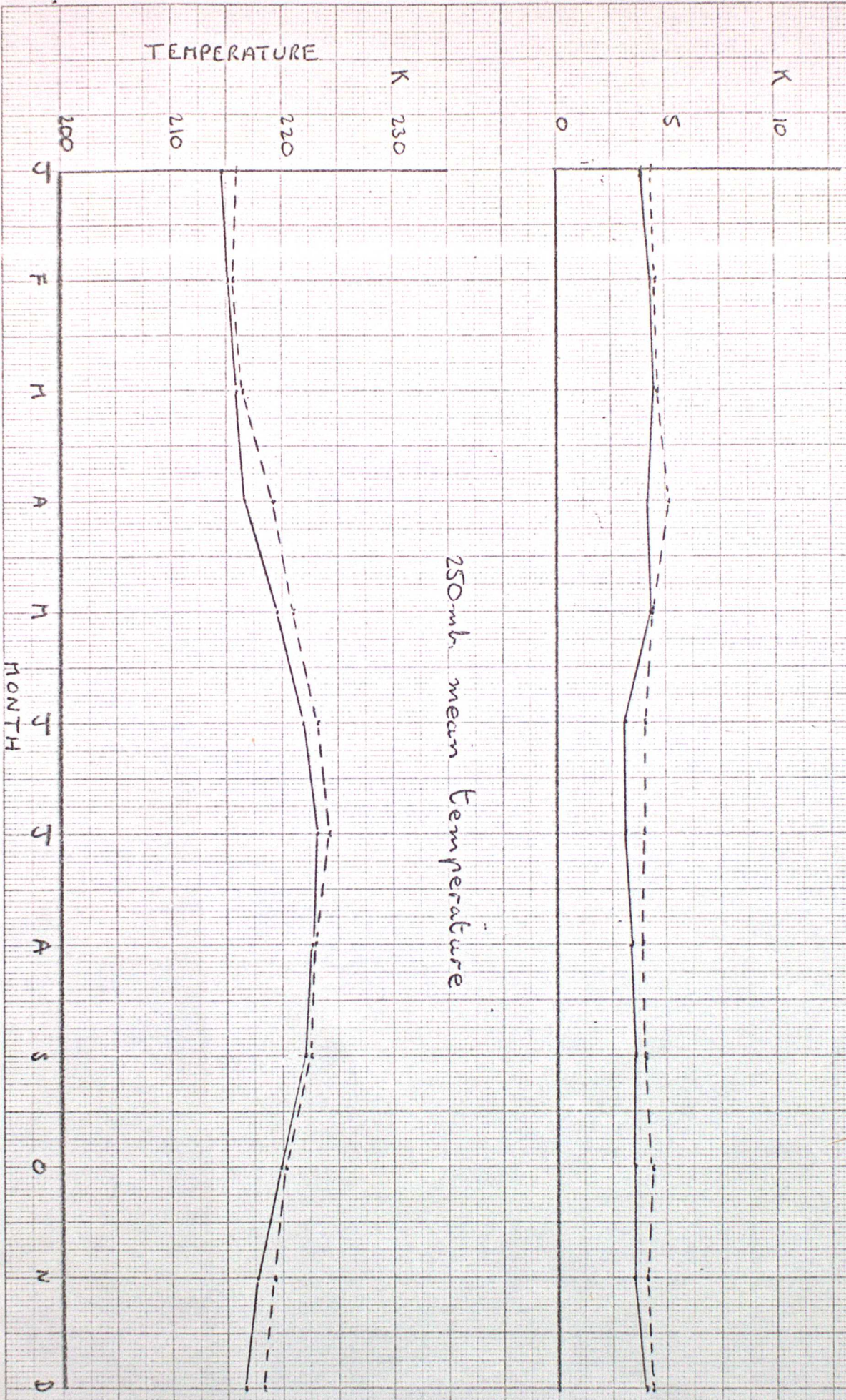


Figure 6

Statistics of 400 radiosonde ascents within 3000 Km. of Lasham
selected from 7 years of data.

100 MB TEMPERATURES

standard deviation

— Land stations
--- Oceanic stations

100mb. mean temperature

