JCMM

Wind profiler – Unified Model comparison statistics

Peter Panagi
and
Ed Dicks

March 2000

INTERNAL REPORT NO.114

NWP Technical Report No.309

Joint Centre for Mesoscale Meteorology

WIND PROFILER - UNIFIED MODEL COMPARISON STATISTICS

Peter Panagi & Ed Dicks
JCMM
Dept. Meteorology
Univ. Reading
PO Box 243
Reading RG6 6BB
March 2000

ABSTRACT

We present here a description of the JCMM contribution to the wind profiler project, part of the COST78-CWINDE99 European profiler-model comparison project. We present the methods used to derive differences between the profilers and Unified Model and describe some of the basic unix and graphics procedures that have enabled us to derive statistics.

Introduction

This short report is concerned with the method used in deriving the statistics for comparing wind-profiler wind speeds and direction directly with operational Unified Model mesoscale output, as part of the COST76 - CWINDE99 project. For information on the profiler project look under

http://rs0300/~cwinde/cwinde99/cwinde99.html

This part of profiler project is a collaboration between the Met. Office and the University of Reading, looking into the benefits that wind profiler data can potentially bring to the operational Unified Model. In addition, a number of cases studies of specific research interest are to be undertaken; the results of these will be presented in other reports. The project is funded by the Met. Office.
Here, we present the initial computational requirements and set up of the project as well as the methods by which statistics are derived and the use of graphics to produce a daily hardcopy archive. Statistical results are presented, but their meteorological interpretation will be the subject of a later report, however preliminary results have been presented at the European Geophysical Society in 1998 (Panagi et al 1999). Specific system details are left to appendices.

Table 1 list those profilers which lie within the current UM mesoscale domain and for which statistics are derived. The MST profiler sites at Aberystwyth, Camborne, Dunkeswell and Pendine are all situated in the UK, while Cabauw is in the Netherlands and La Ferte Vidame in France. In addition, we supply model statistics for the location of the 3GHz Doppler radar at Chilbolton in the UK. The profilers at Aberystwyth, Camborne, Dunkeswell, Pendine and Cabauw work in two modes, high and low, each with a different vertical resolution and base scan height.

Some of the information in Table 1 has changed over the course of the project, as the profilers have been adjusted for better performance, but is up to date at the time of writing (March 2000).

PROFILER	LAT	LON	BASE	MAX	DZ	DT
ABERYSTWYTH	52.42N	4.00W	1700m	16700m	150.0m	12'
CAMBORNE	50.13N	5.10W	305m	8202m	202.5m	30'
CAMBORNE	50.13N	5.10W	189m	2155m	57.8m	30'
DUNKESWELL	50.87N	3.23W	549m	8329m	202.4m	30'
DUNKESWELL	50.87N	3.23W	376m	2284m	57.8m	30'
PENDINE	51.75N	4.52W	325m	8014m	404.7m	30'
PENDINE	51.75N	4.52W	115m	2038m	101.2m	30'
CABAUW	51.95N	4.88E	622m	5276m	202.4m	60'
CABAUW	51.95N	4.88E	137m	1930m	57.8m	60'
LA FERTE VIDAME	48.61N	0.87E	1848m	16848m	500.0m	60'

Table 1: The profiler sites for which statistics are currently available. The BASE and MAX parameters refer to the heights over which the profiler may be active, although frequently there are missing data because the reflected signal is too weak. The DZ parameter is the sampling height (metres) and the DT column gives the time between successive obervations in minutes.

Profiler BUFR data to hourly-averaged data

For a direct comparison with the Unified Model, the profiler data need to be somehow averaged so that the time resolution matches that of the UM data which are available hourly (initially, 24 hours of profiler BUFR encoded data are converted to a single pp-file format for subsequent processing; the procedure is outlined in Appendix B).

The hourly averaging procedure is as follows:

Take a normalised, hourly average (d_0), centred on each hour, of the profiler data (d_j), according to

$$< d_0 > = \left(\sum_j w_j d_j \right) \Big/ \sum_k w_k \qquad \text{(eq. 1)}$$

(it is implicitly assumed that all parameters and variables are also a function of height.) The weights w_j are calculated by applying a triangular filter centred on the hour (t_0), namely

$$\begin{aligned} w_i &= 1 - 2\|t_0 - t_j\|, \quad & t_0 - 1/2 < t_j < t_0 + 1/2 \\ w_i &= 0, & \textit{elsewhere} \end{aligned}$$

with t_j measured in fractional hours, so that profiler data nearer the hour get a greater weighting accordingly, and profiler data greater than 30 minutes away from the hour make no contribution to the hourly mean. There is no vertical averaging

Figures 1 and 2 are the 12 minute and hourly-averaged Aberystwyth data (obtained from the 12 minute data) for July 31st 1999. Inevitably, a certain amount of fine structure seen at high temporal resolution is lost during the averaging process. These and subsequent figures have been plotted using JPLOT running under IDL (Panagi & Dicks, 1997 – this document can be viewed at http://www.meto.gov.uk/mm0100/~appp/uwern/jplot) surface pressure (p*), orographic height ($\varphi*$), temperature (T), u-wind, v-wind, ω and specific humidity (q)

all on model (numerical η) levels, w.r.t. the horizontal grid

From this basic set of model parameters, we can derive various diagnostics from which the winds will be used for a direct comparison with the profiler data. We use the MDIAG suite of programs at JCMM (Panagi & Dicks, 1997, http://www.meto.gov.uk/mm0100/~appp/uwern/mdiag) to compute the diagnostics.

The procedure is as follows:

1. Re-map UM data on model levels onto a uniform 50mb grid between 1000mb and 50mb.
2. Convert ω (Pa/s) to vertical velocity w (m/s) assuming the hydrostatic relation $w = -\omega / \rho g$.
3. Convert u and v on the horizontal grid to westerly and southerly and compute the magnitude and direction from the components.
4. Extract a 24-hour time-height cross-section of the winds at each of the profiler sites (in fact the nearest UM grid point is used).
5. Re-map the time-height cross-sections from pressure (mb) to height (m) using the same vertical resolution as the profiler.

The final product is a 24-hour time-height cross-section of the winds u, v, w, horizontal speed and direction at hourly intervals at each of the profiler sites, starting at 00Z and finishing at 24Z on each day (more details can be found in Appendix A).

Table 2 below lists altitude information for both the actual profiler and nearest UM Mesoscale model altitude.

Station	Lat	Lon	Ht	Nearest MES		MES Ht
Aberystwyth	52.42	-4.00	50	52.44	-3.96	178
Camborne	50.13	-5.10	88	50.11	-5.09	0
Cabauw	51.95	4.88	0	52.00	4.82	3
Dunkeswell	50.87	-3.23	253	50.91	-3.21	195
Pendine	51.75	-4.52	7	51.77	-4.47	41
La Ferte Vidame	48.61	0.87	245	48.66	0.81	217

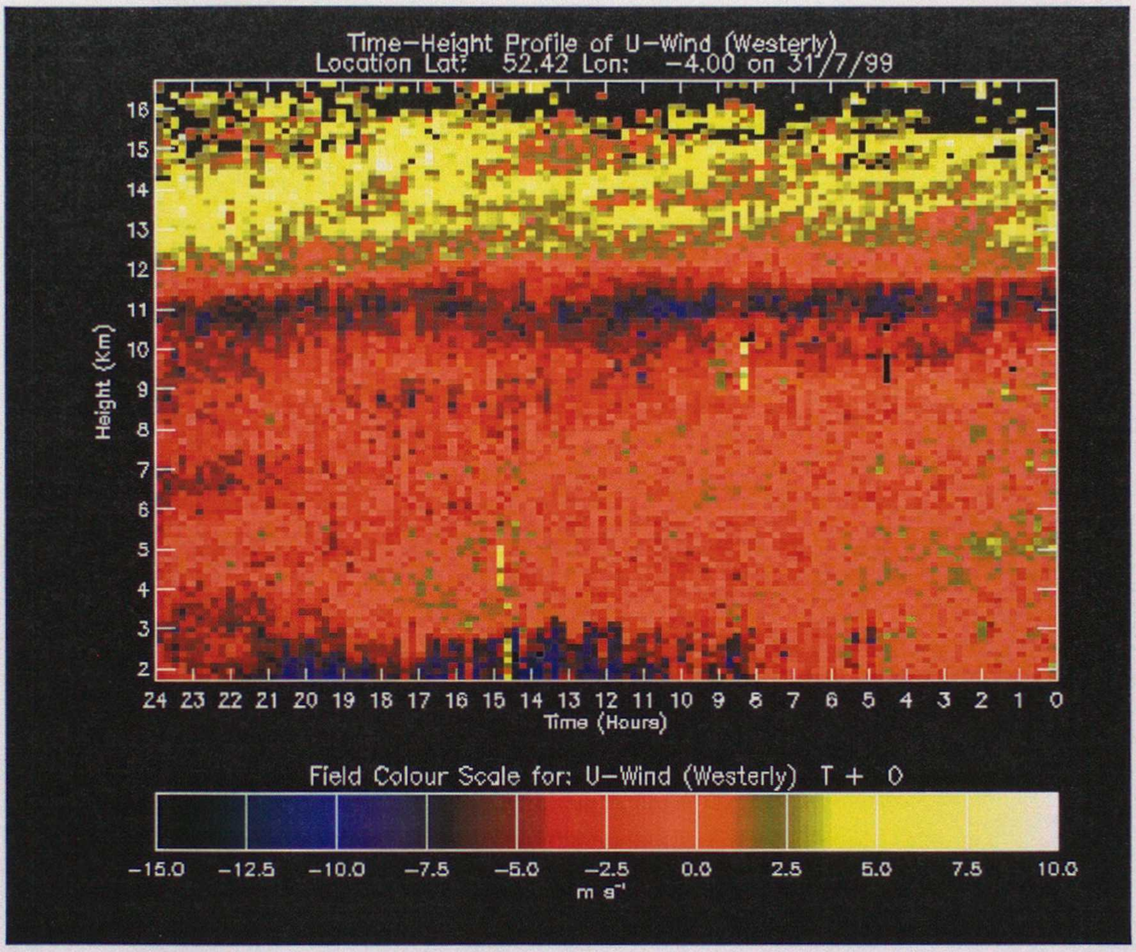


Fig.1 12-minute resolution Aberystwyth MST profiler horizontal u-wind data for 31st July 1999. Black areas at high altitudes indicate missing data.

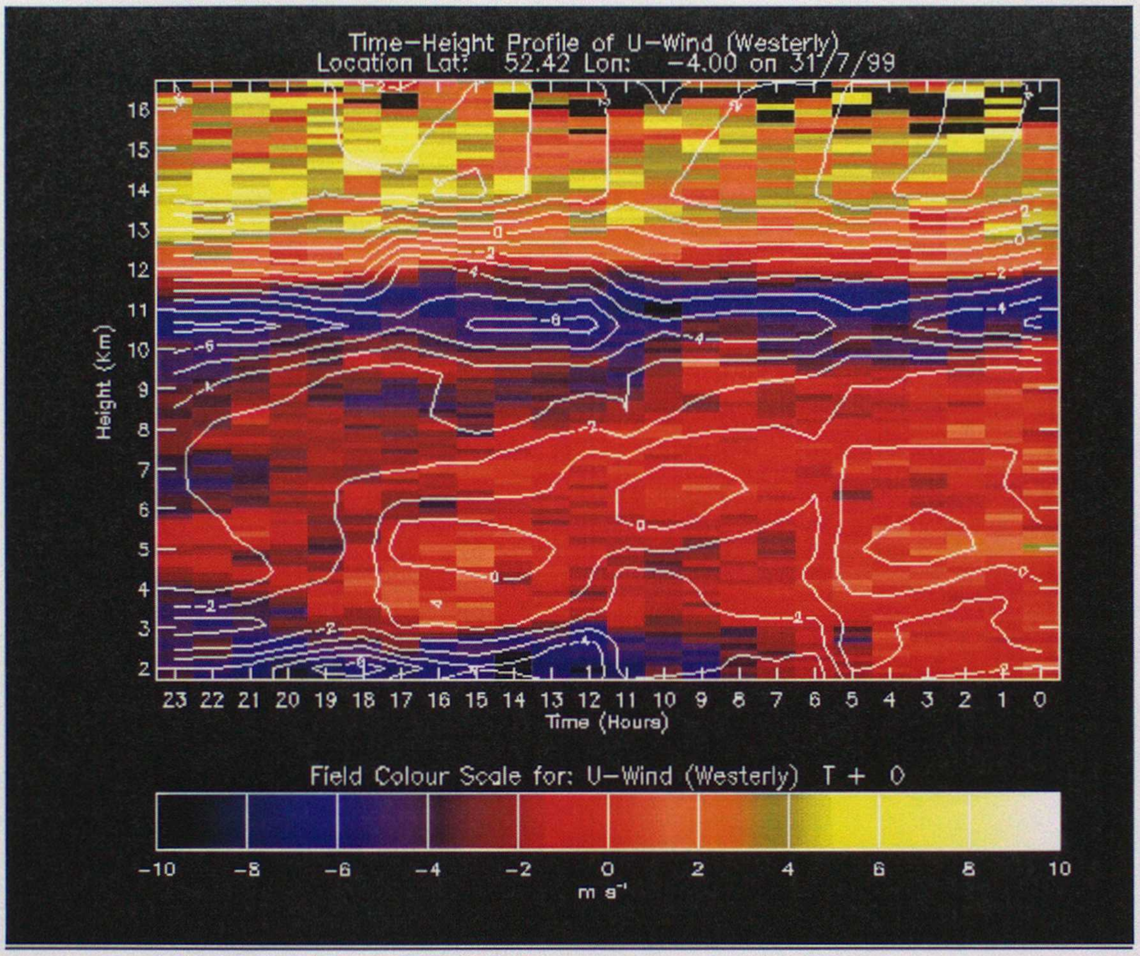


Fig. 2 Hourly-averaged Aberystwyth MST profiler u-wind data for 31st July 1999, obtained from the 12-minute data calculated according to (eq. 1). Overplotted are contours of the Unified Model u-wind extracted at the nearest point to the profiler (following section).

Unified Model Mesoscale data

The Unified Model Mesoscale area, since June 1998, covers a 146x182 horizontal and 38-level vertical domain, on a rotated latitude/longitude grid. The approximate horizontal grid resolution is 0.11x0.11 degrees, or about 12.8km. Figure 3 below shows the u-wind at 850mb over the UK mesoscale domain at 12Z on July 31st 1999.

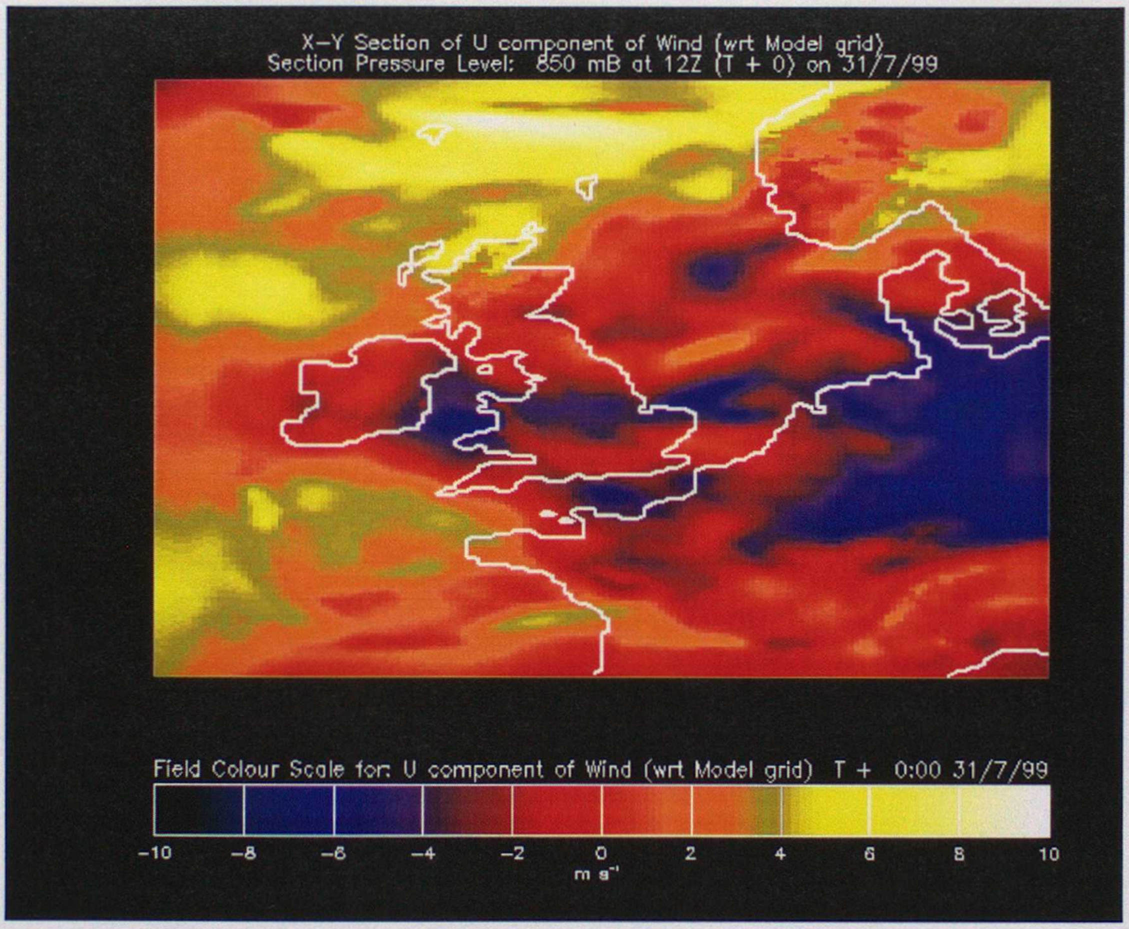


Figure 3: The UK mesoscale domain. Plotted is the u-wind at 850mb at 12Z on 31st July 1999.

The UM UK mesoscale domain data are available daily as four forecasts generated at 00Z, 06Z, 12Z and18Z. Each forecast provides analyses and hourly forecasts for T+0, T+1,....T+5 (in fact, the forecasts go out to T+36, but forecasts beyond T+5 are of no relevance to this project at present).
Each forecast provides the following fields

Computed Statistics

We compute daily statistics, for each of the sites, for each forecast T+0, T+1, ... T+5; this is as a sum of the first 5 hours of the 4 forecasts starting at 00Z, 06Z, 12Z and 18Z. In particular, we compute a mean of the magnitude of the difference between profiler and UM over some period P, namely

$$MEAN = \frac{1}{N}\sum_{P}(profiler - UM)$$

as a function of height, and an average of the RMS deviation between profiler and UM over a period P, namely

$$RMS = \sqrt{\frac{\sum_{P}(profiler - UM)^2}{N}}$$

also as a function of height. Here, N represents the number of observations that make a contribution, since there may be missing data at certain times and heights due to insufficient signal from the profiler.

Monthly-averaged results

The following show monthly means and the monthly RMS deviation of u-wind, v-wind, wind speed and direction for the months March 1999 to March 2000, for the profilers Aberystwyth (ABWWP), Cabauw (CABWP), Camborne (CAMWP), Dunkeswell (DUNWP), La Ferte Vidame (LFVWP) and Pendine (PENWP). The plots are for deviations between profiler and model analyses (T+0).

The labelling and format of the plots is as follows:

(a) – (d) show the mean difference averaged over the month as a function of height.

(e) – (h) show the RMS deviation averaged over the month as a function of height.

The titles indicate which field is being plotted, the abcissa units are the year and month over which the average is made (YYMM) and the ordinate the height.

The plots have been grouped by profiler, so that there is continuous record of each profiler over the period for which we have been able to derive statistics.

The final sets of plots, Figures 75-79, show the mean monthly RMS deviation (ABWWP-UM) of each of the 6 forecasts T+0, T+1 ..... T+5 of the wind speed, direction, vertical velocity, u-wind and v-wind, for the month of July 1999.

DAILY ARCHIVES

In addition to the daily profiler statistics, we produce hardcopy archives of various diagnostics, derived from the UM data, with a view to producing 2 or 3 case studies that will show the potential impact that profiler observations may have on the UM forecast. Also, it may be possible to categorise any significant differences between profiler and UM into a small number of distinct weather events/types. In addition, the daily hardcopy archive will include precipitation maps from the UK network radar, to supplement understanding. The case studies will be presented elsewhere.

APPENDIX A

UNIX scripts, FORTRAN programs and directory structure

The 6-hourly UM forecasts from T+0 to T+5 are copied across to

/data/rs0200/oppp/${DATE}.${FC}Z.pp

some 1-2 hours after their availability on COSMOS. The extraction of the required fields from the rolling UM fieldsfile archive, and the subsequent transfer to the HP workstation RS0200 is regulated by 4 "cron" scripts, residing as

/home/rs0200/oppp/Scripts/get.${FC}Z.scr

Thus for each day we obtain 4 mesoscale forecast files, from T+0 to T+5, of the fields $p*, T, u, v, q, \omega, cldlwc, cldice, orography$, all on model η-levels. Each file is approximated 165Mb in size.
The model-level files are then run through the program MDIAG (Panagi & Dicks, 1997) to re-map data onto constant pressure surfaces, and then generate the following diagnostics on 50hPa pressure surface between 1000hPa and 50hPa

$u-wind \quad u$

$v-wind \quad v$

$wind \ \ speed \quad V=\sqrt{u^2+v^2}$

$wind \ \ direction$

$absolute \ \ vorticity \quad \xi=\frac{1}{a\cos\varphi}\left(\frac{\partial v}{\partial\lambda}-\frac{\partial(u\cos\varphi)}{\partial\varphi}\right)+f$

$vertical \ \ velocity \quad w=-\frac{\omega}{\rho g}$

$potential\, temperature \quad \theta$

$\partial\vartheta/\partial p$

$wet-bulb \ \ potential\, temperature \quad \vartheta_w$

$dry \ \ PV \quad Q=-g\left(-\frac{1}{a\cos\varphi}\frac{\partial v}{\partial p}\frac{\partial\theta}{\partial\lambda}+\frac{1}{a}\frac{\partial u}{\partial p}\frac{\partial\theta}{\partial\varphi}+\frac{\partial\theta}{\partial p}\xi\right)$

$dry \ \ static \ \ stability \, N^2=-\frac{\rho g^2}{\theta}\left(\frac{\partial\theta}{\partial p}\right)$

$moist \ \ static \ \ stability$

$geopotential \ \ height$

$relative \ \ humidity \ \ w.r.t. \ \ ice$

$cloud \ \ liquid \ \ water$

$cloud \ \ ice$

The resulting files named according to the convention

/data/rs0200/oppp/${DATA}.${FC}Z.pp.mdiag

After the 18Z forecast has been copied and the diagnostics computed, the TIME-HEIGHT cross-sections at the profiler sites are extracted by re-mapping the pressure-level fields onto a height field (metres) that matches the vertical sampling of the individual profiler. At this stage, the model-level data are archived onto DLT for potential use as case studies.

The next stage is to hourly-average the profiler data and compute differences with the UM data. The time-height data and difference data are ftp'd across from rs0200 to mm0600 where subsequent IDL procedures plot the daily archive of required fields.

All commands and programs are executed using the CRON scripts

/home/rs0200/oppp/Scripts/get.${FC}Z.cron

APPENDIX B

Conversion of Profiler BUFR data to PP format.

A generic conversion program has been written to convert BUFR encoded data from the profiler sites to PP format data (time versus height), and can potentially be used for any profiler site.

The first thing to note is that, for plotting purposes, the PP format data arrays must be regular in both time and height. This means that for each individual site it must be decided a-priori as to the number of required data dimensions in the time and height senses. These values are set in the conversion program (a set for each profiler site) so the process knows exactly how much data to expect and hence can act accordingly if any data items and/or data files are missing. These dimensions are set by assigning a nominal time interval (dt) to the profiler site (this is usually trivial as the dt is usually constant, and in fact only varies slightly for site ABWWP). The range in time is always from 0Z to 0Z on the following day, hence with the nominal dt we can work out how many time points (Nt) are required. The height dimension is decided upon by taking the lowest available height up to some pre-decided maximum height (dz is always constant), hence giving the number of height points Nh. All fields written to the PP format files are then of dimension Nt by Nh.

If any data items or data files are missing then the conversion program assigns an appropriate missing data indicator to the relevant entries of the data arrays. Also, if the data quality flags are set in the BUFR files to indicate poor quality data then these data items are not used, and instead the missing data indicator is used. Also, the profiler site ABWWP sometimes delivers data at an increased time increment to the usual, (for example 15 minutes compared to the usual nominal 12.75 minutes). When this happens the resultant PP data set cannot be used as the assignment of data becomes irregular; if this is detected a warning message is written to the log file.

The conversion of the BUFR data to PP format has been automated in a “cron” job. This spawns 3 “at” jobs, 2 of which perform the data conversions and the other the generation of an automatic log file (1 for each day and containing all sites) which summarises the amount of missing data.

At present, the profiler sites are processed in 2 batches, hence the 2 "at" jobs. The first processes sites ABWWP, CAMWP, CB2WP, DUNWP, DN2WP, PENWP, and PN2WP, whilst the second job processes sites CABWP, CB2WP and LFVWP. The second job is run 24 hours later than the first job as some of the required data has not arrived in time for all the sites to be processed together.

The data processing takes place on the HP machine rs0200 at the Beaufort Park site, all code and scripts reside in directory

/data/rs0200/cwinde/bin

The cron script is: master_ppf

This calls the script makeppf for each site, for example to process data for 26/01/99 and site ABWWP the calling sequence would be:

ksh makeppf ABWWP 1999 01 26

The makeppf script then calls a Fortran executable with a separate executable existing for each site, which are compiled from the source code bufr2pp.f, using the script compile_b2p. The conversion program requires an initial data file containing the number and names of the input BUFR files, this is created by the script makeppf. The log file generation script is called makeppf_log.

ACKNOWLEDGEMENTS: Thanks to Myles Turp at Beaufort Park for making available the BUFR-encoded daily profiler data, and to Keith Browning for reviewing this report prior to publication.

REFERENCES

Panagi P.M., Dicks E.M., **1997,**
"Met. Office Unified Model data, diagnostics, graphics programs and other observational data available from JCMM through the aegis of the Universities Weather Research Network UWERN"**, JCMM Internal report, 69**

Panagi P.M., Dicks E.M., Hamer G.L., Nash J., **1999,**
"Preliminary results of the routine comparison of wind profiler data with the UK Met. Office Mesoscale model vertical wind profiles", proc. 1998 EGS, The Hague, *accepted*

Fig. 4a (ABWWP-UM) u-wind

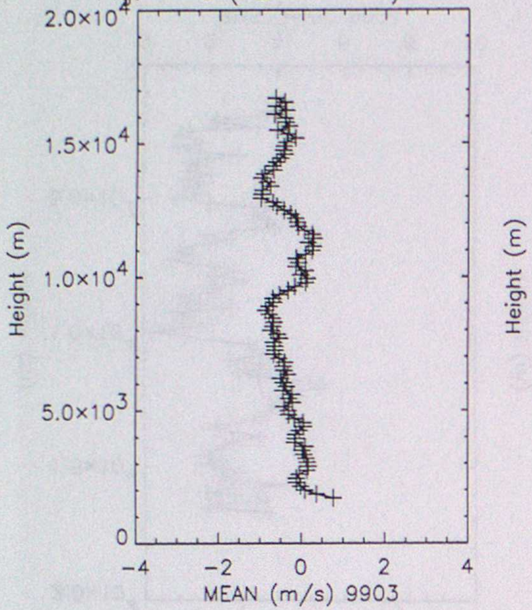


Fig. 4b (ABWWP-UM) v-wind

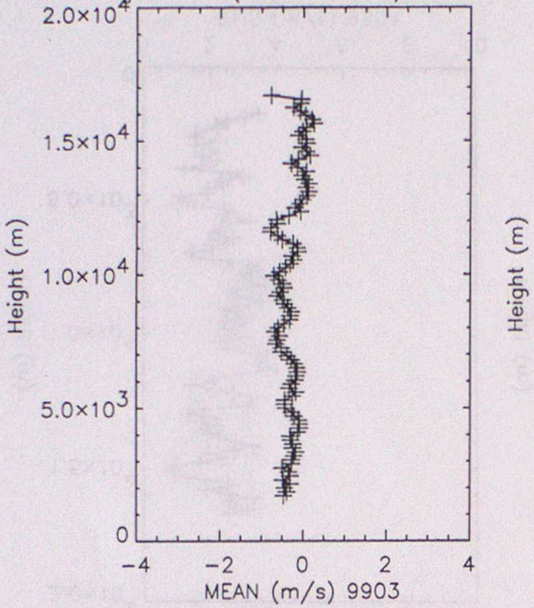


Fig. 4c (ABWWP-UM) speed

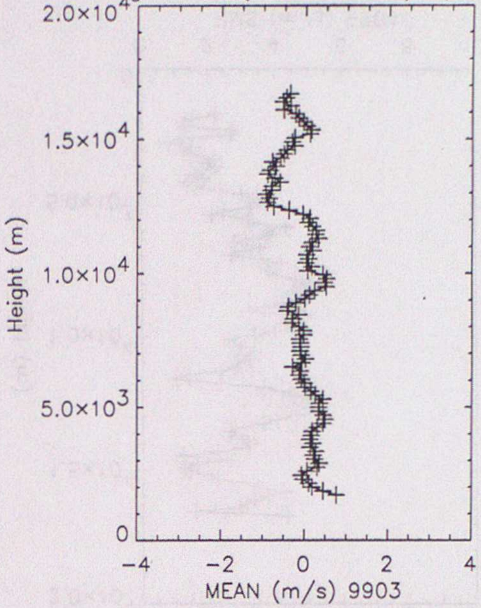


Fig. 4d (ABWWP-UM) dirn.

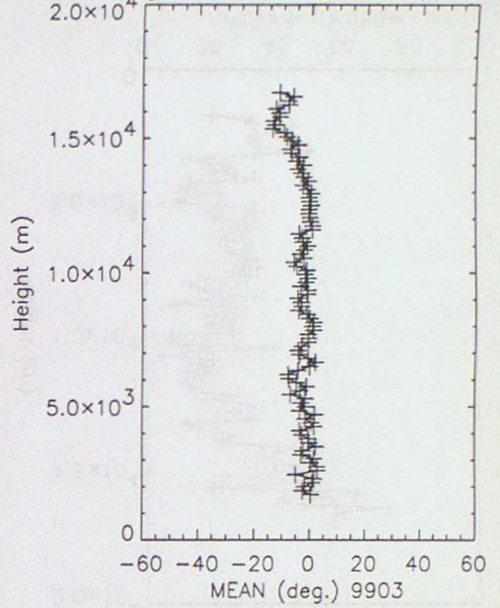


Fig. 4e (ABWWP-UM) u-wind

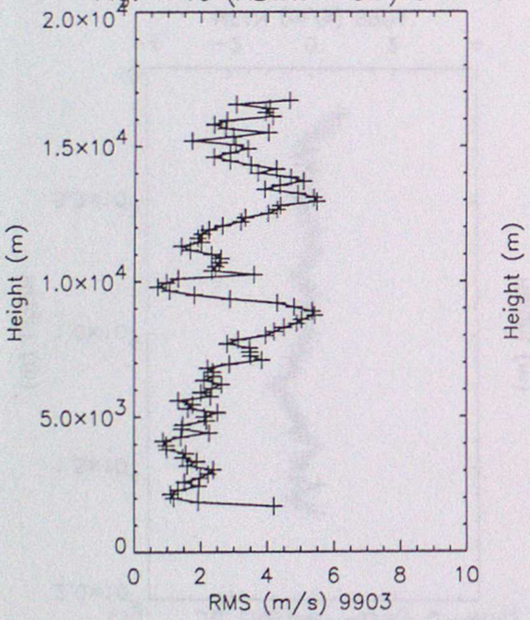


Fig. 4f (ABWWP-UM) v-wind

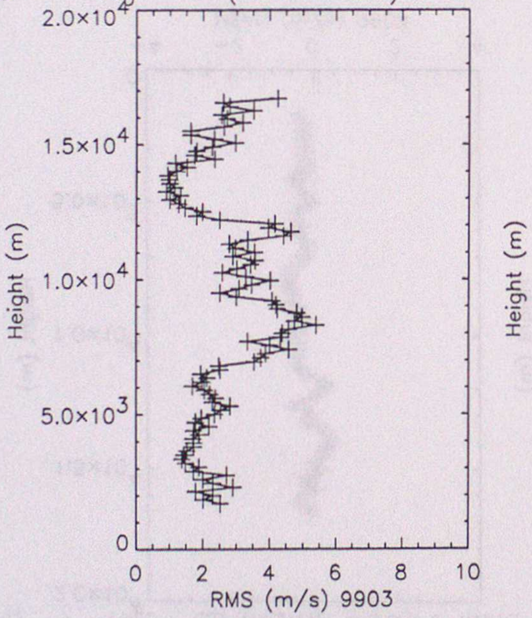


Fig. 4g (ABWWP-UM) speed

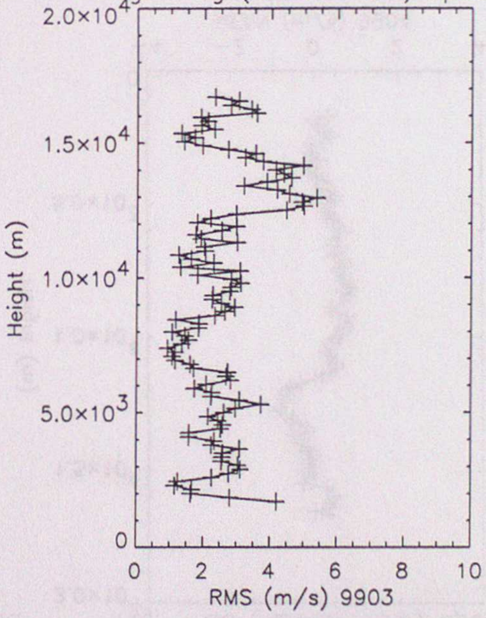


Fig. 4h (ABWWP-UM) dirn.

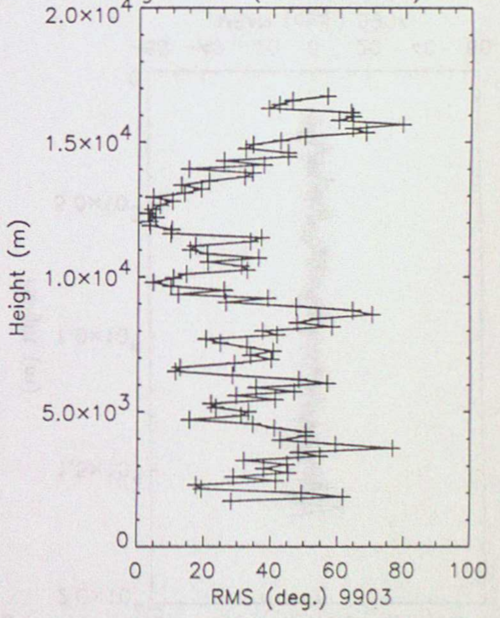


Fig. 5a (ABWWP-UM) u-wind

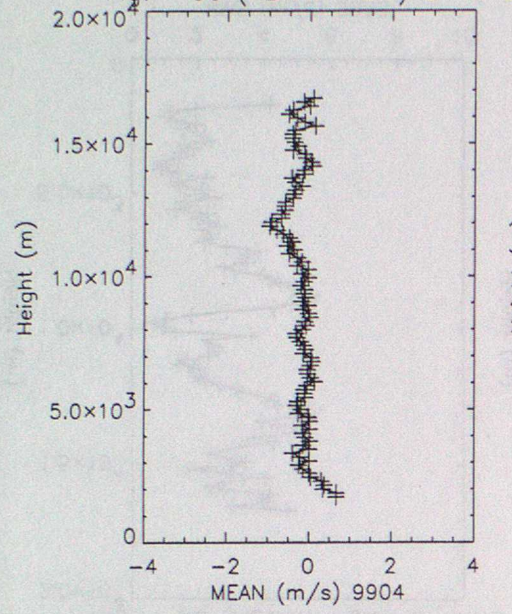


Fig. 5b (ABWWP-UM) v-wind

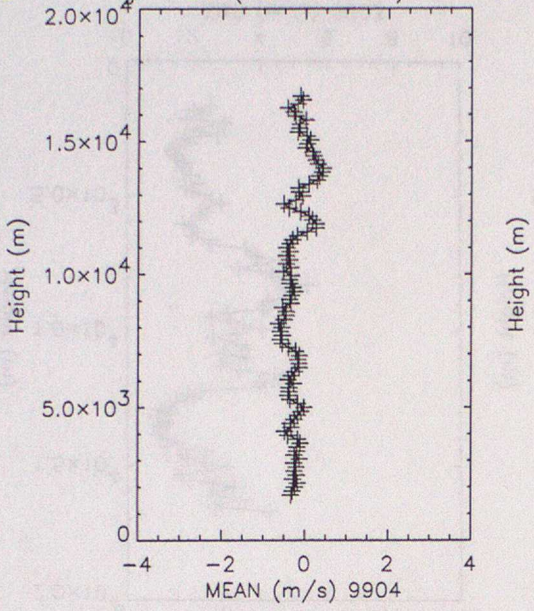


Fig. 5c (ABWWP-UM) speed

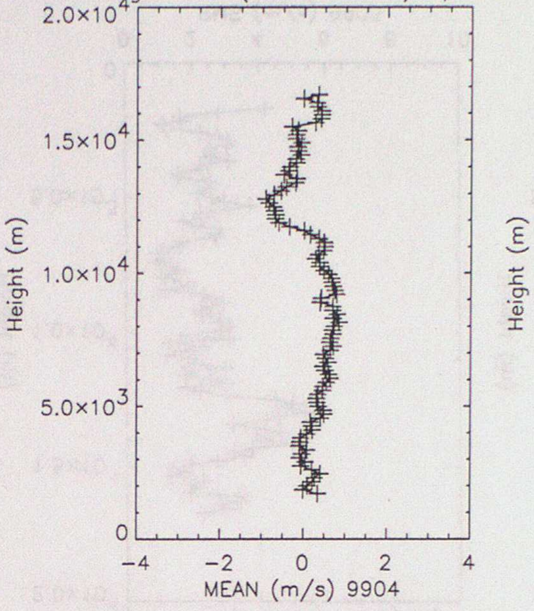


Fig. 5d (ABWWP-UM) dirn.

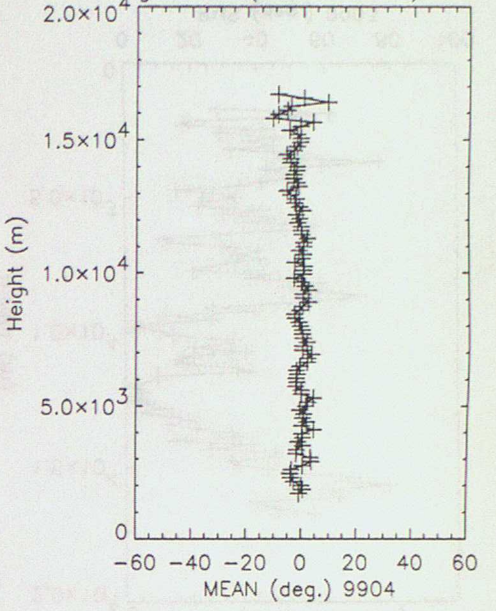


Fig. 5e (ABWWP-UM) u-wind

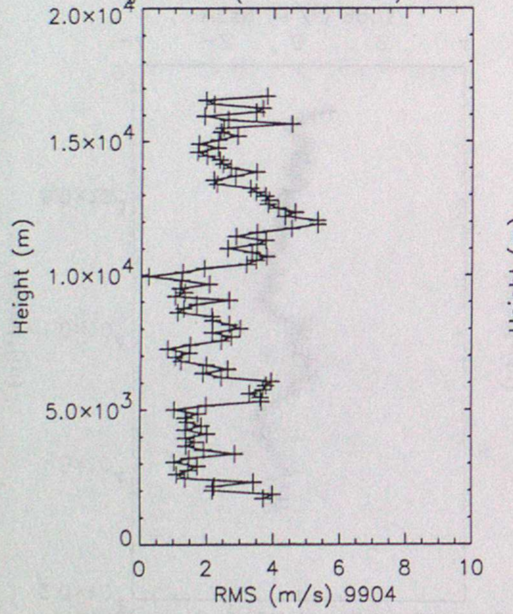


Fig. 5f (ABWWP-UM) v-wind

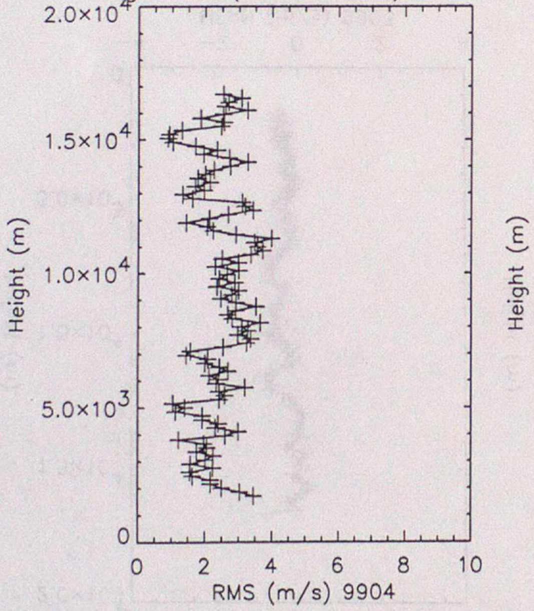


Fig. 5g (ABWWP-UM) speed

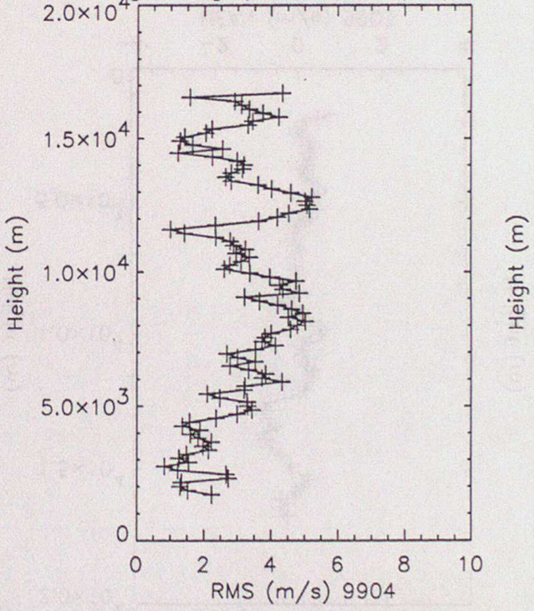


Fig. 5h (ABWWP-UM) dirn.

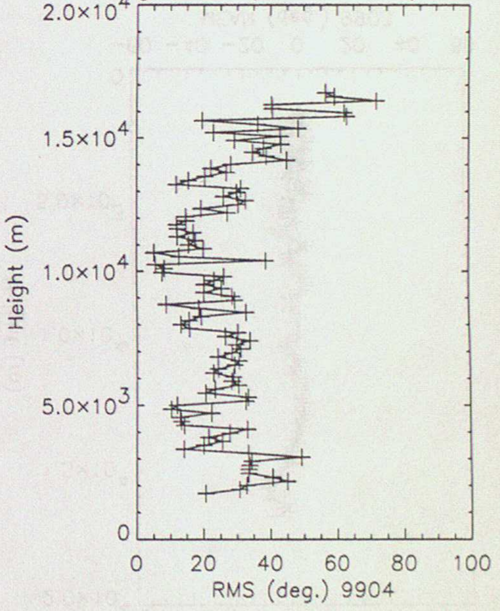


Fig. 6a (ABWWP-UM) u-wind

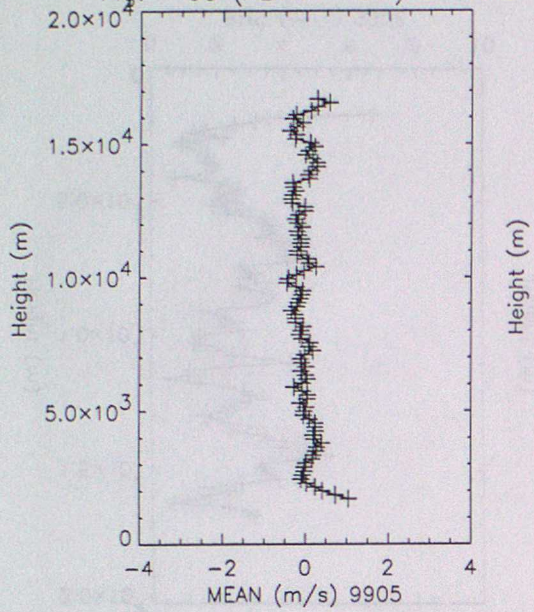


Fig. 6b (ABWWP-UM) v-wind

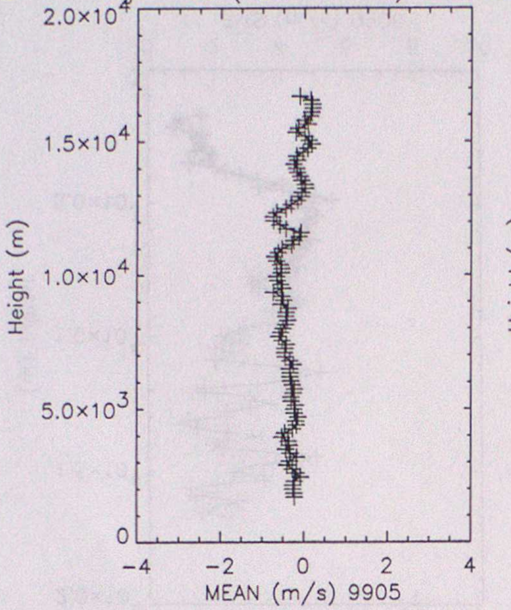


Fig. 6c (ABWWP-UM) speed

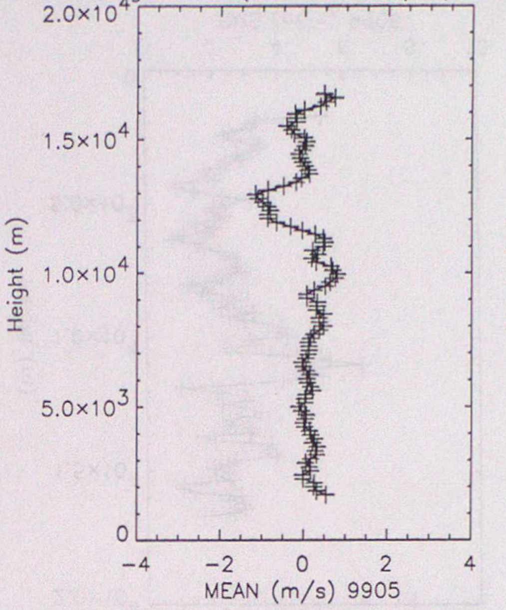


Fig. 6d (ABWWP-UM) dirn.

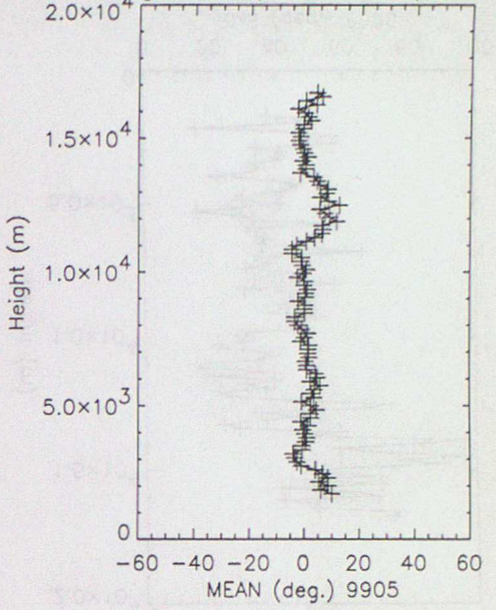


Fig. 6e (ABWWP-UM) u-wind

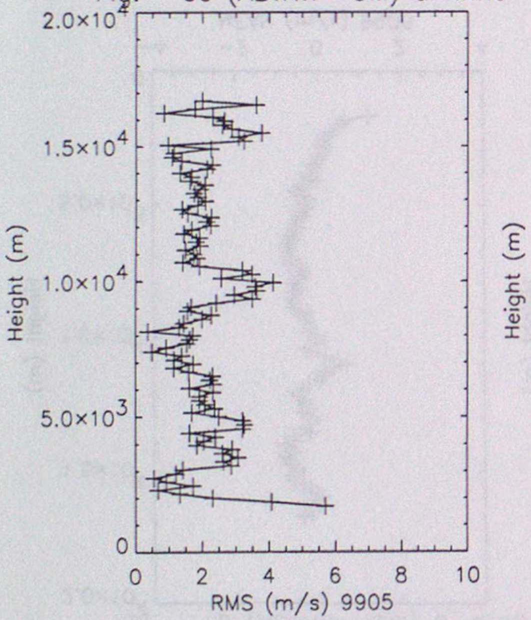


Fig. 6f (ABWWP-UM) v-wind

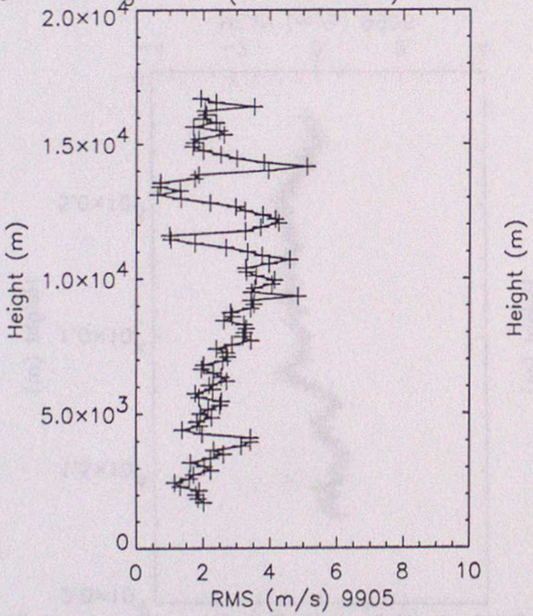


Fig. 6g (ABWWP-UM) speed

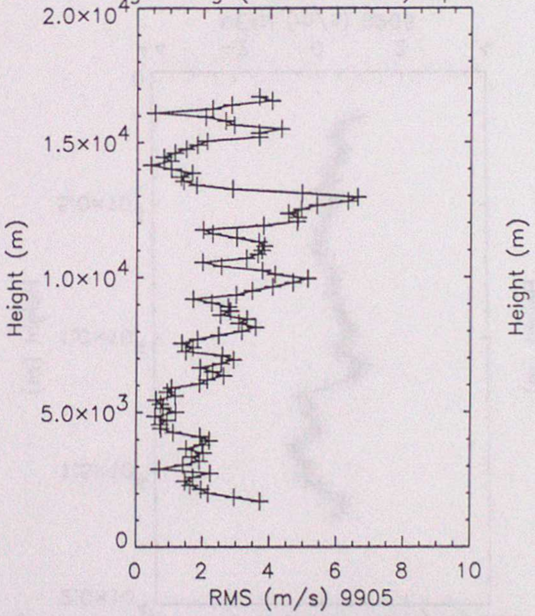


Fig. 6h (ABWWP-UM) dirn.

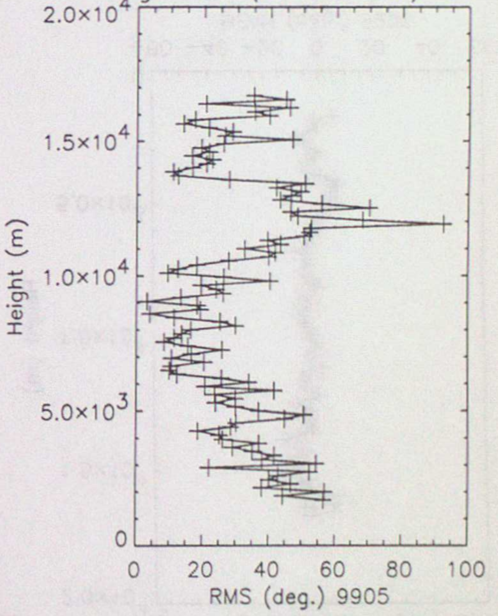


Fig. 7a (ABWWP-UM) u-wind

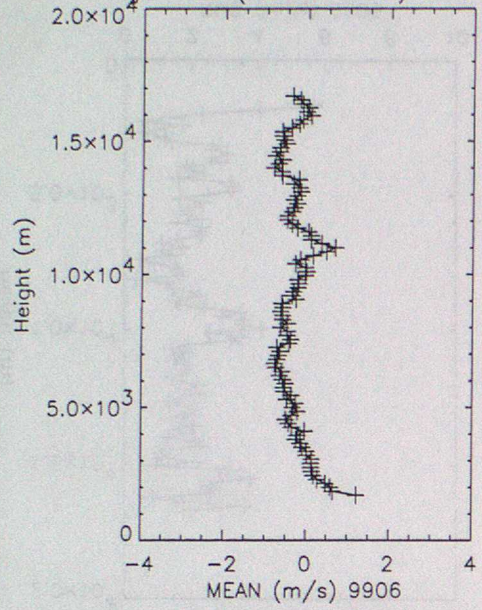


Fig. 7b (ABWWP-UM) v-wind

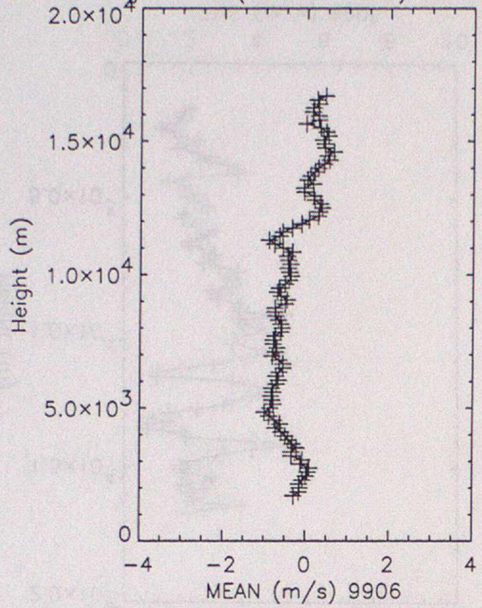


Fig. 7c (ABWWP-UM) speed

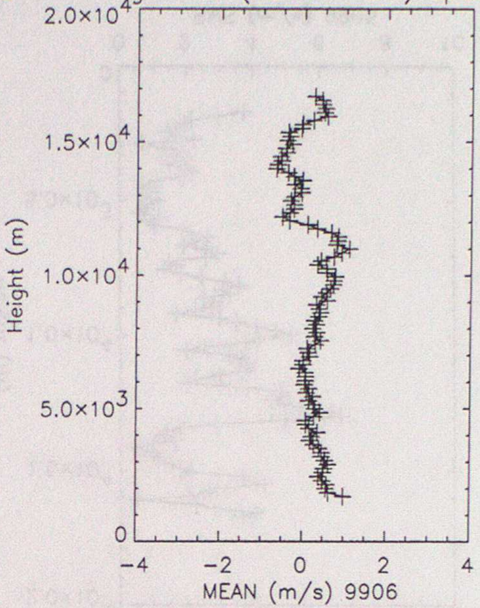


Fig. 7d (ABWWP-UM) dirn.

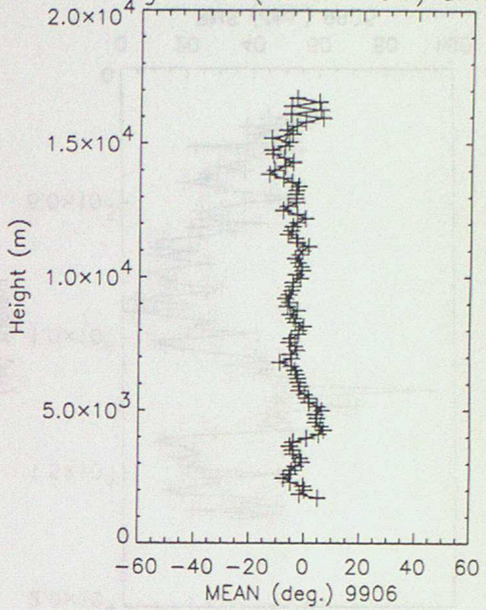


Fig. 7e (ABWWP-UM) u-wind

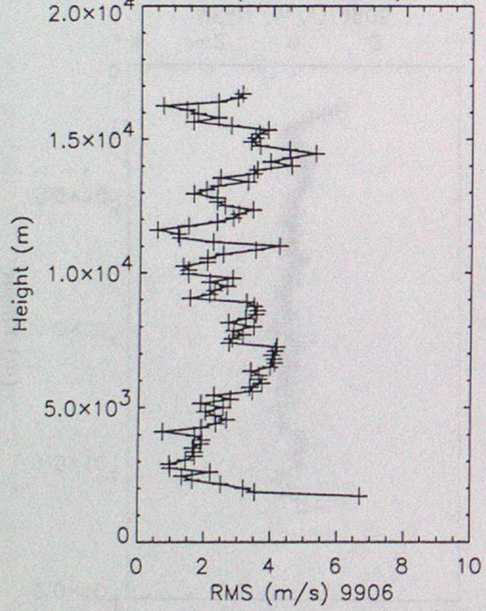


Fig. 7f (ABWWP-UM) v-wind

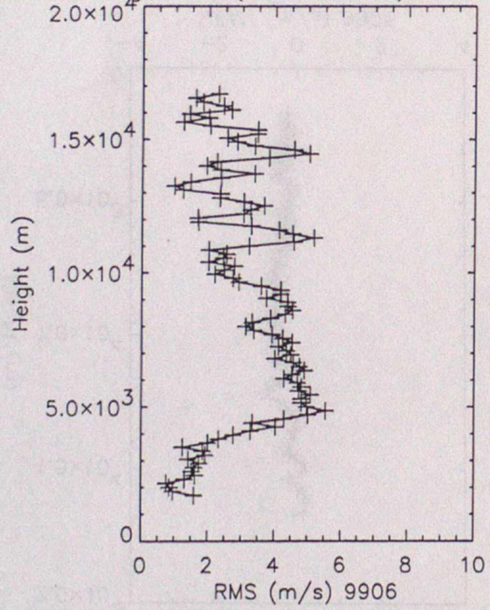


Fig. 7g (ABWWP-UM) speed

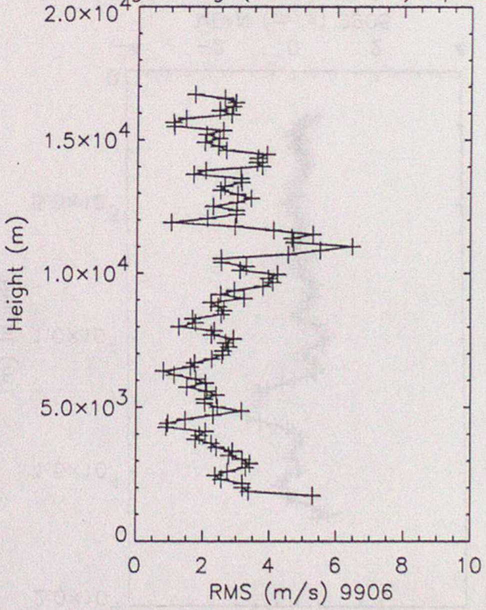


Fig. 7h (ABWWP-UM) dirn.

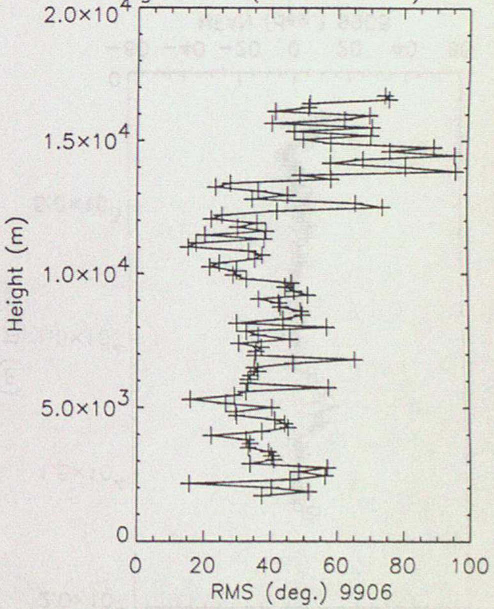


Fig. 8a (ABWWP–UM) u–wind

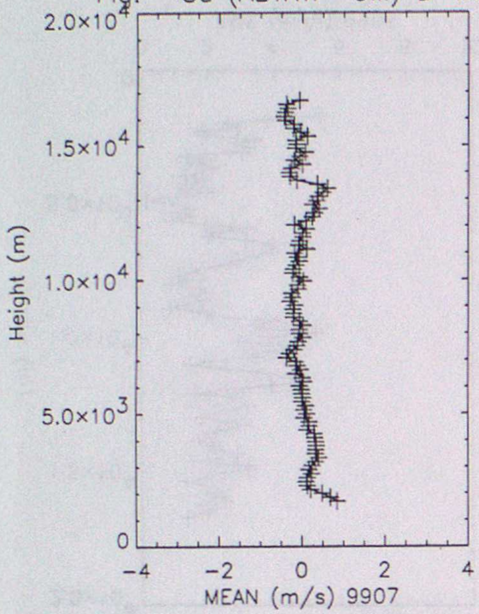


Fig. 8b (ABWWP–UM) v–wind

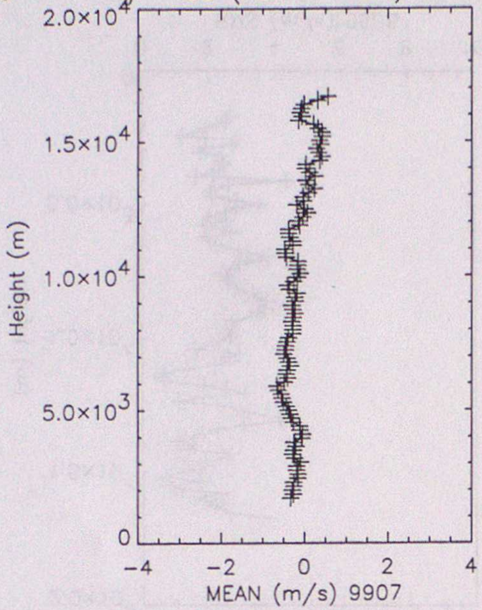


Fig. 8c (ABWWP–UM) speed

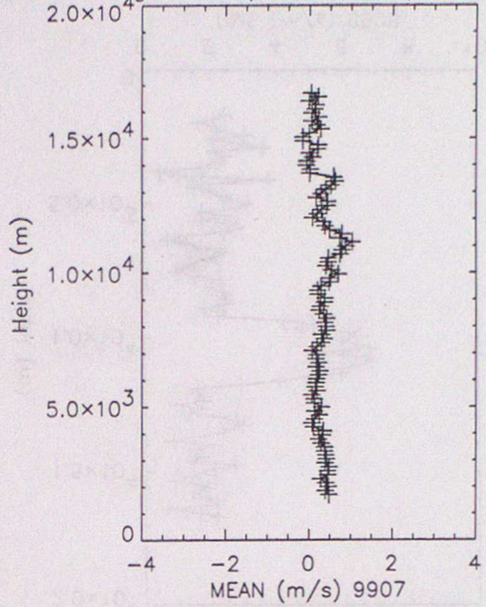


Fig. 8d (ABWWP–UM) dirn.

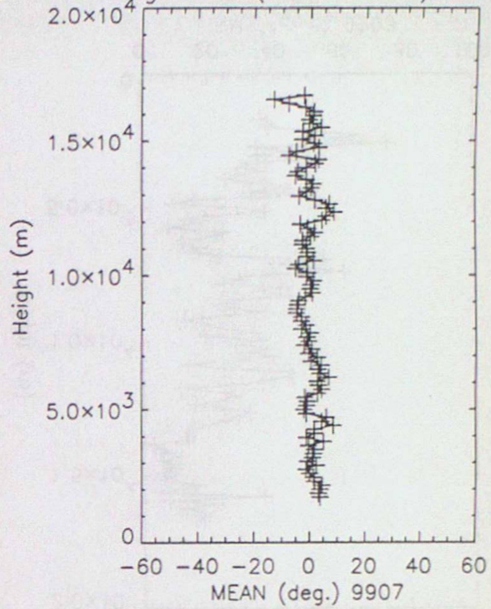


Fig. 8e (ABWWP–UM) u–wind

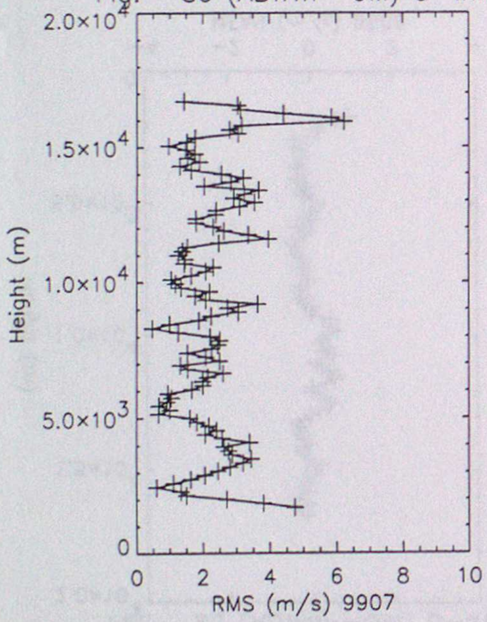


Fig. 8f (ABWWP–UM) v–wind

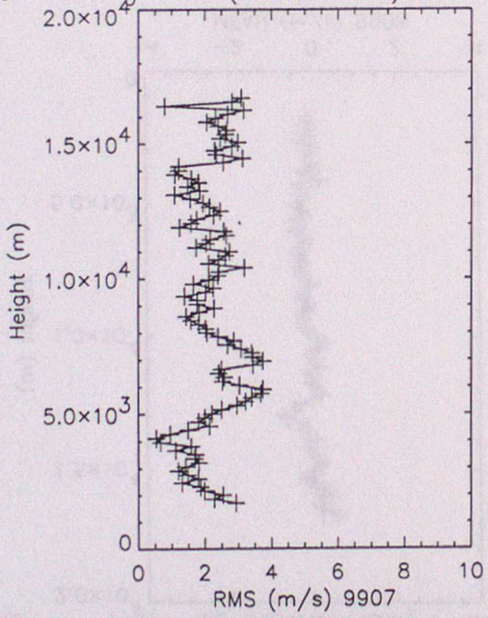


Fig. 8g (ABWWP–UM) speed

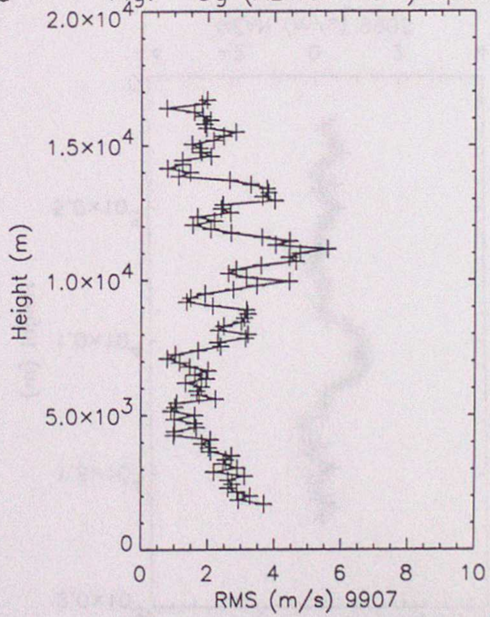
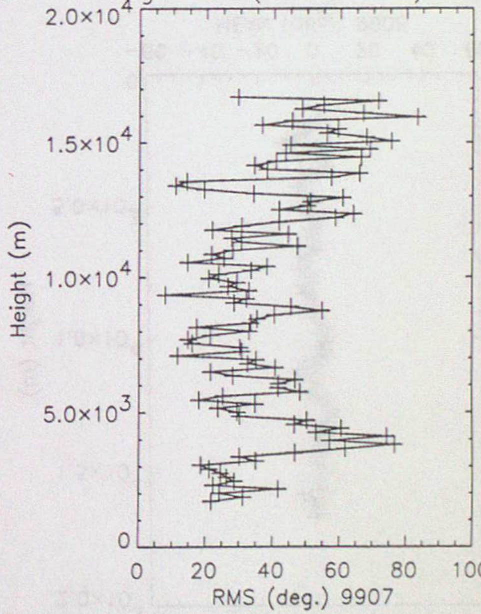


Fig. 8h (ABWWP–UM) dirn.



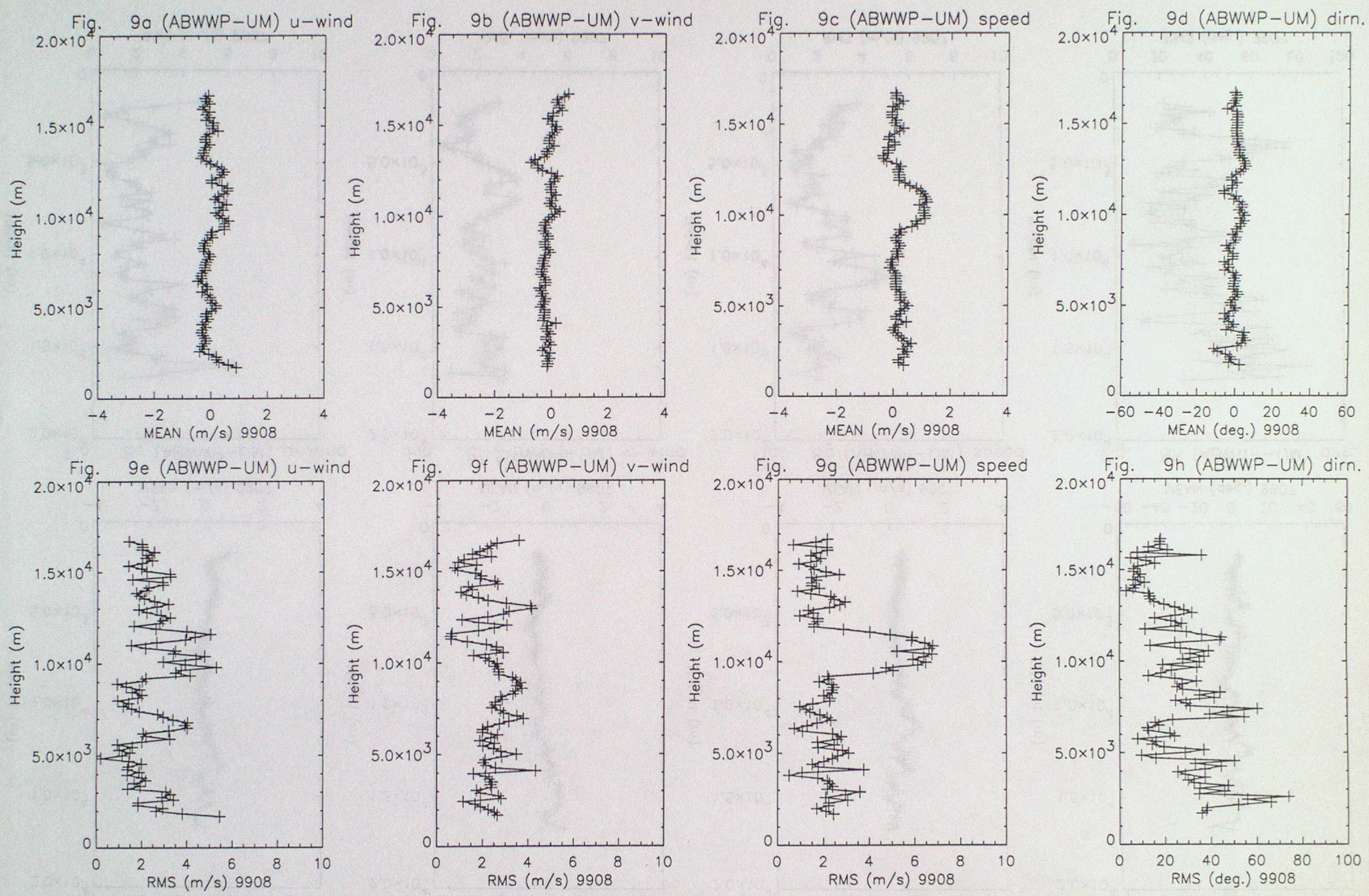


Fig. 9a (ABWWP-UM) u-wind
Fig. 9b (ABWWP-UM) v-wind
Fig. 9c (ABWWP-UM) speed
Fig. 9d (ABWWP-UM) dirn.
Height (m)
MEAN (m/s) 9908
MEAN (deg.) 9908
Fig. 9e (ABWWP-UM) u-wind
Fig. 9f (ABWWP-UM) v-wind
Fig. 9g (ABWWP-UM) speed
Fig. 9h (ABWWP-UM) dirn.
RMS (m/s) 9908
RMS (deg.) 9908

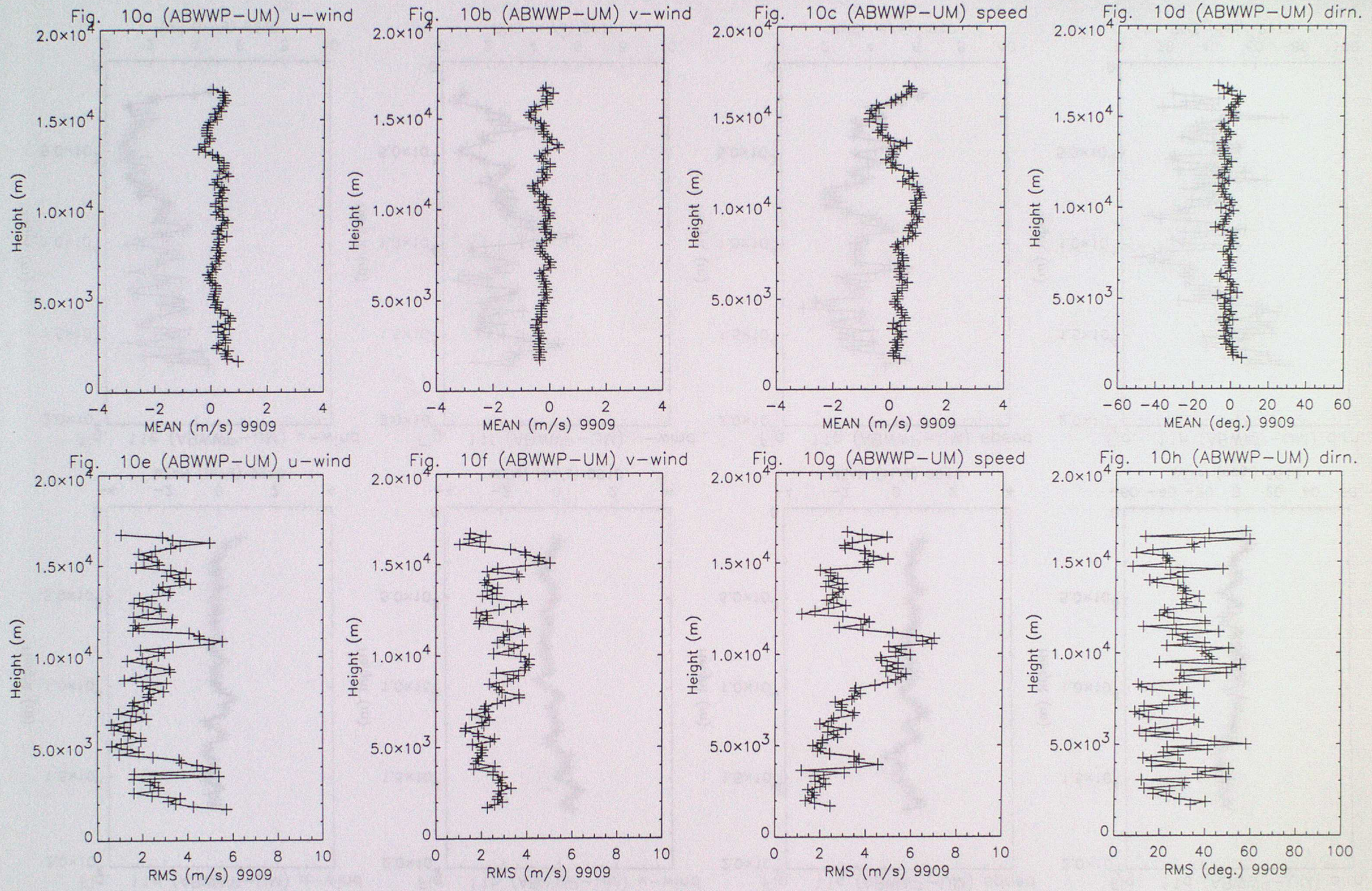


Fig. 10a (ABWWP-UM) u-wind

Fig. 10b (ABWWP-UM) v-wind

Fig. 10c (ABWWP-UM) speed

Fig. 10d (ABWWP-UM) dirn.

Fig. 10e (ABWWP-UM) u-wind

Fig. 10f (ABWWP-UM) v-wind

Fig. 10g (ABWWP-UM) speed

Fig. 10h (ABWWP-UM) dirn.

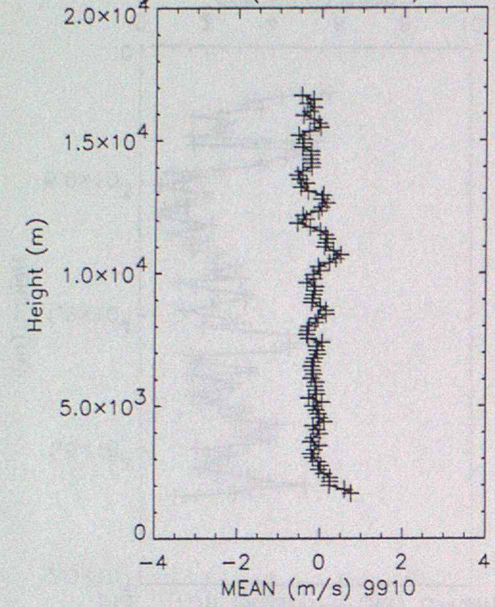


Fig. 11a (ABWWP–UM) u–wind

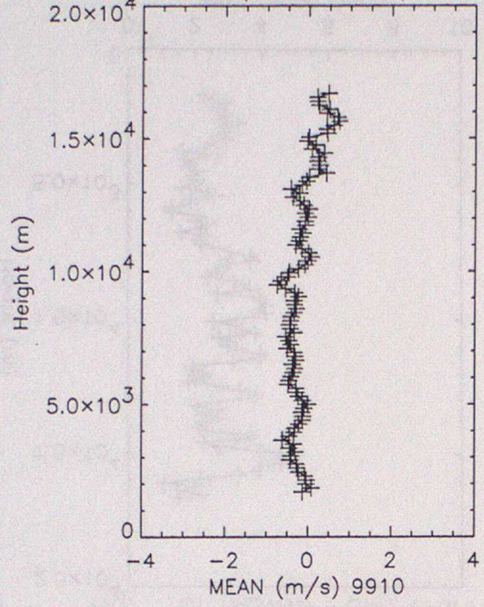


Fig. 11b (ABWWP–UM) v–wind

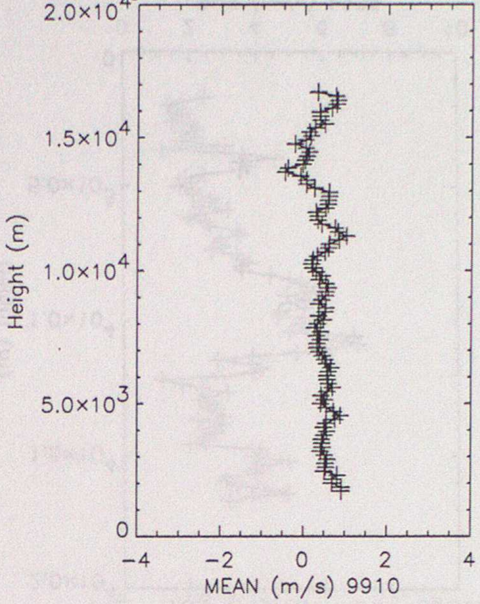


Fig. 11c (ABWWP–UM) speed

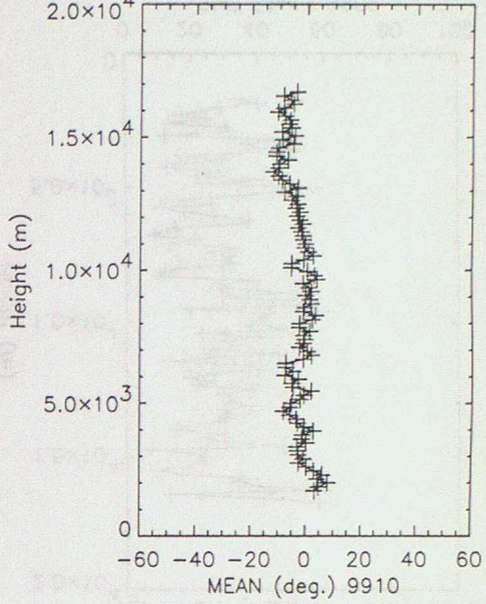


Fig. 11d (ABWWP–UM) dirn.

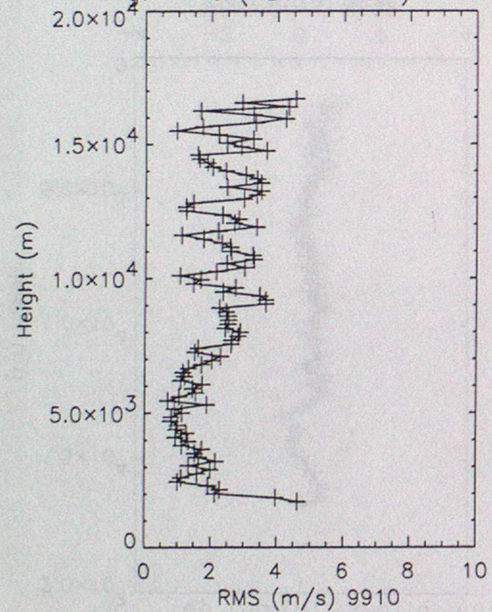


Fig. 11e (ABWWP–UM) u–wind

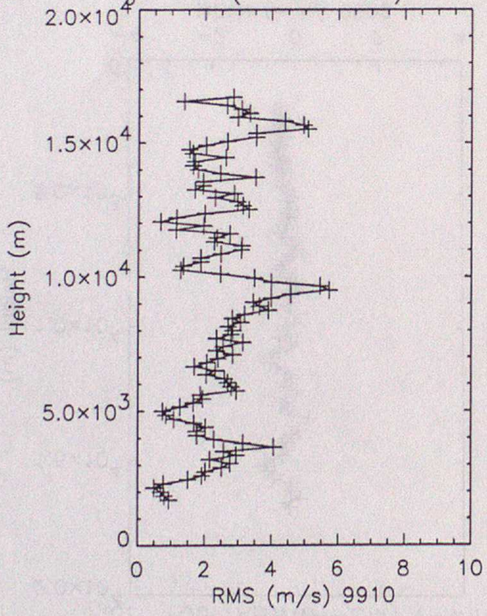


Fig. 11f (ABWWP–UM) v–wind

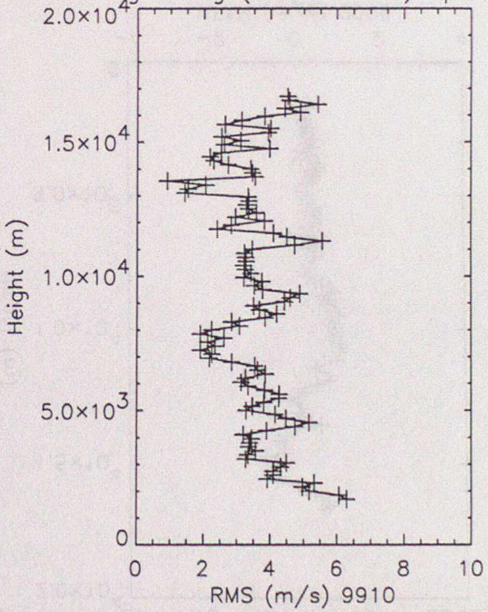


Fig. 11g (ABWWP–UM) speed

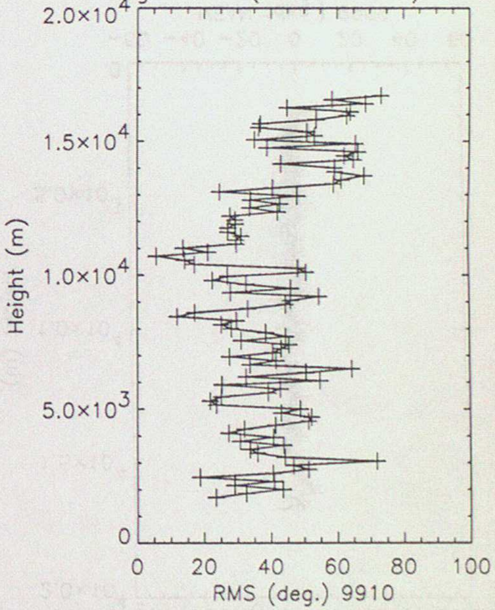


Fig. 11h (ABWWP–UM) dirn.

Fig. 12a (ABWWP-UM) u-wind

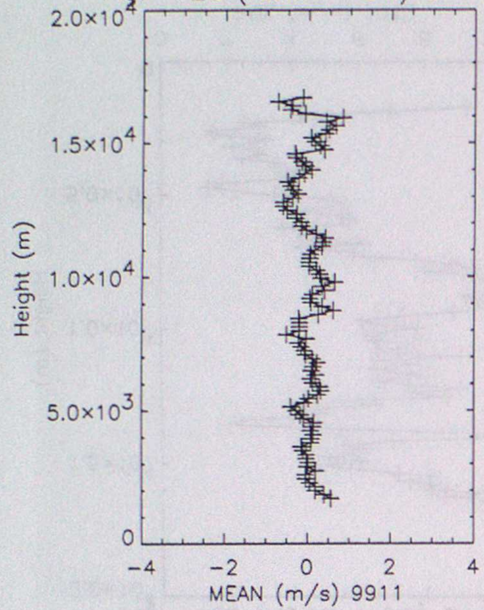


Fig. 12b (ABWWP-UM) v-wind

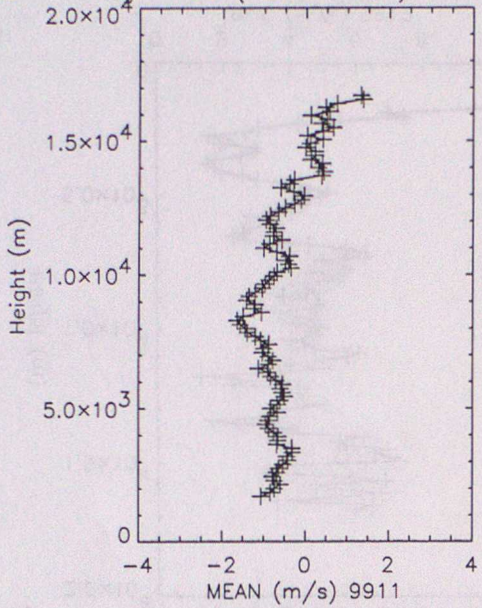


Fig. 12c (ABWWP-UM) speed

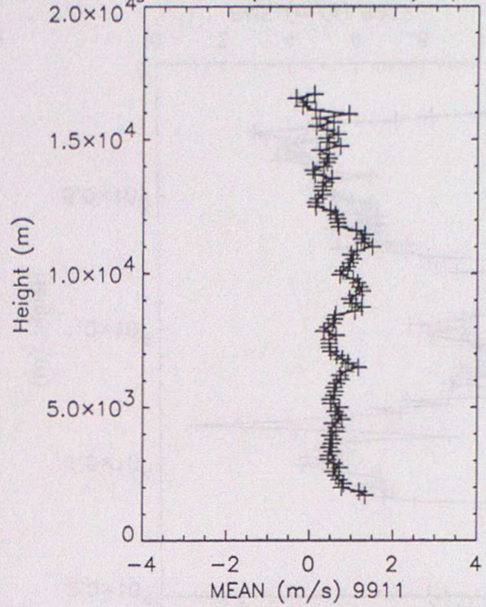


Fig. 12d (ABWWP-UM) dirn.

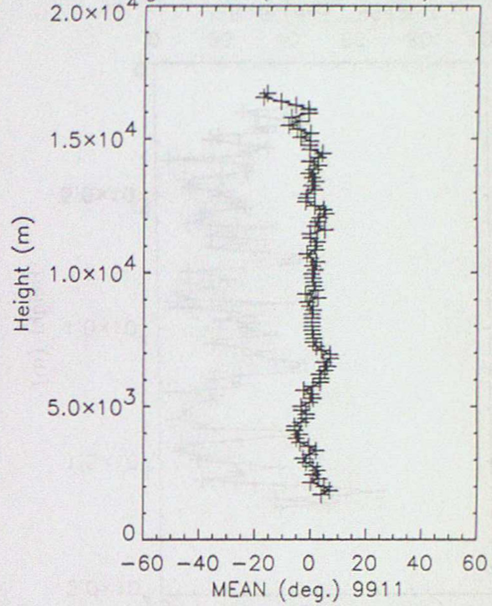


Fig. 12e (ABWWP-UM) u-wind

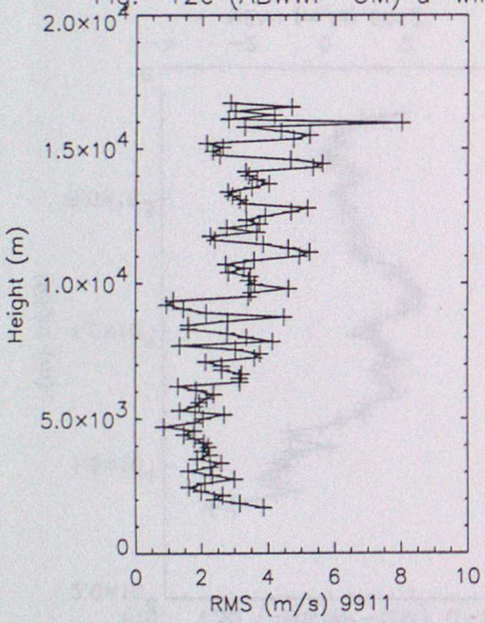


Fig. 12f (ABWWP-UM) v-wind

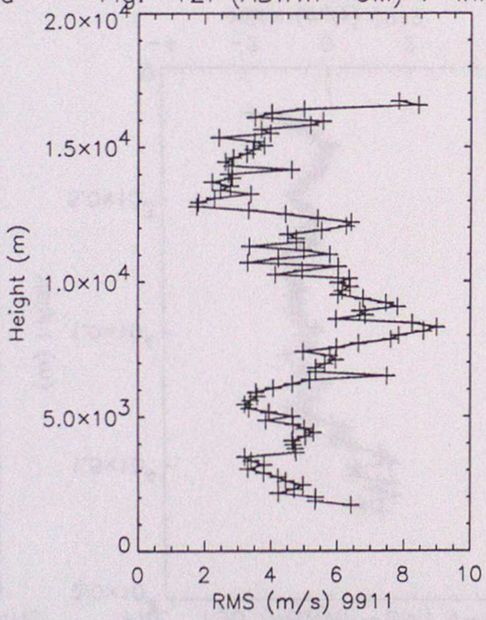


Fig. 12g (ABWWP-UM) speed

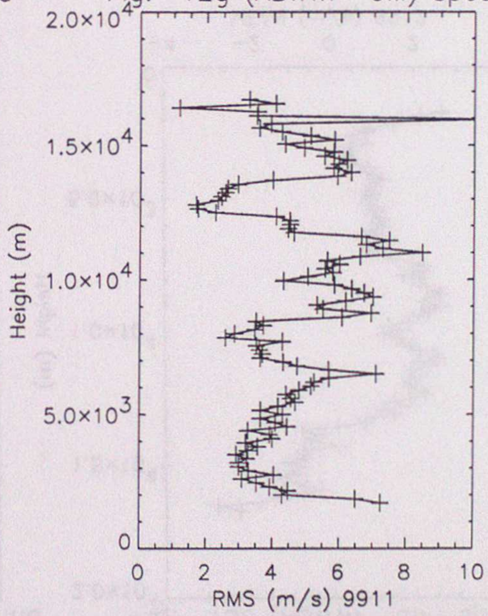
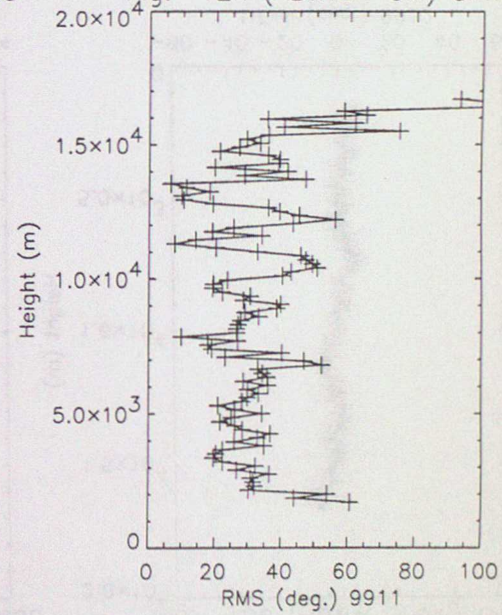


Fig. 12h (ABWWP-UM) dirn.



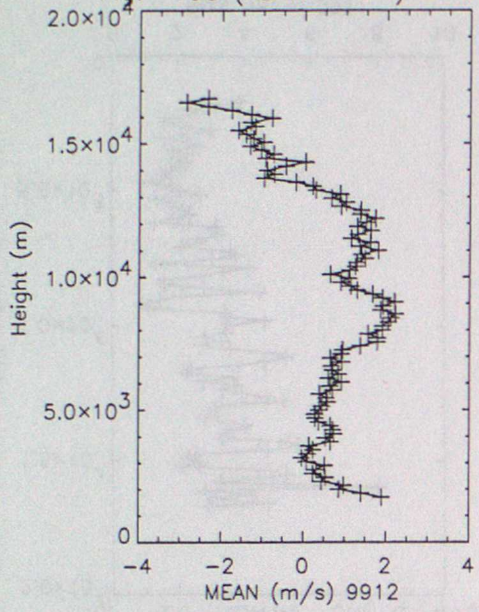


Fig. 13a (ABWWP-UM) u-wind

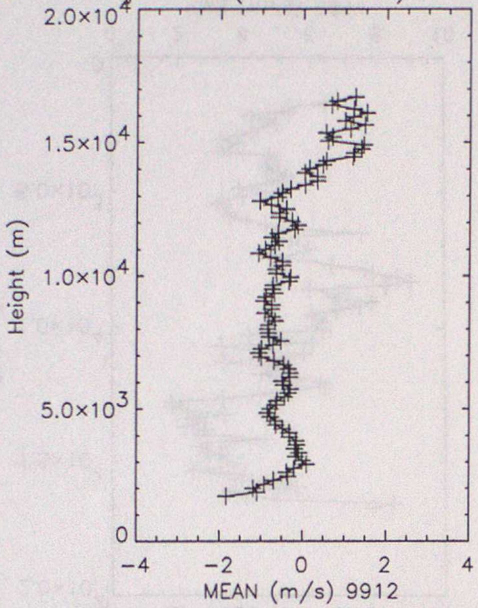


Fig. 13b (ABWWP-UM) v-wind

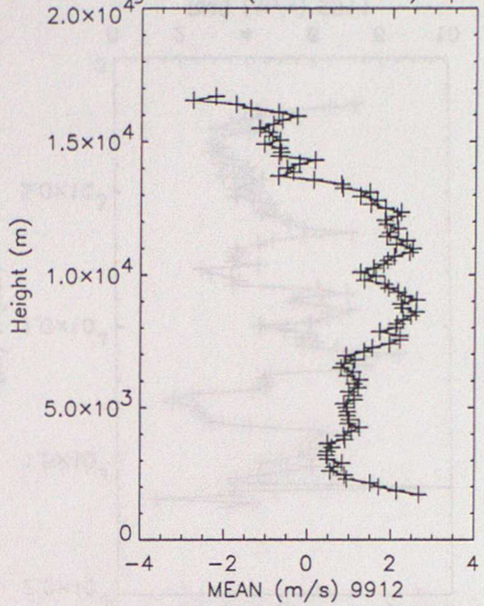


Fig. 13c (ABWWP-UM) speed

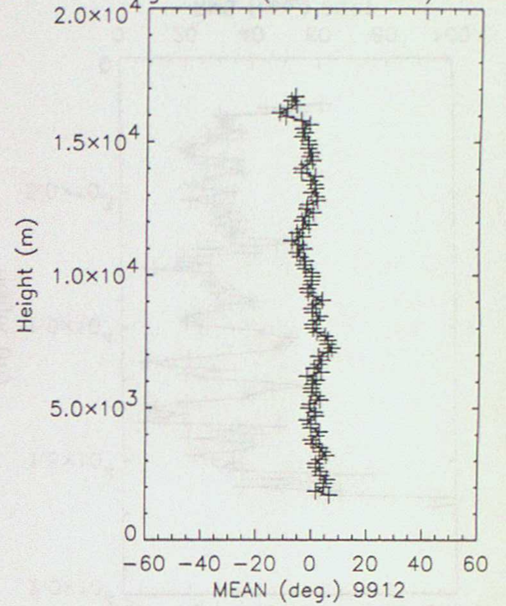


Fig. 13d (ABWWP-UM) dirn.

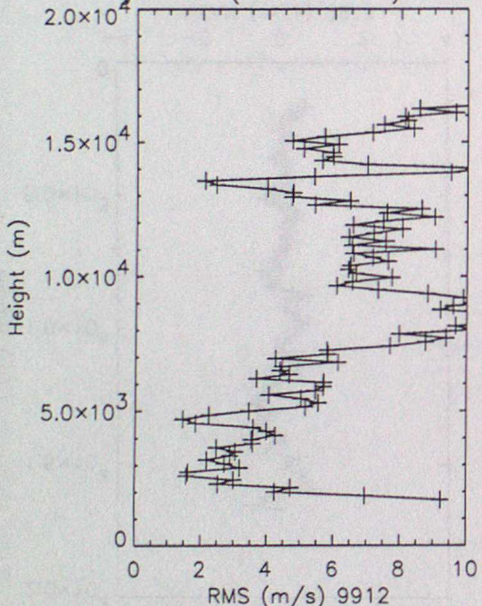


Fig. 13e (ABWWP-UM) u-wind

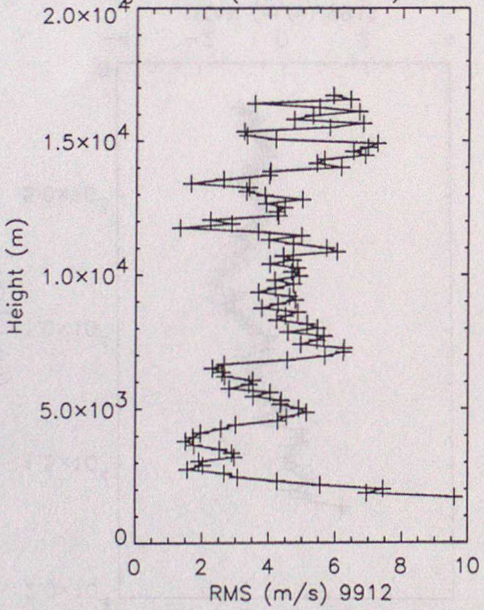


Fig. 13f (ABWWP-UM) v-wind

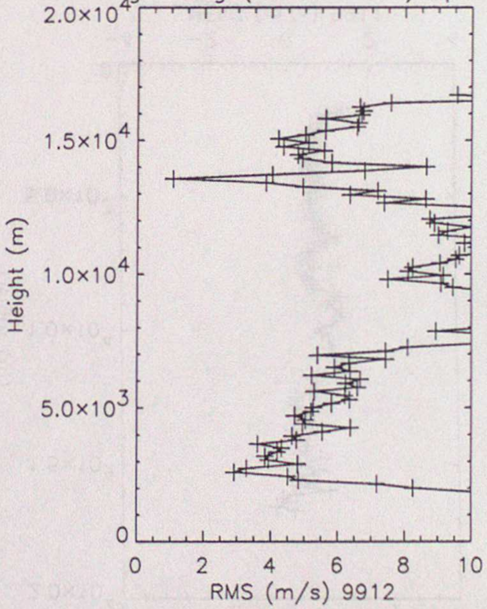


Fig. 13g (ABWWP-UM) speed

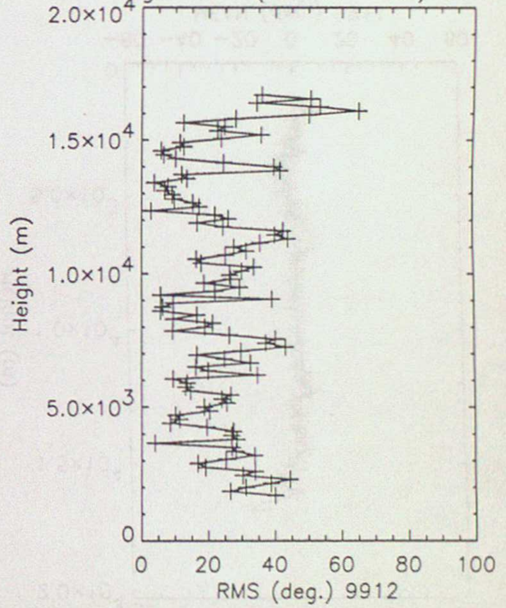


Fig. 13h (ABWWP-UM) dirn.

Fig. 14a (ABWWP-UM) u-wind

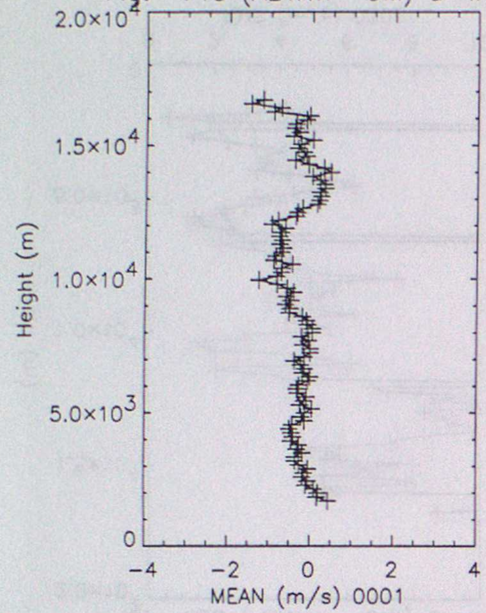


Fig. 14b (ABWWP-UM) v-wind

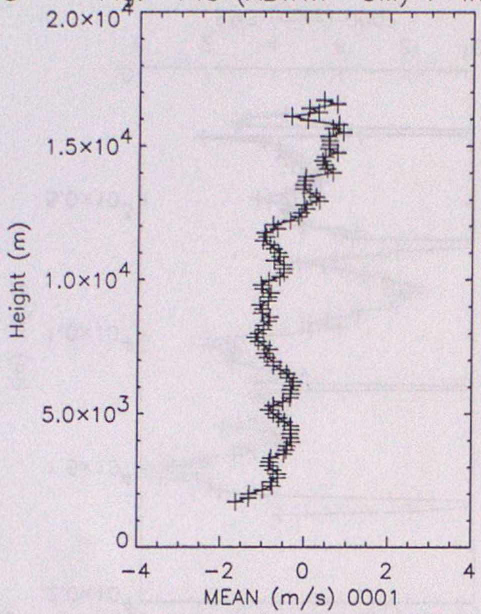


Fig. 14c (ABWWP-UM) speed

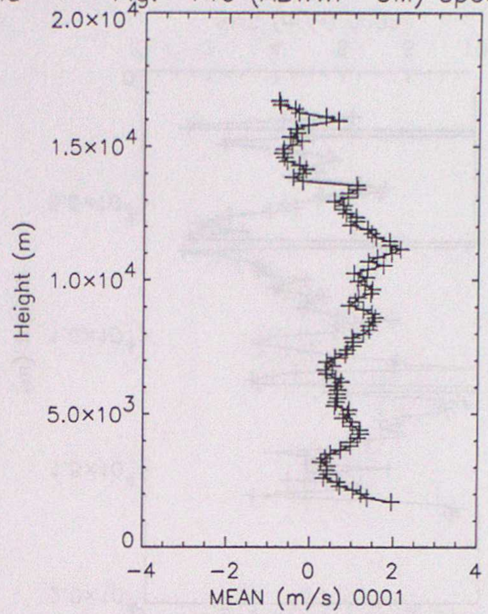


Fig. 14d (ABWWP-UM) dirn.

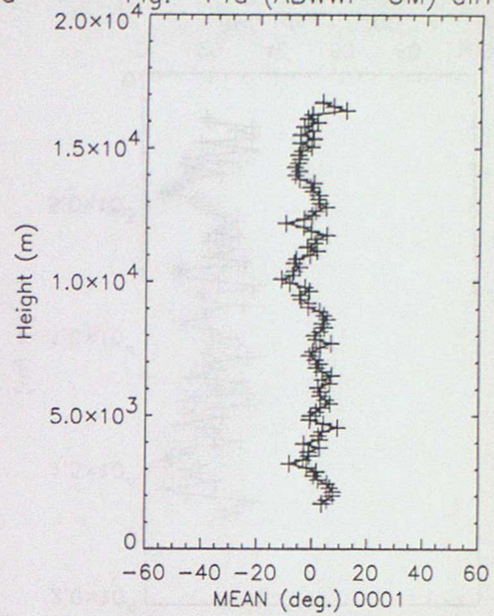


Fig. 14e (ABWWP-UM) u-wind

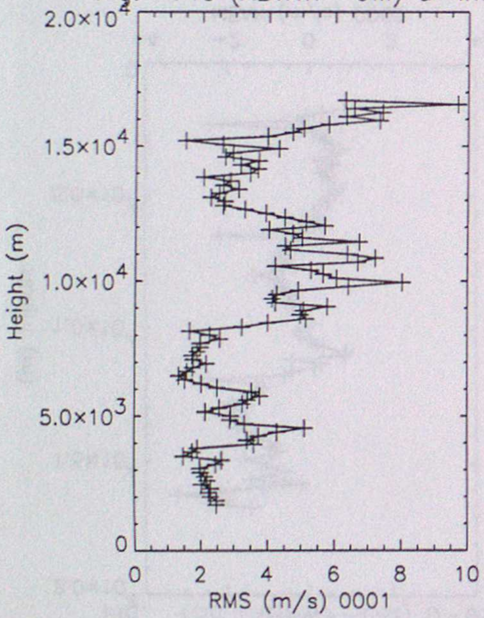


Fig. 14f (ABWWP-UM) v-wind

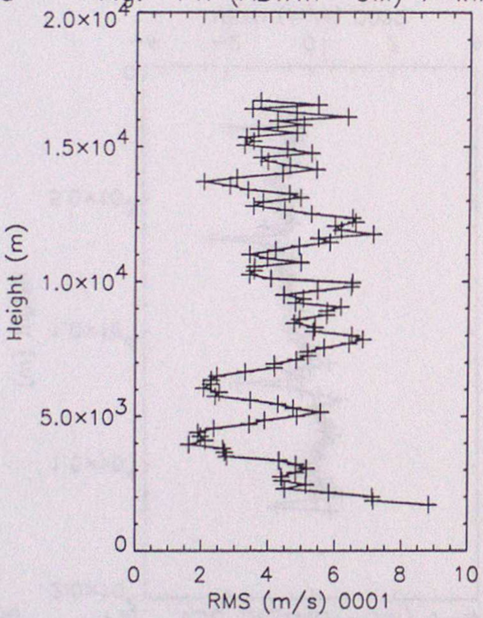


Fig. 14g (ABWWP-UM) speed

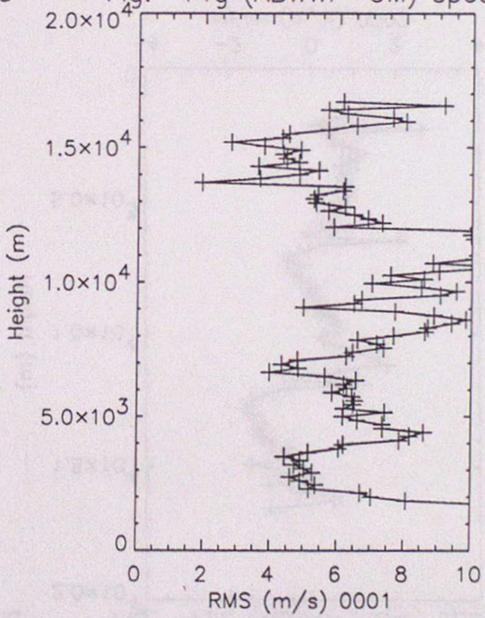


Fig. 14h (ABWWP-UM) dirn.

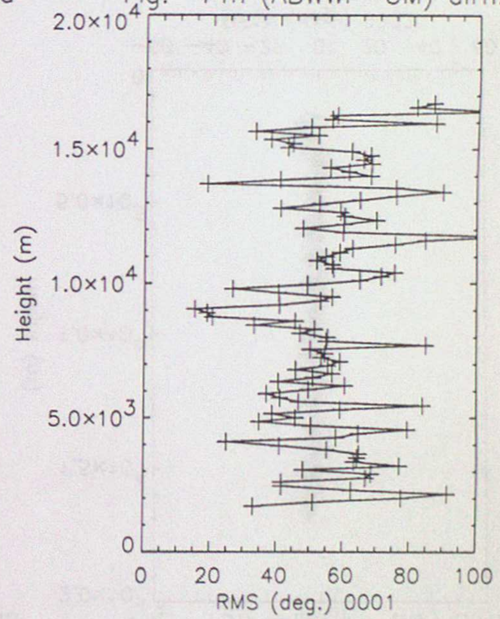


Fig. 15a (ABWWP-UM) u-wind

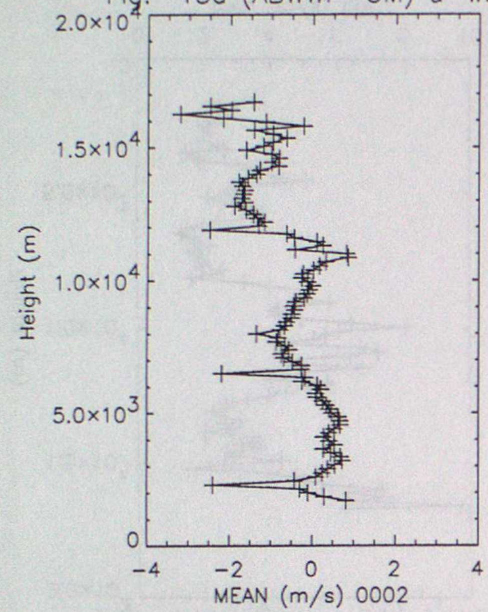


Fig. 15b (ABWWP-UM) v-wind

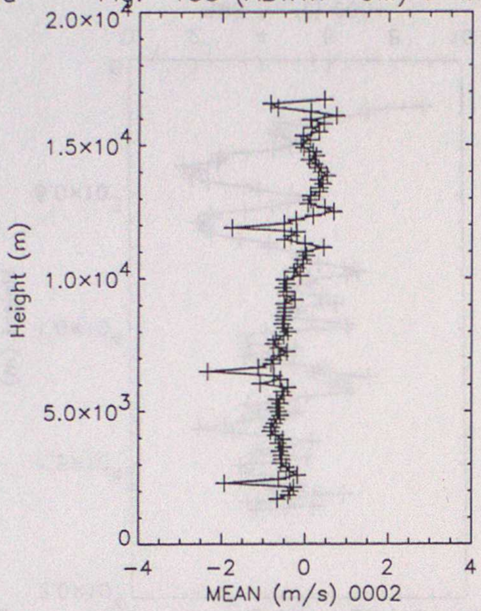


Fig. 15c (ABWWP-UM) speed

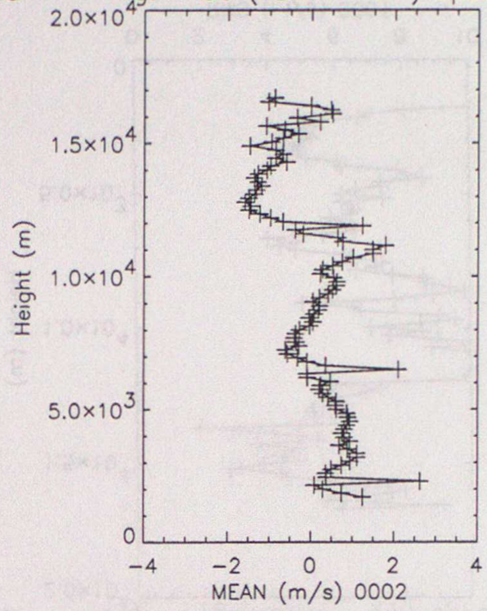


Fig. 15d (ABWWP-UM) dirn.

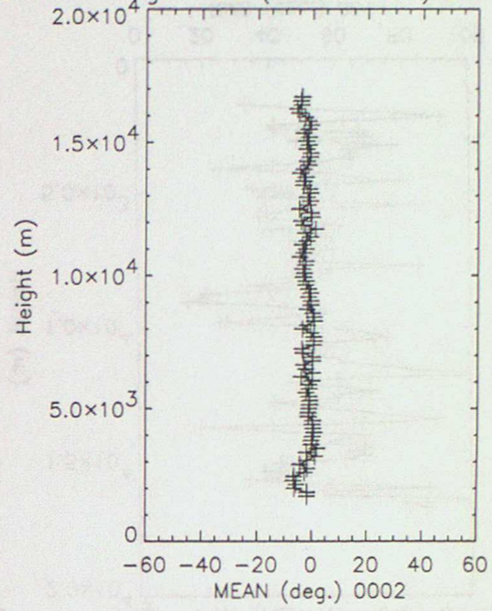


Fig. 15e (ABWWP-UM) u-wind

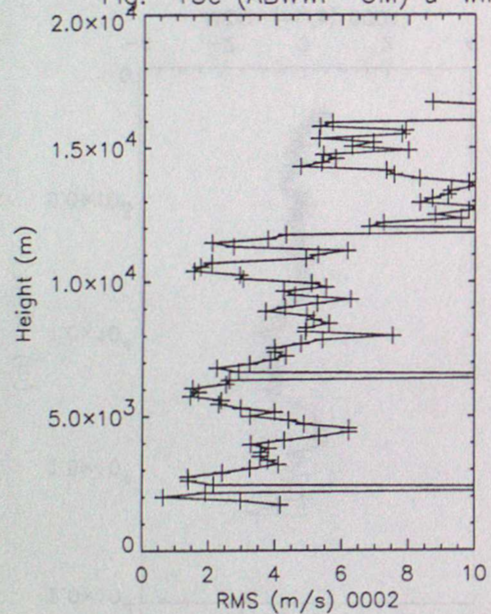


Fig. 15f (ABWWP-UM) v-wind

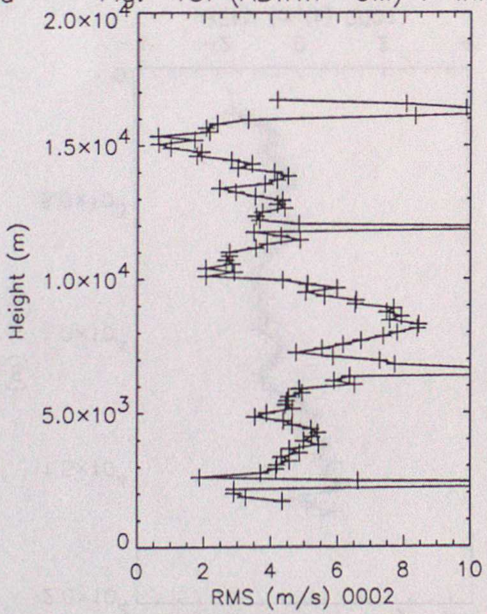


Fig. 15g (ABWWP-UM) speed

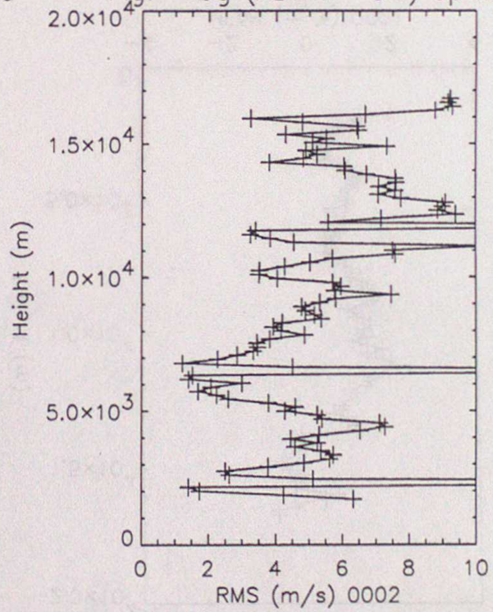


Fig. 15h (ABWWP-UM) dirn.

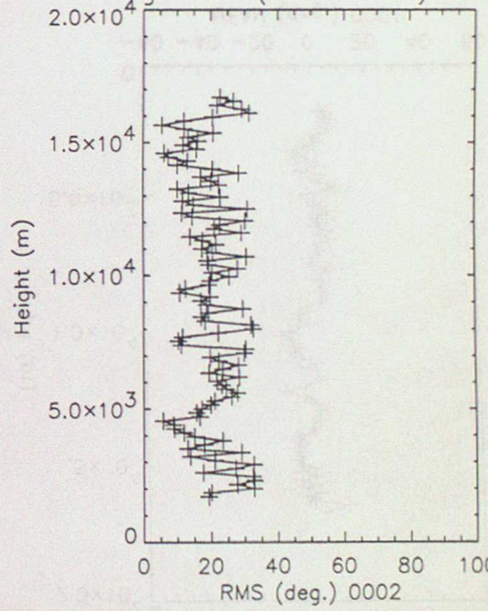


Fig. 16a (ABWWP-UM) u-wind

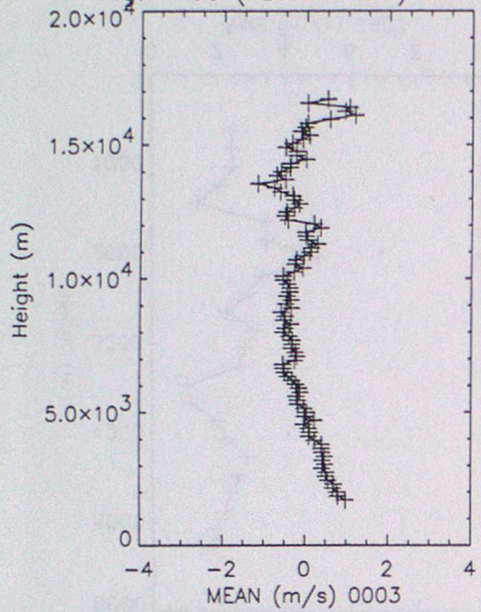


Fig. 16b (ABWWP-UM) v-wind

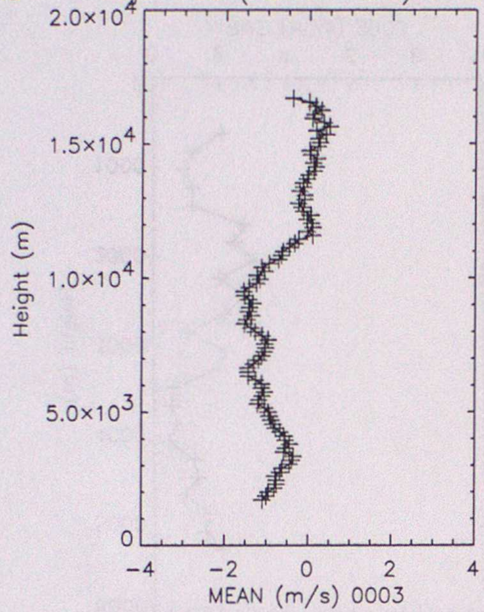


Fig. 16c (ABWWP-UM) speed

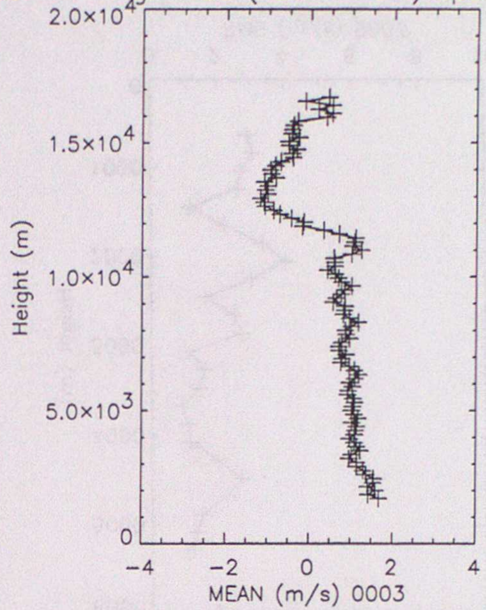


Fig. 16d (ABWWP-UM) dirn.

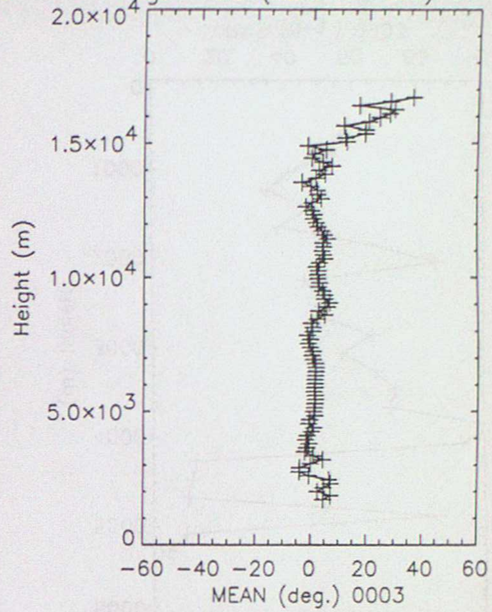


Fig. 16e (ABWWP-UM) u-wind

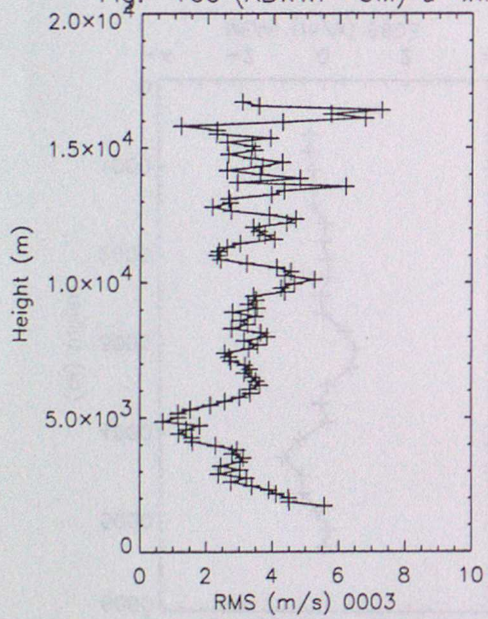


Fig. 16f (ABWWP-UM) v-wind

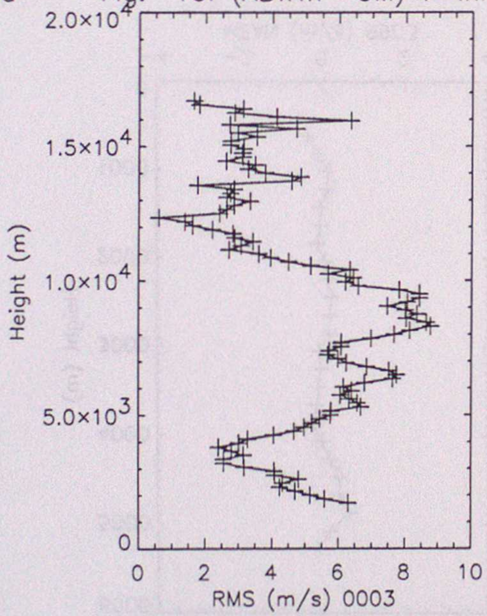


Fig. 16g (ABWWP-UM) speed

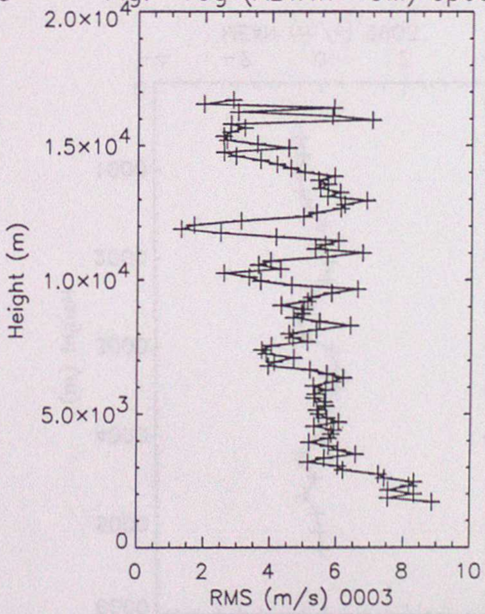


Fig. 16h (ABWWP-UM) dirn.

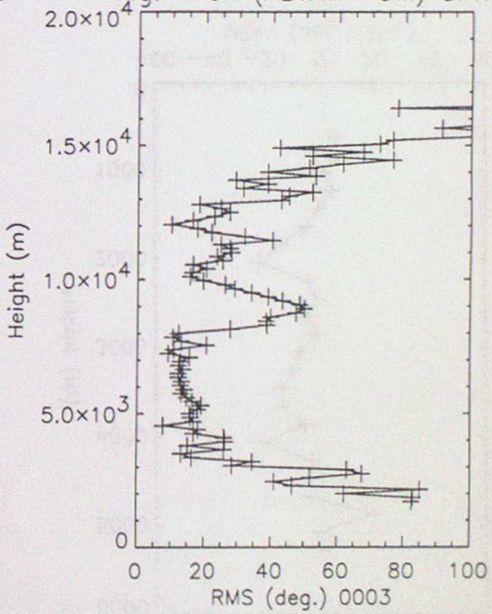


Fig. 17a (CABWP−UM) u−wind

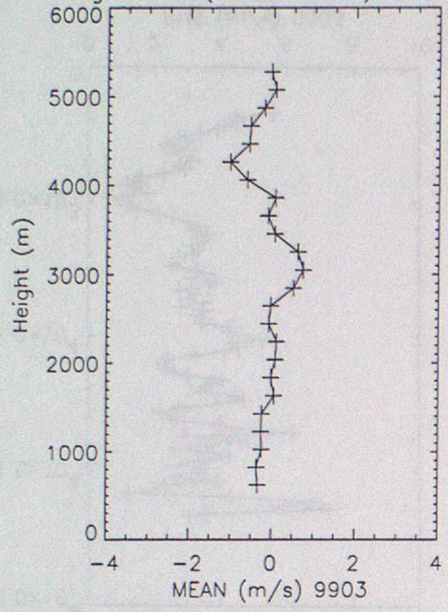


Fig. 17b (CABWP−UM) v−wind

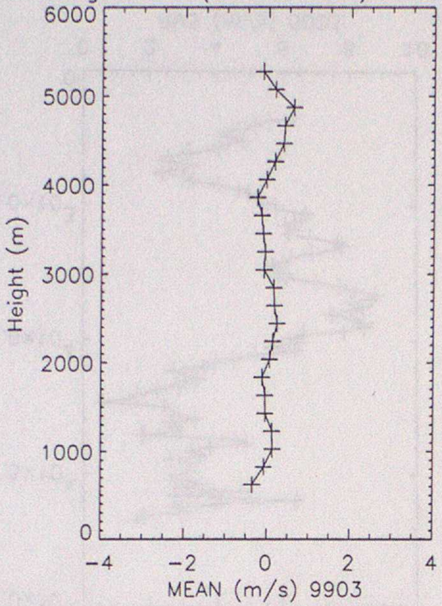


Fig. 17c (CABWP−UM) speed

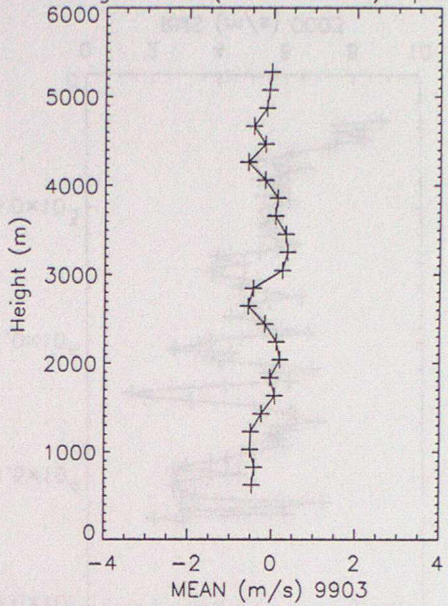


Fig. 17d (CABWP−UM) dirn.

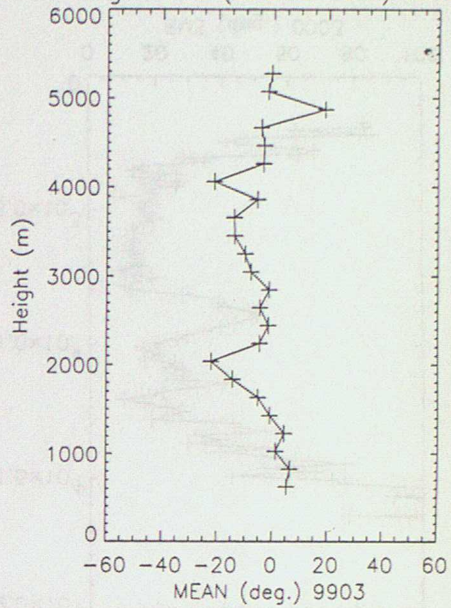


Fig. 17e (CABWP−UM) u−wind

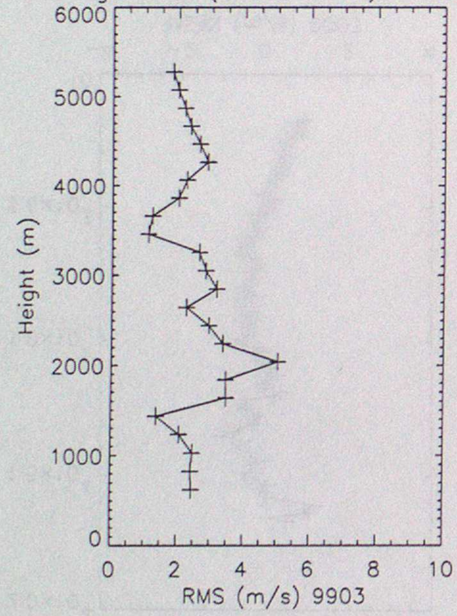


Fig. 17f (CABWP−UM) v−wind

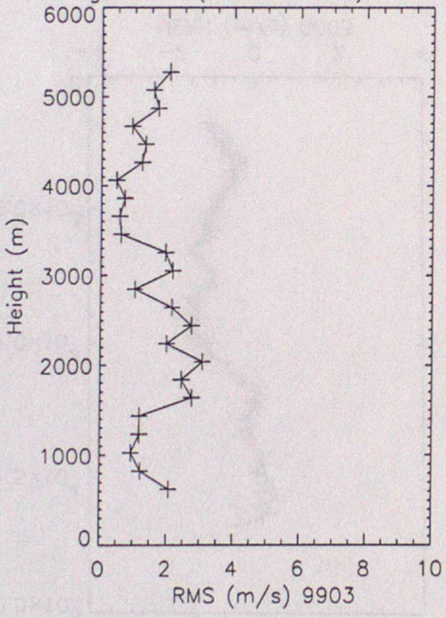


Fig. 17g (CABWP−UM) speed

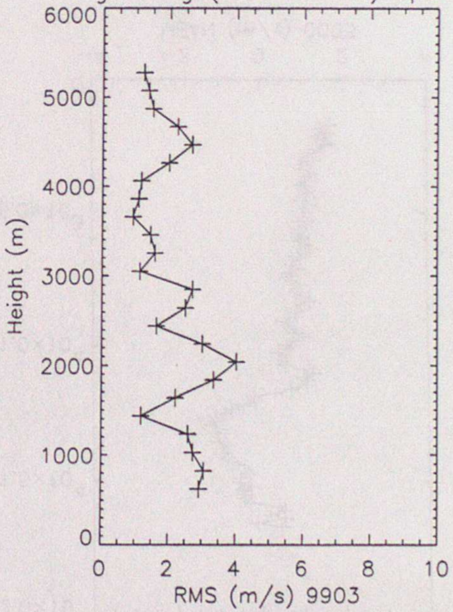


Fig. 17h (CABWP−UM) dirn.

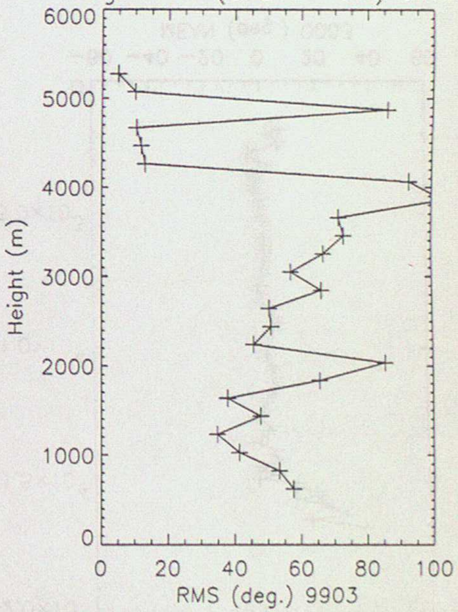


Fig. 18a (CABWP-UM) u-wind

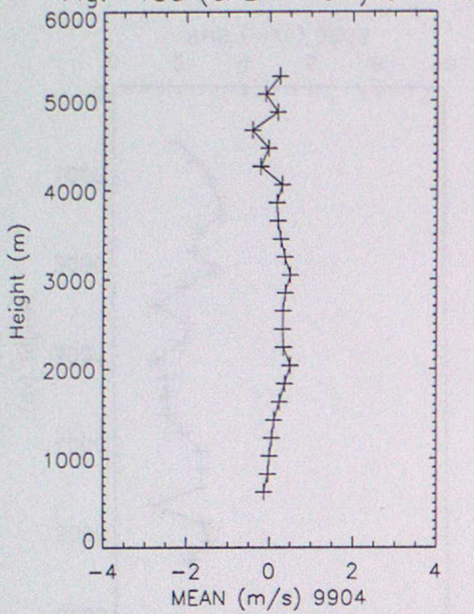


Fig. 18b (CABWP-UM) v-wind

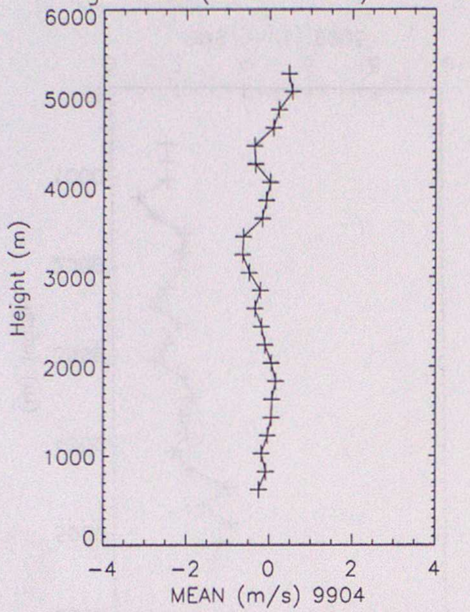


Fig. 18c (CABWP-UM) speed

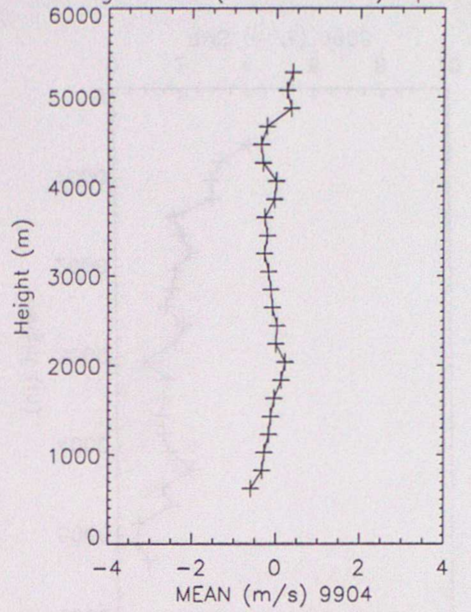


Fig. 18d (CABWP-UM) dirn.

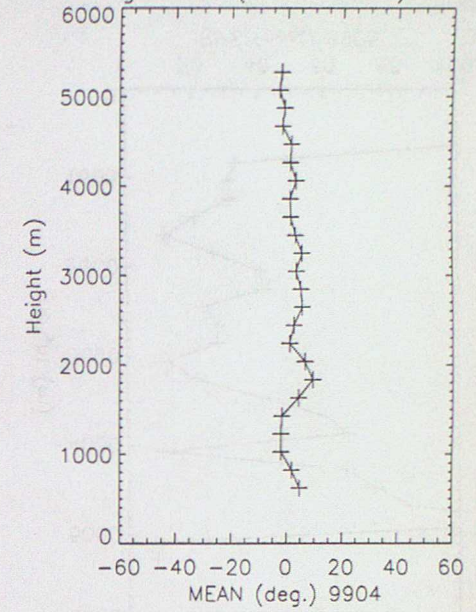


Fig. 18e (CABWP-UM) u-wind

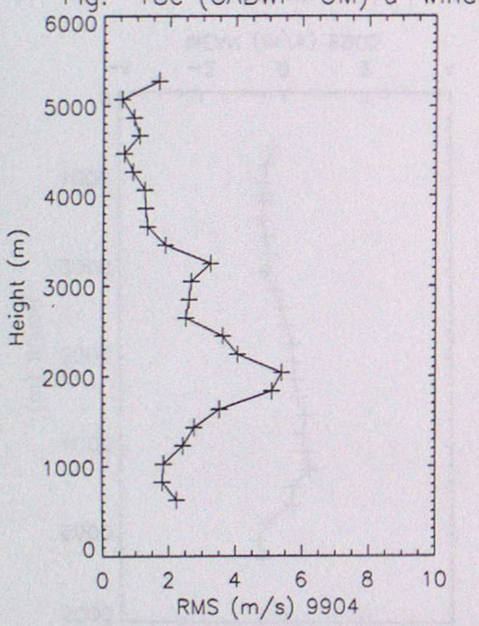


Fig. 18f (CABWP-UM) v-wind

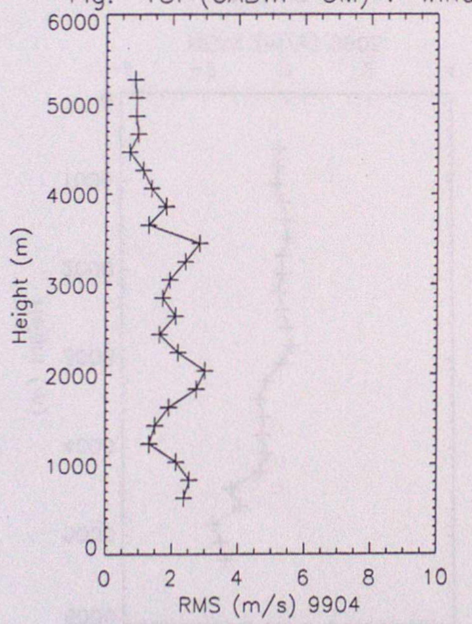


Fig. 18g (CABWP-UM) speed

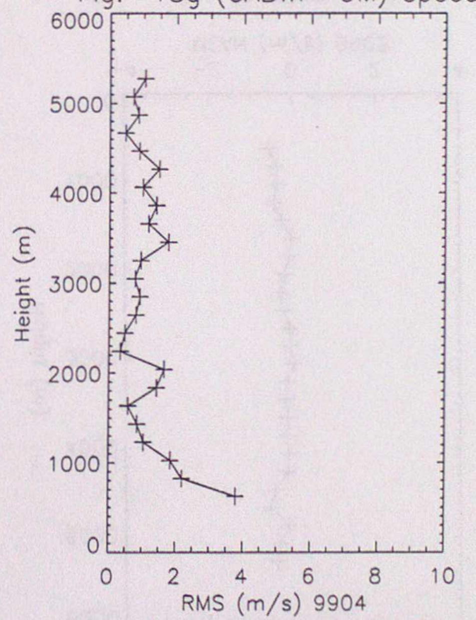


Fig. 18h (CABWP-UM) dirn.

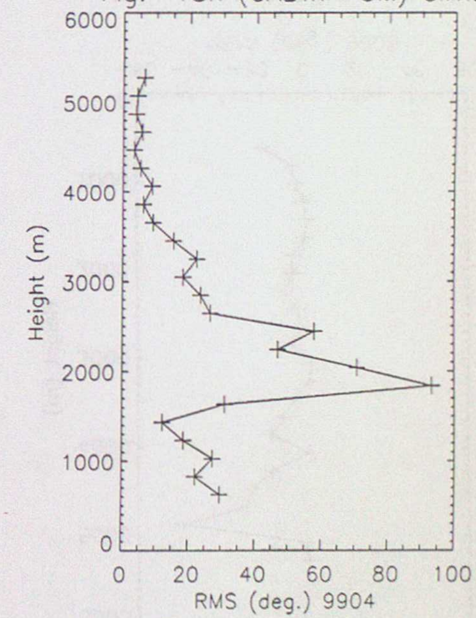


Fig. 19a (CABWP-UM) u-wind

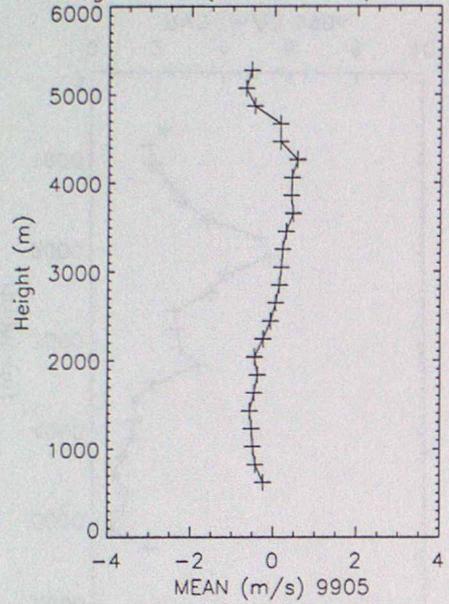


Fig. 19b (CABWP-UM) v-wind

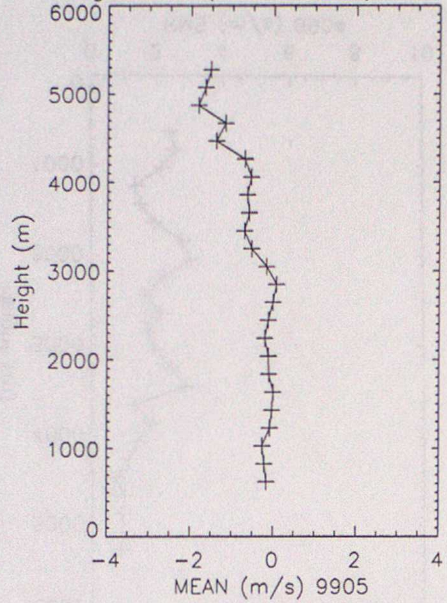


Fig. 19c (CABWP-UM) speed

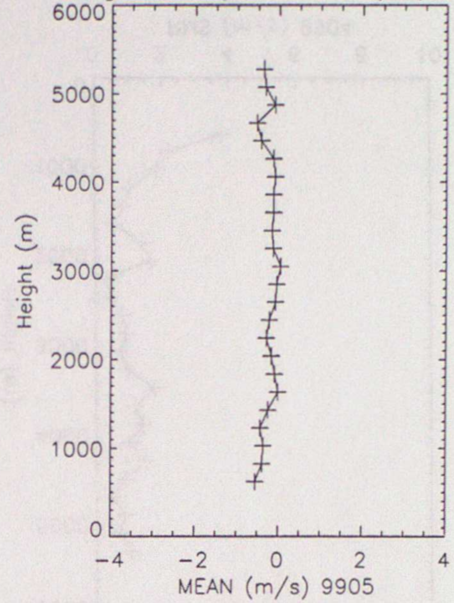


Fig. 19d (CABWP-UM) dirn.

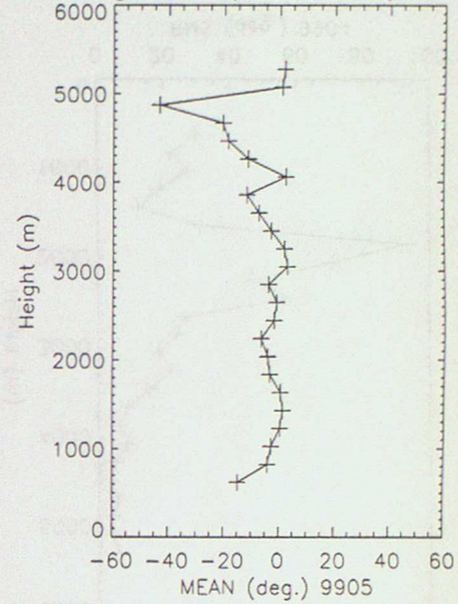


Fig. 19e (CABWP-UM) u-wind

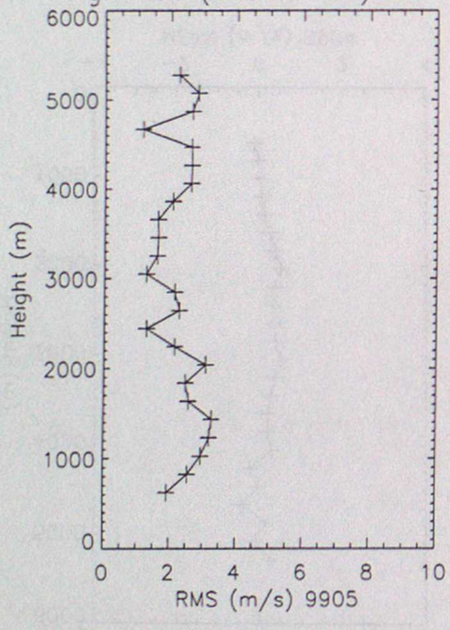


Fig. 19f (CABWP-UM) v-wind

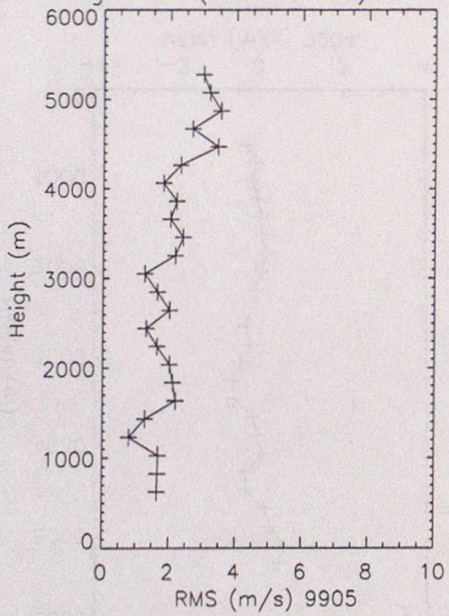


Fig. 19g (CABWP-UM) speed

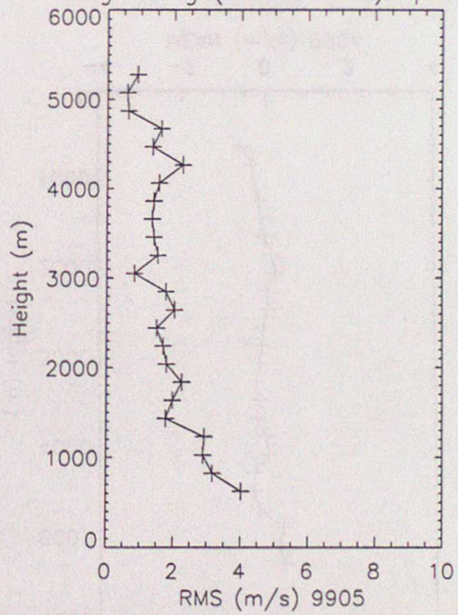
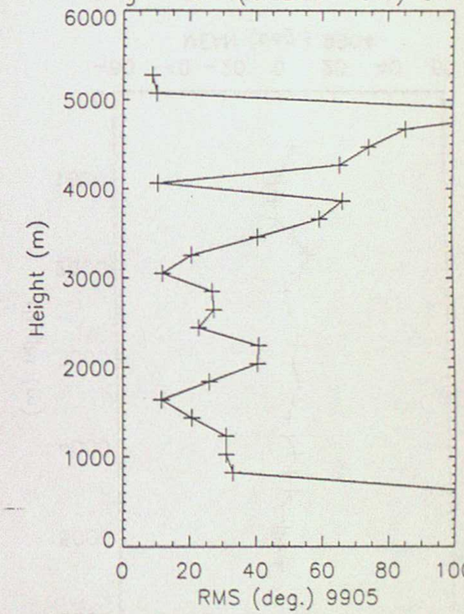


Fig. 19h (CABWP-UM) dirn.



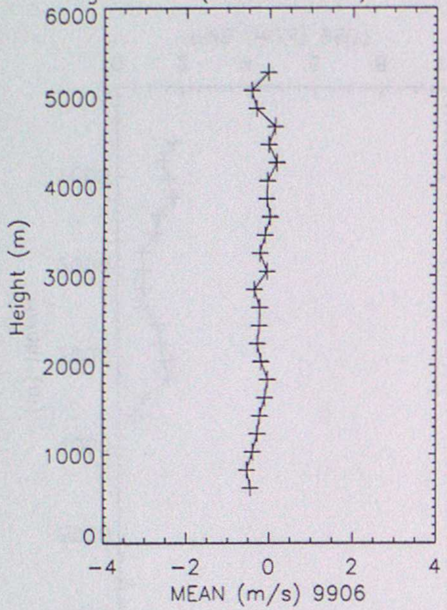


Fig. 20a (CABWP–UM) u–wind

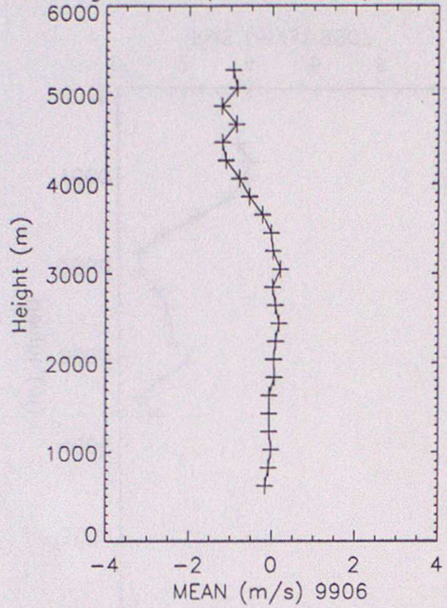


Fig. 20b (CABWP–UM) v–wind

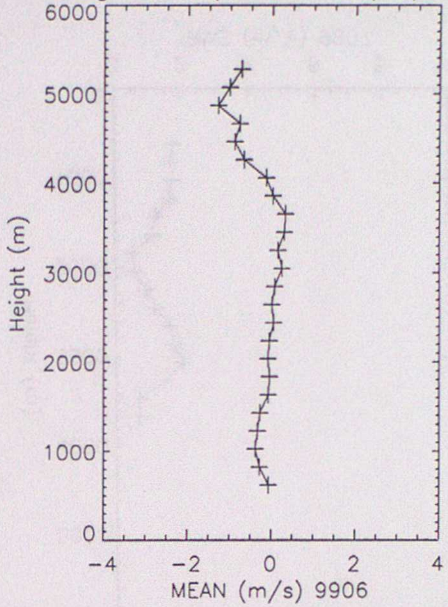


Fig. 20c (CABWP–UM) speed

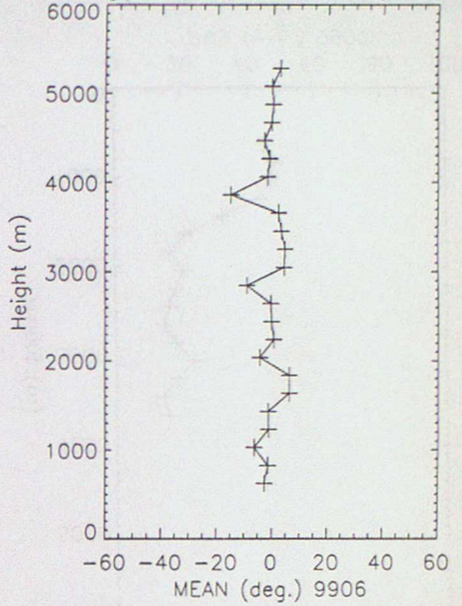


Fig. 20d (CABWP–UM) dirn.

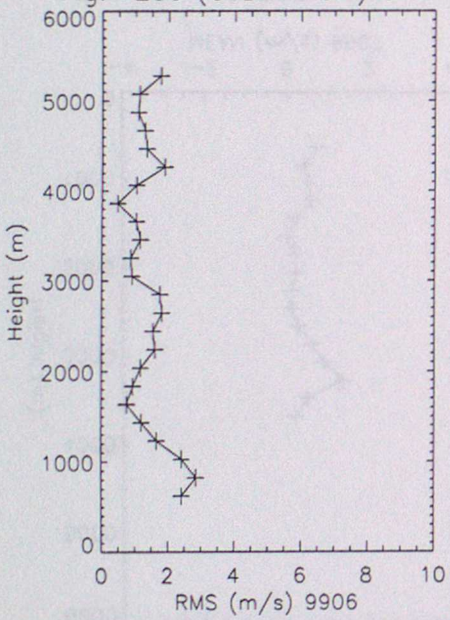


Fig. 20e (CABWP–UM) u–wind

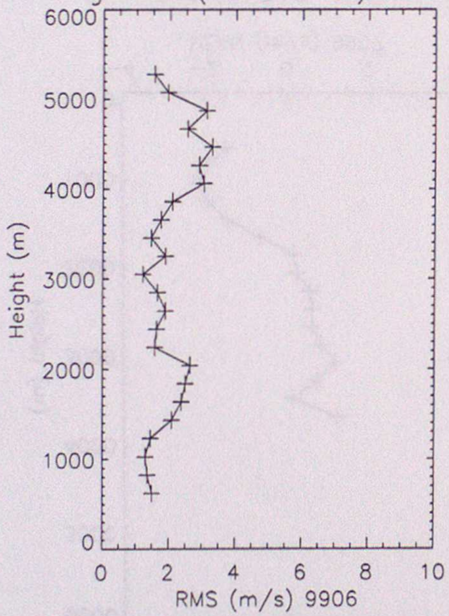


Fig. 20f (CABWP–UM) v–wind

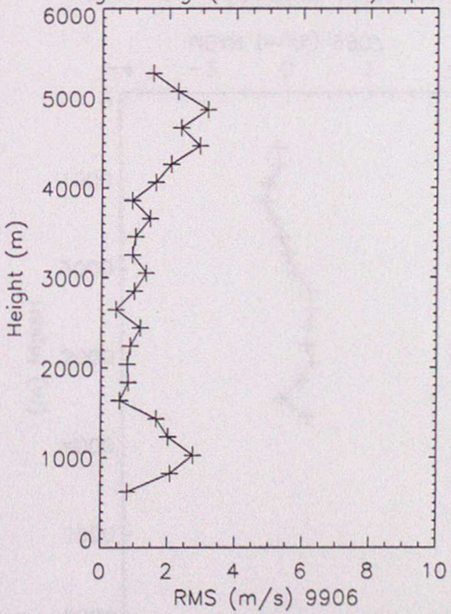


Fig. 20g (CABWP–UM) speed

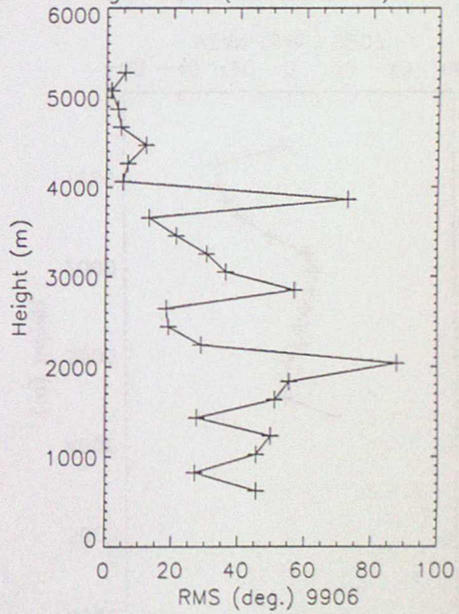


Fig. 20h (CABWP–UM) dirn.

Fig. 21a (CABWP-UM) u-wind

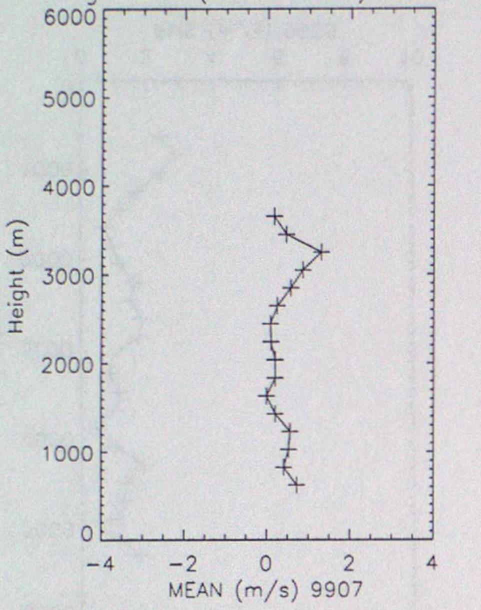


Fig. 21b (CABWP-UM) v-wind

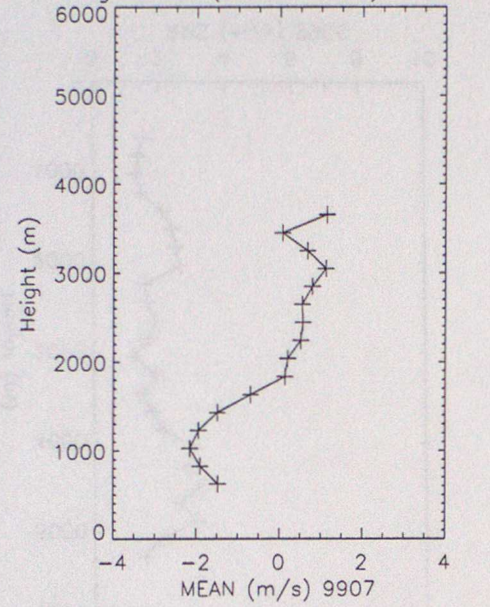


Fig. 21c (CABWP-UM) speed

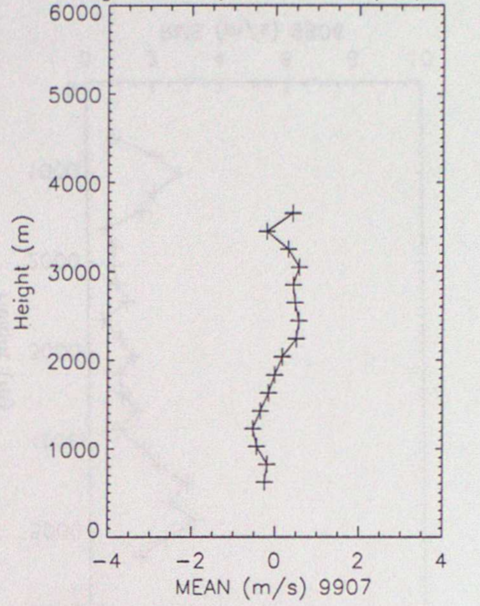


Fig. 21d (CABWP-UM) dirn.

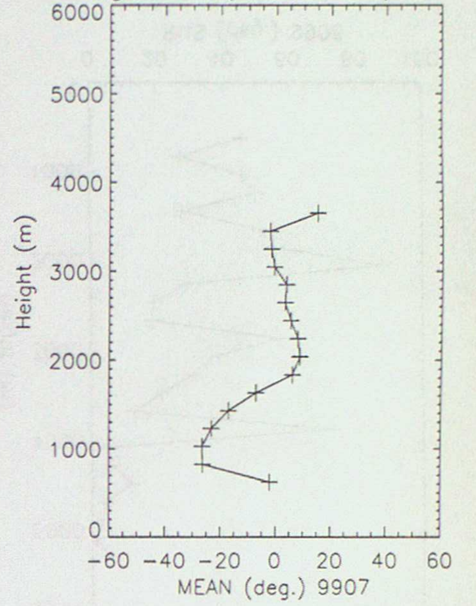


Fig. 21e (CABWP-UM) u-wind

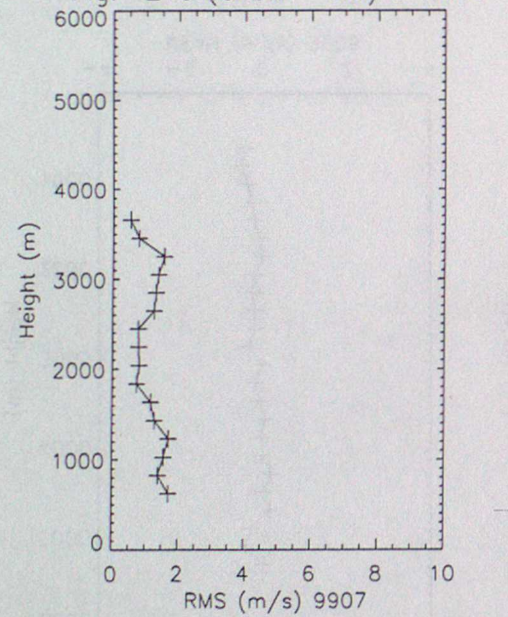


Fig. 21f (CABWP-UM) v-wind

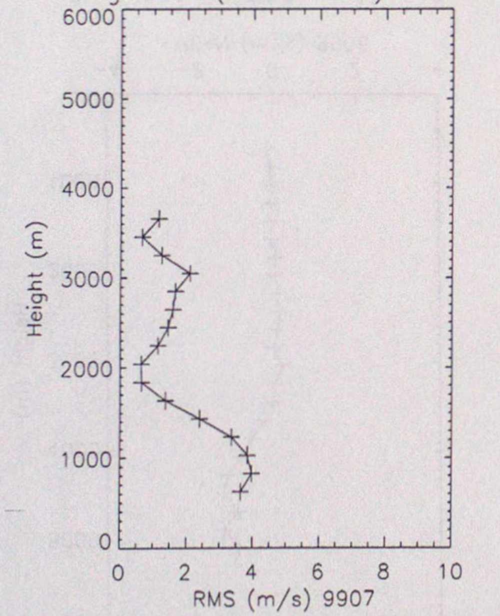


Fig. 21g (CABWP-UM) speed

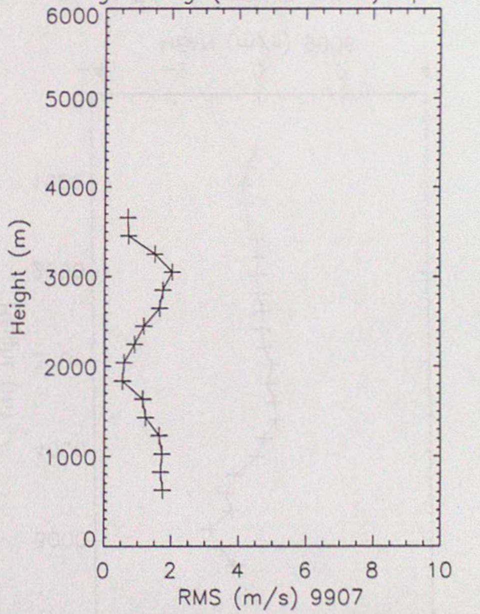


Fig. 21h (CABWP-UM) dirn.

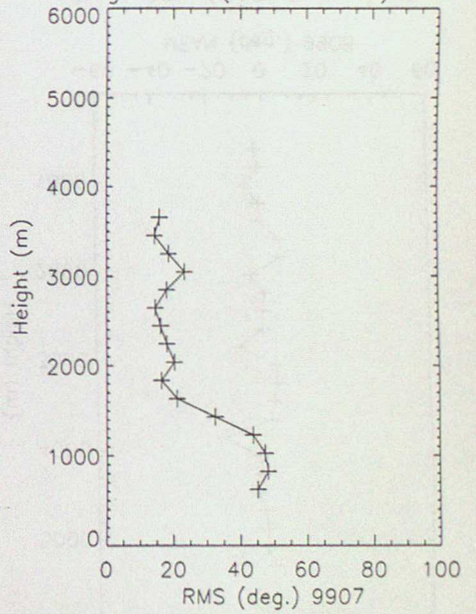


Fig. 22a (CABWP–UM) u–wind

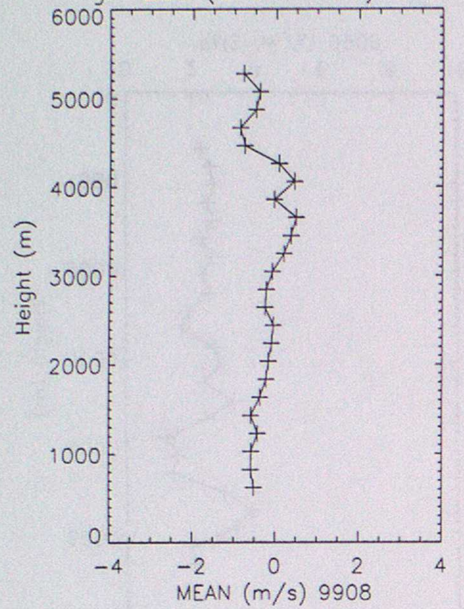


Fig. 22b (CABWP–UM) v–wind

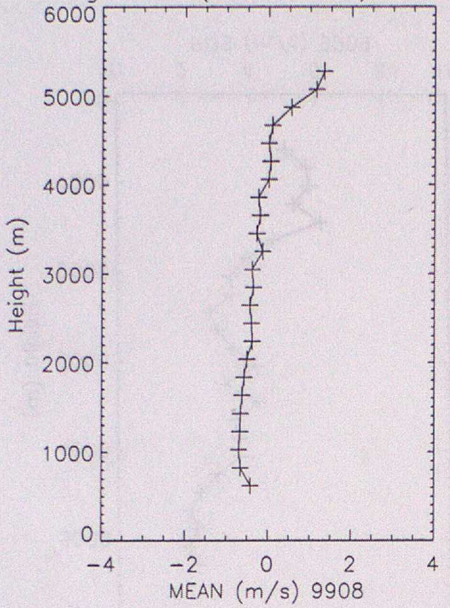


Fig. 22c (CABWP–UM) speed

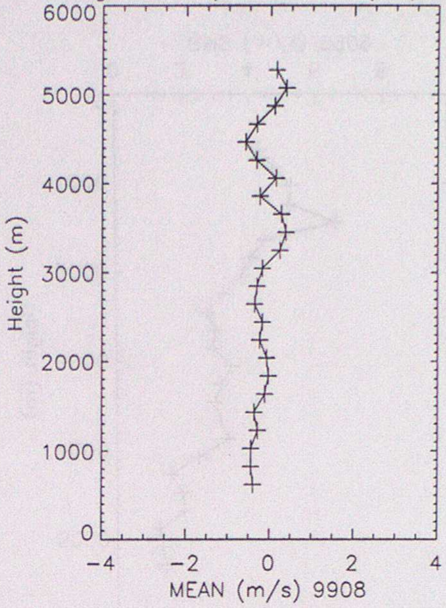


Fig. 22d (CABWP–UM) dirn.

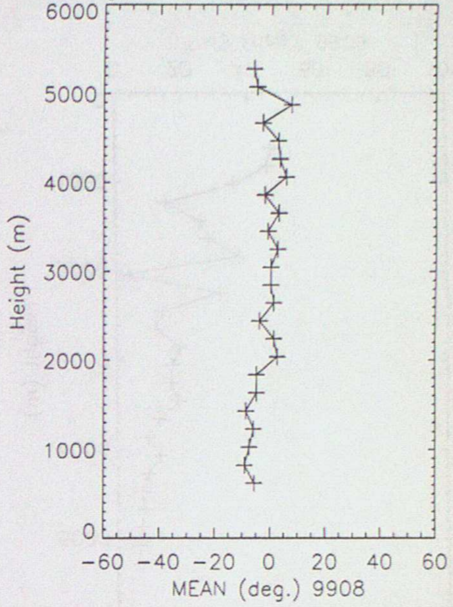


Fig. 22e (CABWP–UM) u–wind

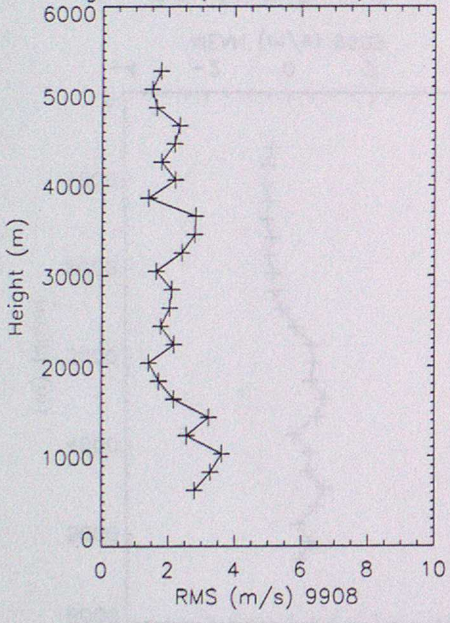


Fig. 22f (CABWP–UM) v–wind

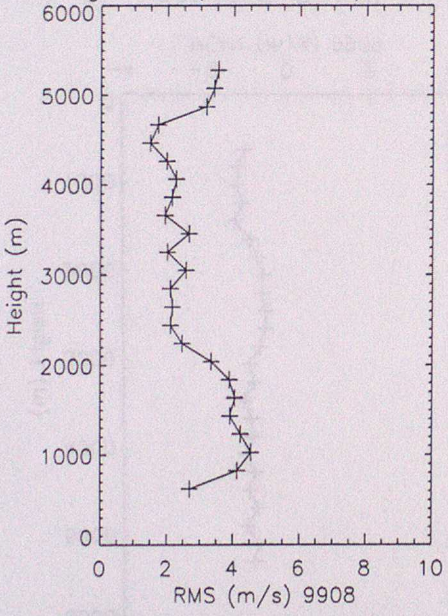


Fig. 22g (CABWP–UM) speed

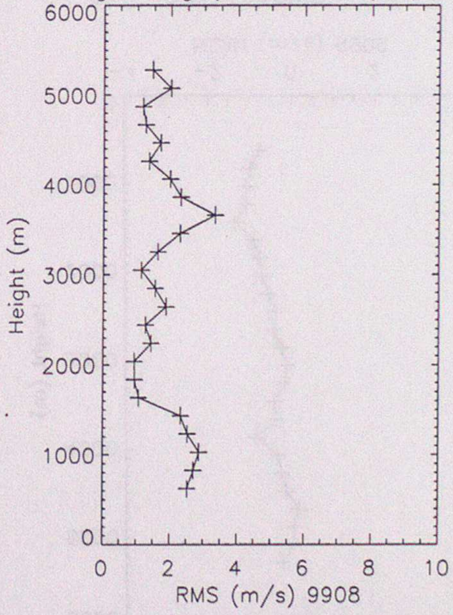


Fig. 22h (CABWP–UM) dirn.

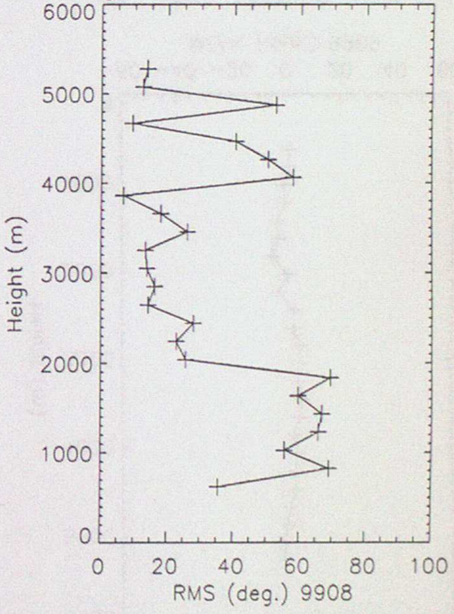


Fig. 23a (CABWP-UM) u-wind

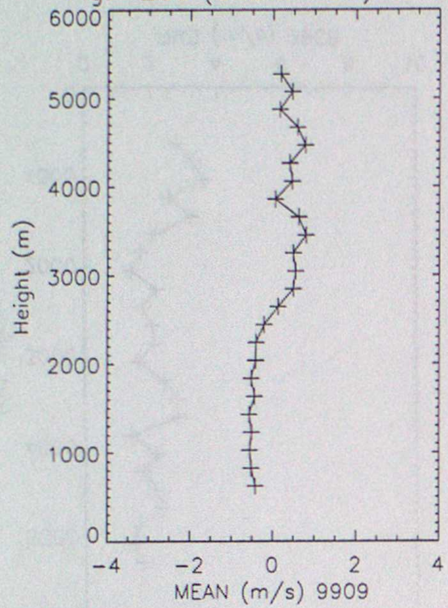


Fig. 23b (CABWP-UM) v-wind

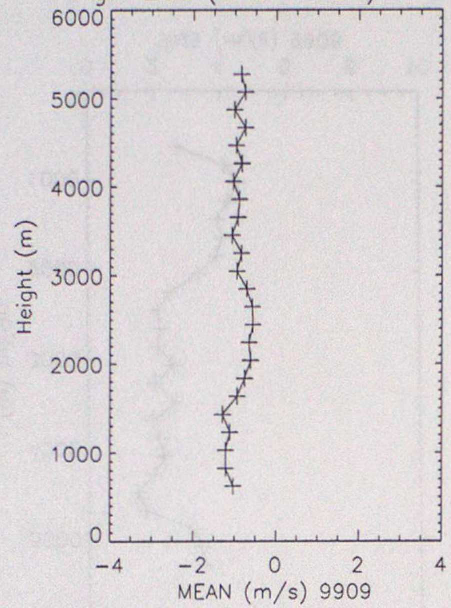


Fig. 23c (CABWP-UM) speed

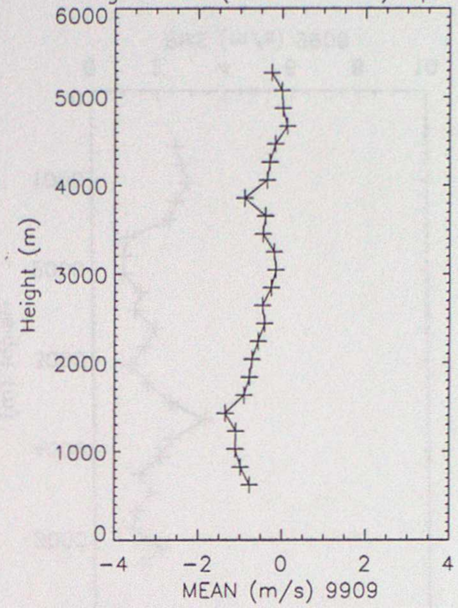


Fig. 23d (CABWP-UM) dirn.

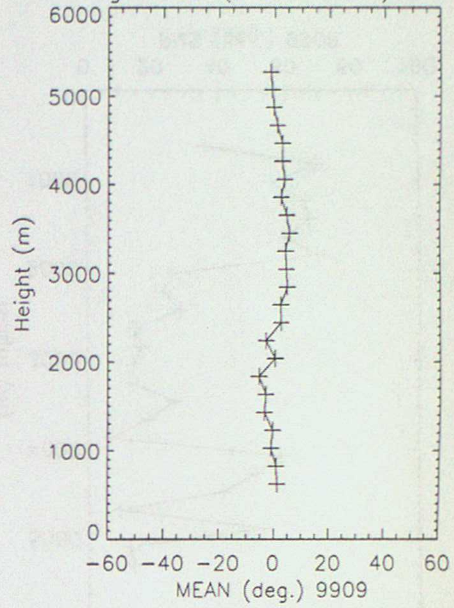


Fig. 23e (CABWP-UM) u-wind

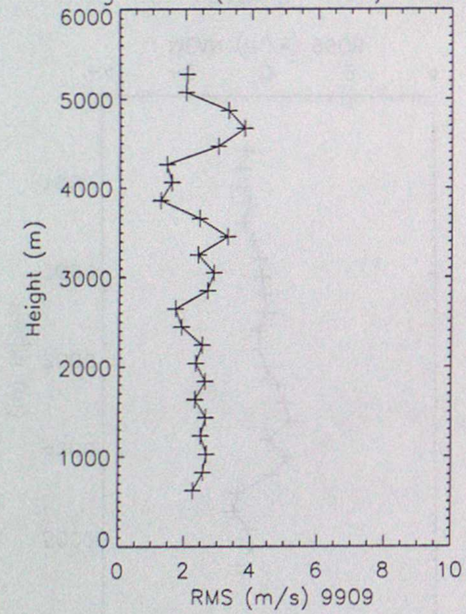


Fig. 23f (CABWP-UM) v-wind

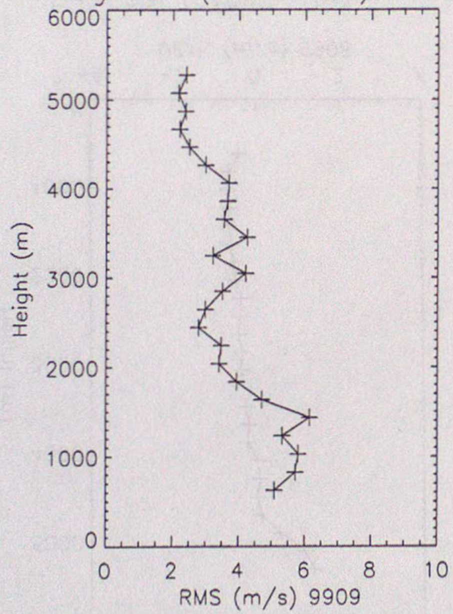


Fig. 23g (CABWP-UM) speed

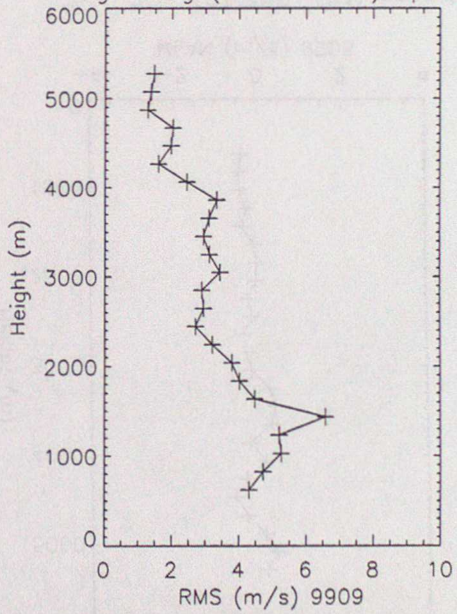
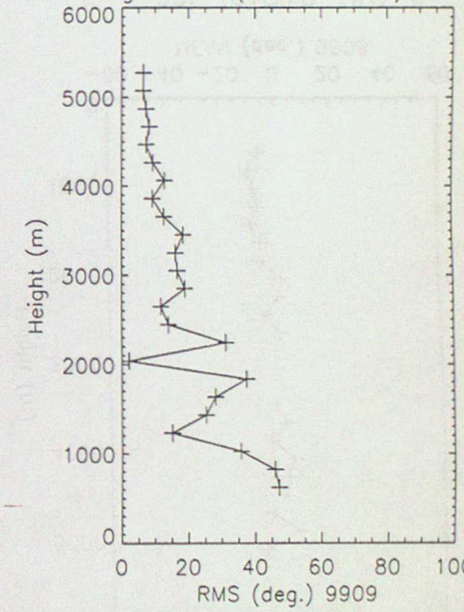


Fig. 23h (CABWP-UM) dirn.



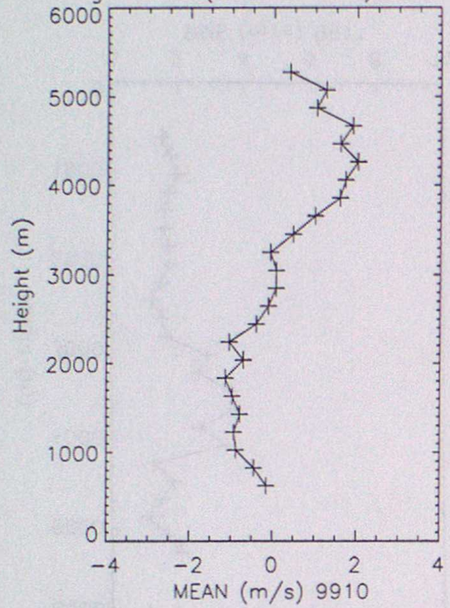


Fig. 24a (CABWP-UM) u-wind

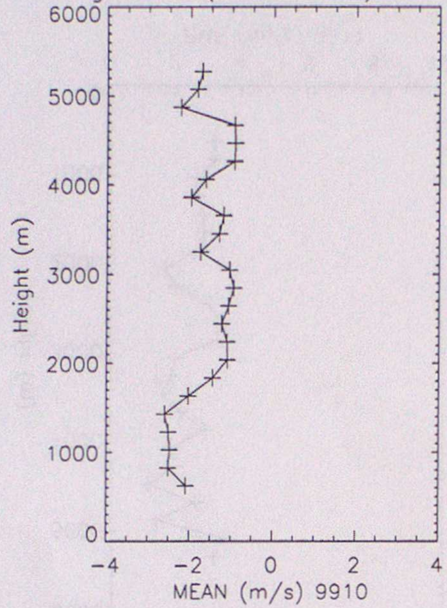


Fig. 24b (CABWP-UM) v-wind

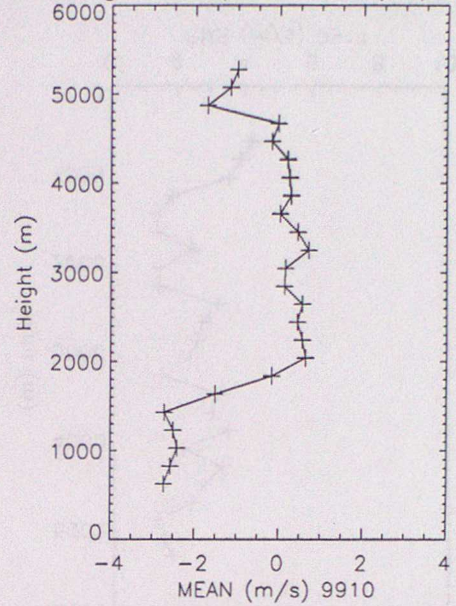


Fig. 24c (CABWP-UM) speed

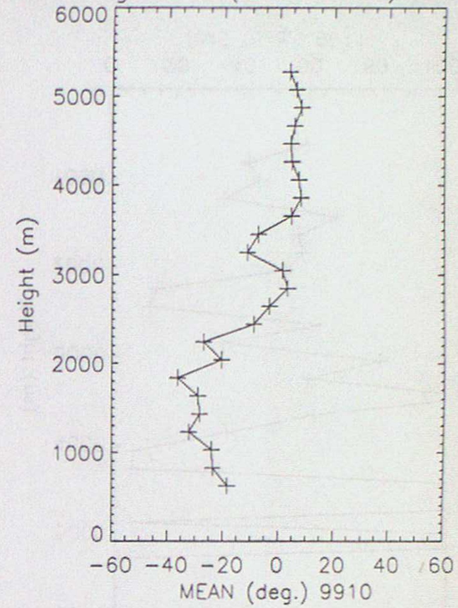


Fig. 24d (CABWP-UM) dirn.

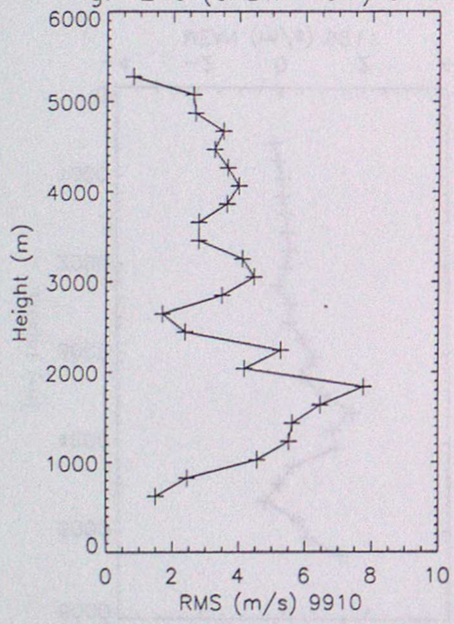


Fig. 24e (CABWP-UM) u-wind

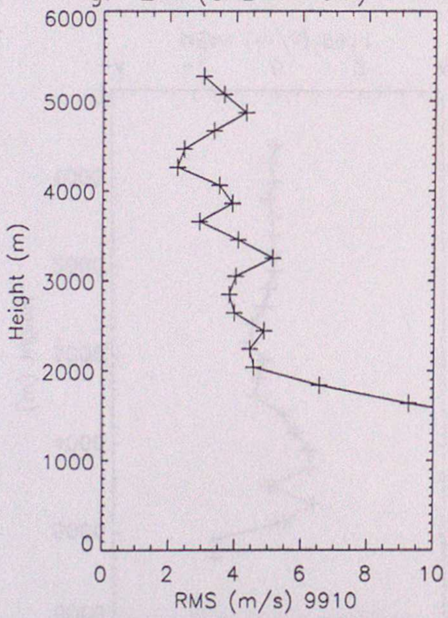


Fig. 24f (CABWP-UM) v-wind

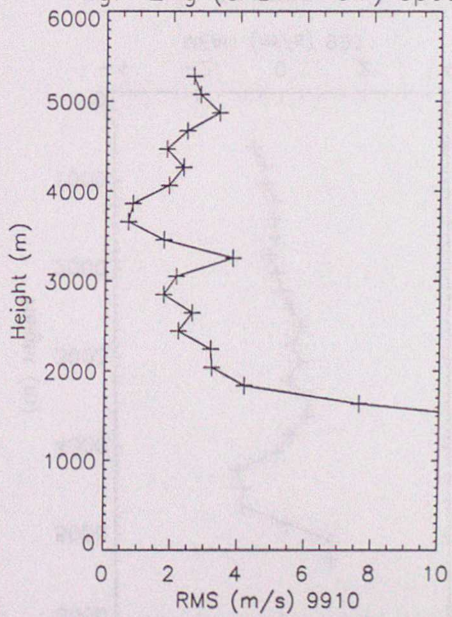


Fig. 24g (CABWP-UM) speed

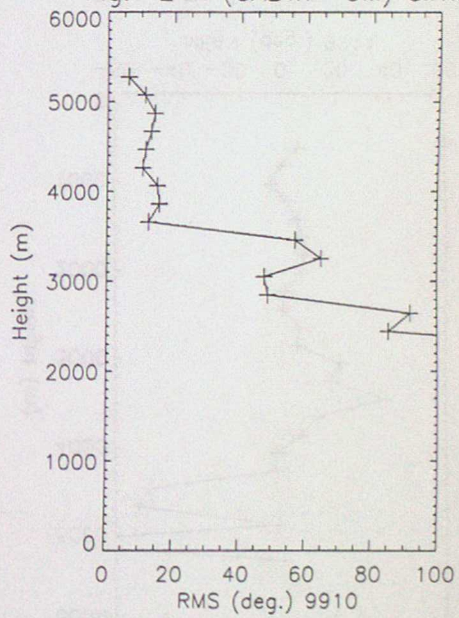


Fig. 24h (CABWP-UM) dirn.

Fig. 25a (CABWP-UM) u-wind

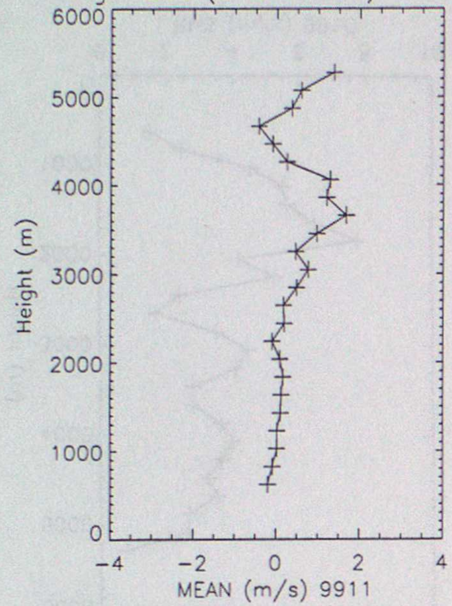


Fig. 25b (CABWP-UM) v-wind

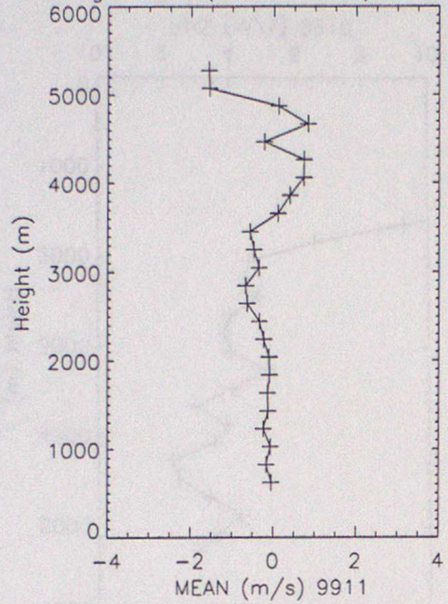


Fig. 25c (CABWP-UM) speed

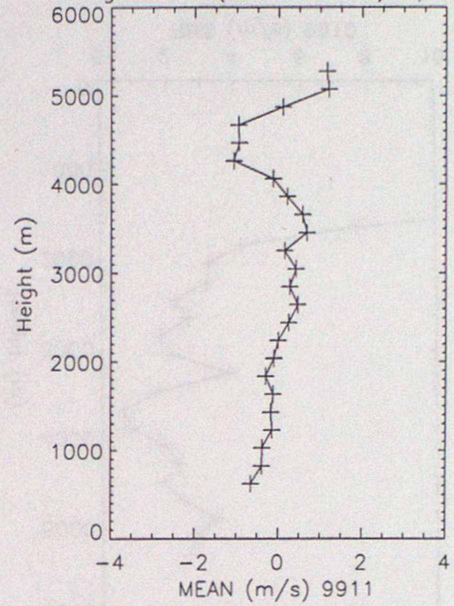


Fig. 25d (CABWP-UM) dirn.

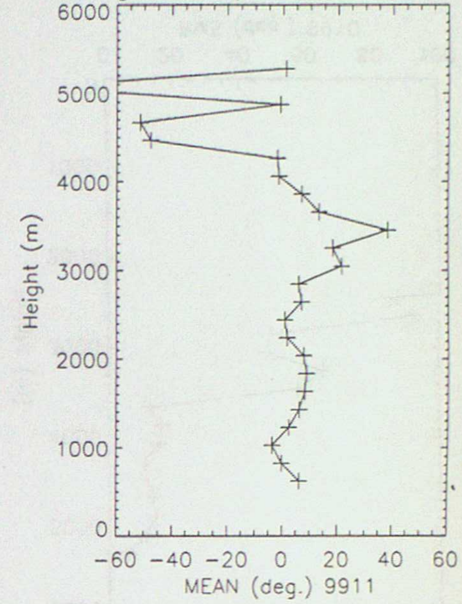


Fig. 25e (CABWP-UM) u-wind

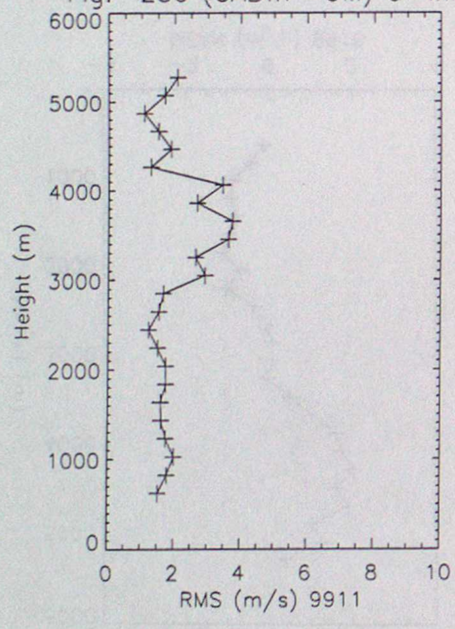


Fig. 25f (CABWP-UM) v-wind

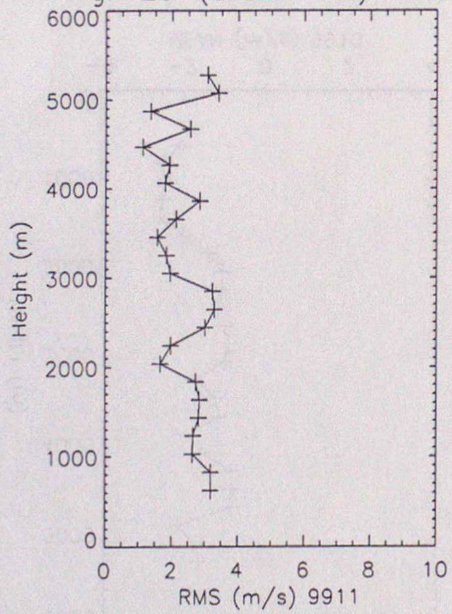


Fig. 25g (CABWP-UM) speed

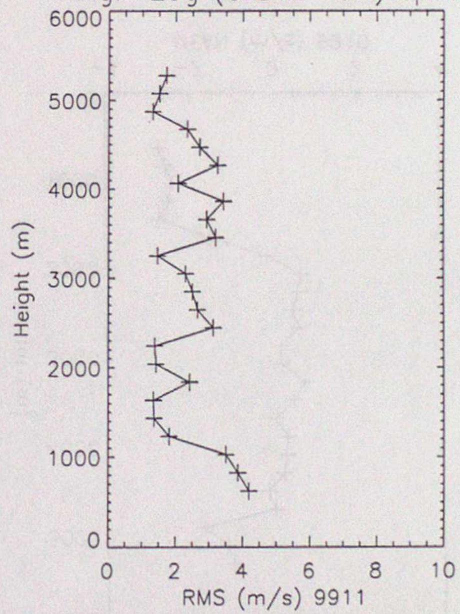


Fig. 25h (CABWP-UM) dirn.

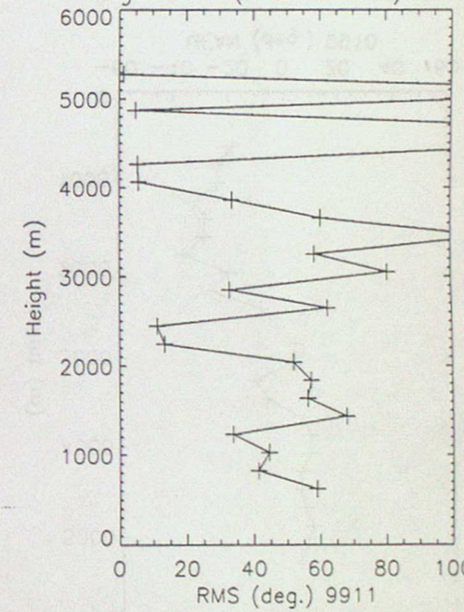


Fig. 26a (CABWP-UM) u-wind

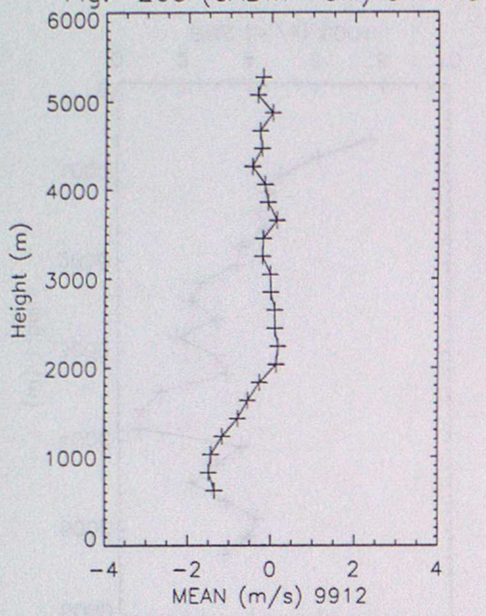


Fig. 26b (CABWP-UM) v-wind

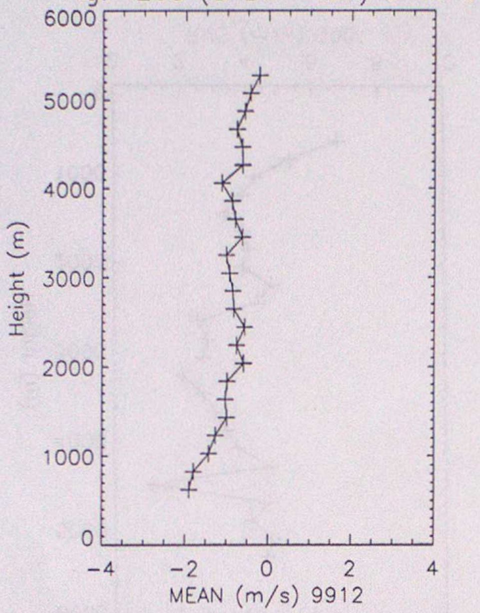


Fig. 26c (CABWP-UM) speed

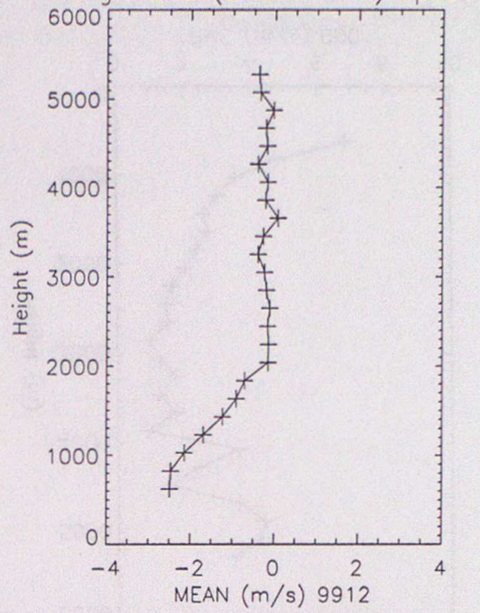


Fig. 26d (CABWP-UM) dirn.

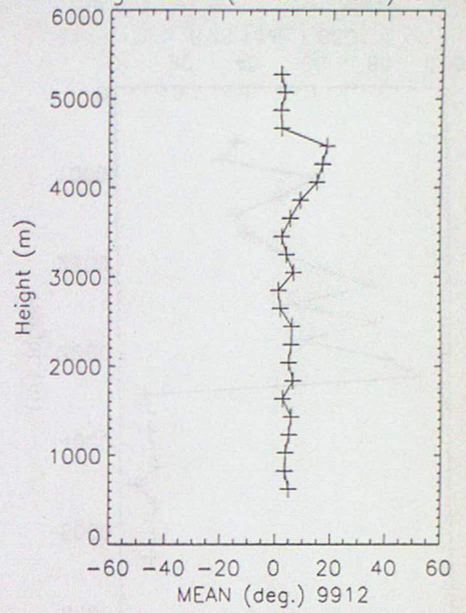


Fig. 26e (CABWP-UM) u-wind

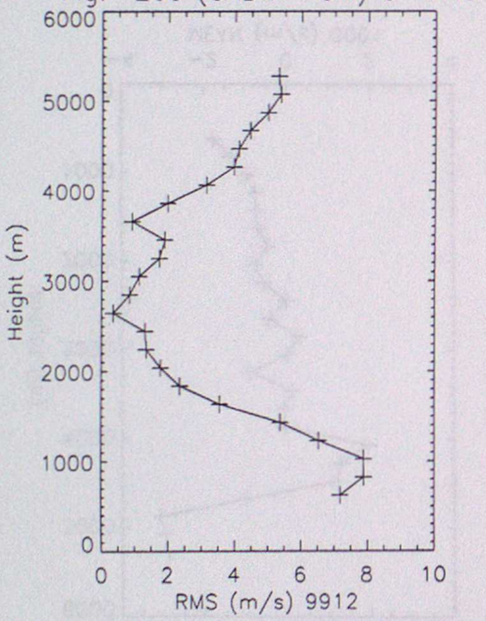


Fig. 26f (CABWP-UM) v-wind

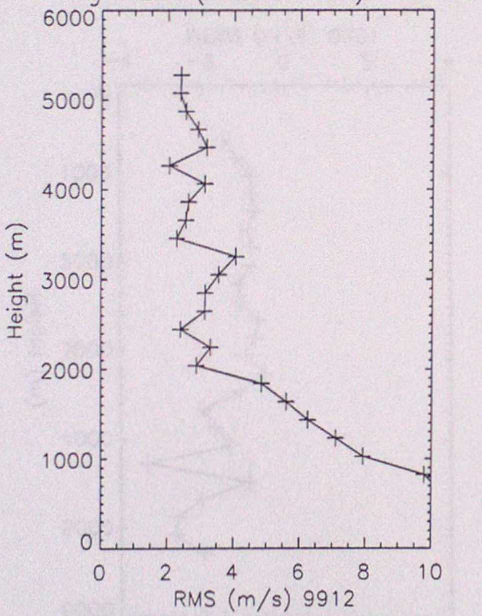


Fig. 26g (CABWP-UM) speed

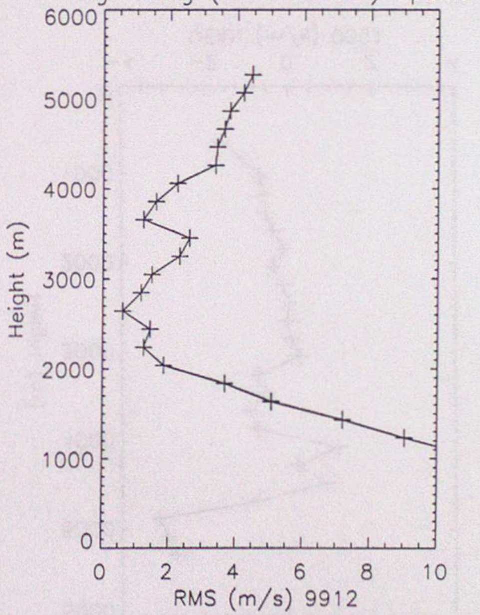


Fig. 26h (CABWP-UM) dirn.

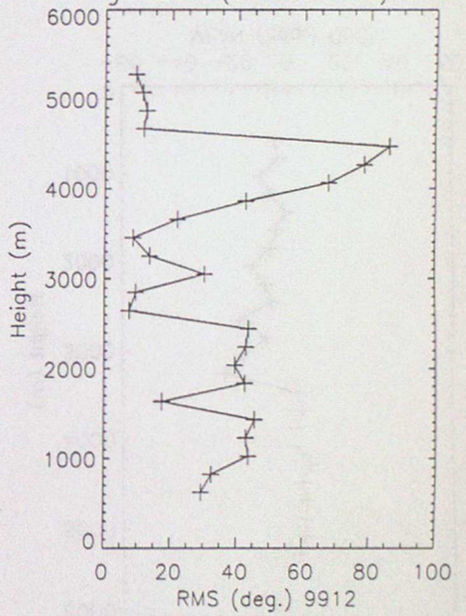


Fig. 27a (CABWP−UM) u−wind

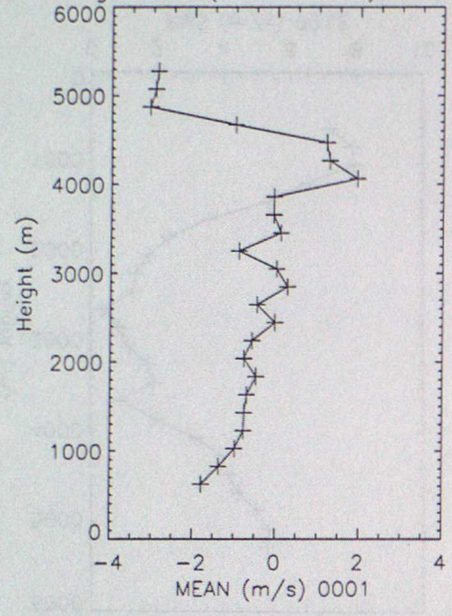


Fig. 27b (CABWP−UM) v−wind

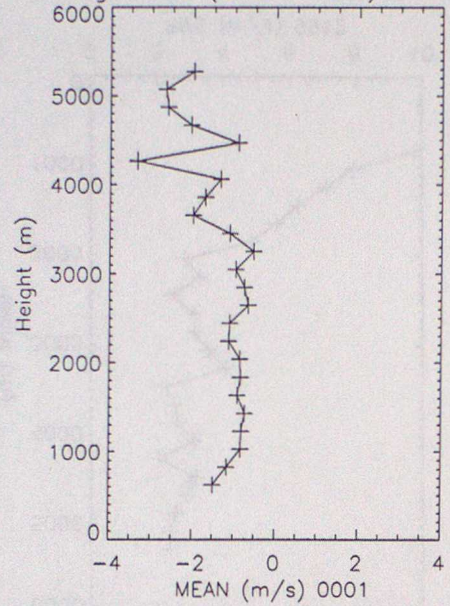


Fig. 27c (CABWP−UM) speed

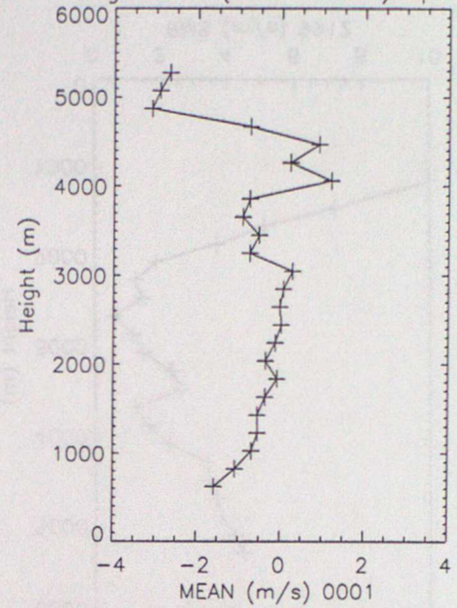


Fig. 27d (CABWP−UM) dirn.

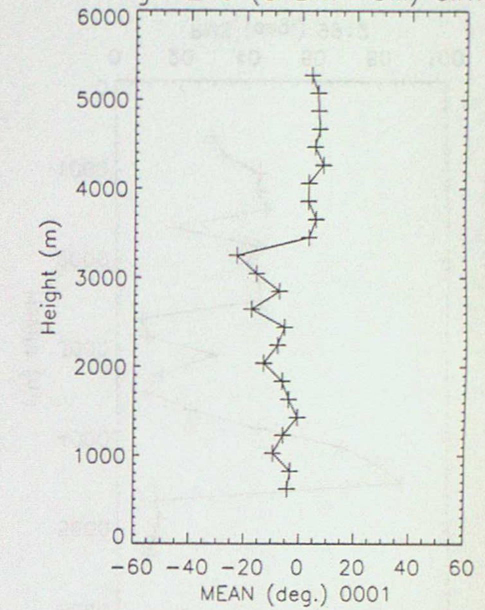


Fig. 27e (CABWP−UM) u−wind

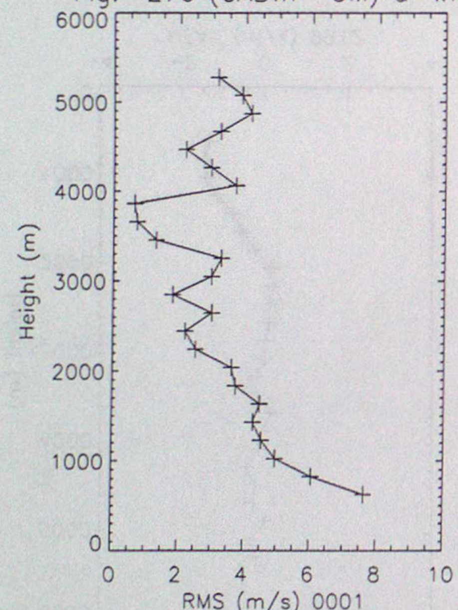


Fig. 27f (CABWP−UM) v−wind

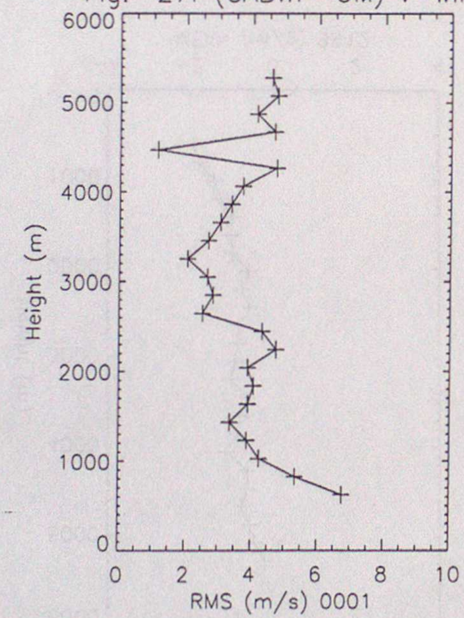


Fig. 27g (CABWP−UM) speed

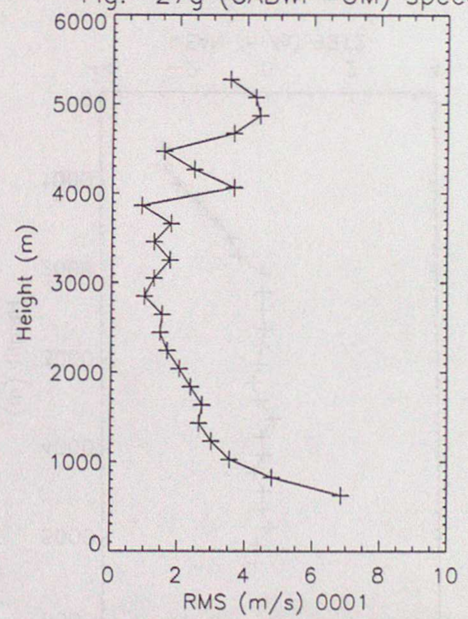


Fig. 27h (CABWP−UM) dirn.

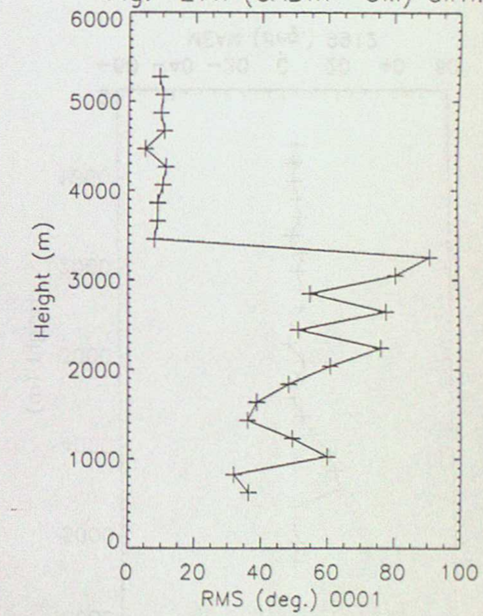


Fig. 28a (CABWP-UM) u-wind

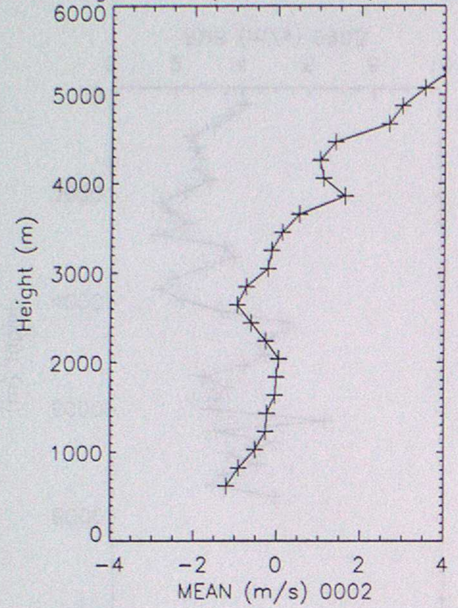


Fig. 28b (CABWP-UM) v-wind

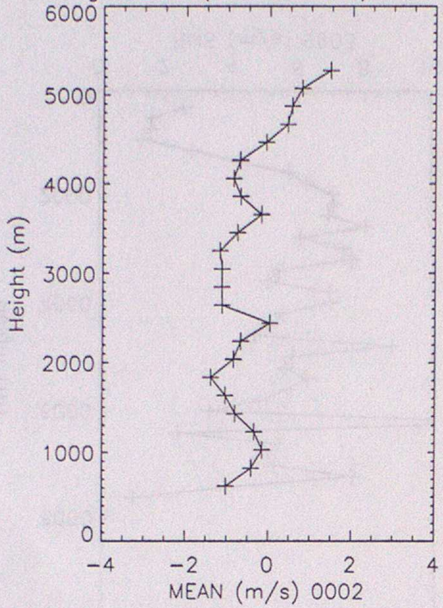


Fig. 28c (CABWP-UM) speed

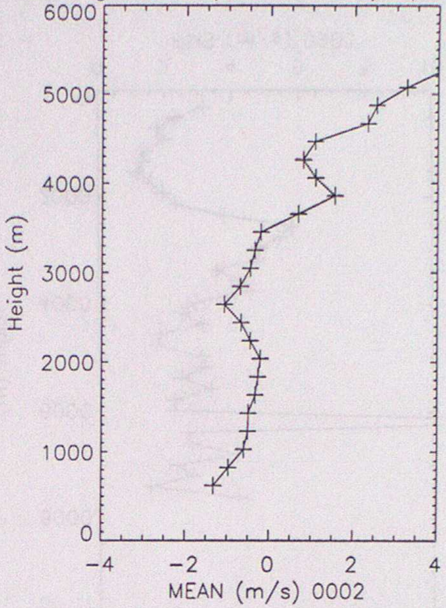


Fig. 28d (CABWP-UM) dirn.

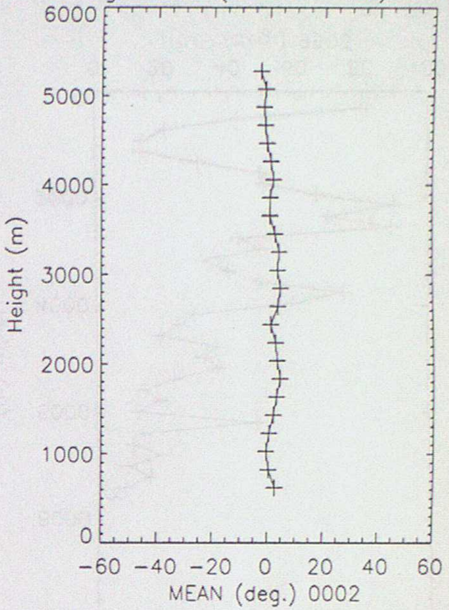


Fig. 28e (CABWP-UM) u-wind

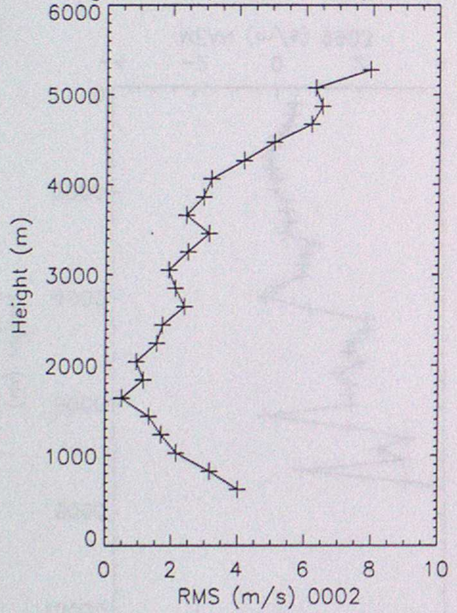


Fig. 28f (CABWP-UM) v-wind

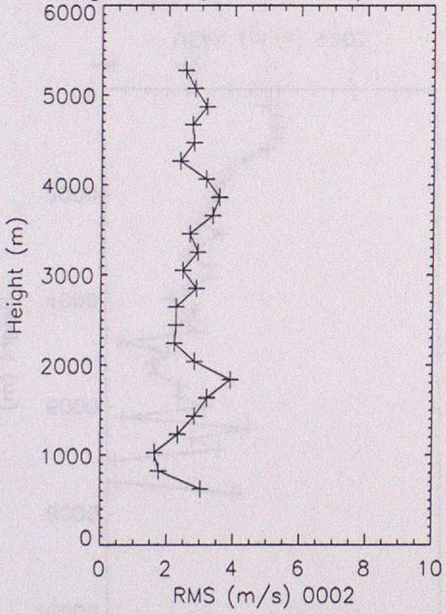


Fig. 28g (CABWP-UM) speed

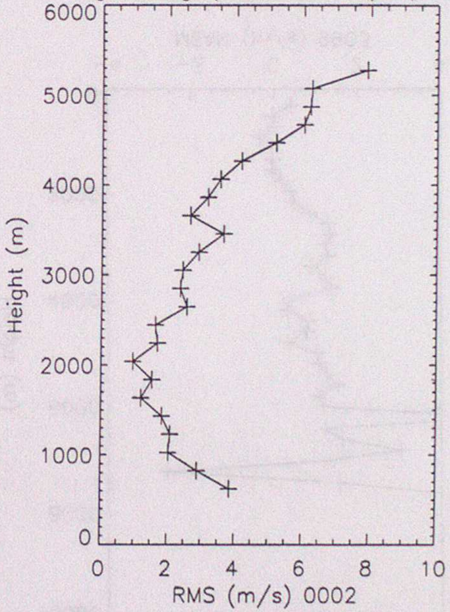


Fig. 28h (CABWP-UM) dirn.

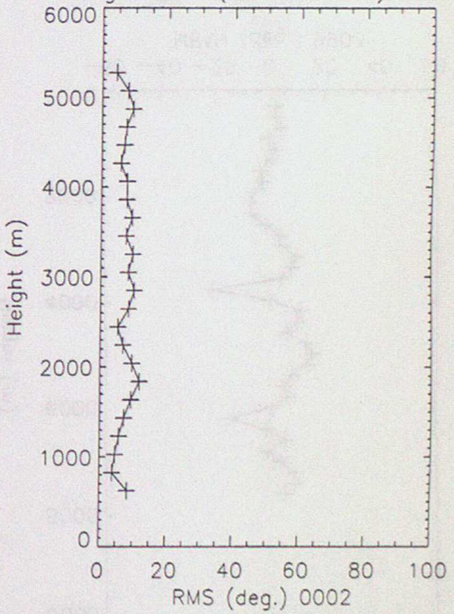


Fig. 29a (CAMWP-UM) u-wind

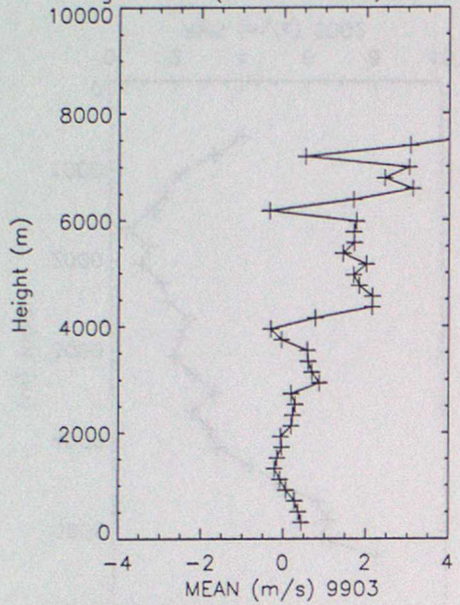


Fig. 29b (CAMWP-UM) v-wind

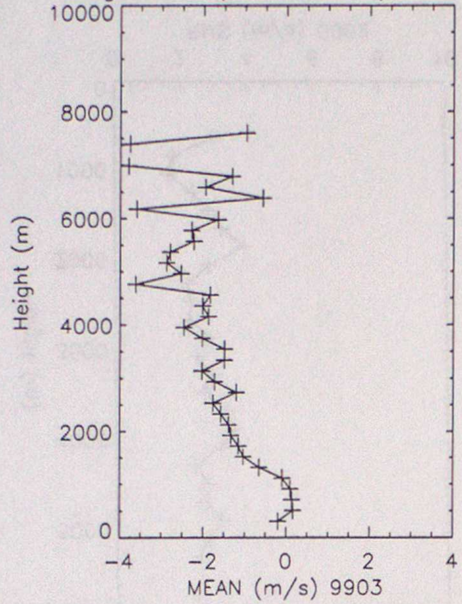


Fig. 29c (CAMWP-UM) speed

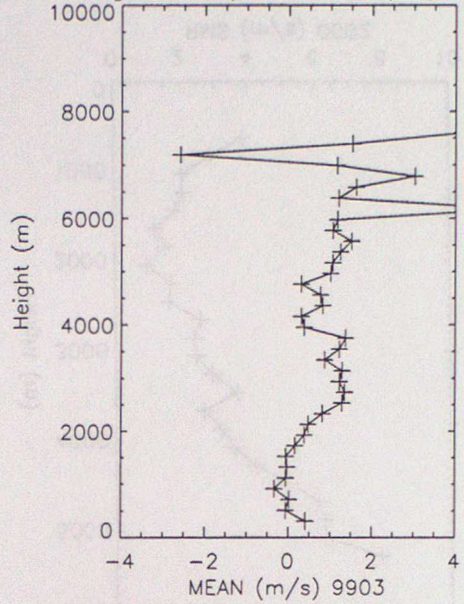


Fig. 29d (CAMWP-UM) dirn.

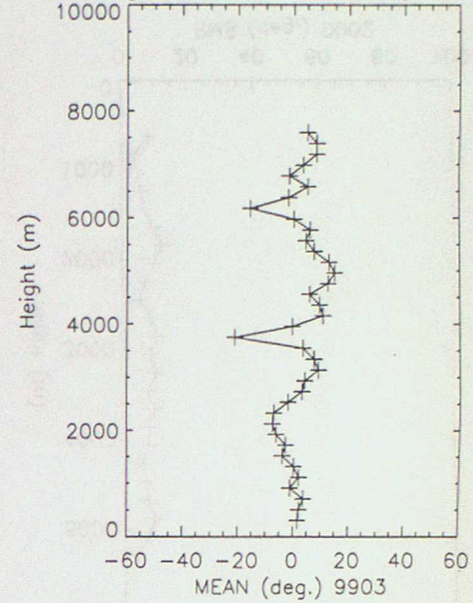


Fig. 29e (CAMWP-UM) u-wind

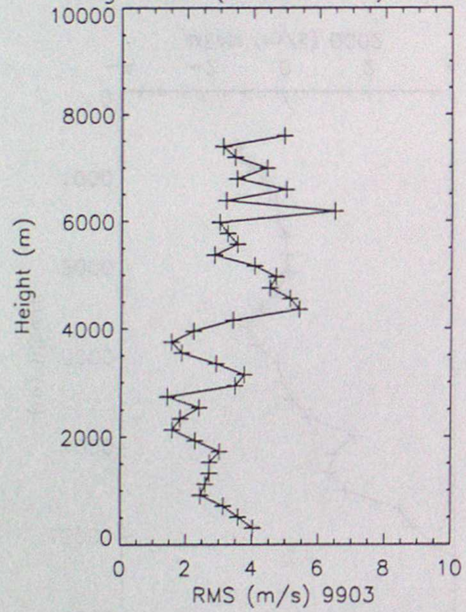


Fig. 29f (CAMWP-UM) v-wind

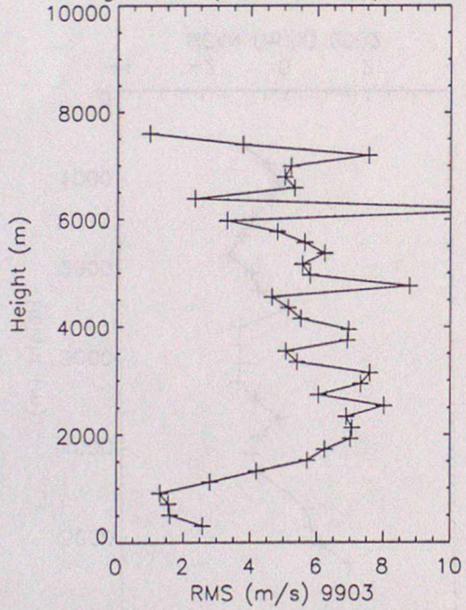


Fig. 29g (CAMWP-UM) speed

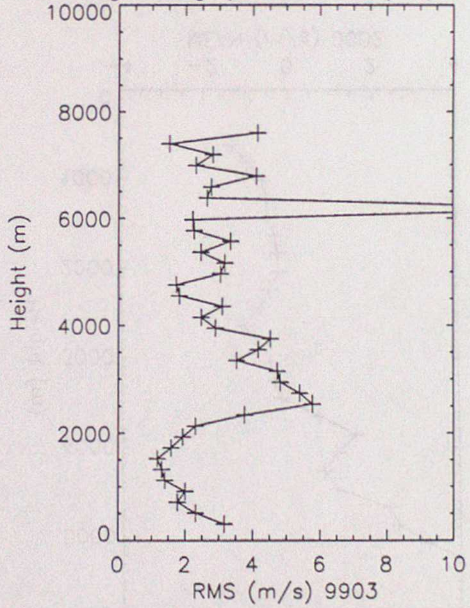


Fig. 29h (CAMWP-UM) dirn.

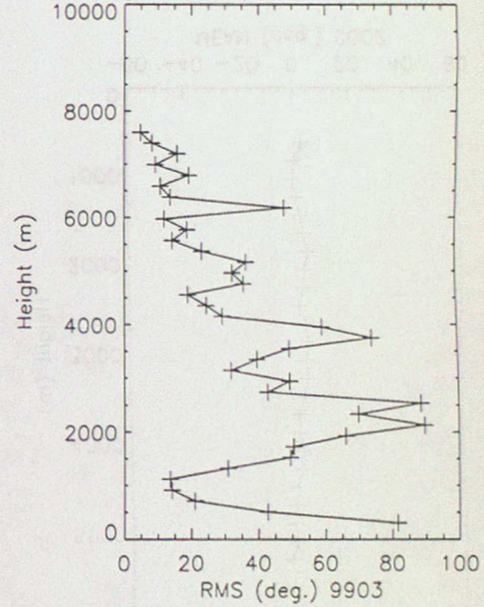


Fig. 30a (CAMWP-UM) u-wind

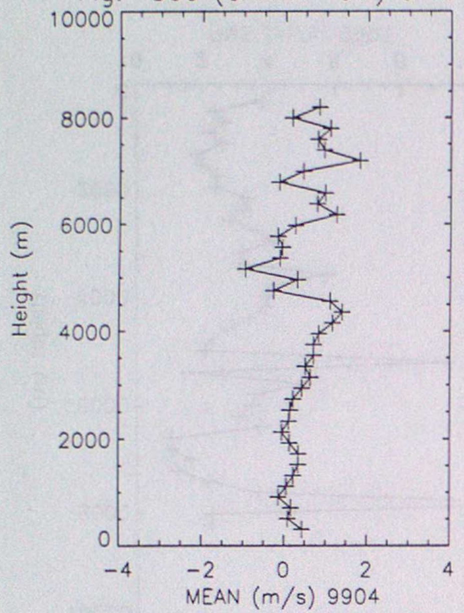


Fig. 30b (CAMWP-UM) v-wind

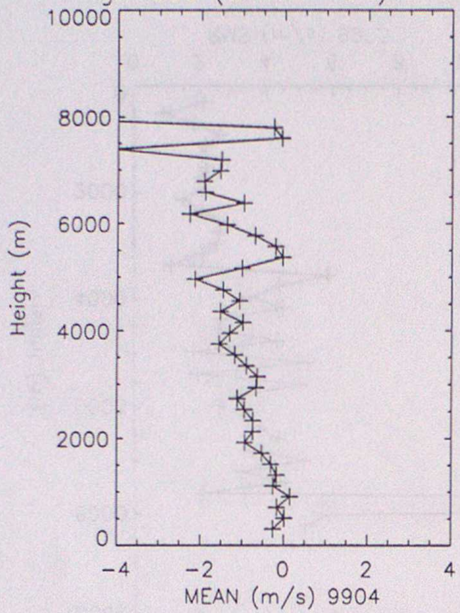


Fig. 30c (CAMWP-UM) speed

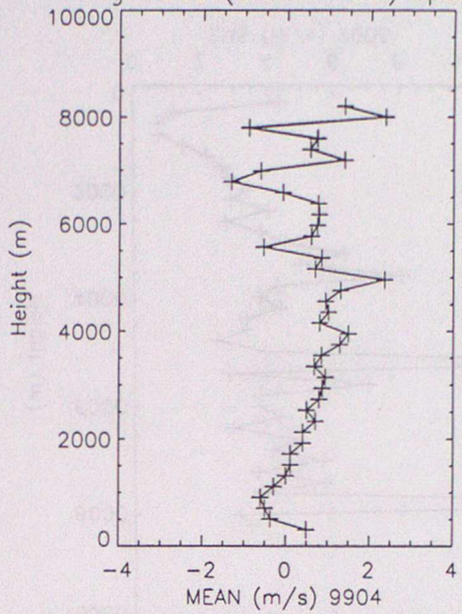


Fig. 30d (CAMWP-UM) dirn.

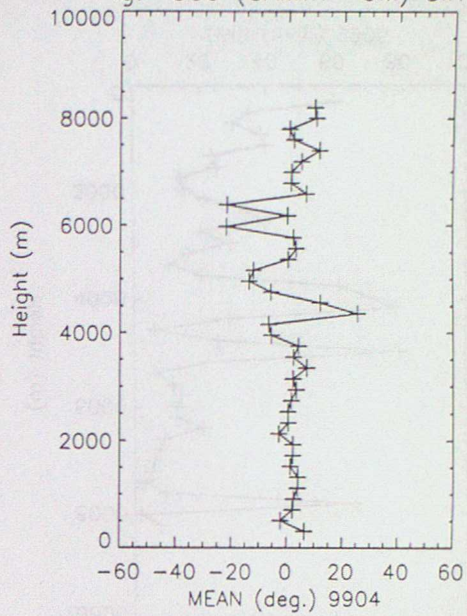


Fig. 30e (CAMWP-UM) u-wind

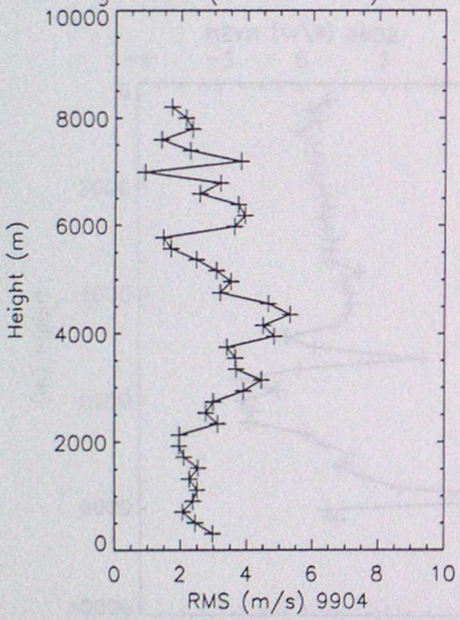


Fig. 30f (CAMWP-UM) v-wind

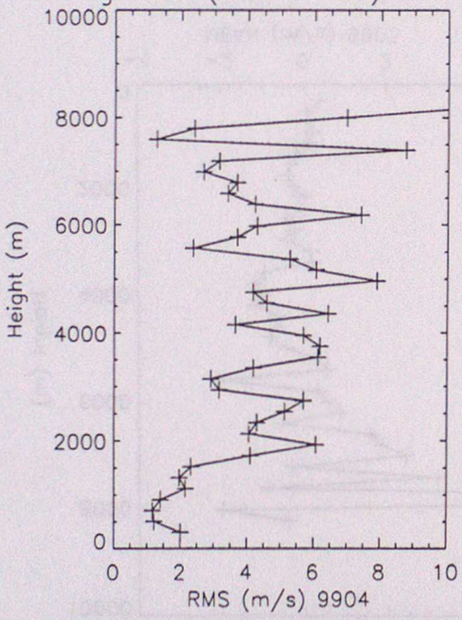


Fig. 30g (CAMWP-UM) speed

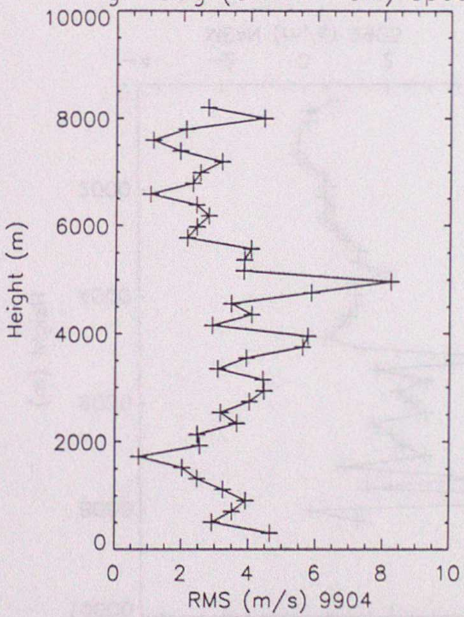


Fig. 30h (CAMWP-UM) dirn.

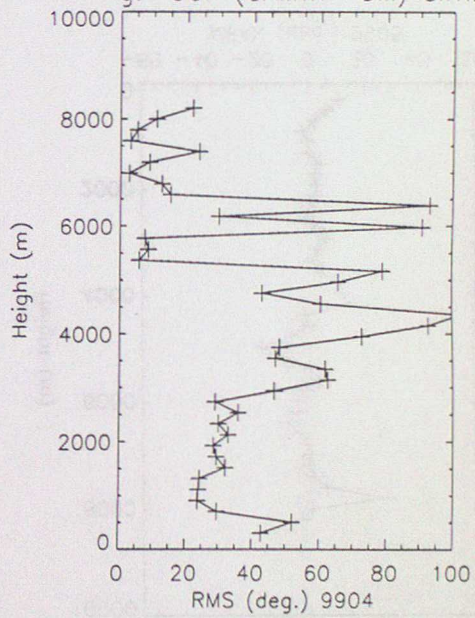


Fig. 31a (CAMWP-UM) u-wind

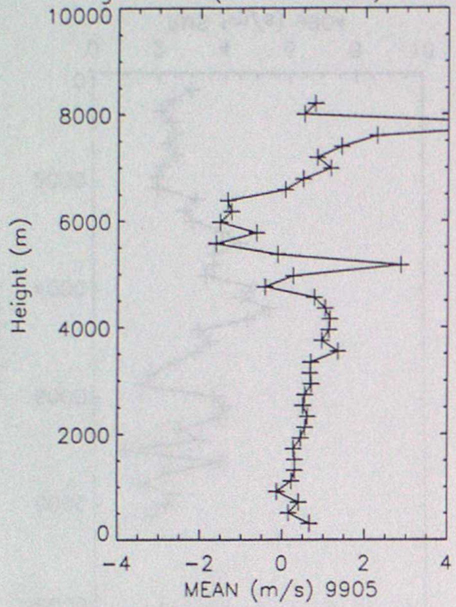


Fig. 31b (CAMWP-UM) v-wind

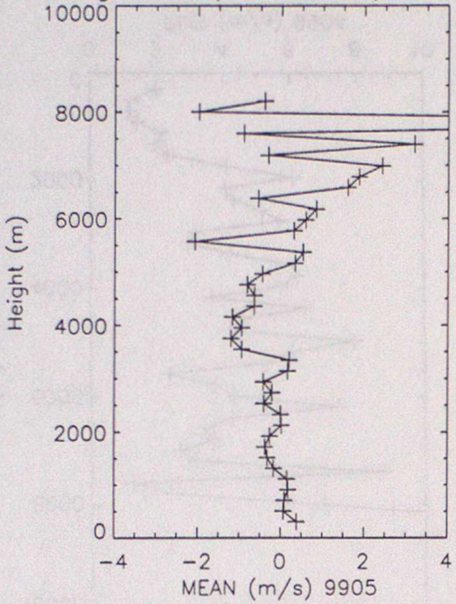


Fig. 31c (CAMWP-UM) speed

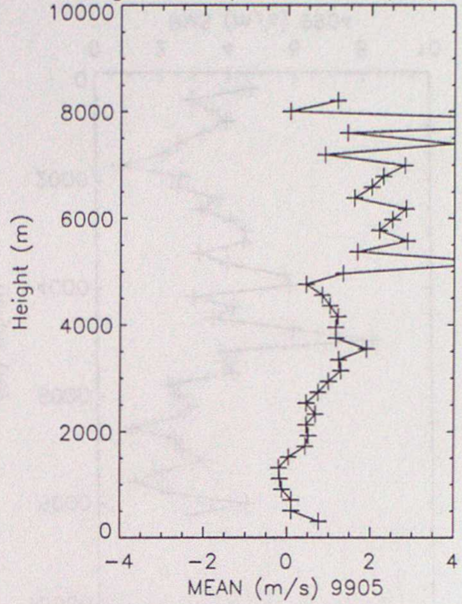


Fig. 31d (CAMWP-UM) dirn.

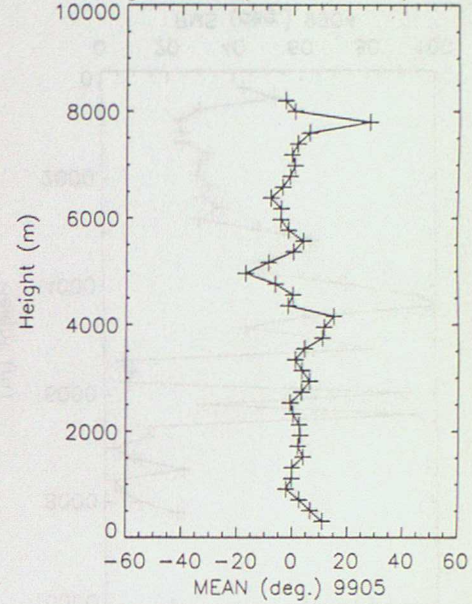


Fig. 31e (CAMWP-UM) u-wind

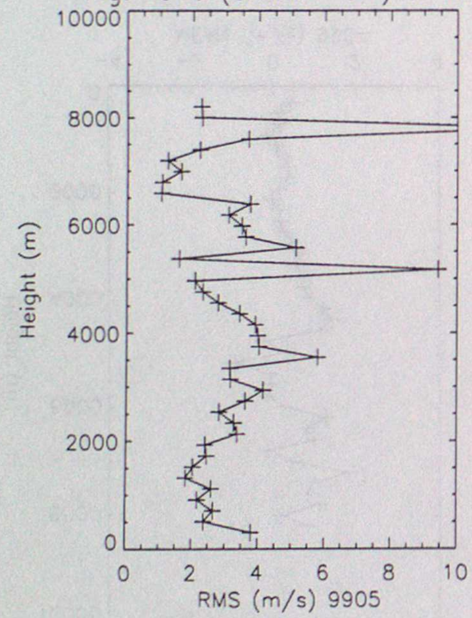


Fig. 31f (CAMWP-UM) v-wind

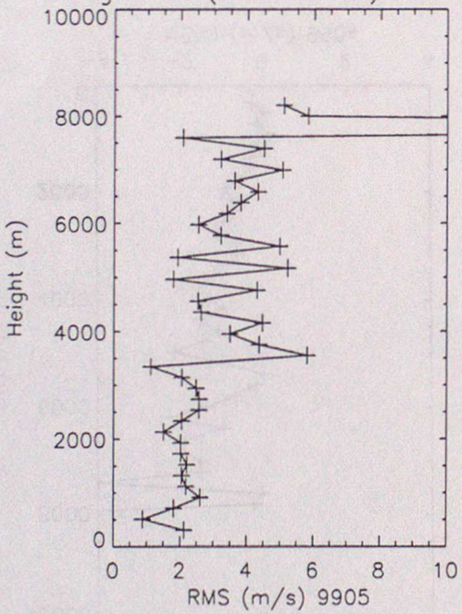


Fig. 31g (CAMWP-UM) speed

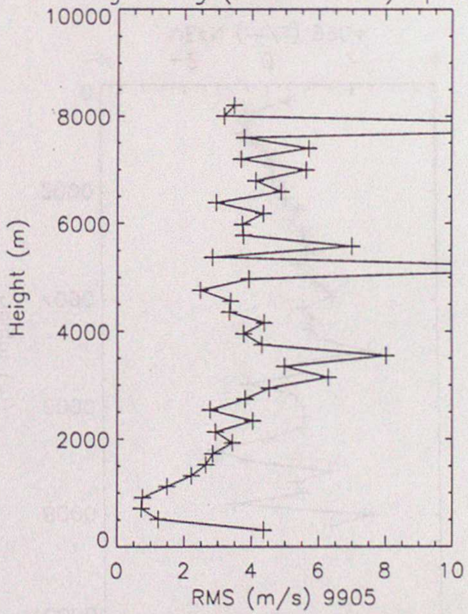


Fig. 31h (CAMWP-UM) dirn.

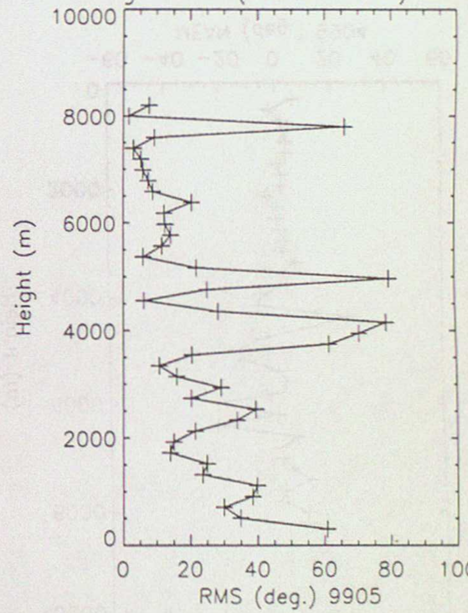


Fig. 32a (CAMWP-UM) u-wind

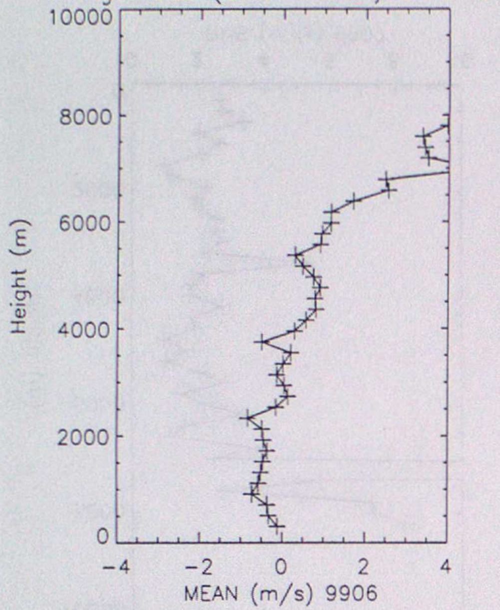


Fig. 32b (CAMWP-UM) v-wind

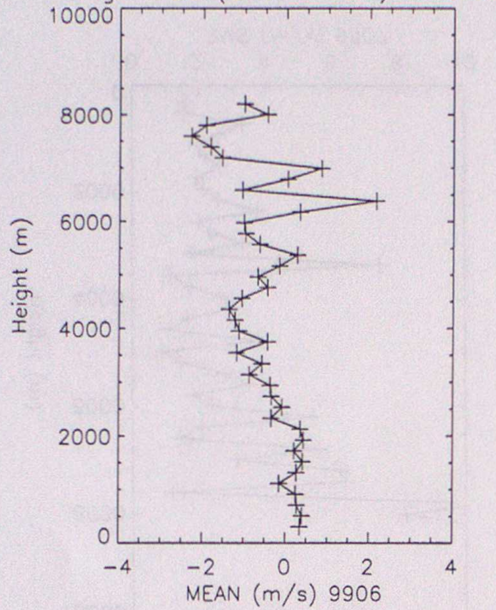


Fig. 32c (CAMWP-UM) speed

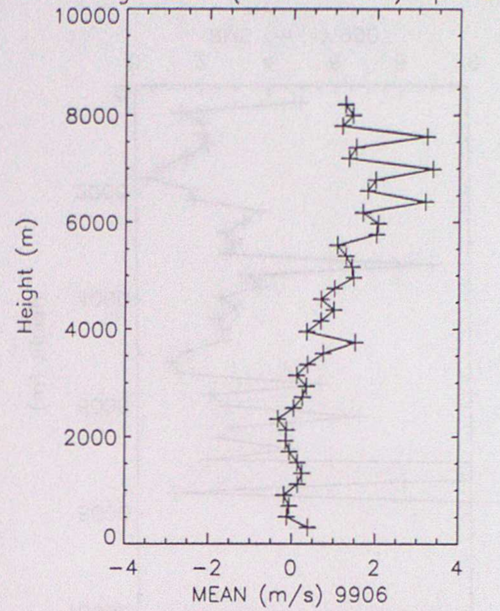


Fig. 32d (CAMWP-UM) dirn.

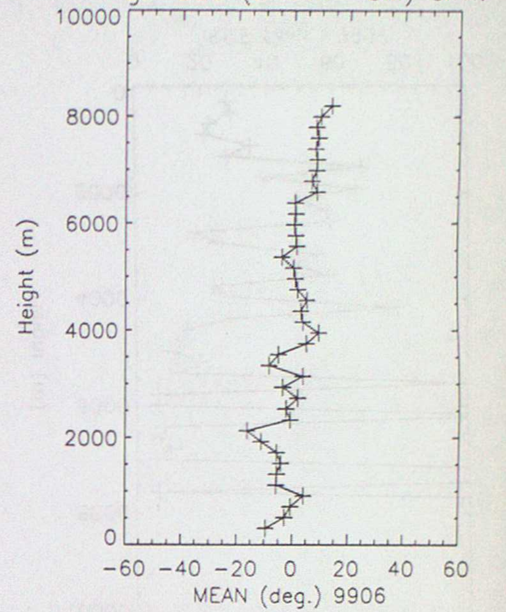


Fig. 32e (CAMWP-UM) u-wind

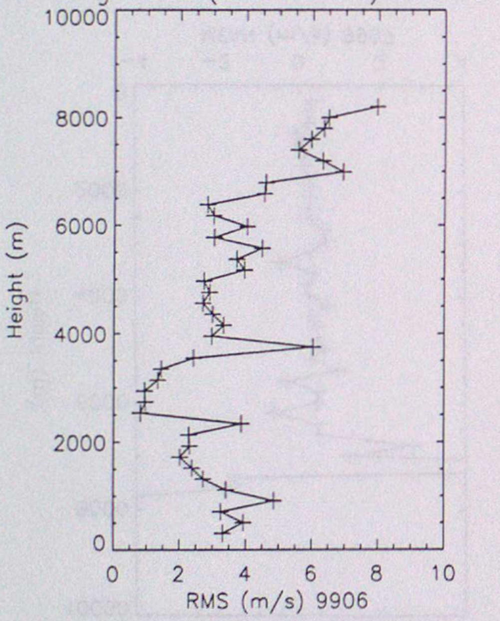


Fig. 32f (CAMWP-UM) v-wind

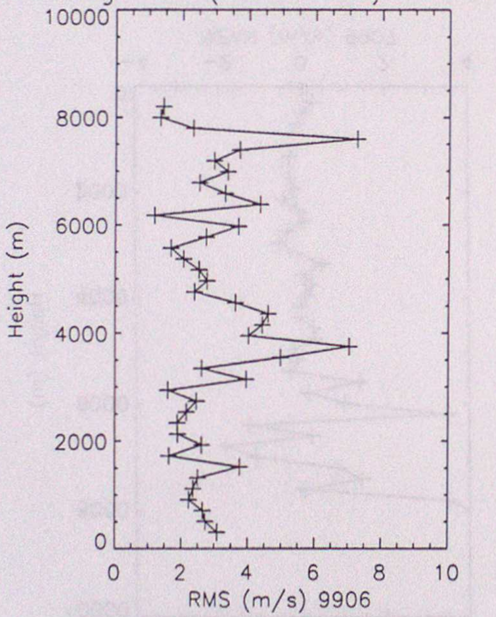


Fig. 32g (CAMWP-UM) speed

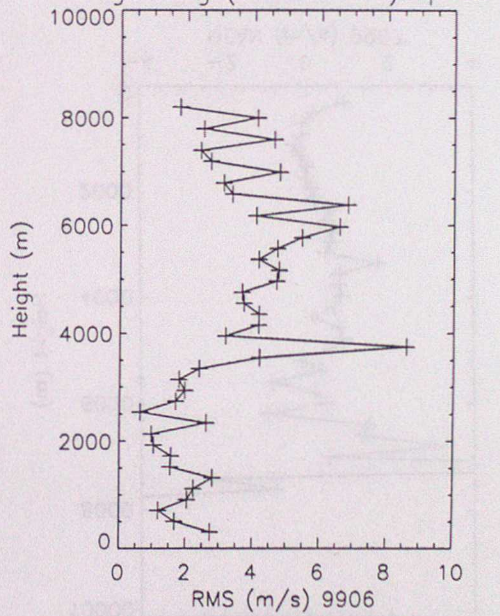
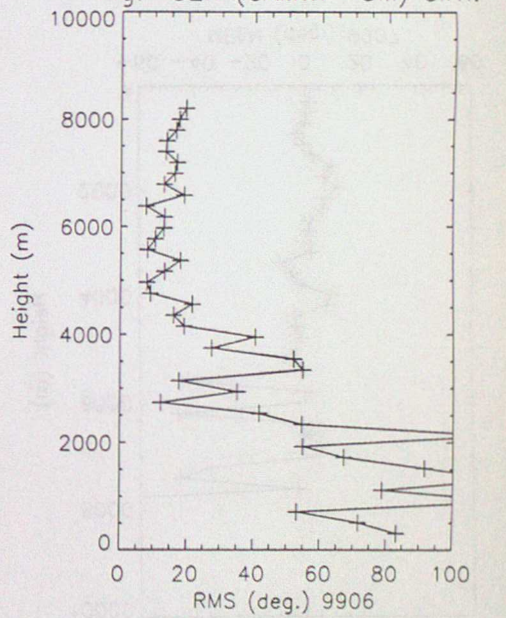


Fig. 32h (CAMWP-UM) dirn.



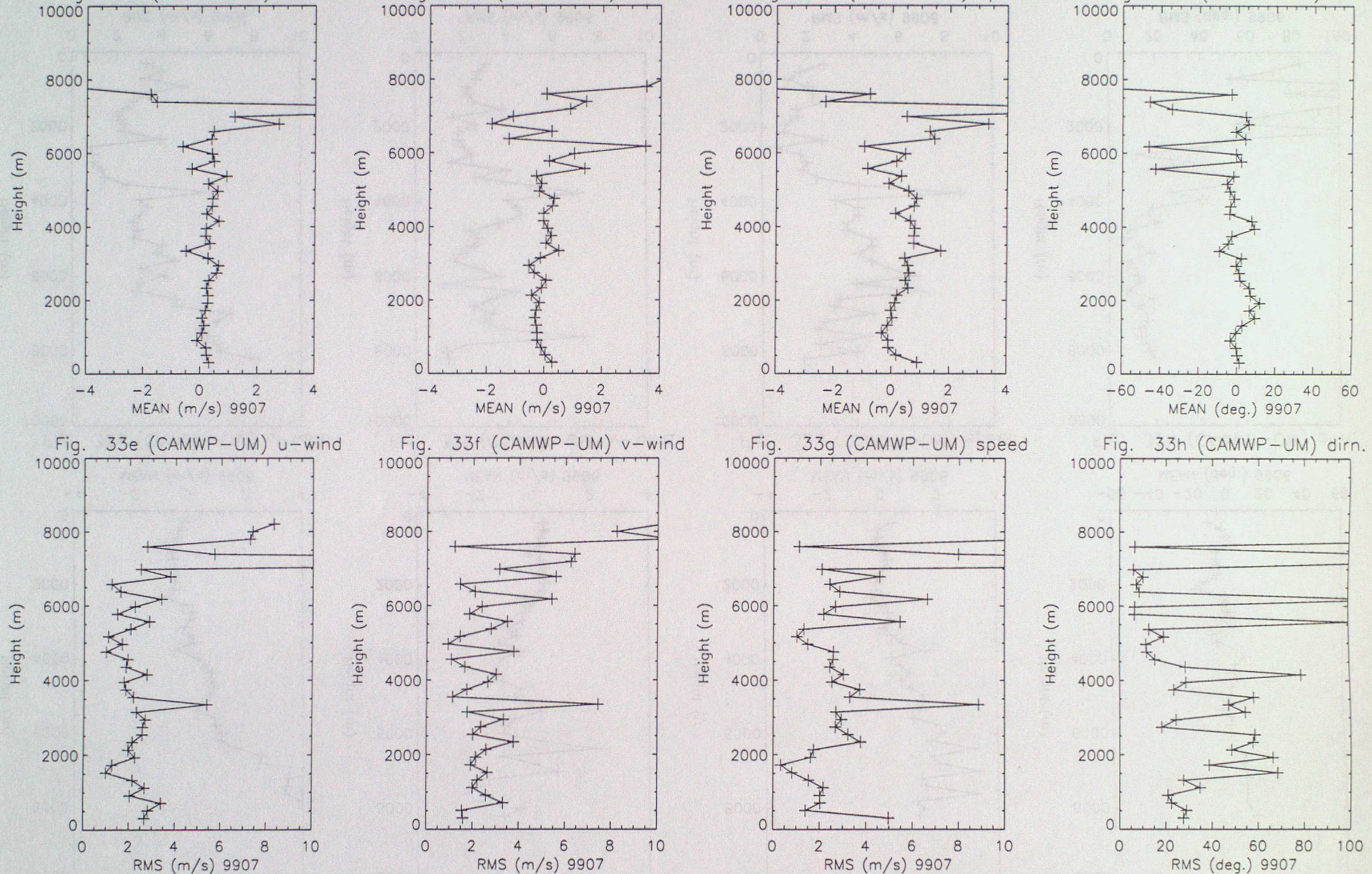


Fig. 33a (CAMWP-UM) u-wind
Fig. 33b (CAMWP-UM) v-wind
Fig. 33c (CAMWP-UM) speed
Fig. 33d (CAMWP-UM) dirn.
Fig. 33e (CAMWP-UM) u-wind
Fig. 33f (CAMWP-UM) v-wind
Fig. 33g (CAMWP-UM) speed
Fig. 33h (CAMWP-UM) dirn.

Fig. 34a (CAMWP-UM) u-wind

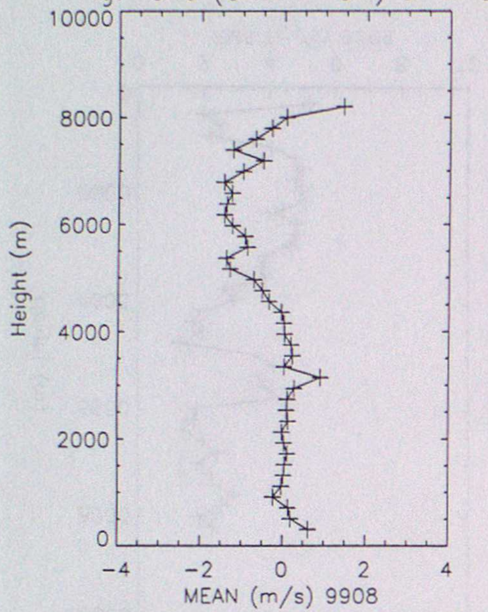


Fig. 34b (CAMWP-UM) v-wind

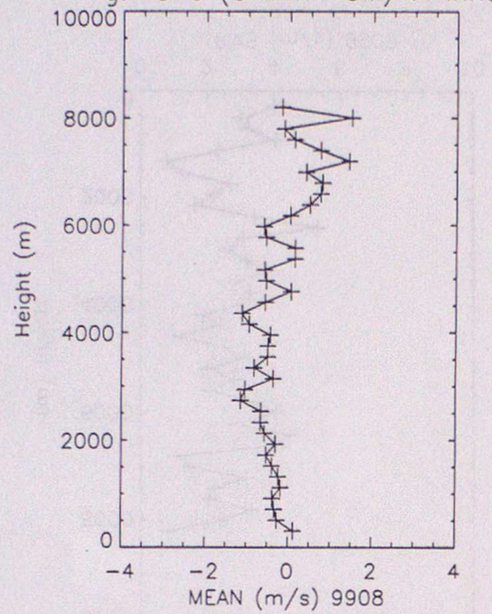


Fig. 34c (CAMWP-UM) speed

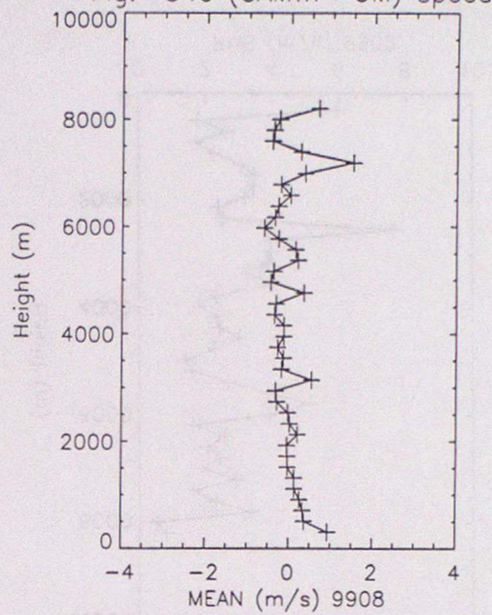


Fig. 34d (CAMWP-UM) dirn.

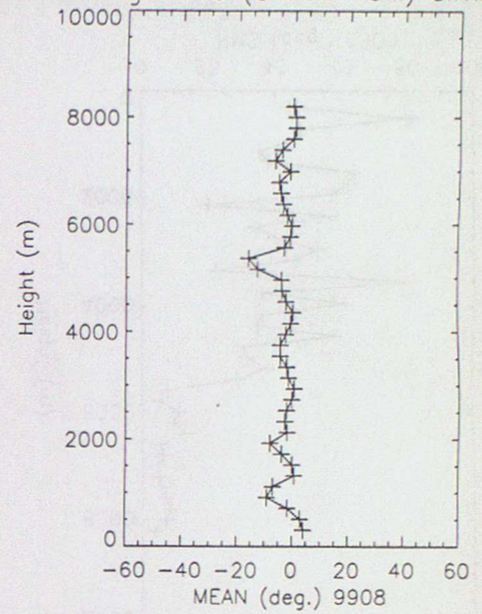


Fig. 34e (CAMWP-UM) u-wind

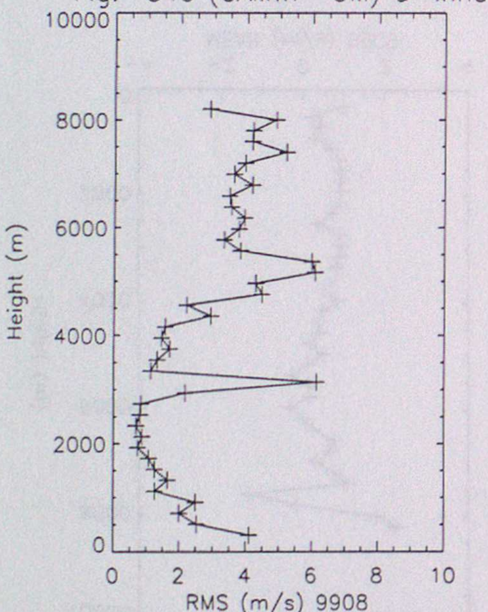


Fig. 34f (CAMWP-UM) v-wind

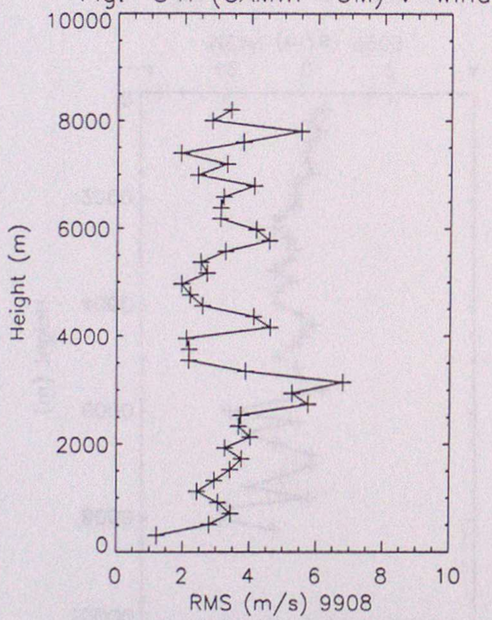


Fig. 34g (CAMWP-UM) speed

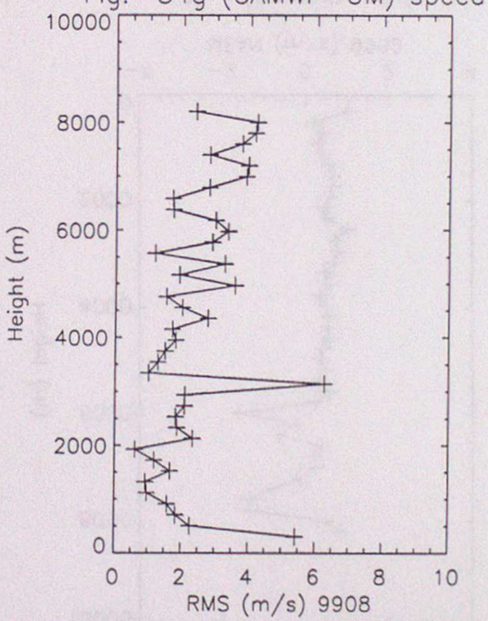


Fig. 34h (CAMWP-UM) dirn.

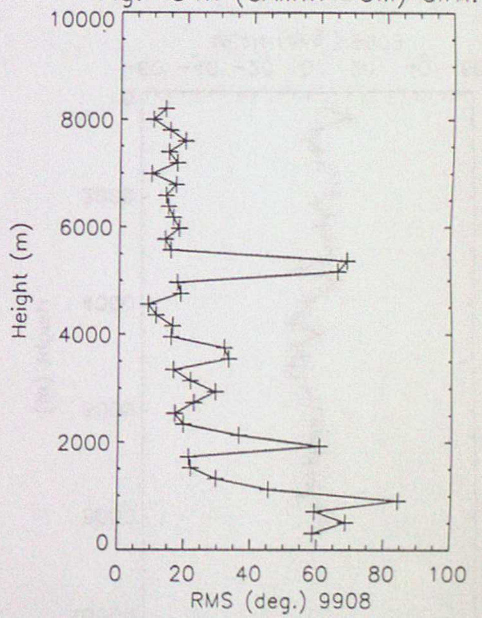


Fig. 35a (CAMWP-UM) u-wind

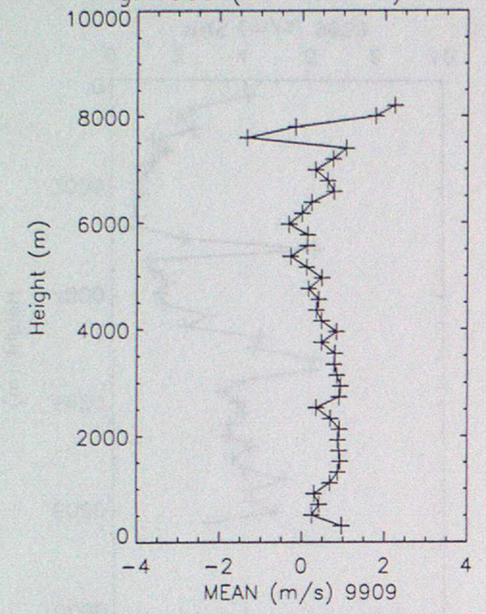


Fig. 35b (CAMWP-UM) v-wind

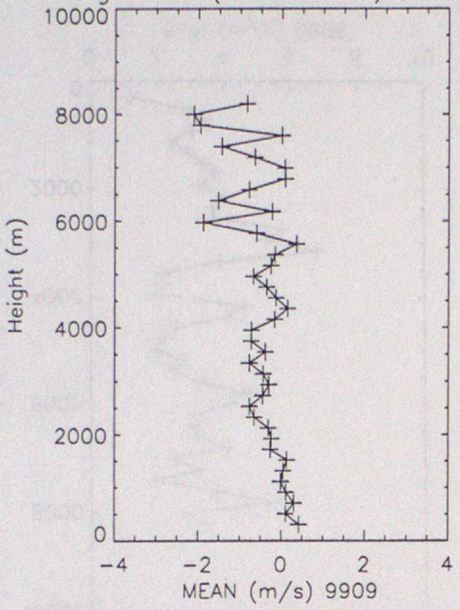


Fig. 35c (CAMWP-UM) speed

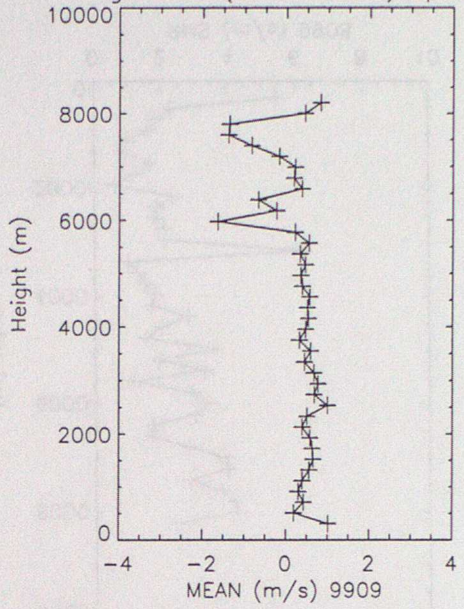


Fig. 35d (CAMWP-UM) dirn.

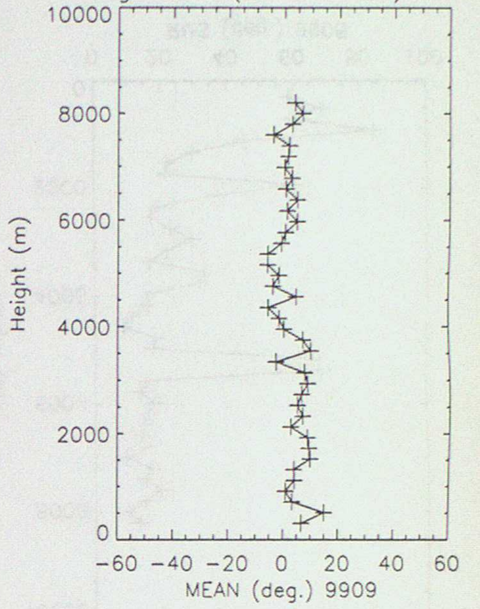


Fig. 35e (CAMWP-UM) u-wind

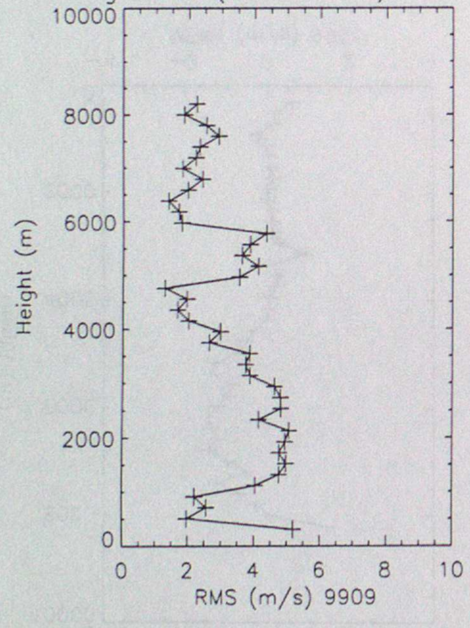


Fig. 35f (CAMWP-UM) v-wind

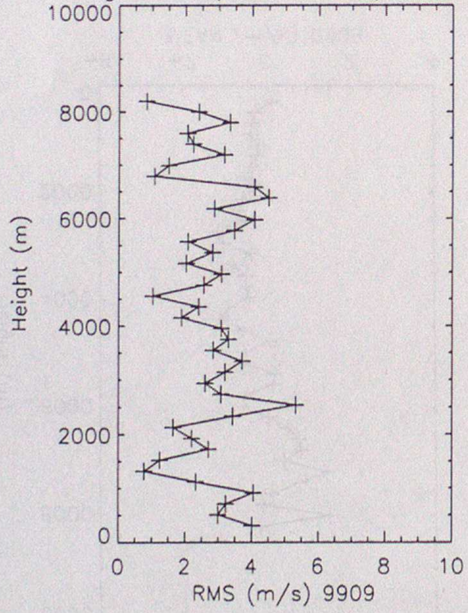


Fig. 35g (CAMWP-UM) speed

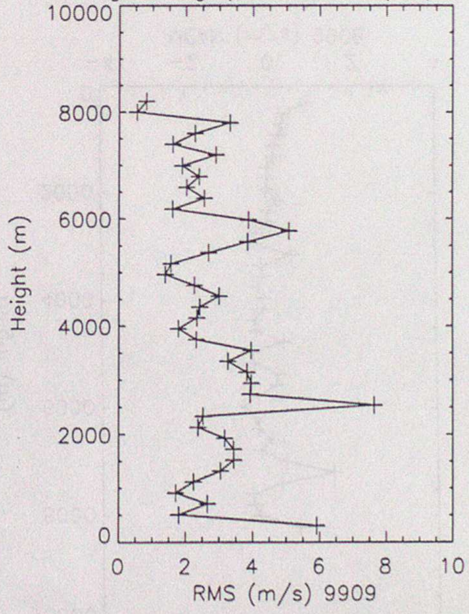


Fig. 35h (CAMWP-UM) dirn.

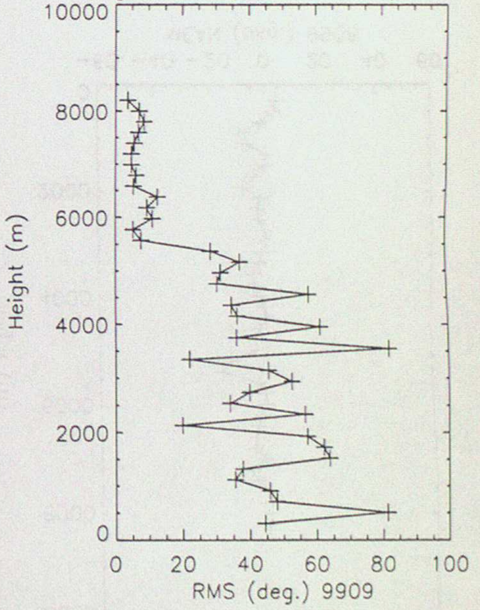


Fig. 36a (CAMWP-UM) u-wind

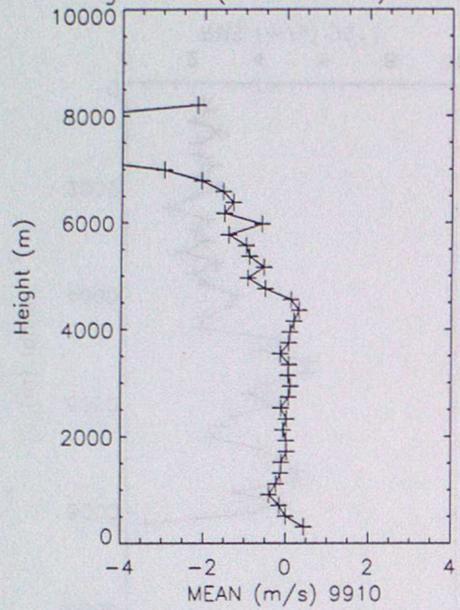


Fig. 36b (CAMWP-UM) v-wind

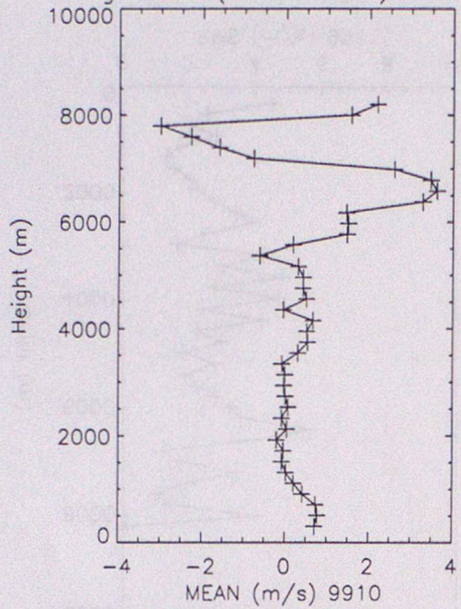


Fig. 36c (CAMWP-UM) speed

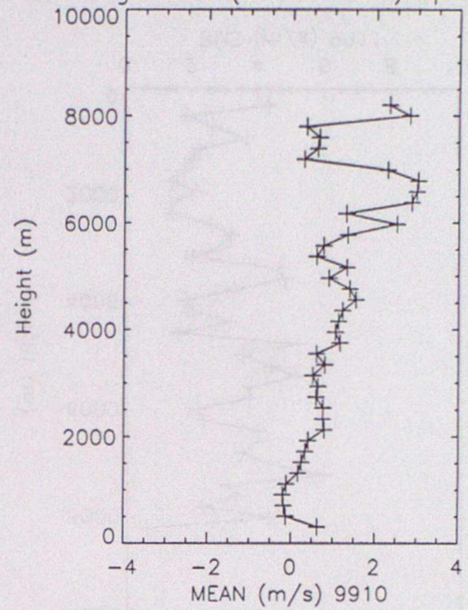


Fig. 36d (CAMWP-UM) dirn.

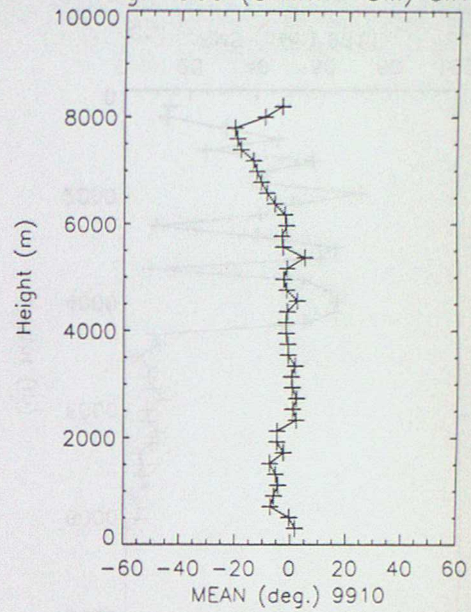


Fig. 36e (CAMWP-UM) u-wind

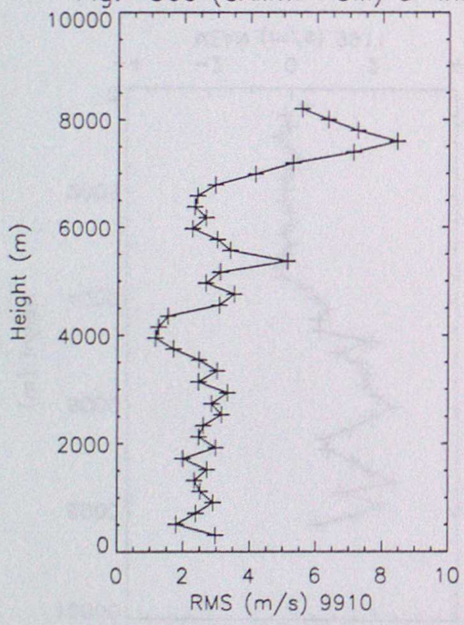


Fig. 36f (CAMWP-UM) v-wind

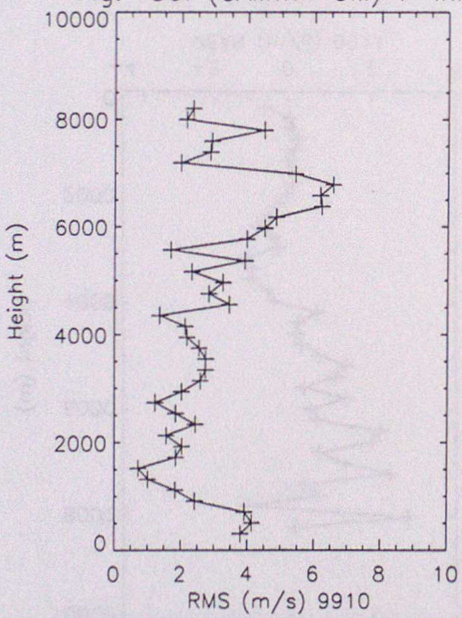


Fig. 36g (CAMWP-UM) speed

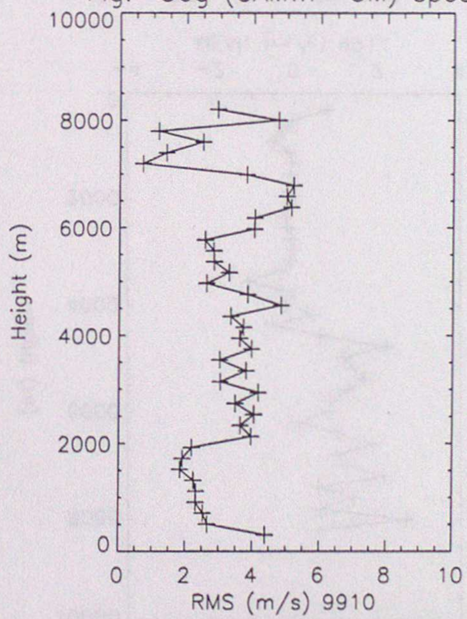


Fig. 36h (CAMWP-UM) dirn.

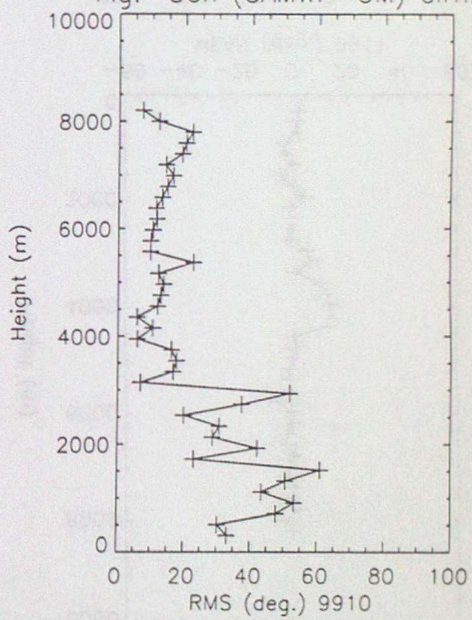


Fig. 37a (CAMWP-UM) u-wind

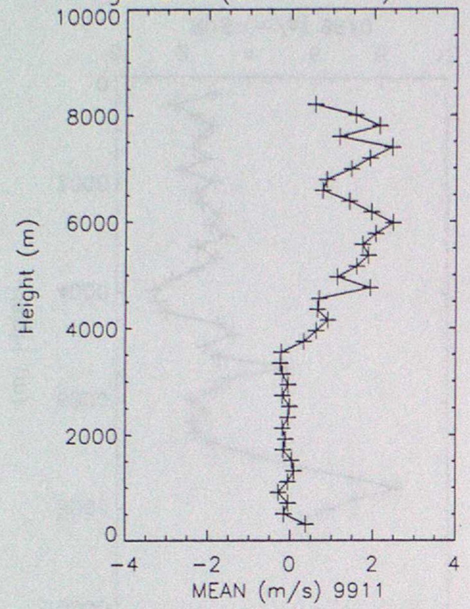


Fig. 37b (CAMWP-UM) v-wind

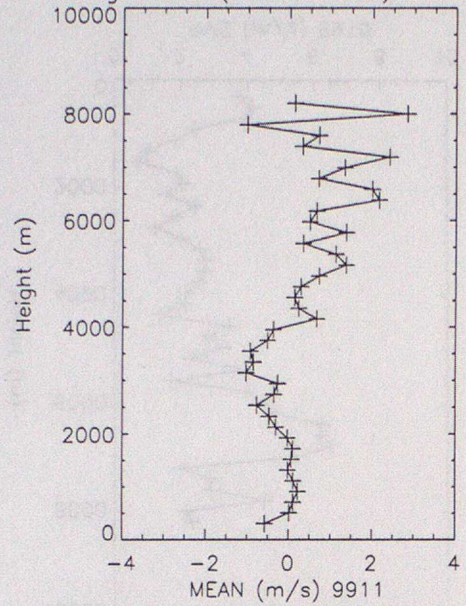


Fig. 37c (CAMWP-UM) speed

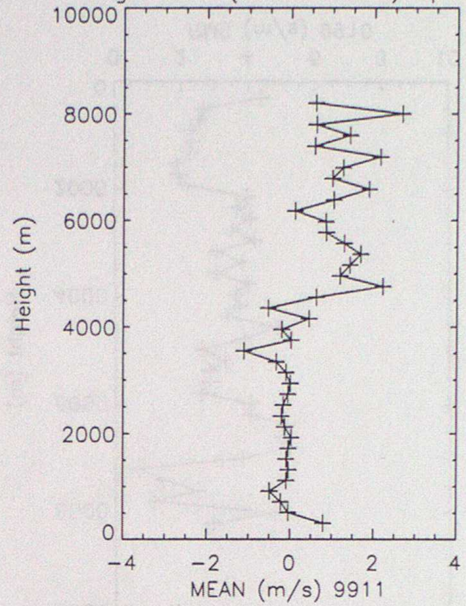


Fig. 37d (CAMWP-UM) dirn.

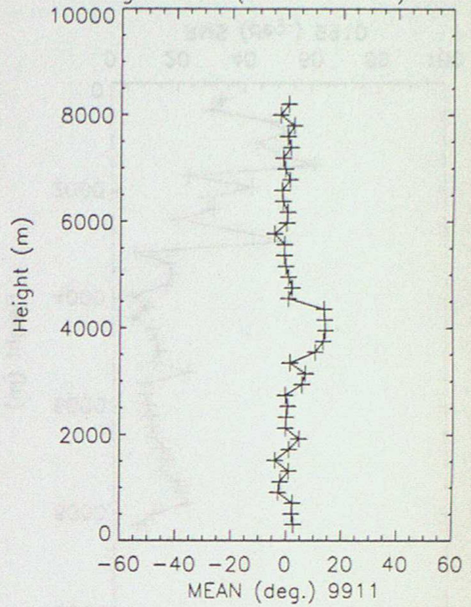


Fig. 37e (CAMWP-UM) u-wind

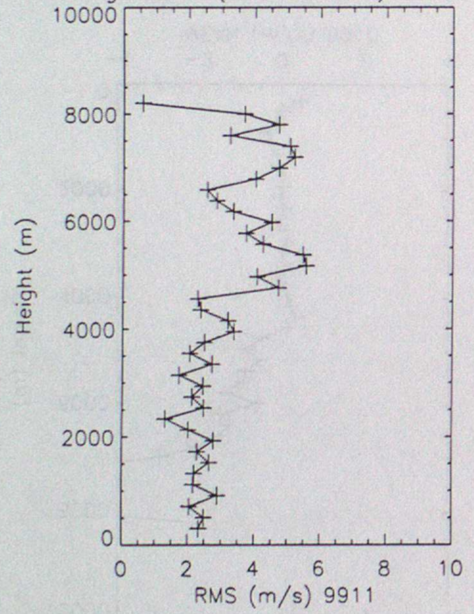


Fig. 37f (CAMWP-UM) v-wind

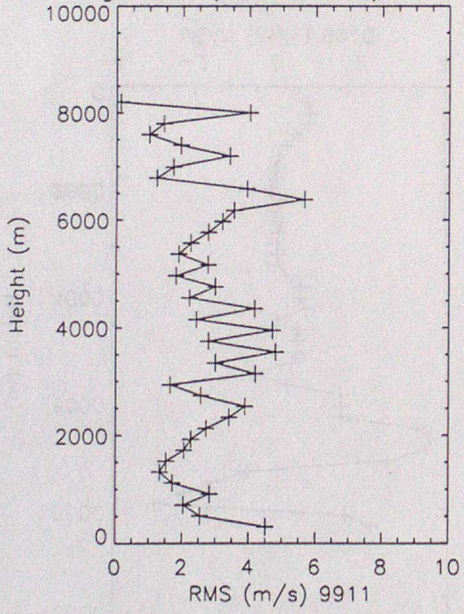


Fig. 37g (CAMWP-UM) speed

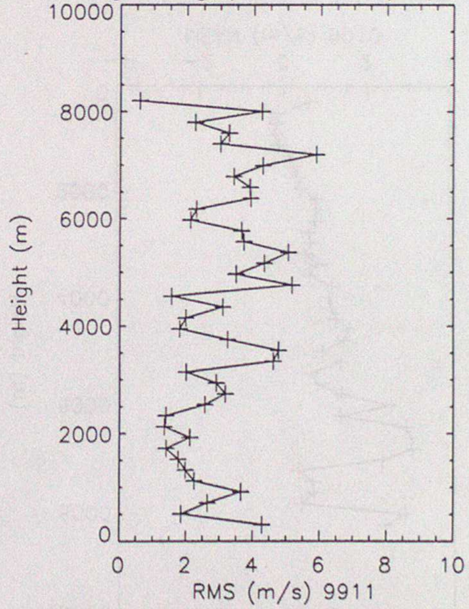


Fig. 37h (CAMWP-UM) dirn.

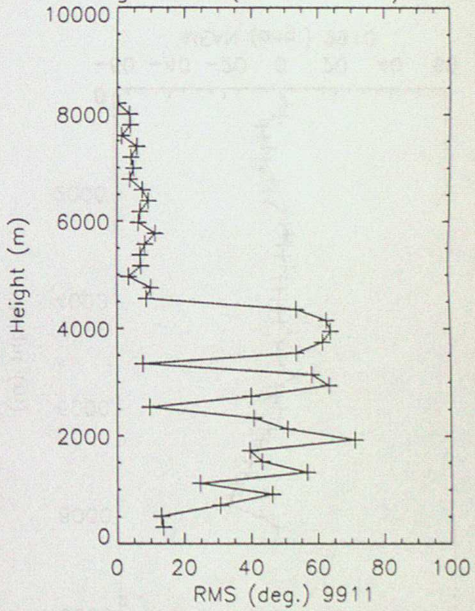


Fig. 38a (CAMWP-UM) u-wind

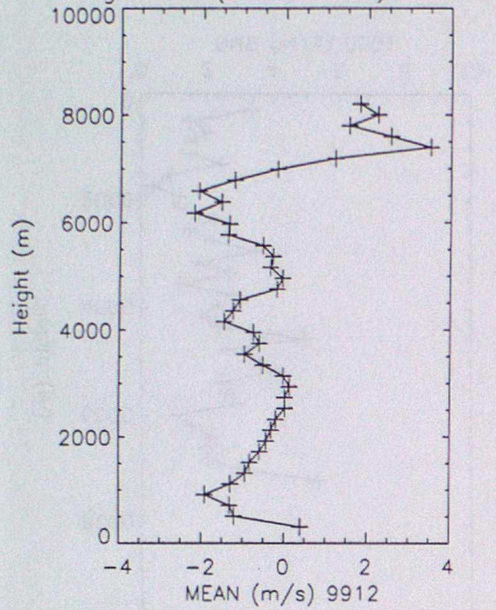


Fig. 38b (CAMWP-UM) v-wind

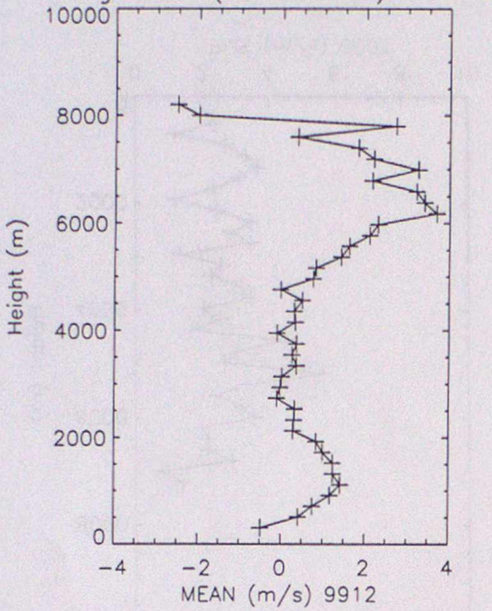


Fig. 38c (CAMWP-UM) speed

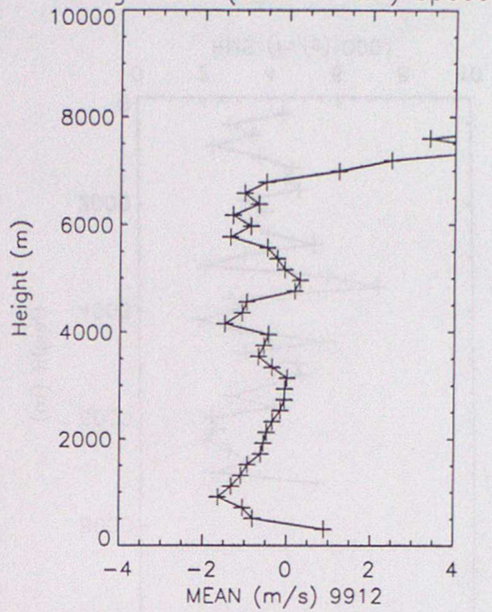


Fig. 38d (CAMWP-UM) dirn.

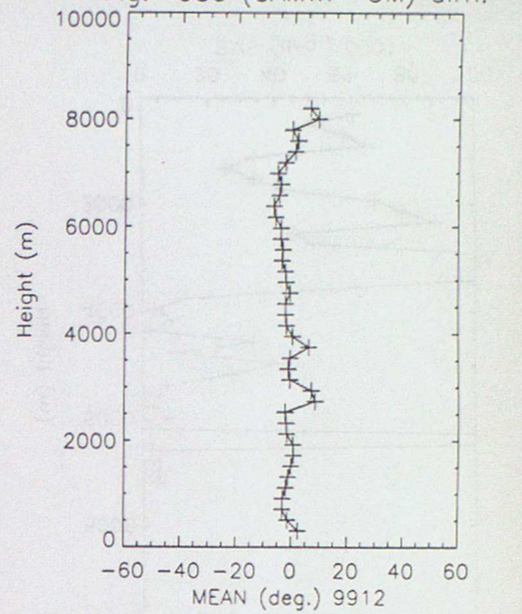


Fig. 38e (CAMWP-UM) u-wind

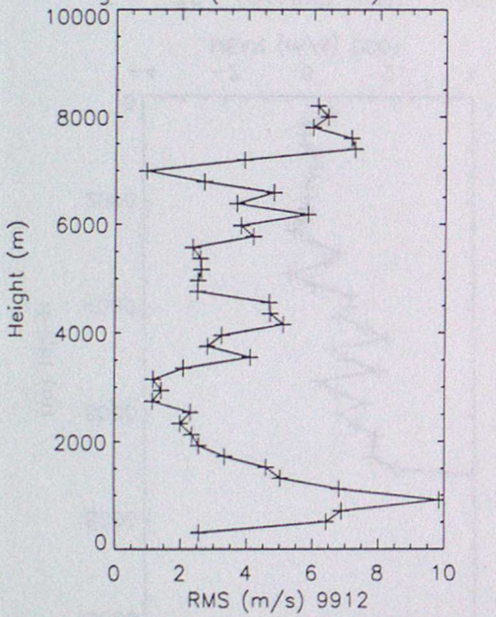


Fig. 38f (CAMWP-UM) v-wind

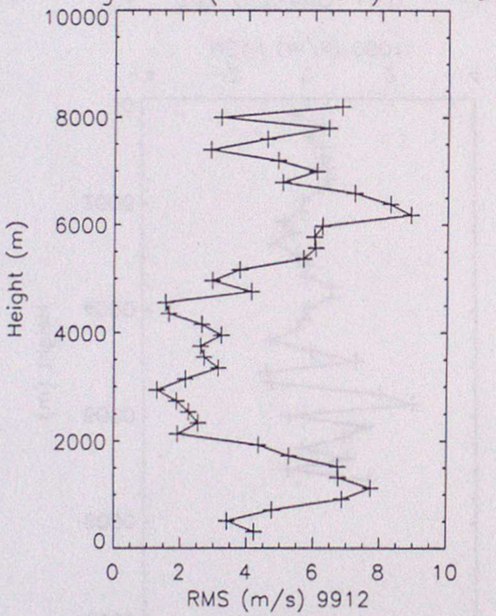


Fig. 38g (CAMWP-UM) speed

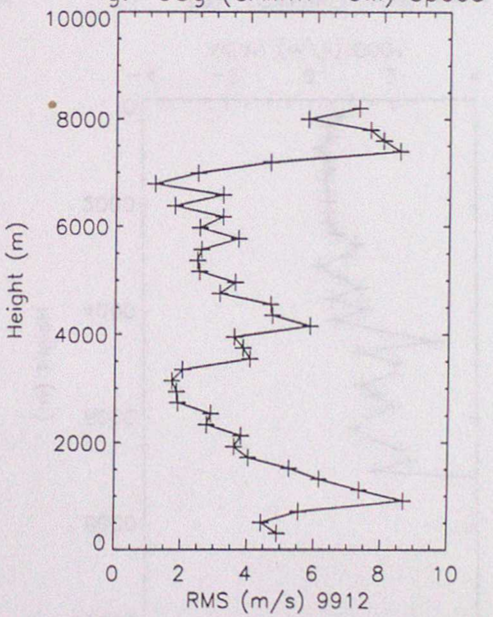
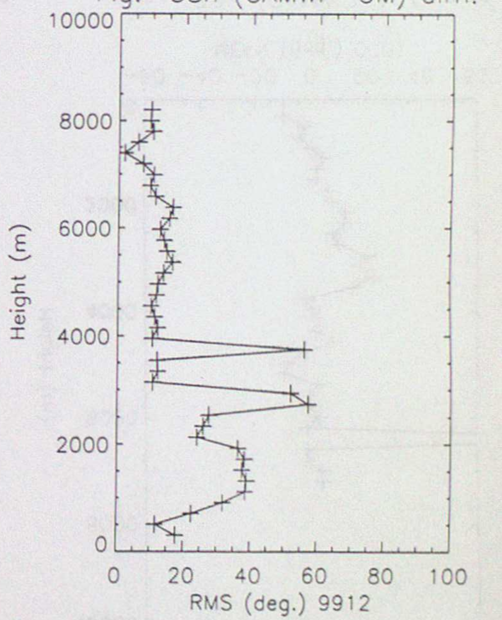


Fig. 38h (CAMWP-UM) dirn.



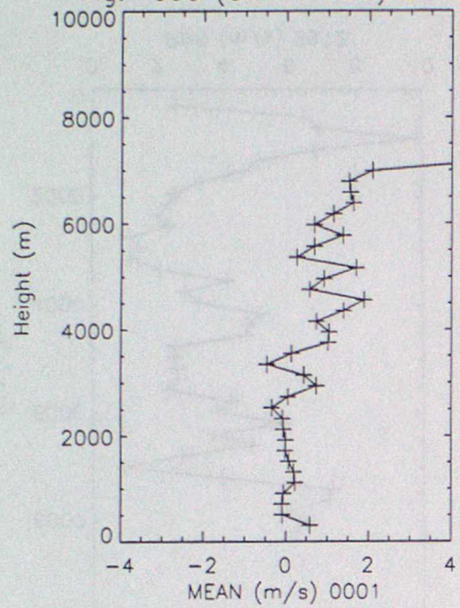


Fig. 39a (CAMWP-UM) u-wind

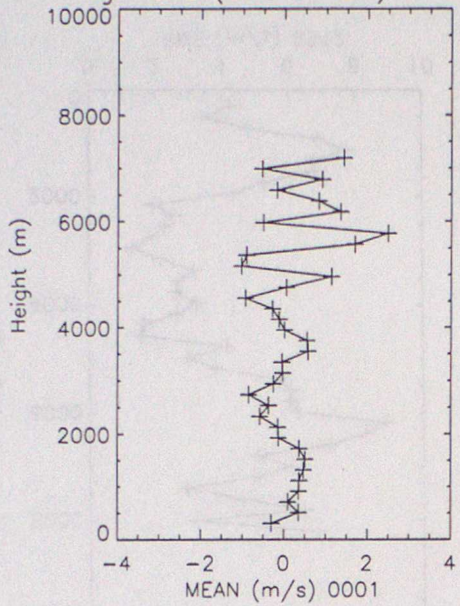


Fig. 39b (CAMWP-UM) v-wind

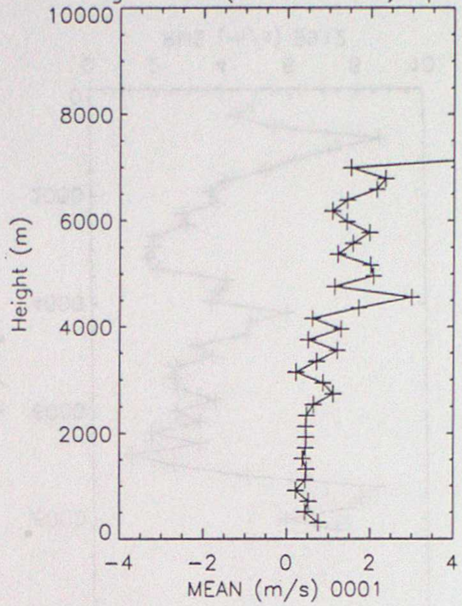


Fig. 39c (CAMWP-UM) speed

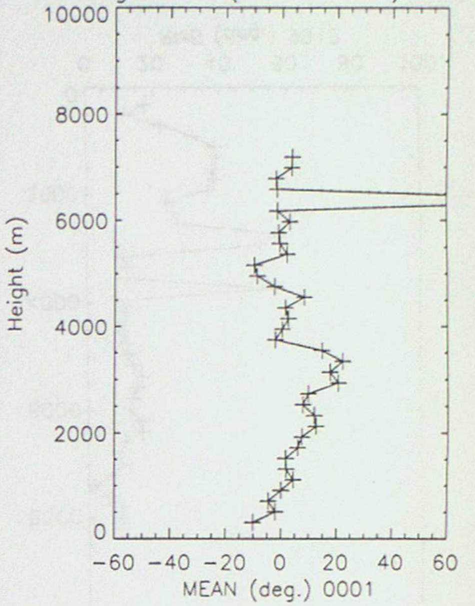


Fig. 39d (CAMWP-UM) dirn.

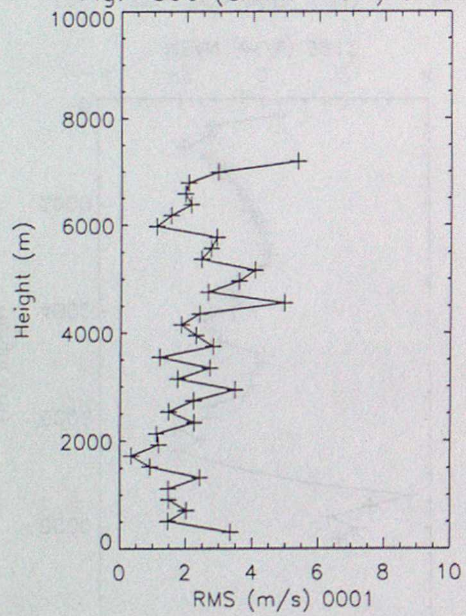


Fig. 39e (CAMWP-UM) u-wind

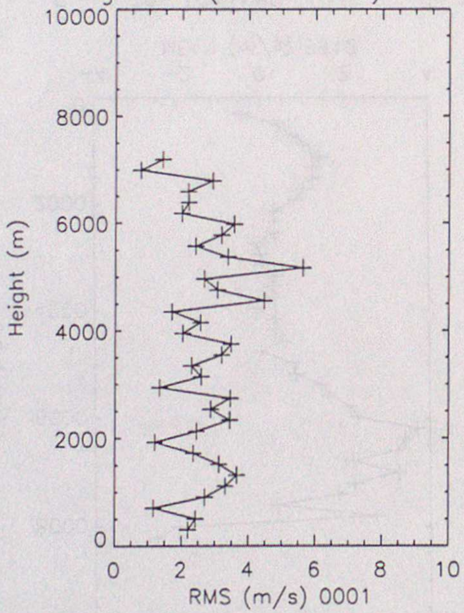


Fig. 39f (CAMWP-UM) v-wind

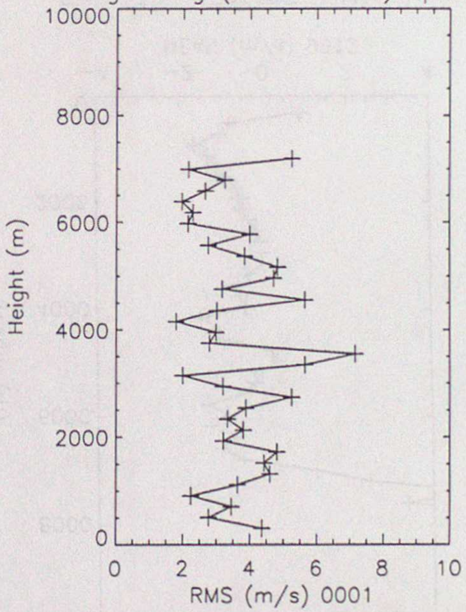


Fig. 39g (CAMWP-UM) speed

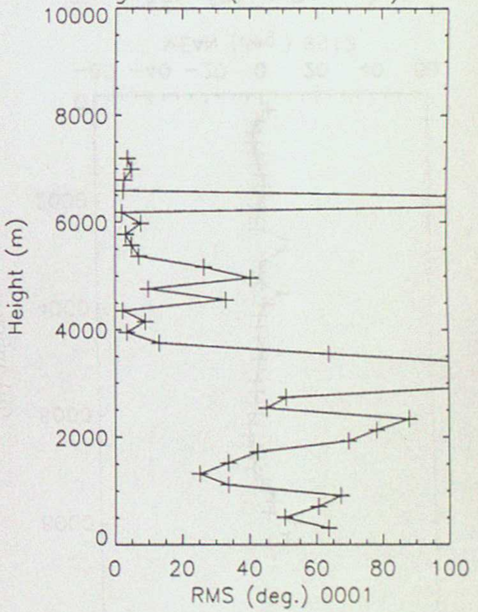


Fig. 39h (CAMWP-UM) dirn.

Fig. 40a (CAMWP-UM) u-wind

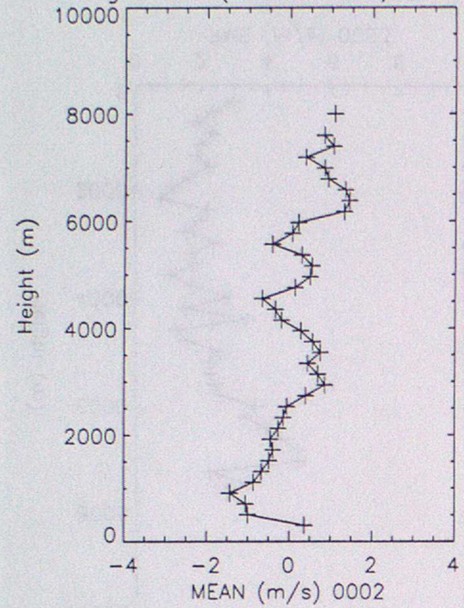


Fig. 40b (CAMWP-UM) v-wind

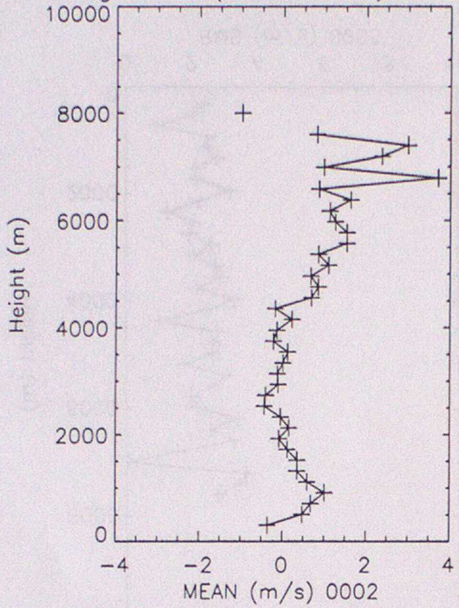


Fig. 40c (CAMWP-UM) speed

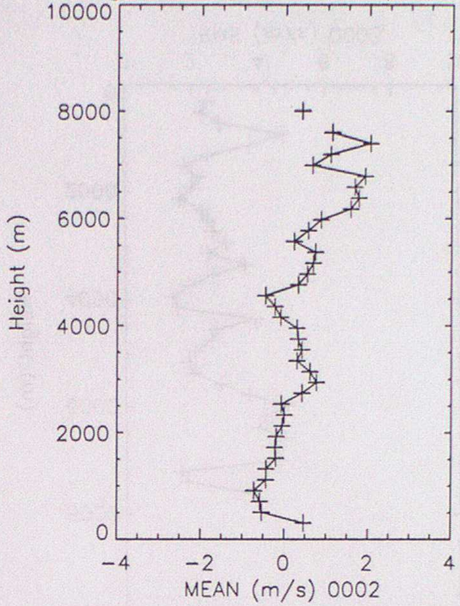


Fig. 40d (CAMWP-UM) dirn.

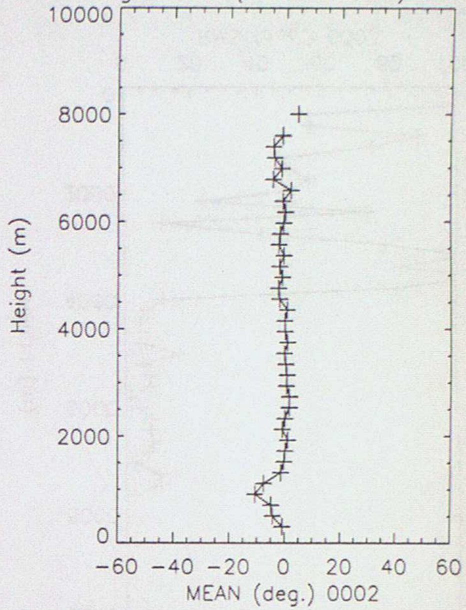


Fig. 40e (CAMWP-UM) u-wind

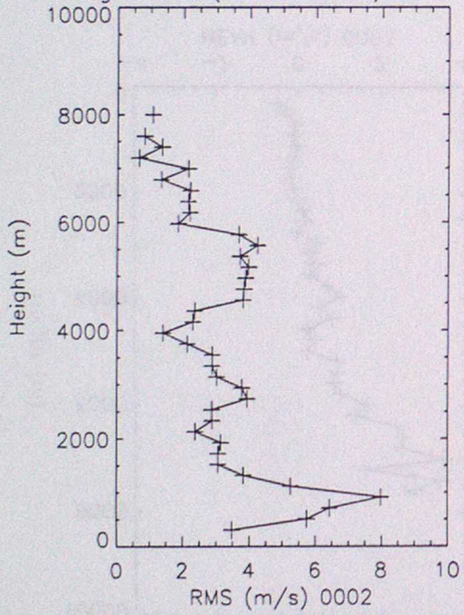


Fig. 40f (CAMWP-UM) v-wind

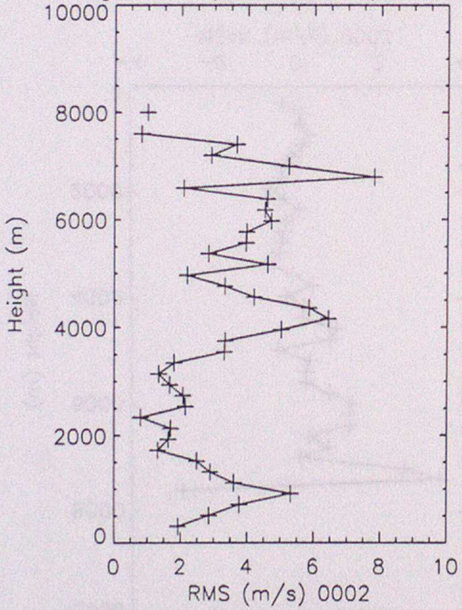


Fig. 40g (CAMWP-UM) speed

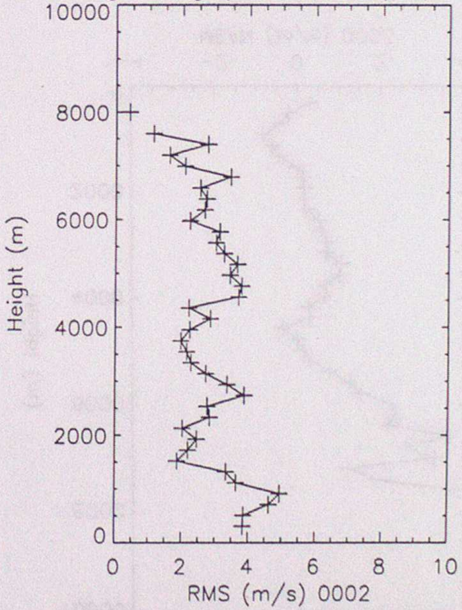


Fig. 40h (CAMWP-UM) dirn.

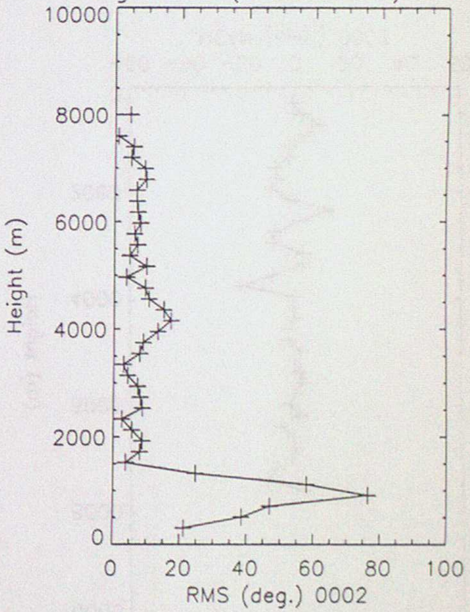


Fig. 41a (CAMWP-UM) u-wind

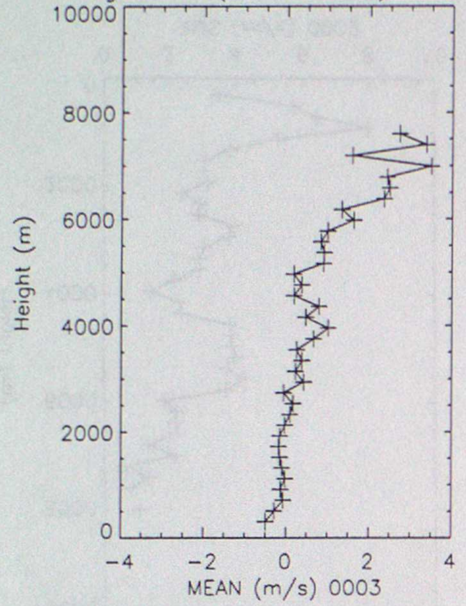


Fig. 41b (CAMWP-UM) v-wind

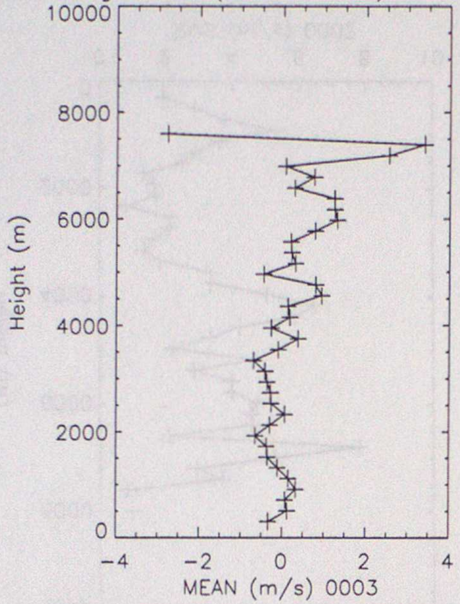


Fig. 41c (CAMWP-UM) speed

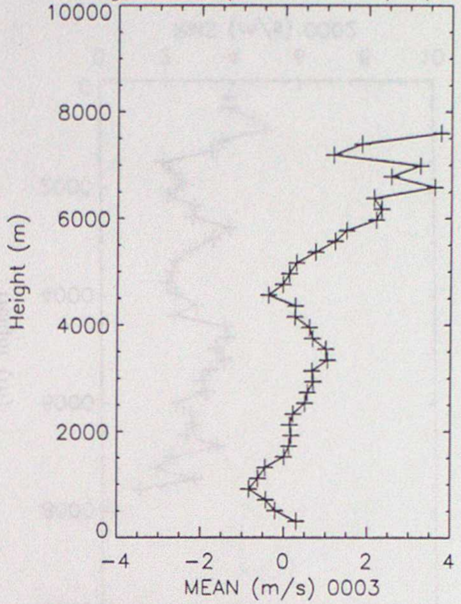


Fig. 41d (CAMWP-UM) dirn.

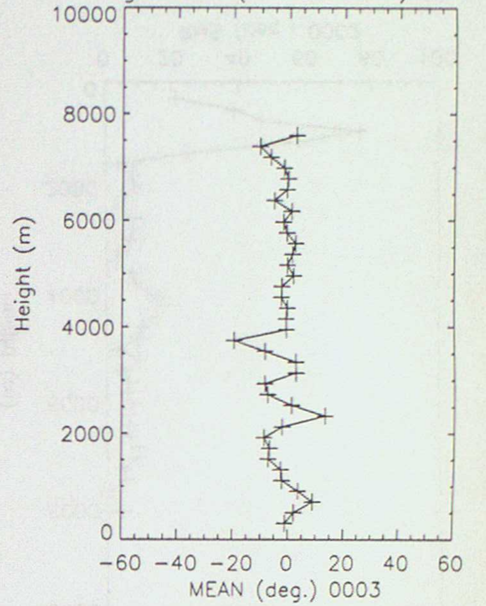


Fig. 41e (CAMWP-UM) u-wind

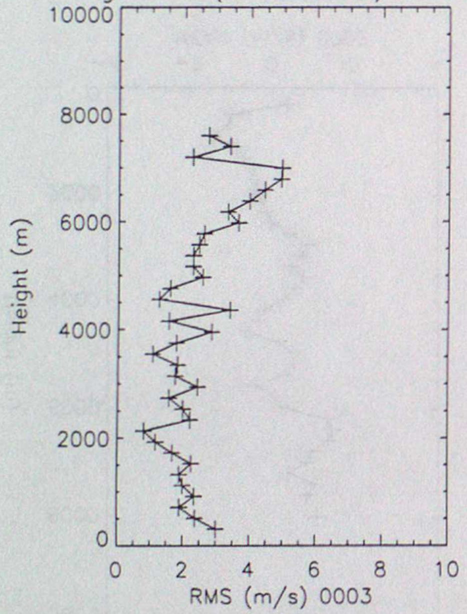


Fig. 41f (CAMWP-UM) v-wind

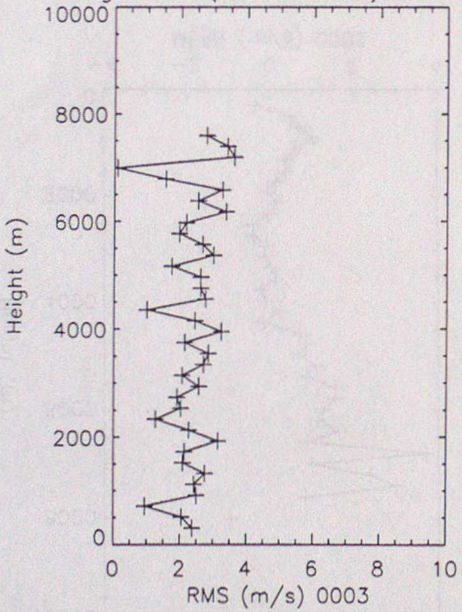


Fig. 41g (CAMWP-UM) speed

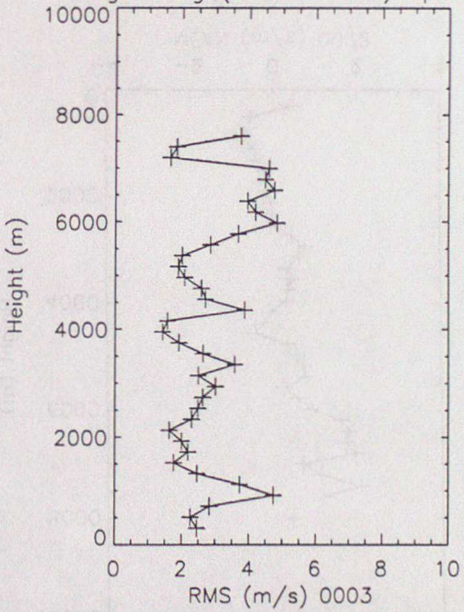


Fig. 41h (CAMWP-UM) dirn.

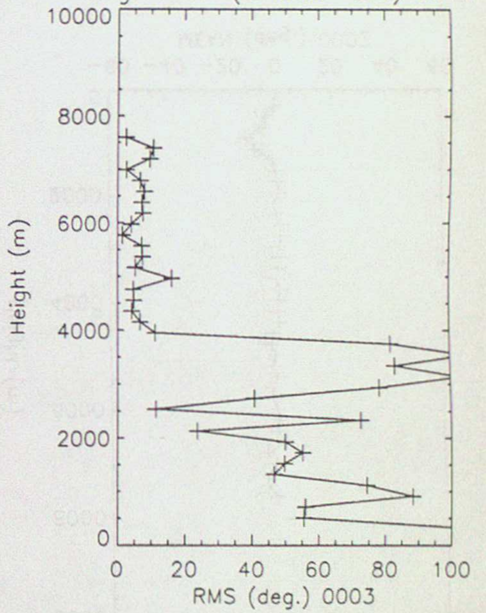


Fig. 42a (DUNWP-UM) u-wind

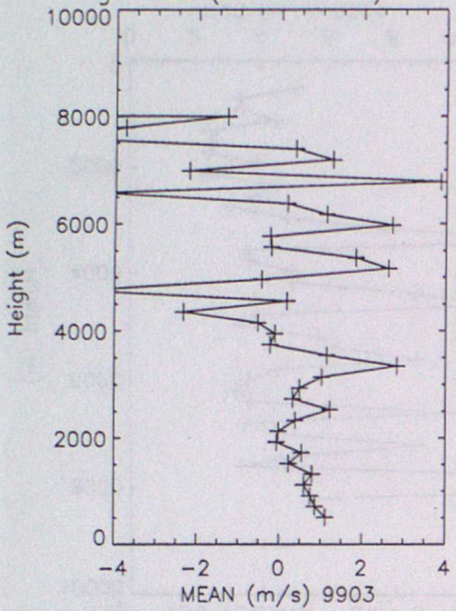


Fig. 42b (DUNWP-UM) v-wind

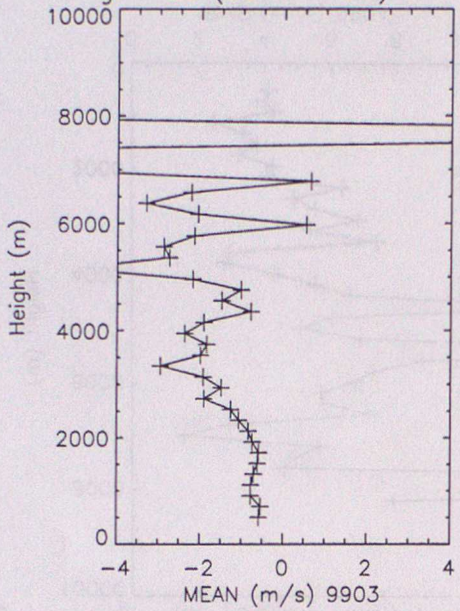


Fig. 42c (DUNWP-UM) speed

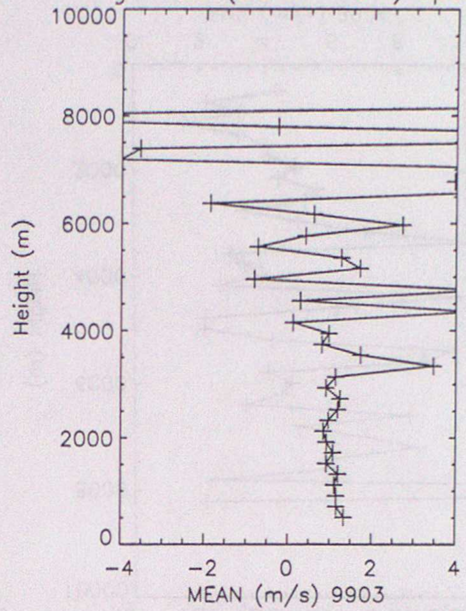


Fig. 42d (DUNWP-UM) dirn.

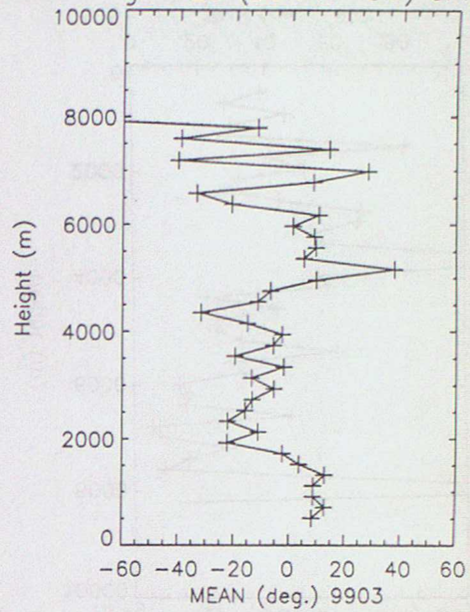


Fig. 42e (DUNWP-UM) u-wind

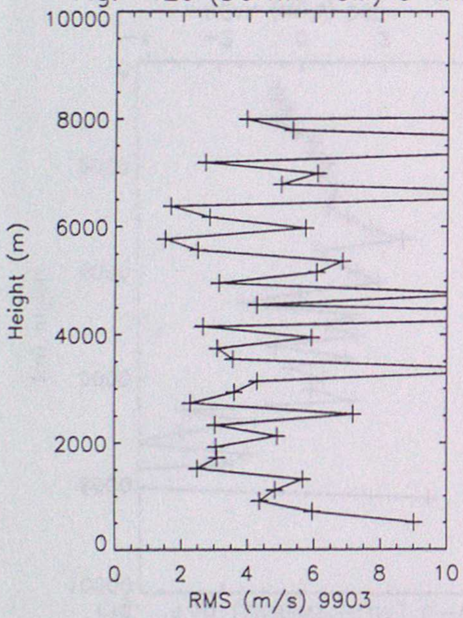


Fig. 42f (DUNWP-UM) v-wind

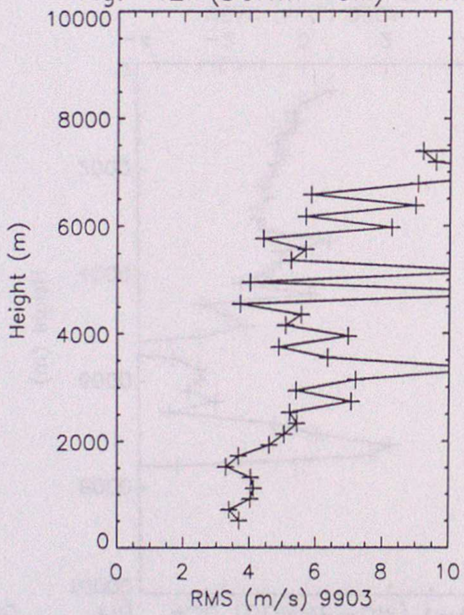


Fig. 42g (DUNWP-UM) speed

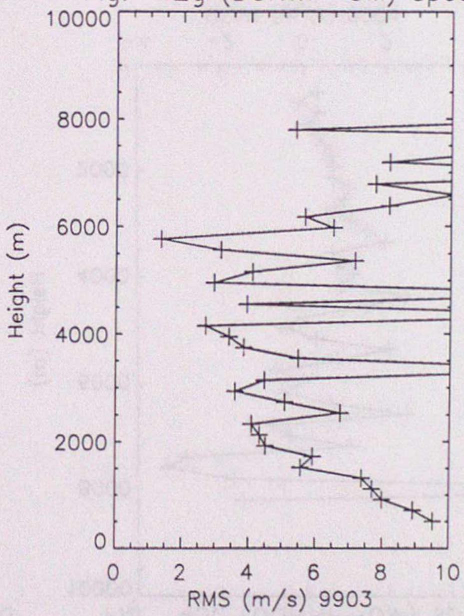
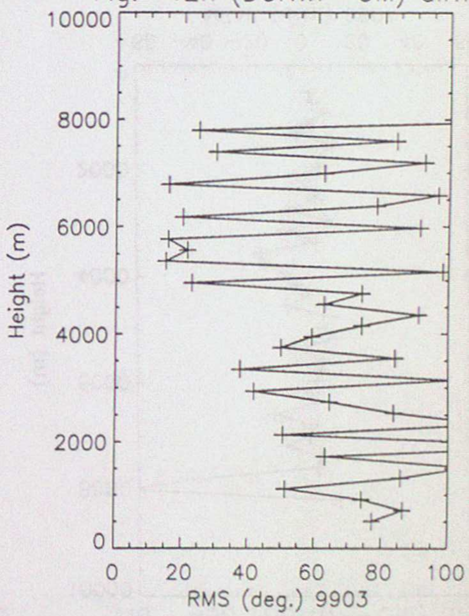


Fig. 42h (DUNWP-UM) dirn.



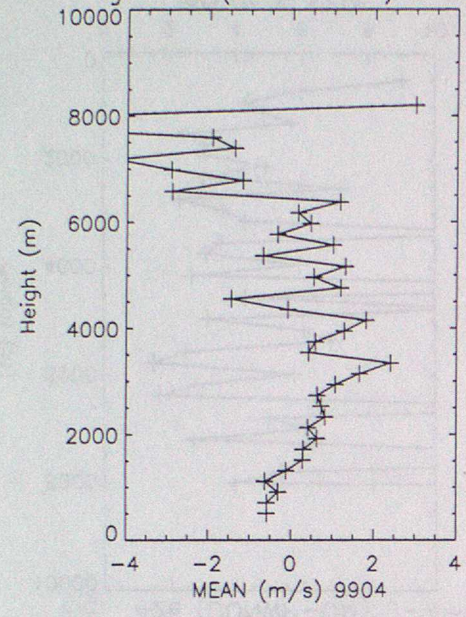


Fig. 43a (DUNWP-UM) u-wind

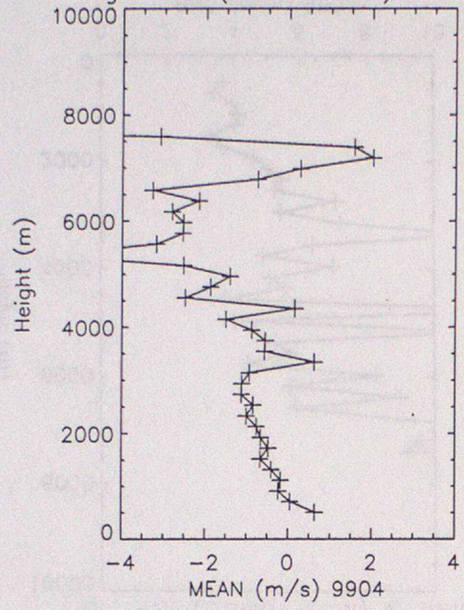


Fig. 43b (DUNWP-UM) v-wind

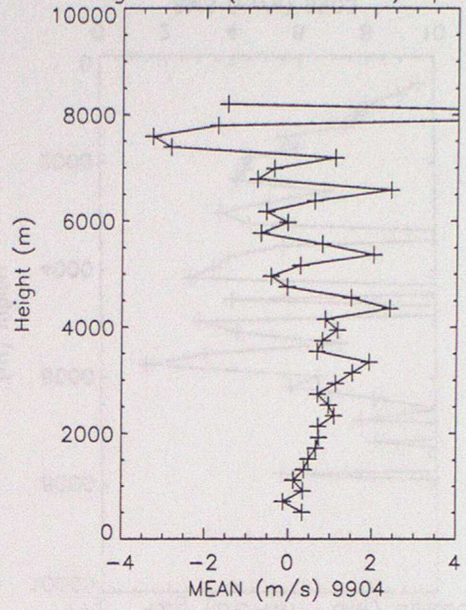


Fig. 43c (DUNWP-UM) speed

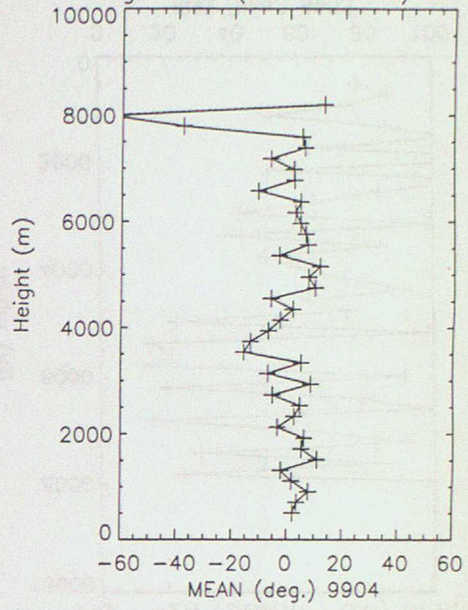


Fig. 43d (DUNWP-UM) dirn.

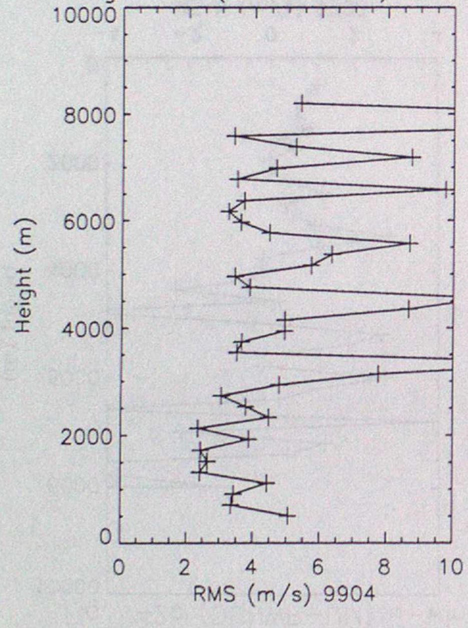


Fig. 43e (DUNWP-UM) u-wind

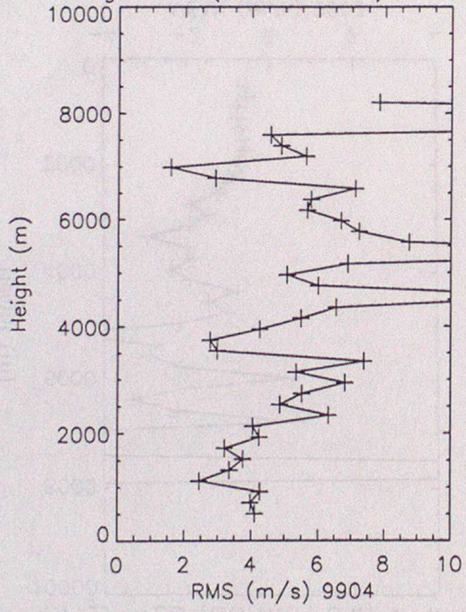


Fig. 43f (DUNWP-UM) v-wind

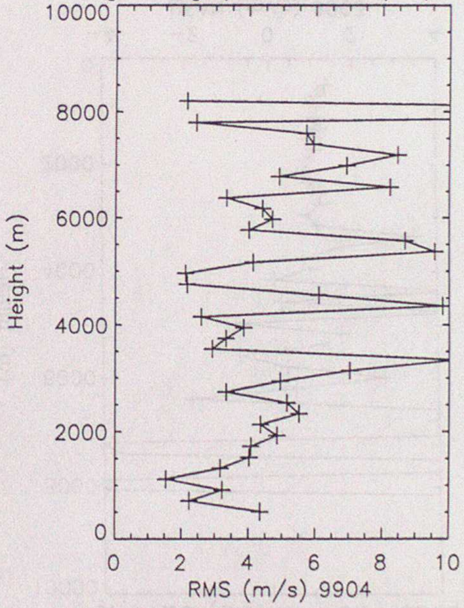


Fig. 43g (DUNWP-UM) speed

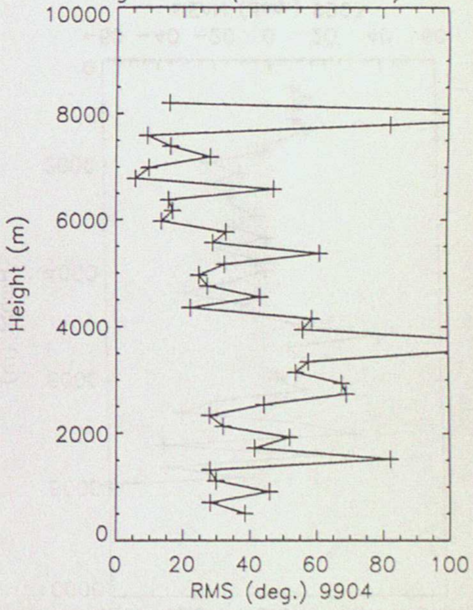


Fig. 43h (DUNWP-UM) dirn.

Fig. 44a (DUNWP-UM) u-wind

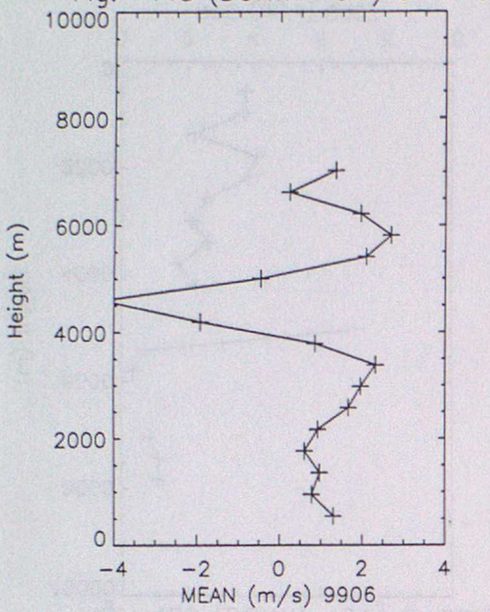


Fig. 44b (DUNWP-UM) v-wind

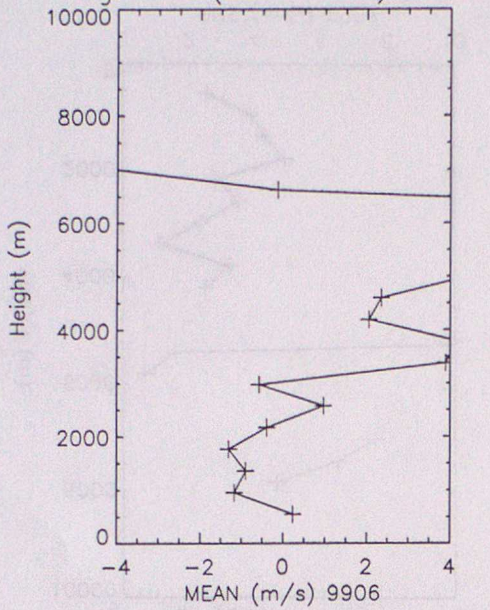


Fig. 44c (DUNWP-UM) speed

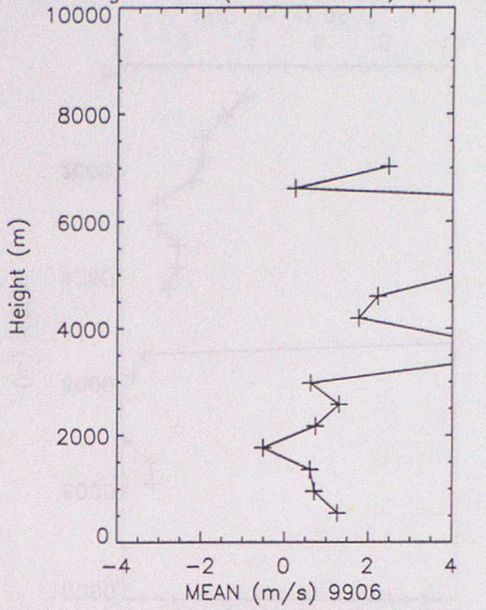


Fig. 44d (DUNWP-UM) dirn.

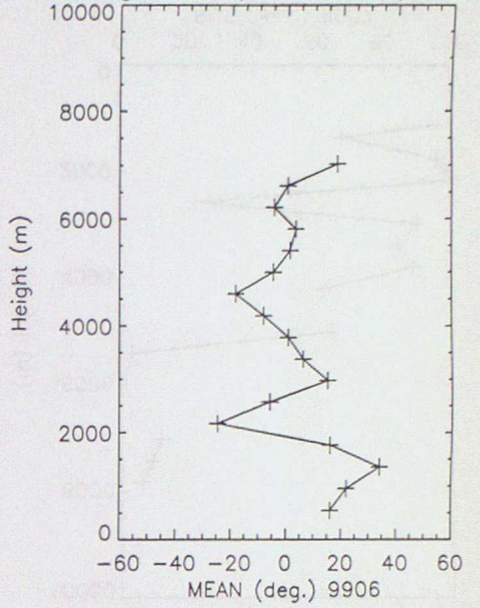


Fig. 44e (DUNWP-UM) u-wind

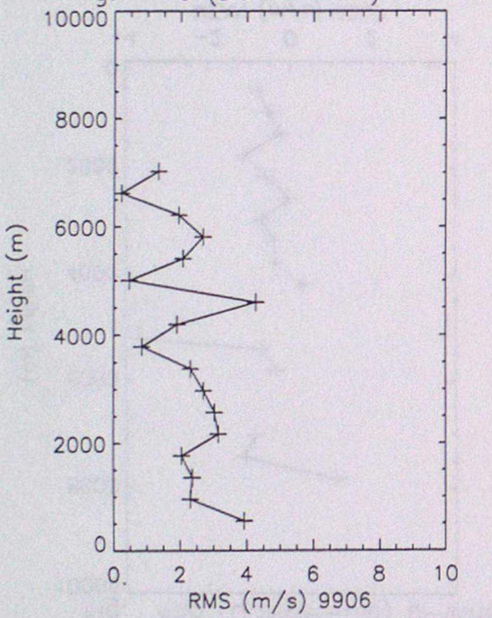


Fig. 44f (DUNWP-UM) v-wind

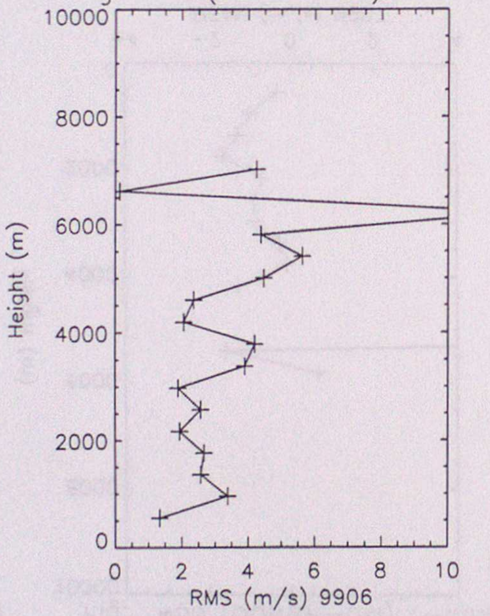


Fig. 44g (DUNWP-UM) speed

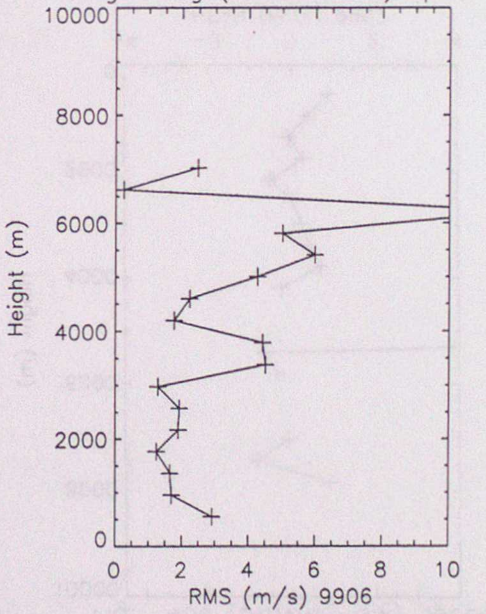


Fig. 44h (DUNWP-UM) dirn.

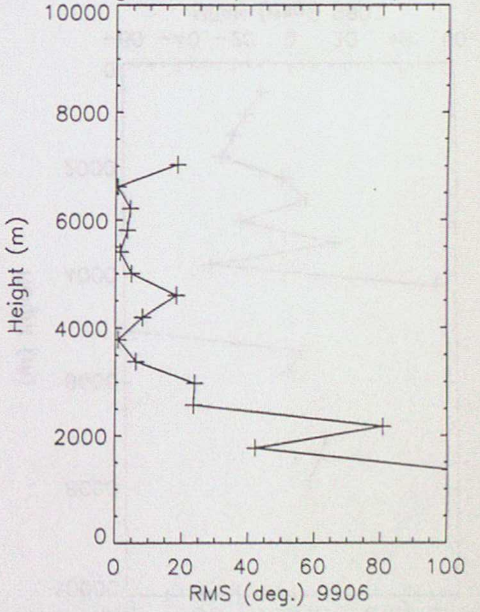


Fig. 45a (DUNWP-UM) u-wind

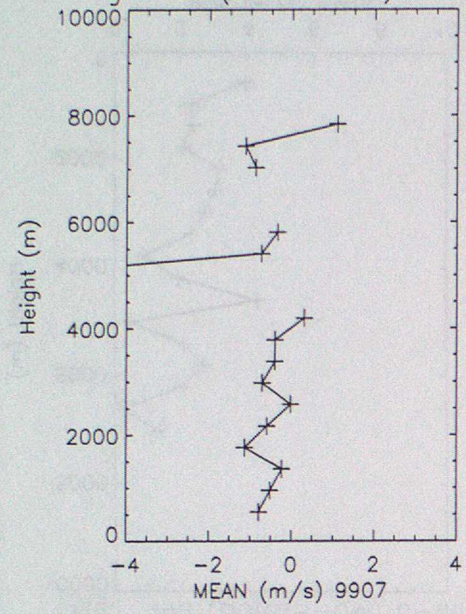


Fig. 45b (DUNWP-UM) v-wind

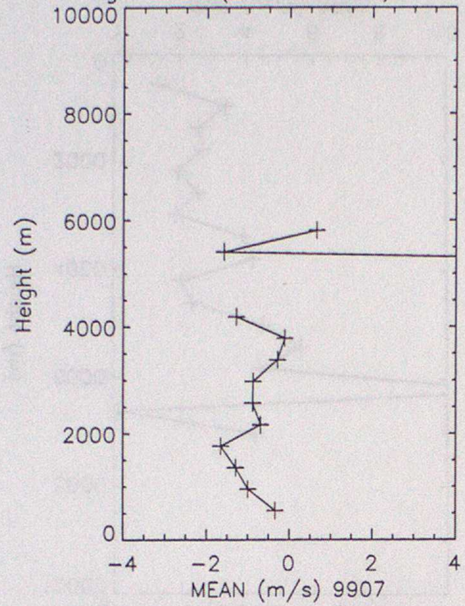


Fig. 45c (DUNWP-UM) speed

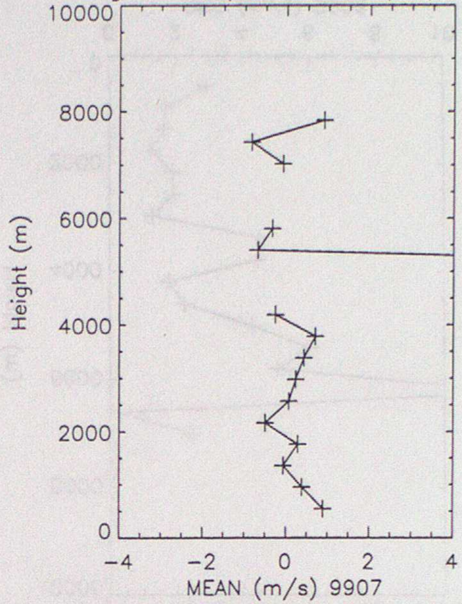


Fig. 45d (DUNWP-UM) dirn.

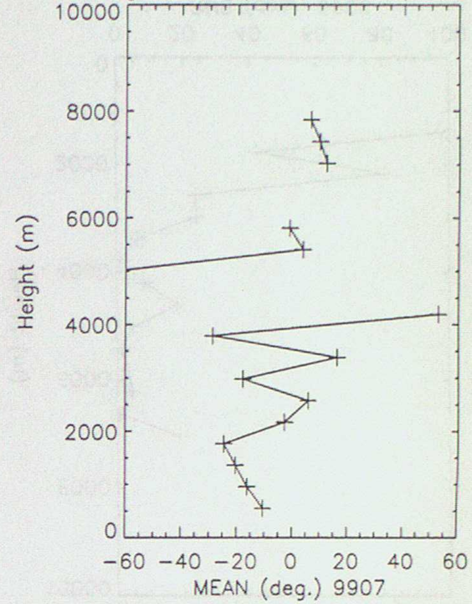


Fig. 45e (DUNWP-UM) u-wind

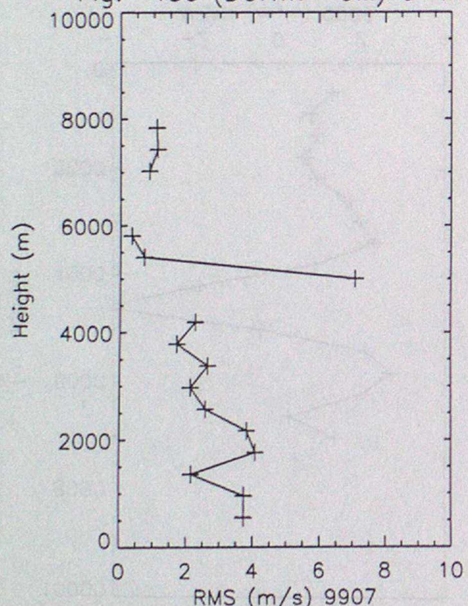


Fig. 45f (DUNWP-UM) v-wind

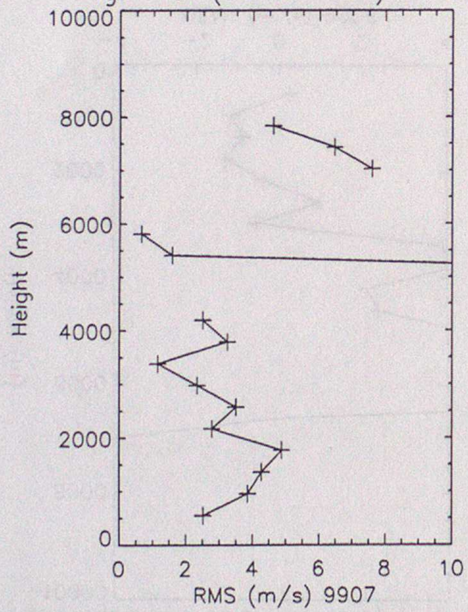


Fig. 45g (DUNWP-UM) speed

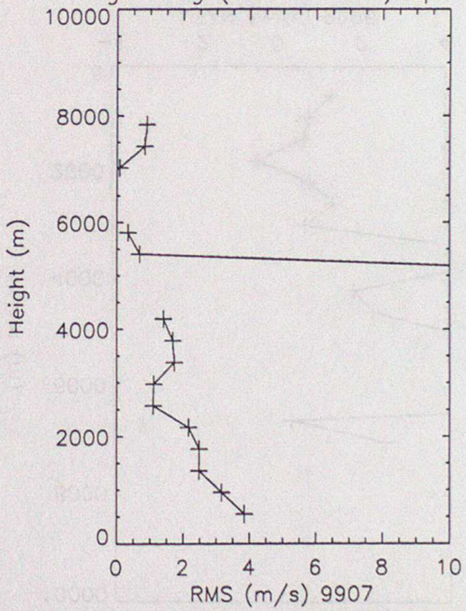


Fig. 45h (DUNWP-UM) dirn.

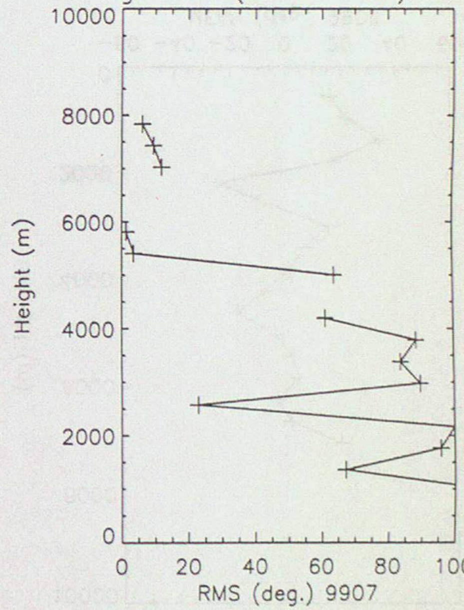


Fig. 46a (DUNWP-UM) u-wind

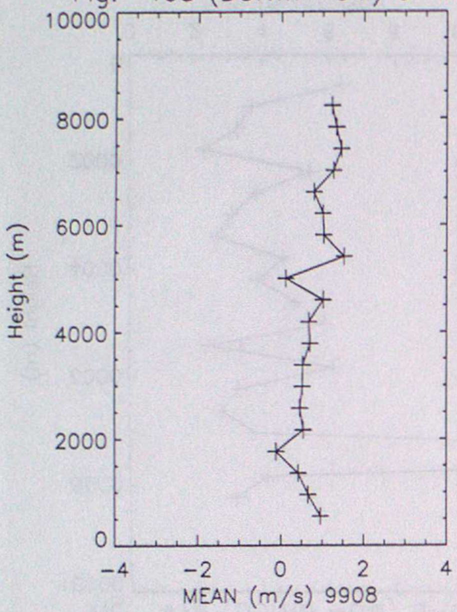


Fig. 46b (DUNWP-UM) v-wind

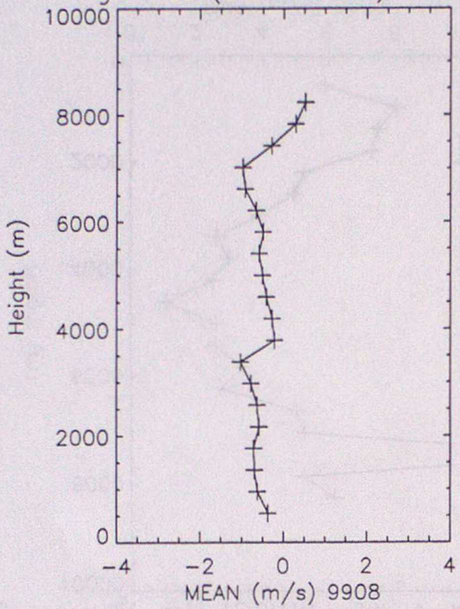


Fig. 46c (DUNWP-UM) speed

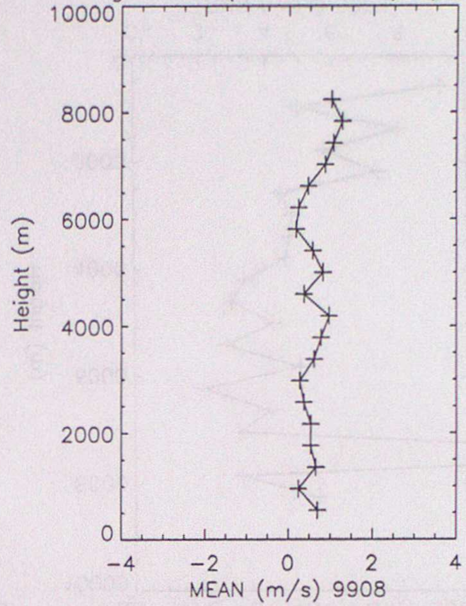


Fig. 46d (DUNWP-UM) dirn.

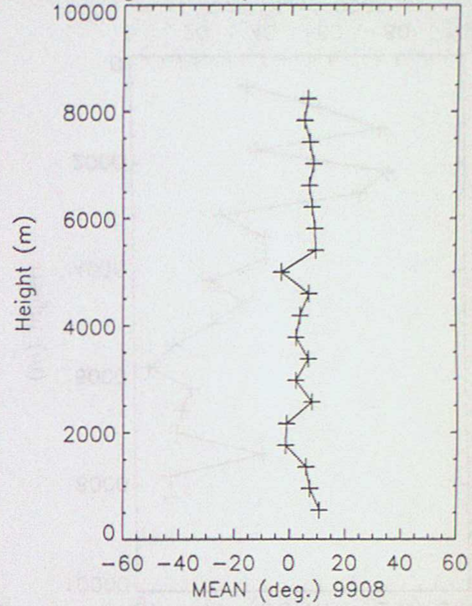


Fig. 46e (DUNWP-UM) u-wind

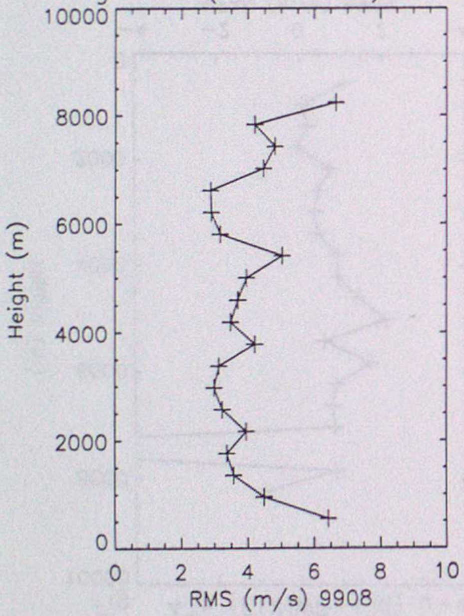


Fig. 46f (DUNWP-UM) v-wind

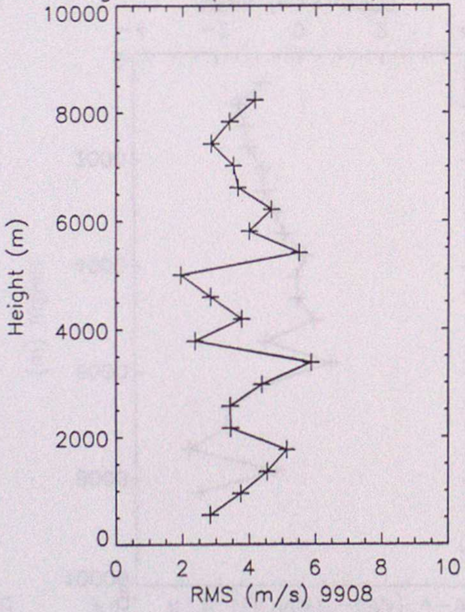


Fig. 46g (DUNWP-UM) speed

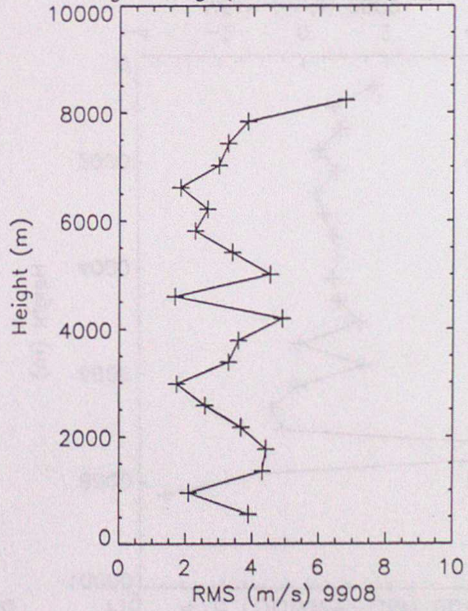


Fig. 46h (DUNWP-UM) dirn.

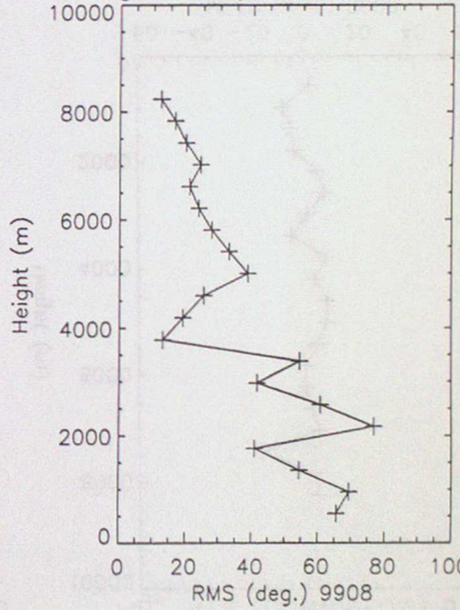


Fig. 47a (DUNWP-UM) u-wind

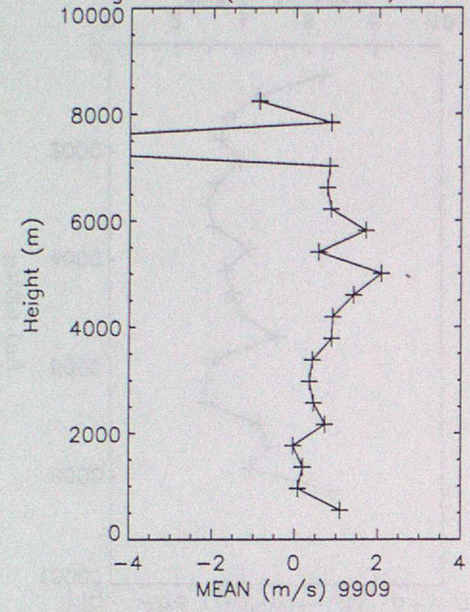


Fig. 47b (DUNWP-UM) v-wind

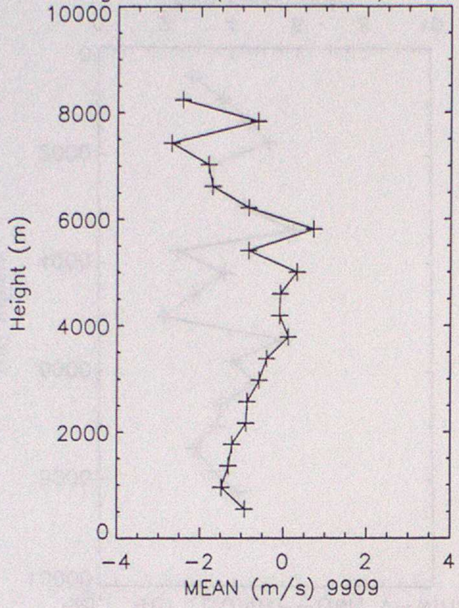


Fig. 47c (DUNWP-UM) speed

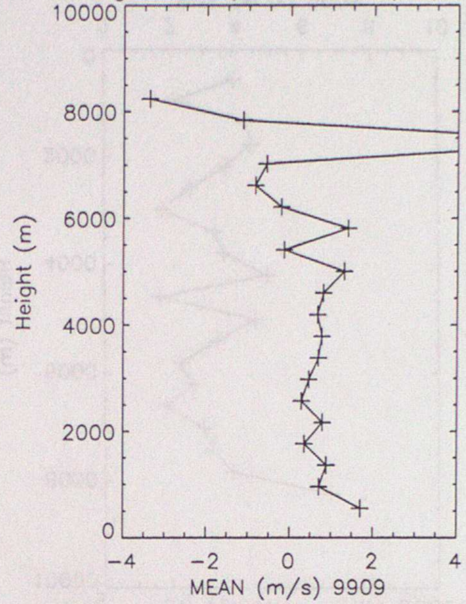


Fig. 47d (DUNWP-UM) dirn.

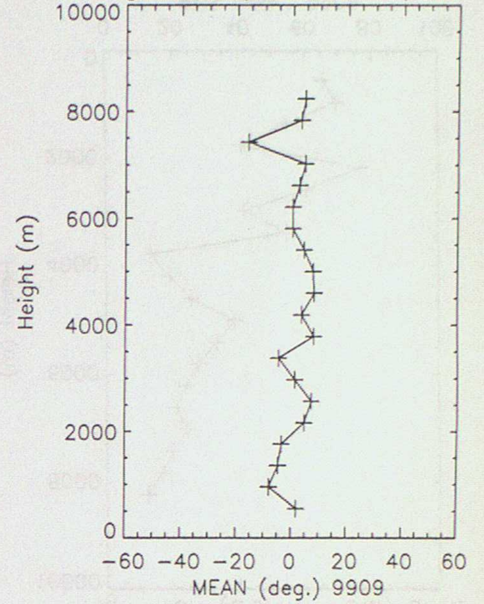


Fig. 47e (DUNWP-UM) u-wind

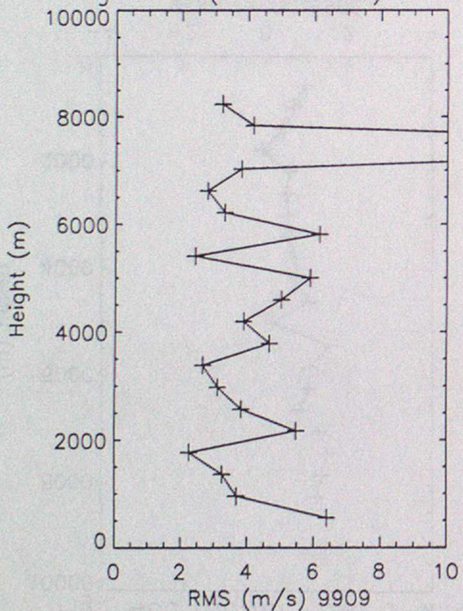


Fig. 47f (DUNWP-UM) v-wind

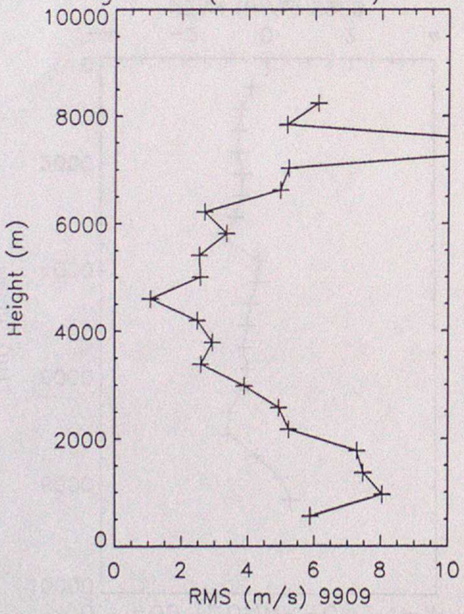


Fig. 47g (DUNWP-UM) speed

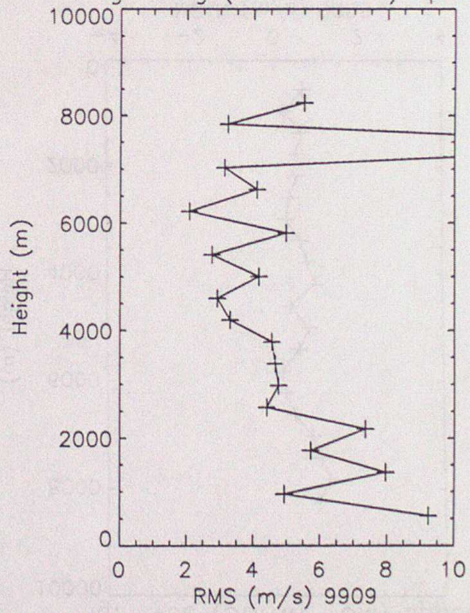
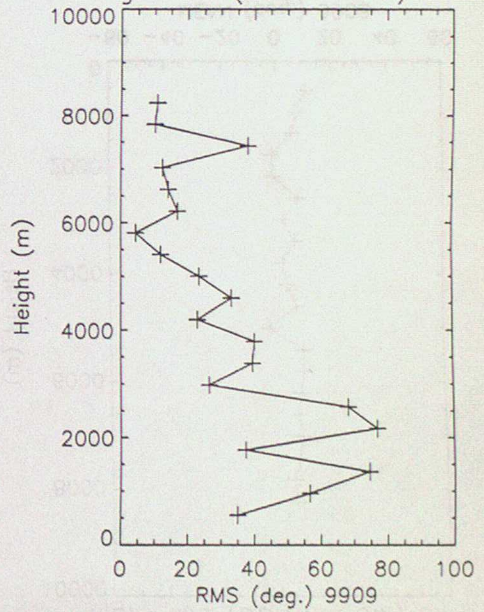


Fig. 47h (DUNWP-UM) dirn.



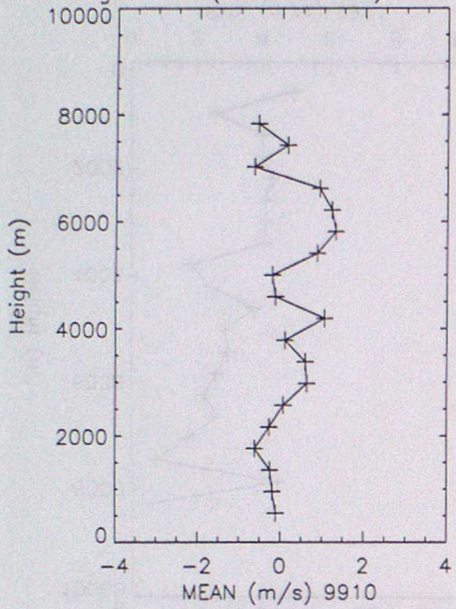


Fig. 48a (DUNWP-UM) u-wind

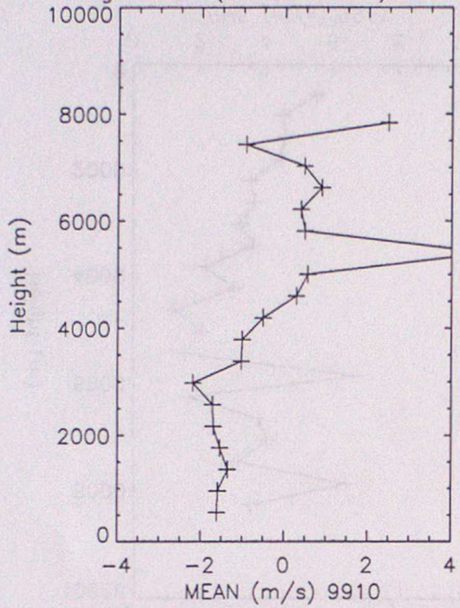


Fig. 48b (DUNWP-UM) v-wind

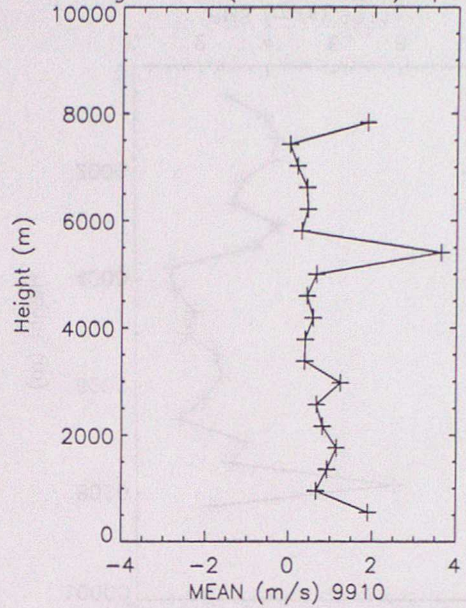


Fig. 48c (DUNWP-UM) speed

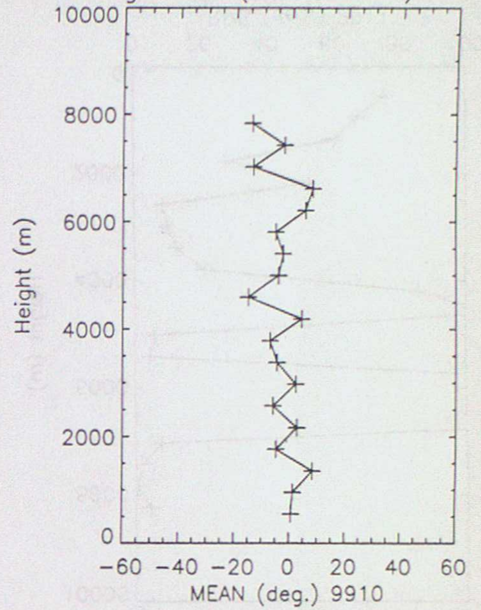


Fig. 48d (DUNWP-UM) dirn.

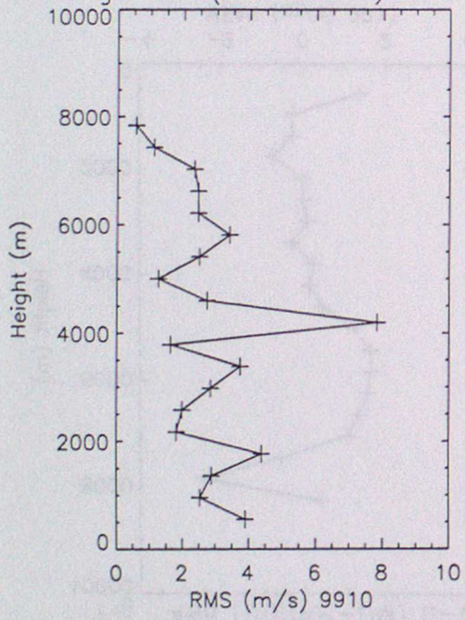


Fig. 48e (DUNWP-UM) u-wind

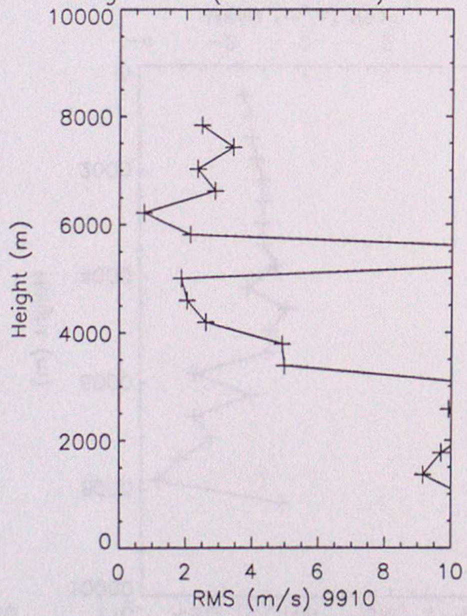


Fig. 48f (DUNWP-UM) v-wind

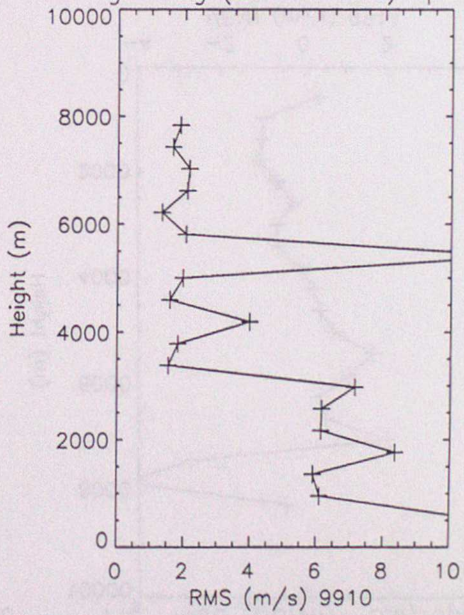


Fig. 48g (DUNWP-UM) speed

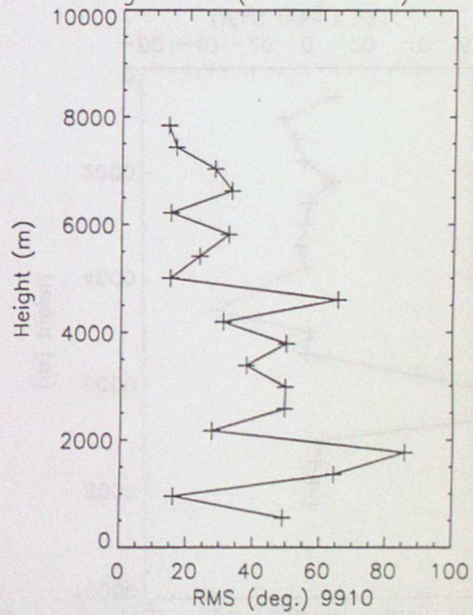


Fig. 48h (DUNWP-UM) dirn.

Fig. 49a (DUNWP-UM) u-wind

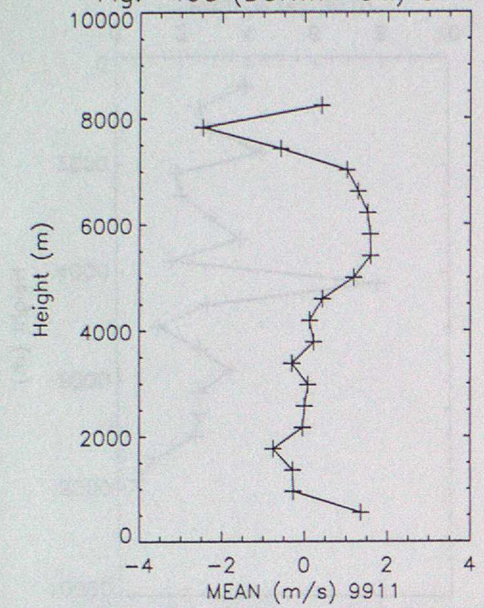


Fig. 49b (DUNWP-UM) v-wind

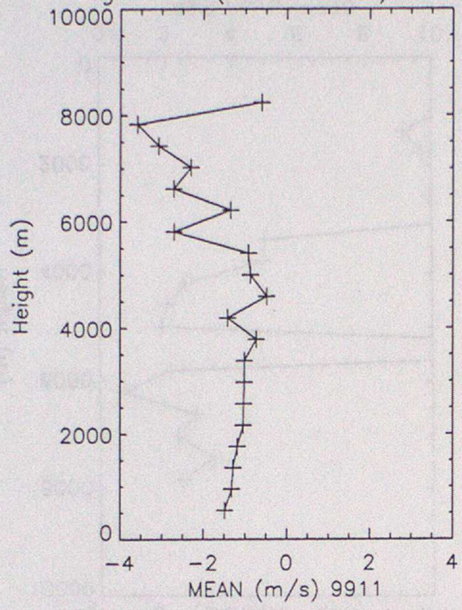


Fig. 49c (DUNWP-UM) speed

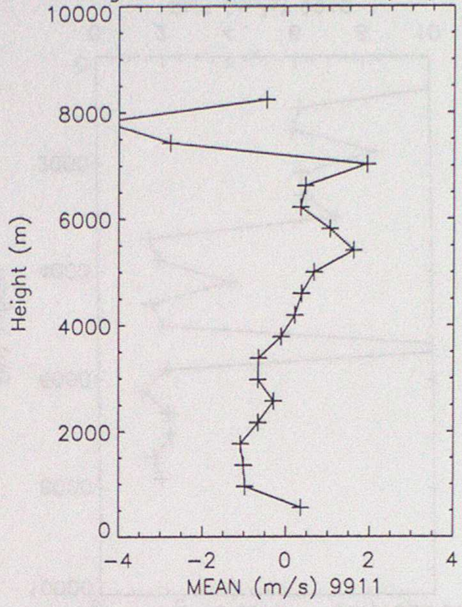


Fig. 49d (DUNWP-UM) dirn.

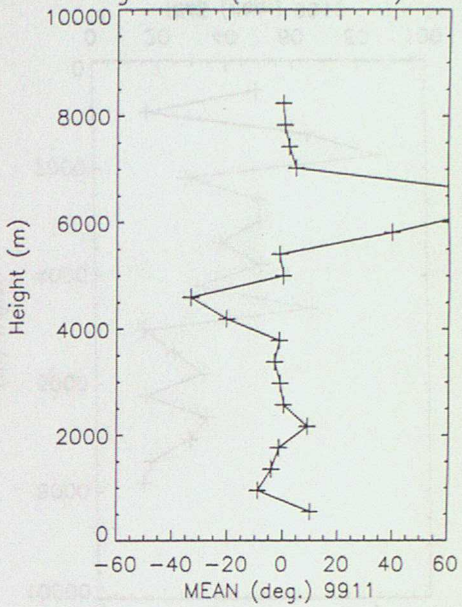


Fig. 49e (DUNWP-UM) u-wind

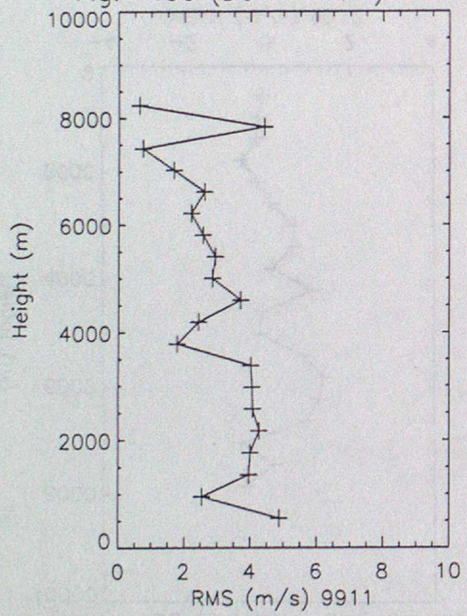


Fig. 49f (DUNWP-UM) v-wind

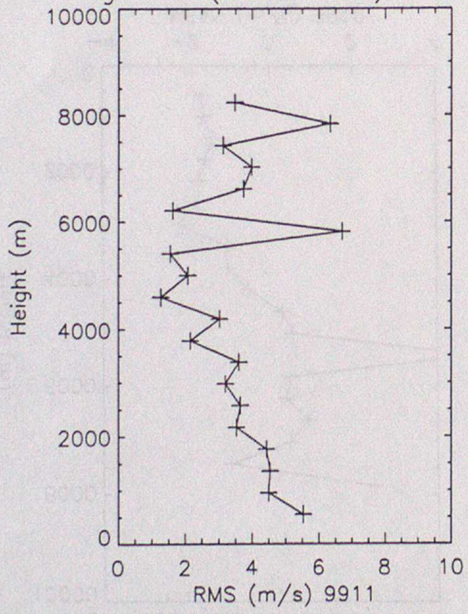


Fig. 49g (DUNWP-UM) speed

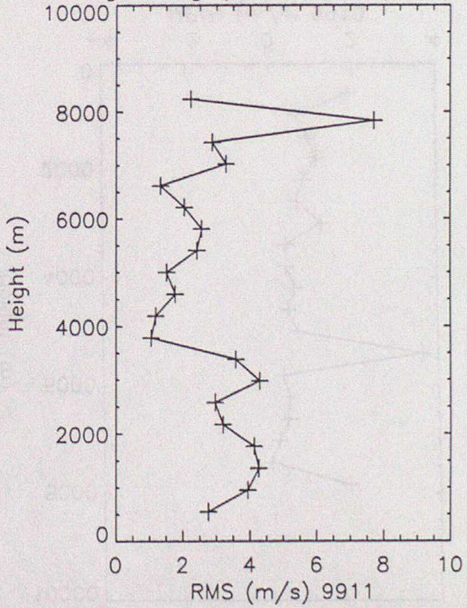


Fig. 49h (DUNWP-UM) dirn.

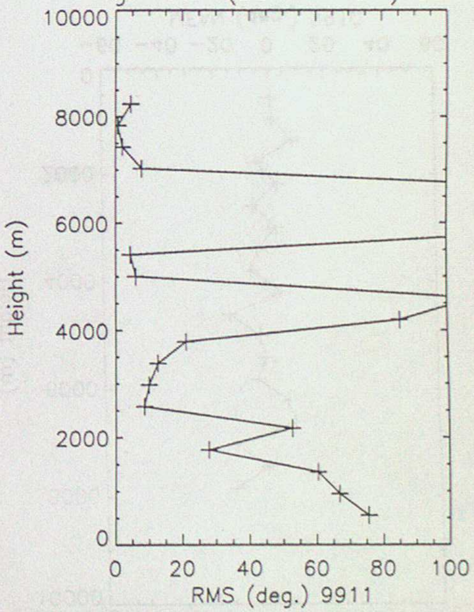


Fig. 50a (DUNWP−UM) u−wind

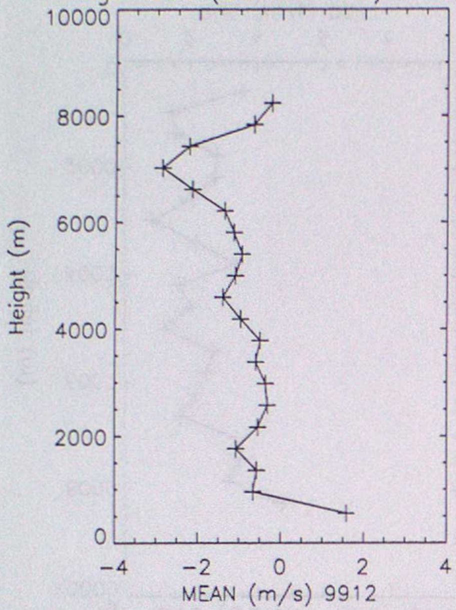


Fig. 50b (DUNWP−UM) v−wind

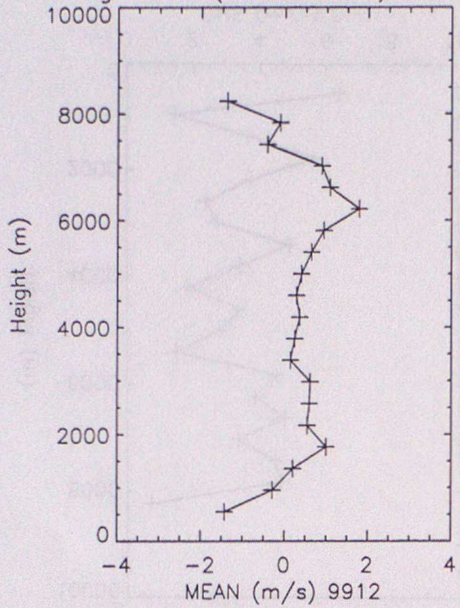


Fig. 50c (DUNWP−UM) speed

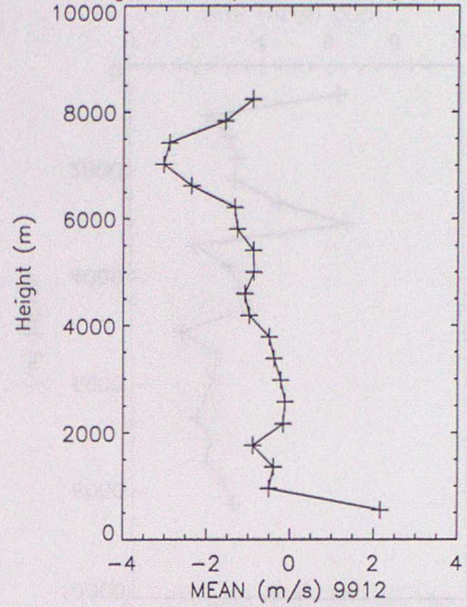


Fig. 50d (DUNWP−UM) dirn.

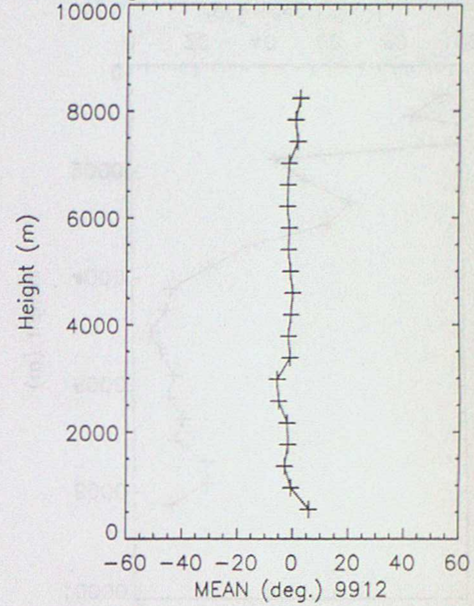


Fig. 50e (DUNWP−UM) u−wind

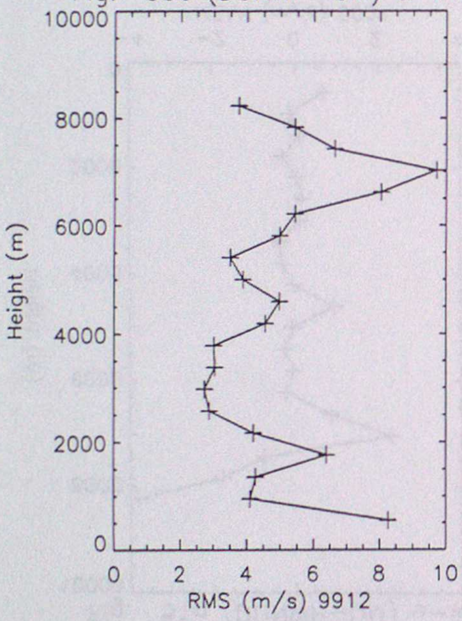


Fig. 50f (DUNWP−UM) v−wind

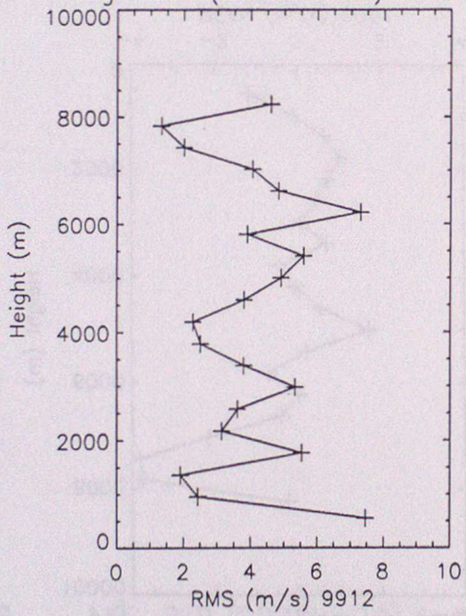


Fig. 50g (DUNWP−UM) speed

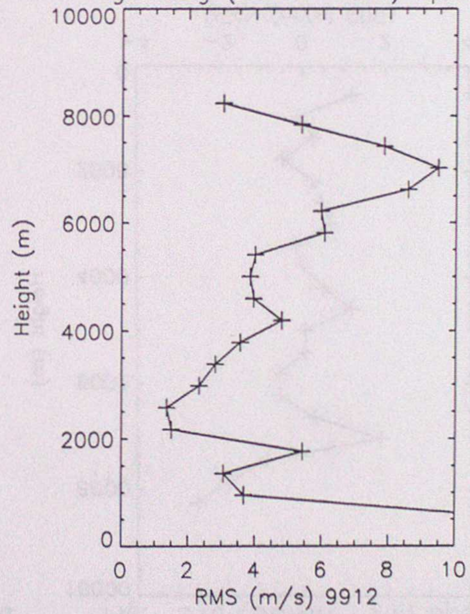


Fig. 50h (DUNWP−UM) dirn.

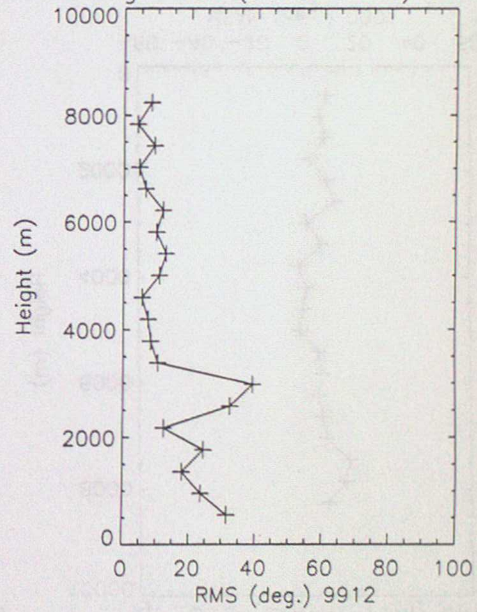


Fig. 51a (DUNWP-UM) u-wind

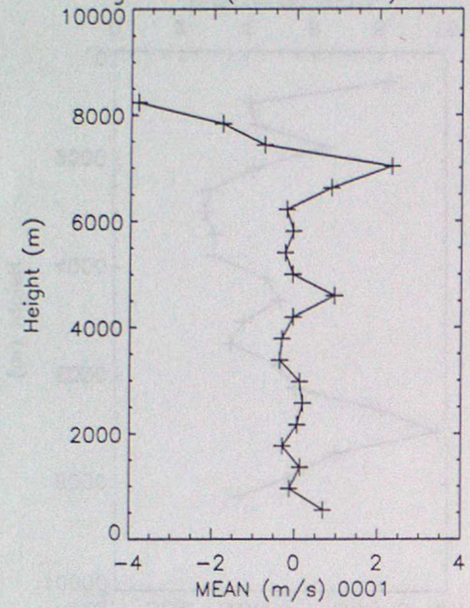


Fig. 51b (DUNWP-UM) v-wind

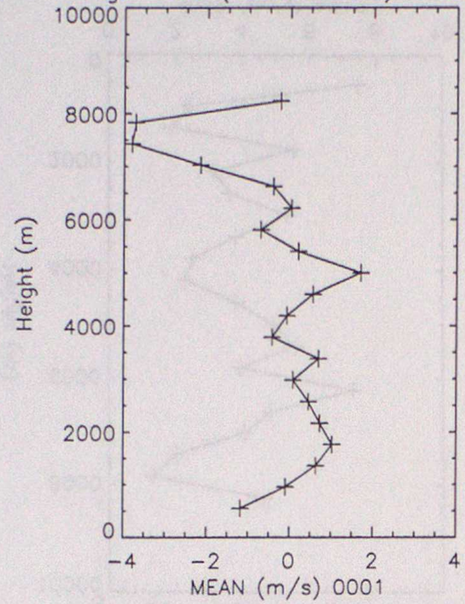


Fig. 51c (DUNWP-UM) speed

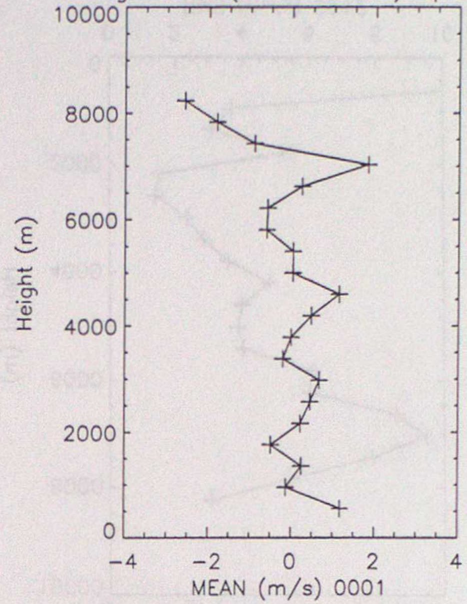


Fig. 51d (DUNWP-UM) dirn.

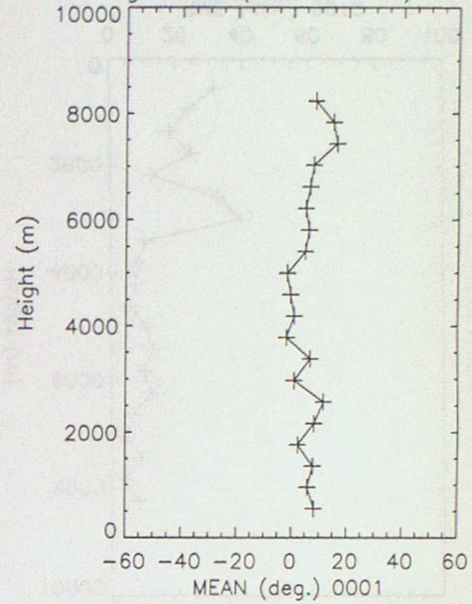


Fig. 51e (DUNWP-UM) u-wind

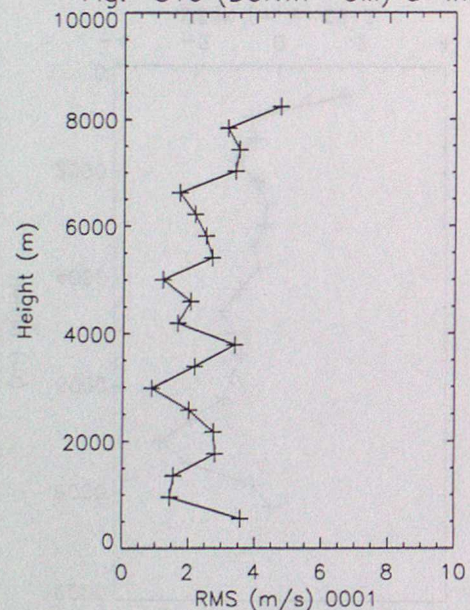


Fig. 51f (DUNWP-UM) v-wind

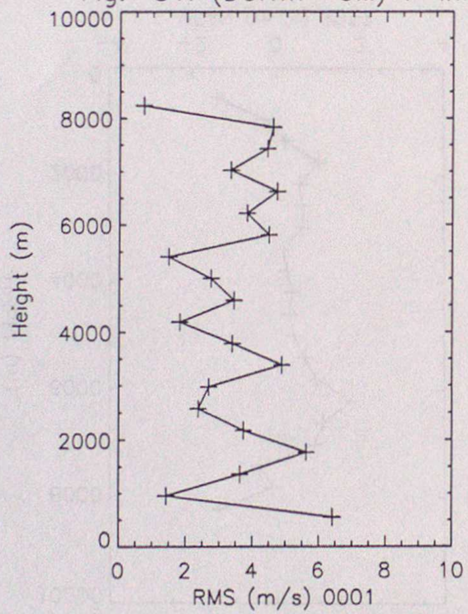


Fig. 51g (DUNWP-UM) speed

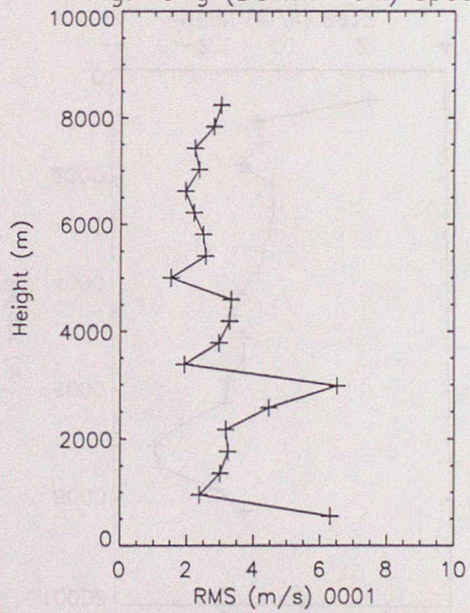


Fig. 51h (DUNWP-UM) dirn.

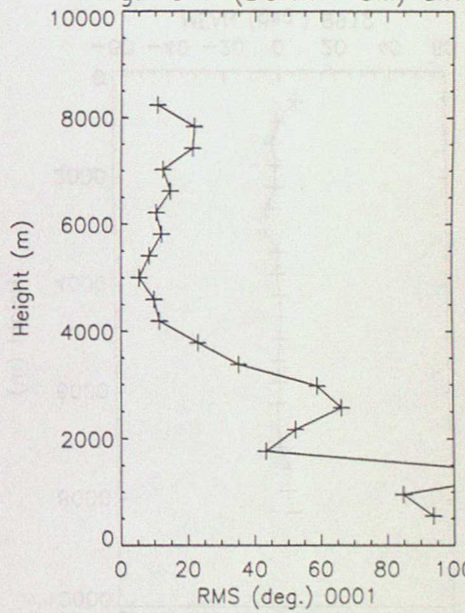


Fig. 52a (DUNWP–UM) u–wind

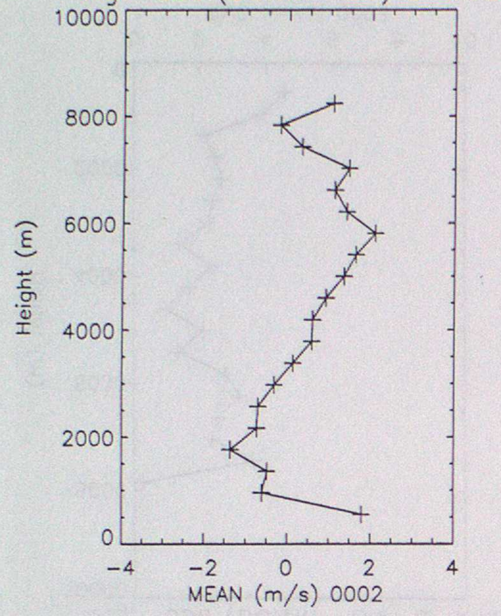


Fig. 52b (DUNWP–UM) v–wind

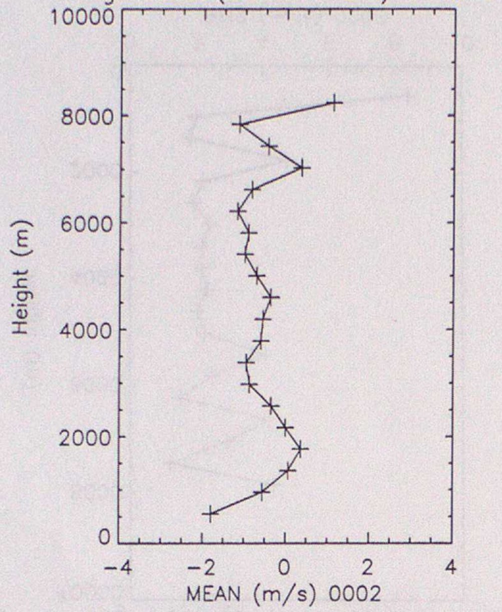


Fig. 52c (DUNWP–UM) speed

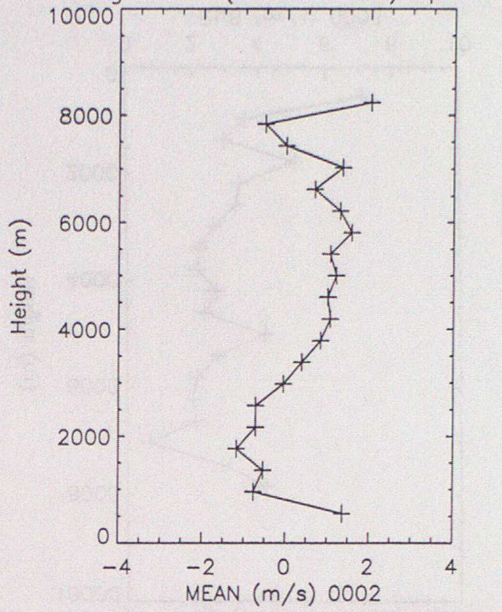


Fig. 52d (DUNWP–UM) dirn.

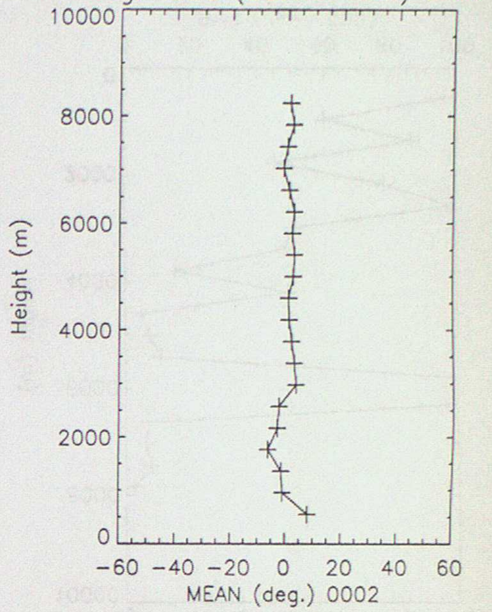


Fig. 52e (DUNWP–UM) u–wind

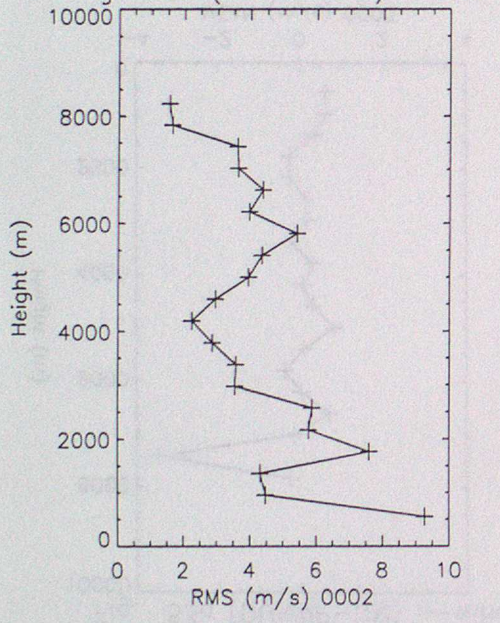


Fig. 52f (DUNWP–UM) v–wind

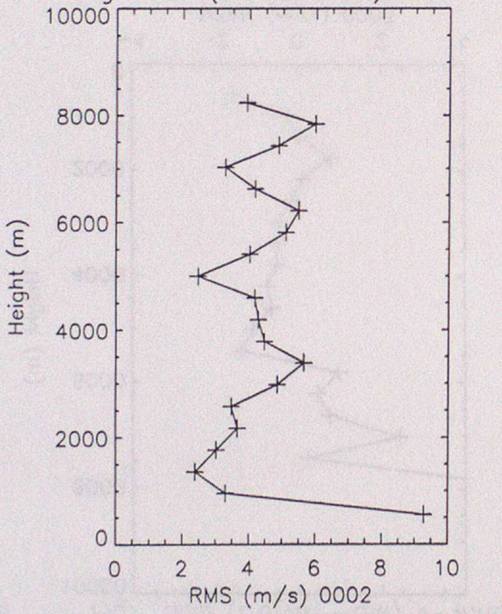


Fig. 52g (DUNWP–UM) speed

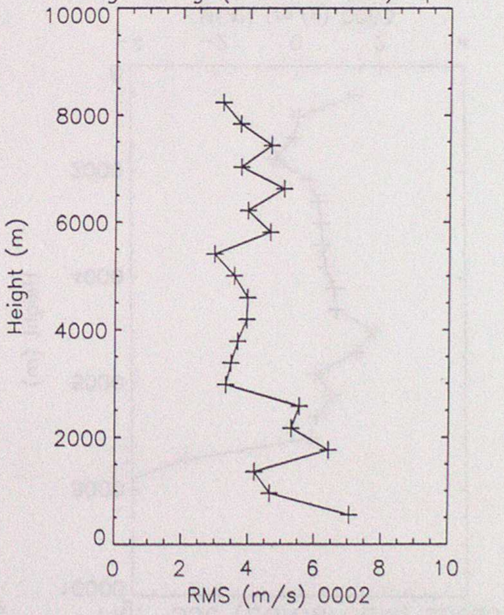


Fig. 52h (DUNWP–UM) dirn.

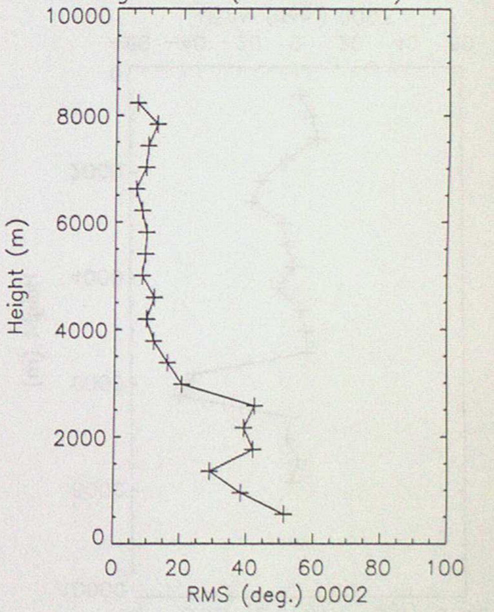


Fig. 53a (DUNWP-UM) u-wind

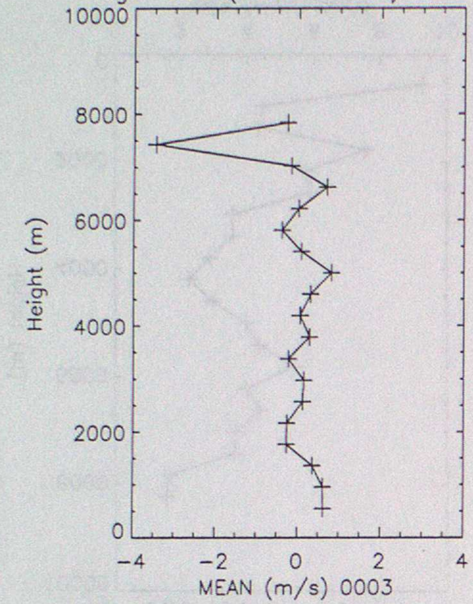


Fig. 53b (DUNWP-UM) v-wind

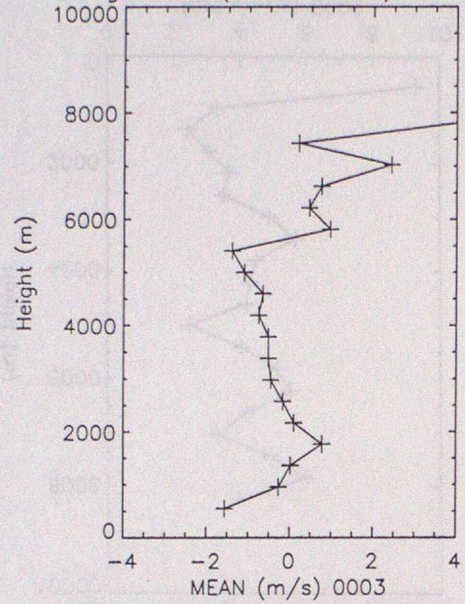


Fig. 53c (DUNWP-UM) speed

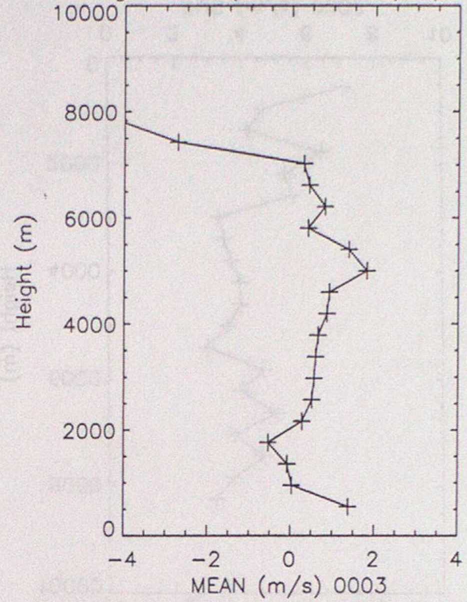


Fig. 53d (DUNWP-UM) dirn.

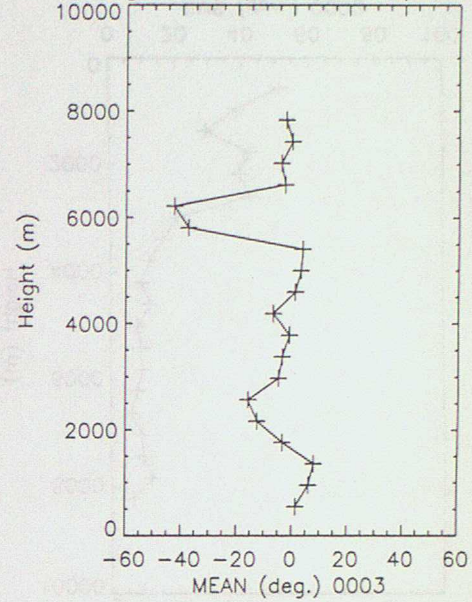


Fig. 53e (DUNWP-UM) u-wind

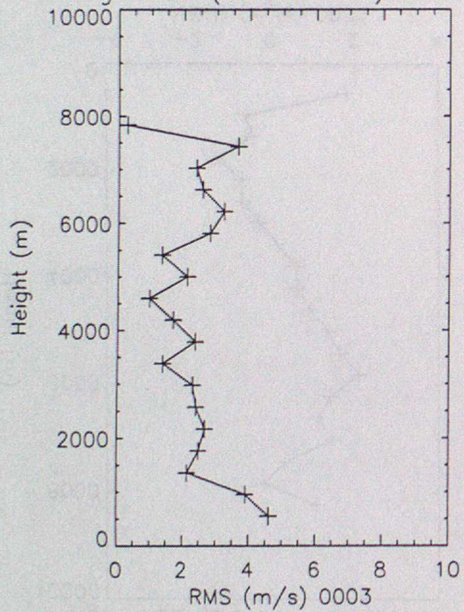


Fig. 53f (DUNWP-UM) v-wind

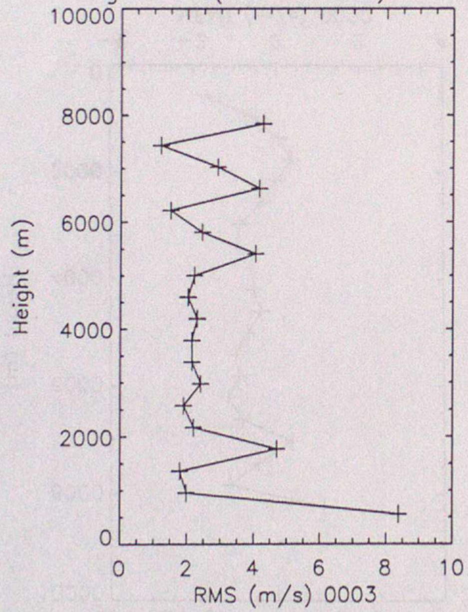


Fig. 53g (DUNWP-UM) speed

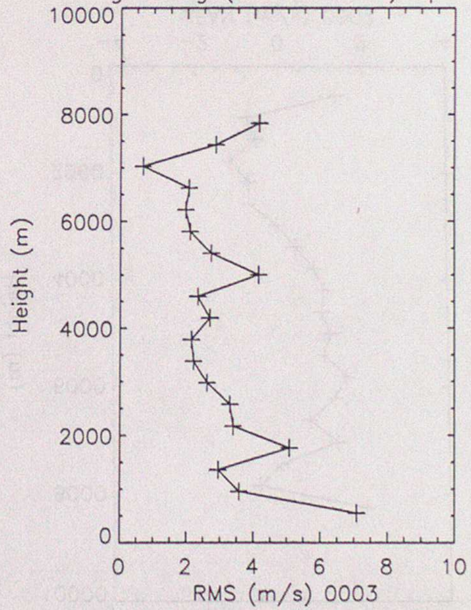


Fig. 53h (DUNWP-UM) dirn.

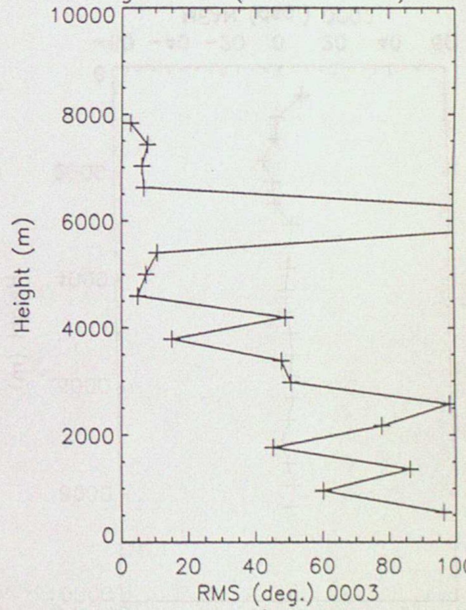


Fig. 54a (LFVWP-UM) u-wind

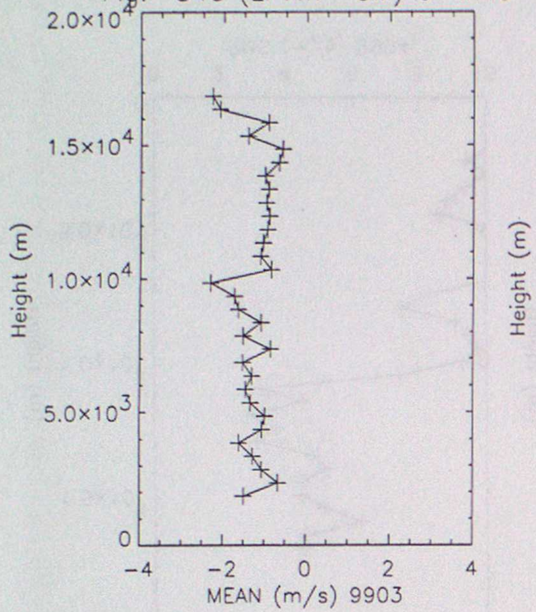


Fig. 54b (LFVWP-UM) v-wind

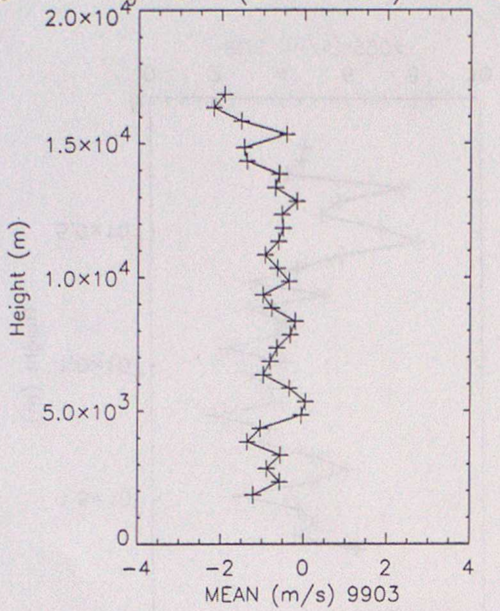


Fig. 54c (LFVWP-UM) speed

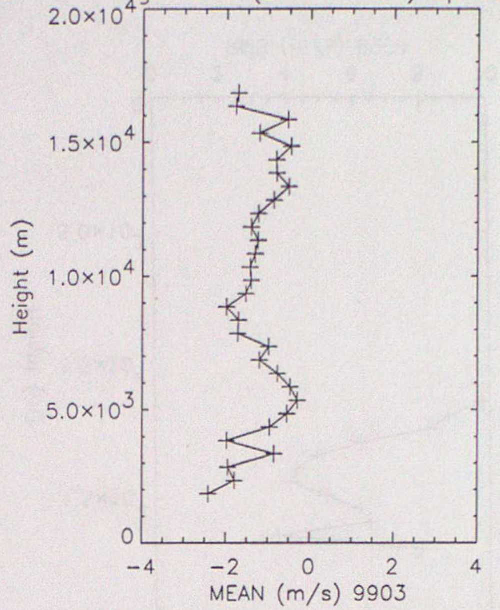


Fig. 54d (LFVWP-UM) dirn.

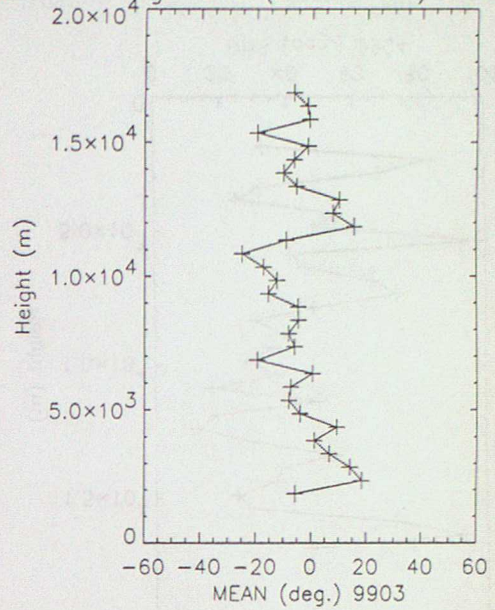


Fig. 54e (LFVWP-UM) u-wind

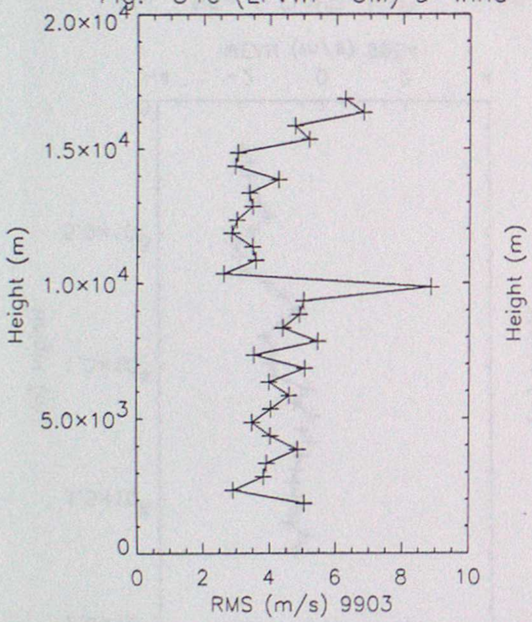


Fig. 54f (LFVWP-UM) v-wind

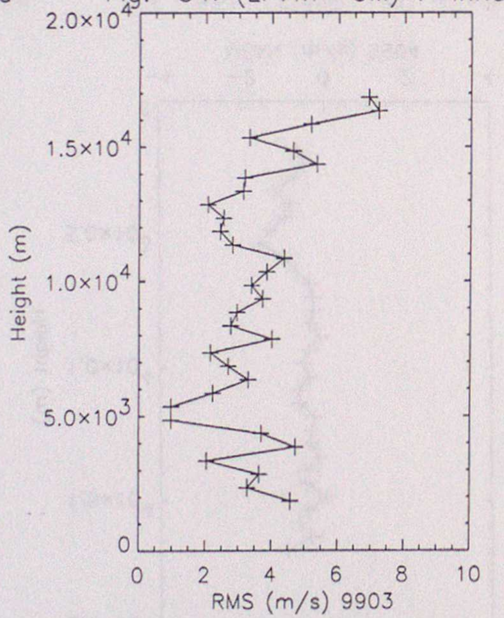


Fig. 54g (LFVWP-UM) speed

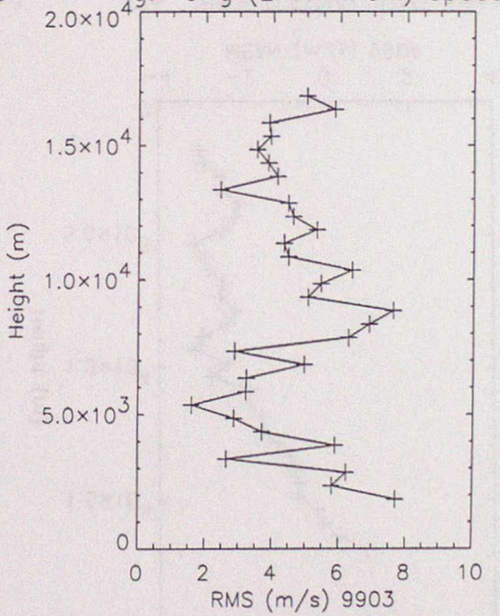


Fig. 54h (LFVWP-UM) dirn.

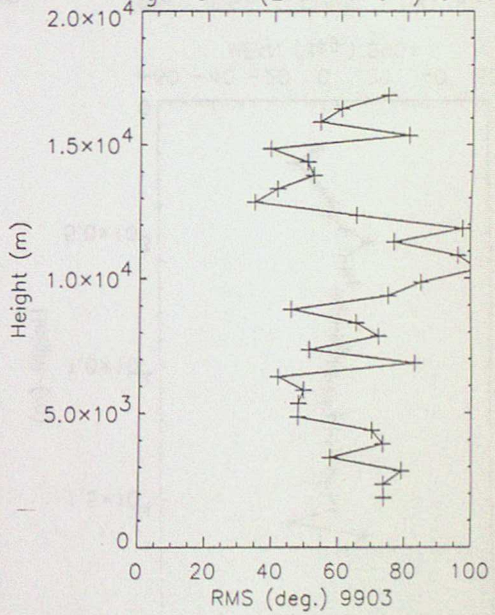


Fig. 55a (LFVWP-UM) u-wind

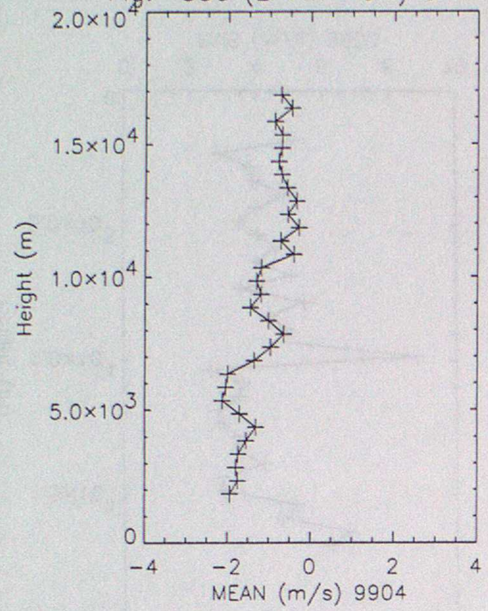


Fig. 55b (LFVWP-UM) v-wind

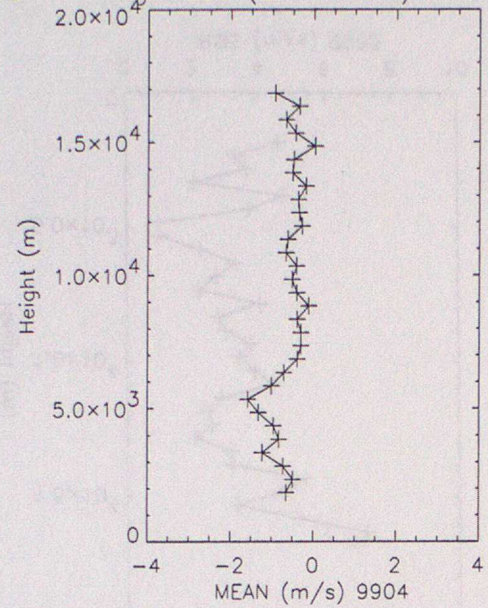


Fig. 55c (LFVWP-UM) speed

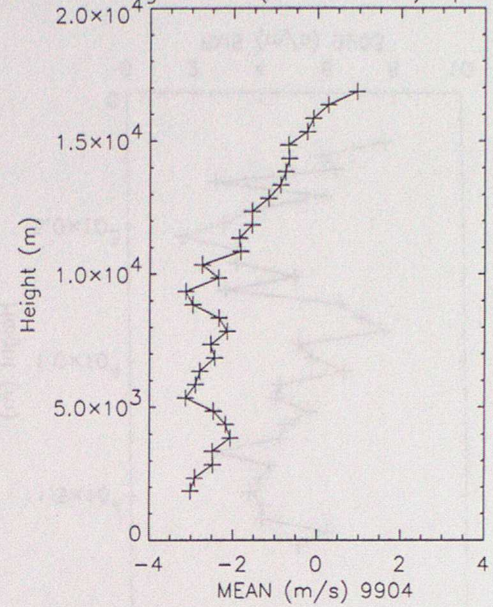


Fig. 55d (LFVWP-UM) dirn.

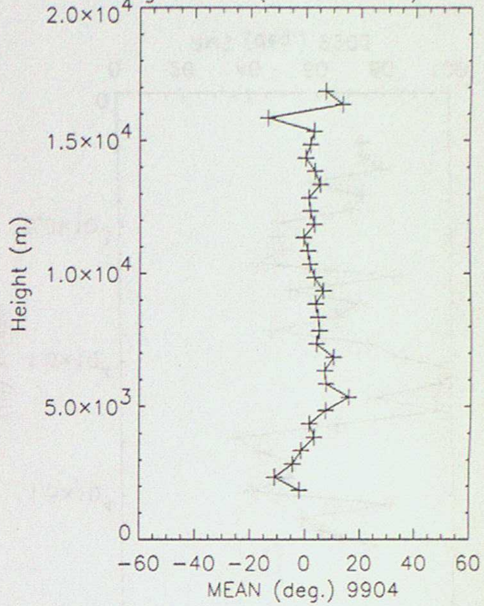


Fig. 55e (LFVWP-UM) u-wind

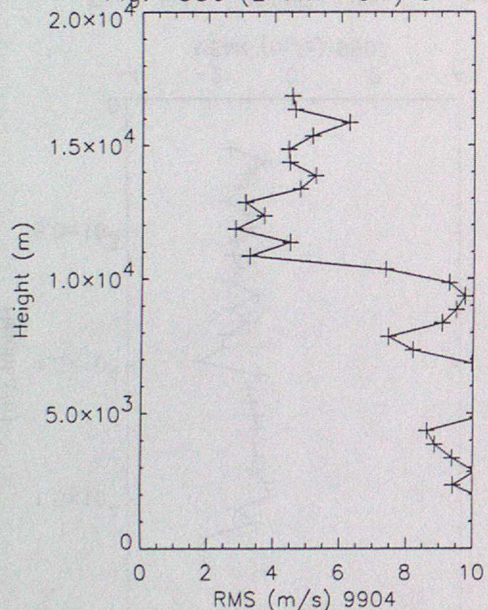


Fig. 55f (LFVWP-UM) v-wind

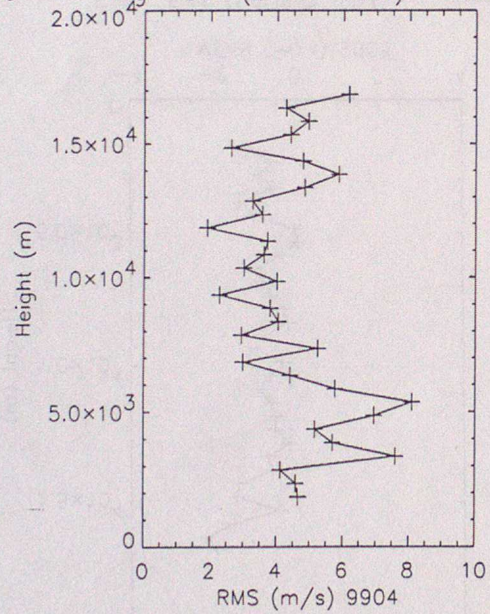


Fig. 55g (LFVWP-UM) speed

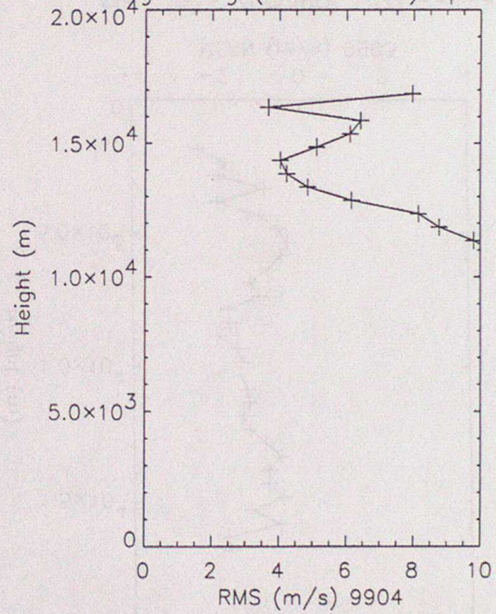


Fig. 55h (LFVWP-UM) dirn.

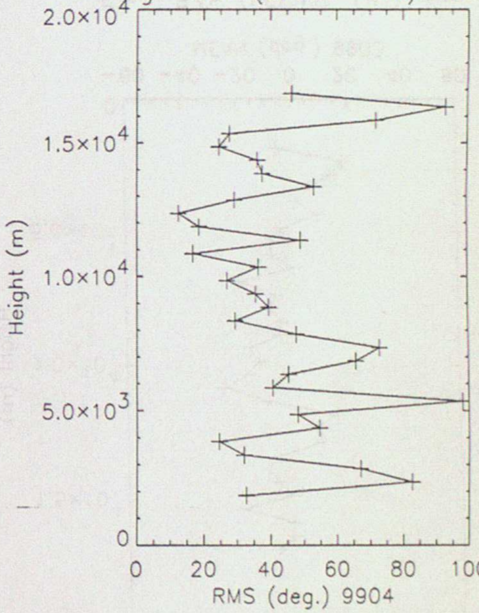


Fig. 56a (LFVWP-UM) u-wind

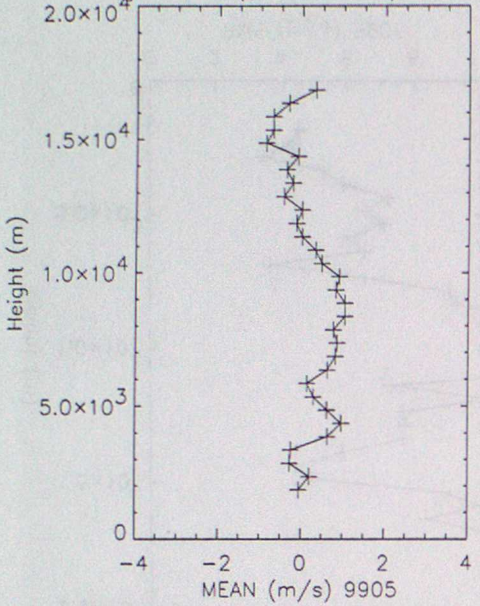


Fig. 56b (LFVWP-UM) v-wind

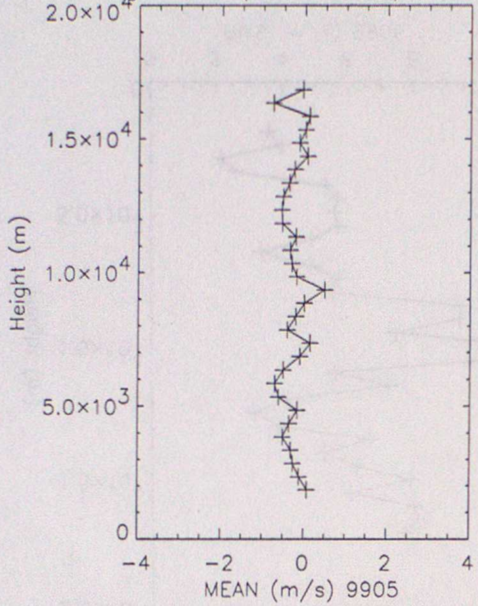


Fig. 56c (LFVWP-UM) speed

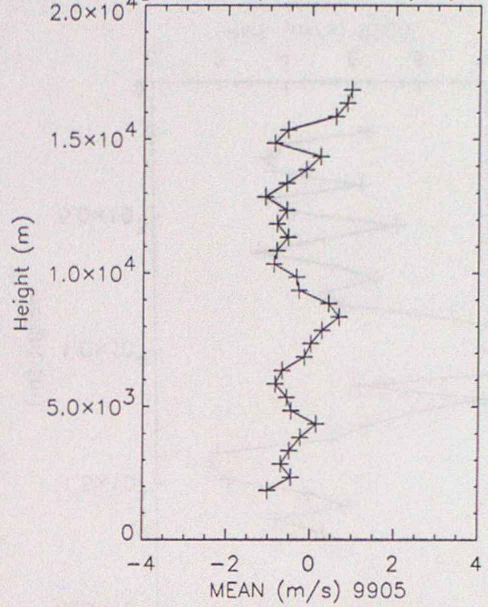


Fig. 56d (LFVWP-UM) dirn.

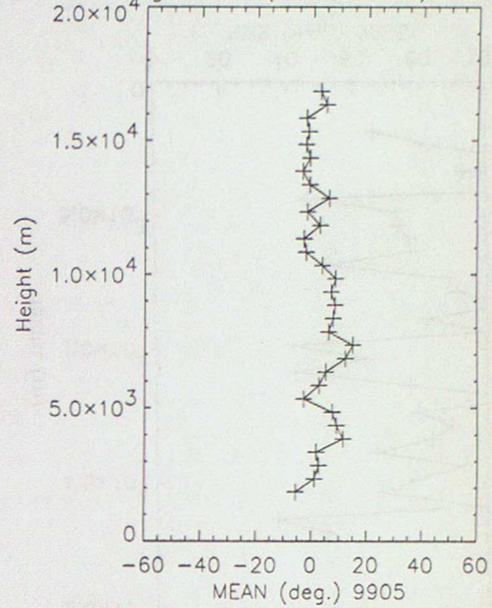


Fig. 56e (LFVWP-UM) u-wind

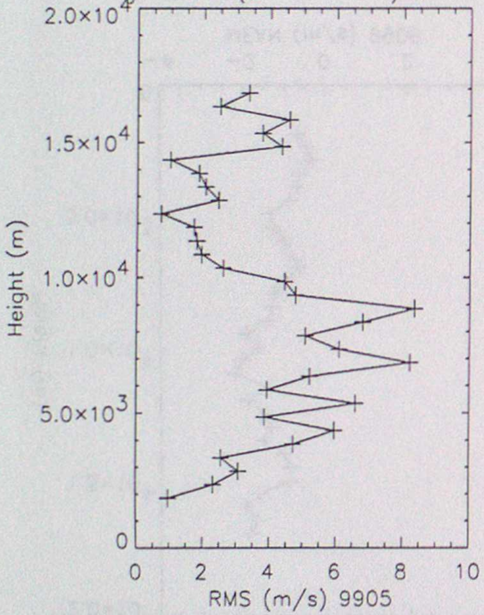


Fig. 56f (LFVWP-UM) v-wind

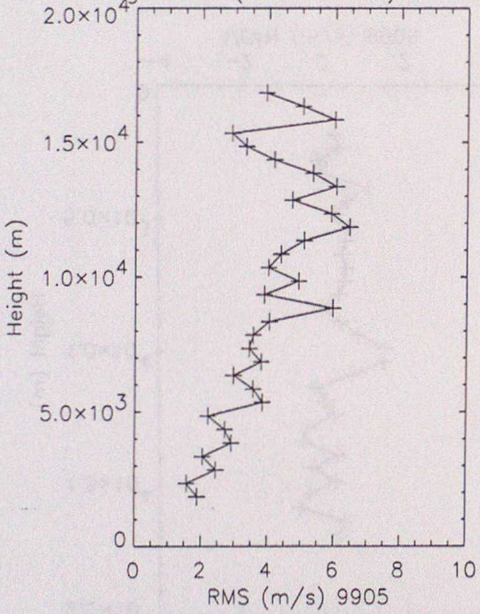


Fig. 56g (LFVWP-UM) speed

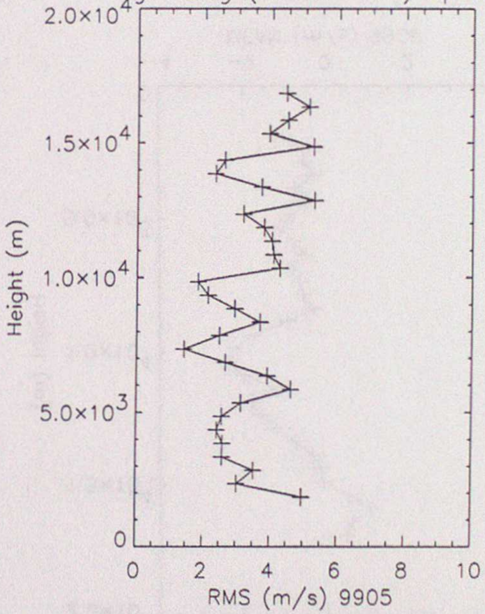


Fig. 56h (LFVWP-UM) dirn.

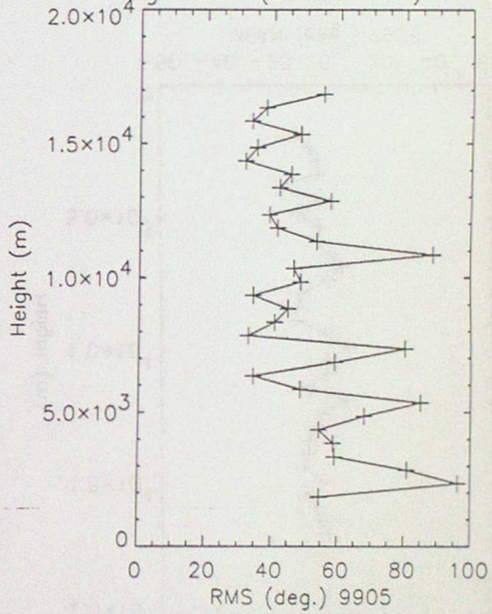


Fig. 57a (LFVWP-UM) u-wind

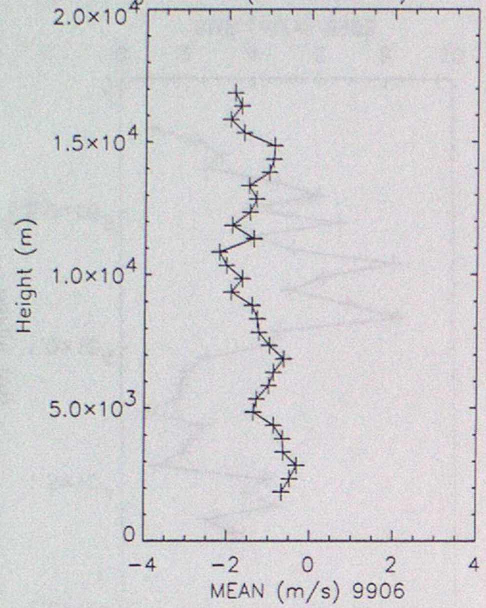


Fig. 57b (LFVWP-UM) v-wind

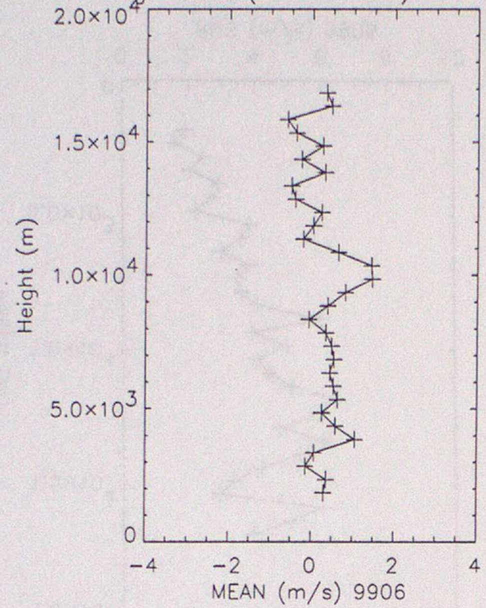


Fig. 57c (LFVWP-UM) speed

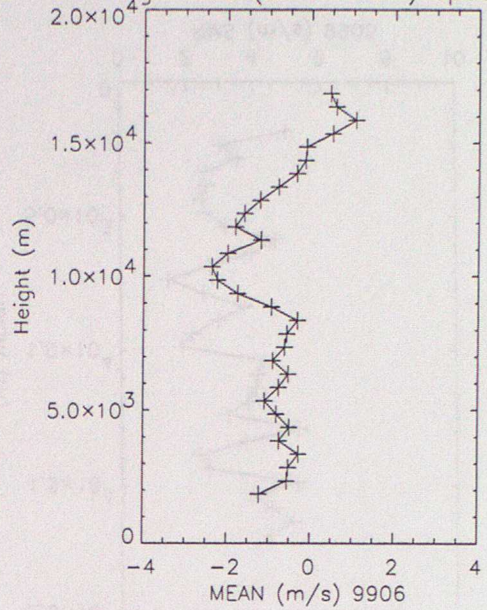


Fig. 57d (LFVWP-UM) dirn.

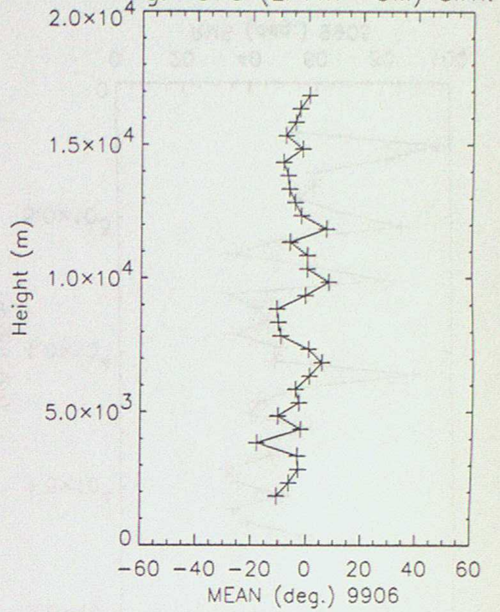


Fig. 57e (LFVWP-UM) u-wind

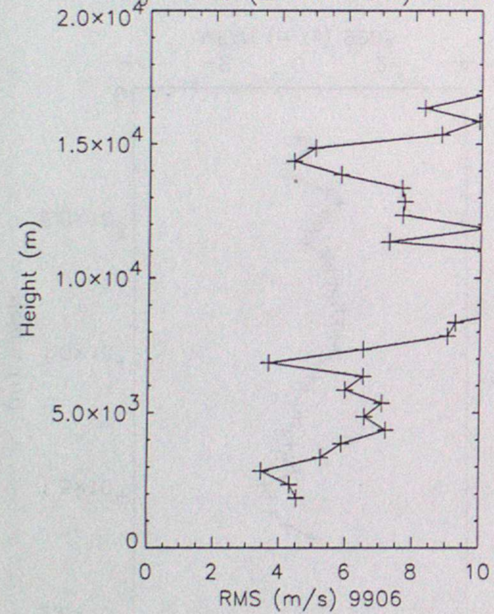


Fig. 57f (LFVWP-UM) v-wind

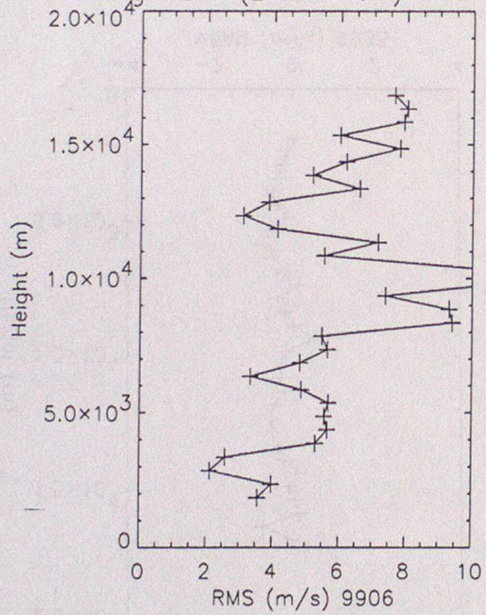


Fig. 57g (LFVWP-UM) speed

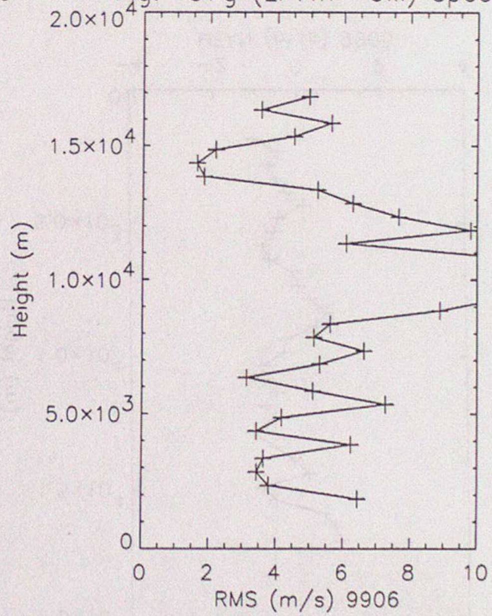
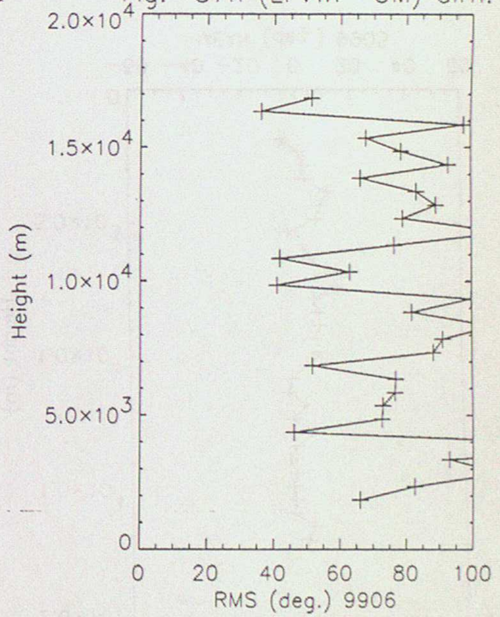


Fig. 57h (LFVWP-UM) dirn.



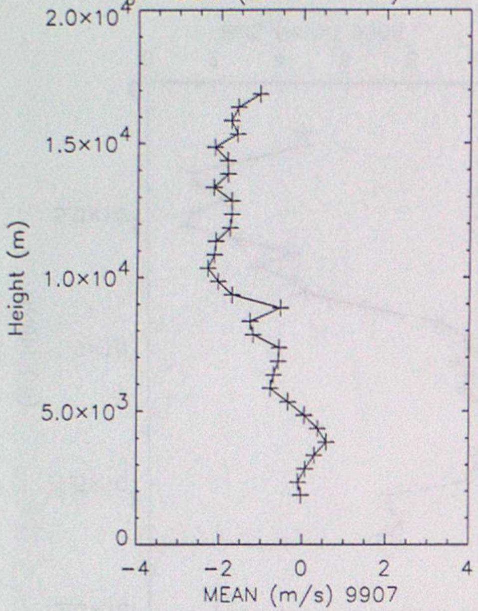


Fig. 58a (LFVWP-UM) u-wind

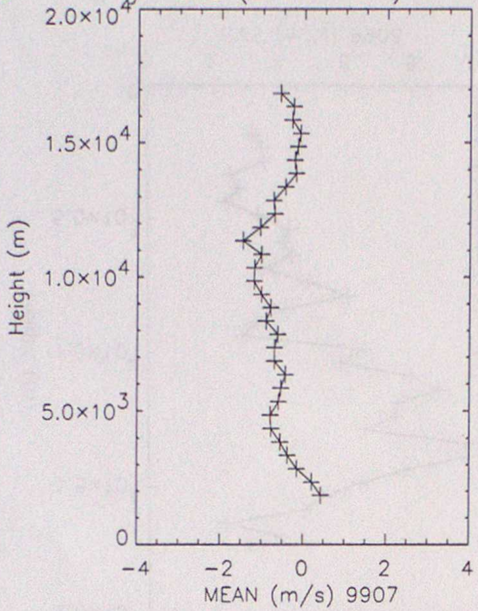


Fig. 58b (LFVWP-UM) v-wind

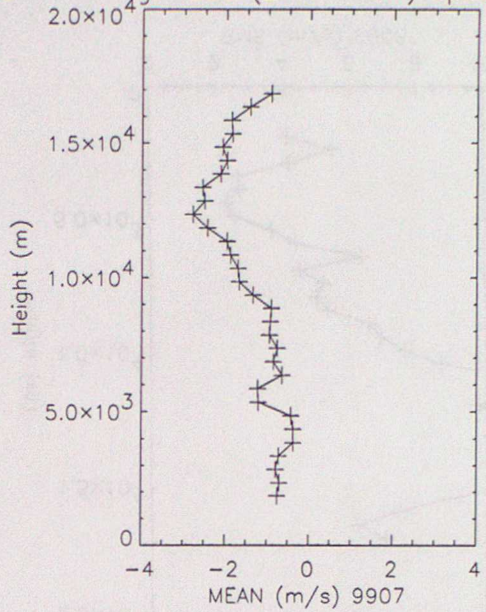


Fig. 58c (LFVWP-UM) speed

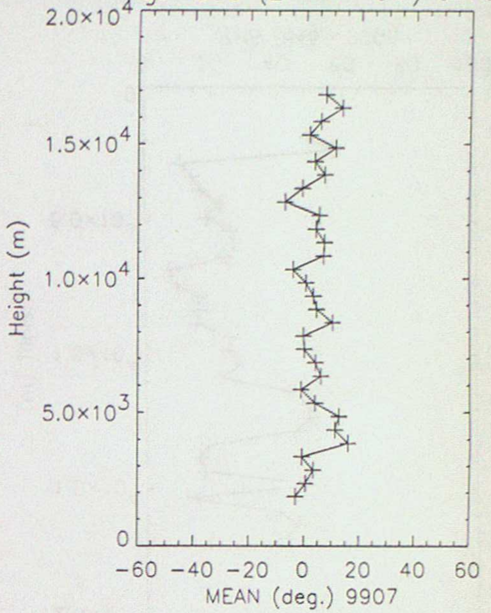


Fig. 58d (LFVWP-UM) dirn.

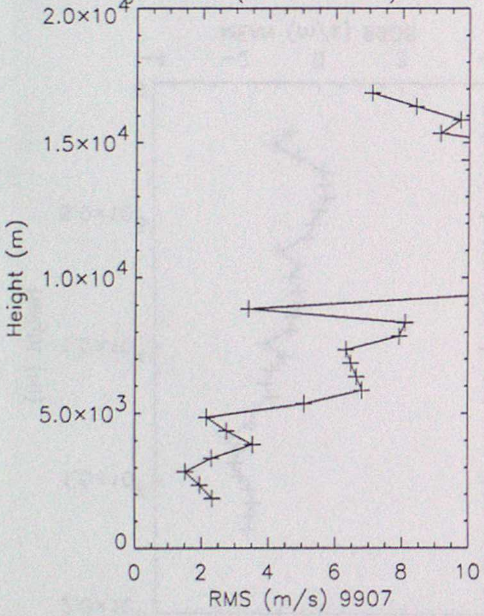


Fig. 58e (LFVWP-UM) u-wind

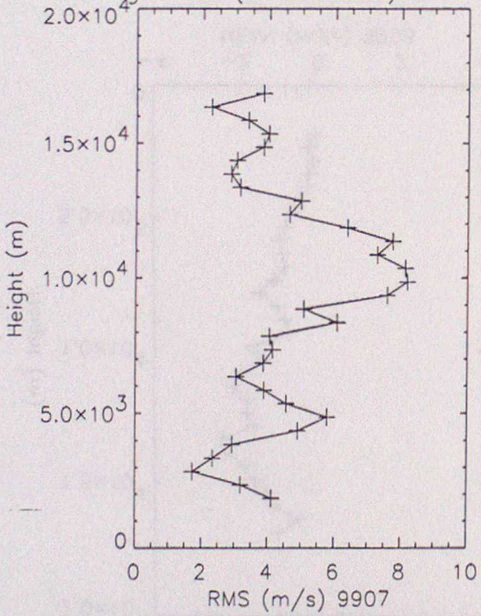


Fig. 58f (LFVWP-UM) v-wind

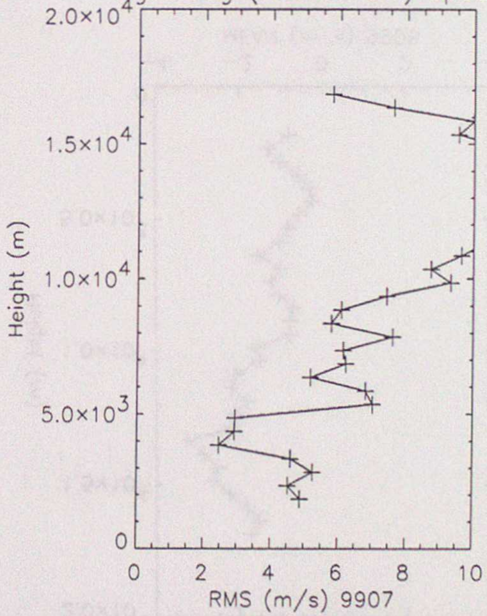


Fig. 58g (LFVWP-UM) speed

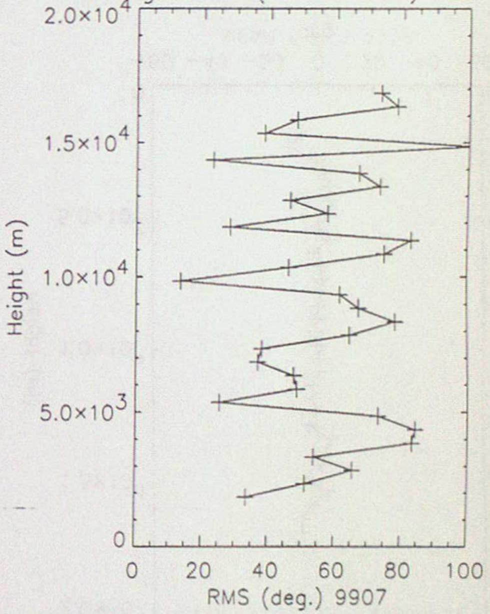


Fig. 58h (LFVWP-UM) dirn.

Fig. 59a (LFVWP-UM) u-wind

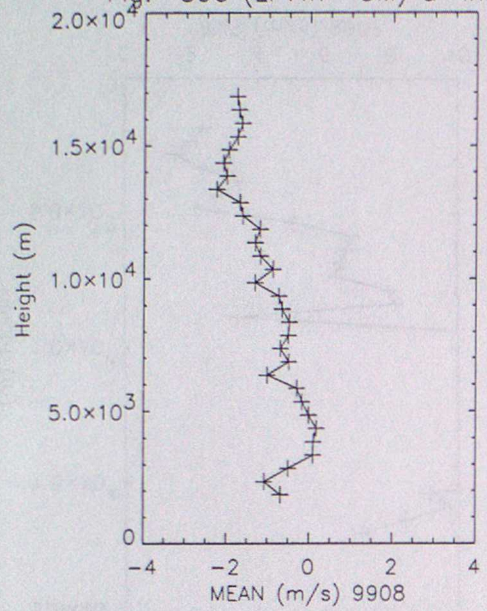


Fig. 59b (LFVWP-UM) v-wind

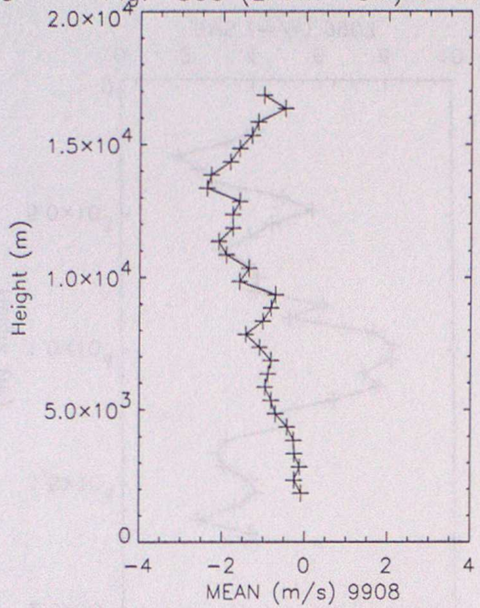


Fig. 59c (LFVWP-UM) speed

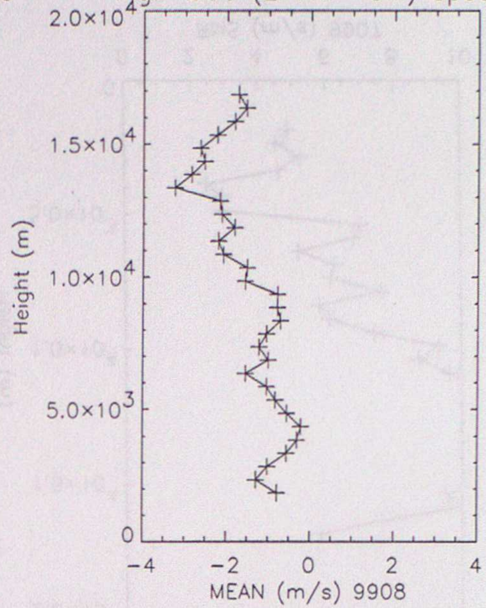


Fig. 59d (LFVWP-UM) dirn.

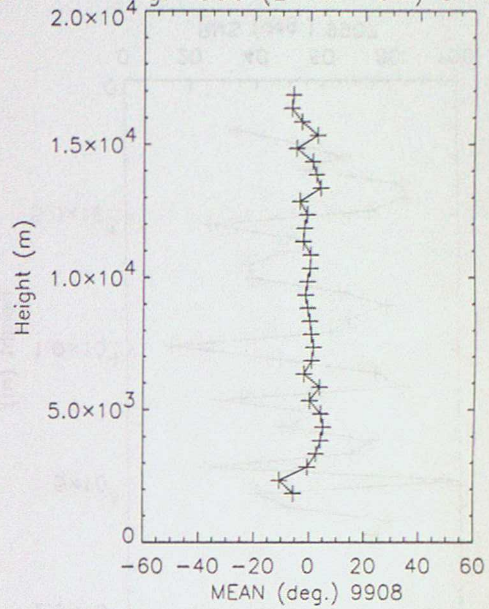


Fig. 59e (LFVWP-UM) u-wind

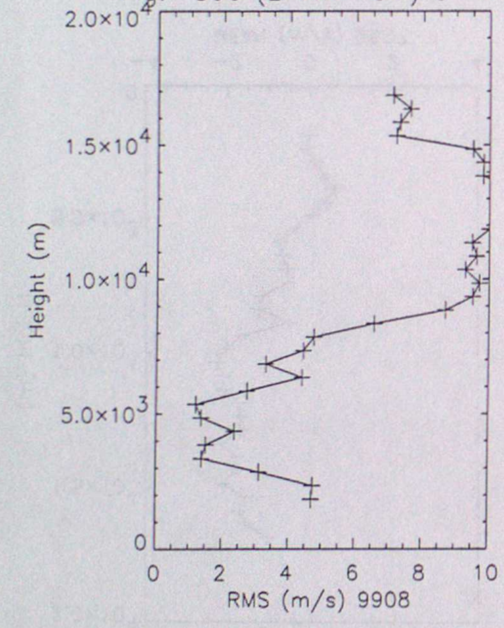


Fig. 59f (LFVWP-UM) v-wind

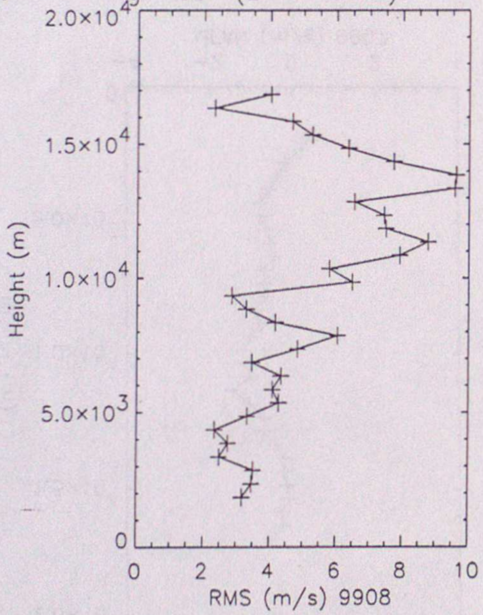


Fig. 59g (LFVWP-UM) speed

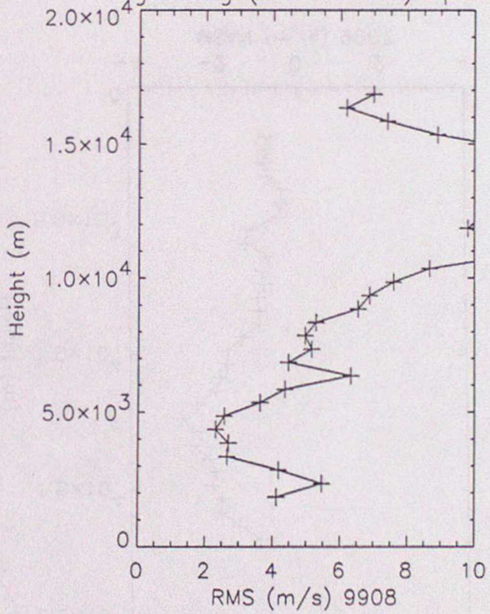
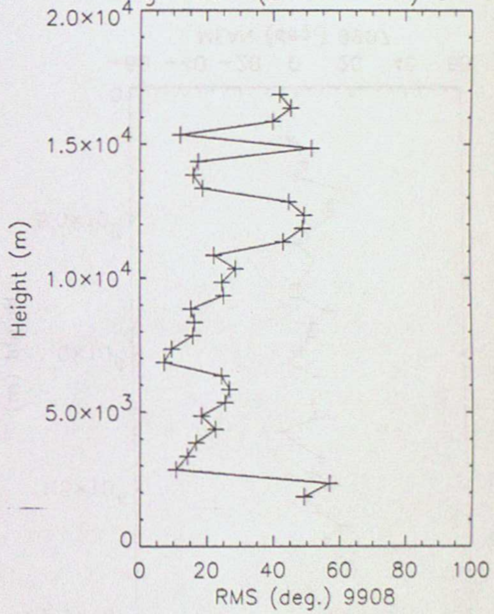


Fig. 59h (LFVWP-UM) dirn.



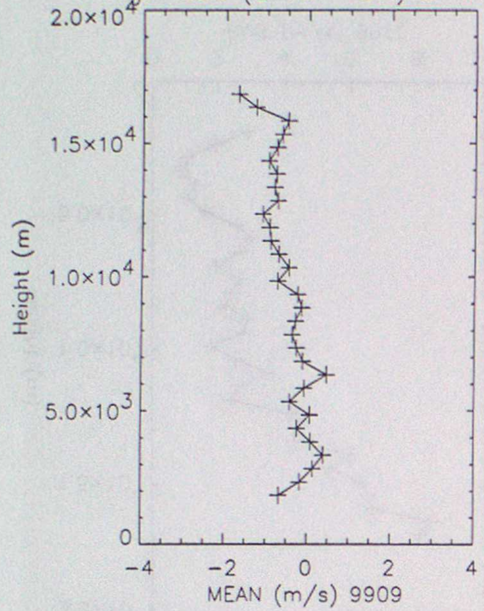


Fig. 60a (LFVWP-UM) u-wind

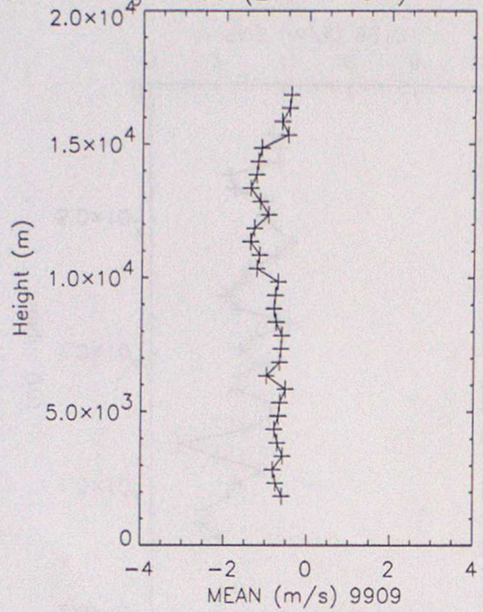


Fig. 60b (LFVWP-UM) v-wind

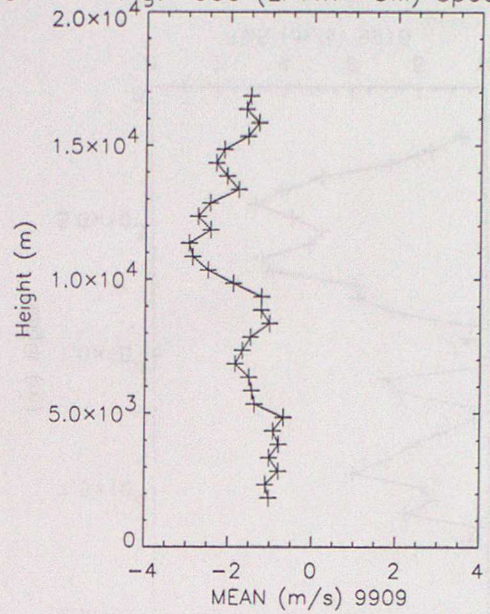


Fig. 60c (LFVWP-UM) speed

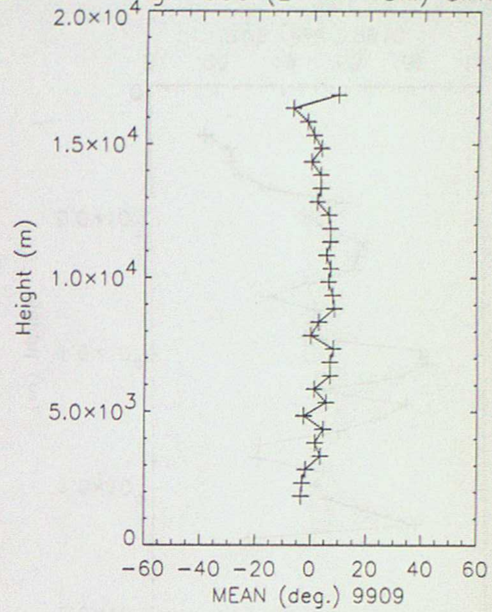


Fig. 60d (LFVWP-UM) dirn.

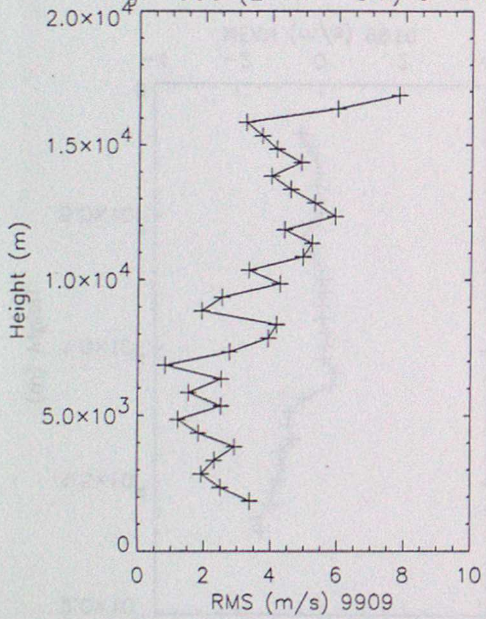


Fig. 60e (LFVWP-UM) u-wind

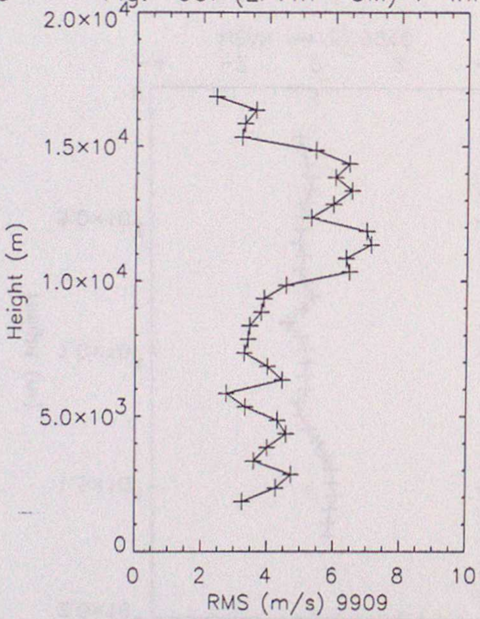


Fig. 60f (LFVWP-UM) v-wind

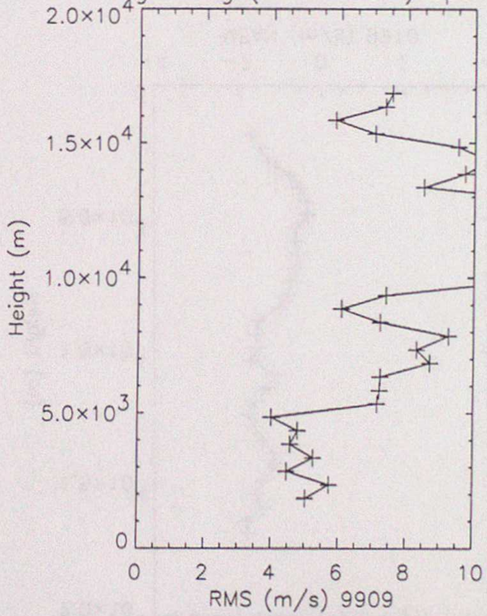


Fig. 60g (LFVWP-UM) speed

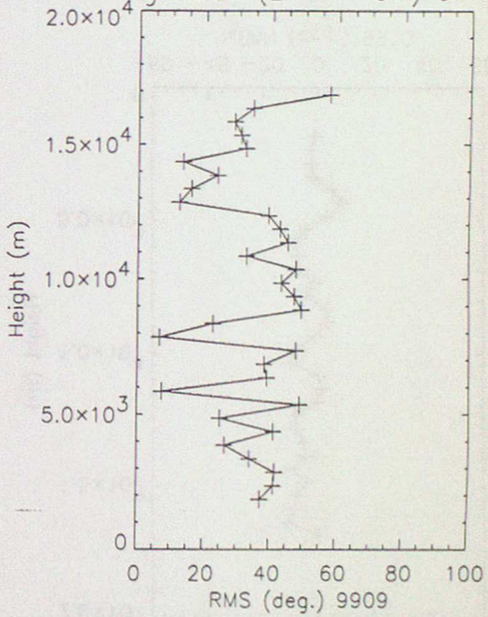


Fig. 60h (LFVWP-UM) dirn.

Fig. 61a (LFVWP-UM) u-wind

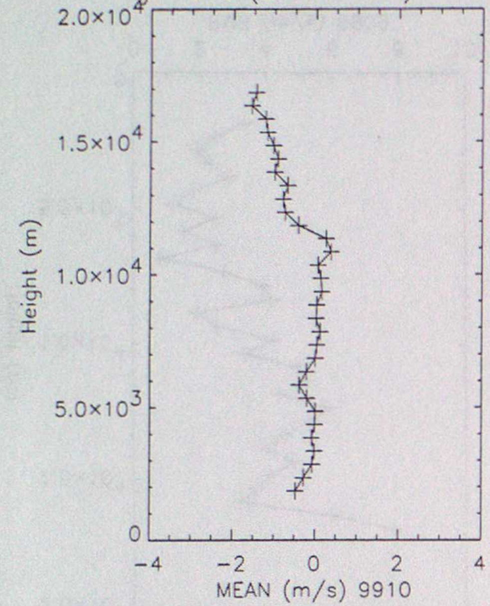


Fig. 61b (LFVWP-UM) v-wind

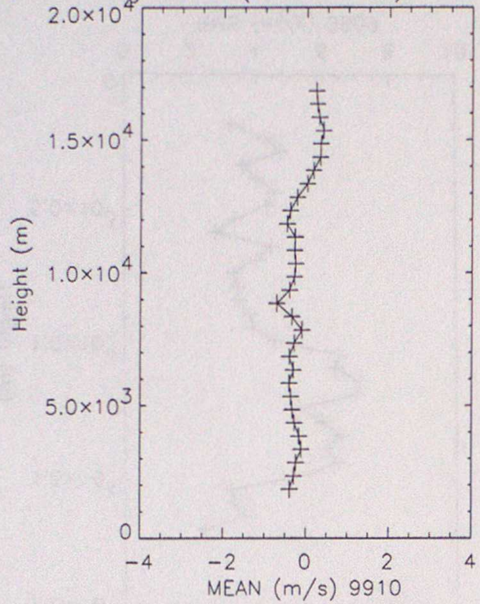


Fig. 61c (LFVWP-UM) speed

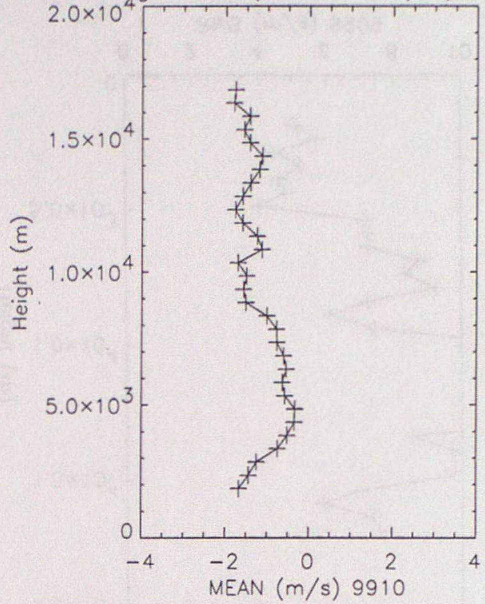


Fig. 61d (LFVWP-UM) dirn.

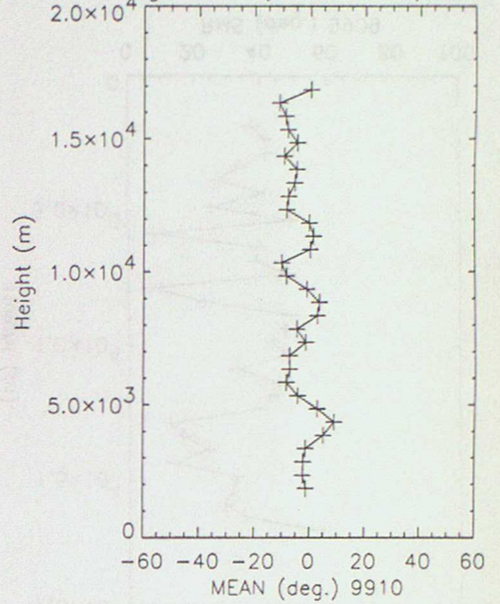


Fig. 61e (LFVWP-UM) u-wind

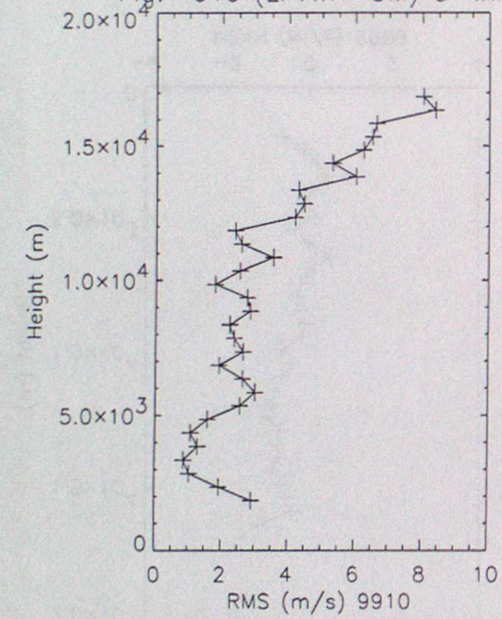


Fig. 61f (LFVWP-UM) v-wind

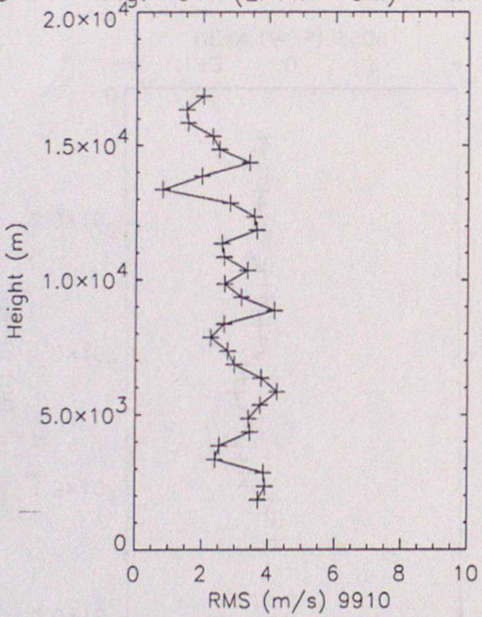


Fig. 61g (LFVWP-UM) speed

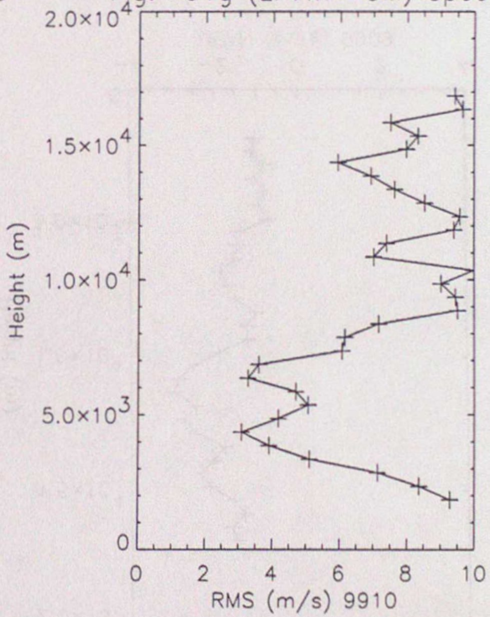


Fig. 61h (LFVWP-UM) dirn.

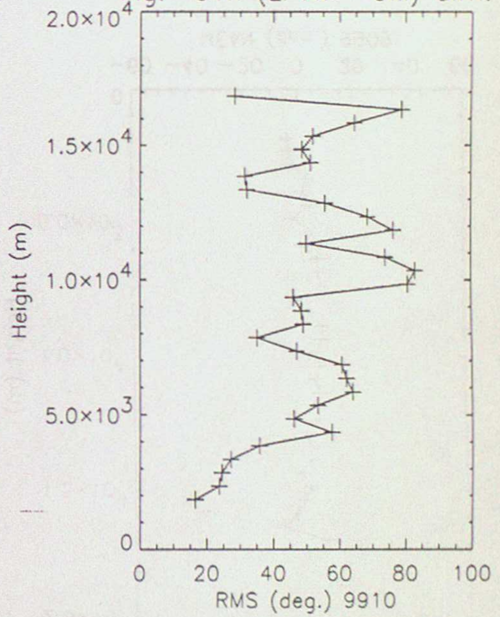


Fig. 62a (LFVWP-UM) u-wind

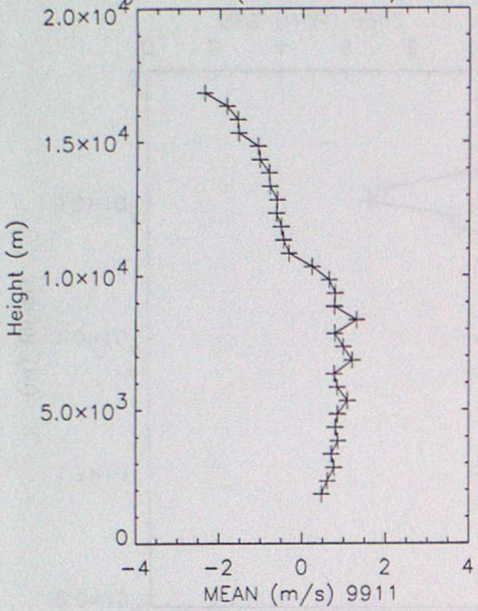


Fig. 62b (LFVWP-UM) v-wind

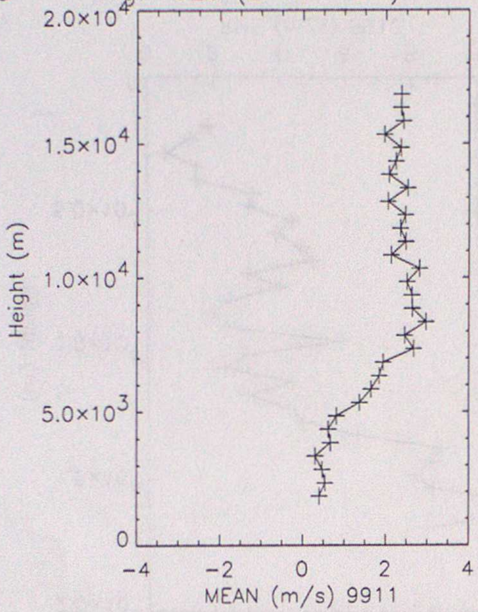


Fig. 62c (LFVWP-UM) speed

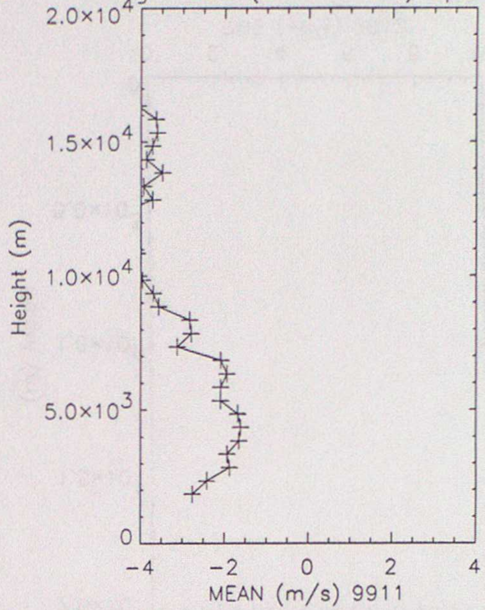


Fig. 62d (LFVWP-UM) dirn.

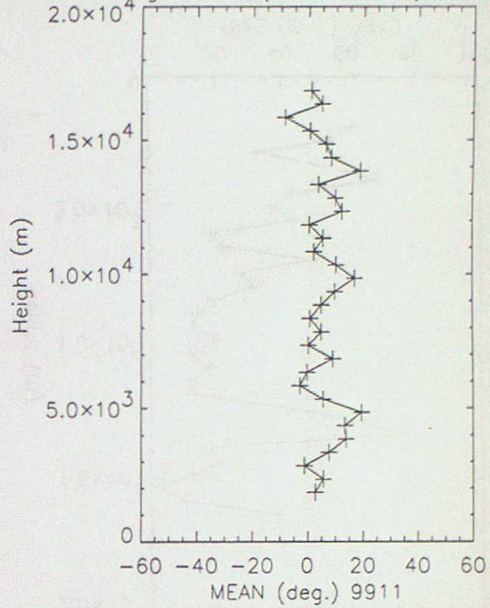


Fig. 62e (LFVWP-UM) u-wind

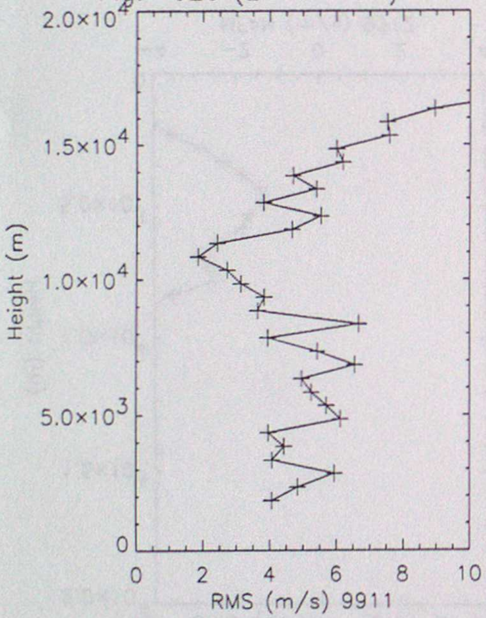


Fig. 62f (LFVWP-UM) v-wind

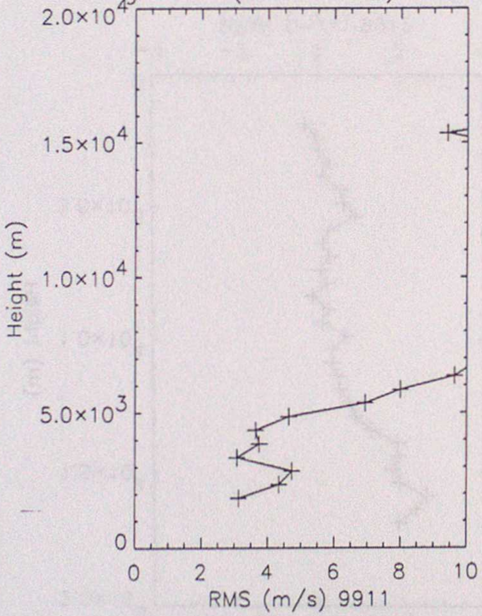


Fig. 62g (LFVWP-UM) speed

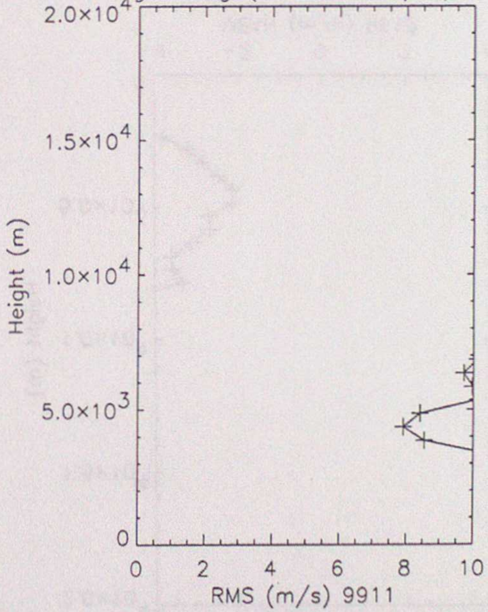
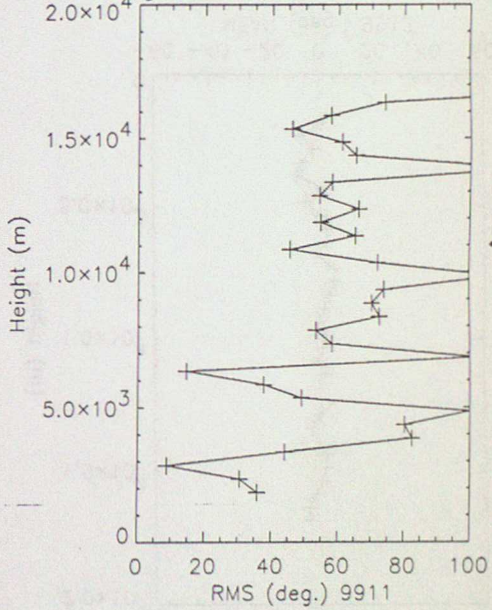


Fig. 62h (LFVWP-UM) dirn.



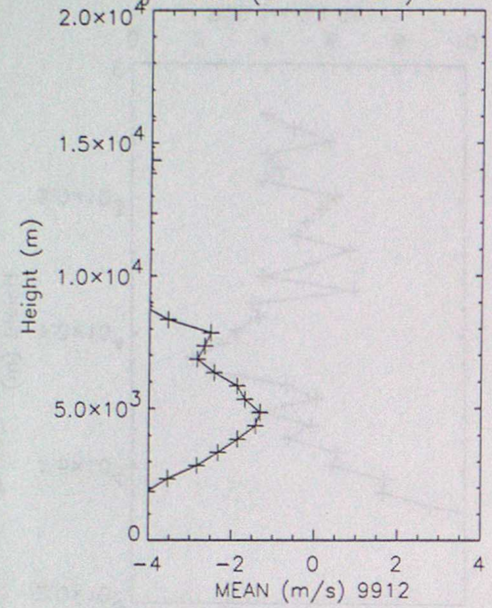


Fig. 63a (LFVWP–UM) u–wind

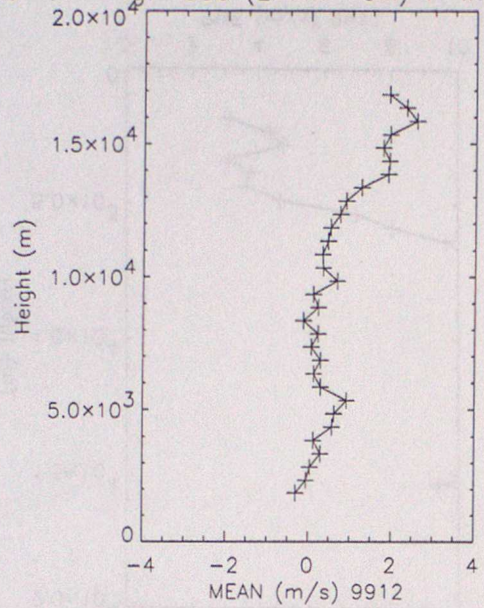


Fig. 63b (LFVWP–UM) v–wind

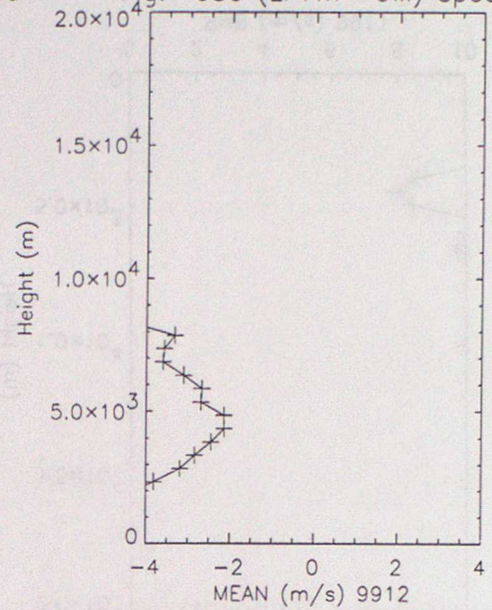


Fig. 63c (LFVWP–UM) speed

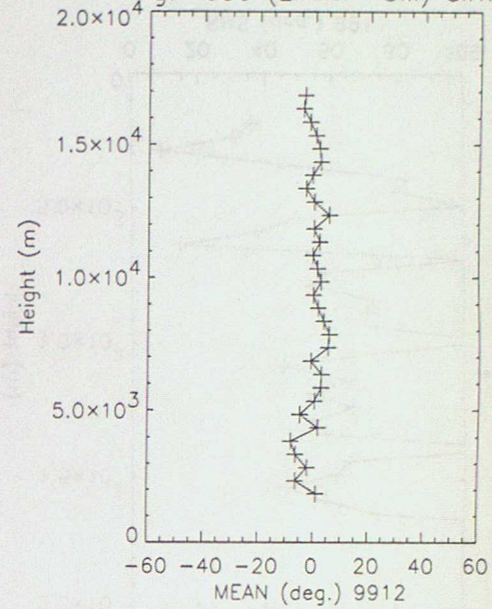


Fig. 63d (LFVWP–UM) dirn.

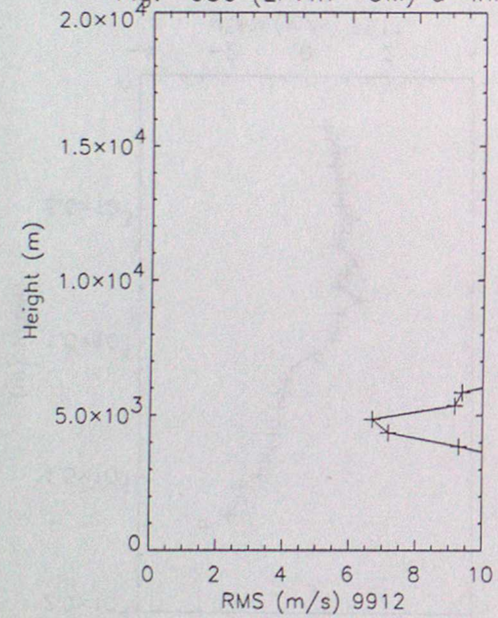


Fig. 63e (LFVWP–UM) u–wind

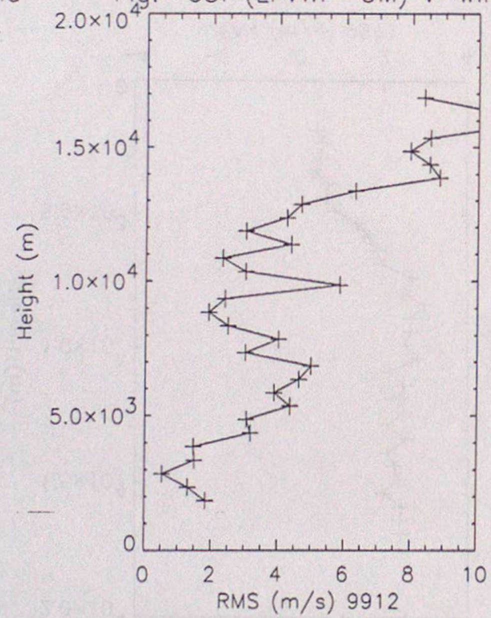


Fig. 63f (LFVWP–UM) v–wind

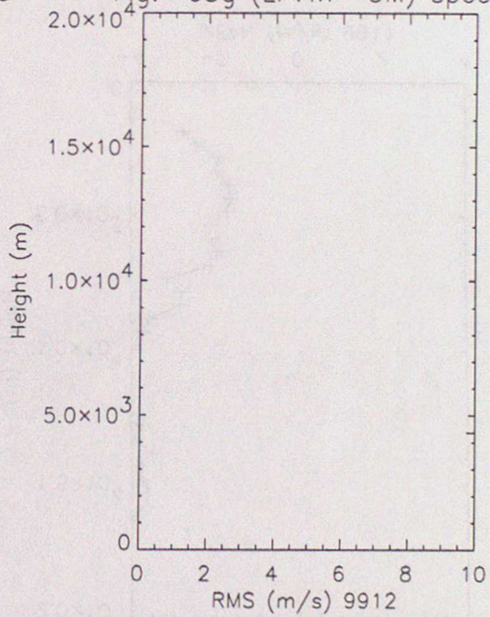


Fig. 63g (LFVWP–UM) speed

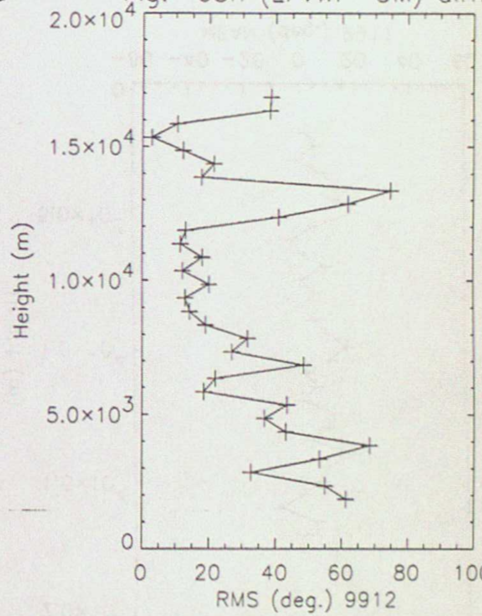


Fig. 63h (LFVWP–UM) dirn.

Fig. 64a (LFVWP-UM) u-wind

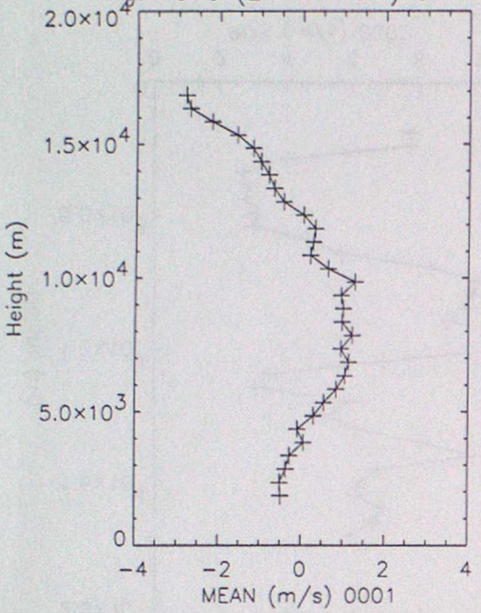


Fig. 64b (LFVWP-UM) v-wind

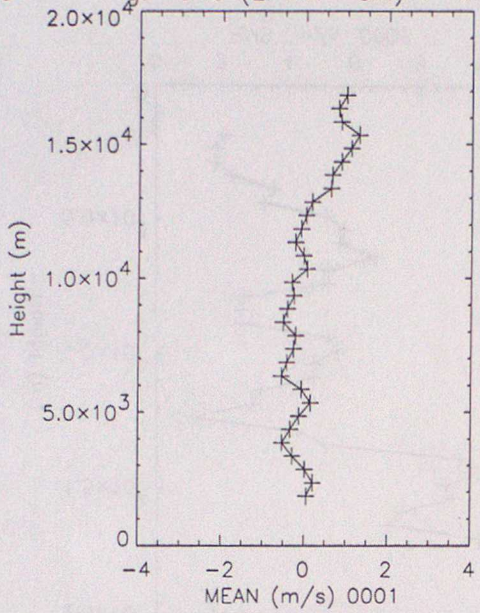


Fig. 64c (LFVWP-UM) speed

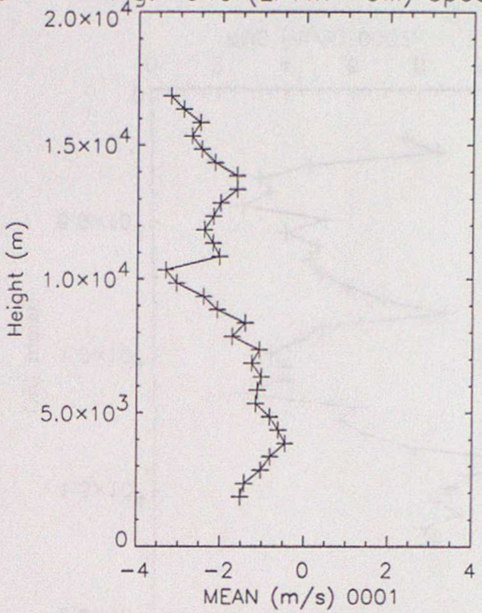


Fig. 64d (LFVWP-UM) dirn.

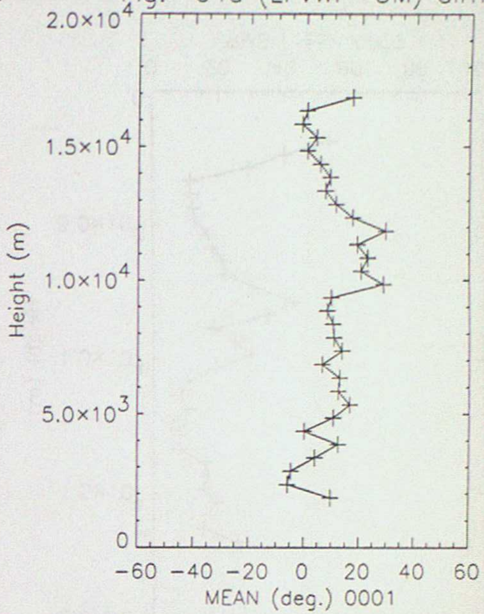


Fig. 64e (LFVWP-UM) u-wind

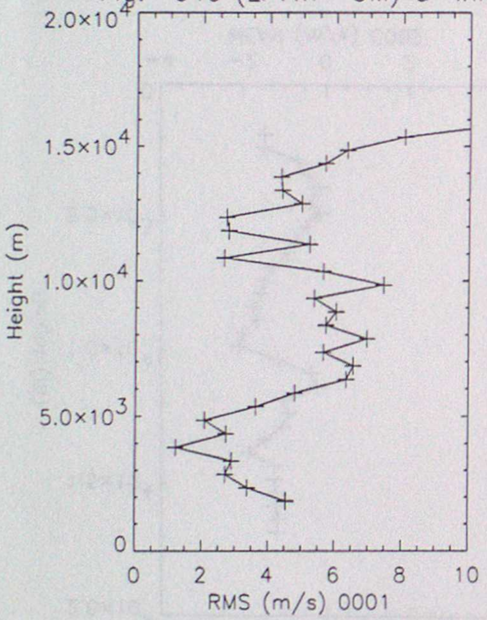


Fig. 64f (LFVWP-UM) v-wind

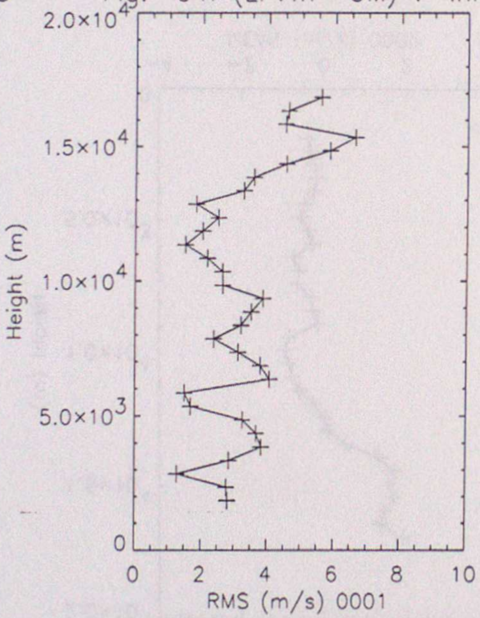


Fig. 64g (LFVWP-UM) speed

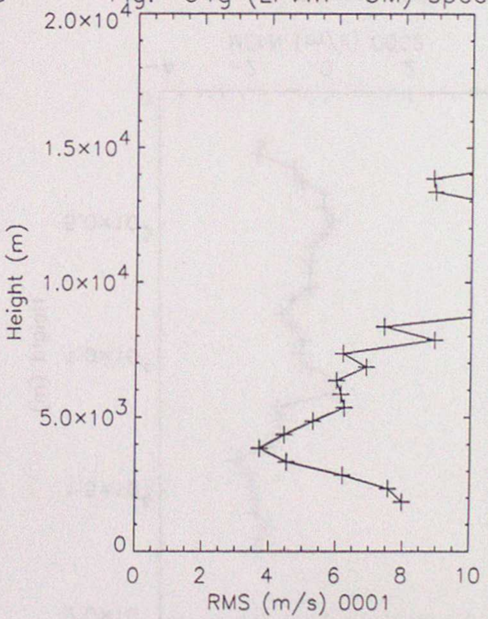
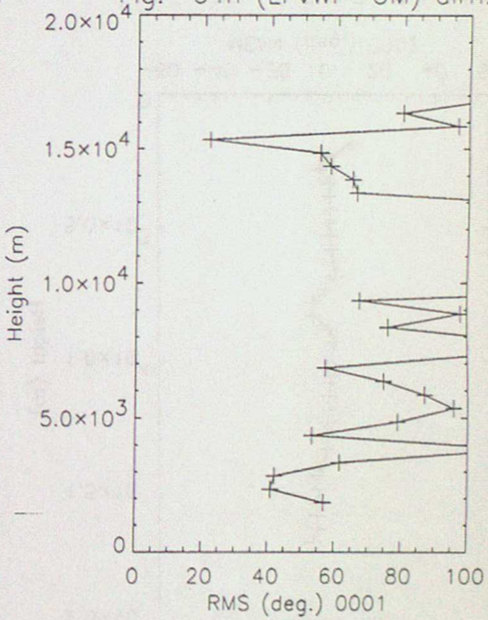


Fig. 64h (LFVWP-UM) dirn.



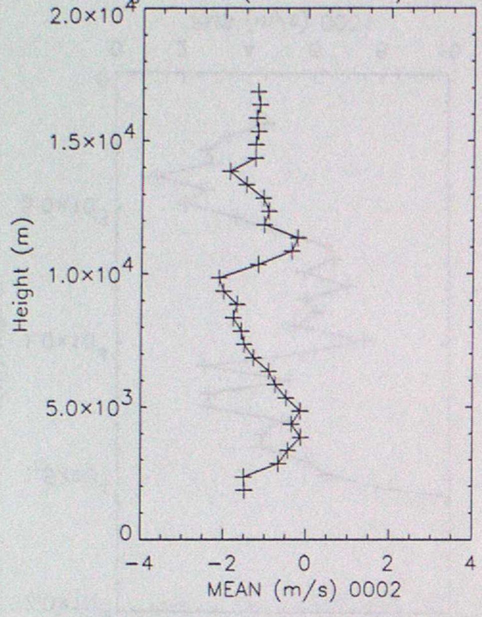


Fig. 65a (LFVWP-UM) u-wind

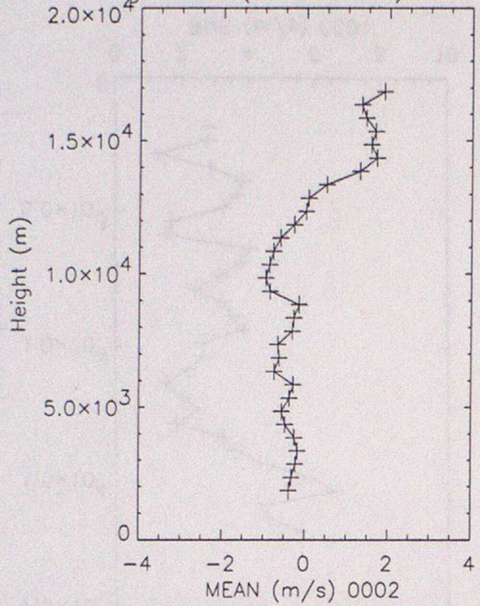


Fig. 65b (LFVWP-UM) v-wind

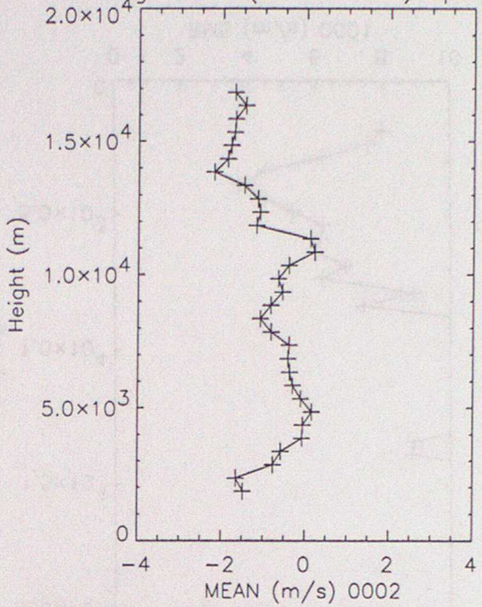


Fig. 65c (LFVWP-UM) speed

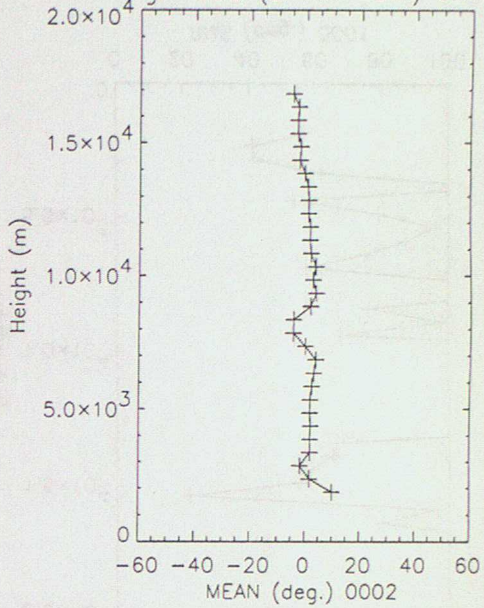


Fig. 65d (LFVWP-UM) dirn.

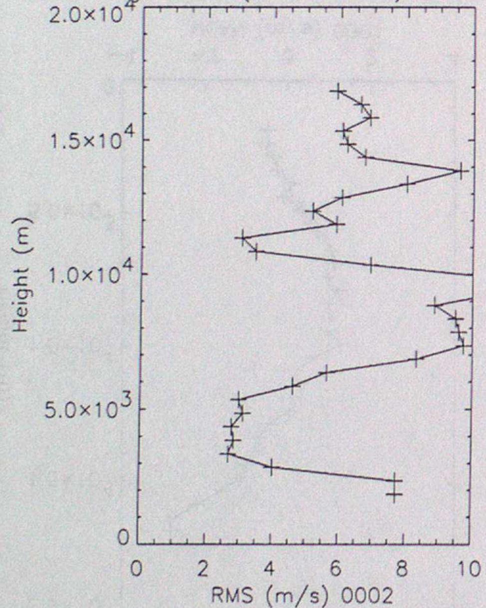


Fig. 65e (LFVWP-UM) u-wind

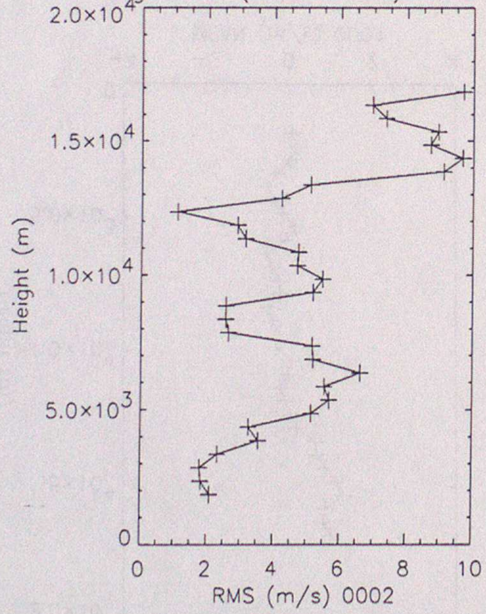


Fig. 65f (LFVWP-UM) v-wind

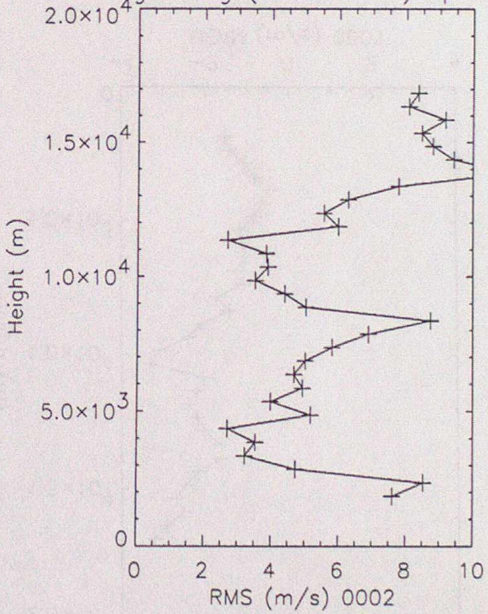


Fig. 65g (LFVWP-UM) speed

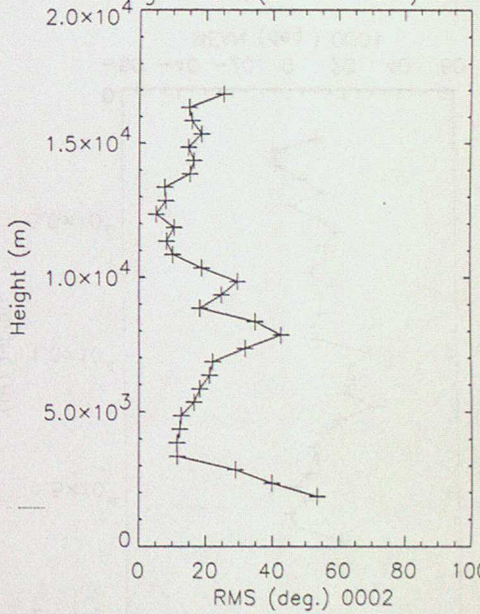


Fig. 65h (LFVWP-UM) dirn.

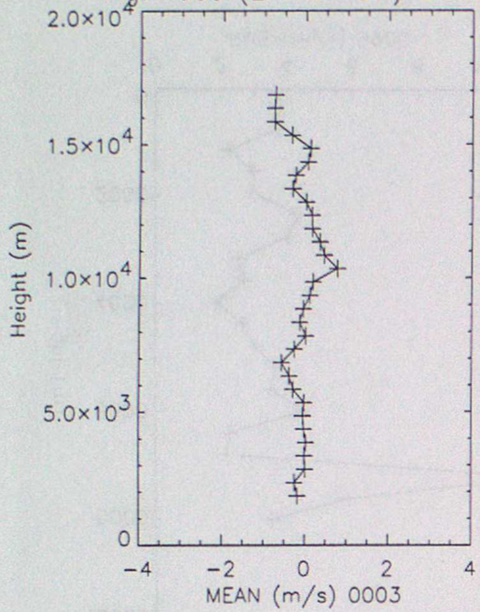


Fig. 66a (LFVWP-UM) u-wind

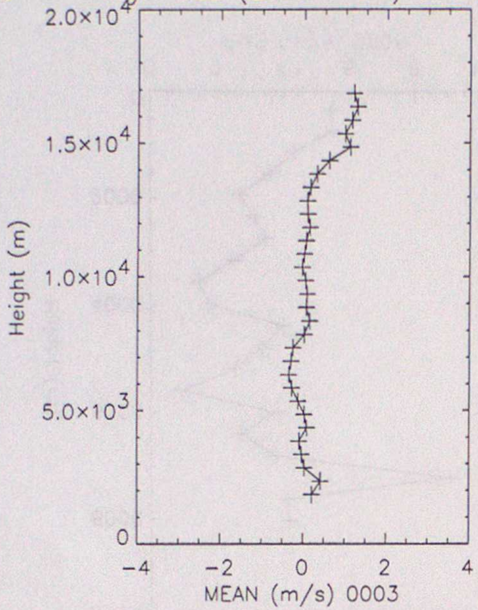


Fig. 66b (LFVWP-UM) v-wind

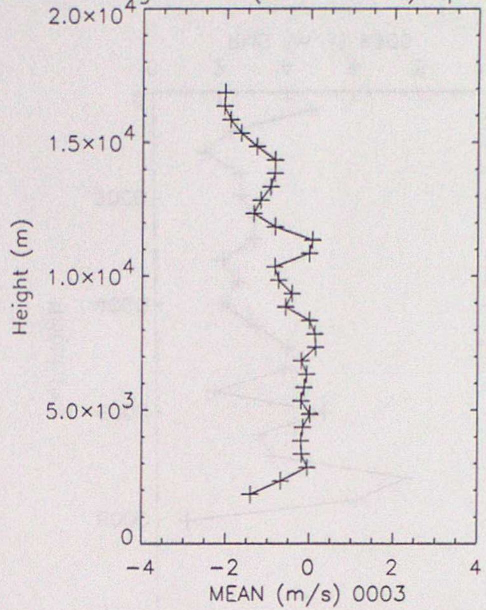


Fig. 66c (LFVWP-UM) speed

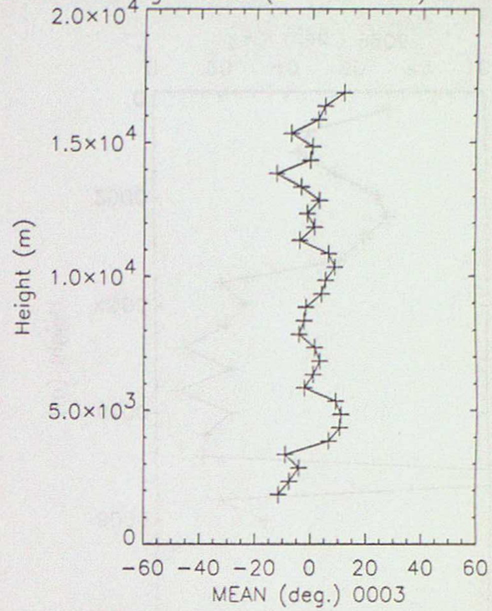


Fig. 66d (LFVWP-UM) dirn.

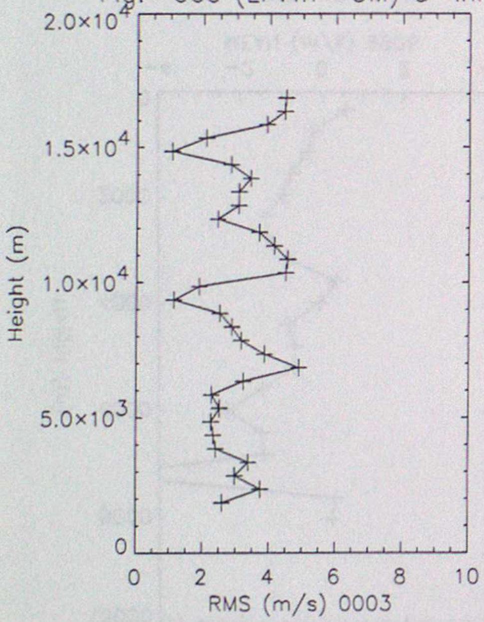


Fig. 66e (LFVWP-UM) u-wind

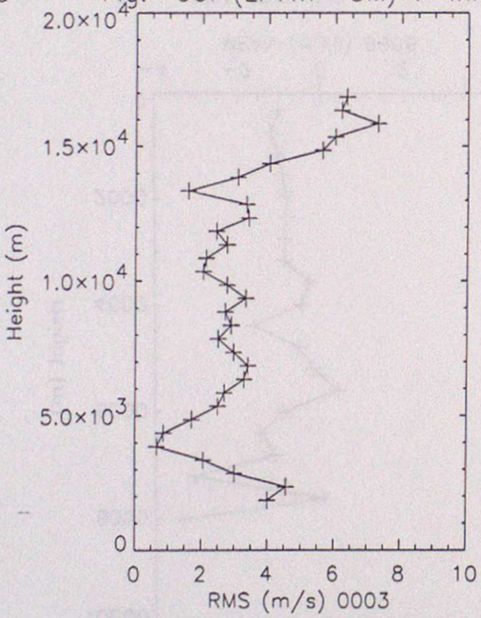


Fig. 66f (LFVWP-UM) v-wind

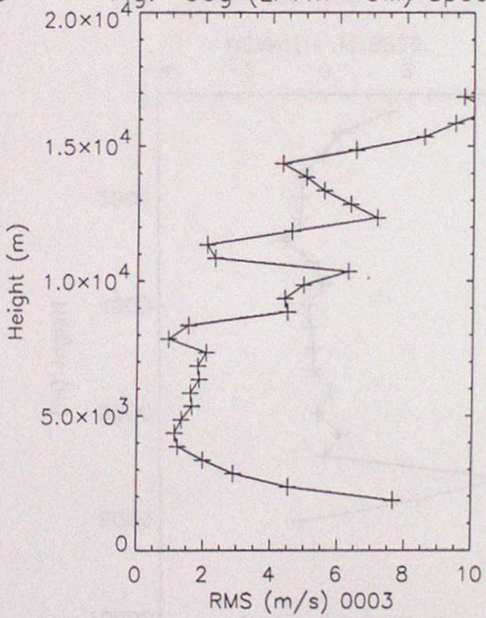


Fig. 66g (LFVWP-UM) speed

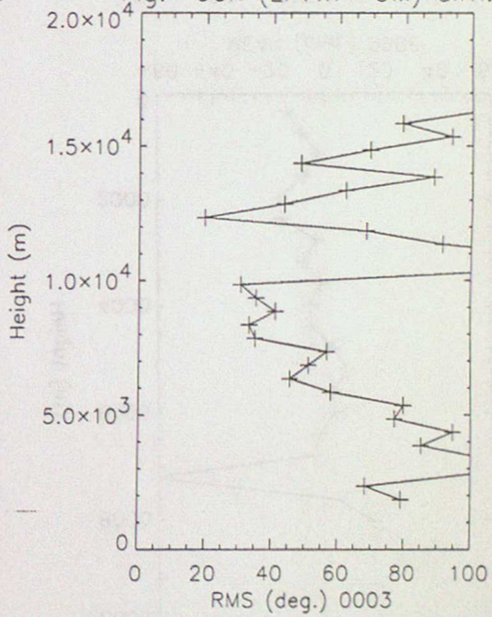


Fig. 66h (LFVWP-UM) dirn.

Fig. 67a (PENWP-UM) u-wind

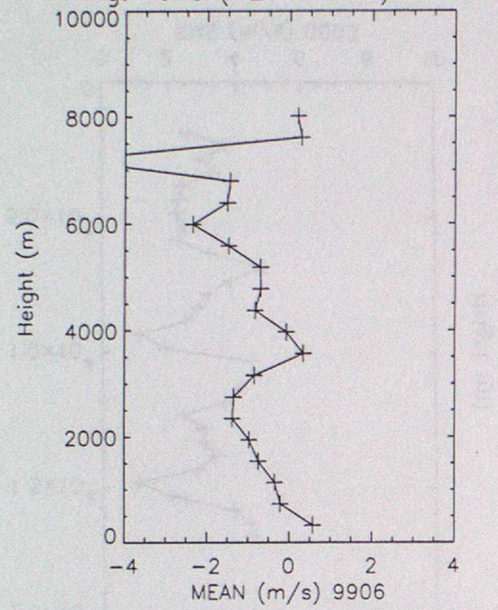


Fig. 67b (PENWP-UM) v-wind

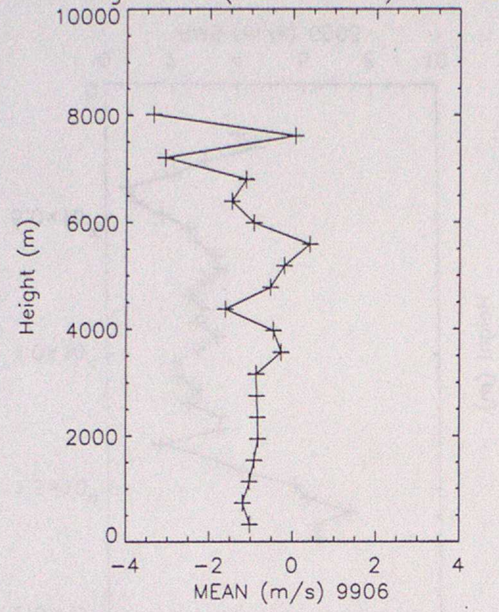


Fig. 67c (PENWP-UM) speed

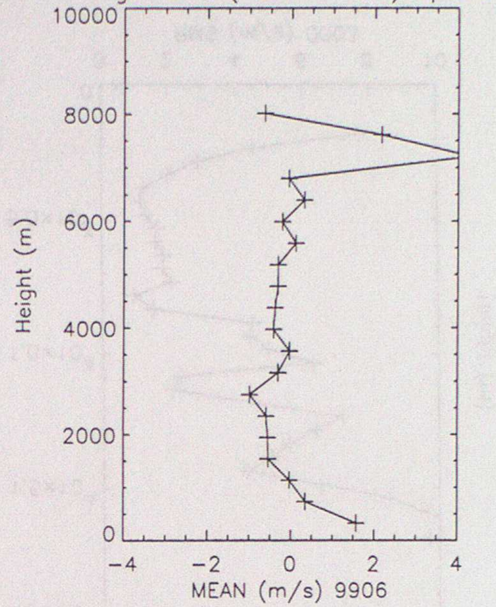


Fig. 67d (PENWP-UM) dirn.

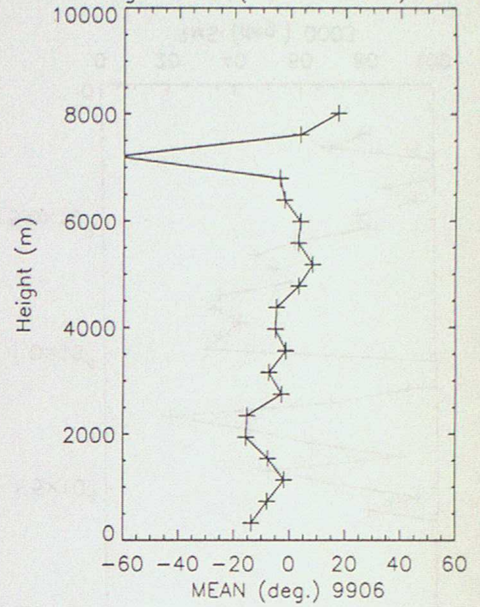


Fig. 67e (PENWP-UM) u-wind

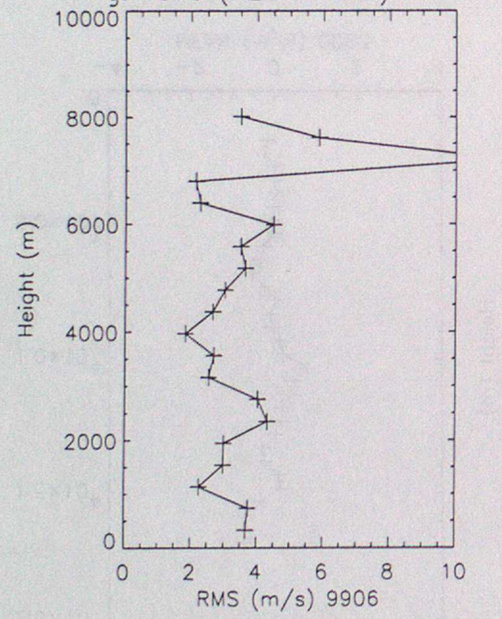


Fig. 67f (PENWP-UM) v-wind

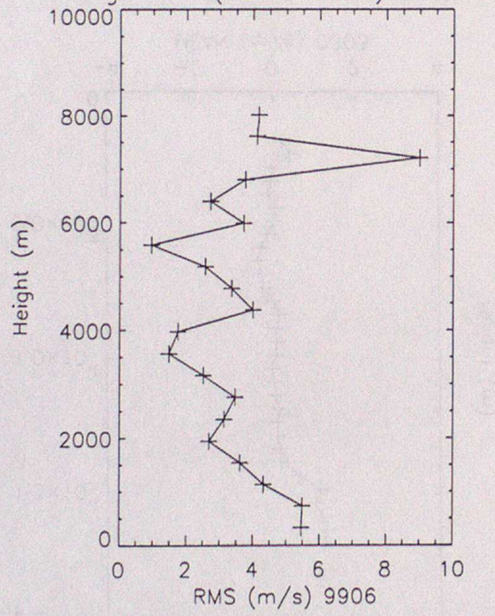


Fig. 67g (PENWP-UM) speed

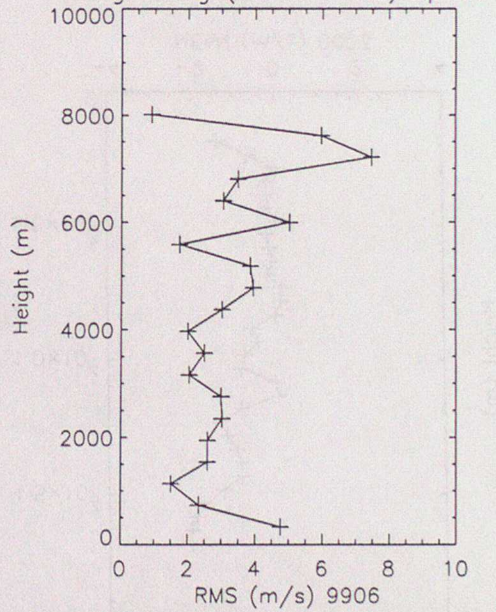


Fig. 67h (PENWP-UM) dirn.

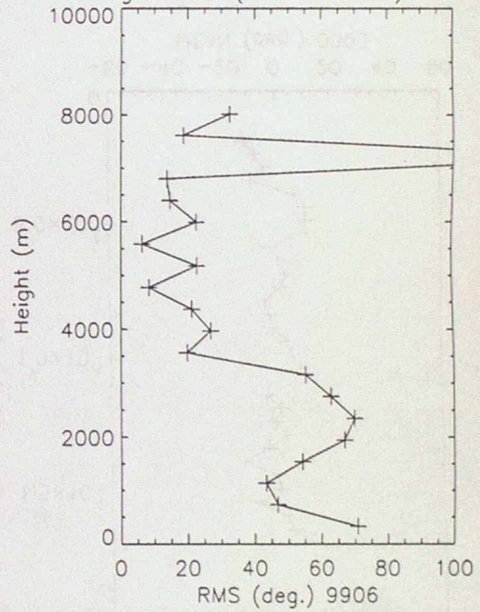


Fig. 68a (PENWP-UM) u-wind

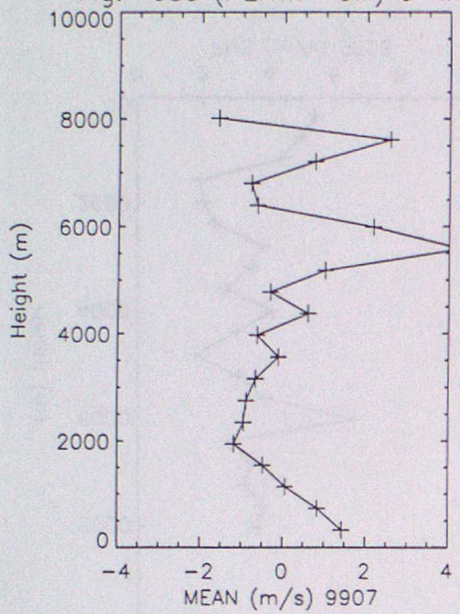


Fig. 68b (PENWP-UM) v-wind

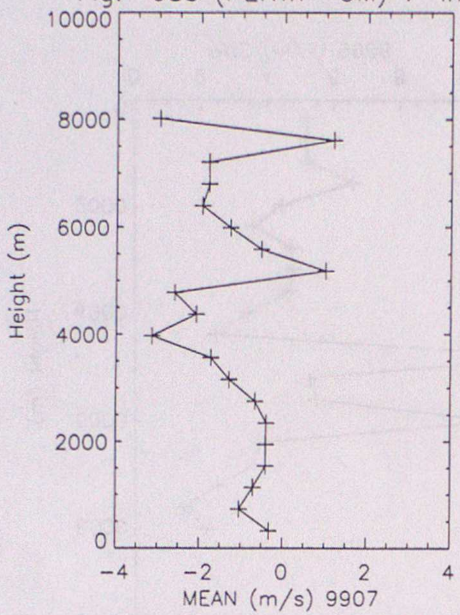


Fig. 68c (PENWP-UM) speed

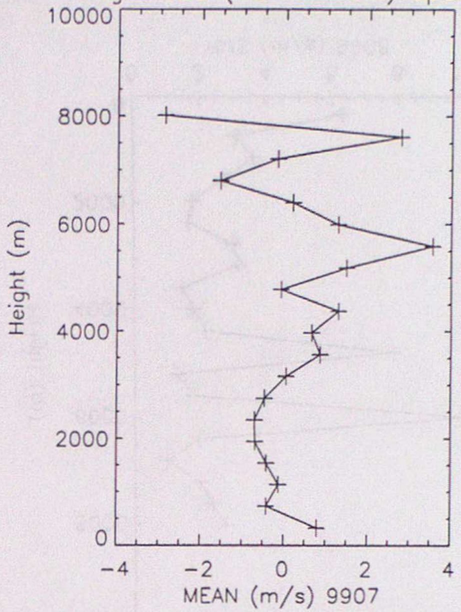


Fig. 68d (PENWP-UM) dirn.

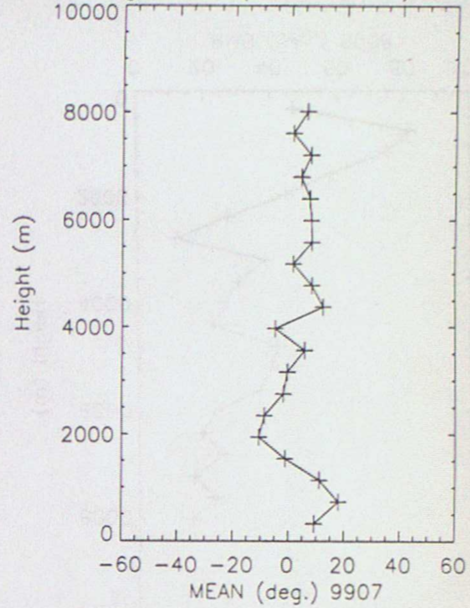


Fig. 68e (PENWP-UM) u-wind

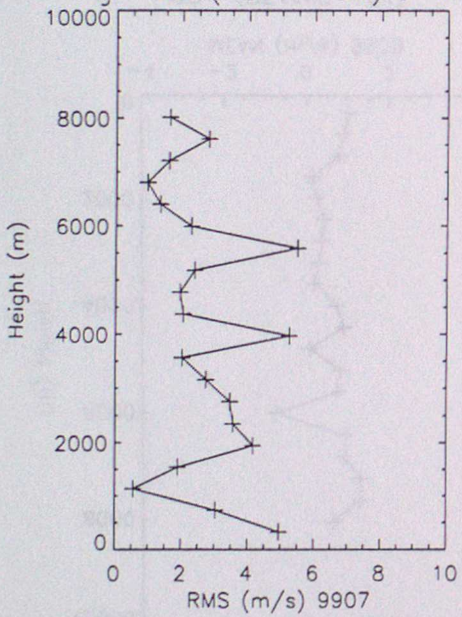


Fig. 68f (PENWP-UM) v-wind

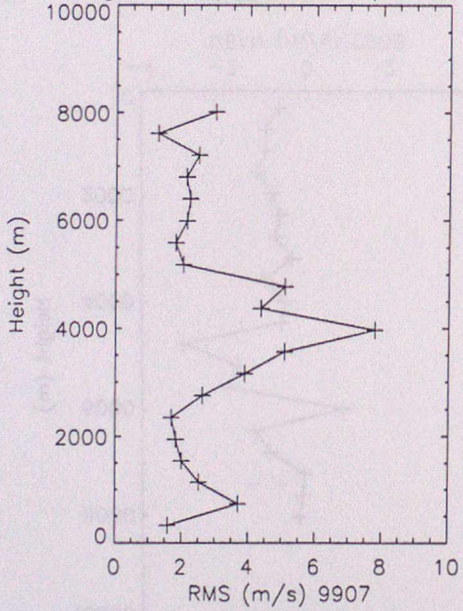


Fig. 68g (PENWP-UM) speed

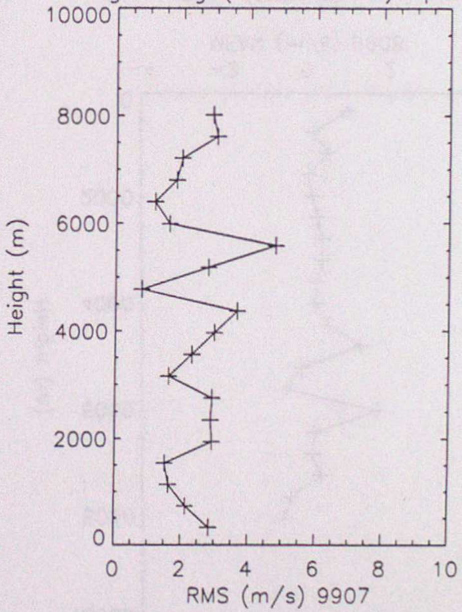


Fig. 68h (PENWP-UM) dirn.

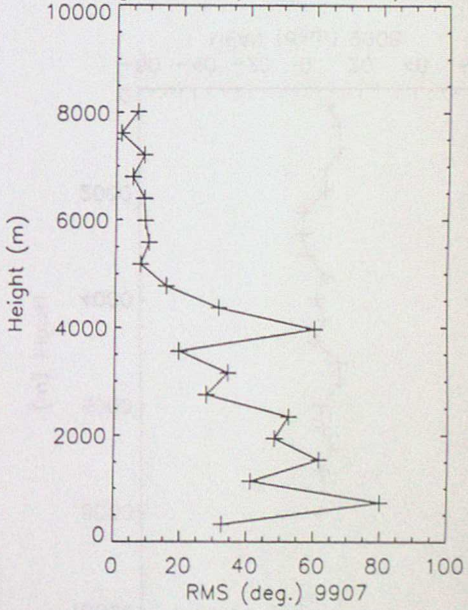


Fig. 69a (PENWP-UM) u-wind

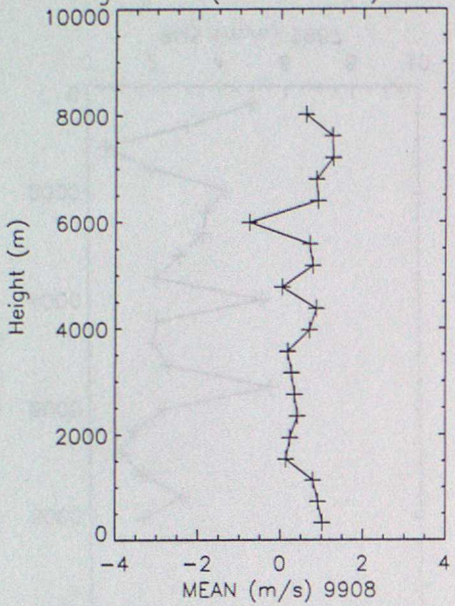


Fig. 69b (PENWP-UM) v-wind

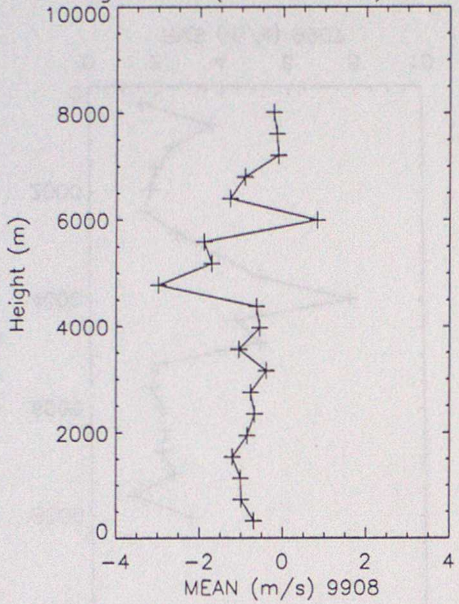


Fig. 69c (PENWP-UM) speed

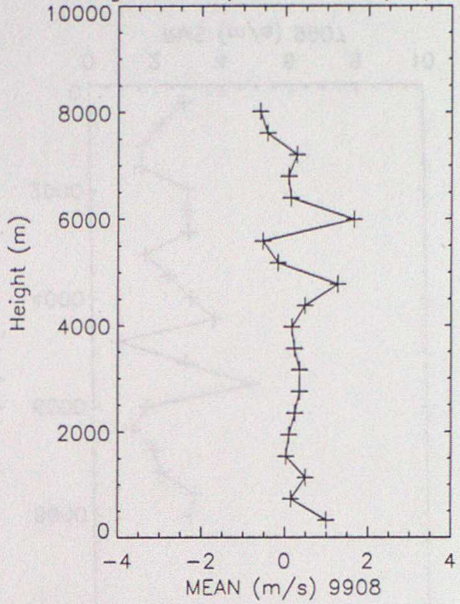


Fig. 69d (PENWP-UM) dirn.

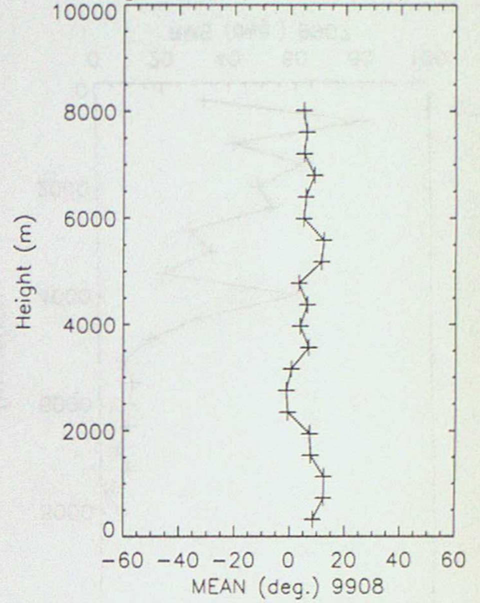


Fig. 69e (PENWP-UM) u-wind

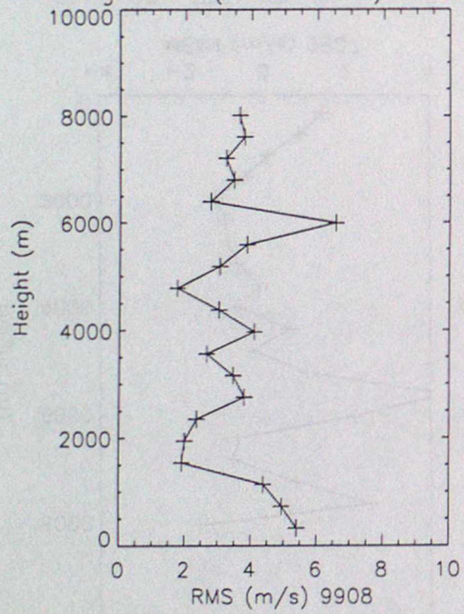


Fig. 69f (PENWP-UM) v-wind

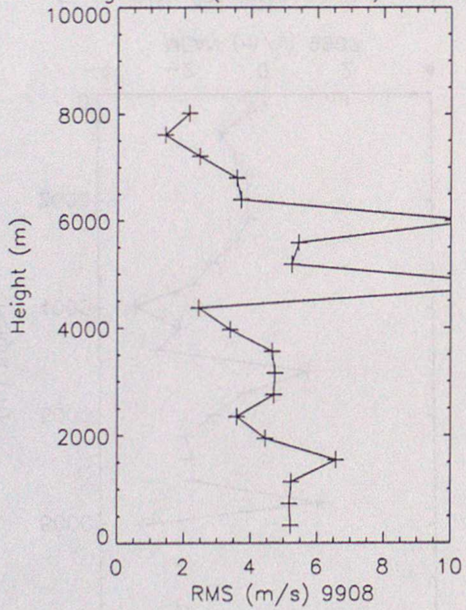


Fig. 69g (PENWP-UM) speed

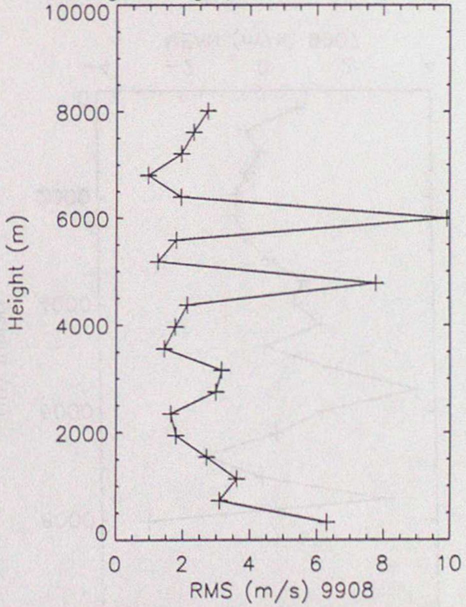


Fig. 69h (PENWP-UM) dirn.

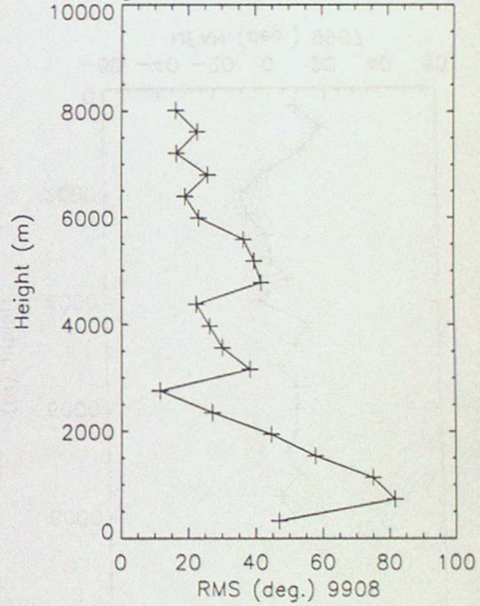


Fig. 70a (PENWP-UM) u-wind

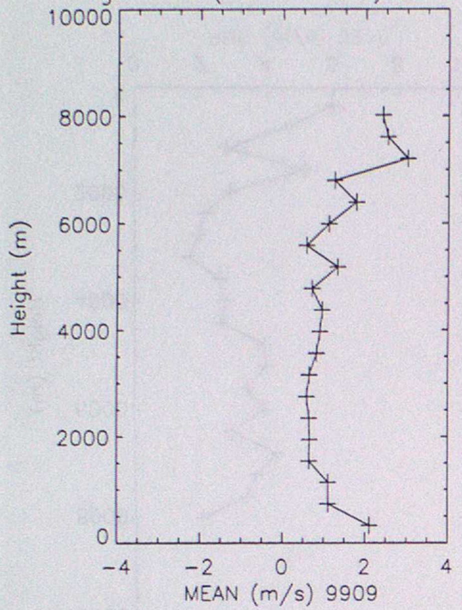


Fig. 70b (PENWP-UM) v-wind

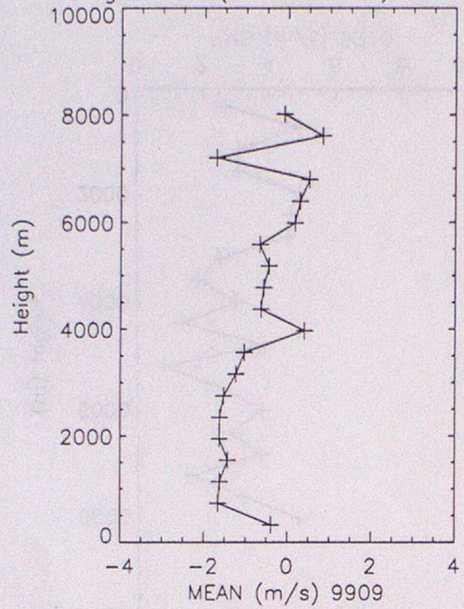


Fig. 70c (PENWP-UM) speed

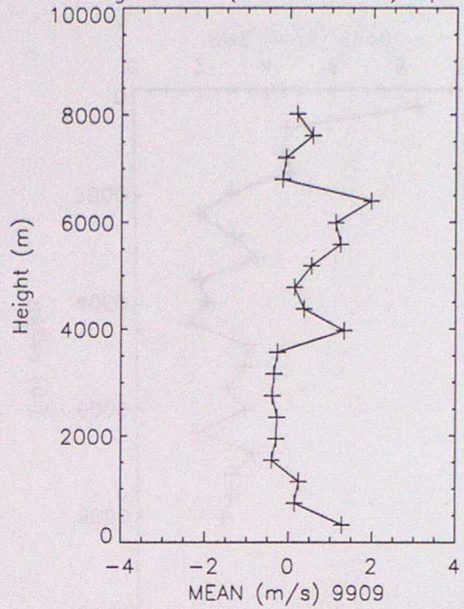


Fig. 70d (PENWP-UM) dirn.

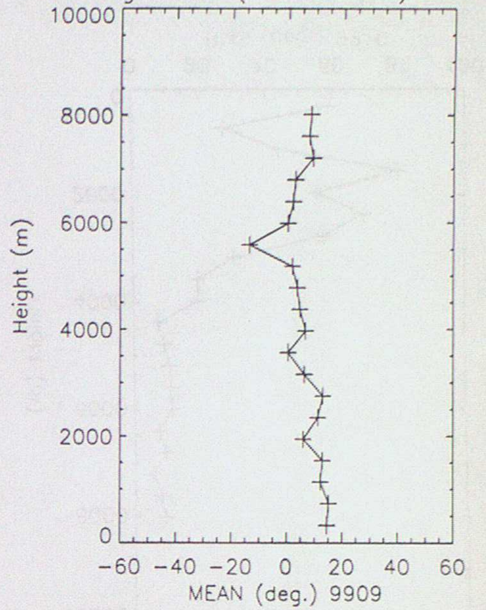


Fig. 70e (PENWP-UM) u-wind

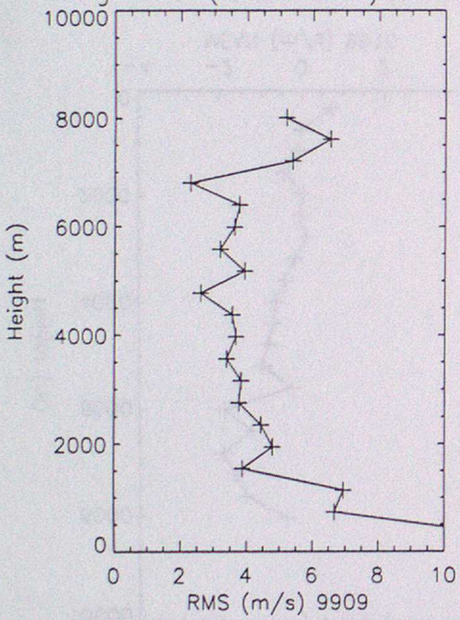


Fig. 70f (PENWP-UM) v-wind

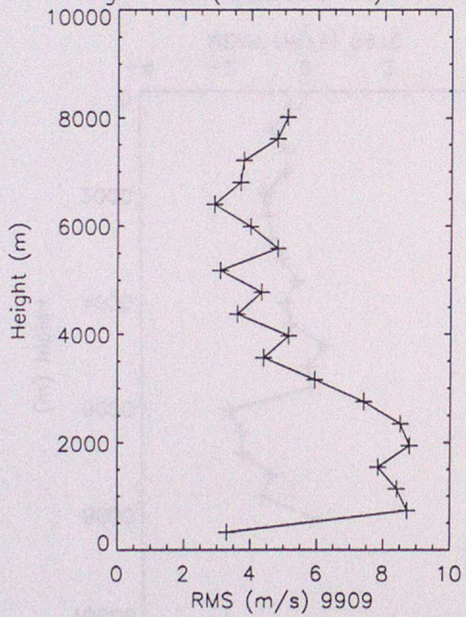


Fig. 70g (PENWP-UM) speed

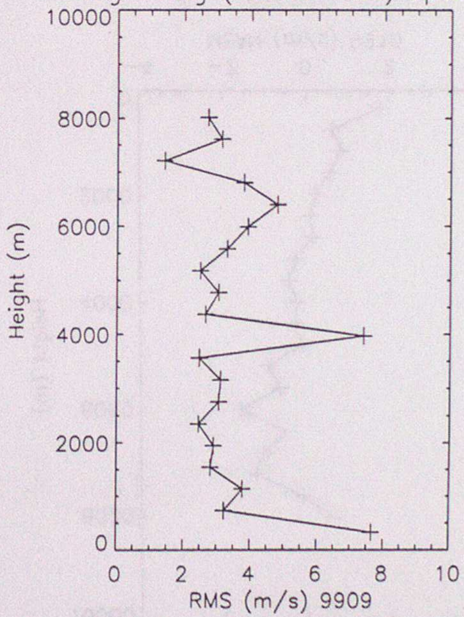


Fig. 70h (PENWP-UM) dirn.

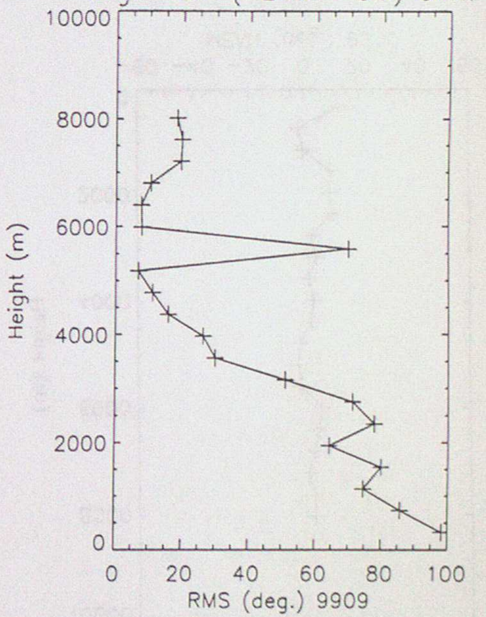


Fig. 71a (PENWP-UM) u-wind

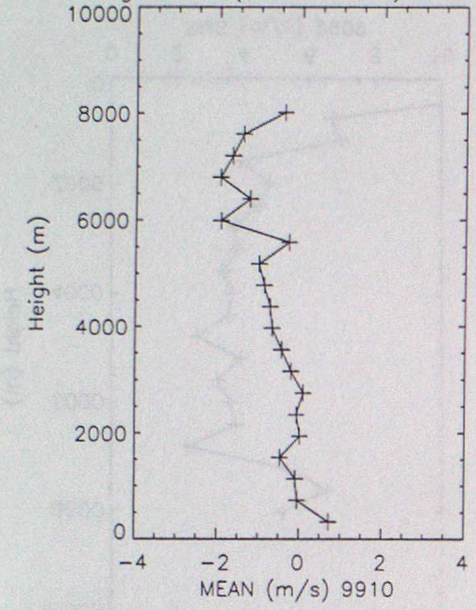


Fig. 71b (PENWP-UM) v-wind

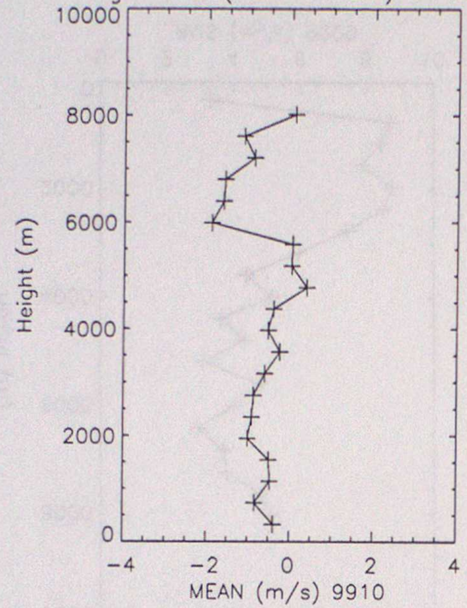


Fig. 71c (PENWP-UM) speed

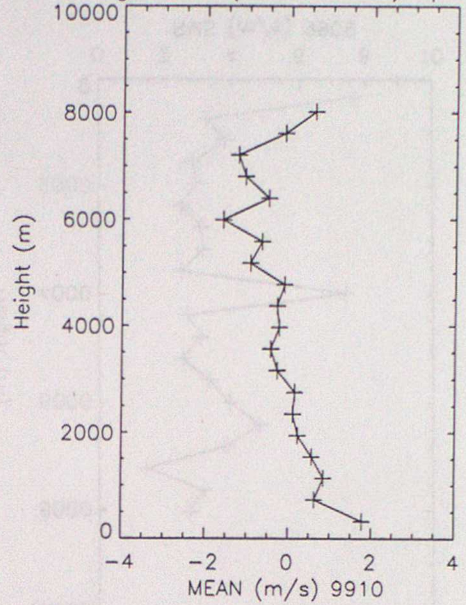


Fig. 71d (PENWP-UM) dirn.

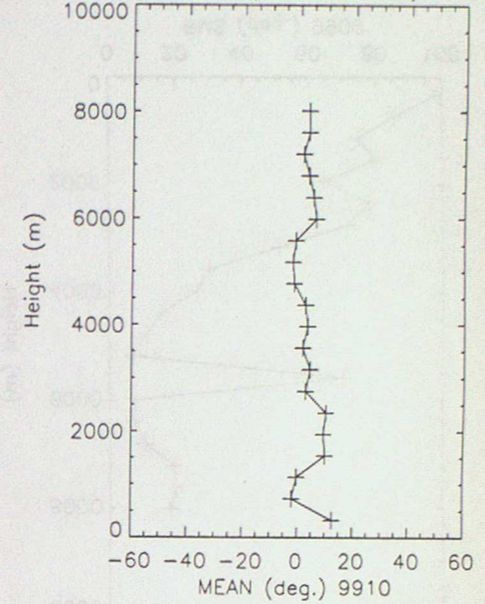


Fig. 71e (PENWP-UM) u-wind

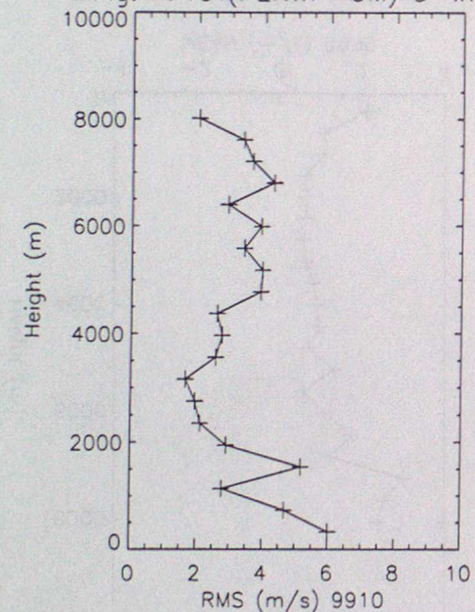


Fig. 71f (PENWP-UM) v-wind

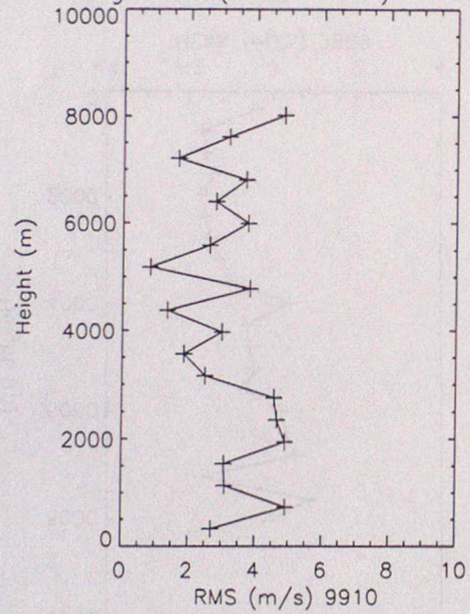


Fig. 71g (PENWP-UM) speed

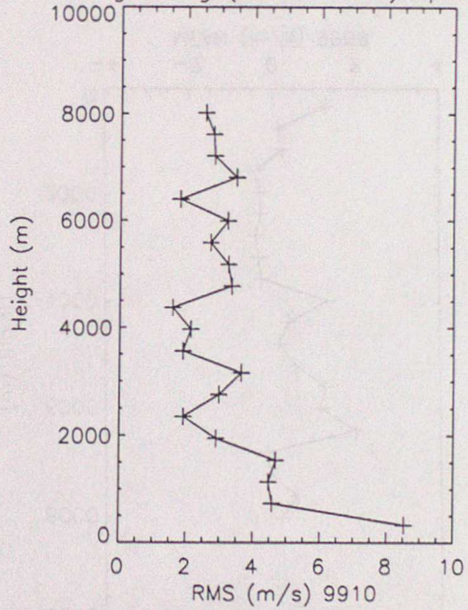


Fig. 71h (PENWP-UM) dirn.

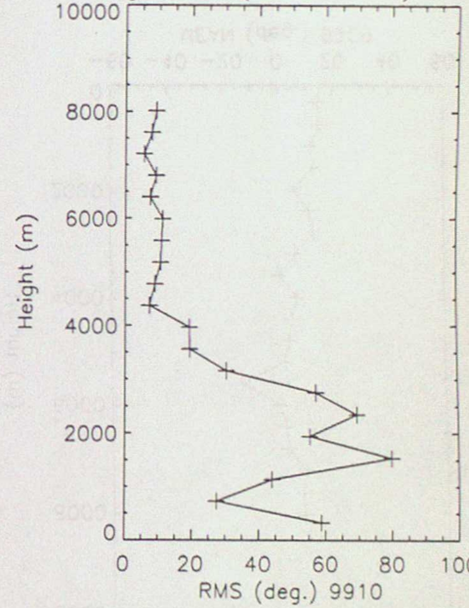


Fig. 72a (PENWP-UM) u-wind

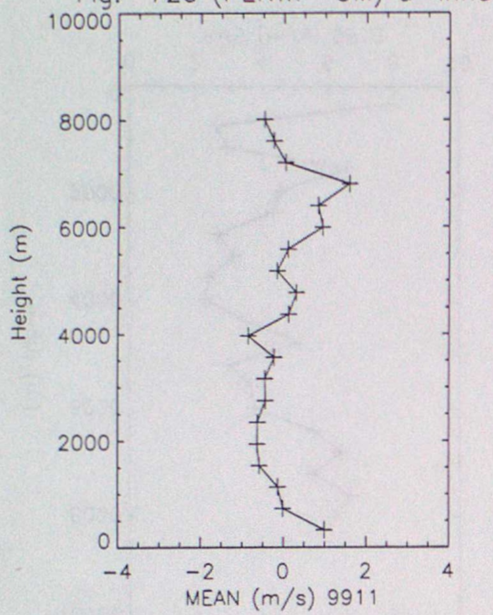


Fig. 72b (PENWP-UM) v-wind

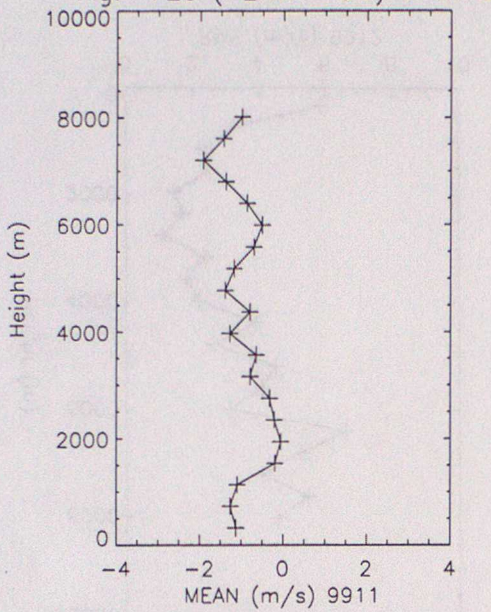


Fig. 72c (PENWP-UM) speed

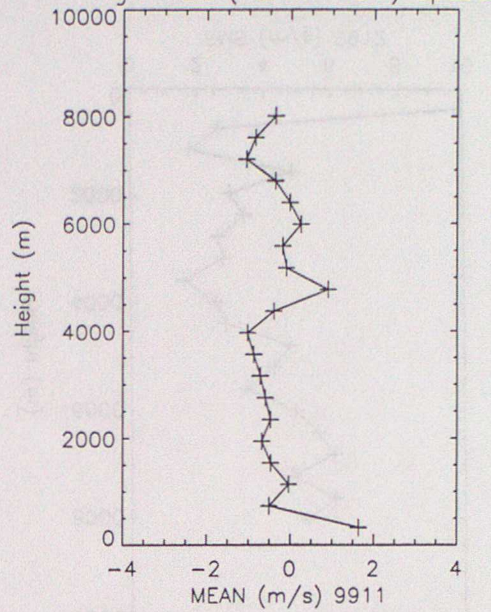


Fig. 72d (PENWP-UM) dirn.

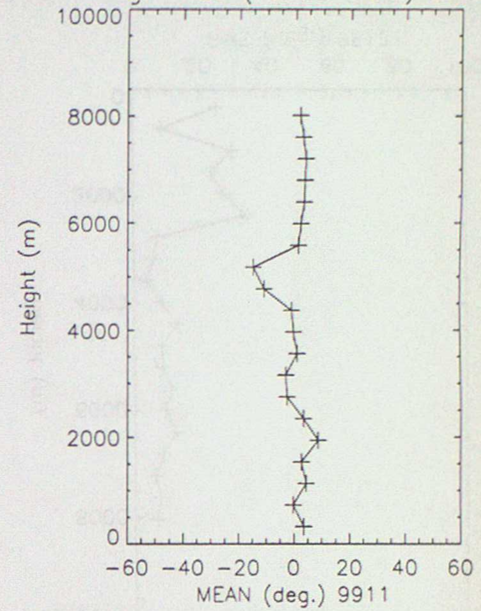


Fig. 72e (PENWP-UM) u-wind

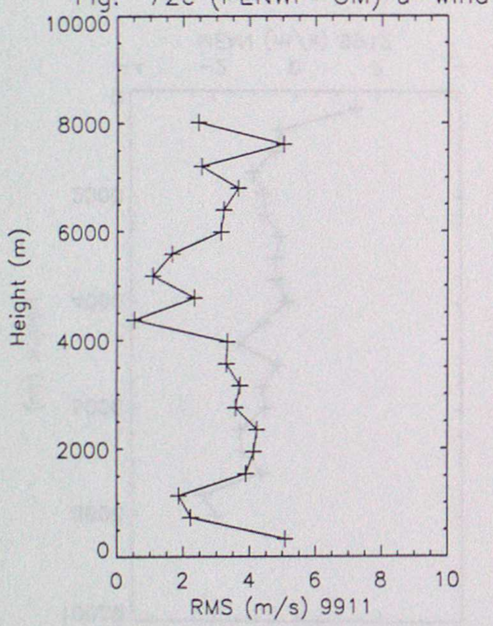


Fig. 72f (PENWP-UM) v-wind

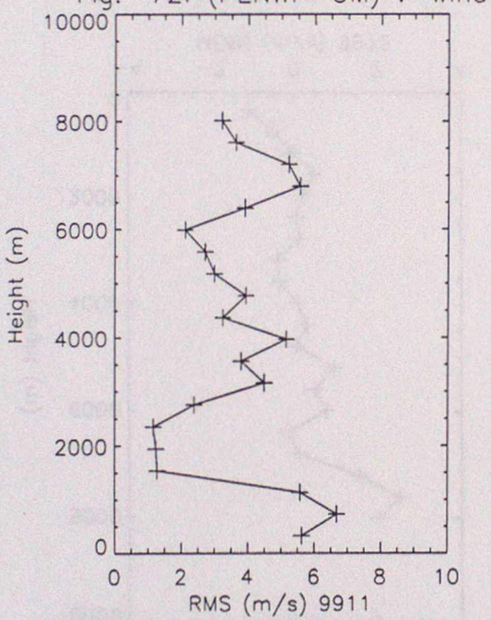


Fig. 72g (PENWP-UM) speed

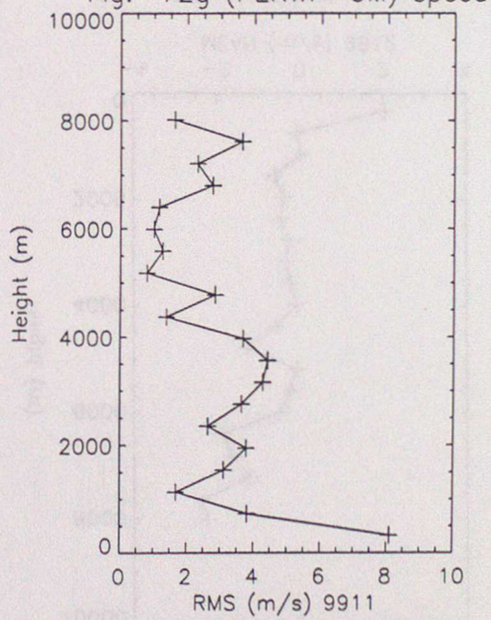


Fig. 72h (PENWP-UM) dirn.

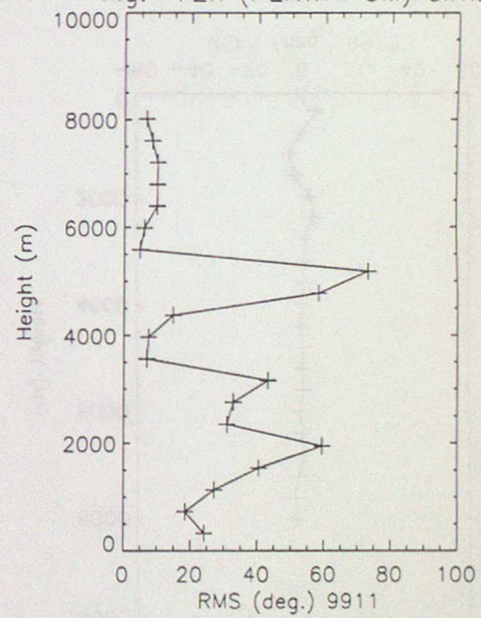


Fig. 73a (PENWP-UM) u-wind

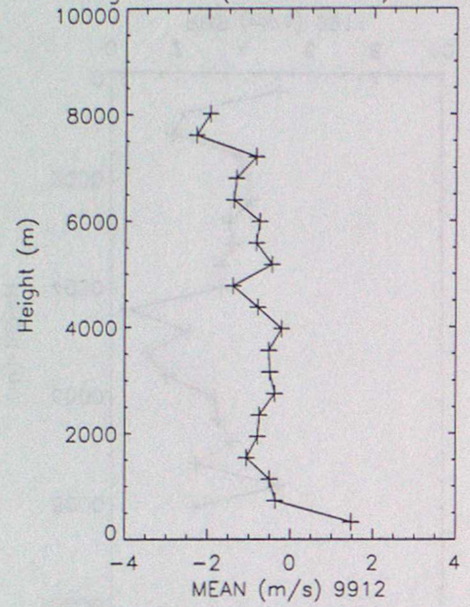


Fig. 73b (PENWP-UM) v-wind

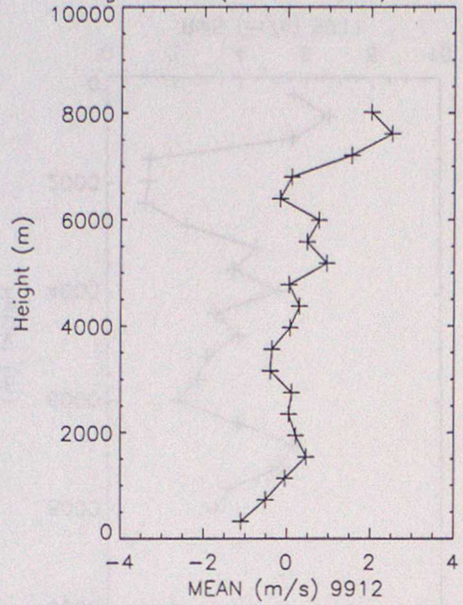


Fig. 73c (PENWP-UM) speed

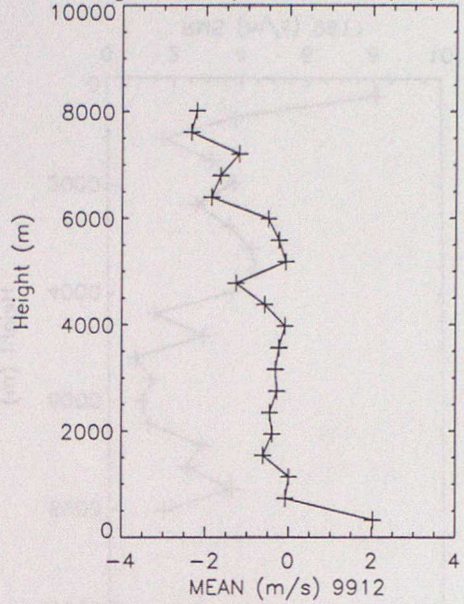


Fig. 73d (PENWP-UM) dirn.

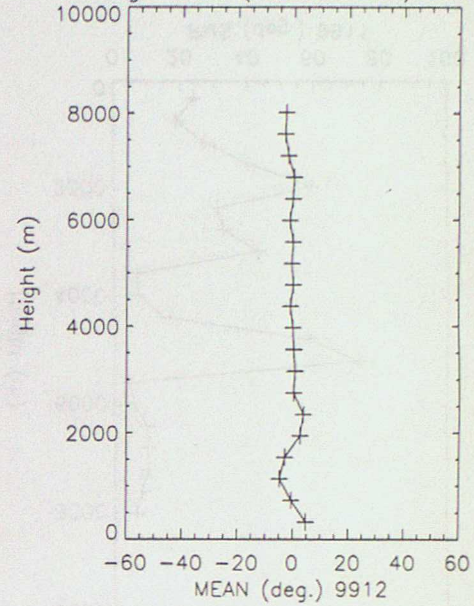


Fig. 73e (PENWP-UM) u-wind

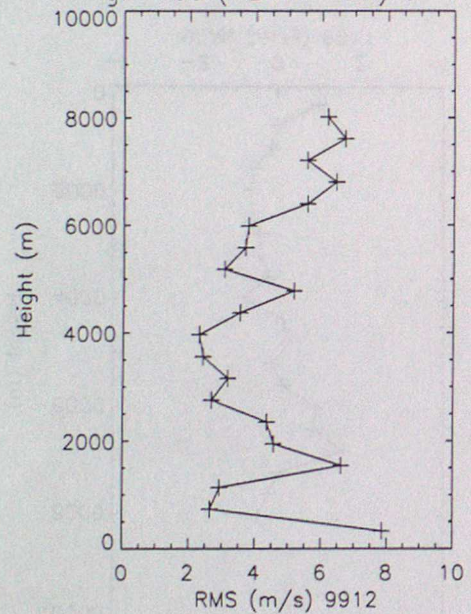


Fig. 73f (PENWP-UM) v-wind

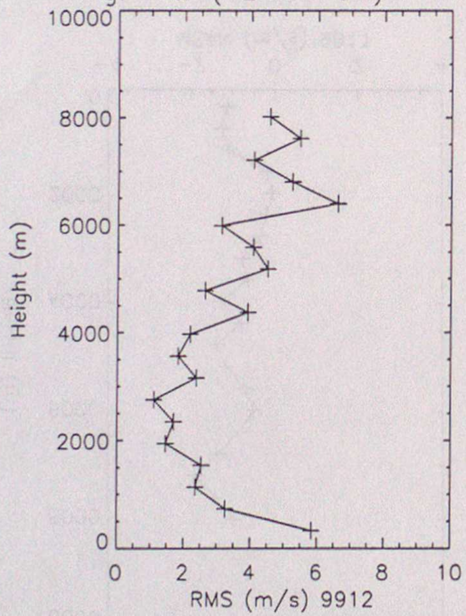


Fig. 73g (PENWP-UM) speed

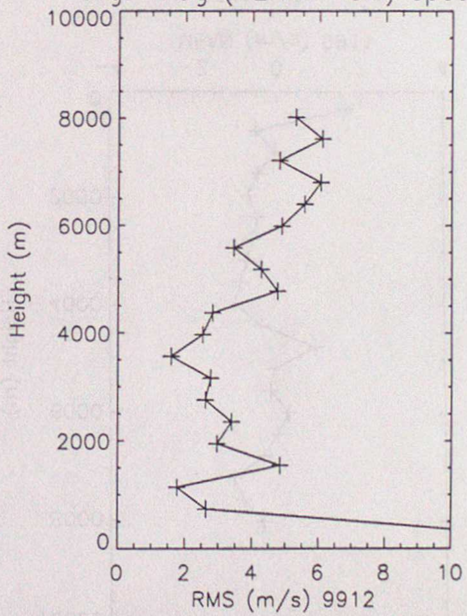


Fig. 73h (PENWP-UM) dirn.

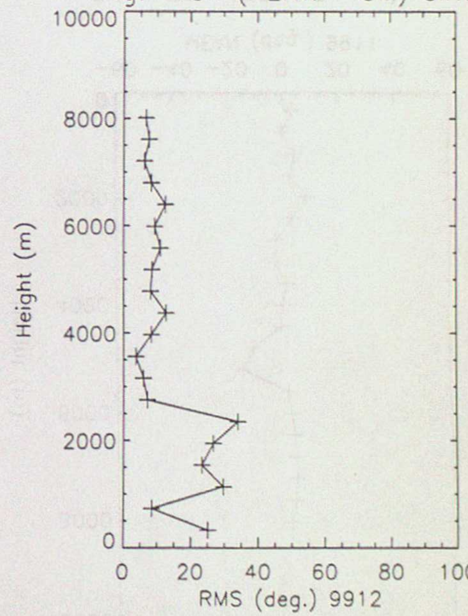


Fig. 74a (PENWP-UM) u-wind

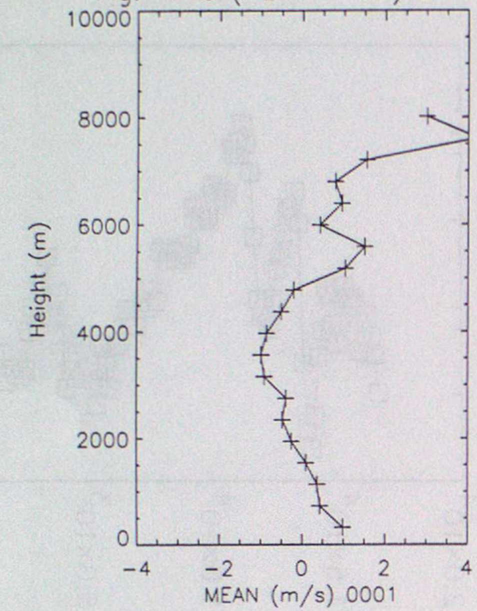


Fig. 74b (PENWP-UM) v-wind

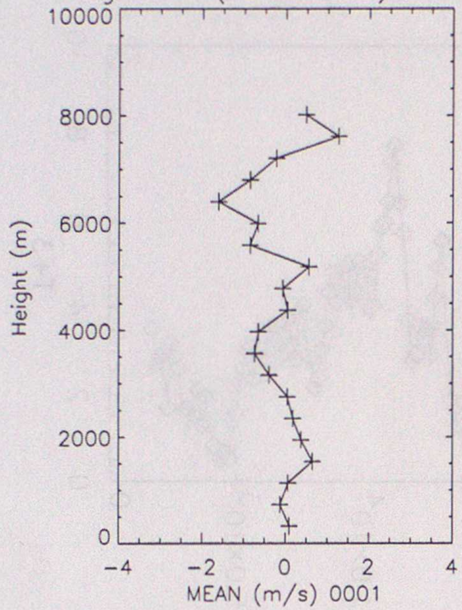


Fig. 74c (PENWP-UM) speed

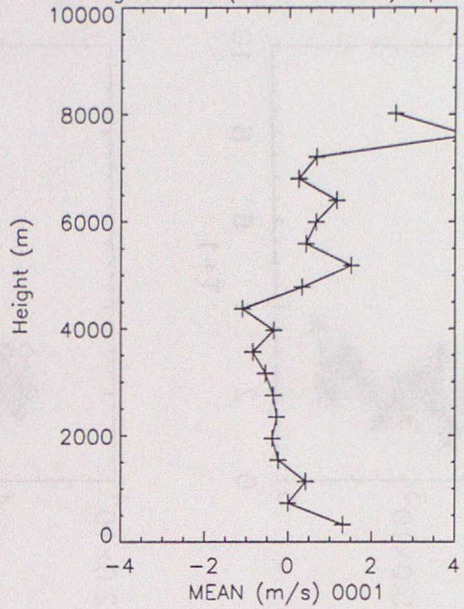


Fig. 74d (PENWP-UM) dirn.

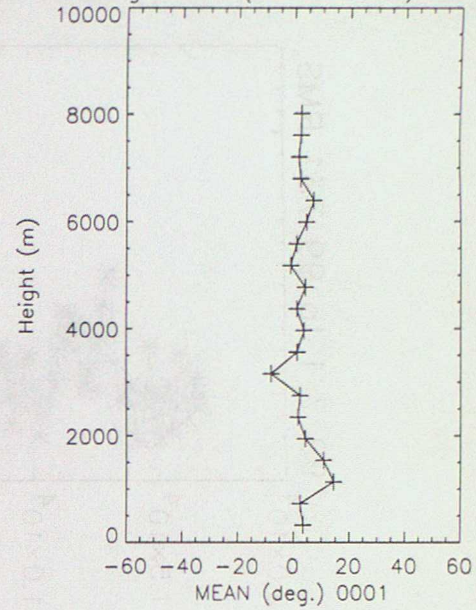


Fig. 74e (PENWP-UM) u-wind

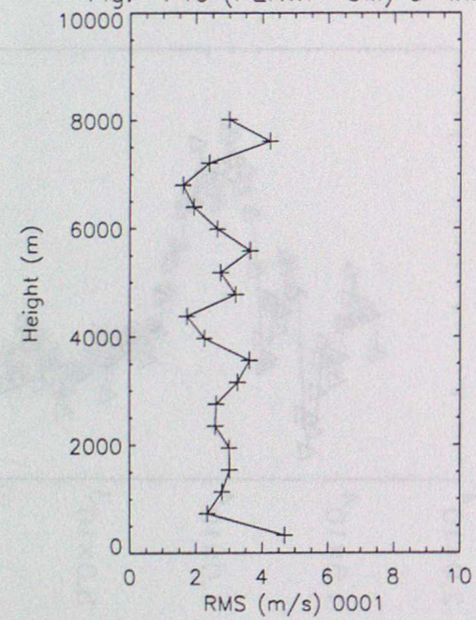


Fig. 74f (PENWP-UM) v-wind

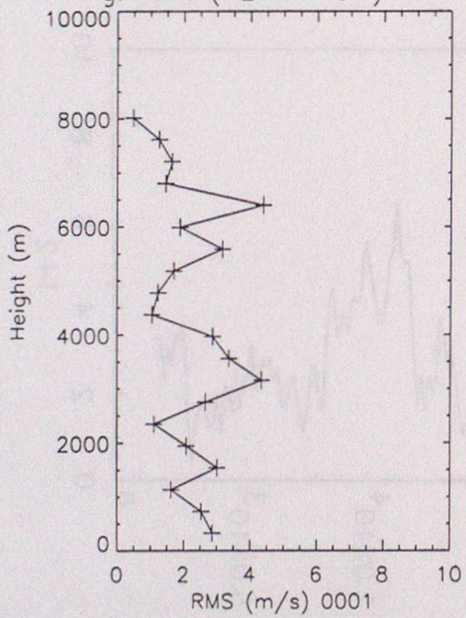


Fig. 74g (PENWP-UM) speed

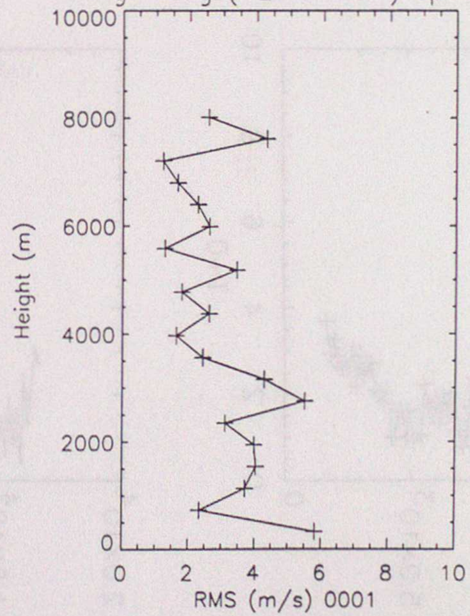


Fig. 74h (PENWP-UM) dirn.

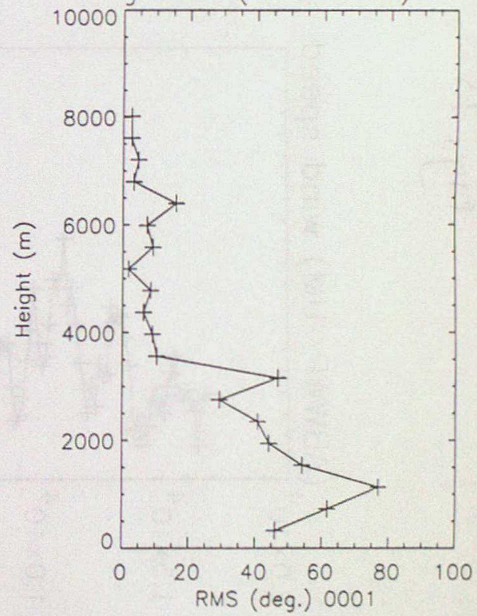
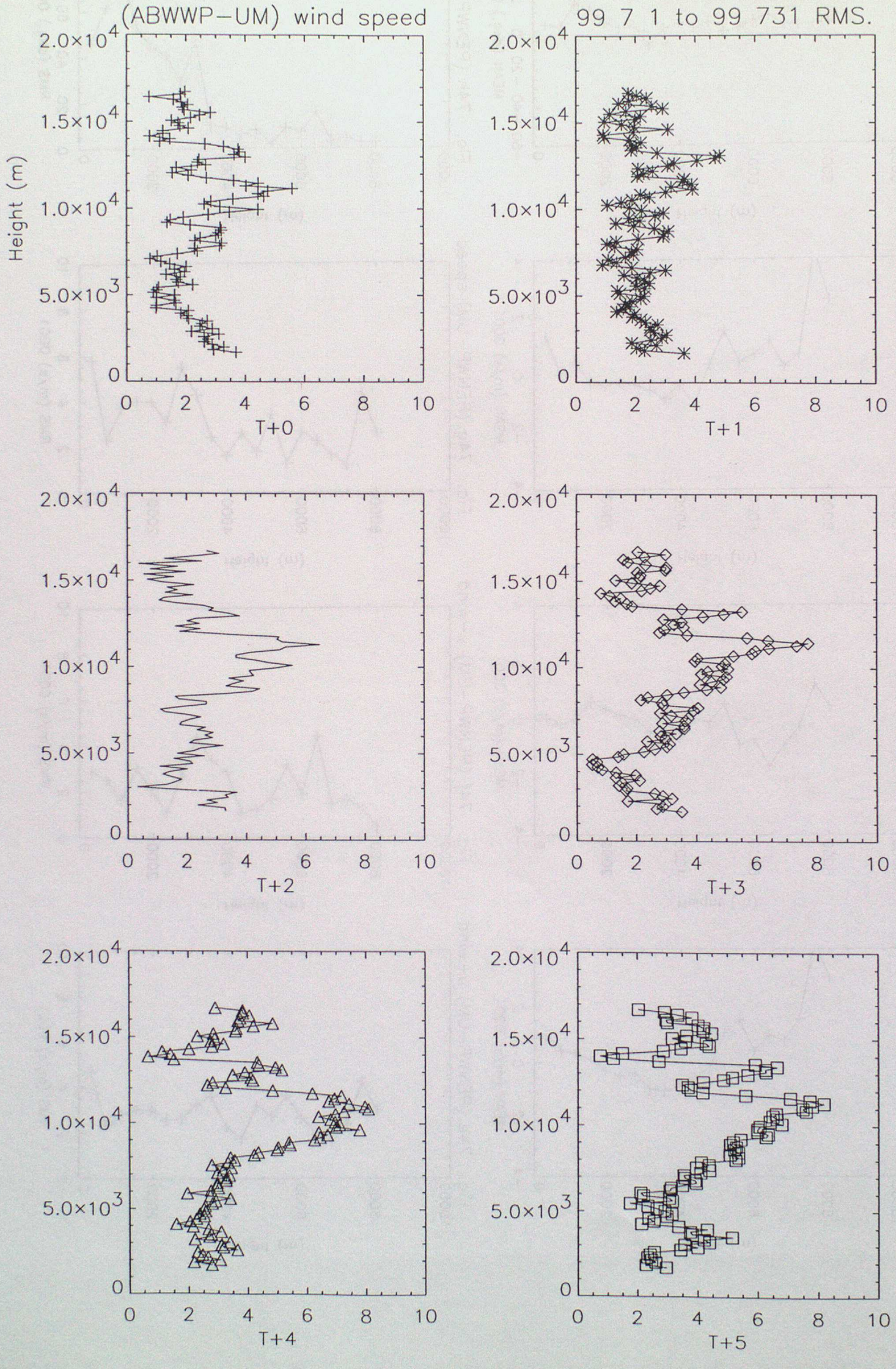
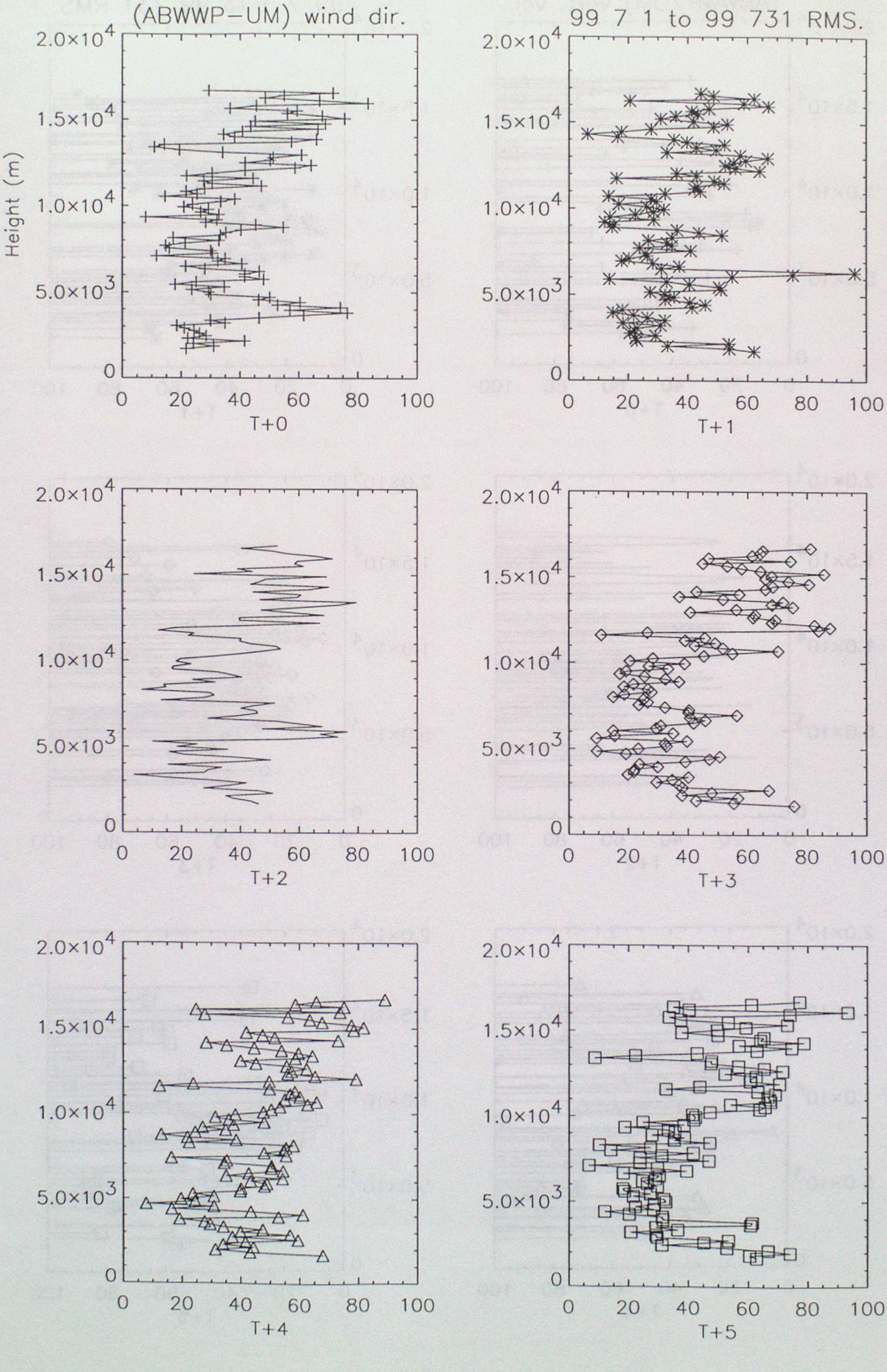


Fig. 75



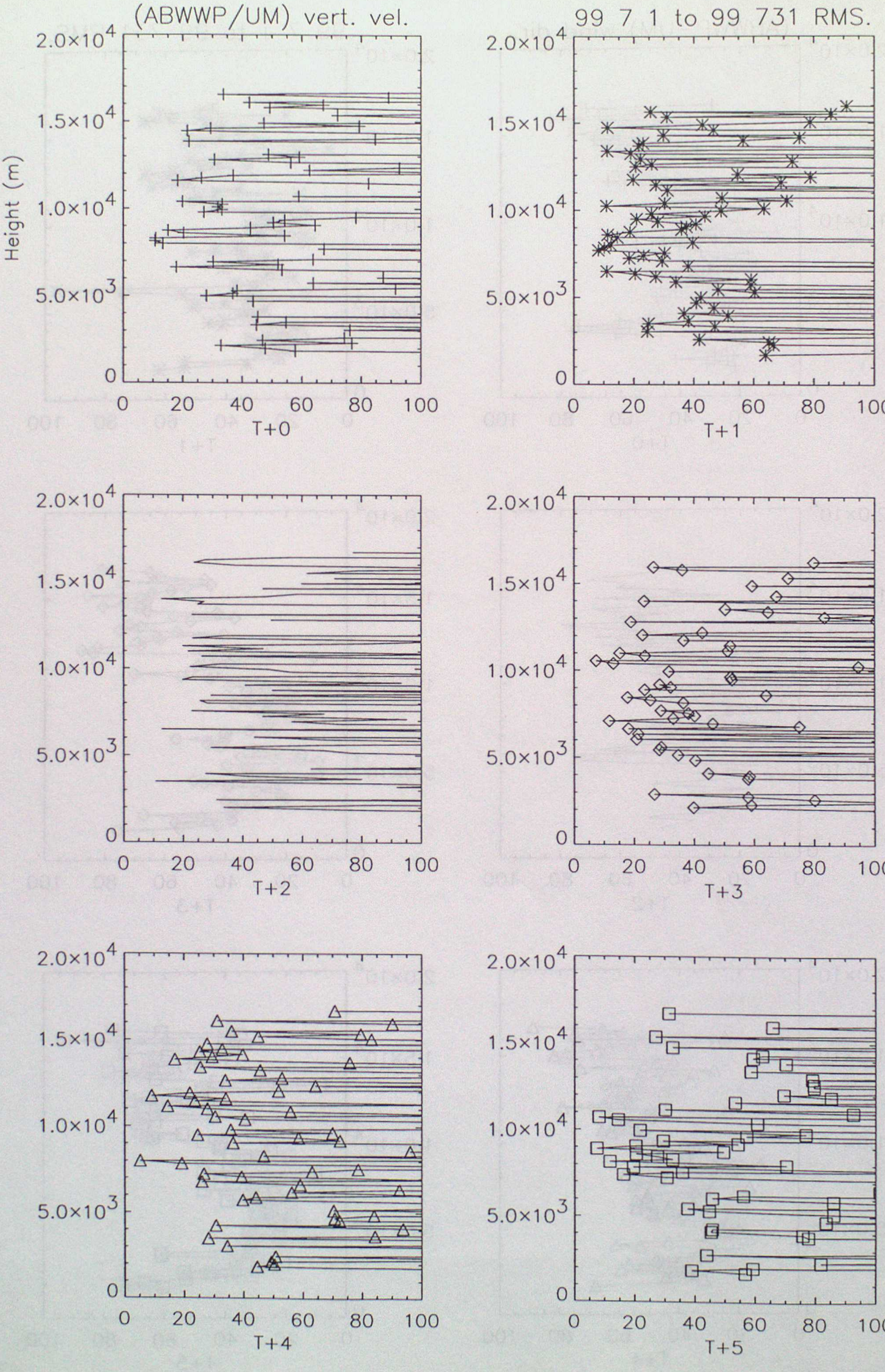
(ABWWP-UM) wind speed
99 7 1 to 99 731 RMS.
Height (m)
2.0×10^4
1.5×10^4
1.0×10^4
5.0×10^3
0
0 2 4 6 8 10
T+0
T+1
T+2
T+3
T+4
T+5

Fig. 76

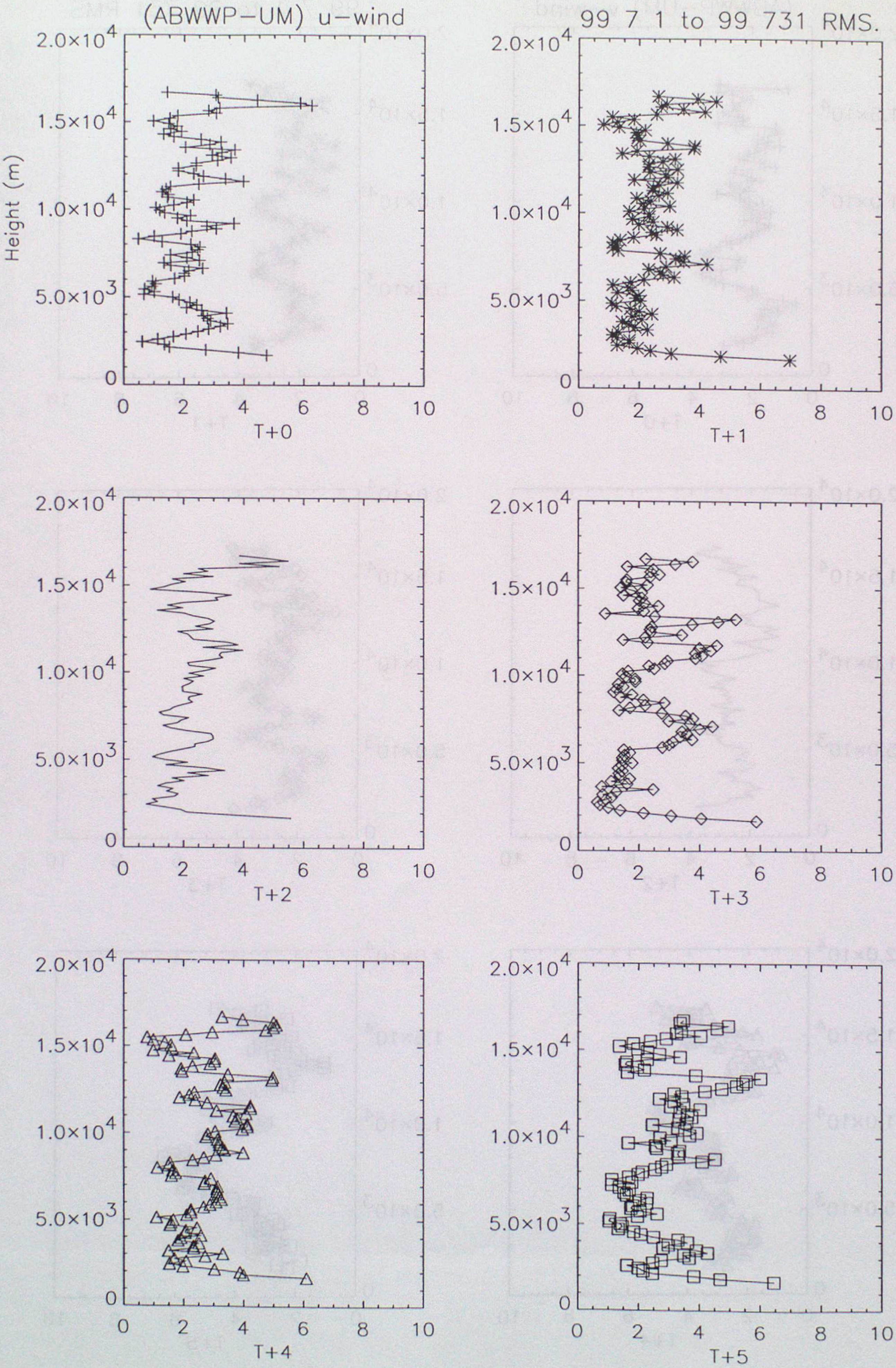


(ABWWP−UM) wind dir.
99 7 1 to 99 731 RMS.
Height (m)
2.0×10^4
1.5×10^4
1.0×10^4
5.0×10^3
0
0 20 40 60 80 100
T+0
T+1
T+2
T+3
T+4
T+5

Figs 77

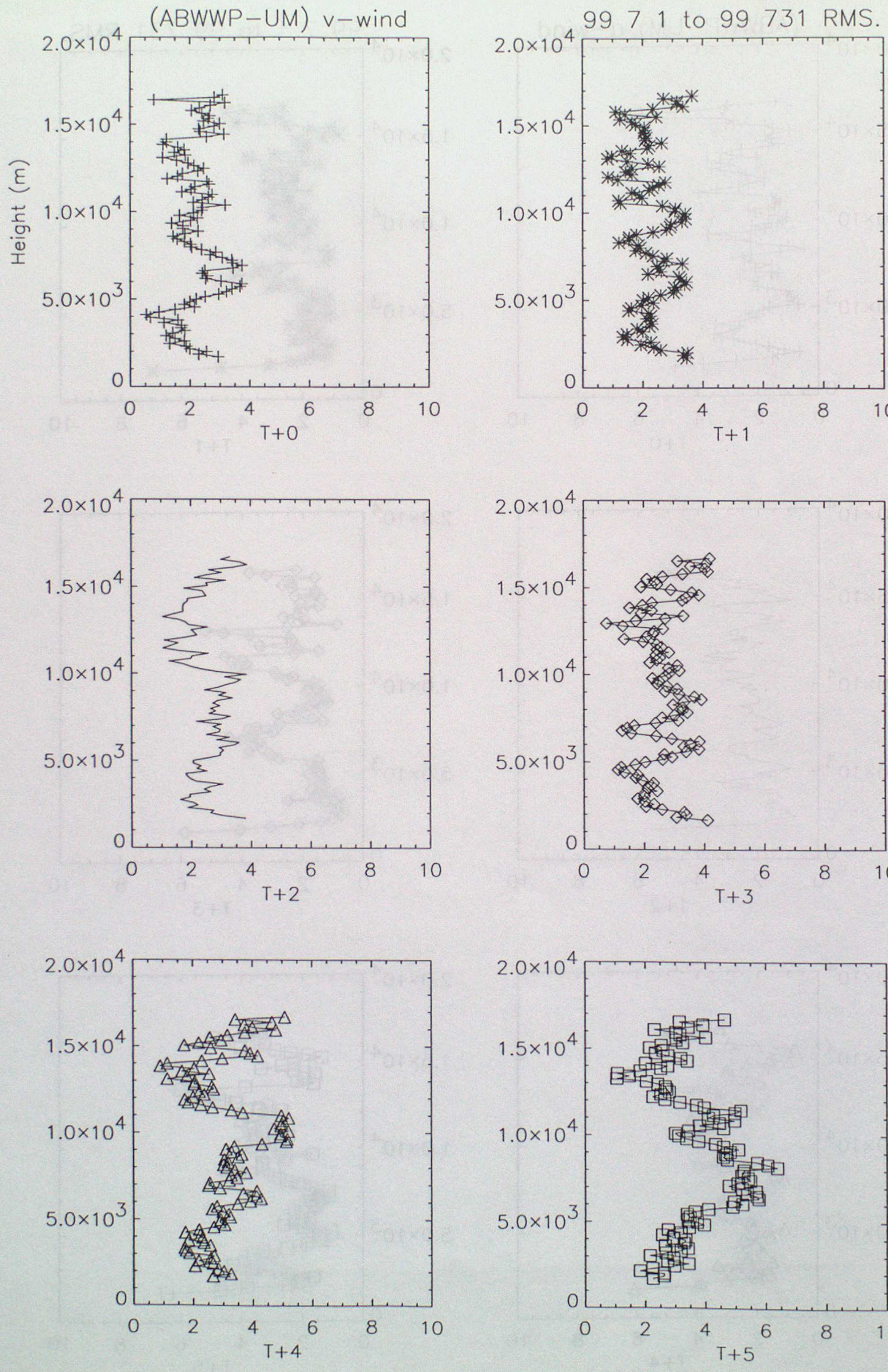

(ABWWP/UM) vert. vel.
99 7 1 to 99 731 RMS.
Height (m)
2.0×10^4
1.5×10^4
1.0×10^4
5.0×10^3
0
0 20 40 60 80 100
T+0
T+1
T+2
T+3
T+4
T+5

Figs. 78



(ABWWP-UM) u-wind
99 7 1 to 99 731 RMS.
Height (m)
2.0×10^4
1.5×10^4
1.0×10^4
5.0×10^3
0
0 2 4 6 8 10
T+0
T+1
T+2
T+3
T+4
T+5

Figs. 79.



(ABWWP−UM) v−wind
99 7 1 to 99 731 RMS.
Height (m)
2.0×10^4
1.5×10^4
1.0×10^4
5.0×10^3
0
0 2 4 6 8 10
T+0
T+1
T+2
T+3
T+4
T+5