

SOME POSSIBLE VLT SITES IN CHILE

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ABSTRACT

A report is given on the site-testing programme for a Very Large Telescope in Chile. Data are now available from seven months of investigations. Comments are made on the places which have so far seemed most attractive. Meteorological data from constant monitoring of a coastal mountain, Paranal, are presented and discussed. These data indicate an average percentage of photometric nights of around 85. Atmospheric integrated water-vapour content seems very low in the winter but relatively high in the summer. Other meteorological parameters seem favourable for astronomical observations.

INTRODUCTION

The ESO survey for possible sites in Chile for a Very Large Telescope (VLT) is now entering its second year. Reports on the initial considerations and first practical approaches have been given by Ardeberg (1983) and by Woltjer (1984). A preliminary analysis of the first month of dedicated site testing has been made by Ardeberg and Lindgren (1984).

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Procedures for evaluation of site-test data have only very recently reached a more final definition. Therefore, the results reported in the present paper are still preliminar. They should, however, be consistent enough to permit some general conclusions regarding the region investigated and the qualities of some possible sites for a VLT.

REGION AND POSSIBLE SITES

The general features of the region of interest have been described by Ardeberg (1983) and by Woltjer (1984). Here, it is only recalled that all places subject to closer investigation during the last few months are situated between latitudes -28° and -21° . More extensive examination has only been made of places north of latitude -25° .

Whereas a large number of possible sites have been visited and investigated, so far less than ten specific places have been given more detailed and long-term attention. These places are Paranal at geographical longitude $70^{\circ}25'$ West and latitude $-24^{\circ}40'$ and with an elevation of close to 2700 metres, Armazoni at $70^{\circ}10'$ West and $-24^{\circ}35'$ and an elevation of 3100 metres, Sierra del Profeta y Aspera at approximately $69^{\circ}15'$ West and $-24^{\circ}45'$ and an elevation of around 3600 metres, Sierra de Varas at $69^{\circ}05'$ West and $-24^{\circ}50'$ and an elevation of 4200 metres, Tolar at $70^{\circ}05'$ West and $-21^{\circ}55'$ and an elevation of 2400 metres, and finally the Atacama mountains to the North-North-East of San Pedro de Atacama at approximately $68^{\circ}00'$ West and $-22^{\circ}40'$ and with elevations above 5000 metres.

More detailed comments on most of these places can be found in Ardeberg (1983), Woltjer (1984) and in Ardeberg and Lindgren (1984).

RESULTS FROM MONITORING AT PARANAL

A permanent site-testing group was installed at the summit of Paranal in September 1983, and it has worked continuously there since then. Two observers are present all the time and continuous observations are made of sky conditions, integrated atmospheric water-vapour content, wind speed and wind direction, temperature and local humidity. Sky conditions are explicitly checked at least every hour, the integrated atmospheric water-vapour content is measured at least every second hour, whereas continuous tracings are made of wind speed and wind direction, temperature and local humidity.

Table 1 gives details regarding the sky conditions at Paranal during the seven months which have so far been covered by observations. Corresponding data for La Silla are given for comparison. The definitions of photometric and spectroscopic nights are the same as described in Ardeberg (1984). Graphical comparisons of the observing conditions at Paranal and La Silla are shown in Figures 1 and 2.

Figures 3 and 4 show the results of measurements of integrated atmospheric water-vapour content. The gap in September reflects the fact that after six days of observations in the beginning of the month an interruption had to be made before continuous monitoring could start about two weeks later. The interruption was for manpower reasons only. In the middle of December another, relatively short, period void of measurement data is noticeable. This is due to presence of clouds making meaningful measurements impossible. Arrows in the upper part of the December frame indicate water-vapour contents above ten millimetres precipitable water.

Wind-speed statistics for September and October 1983 are given in Table 2. The data refer to wind-speed averages over one hour. Especially at higher wind speeds our tracings permit much higher time resolution.

Table 1: Sky conditions at Paranal and at La Silla

	SEP	OCT	NOV	DEC	JAN	FEB	MAR	TOT
No. of Nights Monitored	15	31	30	31	31	29	31	198
No. of Photom. Nights	14	29	30	30	20	22	25	170
No. of Spectrosc. Nights	15	31	30	30	24	24	27	181
No. of Useless Nights	0	0	0	1	7	5	4	17
% Photom. Nights	93	94	100	97	65	76	81	86
% Spectrosc. Nights	100	100	100	97	77	83	87	91
No. of Nights Monitored	15	31	30	31	31	29	31	198
No. of Photom. Nights	9	21	15	18	20	23	21	127
No. of Spectrosc. Nights	12	29	26	30	23	28	27	175
No. of Useless Nights	3	2	4	1	8	1	4	23
% Photom. Nights	60	68	50	58	65	79	68	64
% Spectrosc. Nights	80	94	87	97	74	97	87	88

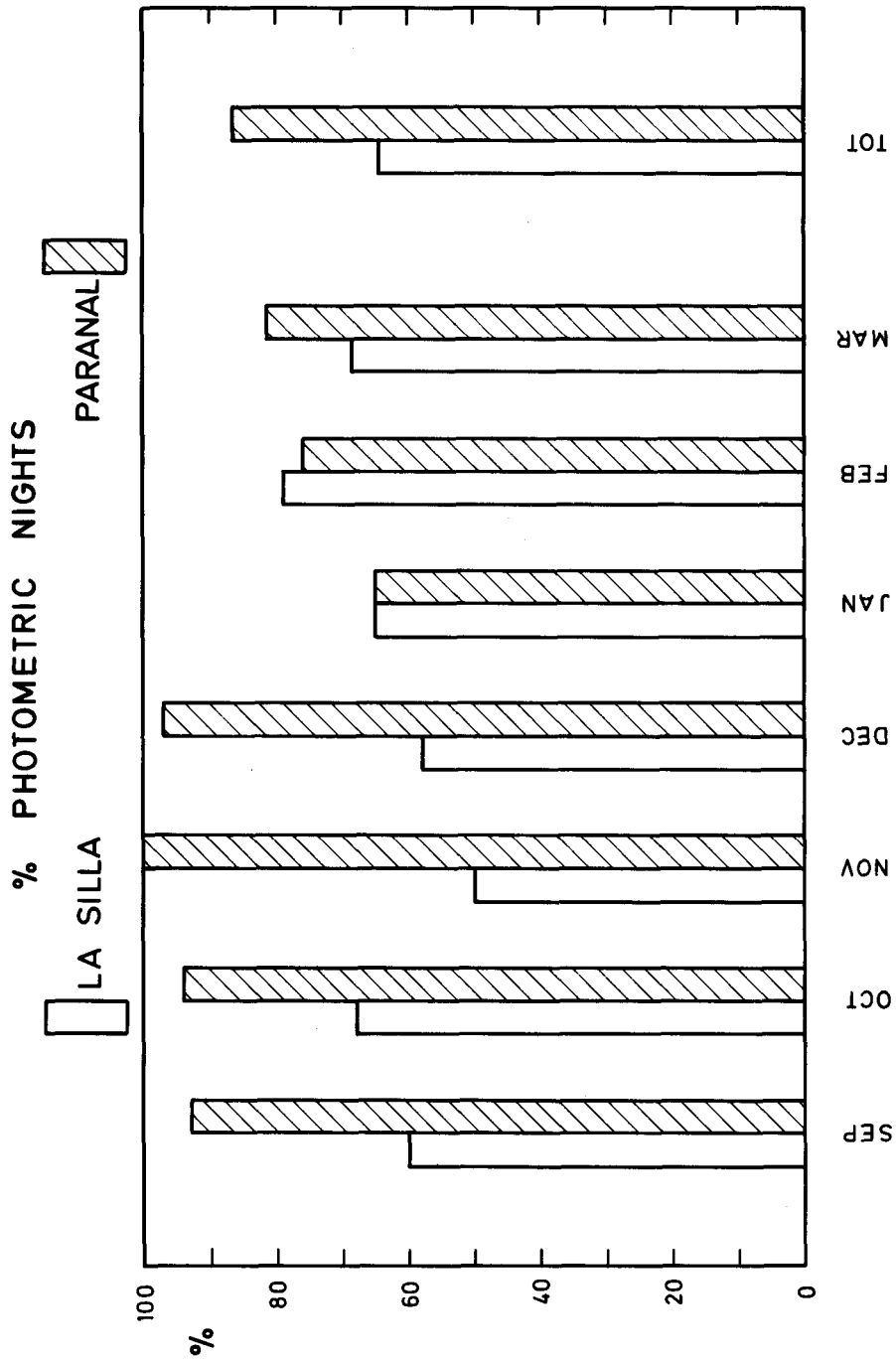


Fig. 1: Photometric nights at Paranal and at La Silla

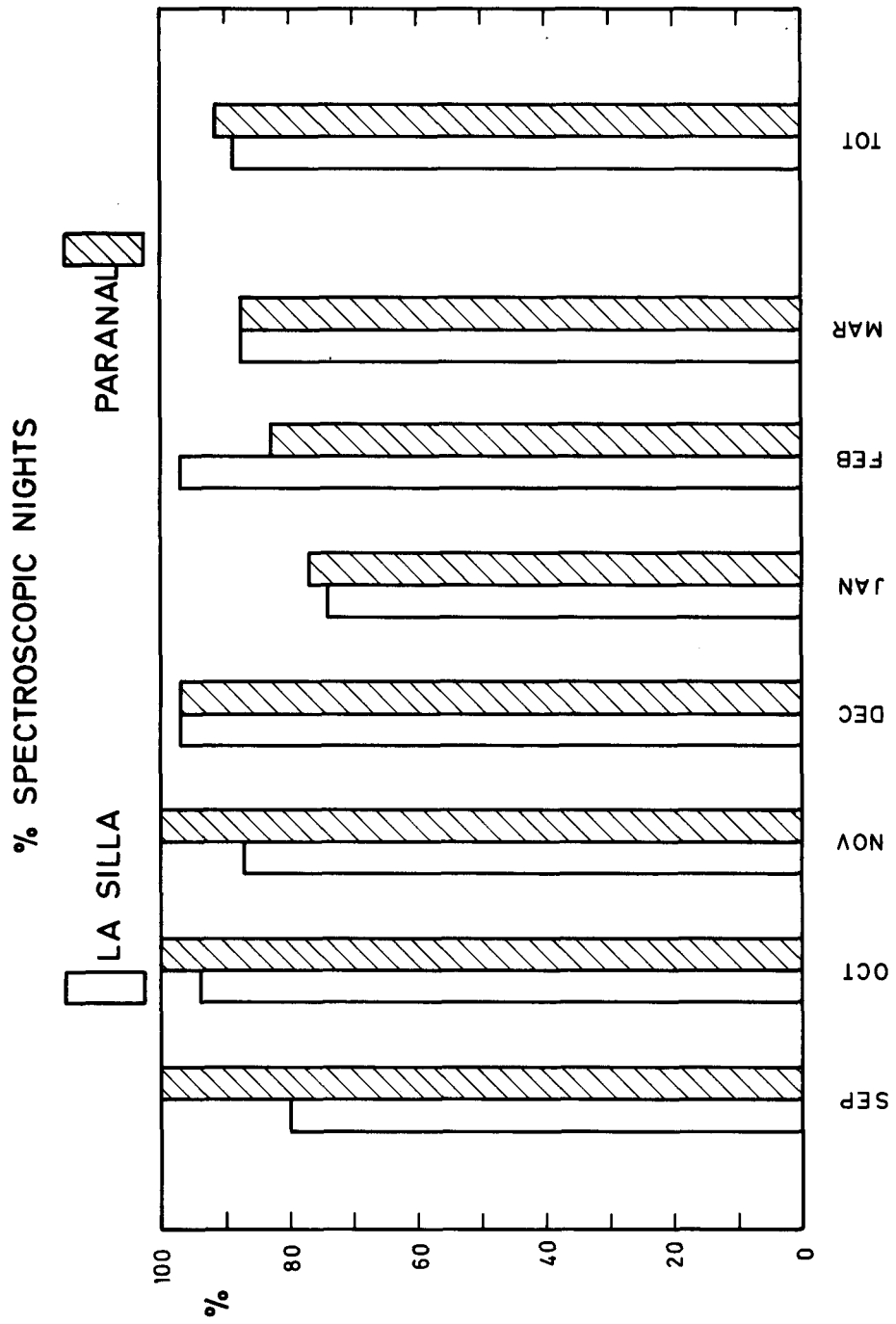


Fig. 2: Spectroscopic nights at Paranal and at La Silla

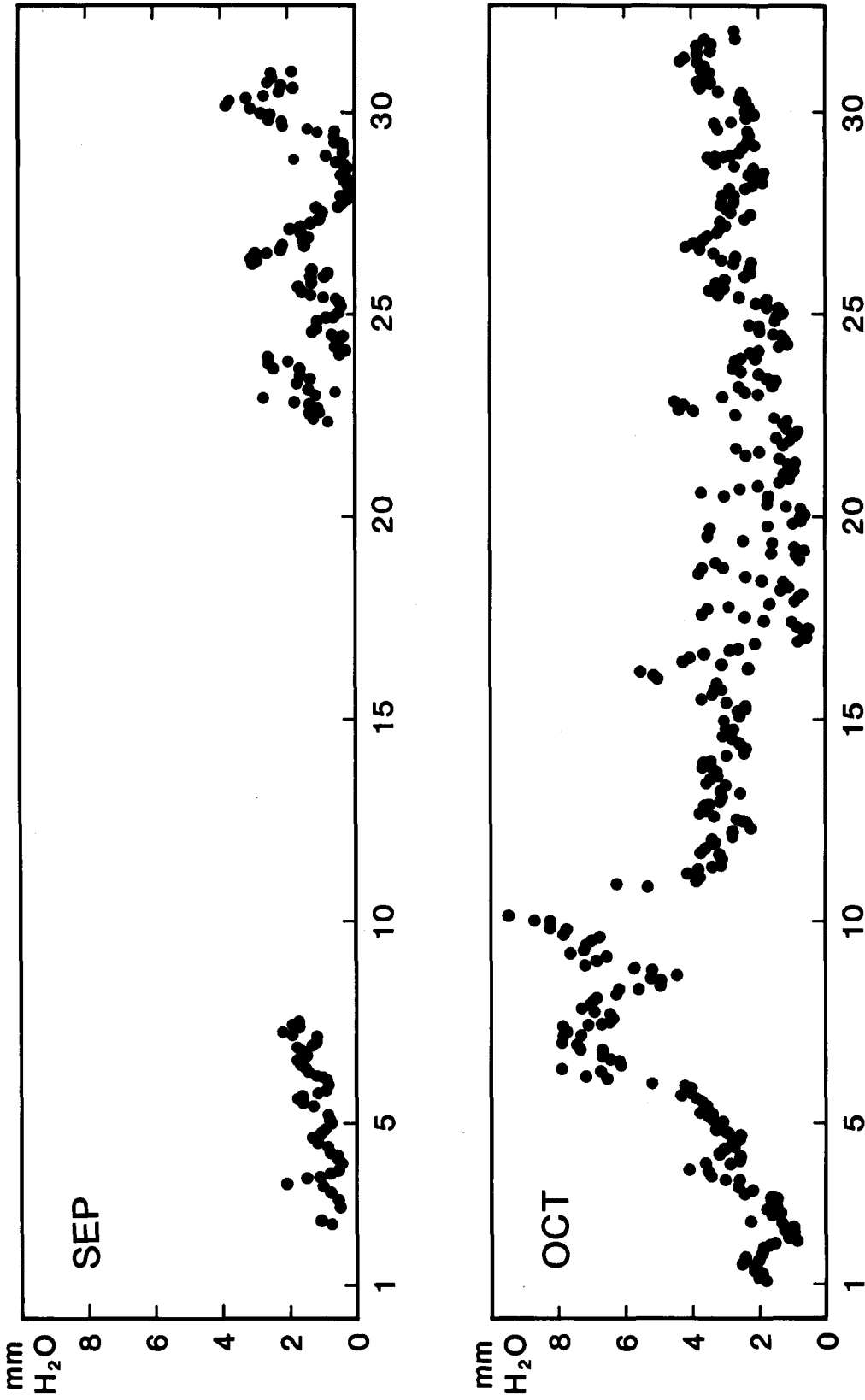


Fig. 3: Integrated atmospheric water-vapour content at Paranal

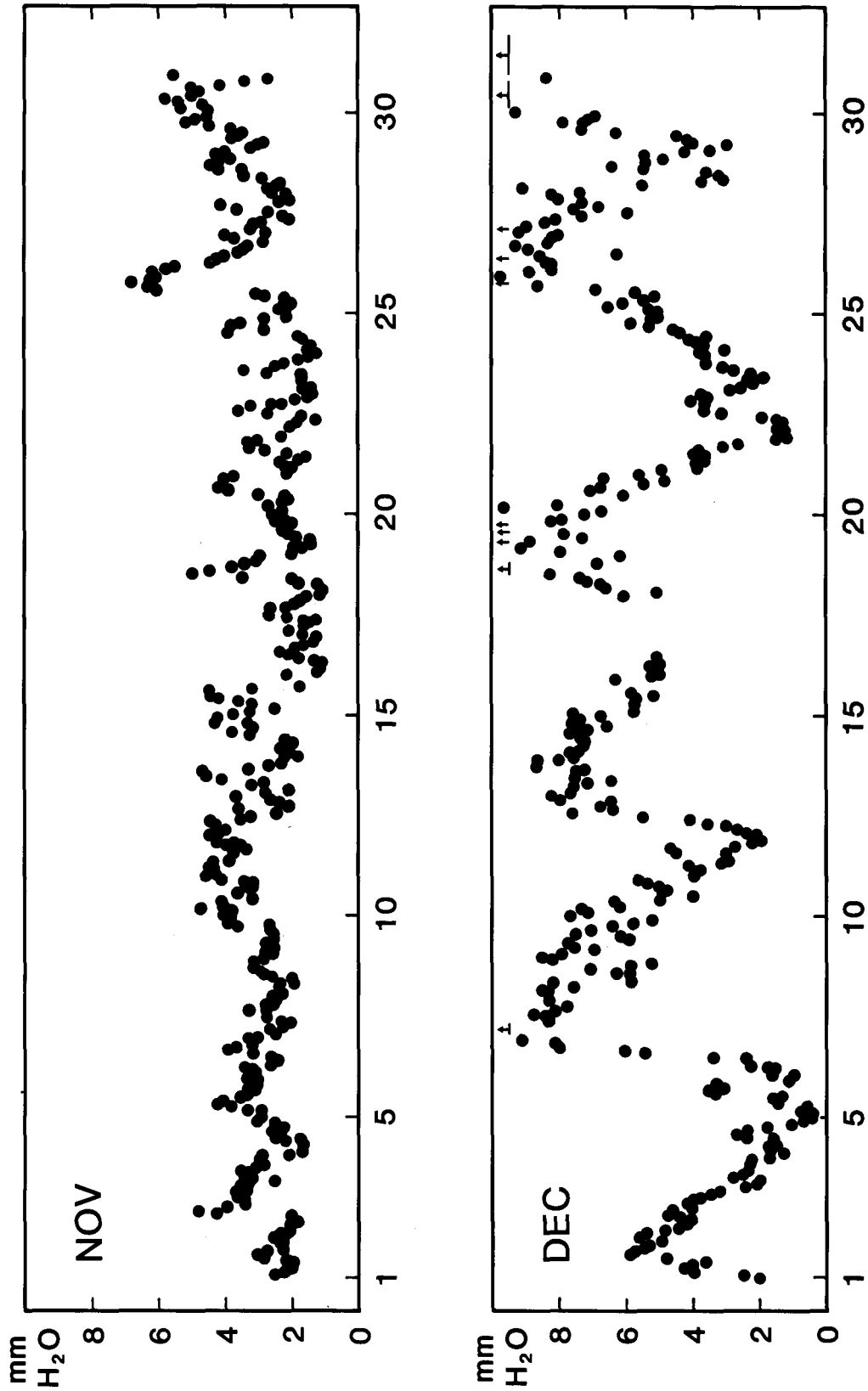


Fig. 4: Same as Figure 3

Temperature statistics seem favourable. The difference between maximum day-time temperature and minimum night-time temperature is only exceptionally more than ten degrees C. The night-time temperature range is normally not beyond two degrees C. The highest day-time temperature recorded is $+24.5^{\circ}\text{C}$, preceded and followed by night-time minima of $+14.5^{\circ}\text{C}$ in both cases. The second-highest temperature recorded is $+22.0^{\circ}\text{C}$, preceded and followed by night-time minima of $+14.0^{\circ}\text{C}$. The lowest night-time temperature recorded is $+2.0^{\circ}\text{C}$ preceded and followed by day-time maxima of $+15.0^{\circ}\text{C}$.

Table 2: Wind-speed statistics for Paranal for September, October and November, 1983. Wind-speed data are given in percent.

Wind speed km h^{-1}	SEP	OCT	NOV
0 - 20	29	45	38
21 - 40	37	41	44
41 - 60	17	9	16
61 - 80	13	5	2
81 - 100	3	0	0
101 - 120	1	0	0

DISCUSSION OF PARANAL DATA

It seems obvious that the sky conditions at Paranal have been rather favourable during the period covered by our observations. At the same time as La Silla has shown quite good over-all conditions, Paranal has turned out considerably better concerning photometric nights. Especially regarding seasonal variations it will be interesting to see statistics for a complete year of sky monitoring.

Whereas the integrated atmospheric water-vapour content is excellent in September it slowly increases in the following months. This is most probably a reflection of a temperature-dependent seasonal trend. Again, data over a more extended observing period will be very interesting. Meanwhile we note the periodic variations in December with a period of around five days and the smaller variations in the first part of September.

The wind-speed statistics available are very satisfactory with low frequency of high wind speeds. It is pointed out that the data in Table 2 refer to late winter and early spring, when winds are normally stronger than in summer time (Fuenzalida, 1984).

Finally, temperature conditions are very satisfactory. This is true for day-to-night variations as well as for variations during the nights.

OTHER SITES

The meteorological data obtained at other sites are much less abundant than those obtained at Paranal. A more significant comparison has therefore to be postponed until more observations have been made. Still, some general remarks may already be made.

Data obtained at Armazoni are normally very similar to those from Paranal. Sky conditions are very much the same. Whereas temperatures are normally somewhat lower at Armazoni, integrated atmospheric water-vapour content is generally not significantly below that at Paranal.

At Sierra del Profeta y Aspera cloudiness tends to be somewhat less favourable than at Paranal. As for Armazoni, lower temperatures are not accompanied by significantly lower amounts of atmospheric water vapour.

The high mountain peaks to the North-North-East of San Pedro de Atacama tend to show the most notable fluctuations in meteorological parameters. Clouds tend to be more abundant than at Paranal but night-time skies are still very clear. Atmospheric water-vapour content is sometimes exceptionally low, but this is not always the case.

Remaining sites are not observed well enough for any relevant comparisons to be made in the present state.

CONCLUSIONS

Meteorological data now available tend to confirm our previous impressions that the part of Chile under investigation presents aspects very favourable for astronomical observations. As a result, our site tests continue. At least for the more immediate future they cover all the possible sites mentioned in the present paper.

REFERENCES

- Ardeberg, A.: 1983, Site Selection for a Very Large Telescope, in Proceedings of ESO Workshop on ESO's Very Large Telescope, Cargèse, 16-19 May 1983, eds. J.-P. Swings and K. Kjär.
- Ardeberg, A.: 1984, Observatorio del Roque de los Muchachos - The Swedish Experience, in Proceedings of ESO Workshop on Site Testing for Future Large Telescopes, La Silla 4-6 October 1983, eds. A. Ardeberg and L. Woltjer.
- Ardeberg, A. and Lindgren, H.: 1984, First Results from Initial Site Testing for a Very Large Telescope in Chile, in Proceedings of ESO Workshop on Site Testing for Future Large Telescopes, La Silla, 4-6 October 1983, eds. A. Ardeberg and L. Woltjer.
- Fuenzalida, H.: 1984, Meteorological Conditions in Northern Chile, in Proceedings of ESO Workshop on Site Testing for Future Large Telescopes, La Silla, 4-6 October 1983, eds. A. Ardeberg and L. Woltjer.
- Woltjer, L.: 1984, Site Testing for the VLT in Northern Chile, in Proceedings of ESO Workshop on Site Testing for Future Large Telescopes, La Silla, 4-6 October 1983, eds. A. Ardeberg and L. Woltjer.