EXPERIENCE IN OPERATING A LIMITED GLOBAL NETWORK OF STATIONS MEASURING FULL-DISC OSCILLATIONS OF THE SUN

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ABSTRACT. Details are given about the operation of a two station network and of a new semi-automatic station which has recently been added. Comparison is made with predicted duty cycles. A possible way of quantifying the sky quality is also given.

1. INTRODUCTION

The spectrum of solar p-modes in the 5-minute region provides a rich but complex source of information concerning the solar interior(1). However, the interpretation of the spectrum is hampered by artifacts generated by noise and by breaks in the data acquisition produced by the day-night cycle, bad weather and instrument failure. If the observations were made from a network of sites distributed around the globe, such breaks would be reduced. This paper presents the performance figures for an actual network of two stations. The operation and performance of a third, semi-automatic station is described. Comparison is made with the predictions of Hill and Newkirk(2).

2. PERFORMANCE OF THE TWO STATION NETWORK

For portions of each year since 1981 manned observations, using optical resonant-scattering spectrometers(3) have been made at Izana on Tenerife and Haleakala in Hawaii. Long stretches of joint operation at the two sites occurred in 1981 and 1984 and performance figures for these years are presented in Table 1a. Ideally these stations provide a coverage of 22 hours per day(4) but the actual duty cycles obtained were 51% (1981) and 49% (1984). These figures refer to the summer season when high insolation is expected(5). Hill and Newkirk(2) use a much higher duty cycle for Hawaii than we have achieved. and give the duty cycle for two stations as 60%.

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Table 1a Performance figures for the two station network in 1981 and 1984

	No. possible days	No. good* days	Avg.hours per good*day	Avg.hours incl.all days
<u>1981</u>				
Tenerife	89	70	8.6	6.7
Hawaii	82	42	7.6	3.9
<u>1984</u>				
Tenerife	126	104	10.9	9.0
Hawaii	89	45	9.7	4.9

*on a good day we use at least 5 hours data

Loss of time due to instrument failure is about 3%

Table 1b Preliminary performance figures for the Australian station December 1985 - May 1986

No. possible days	Days lost due to instrument failure	Days with full data string
137	31	70

It is hoped that a quantitative appraisal of the sites may be made by studying the atmospheric extinction. Tenerife data for Summer 1984 are shown in Figure 1. There is a clear degradation of the site in July and August.

3. IMPLEMENTATION OF THE THIRD STATION

<u>(a) Automation and siting</u>: Our third station is, and subsequent stations will be, semi-automatic as opposed to fully manned. It was constructed in Carnarvon, Western Australia on a site owned by the Overseas Telecommunications Commission of Australia. This site was chosen because it fills the gap between sunset in Hawaii and dawn in Tenerife, the insolation record is good and O.T.C. were willing and able to provide the support required.

<u>(b) Instrumentation and housing</u>: The instrument is a resonant scattering spectrometer operating on the K Fraunhofer absorption line at 769.9 nm, and is similar in principle to that described in ref.3. The Carnarvon instrument is equatorially mounted rather than coelostat fed to avoid the noon shadow at equinox and spurious polarisation effects due to reflections.

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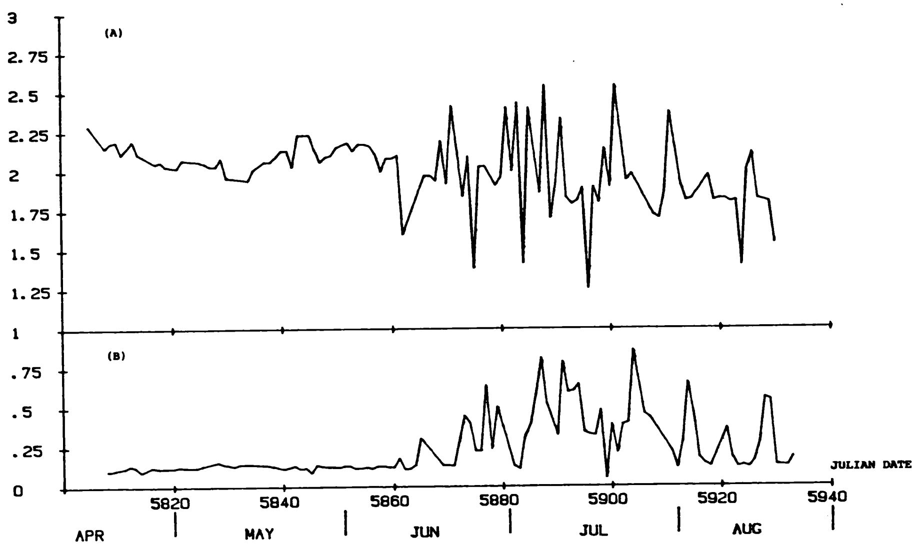

Figure 1 Plots showing atmospheric conditions in 1984 for Tenerife. Transmitted intensity I was fitted to $I_0 \exp(-\mu x)$ for 8 hours per day (4 hours either side of noon), where x is $(\cos(\text{Zenith distance}))^{-1}$. Graph (A) shows I_0 as a function of day; (B) shows μ versus day. It is not yet known if the large variations of I_0 and μ in July and August are typical.

Preliminary tests of the spectrometer were carried out on site in 1984. In 1985 the instrumentation was housed in an air-conditioned, 3.9 m diameter, astronomical dome. To ensure adequate temperature stability a glass window is mounted in the dome slit so that the system is completely enclosed.

(c) Data acquisition and control: The station is under the control of a Hewlett-Packard HP85 computer which takes and stores data, and monitors and maintains the mount and dome operations. Results are taken in 42 sec cycles comprising 5 sec housekeeping, 30 sec of data acquistion and 7 sec statistics and they are stored on magnetic tape. One tape is filled every five days after which an operator replaces the tape, checks the computer clock and the cleanliness of the dome window and instrument apertures.

Both the equatorial mount and the dome window are servo-linked to the Sun, the former to a precision of about 1 sec of arc, the latter so as to keep the mount properly in sunshine. The computer monitors the status of the servo signals and is able to take control of the dome and mount where necessary, such as after a malfunction, or at dusk when the system must be repositioned for dawn. In poor weather the mount is driven in right ascension at 15° per hour without the solar servo and the dome slaves the mount via an infra-red servo loop.

4. RESULTS FROM CARNARVON

The station has been operational since August 1985. Reliability (about 75%) and duty cycle (about 50%) may be estimated from Table 1b which gives preliminary performance figures for the station since late December 1985 when the system was overhauled.

Figure 2 shows the result of a comparison made between measurements at Carnarvon and the proven station at Izana taken on 1st September 1985. Data were calibrated and had known velocities (such as the spin of the Earth) removed. At dawn at Izana and dusk at Carnarvon small non-solar velocity residuals are produced by the differential effect of atmospheric extinction. Hence before plotting, both data strings were subjected to a moving mean analysis. It can be seen that agreement between the sites is good, the r.m.s. deviation between the two data sets being 0.7 ms^{-1}.

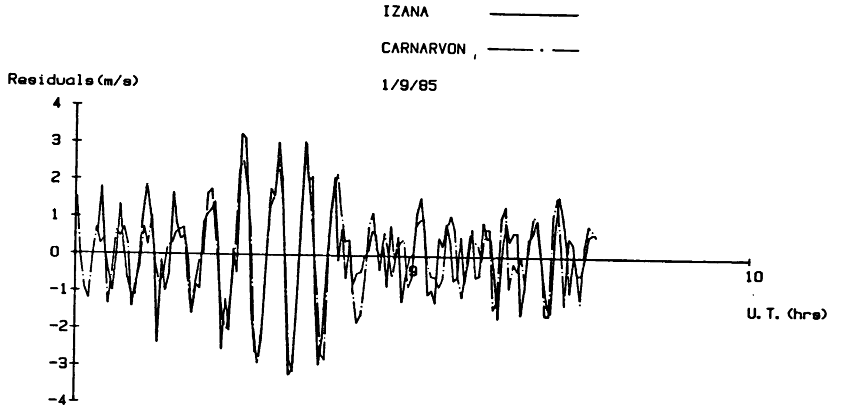

Figure 2 Comparison between velocity residuals obtained in Carnarvon and Izana (see text)

5. COMMENTS

Results from our, as yet incomplete, network of stations suggest that our real instruments have poorer duty cycles than anticipated in Hill and Newkirk's evaluations and that a full network should comprise at least six sites. We have developed a prototype semi-automatic system capable of forming the basis of such a network.

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7. REFERENCES

1. J. Christensen-Dalsgaard, D.O. Gough and J. Toomre, Science 229 (1985) 923

2. F. Hill and G. Newkirk Jr., Sol. Phys. 95 (1985) 201

3. J.R. Brookes, G.R. Isaak and H.B. van der Raay. R.A.S. Mon. Not. 185 (1978) 1

4. A. Claverie, G.R. Isaak, C.P. McLeod, H.B. van der Raay, P.L. Palle and T. Roca Cortes, Mem. S.A. It. 55 (1984) 63
5. P.N. Brandt and H. Wohl, Joint Organisation for Solar Observations Annual Report (1979)