LONG-TERM MODULATION OF COSMIC RAYS DURING SOLAR CYCLE 21

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1. Introduction. In recent years we have reported (1, 2, 3) results from the Australian chain of neutron monitors relating to Forbush-type decreases observed during Solar Cycle 21. It was concluded that the rigidity dependence of the decreases observed in the southern hemisphere during this period is essentially the same now as it was in the previous cycle. Fitting the data from ten Forbush-type decreases of amplitude $\geq 4\%$ during the period September 1977 to January 1983 to a modulation function of the form $\exp(-K/P^{\gamma})$ showed that these events were consistent with $0.5<\gamma<0.9$, with the mean γ-value close to 0.7. In this paper we report a preliminary result concerning the rigidity dependence of the longer-term solar cycle modulation.

2. Neutron Monitors, Data and Methods. The neutron monitors chiefly referred to in this paper are 9NM64-type, located near sea level at Hobart (42.9°S, 147.3°E, vertical cut-off 1.89 GV), Brisbane (27.4°S, 153.1°E, 7.24 GV) and Darwin (12.4°S, 130.9°E, 14.07 GV). The neutron monitor at The Springs at an altitude of 725m on the slopes of Mt.Wellington, overlooking Hobart, is currently a 6NM64, but before 1967 there was a 12-counter IGY-type monitor at this site. By careful normalisation of data from different neutron monitors operated in the Hobart area it has been possible to obtain a continuous record of intensity back to July 1956. Other monitors operated by the Hobart group include a 12-counter IGY-type at Mawson, Antarctica (67.6°S, 62.9°E, 0.22 GV) and IGY-type monitors operated at Lae, New Guinea (6.7°S, 147.0°E, 15.52 GV) for some years beginning with the IGY period, and at Brisbane from 1960 until the 9NM64 was installed. It is hoped that it will be possible in the near future to coordinate the results from these stations to determine the solar cycle modulation during Solar Cycle 20, as observed by these southern recorders.

The 11-year solar cycle modulation was assumed to be of the exponential form with exponent $-K/P^{\gamma}$, as discussed in earlier papers (1, 2, 3). An attempt was made to find a best-fit γ, using monthly mean data selected to be relatively free from Forbush-type decreases. Figures 1 and 2 show respectively the long term changes observed at Mt.Wellington, and daily mean intensities over the 4-months period including the major transient event of July, 1982.

3. Results. The long-term modulation, using monthly mean intensities selected as above, and referred to November 1977 as a normalising level, appear to be in accordance with the exponent $\gamma = 1$, provided only Brisbane and Hobart data are used. Darwin data do not conform to this pattern except perhaps during the early years of the cycle until about the end of 1980, since when the Darwin long-term intensity has been largely steady, apart from Forbush-type decreases and as yet unidentified

small changes of the order of 1%. Thus these results must be regarded as preliminary.

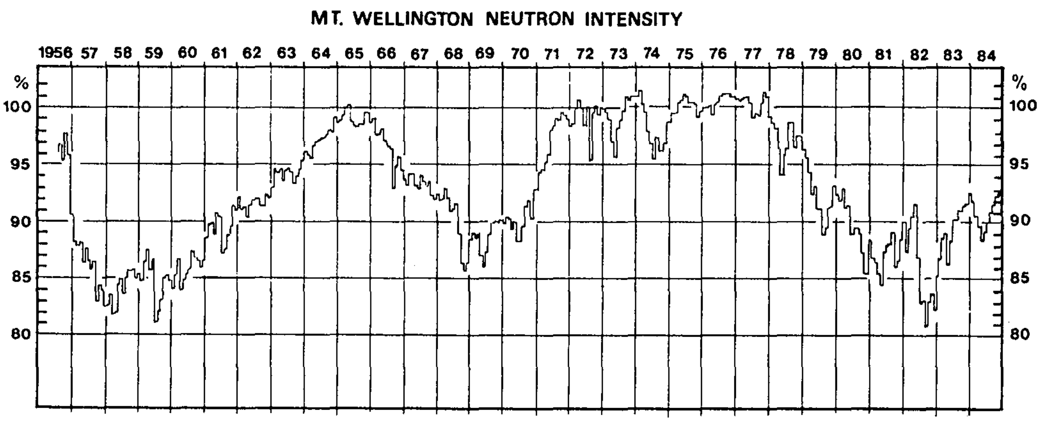
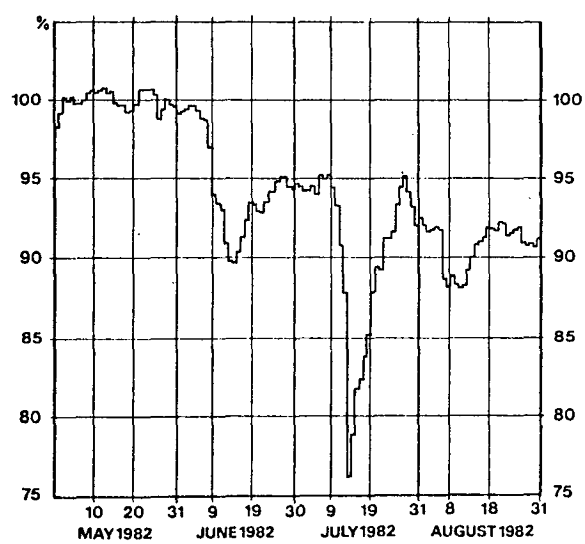


FIGURE 1

Monthly mean neutron intensities relative to May, 1965.

FIGURE 2

Daily mean pressure-corrected Mt.Wellington neutron intensities for May-August 1982, expressed as percent of mean level for May.



4. Discussion. The results seem to confirm the conclusion reached earlier that the Forbush-type modulation and the 11-year cyclic changes have a different rigidity response, and thus is probably caused by different mechanisms under solar influence; however, from our preliminary analysis it may be that the long-term changes have been limited to rigidities below about 10 GV since solar maximum, which occurred in December 1979. This observation would agree with a report by Lockwood and Webber (4) that the observed hysteresis effect between the integral intensity measured by satellite cosmic ray telescopes and Mt.Washington neutron monitor counting rates can be explained by a change in the rigidity dependence of the diffusion coefficient during Solar Cycle 20, 1965-1976, and suggests that similar changes in rigidity response are occurring in the current cycle.

Semi-quantitative evidence against the contention that the long-term solar cycle modulation is made up from superimposed Forbush-type decreases may be obtained from data such as displayed in Figure 2. Here, it may be seen that the very large transient event in July 1982 completely recovered by late July, and that the intensity changes during the period May-August may be considered to be composed of long-lasting possibly stepwise decreases on which the shorter transients are superimposed. Indeed, if the Forbush-type decreases are considered separately, the total 'count' removed by them is only about half the total removed by the longer-term effect.

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6. References.

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