

ELEMENTAL ABUNDANCES IN COROTATING EVENTS

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1. Introduction. Large, persistent solar-wind streams in 1973 and 1974 produced corotating interaction regions which accelerated particles to energies of a few MeV/nucleon. The proton to helium ratio (H/He) reported in reference (1) was remarkably constant at a value (22 ± 5) equal to that in the solar wind (21 ± 3), suggesting that particles were being accelerated directly out of the solar wind. In this paper we report on preliminary results from a similar study approximately 11 years (i.e., one solar cycle) later. Corotating events have been identified by surveying the solar wind data, energetic particle time-histories and anisotropies. This data was all obtained from the ISEE-3/ICE spacecraft. These events also show H/He ratios similar to that in the solar wind. In addition, we have examined other corotating events at times when solar flare events could have injected particles into the corresponding corotating interaction regions. We find that in these cases there is evidence for H/He ratios which are significantly different from that of the solar wind but which are consistent with the range of values found in solar flare events.

2. Results. In Figure 1 we present a 27-day recurrence plot of the solar wind speed obtained from the Los Alamos National Laboratory Solar Wind Experiment on the ISEE-3 spacecraft (now renamed ICE); this data was processed by a simplified algorithm adequate for this purpose and is not to be considered definitive. ICE at this time was near 1 AU, leading the Earth in its orbit. Figure 1 shows the formation of two recurrent solar wind streams. A similar plot for the interplanetary magnetic field direction shows that these two streams are in opposite portions of a two sector magnetic field pattern. Using Figure 1 and particle time-history plots, we identified eight different time intervals as candidate corotating events. Low energy electron rates and high energy proton rates were scanned for any evidence of impulsive (solar) origin. In addition, anisotropy data was examined for apparent flow from the east. (Corotating events typically have particle flow from the east. This results from the vector sum of the radial Compton-Getting anisotropy due to the outward flow of the solar wind and the backward flow along the interplanetary magnetic field lines from the presumed acceleration region at several AU from the Sun.) The H/He ratio was evaluated for each interval in the energy range 4.5-6.5 MeV/nucleon. Also the C/O ratio was evaluated in the energy range 1.8-2.8 MeV/nucleon. Averaged over all eight intervals we find $H/He = 20 \pm 8$ and $C/O = .8 \pm .2$ (to be compared with $H/He = 22 \pm 5$ and $C/O = .8 \pm .2$ in reference (1)).

Other time periods since the launch of ISEE-3 in 1978 have been examined in a similar manner. A long-lived high-speed stream gave rise to a brief but apparently clean corotating event August 1-4, 1979. The

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anisotropy data shows clear evidence of backwards flow into the inner solar system. The previous two appearances of this stream were associated with large solar flares. Evaluating the H/He ratio for August 1-2 we find $H/He = 67 \pm 4$, distinctly different from the ratios found in 1984. On the other hand, this value is well within the range found for solar flares (e.g., 20 to 156 cited in reference (1)).

Conclusions. Corotating events associated with two recurrent high-speed streams in 1984 show evidence that their source population is the solar wind, as was also found in reference (1) for streams existing approximately 11 years earlier. Evidence has been presented however that other corotating events are dominated by particles injected by solar flares.

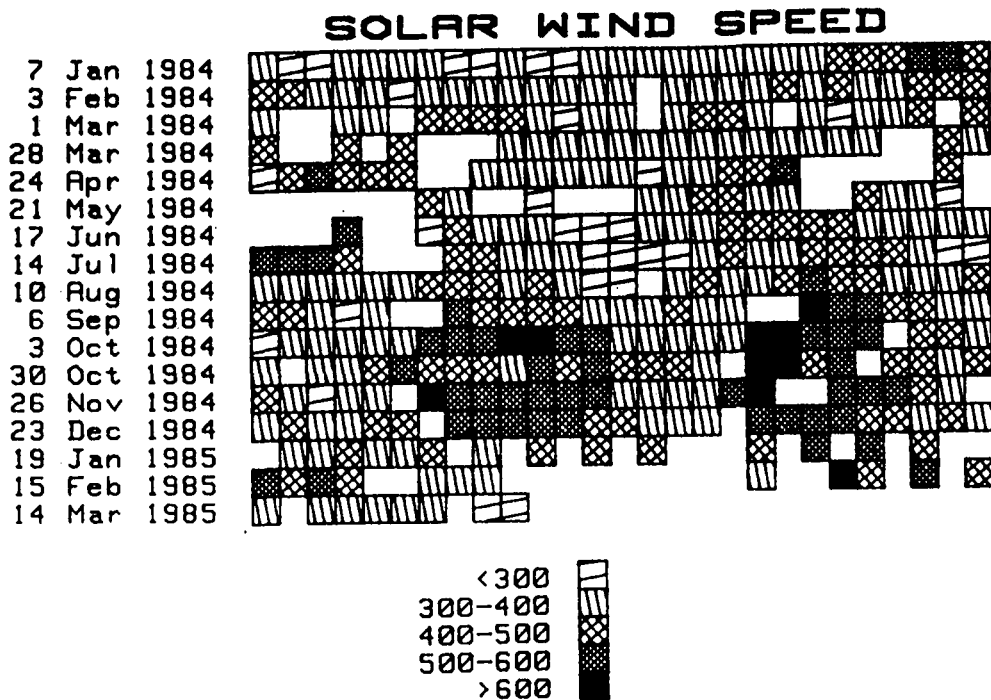


Figure 1

References

1. McGuire, R. E., T. T. von Rosenvinge, and F. B. McDonald, *Ap. J.*, 224, L87, 1978.