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RELATION OF THE OBSERVED FAR ULTRAVIOLET SOLAR IRRADIANCE TO THE SOLAR MAGNETIC SECTOR STRUCTURE

(Research Note)

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Abstract. Comparison of the observed solar far ultraviolet irradiance and the observed solar sector structure during 1969 through 1972 shows a tendency for EUV maxima to be located near sector boundaries.

An influence of the solar magnetic sector structure on terrestrial atmospheric vorticity has been reported recently by Wilcox *et al.* (1973, 1974, 1975). To begin an investigation of the physical cause(s) of this effect it is necessary to consider all solar quantities that may influence the terrestrial atmosphere. We report here a tendency for the observed far ultraviolet solar irradiance to maximize near observed solar sector boundaries. A description of the solar sector structure is given in Wilcox (1968, 1975). The EUV observations were made with the Monitor of Ultraviolet Solar Energy (MUSE) experiments that were launched aboard Nimbus-3 in April 1969 and Nimbus-4 in April 1970. A preliminary discussion of the large-scale EUV irradiance and the solar sector structure has been given by Heath and Wilcox (1974).

The MUSE experiment has been described in detail by Heath (1973). It consists of five broadband photometers which respond to solar radiation from 115 nm to 300 nm. Since the instrument was flown on the Sun-synchronous Nimbus-3 and Nimbus-4 satellites it has been possible to observe the intrinsic variability of the Sun as an EUV variable star. For the present investigation we have used observations obtained with sensor A which is sensitive to wave lengths near 121.6 nm (for a complete description see Heath (1973)). The observations were obtained in the interval from April 1969 through November 1972. Since there are usually two or four sectors per 27-day solar rotation period. we are interested in UV variations on a corresponding time scale. We, therefore, divided the observed EUV intensity for each day by a 27-day mean centered on that day and the results are expressed in arbitrary units. This removes the effects of long-term sensor degradation. During any individual solar rotation the sensor degradation was very small.

The average variation in EUV intensity with respect to 117 sector boundaries is

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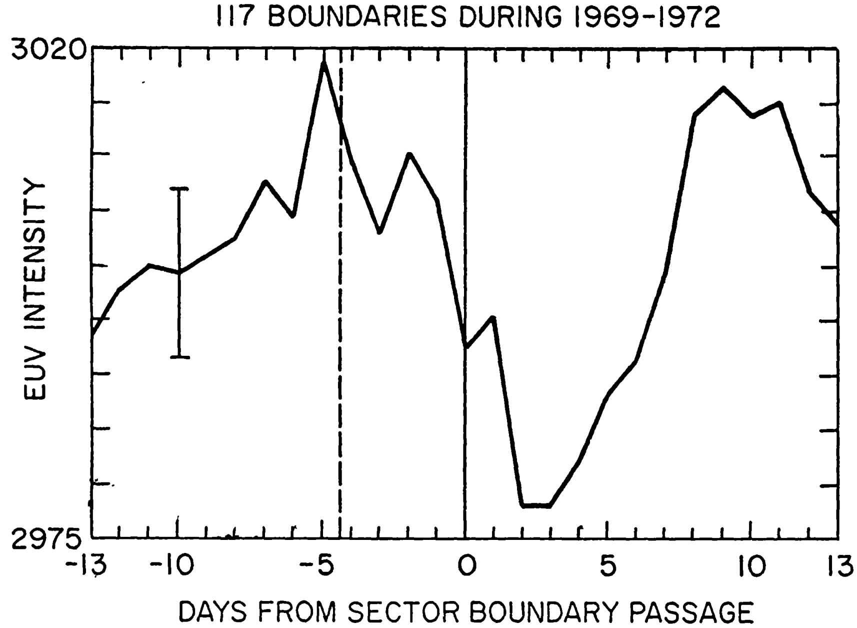

Fig. 1. The average variation of observed UV irradiance with respect to observed solar sector boundaries. In the abscissa 0 represents the time at which a sector boundary was swept past the Earth by the solar wind. The dashed vertical line represents the time at which this sector boundary was near central meridian on the Sun. The error bar shows a typical standard error of the mean EUV irradiance about the 117 boundary passages during 1969–1972 used in this analysis.

shown in Figure 1. The abscissa of Figure 1 can be considered in either terrestrial or in solar terms. It directly represents a time scale at Earth in which 0 is the time at which a sector boundary was observed to be carried past the Earth by the solar wind. The times of sector boundary passages were obtained primarily by spacecraft magnetometer obrsevations, supplemented by the interplanetary field polarity as inferred from polar geomagnetic observations (Svalgaard, 1975). The average transit time for the solar wind to carry a sector boundary from the Sun to the Earth is about $4\frac{1}{2}$ days. A boundary observed at Earth on day 0 in Figure 1 would have been at central meridian on the Sun about $4\frac{1}{2}$ days earlier. A dashed vertical line is drawn in Figure 1 to represent the time at which a sector boundary was near central meridian on the Sun. In solar terms the abscissa of Figure 1 can then be considered to represent heliographic longitude measured from the dashed line that represents the longitude of a solar sector boundary. Each day then corresponds to about 13° of solar longitude.

Figure 1 shows the average EUV irradiance peaks near the dashed line that represents longitude of a solar sector boundary. The other maximum near day 9 is also near a sector boundary, since during most of the interval investigated there were two sectors per solar rotation. The range from maximum to minimum in Figure 1 is about $1\frac{1}{2}\%$.

An alternative representation of the relation between the heliographic longitude of EUV maxima and the longitude of sector boundaries is shown in Figure 2. In the preparation of this figure the daily EUV observations were plotted and the time of relative maxima (and minima) of variations that were several days in width were determined. Using the terrestrial sector boundary passage list of Svalgaard (1975)

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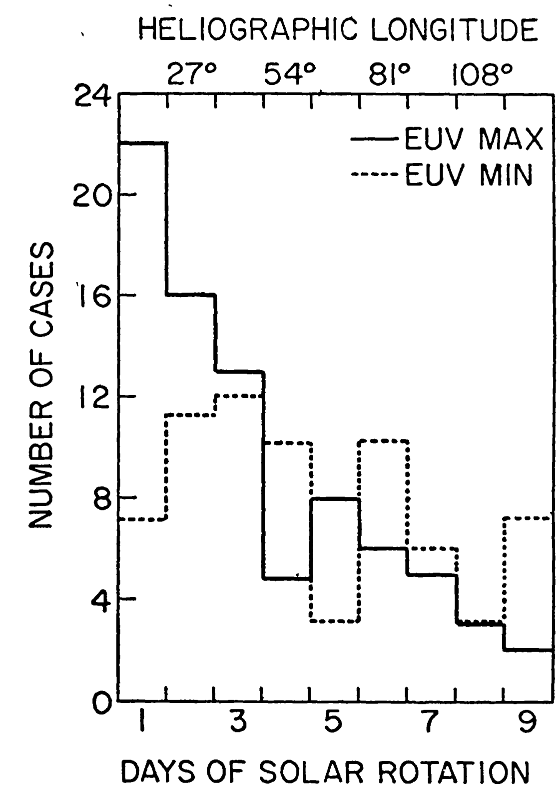

Fig. 2. Solid line: histogram of the distance in heliographic longitude from the longitude of an EUV maximum to the longitude of the nearest solar sector boundary. Dashed line: same for EUV minima.

translated to the Sun assuming a $4\frac{1}{2}$ day transit time, the interval from the time of each EUV maximum to the time at which the nearest sector boundary was at central meridian on the Sun was determined. Figure 2 shows a histogram of these times (maxima: solid line; minima: dashed line). As already discussed above, and as shown in the top abscissa scale of Figure 2, this can be considered to represent the difference in heliographic longitude between the longitude at which the EUV was a maximum and the longitude of the nearest sector boundary. A clear prominence of EUV maxima near solar sector boundaries is shown in Figure 2. We also note, however, that several EUV maxima are located several tens of degrees of longitude away from the nearest sector boundary. The EUV minima are not clearly organized by this analysis.

It thus appears that on the Sun the large scale structure of EUV irradiance is related to the sector structure. Possible terrestrial influences of the large-scale structure of EUV irradiance are under investigation.

Acknowledgements

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