

SOLAR CYCLE EFFECTS IN EQUATORIAL SPREAD F

R. G. RASTOGI AND G. D. VYAS

Physical Research Laboratory, Ahmedabad 380 009 (India)

ABSTRACT

The occurrence of Range type of equatorial spread F at Huancayo for the period 1957 to 1975 has been shown to inversely related to the Zurich sunspot number. The occurrence of Frequency type of spread F is practically independent of solar cycle. Both types of spread F show very large seasonal variation, being present on the average 40% of night time during December (local summer) months and only 5 % of night time during June (local winter) months. The decrease in the occurrence of Range type of spread F during high sunspot years when the post-sunset rise of the F layer is most predominant poses problems in the simple theory of spread F on the F region rise after sunset.

INTRODUCTION

RECENT interests in the transionospheric radio propagation between a satellite and a ground station have almost created explosive studies on equatorial spread F due to its effect on the VHF and UHF radio propagations. The ionospheric data collected during IGY-IGC period had clearly demonstrated the existence of a belt of intense spread F activity between 20° N and 20° S dip latitude (Shimazaki⁶, Wright⁸, Singleton⁷, Chandra and Rastogi¹, showed that the spread F index increased with solar activity at most of the equatorial stations Kodaikanal, Djibouti, Ibadan, but the spread F index at Huancayo during any of the seasons decreased with increasing solar activity. The examination of ionograms at Thumba, a station very close to the magnetic equator, revealed that the equatorial spread F is basically of two types (i) Range spread which occurs in the pre-midnight periods and is correlated with the post-sunset rise of the F region and (ii) Frequency spread which is usually seen in predawn periods (Chandra and Rastogi²). Sastri and Murthy⁵ confirmed that the spread F at Kodaikanal was basically of Range type during pre-midnight period and of Frequency type during post-midnight period. Recently Rastogi and Vyas⁴ have shown that during the high sunspot years the predominant type of spread at Huancayo was Frequency type while during low sunspot years both the types were present. In this note we present the solar cycle variation of nightly average spread F of the two types at Huancayo for the period 1957 to 1975. These results have been extracted from the *f*-plots of Huancayo kindly supplied by the World Data Center A for Geophysics at Boulder (Colo.), U.S.A.

RESULTS

In Fig. 1 are shown the seasonal variation of Frequency and Range spread averaged over the entire period of observation at Huancayo. It is seen that either type of spread is most frequent during December solstices (local summer) and minimum during June solstices (local winter) and no indication of any semi-annual variation is seen. Further on average Frequency spread is slightly more common than the Range spread.

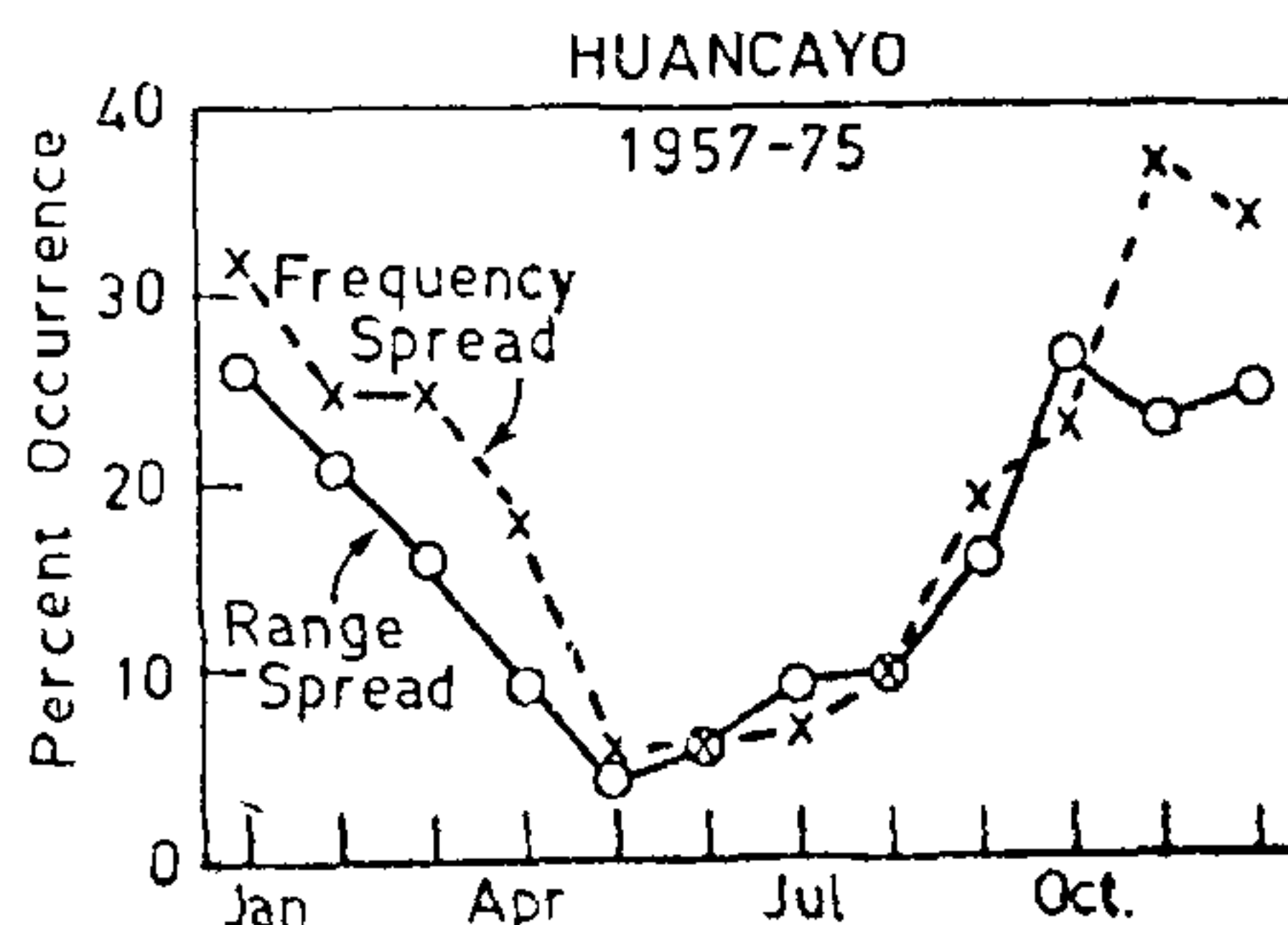


FIG. 1. Seasonal variation of Frequency and Range spread averaged over the period 1957 to 1975.

In Fig. 2 are shown the relation between the occurrence frequency of Range and Frequency spread at Huancayo versus the corresponding Zurich sunspot number separately for the four different seasonal groups of the year (December to February, March to May, June to August and September to November). The least square fitting straight lines, through these data points, are also indicated in the diagram. It is seen from the diagram that the occurrence of frequency spread is practically

independent of sunspot number; the change in occurrence is only about 1 or 2% of the change of sunspot number. Regarding the Range spread, its occurrence frequency is negatively correlated with sunspot number. During September–November or December–February seasons, the sensitivity of the spread is about 20% of the sunspot number. During other seasons the sensitivity is relatively lower. Thus the sensitivity of Frequency spread to changes of sunspot number is higher for the months when the spread is more common and it is less sensitive when the occurrence of spread F is relatively lower.

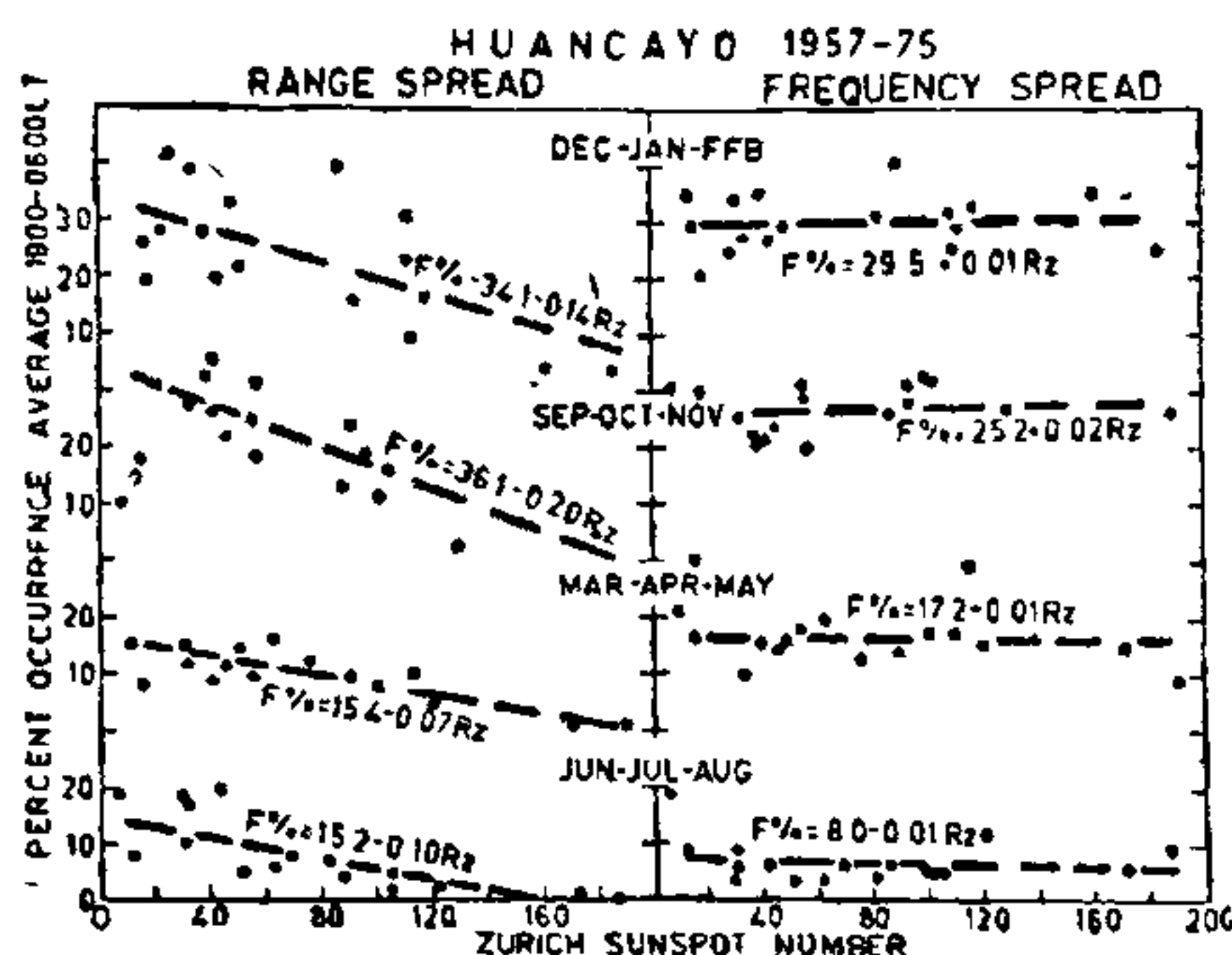


FIG. 2. Relation between the occurrence of Range and Frequency spread at Huancayo versus the corresponding Zurich sunspot number for four different seasons.

It has been shown by Rastogi and Vyas⁴, that the Frequency spread is maximum around midnight or

after midnight while Range spread is maximum around 21–22 hrs.

The pre-midnight spread F is shown to be associated with the post-sunset rise of the F region generated by the evening peak of the eastward electric field in the F region (Rastogi³). The evening peak of the E–W electric field in the F region is most pronounced during high sunspot years when the Range spread is least pronounced. Thus whereas Range spread is closely correlated with the electric field on shorter term variations, it is not so with very long term variations. Evidently there are no simple causes for the equatorial Range spread and many aspects of its variations still need to be identified.

ACKNOWLEDGEMENTS

The authors are thankful to Dr. Alan H. Shapley for supplying the data used in the present analysis. This forms a part of the integrated study of the equatorial spread F supported by the Arthur L Day Grant No. 30 of the U.S. Academy of Sciences. The research at PRL is financed by the Department of Space, Government of India.

1. Chandra, H. and Rastogi, R. G., *J. Atmos. Terr. Phys.*, 1970, 32, 439.
2. — and —, *Ann. Geophys.*, 1972, 28, 37.
3. Rastogi, R. G., *Ibid.*, 1977 (In press).
4. — and Vyas, G. D., *Proc. Ind. Acad. Sci.*, 1977 (In press).
5. Sastri, J. H. and Murthy, B. S.; *Ann. Geophys.*, 1975, 31, 285.
6. Shimazaki, T., *J. Rad. Res. Lab.*, 1959, 6, 669.
7. Singleton, D. G., *J. Geophys. Res.*, 1960, 65, 3615.
8. Wright, R. W., *Ibid.*, 1959, 64, 2203.

JAMNALAL BAJAJ FOUNDATION—AWARDS

JAMNALAL BAJAJ FOUNDATION SOLICITS RECOMMENDATIONS FOR JAMNALAL BAJAJ AWARDS :—

- * A Cash Award of rupees one lakh annually to an institution/institutions and/or an individual/individuals for outstanding contribution in any one or more fields of constructive work.
- * A Cash Award of rupees one lakh annually to an eminent scientist/scientists and/or institution/institutions for pioneering research done on the application of Science and Technology for rural development.
- * Two Awards every year in the form of plaques to Industrial and business organisations for rendering community service. One each for service rendered in RURAL and URBAN areas. The first Awards will be given in NOVEMBER 1978.

For detailed information regarding rules, procedures and guidelines write to :

JAMNALAL BAJAJ FOUNDATION
226, Nariman Point, Bombay 400 021.