JOURNAL OF GEOPHYSICAL RESEARCH, VOL. 85, NO. A3, PAGES 1343-1344, MARCH 1, 1980

COMMENT ON 'ON POSSIBLE CAUSES OF APPARENT LONGITUDINAL VARIATIONS IN OGO 3 OBSERVATIONS OF VLF CHORUS' BY C. T. RUSSELL

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A recent analysis of chorus emissions detected by the OGO 3 satellite [Luette et al., 1977] showed that the emissions tend to occur more frequently along longitudes that contain industrial centers which are located at high latitudes. The authors suggest that power line harmonics (PLH) generated by these centers leak into the magnetosphere and stimulate chorus emissions through cyclotron resonance between PLH and trapped energetic electrons. On the other hand, Russell [1980] suggests that the geographic peaks in chorus activity are not related to man-made radiation but are produced by the satellite's orbital period of 2 days and 33 min, which combines with the earth's rotation to produce a 90° longitudinal periodicity in the orbital parameters. He suggests that longitudes which showed peak chorus activity might have been sampled most frequently when the satellite was in a range of magnetic latitudes or local time sectors where chorus activity is the highest. In this Comment we examine the actual distribution of data samples used by Luette et al. [1977] and show that the longitudinal variation in chorus activity could not have been produced by biased sampling.

First, we consider the possibility of biased sampling in local time. Chorus is known to occur predominantly in the dawn-to-noon local time sector [Russell et al., 1969; Burtis and Helliwell, 1976]. Therefore the percentage of the OGO 3 passes that occurred in this local time sector has been calculated for each 10° longitude increment, and the results are plotted in Figure 1. The horizontal bars at the top of the figure indicate the longitudes of highest chorus occurrence rates [Luette et al., 1977]. It is clear that these high chorus occurrence rates are not due to preferential sampling in the dawn-to-noon sector. The longitudinal periodicity in sampling, referred to by Russell, does not appear in the figure. The reason is that the VLF data were not acquired continuously because of operational constraints such as tracking station operation, interference from other experiments, and poor telemetry. Taken together, these factors tend to wash out any sampling pattern that might be expected from the orbit period.

To search for a possible latitudinal sampling bias, the OGO 3 data set was subdivided into two groups, data from the six 10° longitude bins which comprise the four chorus peaks and the data from the remaining 30 longitude bins. Figure 2 shows the average number of passes through each 10° magnetic latitude for the six active longitude bins (dashed curve). From this figure it is clear that there was no significant difference in latitudinal distribution of data samples between the longitudes with the highest chorus rates and those with low chorus rates. Thus the longitudinal variations in chorus activity cannot be due to latitudinal sampling bias.

It is important to distinguish chorus intensity and chorus occurrence rate. Although chorus intensities may be strongest near the magnetic equator, as was noted by Russell, the Luette et al. [1977] study deals with the occurrence of chorus, independent of its intensity. The earlier chorus study by Burtis and Helliwell [1976] showed that the occurrence rate peaked at ~40° latitude, not at the equator.

Russell states that the north-south asymmetry in the chorus distribution may be due to the satellite's orbit. He argues that inbound passes are in the southern hemisphere but closer to the magnetic equator than outbound passes, which occur at higher latitudes in the northern hemisphere. If the north-south asymmetry in chorus occurrence rate were in fact due to biased sampling, we would predict higher occurrence rates in the northern hemisphere. This is the opposite of the results reported by Luette et al. [1977].

Russell's claim that the Luette et al. [1977] paper provides 'something for nothing' is easily refuted. Satellite surveys have shown that the intensity of power line harmonics in the magnetosphere is frequently below the threshold of most receivers [Luette et al., 1979]. These signals can, however, interact with the trapped energetic particles in the magnetosphere and either be amplified or trigger strong emissions. It has been shown that discrete emissions show temporal growth of 20-40 dB [Helliwell and Katsufrakis, 1974; Stiles and Helliwell, 1977; Burtis and Helliwell, 1975]. Power line radiation, although weak, is coherent, which allows it to be readily amplified to a level that can trigger strong emissions such as chorus [Luette et al., 1979].

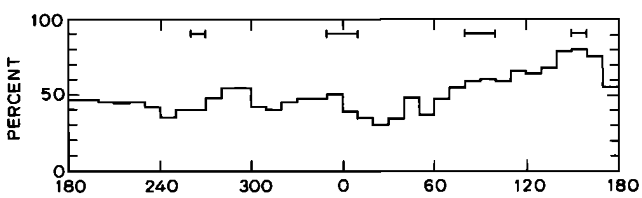

Fig. 1. Percentage of the OGO 3 passes that occurred in the dawn-to-noon local time sector for each 10° longitude increment.

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Paper number 9A1640.
0148-0227/80/009A-1640$01.00

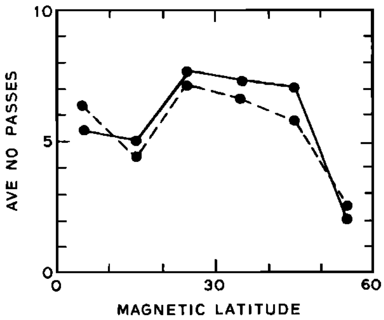

Fig. 2. Average number of passes through each 10° latitude for the six active longitude bins (solid curve) and for the 30 longitudinal bins which contained low chorus activity (dashed curve).

In the Luette et al. study the data set was carefully examined to insure that all longitudes were sampled under similar conditions (local time, magnetic activity, seasons, etc.) and that the observed peaks in the occurrence of chorus were not due to biased sampling. We reaffirm our conclusion that the peaks were not produced by sampling bias and that there appears to be a connection between chorus and industrial centers.

Acknowledgments. This study was supported in part by the National Aeronautics and Space Administration under grant NGL-05-020-008, the National Science Foundation, Atmospheric Sciences Section, under grant ATM78-20967, and the United States Department of Energy.

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(Received February 28, 1979;
revised September 25, 1979;
accepted October 10, 1979.)