JOURNAL OF GEOPHYSICAL RESEARCH, SPACE PHYSICS VOL. 73, NO. 1 JANUARY 1, 1968

Triggering of VLF Magnetospheric Noise by a Low-Power (~100 Watts) Transmitter

I. KIMURA[1]

Radioscience Laboratory, Stanford University, Stanford, California 94305

The phenomenon of artificial triggering of VLF noise in the magnetosphere has been reported by *Helliwell et al.* [1964] and by *Helliwell* [1965]. In the cases described thus far, Morse-code transmissions from NAA at Cutler, Maine (~10^6 watts), or from NPG at Jim Creek, Washington (~2×10^5 watts), were observed to propagate to the conjugate hemisphere in the whistler mode and to trigger a variety of discrete noise forms. A characteristic feature of the data was preferential stimulation of noise by dashes as opposed to dots.

Many examples of NAA triggering have been observed during the austral winter at Eights, Antarctica, a station located approximately conjugate to NAA. The purpose of the present note is to announce observations at Eights of triggering by the low-power, ~100-watt 10.2-khz transmissions from the Omega station at Forest Port, New York.

An example of this phenomenon is shown in Figure 1 in coordinates of frequency from 5 to 15.5 khz versus time in seconds. A sequence of ~1-sec pulses from the Forest Port transmitter appears at the 10.2-khz level. Many of the pulses exhibit irregular broadening, and are followed by faint rising tones of relatively long duration and also by shorter falling tones. Morse-code transmissions from NAA at 14.7 khz appear near the top of the record. Both whistler-mode and direct subionospheric signals are present, but triggering is limited to occasional brief falling tones, barely evident in the illustration.

Four intervals of Omega triggering were found in a study of 643 of the broadband synoptic 2-min/hr recordings made at Eights in the austral winter of 1963. The approximate field-line path of propagation was determined from natural whistlers by identifying the particular whistler component whose travel time at 10.2 khz equaled that of the Omega pulse. A survey of NAA triggering in the same period leads to the comparison of the two types of event presented in Table 1.

In spite of NAA's location at a higher geomagnetic latitude, the typical NAA triggering path has a smaller equatorial radius than does the Omega path, suggesting some type of gyrofrequency control over ducted magnetospheric propagation from the two sources.

The observation of triggered noise from a source radiating only ~100 watts is made more remarkable by the occurrence of examples well after sunrise in the hemisphere of the transmitter. The attenuation of the upgoing signal in the daytime ionosphere has been estimated by *Helliwell* [1965] to be about 20 db. Additional losses over the path due to leakage from ducts, spreading, etc., must be considered, and it is therefore suggested that in the triggering process, the amplitude of the initiating wave is not a primary factor.

TABLE 1. Observations of NAA and Omega Triggering at Eights, Antarctica, in May, June, and July 1963

	NAA	Omega
Transmitter frequency, khz	14.7	10.2
Radiated power, watts	~10^6	~10^2
Geographic longitude of transmitter, west	67°39′	75°05′
Geomagnetic latitude of transmitter, deg	56	55
Equatorial radius of field-aligned path, R_E	2.6–3.2	3.5–3.7 (4 cases)
Most probable time of occurrence, LT	1600–0900	0500–0900
Occurrence frequency at peak hour, per cent of total days	~25	~1–3

[1] Present address: Department of Electronics, Kyoto University, Kyoto, Japan.

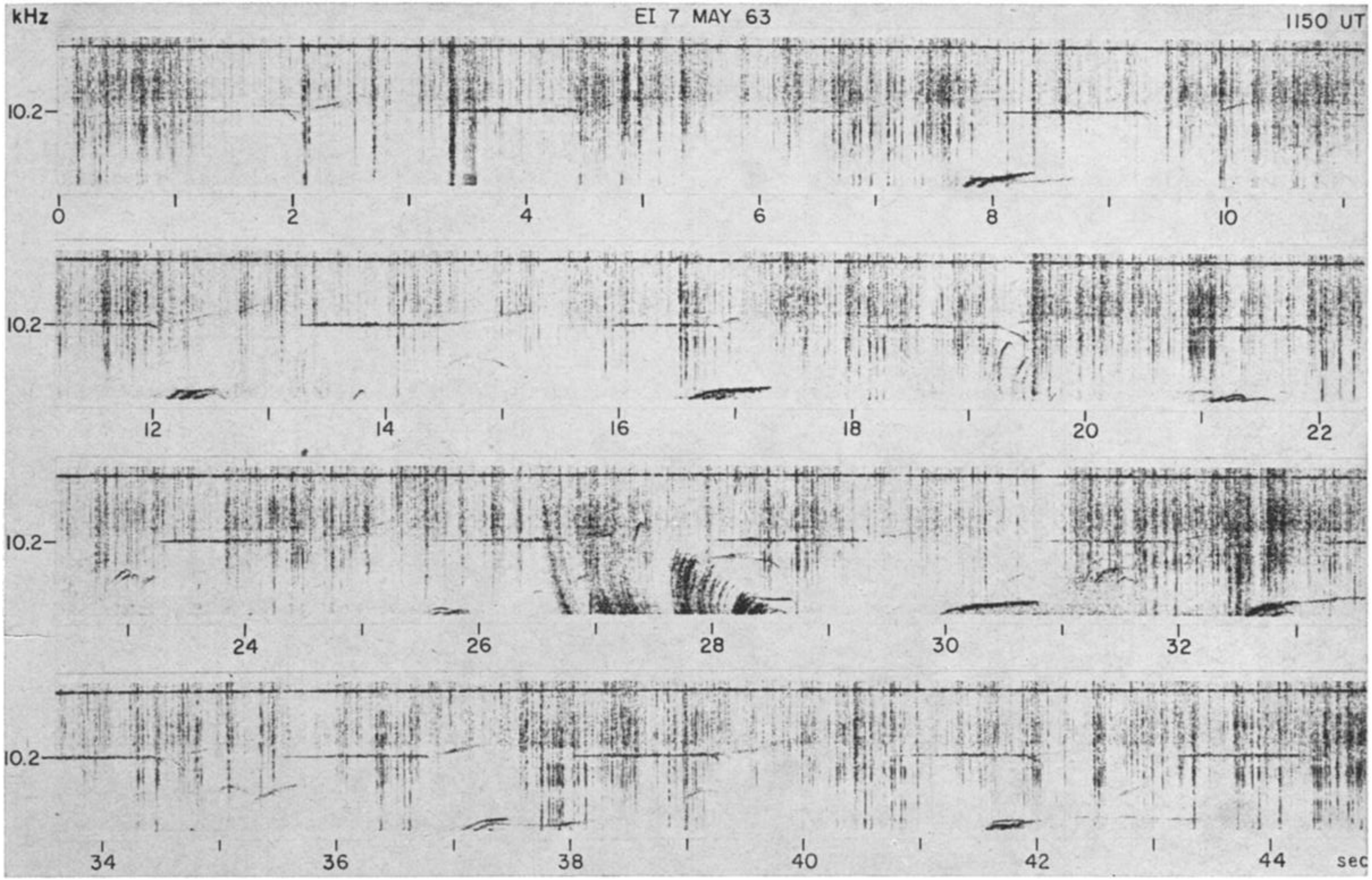

Fig. 1. Spectrum in range 5–15.5 khz illustrating triggering of noise by 10.2 khz Omega transmissions. The observed ~1-second 'pulses' propagated in the whistler mode; the direct subionospheric signal is not evident. Faint evidence of short falling tones triggered by NAA at 14.7 khz appears at $t = 0$–3 and $t \sim 28$ seconds. The data were recorded at Eights, Antarcitca ($L \sim 4$, 77°10′W geographic longitude).

Acknowledgments. I would like to thank Professor R. A. Helliwell, Mr. J. Katsufrakis, and Dr. D. L. Carpenter for helpful discussions and for advice in preparing this note.

This research was supported in part by the Office of Antarctic Programs and the Atmospheric Sciences Section of the National Science Foundation, and in part by the U. S. Air Force, Office of Scientific Research of the Office of Aerospace Research.

References

Helliwell, R. A., *Whistlers and Related Ionospheric Phenomena,* Stanford University Press, Stanford, California, 1965.

Helliwell, R. A., J. Katsufrakis, M. Trimpi, and N. Brice, Artificially stimulated very-low-frequency radiation from the ionosphere, *J. Geophys. Res., 69,* 2391, 1964.

(Received October 10, 1967.)