SHORT COMMUNICATIONS

LOW LATITUDE REFLECTIONS FROM THE AURORA AUSTRALIS*

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Over the past 10 years, radio reflections from aurorae have been fairly extensively studied in the northern hemisphere (Bullough and Kaiser 1954; Booker, Gartlein, and Nichols 1955). The southern auroral zone, however, is so far removed from habitable land that very little information has yet become available on the aurora australis. Visual observations are relatively slight, and radio observations are only now commencing.

In March of this year, at the Radio Observatory of Canterbury University College, situated 14 miles from Christchurch, New Zealand, at lat. 43·6 °S., long. 172·6 °E., geographic, and lat. 47·8 °S. geomagnetic, a search was started for possible radio reflections from the southern aurorae, although the station is at a very low geomagnetic latitude for such studies.

Equipment parameters used in the experiment are as follows:

Transmitter	
Radio frequency	69 Mc/s
Pulse recurrence frequency	75 p.p.s.
Pulse length	20 μsec
Aerial	
Polarization	horizontal
No. of half wave elements	12
Power gain over isotropic radiator	120
Azimuthal half-power points	$\pm 12°$
Elevational half-power points	5·5 and 19·5°
Direction: great circle path to geomagnetic S. pole	195° geographic
Receiver	
Detection sensitivity for P.R.F. and pulse lengths as stated	6×10^{-14} W at aerial terminals
Noise figure	4 dB absolute
Bandwidth	300 kc/s

The maximum angle of aerial elevation from which a radio reflection can be expected on Chapman's (1953) geometrical theory of auroral echoes is given by $\varepsilon_{max.}=\tan^{-1}(\frac{1}{2}\tan\alpha)$, where α is the co-latitude. For the present observatory

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$\alpha = 42 \cdot 2°$, giving a maximum reception angle of 24°, which lies near the upper half-power point of the aerial polar diagram. Since, however, aurorae are seldom seen below a minimum height of 90 km, the maximum elevation angle may be considered to be 21°. The maximum height of echo reflection will be about 250 km, corresponding to an angle ε which has fallen to the lower half-power point.

A graph showing the range-height relationship in terms of aerial elevation angle is given in Figure 1. Following Chapman (1953), it is assumed that any echo region will lie along the Earth's magnetic lines of force, and will be perpendi-

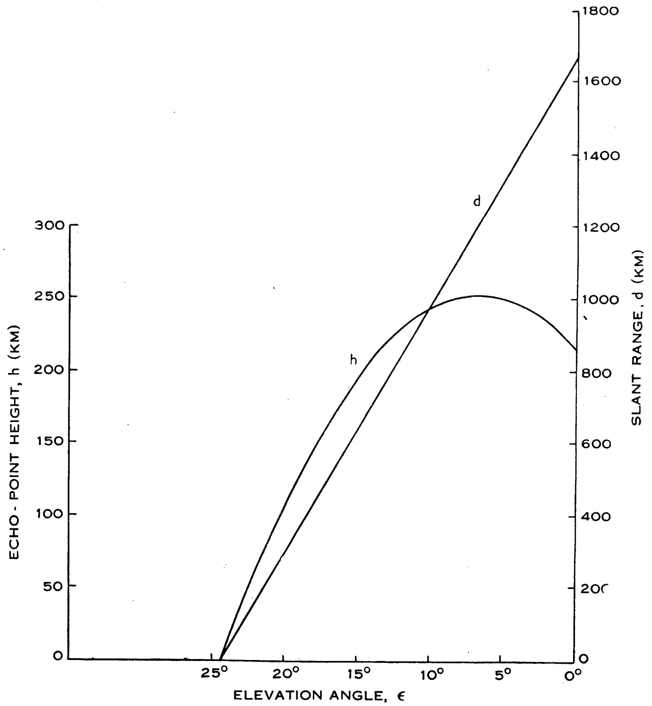

Fig. 1.—Auroral echo heights and slant ranges versus aerial elevation angle, computed for geomagnetic latitude 47·8 °S.

cular to the radio beam. In this case long range will be associated with great height of the echo region, and a low pulse recurrence frequency of 75 p.p.s. was chosen to allow a time base range of approximately 2000 km, in case echoes were received from aurorae up to *F*-region altitudes in the ionosphere. No persistent *F*-region auroral echoes have yet been detected at the observatory.

Auroral radio echoes were recorded continuously at Christchurch on March 10, 1957 between 1341 and 1626 hr U.T. at slant ranges of 325–500 km, despite heavy interference. Heights of 116–165 km corresponding to these ranges are inferred from the Chapman theory. This aurora was observed visually (in generally overcast conditions) over the southern part of New Zealand, Campbell Island, and Australia between 1030 and 1130 U.T., and over the full length of New Zealand between 1300 and 1400 U.T. The display was again visible in

Australia between 1600 and 1630 U.T. (Thomsen, personal communication 1957).

The next radar display was observed on April 10, commencing at 0659 U.T. just after the equipment had been switched on. Comparison with collated visual records (Thomsen, personal communication 1957) and magnetic records (Cullington, personal communication 1957) is given in pictorial representation in Figure 2.

This shows a clear correspondence between the visual and the radar observations. In general an exact correspondence cannot be expected, since the great circle path from the aerial looks over an unbroken 3000 km of the South Pacific Ocean to the geomagnetic pole and visual observers are on the average some 100 km to the west of this path.

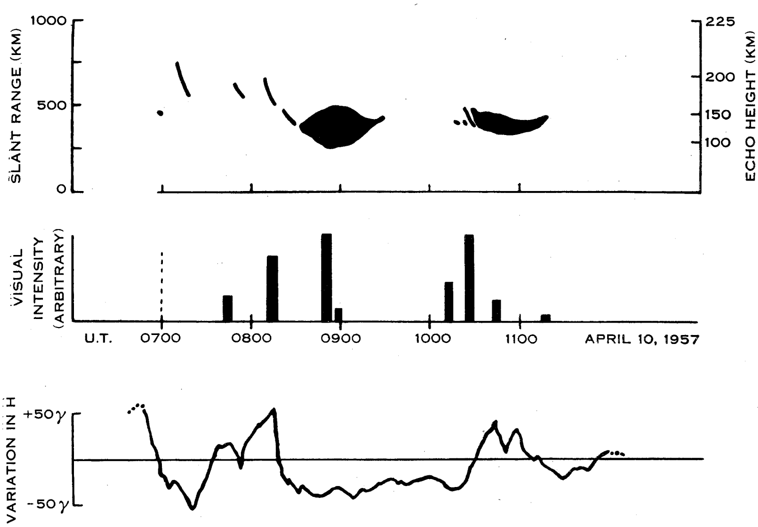

Fig. 2.—Radar, visual, and magnetic correlation for the aurora of April 10, 1957.

The shortest radar range recorded during this display was 250 km, corresponding to a height of 93 km. (The range decreased at the commencement and increased at the conclusion of each of the two main epochs.) Comparison with a record of the *D*-component of the Earth's magnetic field taken on a high speed flux-gate magnetometer some 40 km north of the radar station (Cullington, personal communication) on this occasion supported the observations of Meek (1954) that the commencement of an auroral return coincides with a marked gradient in the magnetogram.

A number of subsequent auroral echoes have now been obtained, as summarized in Table 1.

It is clear from Table 1 that both major and minor displays of the aurora australis can be recorded by radar methods from the low geomagnetic latitude of 47·8 °S. Aurorae Nos. 3–10 in Table 1, in general smaller than No. 2 (of April 10, 1957) have not shown any obvious correlation with magnetograms.

The occurrence of 10 aurorae in 61 days' observing is much higher than was anticipated for this latitude from a survey of northern hemisphere V.H.F. observations.

TABLE 1

SUMMARY OF V.H.F. AURORAL RADAR OBSERVATIONS MARCH 5 TO JUNE 11, 1957

1957 Observing Periods Date	1957 Observing Periods Time (hr U.T.)	Radiated Pulse Power (kW)	Date of Aurora	Periods of Detection (U.T.)	Min. Range and Extent (km)	Computed Echo Height (ex Chapman) (km)
Mar. 5–11	0745–1800	70	Mar. 10	(described in text)		
Apr. 3–12	0700–1800	70	Apr. 10	Fig. 2		
Apr. 13–27	0600–1800					
May 1,3,4	0600–1800					
May 6–8	0600–1800	150	May 7	0920–0921	380	134
				0924–0938	340	120
				0940–0943	320	117
May 12–31	0600–1800	150	May 12	1526–1532	370	131
		150	May 13	1630–1645	340–290	120–105
		150	May 20	0805–0813	275	100
				1441–1447	350	125
		150	May 31	0925–0935	440	152
				1530–1733	350–420	125–146
June 1–4	0530–1800	150	June 2	1332–1354	360–380	128–134
		150	June 4	1035–1047	350–400	125–140
June 6,10,11	0530–1800	150	June 10	0535–0551	300–330	110–120
				0558–0625	330	120
				0635–0646	In patches at 350 km	125

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