Aust. J. Phys., 1979, **32**, 287–8

Atmospheric Gravity Wave Production for the Australian Total Solar Eclipse of 23 October 1976

S. M. Ball

Department of Physics, University of Adelaide, Adelaide, S.A. 5001.

Abstract

Calculations are presented which suggest that internal gravity waves generated by the 23 October 1976 total solar eclipse would have come to a focus in a region well north of Australia, and also in Antarctica. No evidence is found for a focus in Western Australia, as suggested by Beer *et al.* (1976).

During a solar eclipse the Moon's shadow moves at supersonic speed through the Earth's atmosphere, generating atmospheric gravity waves which propagate away from the cooling region. Focusing of these waves can occur due to fluctuations in the speed of the Moon's shadow and due to the curvature of the eclipse path. Beer *et al.* (1976) presented calculations of the resulting ray paths for the 23 October 1976 total solar eclipse which suggested that the ray paths would have converged to a focus in Western Australia. As this result seemed unlikely on simple physical grounds, independent calculations have been made and the results are presented here. The eclipse path as outlined in the Astronomical Ephemeris 1976 (HMSO 1974) is used.

A bow wave is produced when the source velocity is greater than the characteristic speed of waves in the medium. The bow wave is at an angle $\theta = \arctan(C_L/V)$ to the direction of motion of the source, where V is the source velocity and

$$C_L = c\omega_g V(\omega_a^2 V^2 - \omega_g^2 c^2)^{-\frac{1}{2}}$$

is the characteristic velocity of the wavefront at low frequencies (see Chimonas 1970). Here c is the velocity of sound, ω_a is the acoustic cutoff frequency and ω_g is the Vaisala–Brunt frequency. Each ray path leaves the Moon's shadow in a direction at right angles to the bow wave and then propagates along a great circle path. The successive positions of the bow wave can be found by joining points of equal time delay along these ray paths. Using a value for C_L of $320\ \mathrm{m\,s^{-1}}$, the northward propagating ray paths are found to converge to a focus north of Australia. The southward propagating waves converge to two separated foci over Antarctica due to the rapid change in speed of the shadow near the end points of the relevant part of the eclipse path. The three foci are shown in Fig. 1, and their approximate positions and times of occurrence are as follows:

Lat. (°N.)	Long. (°E.)	Time (U.T.)	Lat. (°S.)	Long. (°W.)	Time (U.T.)	Lat. (°S.)	Long. (°W.)	Time (U.T.)
21	150	1230	78	110	1200	77	40	1200

Inspection of any ground level microbarograph recordings or ionospheric data from stations in Antarctica during this period could be valuable in verifying the theory of Chimonas (1970).

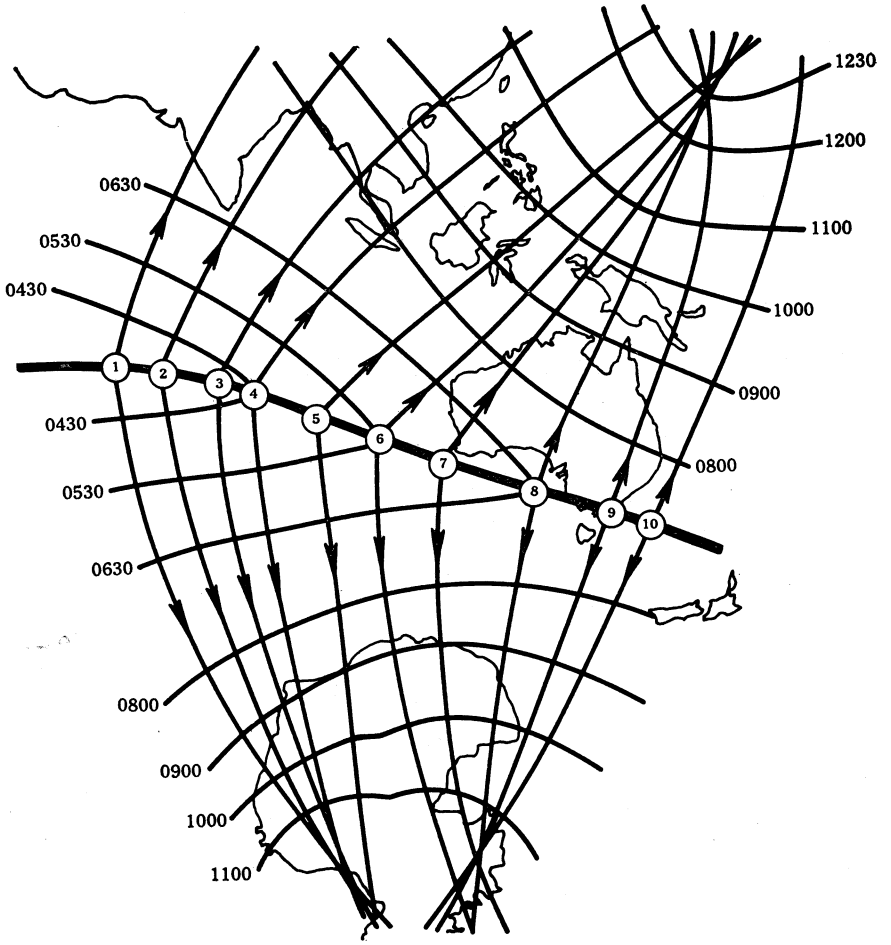

Fig. 1. Focusing of bow waves. Wavefronts are drawn for constant values of time delay T, assuming a wave speed of 320 $m s^{-1}$. The ray paths are drawn originating from the lunar shadow at times t (h) given by (1) 0350, (2) 0400, (3) 0415, (4) 0430, (5) 0500, (6) 0530, (7) 0600, (8) 0630, (9) 0640 and (10) 0644. All times are expressed in U.T.

References

Beer, T., Goodwin, G. L., and Hobson, G. J. (1976). *Nature* **264**, 420.
Chimonas, G. (1970). *J. Geophys. Res.* **75**, 5545.
HMSO (1974). 'The Astronomical Ephemeris for the Year 1976', p. 351 (HMSO: London).

Manuscript received 25 January 1979