into account. Other factors may have to be modified as more eclipse data become available.

This work was supported by the Air Force Cambridge Research Laboratories, Office of Aerospace Research. We thank the Naval Security Group, the Northwest Receiving Site and the Edward Ball Marine Laboratory of Florida State University for help.

B. J. Flaherty
H. R. Cho
K. C. Yeh

Ionosphere Radio Laboratory,
Department of Electrical Engineering,
University of Illinois.

Received May 5, 1970.

[1] Howard, H. T., Lusignan, B. B., Yoh, P., and Eshleman, V. R., *J. Geophys. Res.*, **69**, 540 (1964).
[2] Maynard, L. A., and McAlpine, J. A., *Canad. J. Phys.*, **42**, 1820 (1964).
[3] Pound, T. R., Yeh, K. C., and Swenson, jun., G. W., *J. Geophys. Res.*, **71**, 326 (1966).
[4] Evans, J. V., *J. Geophys. Res.*, **70**, 131 (1965).
[5] Cho, H. R., and Yeh, K. C., *Radio Sci.* (in the press).
[6] Harris, I., and Priester, W., *J. Atmos. Sci.*, **19**, 286 (1962).
[7] Maeda, K., and Kato, S., *Space Sci. Rev.*, **5**, 57 (1966).
[8] Van der Laan, J. E., *J. Geophys. Res.*, **75**, 1312 (1970).

## Possible Detection of Atmospheric Gravity Waves generated by the Solar Eclipse

Chimonas and Hines recently suggested that the cool shadow of the Moon, moving at supersonic speed across the atmosphere of the Earth during a solar eclipse, should generate gravity waves which would build up into a bow wave[1]. They estimated a maximum pressure perturbation (at a distance of 10,000 km from the shadow) of $10^{-5}$ at ground level and $10^{-1}$ at 200 km altitude. The high altitude effect should leave an ionospheric signature in the form of a travelling ionospheric disturbance (TID).

Our group at Stanford has been studying the columnar electron content of the ionosphere for a number of years by measuring the Faraday rotation angle of the VHF transmissions from such geostationary satellites as ATS-I and ATS-III (ref. 2). These measurements have been made at a number of locations in North America. At the time of the solar eclipse of March 7, 1970, four stations were in operation in the western United States.

The gravity waves generated by the eclipse of March 7 should reach California some time after 1900 UT on that day according to the prediction of Chimonas and Hines. Fig. 1 shows the fluctuations in electron content observed along the Stanford to ATS-III and Stanford to ATS-I paths near that time. The 300 km ionospheric points of these paths are separated by about 600 km. The fluctuations were determined by subtracting a 31 min running mean from the observed electron content. The time periods preceding and following the interval depicted in the figure were characterized by very little fluctuation so that the undulations constitute a well isolated event occurring at about the time when the gravity wave was expected.

The two trains of oscillations, although strongly correlated, are not entirely similar, so that the association of peaks in one train with those in the other is a somewhat subjective matter. If the matching suggested by the letters in Fig. 1 is accepted, then, because ATS-III is east of ATS-I, the oscillations can be interpreted in terms of a disturbance travelling east to west. Electron content records from Fort Collins, Colorado (with the 300 km ionospheric point 1,280 km to the east of that on the Stanford ATS-I path), and Clark Lake, California (300 km ionospheric point 600 km south-east of that of Stanford), show disturbances similar to those in Fig. 1. The Clark Lake record is of poor quality, however. Estimates of the time shifts between similar features observed at any three of the four stations allow the horizontal phase velocity of the disturbance to be determined. The geometry is such that it is essential that the Clark Lake information be used, however, because the remaining sub-ionospheric points are nearly in a straight line.

A peak thought to be the same as that labelled *b* in Fig. 1 was observed at 1910 UT at Fort Collins and at 1928 UT at Clark Lake. Assuming that the bumps are matched correctly, the uncertainty in the time of the peaks at Stanford and Fort Collins is $\pm 2$ min, and the uncertainty is $\pm 3$ min at Clark Lake. Using these times and uncertainties, the horizontal phase velocity of bump *b* is $620 \pm 120$ m $s^{-1}$ at a bearing of $279 \pm 25°$ east of north. (The direction given is that of the velocity vector.) Velocities computed for the other bumps are roughly the same. The maximum possible speed for *b* based on the Stanford ATS-I and Stanford ATS-III records is substantially lower, however.

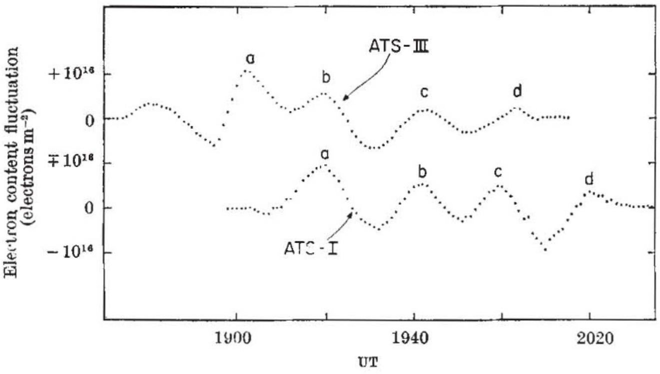

Fig. 1. Fluctuations in electron content along the Stanford to ATS-III and Stanford to ATS-I paths on March 7.

The amplitude of the undulation observed by the two Stanford stations is about $\pm 10^{16}$ electrons $m^{-2}$, and the background electron content amounted to some $60 \times 10^{16}$ electrons $m^{-2}$. The relative amplitude of the undulation was therefore of the order of 1·5 per cent. The corresponding disturbance in the neutral atmosphere (if indeed the fluctuations observed were due to such a disturbance) may have been much larger because the direction of propagation, being roughly perpendicular to the geomagnetic field lines, may have resulted in a weak coupling between the atmospheric waves and the ionization. Disturbances travelling from east to west and having a similar character over the extent of the network (more than 1,000 km) have not been observed previously, although such disturbances travelling from north to south are often seen during geomagnetic storms[3]. The fact that these disturbances, of a rather unusual nature, occurred near the time predicted for arrival of atmospheric gravity waves due to the eclipse and that they came from the direction of the path of the eclipse implies a possible confirmation of Chimonas and Hines's suggestion.

M. J. Davis
A. V. da Rosa

Radioscience Laboratory,
Stanford University,
Stanford, California 94305.

Received May 4, 1970.

[1] Chimonas, G., and Hines, C. O., *J. Geophys. Res.*, **75**, 875 (1970).
[2] Garriott, O. K., Smith, F. L., and Yuen, P. C., *Planet. Space Sci.*, **13**, 829 (1965).
[3] Davis, M. J., and da Rosa, A. V., *J. Geophys. Res.*, **74**, 5721 (1969).