# LETTERS TO THE EDITOR

## GEOPHYSICS

### Laser Radar Echoes from the Clear Atmosphere

USING experimental pulsed ruby laser radars, numerous observations have been made here of echoes from the 'clear' atmosphere. There is no doubt that these returns are caused by backscattering from particulate matter in the aerosol. Even in the clearest conditions echoes are invariably obtained from the immediate vicinity, and these are much enhanced in hazy conditions. Strong signals are commonly noted at heights corresponding to low-level inversions, revealing haze layers which are not discernible by eye.

A particularly interesting series of observations was made on August 19, 1963. These observations were made with an early version of our laser radar having the characteristics given in Table 1. They were made by pointing the radar at an elevation of 15° (on a bearing of 036° T) in the direction of San Francisco Bay, which is some 2·5 nautical miles distant from the laboratory. Although very slight haze had been present in the morning, the afternoon of August 19, 1963, was bright and clear, with blue skies and unrestricted visibility (more than 8 nautical miles). A northerly sea breeze, which was estimated at 5–10 knots in the late forenoon, had freshened to 10–15 knots by the time of observation (1430 P.S.T.). Fig. 1 shows a plot of relative signal intensity versus range for three successive observations made over a period of some 12 min. Log/log co-ordinates have been used to facilitate interpretation. On these co-ordinates a plot of signals from a non-attenuating medium would be a straight line having a slope determined by range.

Fig. 1*a* thus shows an instantaneous, direct observation of discontinuities in clear air which was in motion. We believe that the variations in signal intensity were due to variations in the particulate matter content, and hence in the backscattering characteristics of two or more intermixing aerosols. Figs. 1*b* and *c* show the changes which occurred with time as mixing proceeded or as more homogeneous air passed into the area. A number of other observations made on August 19, 1963, before the series illustrated, showed similar discontinuities fluctuating with time. For comparison, Fig. 1*d* shows returns made in very similar apparent conditions on the following afternoon, August 20, when the aerosol was consistently homogeneous.

Table 1. *SRI* LIDAR *Mark I* (1963)

| | | | |
|---|---|---|---|
| Laser | 3 in. × 1/4 in., 90° *C*-axis ruby crystal, transparent and semi-reflecting coatings on flat ends. *Q*-switched | Receiver | 10 stage RCA photo-multiplier type 7326 |
| Pulse length | 24 n sec | Aperture | 4 in. diam. |
| Peak power | 5 MW | Bandpass | Approx. 20 Å |
| Beam width | 0·5° | | |

The implication of these early observations is very far-reaching. Particulate matter is present in some degree throughout the atmosphere. The possibility of mapping the effects of air motion, and in particular that associated with 'clear air turbulence' by reference to laser radar returns from particulate matter, thus appears to be realistic. Although considerable technological development will be needed and also a better understanding of the nature of clear air turbulence it is suggested this approach to the detection of clear air turbulence is more promising than any based on obtaining optical echoes from variations in the gaseous state of the atmosphere.

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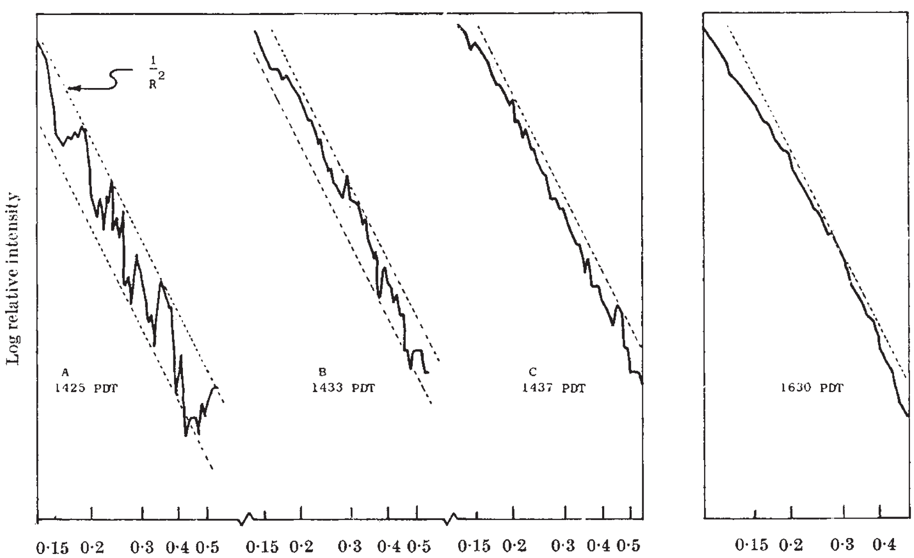


Fig. 1. Clear air observations. *SRI* ruby laser radar (*Mark I*). Bright clear afternoons with good visibility and moderate northerly and easterly winds. Azimuth 36°, elevation 15°

### Magnetic Disturbances preceding the 1964 Alaska Earthquake

THROUGH a fortunate circumstance, a recording magnetometer was operating in the city of Kodiak, 30 km north-west of the surface trace of a fault zone along which movement occurred at the time when the earthquake occurred in Alaska on March 27, 1964. Fortunately, too, the instrument was on such high ground that it was not reached by the subsequent seismic sea wave which virtually destroyed the city. The magnetometer recorded the fact that the largest of several magnetic