Effects on ionosphere

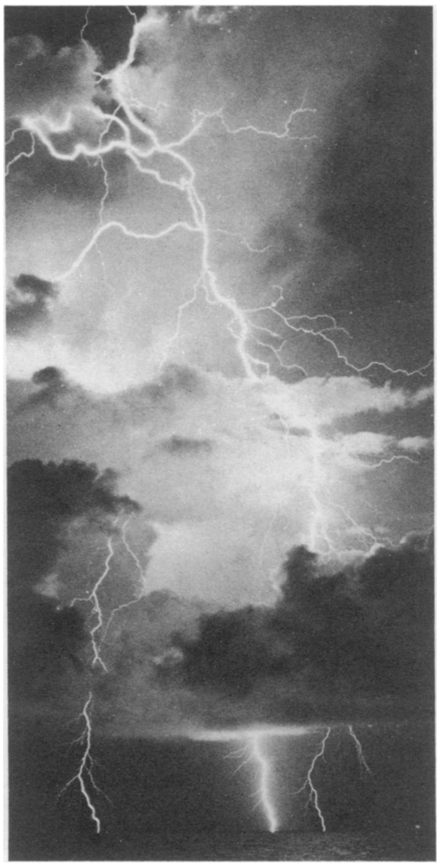
Man has always known that thunderstorms produce acoustic noise, and with the invention of radio, he learned that they also produce electromagnetic noise. Recently, evidence has been accumulating that severe thunderstorms in the central United States produce sound, or pressure-wave disturbances, in the ionosphere, the electrically charged portion of the atmosphere extending from 35 to 600 miles above the earth.

The disturbances, pressure waves with periods of around three minutes, occur in late spring and summer, and only when storm cloud tops exceed 40,000 feet in altitude. It also turns out that severe weather is always high on days when infrasound (low-frequency sound waves below the range of human audibility) occurs in the ionosphere, but not all severe-weather days are accompanied by infrasound.

Drs. Kenneth Davies and John E. Jones of the National Oceanic and Atmospheric Administration's Environmental Research Laboratories in Boulder, Colo., have been studying these disturbances with two radio transmitter-receiver systems. The first has transmitters at Havana, Ill., and receivers at Boulder, 1,300 kilometers away. The second pair, 120 kilometers apart, are at Norman and Stillwater, Okla. High-frequency radio waves are bounced off the ionosphere. Pressure waves move by a train of collisions between molecules. When an infrasonic wave travels upward from the troposphere to the ionosphere the motions of the air molecules are transferred to the electrons in the ionosphere. The electron movement results in an up-and-down movement of the level of reflection of the radio signals, and this, in turn, produces a Doppler shift in the radio echo.

In a recent issue of the JOURNAL OF THE ATMOSPHERIC SCIENCES, Drs. Davies and Jones report the results of observations from four storms in June 1969. They found that whenever large infrasonic disturbances were detected, there have been thunderstorms with cloud tops at or above a height of 40,000 feet within 200 kilometers of the radio reflection point. In one case, a storm with a top of only 39,000 feet near the reflection point of the Oklahoma set apparently did not produce infrasound in the ionosphere. The periods of the infrasonic waves varied between about one and five minutes.

Drs. Davies and Jones believe the infrasonic disturbances in the ionosphere probably originate in the mechanical motions of the thunderstorms. But the magnitude of the radio disturbance is not necessarily directly related to the size of the thunderstorm, and it is difficult at present to relate the ionospheric measurements directly to characteristics of the thunderstorm. □



NOAA

Observations by satellite

Like their sonic and electromagnetic effects, the visible light produced by thunderstorms also reaches far above the earth. In fact, it can be detected by satellites orbiting in space. Photometer observations from the orbiting solar observatory satellite OSO-2, which scanned the earth at night between 35 degrees south latitude and 35 degrees north latitude for a period of eight months, showed that 10 times as many nighttime lightning storms occurred over land as over the ocean (SN: 9/5/70, p. 207).

OSO-5, launched in January 1969, carried six photometers, four of which can be used to detect lightning strokes. In the Aug. 20 NATURE, Drs. J. G. Sparrow and E. P. Ney of the University of Minnesota report that data from two of the photometers confirm the previous findings.

Each photometer is sensitive to a broad spectral region, one covering the range between 3,500 and 5,000 angstorms, the other spanning 6,000 to 8,000 angstroms. Because of interference from moonlight, observations were limited to times near new moon.

Data for the period from February to September 1969 and January to July 1970 from an area covering 60 degrees of latitude at all longitudes were searched by computer to separate abrupt increases in light levels that might be lightning. The selection was further refined manually. The researchers then plotted geographically about 1,000 storm complexes from data on about 7,000 lightning strokes.

The findings confirm that the large majority of nighttime storms occurred over land. "It is also apparent that the North Atlantic Ocean has more lightning storms than similar areas of other oceans." There is a marked scarcity of lightning storms in the principal desert regions, such as the Sahara and Kalihari Deserts, the Great Australian Desert and the arid area in central South America. The number of lightning strokes in each storm complex varied from a minimum of two to about thirty strokes seen in the space of two minutes.

The earlier experiment on OSO-2 in 1965 was conducted when solar activity was at a minimum. The new observations were made at a more active solar period. If there is a connection between solar activity and the frequency of lightning storms, as has been suggested, lightning activity should be greater for the OSO-5 observations. After comparing the results of the two experiments, Drs. Sparrow and Ney found that there has been no significant increase in storminess. □

Sparrow and Ney/Nature

OSO-5 observations confirm that lightning definitely prefers dry land.