

Seasonal Cosmic-Ray Effects at Sea Level*

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BY sending a Neher self-recording electroscop in a 10-cm lead shield repeatedly on a slow Norwegian steamer over the route Vancouver-Los Angeles, around South America and return to Los Angeles and Vancouver we find: (1) As heretofore, an equatorial dip, measured from Los Angeles, of 7 percent on the western side of South America, 8 percent on the eastern side; (2) no seasonal sea-level effect at Los Angeles or at any point south of there down to the Straits of Magellan that is of sufficient magnitude to stand out above the fluctuations—as much as 0.6 percent—observable at the different localities traversed in these voyages; (3) as heretofore on the voyage between Los Angeles and Vancouver, constancy in cosmic-ray intensity in summer and fall, within the limits of uncertainty imposed by the fluctuations, estimated here as certainly not over 1 percent; (4) in winter and spring, however, a definite increase in different voyages of 2 percent or 3 percent in going from Los Angeles to Vancouver.

The results found in (3) and (4) above are interpreted as still further definite evidence for the existence of the “atmospheric-temperature” effect earlier studied by Hess,¹ Compton² and their respective collaborators.

Our results are also in essential agreement, so far as they go, with the findings recently reported by Forbush.³

* For complete paper see *Phys. Rev.* **56**, 487 (1939).

¹ Hess, Graziadei, and Steinmauer, *Wiener Ber. IIa* **143**, 313 (1934) and Hess, **144**, 53 (1935).

² Compton and Turner, *Phys. Rev.* **52**, 799 (1937).

³ S. E. Forbush, *Phys. Rev.* **54**, 975 (1938).

By analyzing the data obtained by the Carnegie Institution's cosmic-ray meters running continuously at its stations at Cheltenham (near Washington Mag. Lat. 50.1 N) Teoloyucan (near Mexico City Mag. Lat. 29.7 N) Christchurch (New Zealand Mag. Lat. 48.0 S) and Huancayo (Peru Mag. Lat. 0.6 S) Forbush finds no seasonal effect (in his words “no twelve-month wave”) at Huancayo, which is in the equatorial belt. He finds a “twelve-month wave” at Cheltenham amounting to 1.6 percent of the normal cosmic-ray intensity and having the maximum in mid-January. He also finds such a wave at Christchurch (Mag. Lat. 48.0 S) having an amplitude of 0.8 percent of the total intensity, its maximum occurring near the end of July (corresponding to the end of January in the Northern Hemisphere). He comments also on such a wave at Hafelekar (near Innsbruck Mag. Lat. 48.0 N) of amplitude 1.9 percent. This may be compared with the smaller of the winter-summer differences found at Vancouver. Only in the case of the “twelve-month wave” of amplitude 1.0 percent at Teoloyucan are Forbush's results somewhat out of line with ours in that, so far as these measurements go, we bring to light no seasonal effect at Los Angeles (Mag. Lat. 41° N) and none at the Straits of Magellan (Mag. Lat. 42 S) both of which are farther from the magnetic equator than is Teoloyucan. The high altitude of this latter station may be the cause of this difference. The effects of altitude great and small are now being tested.