ELEVATION AND ALTITUDE.[1]

Engineers use the word *elevation* with reference to the height of an object, usually on the ground, relative to some sea level or some other fixed datum. In aerology and aviation, heights above ground in free air are commonly referred to as *altitudes*. In meteorology and other scientific discussions, heights either on the ground or above it are sometimes referred to indifferently as elevations or altitudes and the terms are often used interchangeably. In the table of stations in the reports of the U. S. Weather Bureau, height of ground above sea and height of instruments above ground are both referred to as elevations. Such uses of the word elevation are sometimes confusing. Cases have arisen where it was difficult to ascertain whether the height of an instrument, anemometer, barometer, or thermometer, for example, was with reference to sea level or ground level. Of course, this uncertainty could only exist at stations near sea level. It is suggested that a distinction in usage of the terms elevation and altitude, somewhat akin to that suggested by Dr. H. R. Mill for the terms mean and average,[2] may be desirable. Would it not be well to limit the use of the term altitude to heights above ground at a particular location, and the use of the term elevation to the height of the ground or a fixed object on the ground with reference to sea level, or some other definite datum, the actual point of reference being near or remote, as the case may be. On this basis the height of a meteorological station would be given as its elevation and would be the ground level elevation at the station. The heights of the instruments above ground would be expressed as altitudes.—*Robert E. Horton.*

[1] The suggestion by Mr. Horton is an excellent one, and I may express the hope that it will be uniformly adopted by writers for the REVIEW. In the beginning it would be well for each writer to announce on the occasion of the first use of either of the terms "elevation" or "altitude" the sense in which it is used. The official publications of the Weather Bureau where the expression "elevation" appears make it clear what reference point is taken as a base level.—EDITOR.

[2] Cf. MO. WEATHER REV., November, 1918, 46: 514-515.

TEMPERATURES OF THE SOIL AND AIR IN A DESERT.

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[Medical School, University of North Dakota, March 15, 1922.]

The Carnegie Institution of Washington maintains a Desert Laboratory at Tucson, Ariz., where for some years the activities of plants and animals in relation to their desert environment have been studied. Much work has been done with water relations both as to evaporation and movement in soils. Extensive records of soil and air temperature are kept.

While assistant in charge of Professor Tower's "Experiments in Evolution" (see Carnegie Publication No. 263) I undertook a further analysis of the temperature conditions of air and soil. The results have a meteorological as well as a biological interest.

It is a well-recognized fact that the range of temperatures in the desert is tremendous. The surface of the soil is heated and it is a matter of interest to know to what extent this heat is transferred to deeper levels. It is well known that the surface air becomes rapidly chilled in the evening. What is the relation of temperature here to the levels above and the soil beneath? Desert animals and plants live in a comparatively narrow zone.

There were available at Tucson an exceptional aggregation of thermometers. The measurements in air were taken with German-made instruments, having large bulbs and graduated to tenths of a degree centigrade. These instruments were divided into two sets. One set was coated with a glossy white paint and the other with a dull black. I anticipated criticisms of this and so took the precaution to read the standard shelter thermometer at the same time that any other readings were taken. Since they were to be used in the open sunlight, the entire lot were standardized. To do this they were placed at a uniform level about 4 feet above ground and readings were taken every hour of the day. The thermometers were inclined, so that their axes were at right angles to the circle of the sun, insuring uniform exposure at all times. The members of each set differed only by tenths of a degree from each other. The constant necessary to reduce each to the median member of the group was adopted for each thermometer and for each hour of the day separately. All further data were then corrected by these constants.

The soil temperatures were read on standard mercury thermometers, which, like the others, had to be checked in a water bath for comparison. It was found necessary to use a boiling-point thermometer for the surface soil, as the temperature there burst the one first employed. At two of the levels Friez soil thermographs registered continuously and the records from other instruments were available for comparison but from a different locality.

Figure 1 illustrates in diagram the apparatus set up. The levels of the black and white thermometers were the same and the exposure was made uniform through the day as in the tests. The upper six soil thermometers were permanently embedded and were read in place. The depth indicated the distance to the center of the bulb. The thermometers for the deeper levels were slipped into close-fitting glass tubes, so that the bulbs rested in molds in the soil below. These were drawn up rapidly by strings sufficiently high to be read and were immediately dropped back and the tube corked.

After the preliminary tests the reading began at 5:30 a. m., June 17, 1915, and continued almost hourly to 10:30 p. m. The series was repeated nearly daily till September 19, 1915. An inspection of the data showed a repetition of the main features daily. For this reason that day was chosen for presentation which showed the highest temperature reached for the year. This was June 21, 1915.

Table 1 shows the data taken June 21. In the table the data for air and soil temperatures are separated at the ground level. At this point are placed the readings of the standard shelter thermometer and as a matter of added interest readings taken in shade among the red volcanic rocks of the Desert Laboratory grounds. All the apparatus except this one thermometer recorded the conditions in the adobe soil of the garden well away from the rocks. The maximum temperatures reached in the air series at any time of day are in bold-faced type and are arranged to compare the black and white thermometers with the standard shade temperature.

The minimum temperatures for any time of day are given in italics. The peculiar shift of the point of maximum and minimum temperatures is a significant problem. At 4:30, when this shift occurs, the sun is still high and the earth is much hotter than the air immediately above it.