electric junction exploring the vortex and plat the temperature, or we use some form of hygrometer and determine the dew points. In fact we experimentally determine all the elements that enter into the structure of the waterspout and compare our observations with the theories that have been worked out by Ferrel.

I have said enough for the present. I hope to elaborate this effort to help the mathematician and physicist find a new field full of problems for their students. Thus they will help us to develop the talents of future meteorologists.

These are but special illustrations of the general law that thinking, seeing, and doing must go together. We learn by doing as much as by reasoning—each helps the other. Every theory or hypothesis or suggestion should be reduced to exact formula, exact experiment, exact measurement. Precision is the vital essence of all valuable knowledge.

I hope to live to see special schools of meteorology, special laboratories, and mathematical seminaries devoted to this as to every other profession; but for the present at least I urge that you illustrate the value of and enliven the interest of your mathematical and physical courses by frequently quoting or proposing problems drawn from METEOROLOGY.

ON LIGHTNING AND PROTECTION FROM IT.[1]

By Sir JOSEPH LARMOR, F. R. S.

The rationale of electric discharge in a gas is now understood. When a small region becomes conducting through ionization by collisions in the electric field it should spread in the direction in which the field is most intense, which is along the lines of force. Thus the electric rupture is not a tear along a surface but a perforation along a line. This is roughly the line of force of the field; the electrokinetic force induced by the discharge, being parallel to the current, does not modify this conclusion. A zigzag discharge would thus consist of independent flashes, the first one upsetting adjacent equilibria by transference of charge. Successive discharges between the same masses would tend to follow the same ionized path, which may meantime be displaced by air currents.

If the line of discharge is thus determined by the previous electric field, the influence of a lightning conductor in drawing the discharge must be determined by the modification of this electric field which its presence produces. For a field of vertical force, such as an overhead cloud would produce, it may be shown that the disturbance caused by a thin vertical rod is confined to its own immediate neighborhood. Thus while it provides a strong silent discharge from earth into the air, it does not assist in drawing a disruptive discharge from above—except in so far as the stream of electrified air rising from it may provide a path. It is the broader building, to which the rod is attached, that draws the lightning: the rod affords the means of safely carrying it away, and thus should be well connected with all metallic channels on the building as well as with earth. It is the branching top of an isolated tree that attracts the discharge; a wire pole could not do so to a sensible degree. Separate rods projecting upward from the corner of a building do not much affect the field above it, but if they are connected at their summits by horizontal wires, the latter, being thus earthed, lift up the electric field from the top of the building itself to the region above them, and thus take the discharge which they help in attracting, instead of the building below them. Similarly, when the lines of force are oblique to a vertical rod, its presence does somewhat modify the field and protect the lee side; but generally the presence of a rod should not ever be a source of danger, unless the ionized air rising from it provides an actual path for discharge.

[1] *Reprinted from* Report British Association for the Advancement of Science, 83d meeting, Birmingham, September 10–17, 1913. London, 1914. Section of Mathematical and Physical Science, p. 387.

LIGHTNING INJURY TO COTTON AND POTATO PLANTS.*

By L. R. JONES and W. W. GILBERT.

[*Abstract* of a paper presented to the Sixth Annual Meeting of the American Phytopathological Society, Philadelphia, Dec. 29, 1914–Jan. 1, 1915.]

Literature contains meager data concerning lightning injury to herbaceous plants. The authors have evidence that such injury is not uncommon in certain crops, notably cotton and potatoes, and may occur in beets, tobacco, and ginseng. Grass, small grains, and corn seem less liable. Cotton and potatoes when so struck may be killed in roundish spots, 1 to 3 rods in diameter or sometimes several associated smaller spots. There may be no disturbance of soil or physical rupture of plant tissues. The plants near the center wilt, blacken, and die promptly; about the margins some may live days or weeks. Such weakened cotton plants yellow or redden. The injury appears first and worst from the soil line or a little above downward, but may not kill all the underground parts. Partially injured cotton plants may form callus ridges above point of injury and new potato shoots may sprout from base of injured stems. These various facts suggest the theory that when a sudden electric storm follows upon a period of dry weather, lightning discharge spreads horizontally over the moist surface layer of soil and that certain crops are more liable than others, either because of relative tissue resistance or because of character or distribution of aerial parts or root systems.

* *Reprinted by permission* from Phytopathology, No. 6, December, 1914, 4: 406.

WEATHER AND HEALTH.

The Notices of the Imperial Academy of Sciences of Vienna for June 25, 1914, contain a brief statement of the results of a recent investigation of the important question as to the connection between weather and human health, undertaken by Dr. Ernst Brezina and Wilhelm Schmidt at the Austrian Central Meteorological Institute in Vienna and presented to the Academy on June 14, 1914.[1]

Heretofore, as the authors showed, this question has been treated largely if not entirely from the standpoint of the physiologist; therefore it seemed all the more promising to follow more the methods of meteorology and to subdivide the weather more minutely into its elements, thus of course adopting a purely statistical method of treatment.

An unprecedently large and explicit series of meteorological elements, from the records of the Central Meteorological Institute, were compared by a specially appropriate method, day for day, with a series of daily values which presented in a somewhat quantitative manner the condition and behavior of extensive groups of healthy and ill persons. For the present investigation Brezina and Schmidt employed: (1) Records of the average hourly work accomplished by a large number of female employees of the Imperial Census Commission, in punching the counting cards (Zählkarten) (*light mental office work*); (2) the recorded daily number of epileptic attacks (i. e., number of patients affected) among the inmates of the hospital for mental and nervous diseases "Am Steinhof" (*condition of the sick*); (3) daily general estimates of the per-

[1] *Summarized in* Meteorologische Zeitschrift, Braunschweig, Jan. 1915, 32: 43–44.