AN ACCOUNT OF THE FOUNDATION AND WORK OF THE BLUE HILL METEOROLOGICAL OBSERVATORY

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THE BLUE HILL

METEOROLOGICAL OBSERVATORY.

OBJECT OF THE OBSERVATORY.

THE study of high-level meteorology is an important one, but to which little attention has been given in this country. It is true that the United States Signal Service station on Mount Washington was the first complete mountain station in the world, and that the station on Pike's Peak is still the highest, but the observations have not been published *in extenso*. Excepting these two stations, the writer does not know of a single meteorological station in the United States elevated distinctly above the surrounding country. It is not so in Europe. The writer visited, in 1885, nine mountain stations situated at heights ranging from 3,740 to 9,440 feet, whose observations are published in a comprehensive manner; and a number of other mountain stations exist. The French observatories, in particular, have been especially constructed for their purpose, and equipped with registering instruments, at a large cost, which the additions to our knowledge of the physics of the upper atmosphere obtained from them amply repay. (See "The Mountain Meteorological Stations of Europe," by A. Lawrence Rotch, in *American Meteorological Journal*, Vol. II., Nos. 10, 11, and 12, and Vol. III., No. 1.)

Prof. W. M. Davis, in an article in *Science*, Vol. V., No. 121, p. 440, says: "At the level of Pike's Peak the cyclonic rotation of the winds is hardly observable, the observatory there being above the strata of the atmosphere whose circulation is seriously disturbed by passing storms. On Mount Washington the winds whirl round almost in a circle about the progressing storm centre. At Blue Hill we may hope to dis-

cover the true circulation of the lower air, unaffected by the natural or artificial irregularities of surface that modify the records of so many of our Signal stations. The value of observations taken at moderate elevations is attested by the increasing number of mountain observatories in Europe. . . . As Blue Hill has the first private observatory of the kind in this country, we shall look with especial interest for the results of studies based upon its records."

The original plan was to use the Observatory on Blue Hill only for special investigations in meteorology, leaving the regular observations to be carried on by the Signal Service, the writer reserving the right to occupy the station or to close it to the Government by giving due notice. The Chief Signal Officer, however, refused to enter into an agreement to furnish observers, unless the entire control was given to the Signal Office for a period of not less than two years. The writer therefore determined to conduct the observations himself. The proposed work of the Blue Hill Observatory was stated by the writer, in a paper read at the first meeting of the New England Meteorological Society, Oct. 21, 1884, to be as follows: "The investigation of the rainfall at this elevation, the velocity and direction of the wind, the maximum and minimum temperatures, the paths of thunder and other local storms, and such other phenomena as may present themselves. It has been suggested that atmospheric electricity could well be studied here, and for seismometric apparatus the situation of the station would secure absolute freedom from the jar and vibration incident to the passage of neighboring trains and vehicles." It will be seen from the account of the work of the Observatory, that these investigations, with the exception of the last, have been undertaken, together with several others.

THE SITE OF THE OBSERVATORY.

The Blue Hills, situated in Norfolk County, Massachusetts, about ten miles south of Boston State House, are the nearest mountain range to Boston; and though their elevations are not high, the fact that the surrounding country is low makes them count for nearly their full height. Great Blue Hill, the highest

of the range, has an elevation of six hundred and thirty-five feet, and is not only the highest land in eastern Massachusetts, but is also the highest point within ten miles of the Atlantic coast from Maine to Florida. As Great Blue Hill exceeds the other summits of the range by more than one hundred feet, it has the nature of an isolated hill, commanding an unbroken view of the sea-level horizon, thirty-three miles distant, the New Hampshire mountains, seventy miles away, and a hundred and twenty towns and villages. The situation is thus admirable for a meteorological station; and the idea of establishing one, which occurred to the writer in August, 1884, being encouraged by Rev. A. K. Teele of Milton and Prof. W. H. Niles of Cambridge, an acre of land on the south side of the Hill, and a small amount, including the highest point on which were the ruins of the old lookout, was purchased with difficulty. Other land has since been bought, so that there are now some sixty acres about the Observatory. The top of the Hill comprises several acres of nearly barren ground, which culminates in a rocky ledge, fifteen or twenty feet above its general level. The dividing line between Milton and Canton was decided by the selectmen of these towns to pass over the ledge, just south of the site of the Observatory tower, placing the latter in Milton and the main building in Canton. Although careful search was made under the ruins of the lookout for the copper bolt, set by Simeon Borden, about 1832, for the Massachusetts Trigonometrical Survey, it was not found. Its position was, however, known to be 26.25 feet N. 15° 37′ E. of the bolt fixed by the Coast Survey in 1844, which is in plain view, and a brass plate on the lower floor of the tower now marks the site of the Borden bolt, 2.2 feet below it, in latitude 42° 12′ 44″ N., longitude 71° 6′ 53″ W., and 635.05 feet above mean tide. Surveys made by Mr. E. G. Chamberlain and by students of the Institute of Technology confirm the height as sufficiently accurate.

There were two foot-paths leading from the Canton road to the summit, which united about a quarter of a mile below it. It was decided to improve the path starting at the 'Great Oak' opposite Brush Hill road, and accordingly, on Sept. 1,

twenty men began work on it, and in ten days had completed a fair carriage road to the top, having a length of ¾ mile and an average grade of about 1 in 10. The Hill is easily accessible, as, from the foot of this road, it is only a mile and a half to the Readville station, reached in half an hour from Boston by two railroads. Readville is the railroad station and post-office for the Observatory.

The accompanying map of the western portion of the Blue Hills, prepared under the supervision of Rev. A. K. Teele, for his forthcoming History of Milton, is kindly allowed to be published here. It should be stated that the 'House to be erected for the New England Meteorological Society,' which appears on this map, represents the Observatory.

THE BUILDING.

Many were the speculations concerning the building to be erected on Blue Hill, some saying it was a fort, others that it was a monastery, but the majority believed it to be a station for the Signal Service. There were no stations in this country which could be taken as models, and the design was left mainly to the architects, Messrs. Rotch and Tilden, who fixed the cost at $3,500. The contractors, J. H. Burt & Co., commenced work Oct. 18, 1884, and made rapid progress during the fine autumn weather. By Dec. 6 the building was roofed in, rendering the workmen independent of the weather, which had now become cold and stormy. The outside pointing and some of the masonry were left until spring. Plastering was begun Dec. 22, and on Jan. 31, 1885, the writer and his observer moved in.

The Observatory is built of the broken stone found on the Hill, with granite trimmings. It consists of a two-story circular tower of twelve feet inside diameter, twenty-five feet high with a flat roof, which contains the instruments. Extending southward from this tower is a one-story hip-roof house, with two bedrooms, a dining-room and kitchen. A wooden shed adjoins. In the construction every precaution was taken to insure solidity, the walls being twenty inches thick, and the roof well anchored to them. It has, however, been found im-

possible to make the walls impervious to rain, which is driven by heavy gales through the minute cracks which the stone must contain. Several coats of marine varnish have served to disfigure the stone-work, but not to render it water-proof. The walls of the living-rooms are plastered and the floors are of hard pine. In the cellar is a wooden tank, holding nine hundred gallons of water, obtained from the rain falling on the roof, which has always proved sufficient for domestic purposes. A spring furnishes water for drinking. A large stove in the lower room of the tower heats the upper room through a register, and by its flue and that of the kitchen range warms the other rooms also. About ten tons of coal are burnt annually. Double windows are put on throughout the building in winter. A safe built into the chimney protects the records and charts from fire. A telephone line extends down the south side of the Hill to the central office in Milton. There are no houses within a mile of the Observatory, so that, even with this connection with civilization, it is largely dependent on its own resources.

The accompanying photographs of the Observatory and Hill were taken by Sergt. O. B. Cole, of the Boston Signal station.

THE INSTRUMENTS.

When first opened, the Observatory had the instruments of a first-class Signal station. Since then, many self-recording and other instruments have been added, several being brought from Europe last year by the writer. All the elements observed, with the exception of the force of the wind, the kind of clouds and their direction of motion, are now recorded continuously, and with the exception of the New York Meteorological Observatory in Central Park, the writer believes this Observatory to be the best equipped in the United States. The instrumental outfit is now as follows:

Barometers. These are kept in the lower room of the tower, where the temperature is most uniform. The Observatory standard is a Hicks Fortin barometer, reading to .002 inch. Although verified at Kew Observatory, its corrected readings,

as determined indirectly, differ by —.013 inch from the Signal Office standards at Washington. A smaller Green barometer, which reads also to .002 inch, has been compared with those of the Signal Service at Washington and Boston. In reducing the pressure to sea-level, instead of applying a monthly constant, as was the practice of the Signal Service, the correction at Blue Hill is obtained from a table based on Laplace's formula, calculated for a height of six hundred and forty feet, in which the temperature of the external air at the time of observation is one factor. The correction to reduce to the standard gravity of latitude 45°, is the same as that used by the Boston office, as are the temperature correction tables. A Draper barograph, multiplying three times and giving a continuous record, has been in operation since May, 1885. Commencing in July, 1885, the record has been checked by daily comparisons with the standard barometer, and the barograph is now so well regulated that the correction is usually less than .01 inch. A Richard aneroid barograph is kept ready as a reserve instrument.

Thermometers, Hygrometers, etc. The thermometers have all been verified, and the Observatory has Hicks thermometers with Kew certificates, and others made by Baudin of Paris, as standards. From the north side of the tower, fifteen feet above the ground, is built a window shelter, in the construction of which special pains were taken to secure ventilation by making the roof double and by setting the shelter six inches out from the wall, and to prevent radiation by having double windows. An isolated shelter, built according to Prof. H. A. Hazen's specifications, shows seldom a difference of 1°, except during rapid changes of temperature, when the wall shelter is somewhat sluggish. For convenience, therefore, the Green wet and dry bulb and maximum and minimum thermometers, together with the Richard thermograph and registering hygrometer, are kept in the window shelter. The error of the Richard thermograph, ascertained daily by readings with the thermometers, is ordinarily less than 1°. A Draper metallic thermograph, kept at the base station, has a somewhat larger error. A "turnover thermometer" of Negretti and Zambra can be set to register the temperature at any pre-determined hour, and