# SECTION II.—GENERAL METEOROLOGY.

## THE MELTING OF SNOW.

By Robert E. Horton, M. Am. Soc. C. E.

[Dated: 57 North Pine Avenue, Albany, N. Y., Jan. 14, 1916.]

It is a familiar fact that if there is deep snow on the ground streams do not rise as rapidly after a rain as they would if the ground were bare. On the other hand, when there is a fall of light snow followed by a warm heavy rain which removes the snow the intensities of resulting floods are sometimes greatly augmented. In general, there is a marked lag between the melting of snow and the appearance of the resulting water as run-off in the streams.

As an aid to a better understanding of the relation of snow accumulation to the flow of streams and to floods, the writer undertook a number of simple experiments.

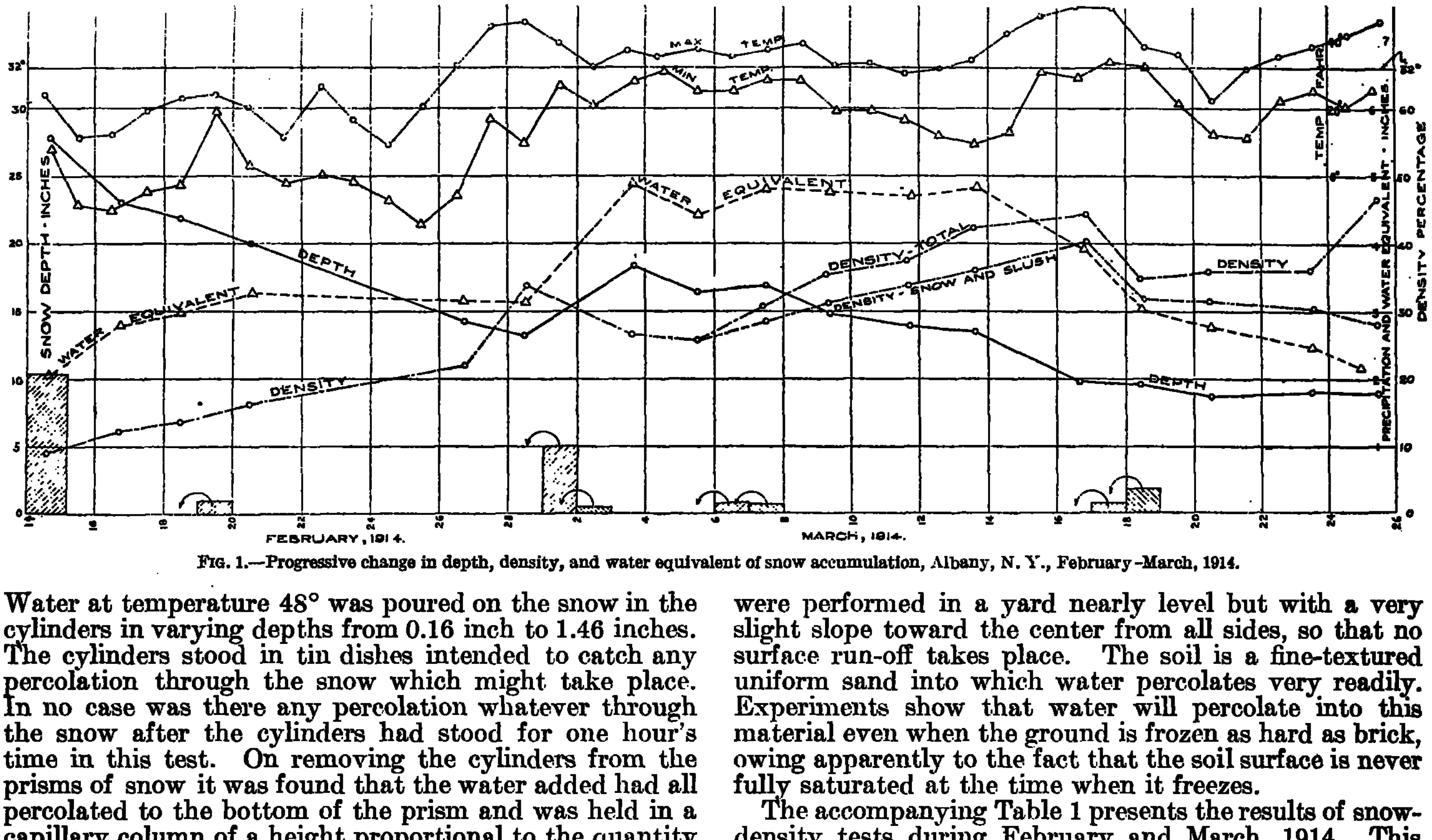

Fig. 1.—Progressive change in depth, density, and water equivalent of snow accumulation, Albany, N. Y., February-March, 1914.

Several cylinders with open ends were filled with snow, the average depth being 5½ inches. The cylinders were each 2.45 inches in diameter and they were placed on end in air at a temperature of from 30° to 32°F. The snow in the cylinders had an average density of 0.333. Water at temperature 48° was poured on the snow in the cylinders in varying depths from 0.16 inch to 1.46 inches. The cylinders stood in tin dishes intended to catch any percolation through the snow which might take place. In no case was there any percolation whatever through the snow after the cylinders had stood for one hour's time in this test. On removing the cylinders from the prisms of snow it was found that the water added had all percolated to the bottom of the prism and was held in a capillary column of a height proportional to the quantity of water added. It was necessary, therefore, to make a further test in order to determine the height to which water would be held in capillary suspension in the bottom of a column of snow before any percolation would take place. By adding increased quantities of water it was found that for the new sample, having density of 0.448, a capillary column 2 inches in height was supported by the snow. This was equivalent to a depth of 1.1 inches of water. It was found, however, that 1.57 inches of the water added to the snow remained therein, indicating that part of the water added remained in the unsaturated prism of snow above the capillary column. From these and other experiments described hereafter it appears that snow under suitable conditions behaves like any other permeable medium, such as a porous soil, as regards the percolation of water through it and its capillary retention in the interstices of the medium. In the experiments above described the snow prisms were placed on a solid surface. If the snow prism was placed on a capillary surface, such for example as a mass of blotting paper or a layer of moist nonsaturated soil, then the capillary lifting power of the snow column would be balanced not by gravity alone but by gravity plus the capillary downward pull of the underlying medium, and a portion of the capillary water held in the snow column would be removed.

During the past three winters there have been unusually heavy falls of snow at Albany, and on each such occasion the writer has kept a record of the progressive decrease in depth and increase in density of snow on the ground, and has performed various experiments to determine the rate of melting of the snow and the disposition of the water produced thereby. These experiments were performed in a yard nearly level but with a very slight slope toward the center from all sides, so that no surface run-off takes place. The soil is a fine-textured uniform sand into which water percolates very readily. Experiments show that water will percolate into this material even when the ground is frozen as hard as brick, owing apparently to the fact that the soil surface is never fully saturated at the time when it freezes.

The accompanying Table 1 presents the results of snow-density tests during February and March, 1914. This series of tests began immediately after a very heavy fall of snow. The depth in the writer's yard was 27.75 inches, as determined from a mean of four samples taken in a galvanized raingage can. The water equivalent was 2.04 inches. This was somewhat greater than the recorded catch at the U. S. Weather Bureau station about 2½ miles distant. Owing to the local surroundings, it appears that the depth of snow which fell at this immediate locality was considerably greater than that which fell in other parts of the city more exposed to the wind. There was little drifting of the snow in the writer's yard.

The results of this series of observations are shown graphically in figure 1, from which it appears that the temperature was uniformly below freezing for six days after the heavy fall of snow. There was but little wind, the snow did not drift but the depth decreased uniformly and the water equivalent and density increased quite uniformly. Similar progressive decrease in depth and increase in density prevailed except when the depth was augmented and the density reduced by additional falls of snow, until the entire snow cover had disappeared. From February 26 on, the temperature generally rose above freezing during the daytime, and during the period with thawing days and freezing nights a layer of slush and ice accumulated underneath the snow as indicated in Table 1, columns 6 and 8. The quantity of slush and ice where the measurements were being taken was probably greater than the average over the entire yard, owing to the slight depression with resulting drainage from the surrounding snow to the lower parts of the depression. This accounts for the total water equivalent being at times greater than the total precipitation as measured by the U. S. Weather Bureau station.

TABLE 1.—*Snow density tests, Albany, N. Y., February–March, 1914.*

| Date. | No. tests. | Time. | Interval. | Depth of snow, etc., on ground. Snow. | Slush. | Snow and sleet. | Ice. | Total. | New snow. Depth. | Water. | Water equivalent. Snow and slush. | Ice. | Total. | Ratio. Snow and slush. | Total. | Water loss. | Precipitation.[1] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) | (13) | (14) | (15) | (16) | (17) | (18) |
| 1914. | | | *Hours.* | *Inches.* | *Inches.* | *Inches.* | *Inches.* | *Inches.* | *Inches.* | *Inches.* | *Inches.* | *Inches.* | *Inches.* | | | *Inches.* | *Inches.* |
| Feb. 14 | 2 | 5 p. m. | 0 | 27.75 | 0 | 27.75 | 0 | ...... | 0 | 0 | 2.04 | 0 | 2.04 | 0.0918 | 0.0918 | ...... | ...... |
| 16 | 4 | 8 a. m. | 39 | 23 | 0 | 23.00 | 0 | ...... | 0 | 0 | 2.80 | 0 | 2.80 | .123 | .123 | −0.76 | 0.02 |
| 17 | | | | | | | | | | | | | | | | | .01 |
| 18 | 3 | 12 m. | 52 | 21.8 | 0 | 21.80 | 0 | ...... | 0.75 | 0.06 | 2.98 | 0 | 2.98 | .136 | .136 | − .18 | ...... |
| 19 | | | | | | | | | | | | | | | | | .20 |
| 20 | 4 | 12:30 p. m. | 48.5 | 20.0 | 0 | 20.00 | 0 | ...... | 2.75 | .137 | 3.29 | 0 | 3.29 | .164 | .164 | − .31 | ...... |
| 26 | 4 | 3 p. m. | 146.5 | 14.06 | 0.25 | 14.31 | 0 | ...... | 0 | 0 | 3.142 | 0 | 3.142 | .220 | .220 | .148 | ...... |
| 28 | 4 | 11 a. m. | 44 | 12.77 | .28 | 13.05 | 0 | ...... | 0 | 0 | 3.146 | 0 | 3.146 | .340 | .340 | − .004 | ...... |
| Mar. 1–2 | | | | | | | | | | | | | | | | | 1.10 |
| 3 | 4 | 4 p. m. | 77 | 17.59 | .81 | 18.40 | 0 | ...... | 6.00 | 1.10 | 4.86 | 0 | 4.86 | .265 | .265 | − .714 | ...... |
| 5 | 4 | 11:30 a. m. | 43.5 | 15.34 | 1.06 | 16.40 | 0 | ...... | 0 | 0 | 4.411 | 0 | 4.411 | .256 | .256 | .449 | ...... |
| 6 | | | | | | | | | | | | | | | | | .16 |
| 7 | 4 | 11:30 a. m. | 48 | 16.90 | 0 | 16.90 | 0.50 | 17.40 | 2.50 | .27 | 4.80 | 0.50 | 5.30 | .284 | .304 | − .389 | .11 |
| 9 | 4 | 10:30 a. m. | 47 | 14.70 | 0 | 14.75 | .75 | 15.50 | 0 | 0 | 4.74 | .75 | 5.49 | .311 | .354 | .06 | ...... |
| 11 | 4 | 4:10 p. m. | 53.7 | 13.80 | 0 | 13.80 | .75 | 14.62 | 0 | 0 | 4.70 | .75 | 5.45 | .338 | .372 | .04 | ...... |
| 13 | 4 | 4 p. m. | 47.8 | 13.45 | 0 | 13.45 | .75 | 14.20 | 0 | 0 | 4.84 | .75 | 5.99 | .360 | .421 | − .14 | ...... |
| 16 | 4 | 4:30 p. m. | 72.5 | 9.75 | 0 | 9.75 | .75 | 10.50 | 0 | 0 | 3.92 | .75 | 4.67 | .401 | .444 | .92 | ...... |
| 17 | | | | | | | | | | | | | | | | | .12 |
| 18 | 4 | 10 a. m. | 41.5 | 9.60 | 0 | 9.60 | .50 | 10.11 | .25 | .46 | 3.05 | .50 | 3.53 | .318 | .348 | .87 | .34 |
| 20 | ...... | Noon | 50 | 8.77 | 0 | 8.77 | .75 | 9.52 | 0 | 0 | 2.74 | .75 | 3.49 | .312 | .366 | .31 | ...... |
| 23 | ...... | Noon | 72 | 8.25 | 0 | 8.77 | .75 | 9.00 | .04 | ...... | 2.48 | .75 | 3.23 | .301 | .360 | .26 | .02 |
| 24 | | | | | | | | | | | | | | | | | .01 |
| 25 | ...... | Noon | 48 | 5.70 | 0 | 8.77 | 1.00 | 6.70 | 0 | 0 | 2.15 | 1.00 | 3.15 | .380 | .472 | .33 | ...... |

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[1] For precipitation 24 hours, U. S. Weather Bureau.

After March 14 the total water equivalent dropped off rapidly, the loss of water being partly due to evaporation, but more largely due, the writer believes, to infiltration in the frozen ground underneath the snow.

Each of the snow densities given in Table 1 is the mean of four tests from samples taken in different parts of the yard, the samples being taken with an inverted iron raingage cylinder and the density determined by weighing. These experiments confirm the earlier conclusions of the writer that an undisturbed layer of snow having an initial density of about 0.10 will increase in the course of the winter to an average density of 0.30 to 0.40. When, however, the layer of slush and ice at the bottom of the snow is taken into account, the density may become much greater, being oftentimes nearly unity when the snow has become reduced by successive thawings and freezings to a nearly solid mass of ice.

On February 20 and again on March 18, 1914, laboratory tests were made to determine the rate of disappearance of a prism of snow under constant temperature conditions. The results of the test of February 20 are shown in Table 2 and those of March 18 in Table 3. In each of these tests a prism of snow was carefully cut out with the galvanized-iron cylinder of the raingage and was set undisturbed upon a perforated pan to permit drainage, the drainage being caught and weighed in a can underneath. The draining and weighing apparatus used is shown in figure 2. The successive forms of the prism as melting progressed in the two tests are shown in figures 3 and 4, respectively. The object of these experiments was to determine, first, the amount of lag in time between a partial melting of the snow and the appearance of the resulting water as run-off; second, to determine the rate of melting per unit of surface exposed at a given temperature. Owing to the fact that the snow prisms became very irregular in form as melting proceeded and

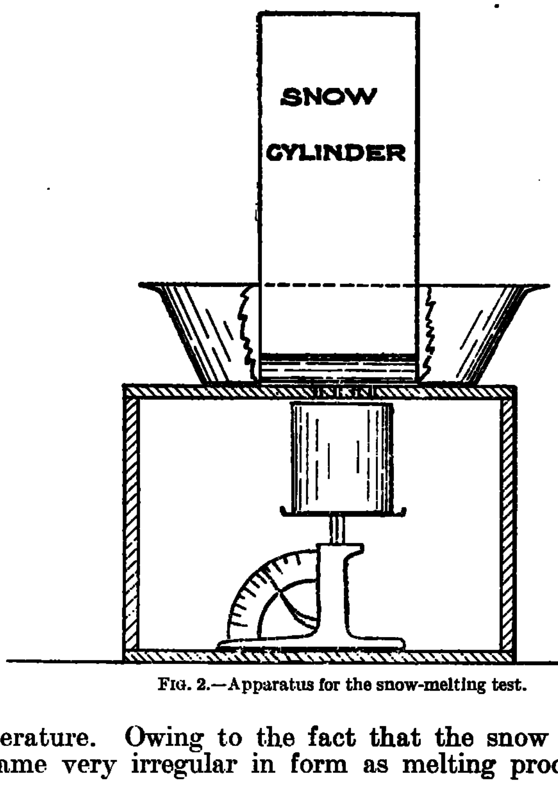

FIG. 2.—Apparatus for the snow-melting test.

further owing to the great difficulty of determining accurately the height of the capillary column of water retained at the base of the prism, the results given in Table 2, column **28**, and in Table 3, column **25**, can only be utilized for the purpose of determining the rate of melting during the earlier stages of the experiments From these figures it appears that each degree of temperature above 32° is able to melt a depth of snow equivalent to from 0.04 to 0.06 inch of water per 24 hours.

TABLE 2.—*Experiments on snow melting, Albany, N. Y., February 20, 1914.*

| Hour. (1) | Height. (2) | Mean diameter. (3) | Perimeter. (4) | Cylindrical surface. (5) | End area. (6) | Total surface. (7) | Mean surface. (8) | Diameter base. (9) | Area base. (10) | Capillary rise. (11) | Storage volume. (12) | Net water, 1/16 cubic inch. (13) | Gain or loss of storage. (14) | Total drainage.[1] (15) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| P. M. | *Inches.* | *Inches.* | *Inches.* | *Sq. inches.* | *Sq. inches.* | *Sq. inches.* | *Sq. inches.* | *Inches.* | *Inches.* | *Inches.* | *Cu. inches.* | | *Cu. inches.* | *Ounces.* |
| 12:48 | 20.00 | 8.0 | 25.13 | 502.6 | 50.26 | 552.9 | | 8.0 | 50.26 | 0 | 0 | 0 | | 0 |
| | | | | | | | 537.2 | | | | | | 0 | |
| 1:00 | 19.80 | 7.65 | 24.02 | 475.6 | 45.96 | 521.6 | | 8.0 | 50.26 | 0 | 0 | 0 | | 0 |
| | | | | | | | 500.2 | | | | | | + 9.6 | |
| 1:30 | 19.00 | 7.32 | 22.99 | 436.8 | 42.08 | 478.8 | | 7.8 | 47.78 | 0.25 | 11.94 | 9.6 | | 0 |
| | | | | | | | 444.9 | | | | | | +25.0 | |
| 2:00 | 17.70 | 6.75 | 21.20 | 375.2 | 35.78 | 411.0 | | 7.7 | 45.57 | .95 | 43.29 | 34.6 | | 0 |
| | | | | | | | 394.4 | | | | | | + 1.6 | |
| 2:30 | 16.60 | 6.60 | 20.73 | 343.6 | 34.21 | 377.8 | | 7.4 | 43.00 | 1.05 | 45.15 | 36.2 | | 12.0 |
| | | | | | | | 352.3 | | | | | | − 3.6 | |
| 3:00 | 15.50 | 6.10 | 19.16 | 297.6 | 29.22 | 326.8 | | 7.2 | 40.72 | 1.00 | 40.72 | 32.6 | | 24. |
| | | | | | | | 308.6 | | | | | | − 7.77 | |
| 3:30 | 14.80 | 5.70 | 17.91 | 264.9 | 25.52 | 290.4 | | 6.9 | 37.39 | .83 | 31.04 | 24.83 | | 34. |
| | | | | | | | 250.9 | | | | | | −12.73 | |
| 4:30 | 12.50 | 4.90 | 15.40 | 192.5 | 18.86 | 211.4 | | 6.2 | 30.20 | .50 | 15.10 | 12.1 | | 49. |
| | | | | | | | 195.2 | | | | | | + 2.1 | |
| 5:40 | 11.00 | 4.70 | 14.76 | 162.3 | 17.35 | 179.0 | | 5.5 | 23.76 | .75 | 17.82 | 14.2 | | 65. |
| | | | | | | | 156.7 | | | | | | − 4.76 | |
| 6:30 | 9.00 | 4.25 | 13.35 | 120.2 | 14.19 | 134.4 | | 5.0 | 19.63 | .60 | 11.78 | 9.44 | | [2] 78. |
| | | | | | | | 96.1 | | | | | | − 6.35 | |
| 8:47 | 6.00 | 2.75 | 8.64 | 51.8 | 5.93 | 57.8 | | 3.5 | 9.65 | .40 | 3.86 | 3.09 | | 94. |
| | | | | | | | 28.9 | | | | | | − 3.09 | |

| Drainage. (16) | Drainage. (17) | Time, days ÷ 1. (18) | Total melting. (19) | Melting per 24 hours. (20) | Melting. depth of water per 24 hours. (21) | Temperature. (22) | Mean. (23) | Difference from 32°. (24) | Melting, per degree per 24 hours. (25) | Melting per square-foot per degree per 24 hours. (26) | Surface exposed. (27) | Melting, depth of water per degree per 24 hours. (28) | Cumulated melting. (29) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Ounces.* | *Cu. inches.* | | *Cu. inches.* | *Cu. inches.* | *Inches.* | *°F.* | *°F.* | *°F.* | *Cu. inches.* | *Cu. inches.* | *Sq. feet.* | *Inches.* | *Cu. inches* |
| | | | | | | 76.0 | | | | | | | |
| 0 | 0 | | | | | | 75.75 | 43.75 | | | 3.73 | | |
| | | | | | | 75.5 | | | | | | | |
| 0 | 0 | 48.0 | 9.6 | 460.8 | | | 74.5 | 42.5 | 10.8 | 3.11 | 3.47 | 0.021 | 9.6 |
| | | | | | | 73.5 | | | | | | | |
| 0 | 0 | 48.0 | 25.0 | 1,200 | 2.70 | | 73.5 | 41.5 | 28.9 | 9.32 | 3.10 | .0647 | 34.6 |
| | | | | | | 73.5 | | | | | | | |
| 12.0 | 20.76 | 48.0 | 22.36 | 1,075 | 2.73 | | 73.25 | 41.25 | 26.1 | 9.53 | 2.74 | .0661 | 56.96 |
| | | | | | | 73.0 | | | | | | | |
| 12.5 | 21.62 | 48.0 | 18.02 | 864 | 2.46 | | 72.5 | 40.5 | 21.3 | 8.70 | 2.45 | .0604 | 74.98 |
| | | | | | | 72.0 | | | | | | | |
| 10.0 | 17.30 | 48.0 | 9.53 | 457 | 1.48 | | 71.5 | 39.5 | 11.6 | 5.42 | 2.14 | .0376 | 84.51 |
| | | | | | | 71.0 | | | | | | | |
| 15.0 | 25.95 | 24.0 | 13.22 | 317 | 1.26 | | 70.25 | 38.25 | 8.31 | 4.78 | 1.74 | .0332 | 97.73 |
| | | | | | | 69.5 | | | | | | | |
| 15.5 | 26.81 | 20.5 | 28.81 | 590 | 3.03 | | 69.25 | 37.25 | 15.9 | 11.7 | 1.36 | .0811 | 126.54 |
| | | | | | | 69.0 | | | | | | | |
| 13.0 | 22.49 | 28.8 | 17.73 | 510 | 3.25 | | 69.5 | 37.5 | 13.6 | 12.5 | 1.09 | .0867 | 144.27 |
| | | | | | | 70.0 | | | | | | | |
| 16.5 | 28.54 | 10.43 | 22.19 | 231 | 2.40 | | 70.6 | 38.6 | 5.98 | 8.97 | 0.67 | .0622 | 166.46 |
| | | | | | | 71.2 | | | | | | | |
| | | | 166.46 | | | | | | | | | | |

[1] Original weight, 97.44 ounces.

[2] Overflow estimated at 10 ounces, probably more.

TABLE 3.—*Snow-melting tests at Albany, N. Y., second series, March 18, 1914.*

| Time. | Height of prism. | Base. |  | Top. |  | Prism. |  |  | Total prism. | Capillary rise. | Storage volume. | Net storage. | Gain or loss. | Drainage. | Total melting. | Time interval. | Melting per 24 hours. | Total area. | Total area. | Melting per square foot in 24 hours. | Melting per square foot in 24 hours. | Temperature. | Excess over 32°. | Melting per square foot per degree in 24 hours. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
|  |  | Mean diameter. | Area. | Mean diameter. | Area. | Mean diameter. | Area. | Perimeter. |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) | (13) | (14) | (15) | (16) | (17) | (18) | (19) | (20) | (21) | (22) | (23) | (24) | (25) |
|  | *In.* | *In.* | *Sq. in.* | *In.* | *Sq. in.* | *In.* | *Sq. in.* | *In.* | *Cu. in.* | *In.* |  | *Cu. in.* | *Cu. in.* | *Cu. in.* | *Cu. in.* | *Hrs.* | *Cu. in.* | *Sq. in.* | *Sq. ft.* | *Cu. in.* | *In.* | *°F.* | *°F.* | *In.* |
| 9:40 a. m. | 9.30 | 7.80 | 47.78 | 7.80 | 47.78 | 7.8 | 47.78 | 24.50 | 372.8 | 0 | 0 | ...... | ...... | ...... | ...... | 0 | ...... | 275.6 | 1.908 | ...... | ...... | 74 | 42 | ...... |
| 10:00 | 9.10 | 7.60 | 45.36 | 7.60 | 45.36 | 7.6 | 45.36 | 23.86 | 345.0 | 0.50 | 22.18 | 14.30 | +14.30 | 0 | 14.30 | ⅓ | 1,030.0 | 262.9 | 1.825 | 564 | 3.94 | 74 | 42 | 0.0938 |
| 10:15 | ...... | 7.50 | Drainage starting. |  |  |  |  | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| 10:20 | 8.90 | 7.60 | 45.36 | 7.50 | 44.18 | 7.55 | 44.77 | 23.71 | 340.4 | .75 | 34.5 | 22.25 | 7.95 | 1.73 | 9.68 | ⅓ | 697.0 | 255.1 | 1.770 | 394 | 2.73 | 71 | 39 | .0700 |
| 10:40 | 8.70 | 7.54 | 44.65 | 7.35 | 42.43 | 7.44 | 43.47 | 23.37 | 328.0 | .75 | 33.5 | 21.61 | − .65 | 6.92 | 6.27 | ⅓ | 451.4 | 246.0 | 1.707 | 264 | 1.83 | 71 | 39 | .0469 |
| 11:00 | 8.50 | 7.53 | 44.53 | 7.34 | 42.31 | 7.44 | 43.47 | 23.37 | 327.5 | .70 | 31.2 | 20.12 | − 1.49 | 12.11 | 10.62 | ⅓ | 764.6 | 241.2 | 1.672 | 458 | 3.18 | 71 | 39 | .0816 |
| 11:20 | 8.40 | 7.50 | 44.18 | 7.33 | 42.20 | 7.42 | 43.24 | 23.31 | 324.0 | .65 | 28.7 | 18.51 | − 1.61 | 6.92 | 5.31 | ⅓ | 382.3 | 237.9 | 1.652 | 232 | 1.61 | 72 | 40 | .0402 |
| 11:40 | 8.00 | 7.18 | 40.49 | 7.22 | 40.94 | 7.20 | 40.72 | 22.61 | 292.2 | .65 | 26.3 | 16.96 | − 1.55 | 8.65 | 7.10 | ⅓ | 511.2 | 221.7 | 1.541 | 332 | 2.30 | 72 | 40 | .0575 |
| 12 m. | 8.00 | 7.10 | 39.59 | 7.15 | 40.15 | 7.12 | 39.81 | 22.36 | 282.5 | .60 | 23.8 | 15.35 | − 1.61 | 6.92 | 5.31 | ⅓ | 382.3 | 219.4 | 1.520 | 251 | 1.74 | 73 | 41 | .0425 |
| 12:20 p. m. | 7.85 | 6.90 | 37.39 | 6.55 | 33.70 | 6.73 | 35.57 | 21.14 | 245.6 | .50 | 18.7 | 12.06 | − 3.29 | 8.65 | 5.36 | ⅓ | 385.9 | 199.3 | 1.381 | 279 | 1.94 | 73.5 | 41.5 | .0467 |
| 12:40 | 7.50 | 6.90 | 37.39 | 6.35 | 31.67 | 6.62 | 34.42 | 20.79 | 237.3 | .50 | 18.7 | 12.06 | 0 | 12.11 | 12.11 | ⅓ | 871.9 | 187.7 | 1.304 | 671 | 4.65 | 74 | 42 | .1110 |
| 1:00 | 7.20 | 6.60 | 34.21 | 6.05 | 28.75 | 6.32 | 31.37 | 19.85 | 207.2 | .50 | 17.1 | 11.02 | − 1.04 | 6.92 | 5.88 | ⅓ | 423.4 | 171.3 | 1.186 | 356 | 2.47 | 74.5 | 42.5 | .0581 |
| 1:20 | 7.00 | 6.45 | 32.57 | 5.95 | 27.80 | 6.20 | 30.19 | 19.47 | 194.8 | .50 | 16.3 | 10.51 | − 0.51 | 6.92 | 6.41 | ⅓ | 461.5 | 163.6 | 1.138 | 406 | 2.82 | 75 | 43 | .0656 |
| 1:40 | 6.90 | 6.35 | 31.67 | 5.85 | 26.87 | 6.10 | 29.22 | 19.16 | 185.4 | .40 | 12.7 | 8.19 | − 2.32 | 6.92 | 4.60 | ⅓ | 331.2 | 159.3 | 1.103 | 301 | 2.09 | 75 | 43 | .0486 |
| 2:00 | 6.70 | 6.32 | 31.37 | 5.82 | 26.60 | 6.07 | 28.93 | 19.07 | 182.6 | .50 | 15.7 | 10.12 | + 1.93 | 6.92 | 8.85 | ⅓ | 637.2 | 154.5 | 1.075 | 590 | 4.09 | 75 | 43 | .0951 |
| 2:20 | 6.70 | 6.20 | 30.19 | 5.65 | 25.07 | 5.92 | 27.52 | 18.59 | 170.5 | .50 | 15.1 | 9.73 | − 0.39 | 6.92 | 6.53 | ⅓ | 470.2 | 149.7 | 1.041 | 451 | 3.13 | 74 | 42 | .0745 |
| 2:40 | 6.50 | 6.05 | 28.74 | 5.40 | 22.90 | 5.78 | 26.24 | 18.15 | 158.5 | .30 | 8.61 | 5.55 | − 4.18 | 8.65 | 4.47 | ⅓ | 321.8 | 141.2 | 0.978 | 329 | 2.28 | 77 | 45 | .0507 |
| 3:00 | 6.20 | 5.90 | 27.34 | 5.20 | 21.23 | 5.55 | 24.19 | 17.43 | 142.7 | .35 | 9.55 | 6.16 | + 0.61 | 6.92 | 7.53 | ⅓ | 543.0 | 129.0 | .895 | 607 | 4.21 | 76 | 44 | .0957 |
| 3:20 | 5.80 | 5.75 | 25.97 | 4.95 | 19.24 | 5.35 | 22.48 | 16.80 | 129.3 | .40 | 10.36 | 6.70 | + 0.54 | 8.65 | 9.19 | ⅓ | 661.2 | 116.0 | .805 | 821 | 5.70 | 75 | 43 | .0133 |
| 3:40 | 5.40 | 5.35 | 22.48 | 4.86 | 18.55 | 5.11 | 20.50 | 16.05 | 109.6 | .30 | 6.75 | 4.35 | − 2.35 | 5.19 | 2.84 | ⅓ | 204.5 | 104.9 | .728 | 281 | 1.95 | 73 | 41 | .0476 |
| 4:00 | 5.38 | 5.28 | 21.89 | 4.82 | 18.25 | 5.09 | 20.35 | 15.99 | 107.0 | .40 | 8.76 | 5.65 | + 1.30 | 3.46 | 4.76 | ⅓ | 342.7 | 104.2 | .721 | 475 | 3.30 | 75 | 43 | .0768 |
| 4:20 | 4.50 | 5.05 | 20.02 | 4.52 | 16.05 | 4.75 | 17.72 | 14.92 | 89.3 | .40 | 8.01 | 5.17 | − 0.48 | 10.38 | 9.90 | ⅓ | 712.8 | 83.1 | .577 | 1,235 | 8.57 | 74 | 42 | .204 |
| 4:40 | 4.00 | 4.85 | 18.47 | 4.40 | 15.20 | 4.67 | 17.13 | 14.67 | 82.9 | .30 | 5.52 | 3.56 | − 1.61 | 5.19 | 3.58 | ⅓ | 257.8 | 74.2 | .515 | 501 | 3.48 | 75 | 43 | .0809 |
| 5:00 | 3.90 | 4.40 | 15.20 | 4.05 | 12.88 | 4.22 | 13.99 | 13.25 | 61.6 | .30 | 4.56 | 2.94 | − 0.62 | 8.65 | 8.03 | ⅓ | 578.2 | 63.9 | .443 | 1,308 | 9.09 | 75 | 43 | .211 |
| 5:20 | 3.80 | 4.10 | 13.20 | 3.85 | 11.64 | 3.97 | 12.38 | 12.47 | 50.8 | .40 | 5.28 | 3.40 | + 0.46 | 5.19 | 5.65 | ⅓ | 406.8 | 59.6 | .414 | 983 | 6.82 | 75 | 43 | .159 |
| 5:40 | 3.20 | 3.60 | 10.18 | 3.45 | 9.34 | 3.52 | 9.73 | 11.05 | 35.0 | .30 | 3.06 | 1.97 | − 1.43 | 5.19 | 3.76 | ⅓ | 270.7 | 44.3 | .307 | 882 | 6.12 | 76 | 44 | .139 |
| 6:00 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| 6:20 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| 6:40 | 2.10 | 2.27 | 4.05 | 2.25 | 3.98 | 2.26 | 4.01 | 7.10 | 9.1 | .40 | 1.62 | 1.04 | − 0.93 | 3.46 | 2.53 | ⅓ | 182.2 | 18.9 | .131 | 1,390 | 9.64 | 74 | 42 | .230 |
| 7:00 | 1.80 | 1.95 | 2.98 | 1.88 | 2.78 | 1.91 | 2.86 | 6.00 | 5.57 | .30 | .894 | 0.58 | − 0.46 | 3.46 | 3.00 | ⅓ | 216.0 | 13.6 | .094 | 2,300 | 15.96 | 75 | 43 | .371 |
| 7:20 | 1.20 | 1.25 | 1.23 | 1.28 | 1.29 | 1.26 | 1.25 | 3.95 | 1.56 | .20 | .246 | .16 | − 0.42 | 3.46 | 3.04 | ⅓ | 218.9 | 6.0 | .041 | 5,341 | 37.06 | 75 | 43 | .859 |
| 7:40 | 0.80 | 1.15 | 1.04 | 1.10 | 0.95 | 1.12 | 0.99 | 3.11 | 1.13 | .20 | .208 | .13 | − 0.03 | 0.865 | 0.84 | ⅓ | 60.5 | 3.43 | .023 | 2,630 | 18.25 | 74 | 42 | .434 |
| 8:00 | .30 | 0.50 | 0.196 | 0.45 | 0.159 | 0.48 | 0.18 | 0.565 | 0.09 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| 8:05 | 0 | ...... | ...... | 0 | ...... | 0 | 0 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |

In figure 5 an effort has been made to determine the relation between the total amount of melting expressed as a depth of water in inches, and the amount of percolation taking place from a snow prism. The line marked "total melting, cubic inches," figure 5, has been obtained by adding together the percolation and the quantity of water accumulated or stored in the base of the snow column in the form of slush. Later experiments on the percolation of water through snow indicate, however, that this line does not represent the total amount of melting. Melting takes place at the surface and the resulting water percolates downward through the prism of snow, part of the water remaining in the portion of the prism above the saturated column as a capillary film. The experiment does, however, illustrate strikingly the lag in time between the melting and the appearance of run-off, since in the experiments illustrated in figure 5 two hours elapsed after melting began before any percolation took place. In the meantime snow equivalent to something more than 34 cubic inches of water had been melted.

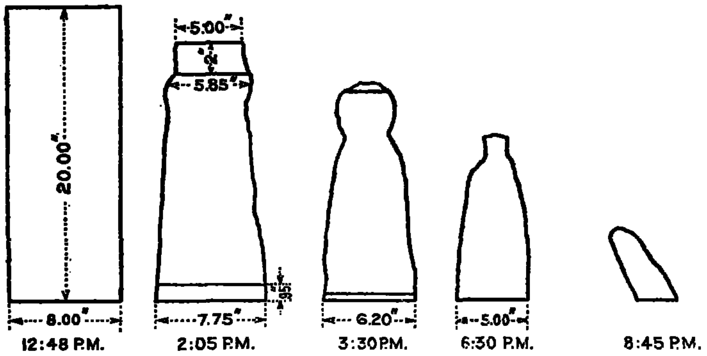

FIG. 3.—Snow prism during melting, Feb. 20, 1914. Experiment started at 12:48 p. m.; drainage started at 2:05 p. m.

As the total weight of percolation finally obtained from the melting of the prism was but slightly less than the weight of the original volume of water contained in the experimental prism, it appears that the loss from surface evaporation during these tests was comparatively slight. The more rapid melting of the less dense, newly fallen snow lying on the surface is clearly illustrated by figure 3.

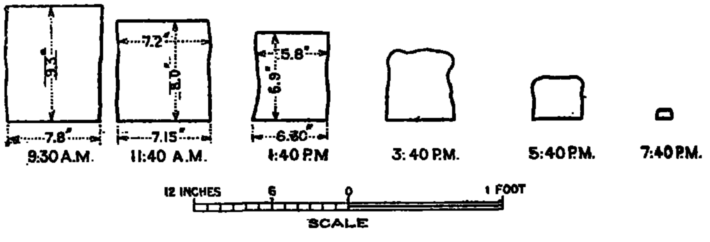

FIG. 4.—Snow prism during melting, March 18, 1914.

It was noted in the experiments that the height of the capillary column at the base of the prism gradually increased to a maximum before percolation began.

After percolation began the process seemed to be very irregular, the water flushing out at times rapidly, then again there would be but little percolation for a time. Some of the snow crystals were apparently melted by the percolating water so that the porosity of the base of the column was increased and its capillary power decreased, thus the height of the capillary column decreased as the melting of the prism progressed.

**TABLE 4.**—*Snow density tests, Albany, N. Y., December, 1915–January, 1916.*

| Date. | Total depth. | New snow. | Slush or ice bottom. | Total water equivalent. | Ratio. | Precipitation, U. S. Weather Bureau, Albany, N. Y. | Total supply. | Gain or loss. | Maximum temperature. | Minimum temperature. |
|---|---|---|---|---|---|---|---|---|---|---|
| (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) |
| | *Inches.* | *Inches.* | *Inches.* | *Inches.* | | *Inches.* | *Inches.* | *Inches.* | *°F.* | *°F.* |
| Dec. 13 | | | | | | 1.98S. | | | 32 | 18 |
| 14 | | | | | | 0.35S. | | | 32 | 23 |
| 15 | 29.82 | 29.75 | 0 | 3.465 | 0.116 | | 3.465 | +3.465 | 27 | 19 |
| 16 | | | | | | | | | 30 | 16 |
| 17 | 23.50 | 0 | 0.755 | 3.345 | .141 | 0.23R. | 3.70 | −0.36 | 38 | 13 |
| 18 | 18.50 | 0 | 0.505 | 3.486 | .189 | 1.12R. | 4.82 | −1.32 | 39 | 36 |
| 19 | | | | | | | | | 37 | 30 |
| 20 | 14.50 | 0 | 0 | 3.486 | .241 | | | | 34 | 23 |
| 21 | | | | | | | | | 32 | 22 |
| 22 | 14.50 | 0 | 0 | 3.423 | .236 | | | | 32 | 15 |
| 23 | | | | | | 0.05R. | 4.87 | | 39 | 31 |
| 24 | 11.00 | 0 | 0 | 2.961 | .269 | | | | 42 | 35 |
| 25 | | | | | | 0.01R. | 4.88 | | 45 | 34 |
| 26 | | | | | | 1.84R.<br>S. | 6.72 | | 46 | 23 |
| 27 | | | | | | | | | 35 | 26 |
| 28 | 10.75 | 0 | 0 | | .214 | 0.035 | 6.75 | | 38 | 32 |
| 29 | | | | | | 0.625 | 7.37 | | 32 | 22 |
| 30 | 18.50 | 7.00 | 0 | | .234 | | | | 22 | 8 |
| 31 | | | | | | | | | 20 | 2 |
| Jan. 1 | | | | | | | | | | |
| 2 | | | | | | | | | | |
| 3 | 16.50 | 0 | 0 | | .298 | | | | | |

A fall of $29\frac{7}{8}$ inches of snow occurred at Albany December 13–14, 1915. The results of density tests of this snow layer and of subsequent falls of snow are shown in Table 4. At the time this snow fell the ground was not saturated and was but little frozen. Snow temperature gradients have been taken in this snow as shown on figure 6. The temperature at the ground surface remained nearly constant from December 15, 1915, to January 1, 1916, at 30° to 32°. The temperature within the mass of snow gradually decreased from the bottom to the surface as long as the temperature was low. On January 1, 1916, with an air temperature of 30°, the minimum temperature of the preceding day having been −2°F., there was a sharp inversion of temperature 5 inches below the surface in the snow layer.

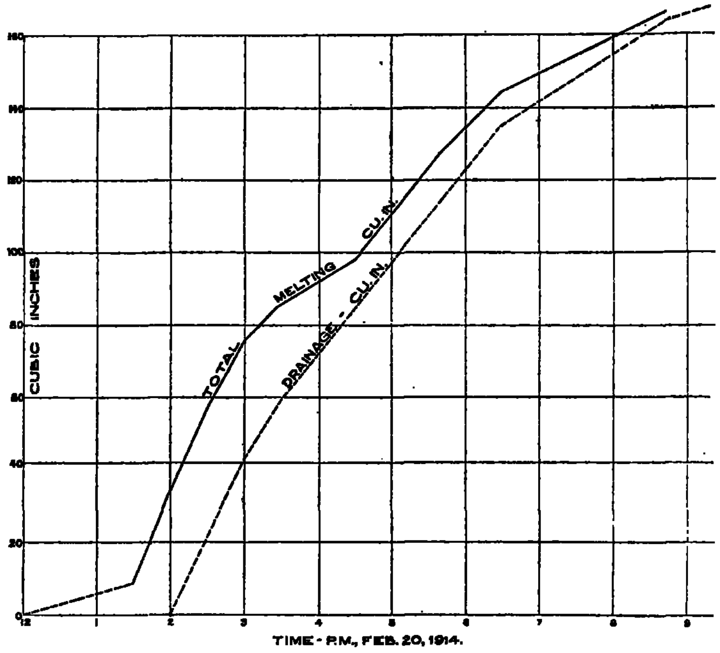

FIG. 5.—Illustrating time lag in run-off from melting snow. (Experiment of Feb. 20, 1914.)

On December 25, 1915, an experiment was made to determine the maximum rate of percolation through a prism of this snow, treating it as a porous medium. For this purpose a prism of snow of 4.71 square inches cross section was used, its temperature being about 30° and its average density 0.64, the snow being packed into the tube as uniformly as possible. The depth of the prism was 21 inches. When the surface of this prism of snow was kept covered with water at 32°, the water flowed through the snow prism by percolation at a velocity corresponding to a depth of 2.28 inches (0.19 foot) on the surface per minute. This may be taken to represent the transmission constant analogous to the transmission constant for flow of ground-water for snow having a porosity of 36 per cent and at the given temperature.

Where snow lying on the ground contains a saturated layer or layer of slush at the bottom, the water will tend to flow along the ground surface from higher to lower levels apparently in accordance with the ordinary laws governing the flow of ground-waters. Using the transmission constant determined as above for snow of the given density and taking the height of the capillary column as $D$, the rate of horizontal flow of water along the ground surface would be

$$q = 0.19SD,$$

where $q$ = the quantity of flow in cubic feet per minute per foot of width, measured at right angles to the direction of slope; $S$ = slope of the ground surface.

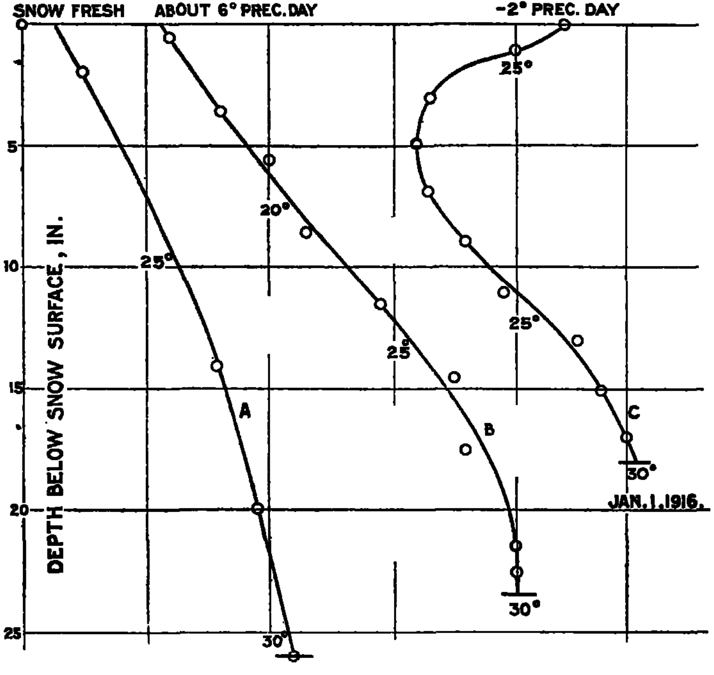

FIG. 6.—Vertical temperature gradients in snow, at Albany, N. Y.

Under the conditions given, with a ground-surface slope of 1 in 50 or 100 feet per mile, and with a depth of slush of 0.10 foot, the rate of flow through a layer of slush would be 1.6 cubic feet per day per linear foot. This is equivalent to about 0.1 cubic foot per second per mile and illustrates the extremely slow rate at which a stream may be fed from the melting of snow where the water must flow through the layer of snow itself.

Since the transmission constant for a porous medium increases much more rapidly than the porosity, it is probable that the rate of flow through snow of the ordinary densities—say 0.30 to 0.40—of an accumulated snow layer would be four or five times as great as through the sample tested, and freshly fallen snow of density about 0.10 offers comparatively little resistance to the flow of water over the surface of the ground. Further experiments are needed to determine the transmission constants for snow of various densities.

During the winter of 1914 the ground was thoroughly frozen when the heavy snow fell. In the snowfall of December 14, 1915, the ground was but little frozen and fairly dry. During 1914 a layer of slush and ice appeared at the bottom of the snow, as shown in Table 1. Since the snowfall of December 14, 1915, there has been little accumulation of slush or ice at the bottom of the snow, although the temperature has been above 32° much of the time and a rain of 1.35 inches fell on December 17–18, 1915. There was no appreciable difference in the appearance of the snow cover before and after this rain. The accumulated water on the ground surface before this rain was 3.34 inches, and following the rain it was 3.49 inches. This was accompanied by a decrease in depth of the snow layer from 23.5 to 14.5 inches and by an increase in density from 0.141 to 0.241. As shown by the above figures, practically none of the rainfall of December 17 or 18 remained in the body of the snow. A marked rise in the ground-water level underneath the writer's yard took place, however, a day or so following this rain, indicating that the rain had simply filtered for the most part through the snow and percolated into the ground in very much the same manner as if there had been no snow cover.

To melt 1 pound of ice or snow at 32° requires the addition of 143.8 b. t. u. or at 777.5 ft.-lbs. each, 111,804.5 ft.-lbs., or roundly 3.4 h. p. for one minute.

Let,

$r$ = depth of rainfall, inches;
$w$ = water equivalent of accumulated snow on ground in inches;
$t_r$ = temperature of rain (°$F$.);
$t_a$ = temperature of air (°$F$.).

We shall assume $t_r = t_a = t$, and that 27.72 cu. ins. = 1 pound of water. For melting by rain alone, there will be required a rainfall such that

$$(t-32^\circ)\frac{r}{27.72}=143.8\frac{w}{27.72}$$

or,

$$(t-32^\circ)r=143.8w$$

$$r=\frac{143.8}{t-32^\circ}w$$

Thus to melt 1 inch of congealed water, or say 5 inches compact snow, or 10 inches loose fresh snow, with rain at 42° would require 14.4 inches of rain. The melting of snow by rain alone is a very slow process. High temperature, especially with direct solar radiation, is much more effective.

### CONCLUSIONS.

Some of the experiments described in this paper must be considered as preliminary and somewhat crude. Those relative to heat absorption by snow will, in particular, bear repeating in the light of the experience gained, and with greater refinement.

The experiments and the writer's observations lead to the following conclusions which, it is believed, are correct:

1. With temperature below freezing, the snow settles by gravity without change in its crystalline structure.

2. If the snow melts at the surface or if warm rain falls on it, most of the water percolates down through the body of the snow, provided the latter is at about 32° temperature and a part of the water adheres to the snow crystals as a capillary film.

3. If alternate thawing and freezing occur or if the interior of the body of the snow has a temperature well below freezing when rain falls or when the surface is melting, the adhering films become frozen to the snow and increase the size and volume of the crystals, changing their crystalline form and increasing the density of the mass. This is apparently the cause of the snow becoming coarse grained with age. The infiltrated water melts some crystals, especially the smaller ones. The size of the pores is thus increased and the capillary supporting power of the snow decreased, as was observed in the experiments shown in figure 3.

4. There may thus result from alternate thawings and freezings, or from rain, a further increase in density independent of the decrease in depth of the snow.

5. Under suitable conditions of low snow temperature, rain may freeze at the surface, forming a crust.

6. When a thaw occurs after a cold snap, the snow at a little depth below its surface being much below freezing temperature, the water resulting from surface melting percolates to a slight depth in the snow and becomes fixed by the freezing of the liquid films on the crystals, forming stratification in the snow mass.

7. When snow and water are in temperature equilibrium (i. e., 32°), percolation and capillary action through the snow may take place in the same manner as the flow of water through a porous soil.

8. Snow in this condition will support a column of water against gravity having a height three to five times $D$ in inches, where $D$ is the snow density (water = 1).

9. The transmission constant for packed snow, density 0.64, was found to be about 2.28 inches depth per minute, which equals 273.6 feet per 24 hours for free downward percolation.

10. When snow stands on a sloping impervious surface, lateral flow will be proportional to the product of the depth of slush under the snow, the transmission factor, and the slope of the surface, jointly.

11. With thawing days and freezing nights, most of the water resulting from the melting of snow lying upon impervious ground will percolate to the bottom of the layer and may there be held by capillary action until subsequent cold converts it into a layer of ice. It may remain as ice until most of the snow above it is melted. This explains the layer of ice commonly observed around the margin of a snow bank as it melts, even when the snow bank lies on a steep slope.

12. The run-off to streams from melting snow, will lag behind the process of melting until, if melting temperatures continue long enough, nearly the whole snow mass will be converted into slush. In the meantime the run-off will take place only through the slow processes of capillary flow.

13. After the greater portion of the snow has been converted into slush subsequent heat—due to direct insolation or to warm rain—may rapidly break down the remaining capillary structure, and cause a relatively rapid flushing of water into the streams with resulting flood conditions. As snow melts ordinarily, the percolating water under the snow accumulates in low places, breaks through the obstructing barrier of slush into outlet channels and the actual rate of run-off is somewhat

greater than would be the case for uniform capillary flow along the surface.

**14.** The rate at which the snow is melted depends on the rate at which heat can be absorbed by the snow surface per unit area with air at the given temperature. The writer's experiments indicate that the melting constant is about 0.04 to 0.06 inch depth of water per 24 hours per degree of temperature above 32°F. Loose snow apparently absorbs heat at about the same rate as packed snow, but as the water equivalent of the former is lower, its rate of disappearance is much more rapid.

**15.** When snow overlies unfrozen ground, or frozen but porous and unsaturated soil, most of the water from melting percolates to the bottom of the snow layer and thence into the soil. The melting of snow or warm rain falling upon a snow cover under suitable conditions, is thus more favorable to the replenishment of ground water than would be an equal volume of rainfall on a bare surface, since in the presence of snow, surface run-off is greatly retarded and the opportunity for infiltration increased.

**16.** Under suitable conditions and especially in the woods where the ground is least frozen, a deep layer of snow on level ground may wholly disappear by invisible percolation without causing any surface run-off whatever. Where there is opportunity for infiltration, the melting of snow contributes more to the ground water and less to the surface run-off than would an equal volume of rain on a bare surface, and by providing a high ground-water level, the effect of the melting of snow cover may be felt for a longer time after the snow has disappeared than if an equal volume of rain had fallen at the same time.

## METEOROLOGY AND SEISMOLOGY AT THE PAN AMERICAN SCIENTIFIC CONGRESS.

By C. FITZHUGH TALMAN, Professor of Meteorology.

[Dated: Weather Bureau, Washington, Jan. 20, 1916.]

In the Second Pan American Scientific Congress, which met in Washington from December 27, 1915, to January 8, 1916, inclusive, meteorology and seismology were represented by a subsection of Section II. All sessions were held in the auditorium of the Carnegie Institution.

On Tuesday morning, December 28, the Subsection on Meteorology and Seismology met in conjunction with the Subsection on Astronomy and Geodesy. Dr. R. S. Woodward, chairman of Section II, addressed the meeting, after which administrative business of the section was disposed of and a program of astronomical and geodetic papers was presented. The first separate session of the Subsection on Meteorology and Seismology was held on the afternoon of December 28.

The attendance in this subsection was gratifyingly large, and this branch of the Pan American Scientific Congress was probably more fully representative of the meteorological and seismological activities of the Americas than any scientific gathering ever before held. Owing to the length of the program, it was found necessary, after the first session, to read by title all papers the authors of which were not in attendance.

The following meteorologists and seismologists attended one or more of the sessions as members of the Congress:

Dr. C. G. Abbot, Smithsonian Institution, Washington.
Dr. H. Arctowski, New York Public Library, New York.
Prof. S. I. Bailey, Harvard College Observatory, Cambridge, Mass.
Dr. L. A. Bauer, Carnegie Institution, Washington.
E. A. Beals, U. S. Weather Bureau, Portland, Oreg.
Prof. W. R. Blair, U. S. Weather Bureau, Washington.
E. H. Bowie, U. S. Weather Bureau, Washington.
C. F. Brooks, Yale University, New Haven.
Prof. J. E. Church, jr., University of Nevada, Reno.
Dr. H. H. Clayton, Oficina Meteorológica Argentina, Buenos Aires.
Dr. I. M. Cline, U. S. Weather Bureau, New Orleans.
Prof. H. J. Cox, U. S. Weather Bureau, Chicago.
Prof. O. L. Fassig, U. S. Weather Bureau, Baltimore.
Prof. H. C. Frankenfield, U. S. Weather Bureau, Washington.
Rev. A. Galán, S. J., Woodstock College, Woodstock, Md.
Rev. M. Gutierrez-Lanza, S. J., Belén College, Habana.
Prof. A. J. Henry, U. S. Weather Bureau, Washington.
Prof. W. H. Hobbs, University of Michigan, Ann Arbor.
Prof. W. J. Humphreys, U. S. Weather Bureau, Washington.
Prof. E. Huntington, Yale University, New Haven.
Dr. T. A. Jaggar, Volcano Observatory, Hawaii.
Prof. H. H. Kimball, U. S. Weather Bureau, Washington.
Dr. C. J. Kullmer, Syracuse University, Syracuse, N. Y.
Dr. L. Landa, director general of public instruction, Honduras.
Dr. C. Lurquin, director, Observatorio Meteorológico del Instituto Médico, Sucre, Bolivia.
Prof. C. F. Marvin, chief, U. S. Weather Bureau, Washington.
Ing. J. C. Millás y Hernández, subdirector of the National Observatory of Cuba, Habana.
Dr. F. E. Nipher, Washington University, St. Louis.
W. G. Reed, Office of Farm Management, Department of Agriculture, Washington.
Rev. S. Sarasola, S. J., director, Observatorio del Colegio de Montserrat, Cienfuegos, Cuba.
Prof. J. Warren Smith, U. S. Weather Bureau, Columbus.
Dr. W. F. G. Swann, Carnegie Institution, Washington.
Prof. C. F. Talman, U. S. Weather Bureau, Washington.
A. H. Thiessen, U. S. Weather Bureau, Salt Lake City.
Rev. F. A. Tondorf, S. J., Georgetown University, Washington.
J. F. Voorhees, U. S. Weather Bureau, Knoxville.
Prof. R. DeC. Ward, Harvard University, Cambridge, Mass.
E. L. Wells, U. S. Weather Bureau, Boise.
Dr. R. S. Woodward, president, Carnegie Institution, Washington.

The attendance included, in addition to these persons, several officials and employees of the Weather Bureau and others who were not members of the Congress.

A brief account of the proceedings follows:

### SECOND PAN AMERICAN SCIENTIFIC CONGRESS, WASHINGTON, DECEMBER 27, 1915–JANUARY 8, 1916.

#### MINUTES OF SUBSECTION IIB, METEOROLOGY AND SEISMOLOGY.

*First session, Tuesday, December 28, 1915, 2:30 p. m.*—The meeting was called to order by Prof. C. F. Marvin, chairman of the subsection, who delivered an address of welcome.

The following papers were read: *

*"Investigations on the prediction of barometric variations." Rev. S. Sarasola, S. J.

Discussion by Messrs. Lurquin and Frankenfield.

*"Origin and course of West Indian hurricanes." J. C. Millás.

Discussion by Messrs. Sarasola and Gutierrez-Lanza.

"Thunderstorms." W. H. Alexander. (Read by Prof. A. J. Henry.)

Discussion by Messrs. Church, Clayton, and Peabody (of Section I).

"Agricultural meteorology." Prof. J. Warren Smith.

Discussion by Messrs. Church, Frankenfield, and Voorhees.

*Second session, Wednesday, December 29, 1915, 2:30 p. m.*—Prof. C. F. Marvin, presiding.

Dr. Woodward announced the membership of the committee on resolutions, which he had been authorized to appoint at the first general meeting of the section, viz: Dr. Woodward (chairman), Prof. Marvin (U. S. A.), Sr. Millás (Cuba), Dr. Clayton (Argentina), and Prof. Morandi[1] (Uruguay).

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*Papers whose titles are preceded by an asterisk are published in abstract on another page of this REVIEW. Some of the papers presented will appear in full in later issues of the REVIEW—C. A., jr.

[1] Prof. Morandi was found not to be in attendance at the congress, and was replaced by Dr. Lurquin (Bolivia.)—C. F. T.