TABLE 3.—*Average hourly rainfall, probability of rain, probability of thunderstorm, June, July, August, and September, 1905–1928*

Hour ending	Average rainfall	Probability rain, per cent	Probability thunderstorm, per cent	Hour ending	Average rainfall	Probability rain, per cent	Probability thunderstorm, per cent
1 a. m.	0.003	3.3	1.0	1 p. m.	.001	13.3	8.4
2 a. m.	.002	2.8	1.0	2 p. m.	.012	14.8	11.3
3 a. m.	.003	3.3	1.1	3 p. m.	.017	16.3	16.4
4 a. m.	.002	3.1	1.2	4 p. m.	.024	19.2	21.6
5 a. m.	.003	3.5	1.0	5 p. m.	.028	20.9	21.8
6 a. m.	.004	3.7	1.1	6 p. m.	.027	20.3	19.7
7 a. m.	.004	4.0	1.7	7 p. m.	.024	20.4	16.1
8 a. m.	.004	5.5	1.6	8 p. m.	.014	18.8	10.9
9 a. m.	.005	6.0	1.8	9 p. m.	.008	15.4	6.7
10 a. m.	.006	8.0	2.6	10 p. m.	.005	9.3	4.2
11 a. m.	.007	9.2	3.5	11 p. m.	.004	6.7	2.3
Noon	.009	10.9	5.2	Midnight	.003	4.3	1.6

The relative humidity runs usually above 80 per cent during the night, while during the day there is a marked drop. The curve is almost the inverse of the temperature curve, and from noon to 4 p. m. the average relative humidity is between 50 and 60 per cent. (M. W. R., July, 1919, pp. 466–468 and Oct., 1919, p. 710.) This compares very well with afternoon readings in many of the interior cities, and shows that the humidity is rarely oppressive during the rainy season. Although the rainfall is heavy, the sandy character of the soil allows a rapid run-off. There is little standing water and no mud. The moisture taken up into the air is rapidly distributed by

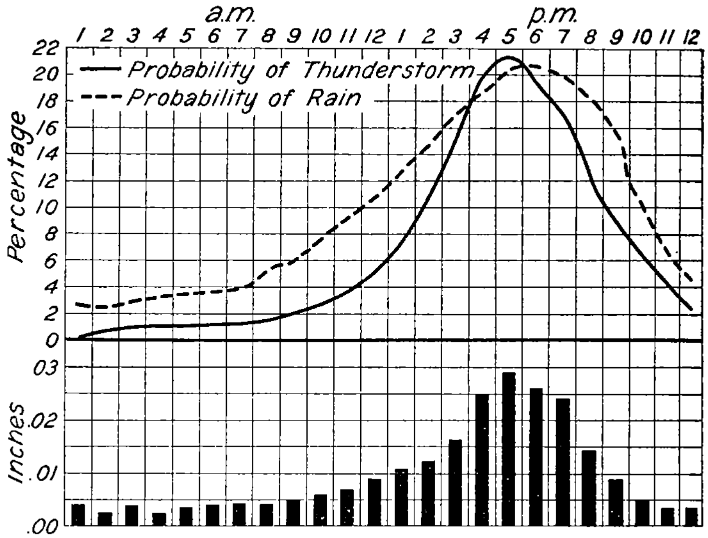

FIGURE 1.—Hourly probability of rain, a thunderstorm and the average precipitation for each hour of the day at Tampa, Fla.

the horizontal air movement and active convection currents, and the humidity is very rarely felt as oppressive

CHANGE IN DENSITY OF SNOW COVER WITH MELTING [1]

551.578.46 (794)

By GEORGE D. CLYDE

[Utah Agricultural Experiment Station, Logan, Utah, July 11, 1929]

Measurements of the density of snow have been made in the Sierra Nevada Mountains for many years. At Summit, Calif., measurements of density at foot intervals in depth have been made over a period of five years. These records indicate no uniformity in density in different layers of deep snow. This variability is due to changing weather conditions during the accumulation of snow cover. Ice layers and crusts form at different intervals during the accumulation period. Measurements in California indicate no relationship between density of top layer of snow cover and the lower depths.

During the spring of 1928 a study was made of snow-melting characteristics on the Wasatch Plateau in central Utah. This plateau rises to an elevation of 10,500 feet. The studies were made on the snow cover at elevations of 8,000 to 10,000 feet. Measurements were made to determine the change in density with depth, and it was found that before melting began and while the average density was still increasing with the advance of spring that there was a marked difference in density at different depths due to ice layers and hard crusts. As the spring advanced and daily temperatures rose it was noticed that these hard layers disappeared and the snow cover took on almost a uniform density from top to bottom. On April 26 a snow profile was obtained which clearly indicated these hard layers. The mean temperature on that day was 45.5° F. At the time of observation at 3 p. m., temperature 80° F., water was running along the top of each layer and dripping off at the outcrop. The surface of the snow was melting and the water was seeping down through the snow layer. When this water struck the impervious ice layer it started moving laterally. The temperature of the water being slightly higher than the ice crust it was gradually softened, the snow layer finally taking on a nearly uniform density. Measurements on April 23 showed the presence of ice layers and crusts throughout the snow depth. By April 30 these layers had entirely disappeared. The following table shows the uniformity of density with depth during the melting period.

TABLE 1.—*Snow west of Mammoth Ranger Station (Wasatch Plateau-Manti National Forest, San Pete County, Utah)*

No.	Depth (inches)	Core (inches)	Water content	Density (%)
A. May 10, 1928. After raining all night 8 a. m.:				
1	4	30	12.0	40.0
2	12	30	12.2	40.7
3	18	30	12.0	40.0
4	24	30	12.0	40.0
B. May 11, 1928. 7 a. m.*:				
1	3	30	10.0	33.0
2	12	30	12.5	41.6
3	18	30	12.5	41.6
4	24	30	11.5	38.3
C. May 12, 1928. After 63 inches of rain had fallen during the day. 6 p. m.**:				
1	4	30	11.8	39.3
2	12	30	12.0	40.0
3	18	30	12.0	40.0
4	24	30	11.5	38.3

* Froze previous night, causing granulation on top and bottom. Drainage from bottom during freezing reduces density on bottom.
** Snow seems to be same density after rain as before, indicating that rain goes right through.

With the snow melting well under way the density during the day is quite uniform throughout the depth. However, if the measurements are made after the snow solidifies at night, the density will be a little lower at the surface and near the bottom. This is probably due to the draining of the free water from these areas after the snow starts solidifying under the decreased temperatures. This difference in density of the upper and lower layers after freezing becomes more marked as the snow cover gets thinner.

[1] Contribution from Department of Irrigation and Drainage, Utah Agricultural Experiment Station. Publication authorized by Director, July 11, 1929.

The density of new snow will average about 10 per cent. The density of an accumulated snow cover is always greater than this, and it increases with the advance of the season until it reaches a maximum just after the water starts leaving the snow. This lag in maximum density after run-off starts is probably due to difference in rate of melting and rate at which water starts to leave the snow at the bottom.

When the snow cover is deep the surface is granular due to the daily melting and freezing. Below the surface layer the snow is finer textured. Where the layer of snow is thin it is granular all the way down as the effect of daily melting and freezing goes through the entire layer.

The winter precipitation season on the Wasatch Plateau is practically over by April 1. On March 28, 1928, the density of the snow cover was 35.1 per cent, none of the snow having melted. The density gradually increased until by April 23 it had reached 41.2 per cent, with still no evidence of melting. By April 27, the density had increased to 49.4 per cent and the snow cover had lost very little water. The melting began when the density was somewhere around 49 per cent. On April 30 the density reached 50.1 per cent, and the snow cover had lost about 25 per cent of its water. By May 3 the density had fallen to 37.9 per cent, the snow cover retaining only 50 per cent of the water present on April 27. These data indicate an increase in density of the snow cover until shortly after the water starts leaving the snow, after which the density decreases. As the water passes downward through the snow layer the smaller snow particles are melted leaving a more porous structure, having a lower density. The density does not seem to continue to decrease with melting but rather quickly reaches a density between 35 and 40 per cent, where it remains practically constant until the snow cover is entirely melted. Figure 1 shows the variation of density

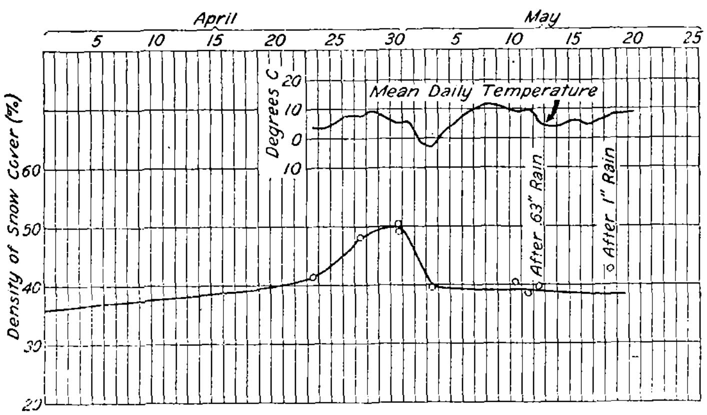

FIGURE 1.—Increase of density to melting point

with the advancing season. It will be noted from this curve that the density started increasing rapidly on April 23.

A continuous temperature record was kept, beginning on April 22. Before this date it was extremely cold. On April 23 the temperature started rising, and for eight days, or until May 1, it remained above freezing night and day. The mean daily temperatures for these days are plotted on Figure 1.

Figure 2 shows an hourly hydrograph of the principal stream in the area studied together with the hourly temperatures.

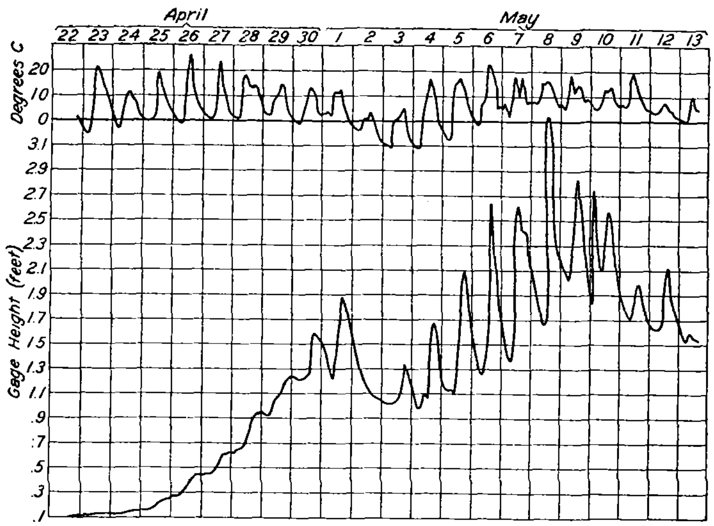

FIGURE 2.—Hourly hydrograph and thermograph at dam site on Gooseberry Creek. Drainage area 6.11 square miles. Elevation, 9,000 feet

NOTE.—Prior to April 22 the temperature was very cold.

It will be noted that there was an accumulation of 27.7° C. above freezing, before the density reached the point of melting on April 27. By May 1 there had been an accumulation of 55.5 day-degrees [2] C. above freezing. During this period the water content of the snow cover had decreased from 17 to 8.2 inches, or 0.16 inch per day degree C. temperature. From April 27 to April 30 the density increased slightly, but the run-off from the snow cover accelerated rapidly. No precipitation fell during the period April 22 to May 7.

SUMMARY

1. There seems to be no relation between the density of the snow layer at different depths during the accumulation season.
2. After melting begins the ice layers and hard crusts disappear and the snow cover takes on almost a uniform density throughout its depth.
3. The density of a snow cover increases throughout the accumulation season reaching its maximum soon after melting starts.
4. As the melting progresses the density decreases to a point usually between 35 and 40 per cent where it remains nearly constant until snow disappears.
5. Data taken in this single experiment indicate that one day degree C. of temperature is required to melt the snow equivalent of 0.16 inch of water.

[2] One day-degree F. is defined as one degree F. for one day or 24 hours. For example, an average daily temperature of 40 degrees for one day would be the equivalent of 40 day degrees.