Snow Measurement Guidelines for National Weather Service Cooperative Observers

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
National Weather Service
Office of Meteorology
Silver Spring, Maryland 20910-3283

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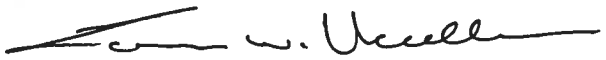
Preface

Snowfall and snow depth and their water equivalent are some of the most difficult, but important, weather elements to measure in an accurate, consistent manner. Snow has a profound effect on the national economy. Large snowstorms can paralyze large metropolitan areas and even isolate entire regions for days, affecting millions of people and resulting in loss of lives and billions of dollars. On the other hand, winter recreational activities that depend on snow generate tens of billions of dollars of revenue and melting western-mountain snowpacks provide beneficial moisture for human and agricultural consumption during the summer.

Effective use of snow data can result in more efficient decision making that affects many sectors of our economy, and in the process, saves millions of dollars. Snow data are used by a wide variety of users, including National Weather Service (NWS) weather and hydrologic forecasters, climate-change researchers, water-resource managers, construction engineers, plow operators, airport managers, winter resort managers, farmers, among many others.

Given the increasing importance of snowfall and snow depth measurements for the diverse applications noted above, there has been a commensurate increase in the concern for the accuracy and consistency of these measurements that make up the "official" national data base. Additionally, as NWS modernization progresses and airport snow observations cease at some locations, other observing options are required (e.g., the cooperative observers network) to preserve climate records and enhance local operational support.

This booklet was prepared by the NWS Office of Meteorology for use by NWS cooperative weather observers. In addition to clarifying previously existing documentation on snow measurement, these guidelines extend (as an option) the standard frequency of four measurements a day (one every 6 hours) from manned NWS stations to the volunteer networks. The NWS strongly encourages adherence to these guidelines for all climatological snow observations to improve the consistency and quality of snowfall data.



Louis W. Uccellini
Director, Office of Meteorology

May 1997

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Snow Measurement Guidelines

Introduction:

The following guidelines were developed from previously existing National Weather Service (NWS) procedures, Federal interagency standards, and input from a broad array of expertise from climatologists, snow specialists, weather observers, and data users that was collected at a conference co-sponsored by the NWS and Colorado State University (CSU) in September 1996. The guidelines are intended to be used as a supplement for NWS Guide WS TA B-0-26 (appendix A). Some of the materials have been extracted from "The Snow Booklet" by Nolan J. Doesken and Arthur Judson, CSU, 1996.

It is essential for all observers to understand the importance of taking standard measurements in the prescribed consistent manner. Inconsistent observing and reporting methods result in incompatible data that can result in profoundly incorrect differences between stations and observers.

Each Season Before the First Snow Falls:

Review these instructions for measuring snow. It is easy to forget what needs to be measured, especially in those parts of the country where snow falls infrequently.

At the beginning of each snowfall/freezing season, remove the funnel and inner measuring tube of the 8-inch manual rain gauge to expose the 8-inch diameter overflow can so that it can more accurately catch frozen precipitation. Put your snowboard(s) out and mark its location with a flag or some other indicator so it can be found after a new snowfall. The snowboard should be located in the vicinity of your station in an open location (not under trees, obstructions, or on the north side of structures in the shadows).

Check your gauge to make sure there are no leaks. If there are leaks, take appropriate action. Once your equipment has been readied for winter, you are prepared for taking snowfall measurements.

Observers should determine and record three values when reporting solid precipitation. They are:

1. Snowfall: Measure the snowfall (snow, sleet, or snow pellets) since the previous snowfall observation,
2. Snow depth: Determine the total depth of snow on the ground at the normal observation time, and
3. Water equivalent: Measure the water equivalent of snowfall since the previous day's observation.

1. Snowfall:

Measure the greatest amount of snowfall that has accumulated on your snowboard (wooden deck or ground if board is not available) since the previous snowfall observation. This measurement should be taken minimally once-a-day (but can be taken up to four times a day, see note below) and should reflect the greatest accumulation of new snow observed (in inches and tenths, for example, 3.9 inches) since the last snowfall observation. If you are not available to watch snow accumulation at all times of the day and night, use your best estimate, based on a measurement of snowfall at the scheduled time of observation along with knowledge of what took place during the past 24 hours. If you are not present to witness the greatest snow accumulation, input may be obtained from other people who were near the station during the snow event. If your observation is not based on a measurement, record in your remarks that the "snow amount based on estimate."Remember, you want to report the greatest accumulation since the last observation. **If snowfall occurred several times during the period, and each snowfall melted either completely or in part before the next snowfall, record the total of the greatest snowdepths of each event** and enter in your remarks "snowfall melted during the OBS period." For example, three separate snow squalls affect your station during your 24-hour reporting day, say 3.0, 2.2, and 1.5 inches. The snow from each event melts off before the next accumulation and no snow is on the ground at your scheduled time of observation. The total snowfall for that reporting 24-hour day is the sum of the three separate snow squalls, 6.7 inches, even though the snow depth on your board at observation time was zero.

Snow often melts as it lands. **If snow continually melts as it lands and the accumulation never reaches 0.1 inches on your measuring surface, record the snowfall as a trace (T),** and record in your remarks that the "snow melted as it landed."

It is essential to measure snowfall (and snow depth) in locations where the effects of blowing and drifting are minimized. Finding a good location where snow accumulates uniformly simplifies all other aspects of the observation and reduces the numerous opportunities for error. In open areas where windblown snow cannot be avoided, several measurements may often be necessary to obtain an average depth. The measurements should not include the largest drifts. In heavily forested locations, try to find an exposed clearing in the trees. Measurements beneath trees are inaccurate because large amounts of snow can accumulate on trees and never reach the ground.

If your daily schedule permits, you may wish to make a snowfall observation every 6 hours, beginning with your regularly scheduled time of observation. This procedure is followed by Weather Service Forecast Offices. Follow the same rules for a once-a-day observation; the snow accumulation reported will be the greatest for the previous 6 hours instead of 24 hours. If you take your observations at this frequency, **make sure that you clear your snowboard (or other measuring surface) no more than once every 6 hours.** Record the frequency of observations during the day in the comments section of your report. **Never add more than four 6-hourly**

observations to determine your 24-hour snowfall total. If you add more than four observations, it will inappropriately inflate the snowfall total.

Freezing rain (glaze ice) should never be reported as snowfall. This precipitation type is liquid precipitation and should be reported as such.

2. Snow Depth:

Determine the total depth of snow, sleet, or ice on the ground. This observation is taken once a day at the scheduled time of observation with a measuring stick. It is taken by measuring the total depth of snow on exposed ground at a permanently mounted snow stake or by taking the average of several depth readings at or near the normal point of observation with a measuring stick. When using a measuring stick, make sure the stick is pushed vertically into the snow until the bottom of the stick rests on the ground. Do not mistake an ice layer or crusted snow as "ground." **The measurement should reflect the average depth of snow, sleet, and glaze ice on the ground at your usual measurement site (not disturbed by human activities). Measurements should not be taken from rooftops, paved areas, etc.**

Note: Even though the depth of hail (usually associated with spring, summer, or fall thunderstorms) at observation time is also reported in the same manner as snow depth, make sure you record in your remarks that the "accumulation on ground is from hail."

Report snow depth to the nearest whole inch, rounding up when one-half inch increments are reached (example 0.4 inches gets reported as a trace (T), 3.5 inches gets reported as 4 inches). Frequently, in hilly or mountainous terrain, you will be faced with the situation where no snow is observed on south-facing slopes while snow, possibly deep, remains in shaded or north-facing areas. Under these circumstances, you should use good judgment to visually average and then measure snow depths in exposed areas within several hundred yards surrounding the weather station. For example, if half the exposed ground is bare and half is covered with 6 inches of snow, the snow depth should be entered as the average of the two readings, or 3 inches. When, in your judgment, less than 50 percent of the exposed ground is covered by snow, even though the covered areas have a significant depth, the snow depth should be recorded as a trace (T). When no snow or ice is on the ground in exposed areas (snow may be present in surrounding forested or otherwise protected areas), record a "0."

When strong winds have blown the snow, take several measurements where the snow was least affected by drifting and average them. If most exposed areas are either blown free of snow while others have drifts, again try to combine visual averaging with measurements to make your estimate.

3. Water Equivalent:

Measure the water equivalent of snowfall since the previous day's observation. This measurement is taken once a day at your specified time of observation. Melt the contents of

your gauge (by bringing it inside your home or adding a measured amount of warm water) and then pour the liquid into the funnel and smaller inner measuring tube and measure the amount to the nearest .01 inch just as you use for measuring rainfall (use the NWS-provided measuring stick). Do not measure the melted precipitation directly in the large 8-inch outer cylinder. Make sure the inner measuring tube cannot fall over when pouring the liquid back into it. If the melted water equivalent (including any added warm water) exceeds 2 inches and cannot fit into the measuring tube all at one time, empty the full measuring tube and pour the remaining liquid from the large 8-inch outer cylinder into the emptied measuring tube. Add and record the water equivalent of the multiple measurements. If you added warm water to the gauge to melt the snow, make sure you accurately measure the amount of warm water added before pouring it into the gauge. Then, when you take your liquid measurement, subtract the amount of warm water added from the total liquid measurement to get your final liquid water equivalent of the snowfall.

As winds increase, gauges collect less and less of the precipitation that actually falls. Generally speaking, the stronger the wind and the drier the snow, the less is captured in the gauge. If you notice that less snow is in the gauge than accumulated on the ground, you should first empty any existing snow from inside the 8-inch cylinder, then use it to take a snow sample, sometimes referred to as "take a core" or "cut a biscuit" from your snow board with the 8-inch overflow can. Melt the biscuit of snow, pour the liquid into the small measuring tube to measure the water equivalent.

Appendix A

WS TA B-0-26
(9-79)

U. S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL WEATHER SERVICE

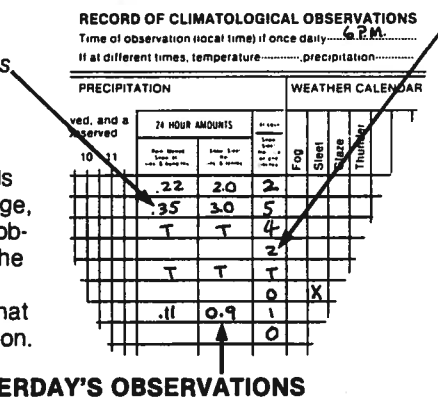
SNOW MEASUREMENT GUIDE

OBSERVERS WITH NON-RECORDING GAGES RECORD THREE MEASUREMENTS WHEN IT SNOWS

(1.) WATER IN THE SNOW

Record in this column to inches and hundredths.

Melt contents of gage and measure like rain. If high winds have blown snow out of the gage, the outer container is used to obtain a substitute sample from the snow on the ground where the depth represents the amount that fell since yesterday's observation.


RECORD OF CLIMATOLOGICAL OBSERVATIONS
Time of observation (local time) if once daily 4 P.M.
If at different times, temperature ..... precipitation .....

PRECIPITATION			WEATHER CALENDAR				
ved, and a served	24 HOUR AMOUNTS						
10 11			Fog	Sleet	Glaze	Thunder	
.22	2.0	2					
.35	3.0	5					
T	T	4					
		2					
T	T	T					
		0	X				
.11	0.9	1					
		0					

(3.) DEPTH OF SNOW ON THE GROUND AT OBSERVATION TIME

Record in this column to nearest inch--if less than ½ inch, record "T".

Any time there is snow on the ground at observation time record average depth on ground at observation time. Include old snow as well as newly fallen snow.

(2.) SNOWFALL SINCE YESTERDAY'S OBSERVATIONS

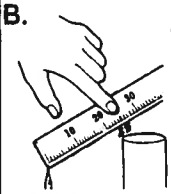
Record in this column to the nearest 0.1 inch.

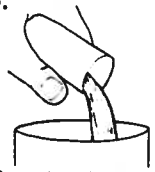
Find some place where the freshly fallen snow is least drifted and is about average depth for the locality. Measure the depth of the snow which fell since yesterday's observation. Report an estimate if the snow melted before observation time.

When significant amounts of new snowfall have occurred round off to the nearest inch and record as, for example, 2.0 and 3.0. (Record as 2.0 not 2, 3.0 not 3).

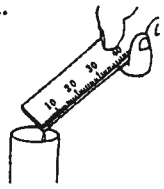
1

A. 
Pour some warm water into the tube

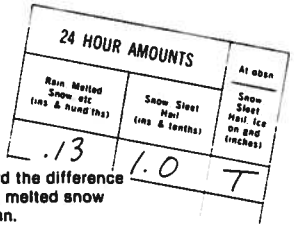
B. 
Measure

C. 
Empty into the can to melt the snow

D. 
Empty the can into the tube

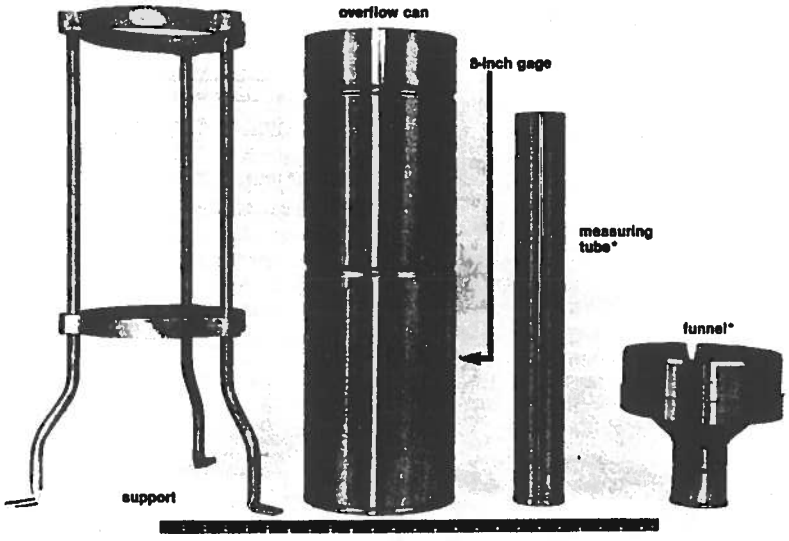
E. 
Measure

F. 
Subtract the first measurement from the second

G. 

Record the difference in the melted snow column.

At the beginning of the snowfall season only the 8-inch gage can is exposed to catch the snow. The funnel and measuring tube are removed at the beginning of the snowfall season. The measuring tube is used to measure the water from the melted snow.



*removed during winter months

snow won't fall in representative quantity into the gage if the funnel and measuring tube are not removed.

(See reverse side for steps 2 and 3)

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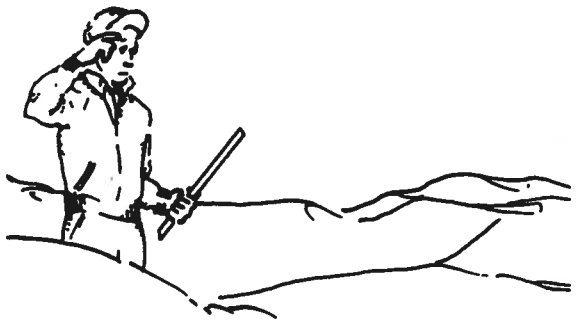
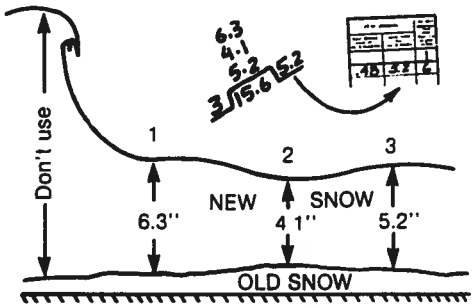
2 TO MEASURE SNOWFALL SINCE YESTERDAY'S OBSERVATIONS

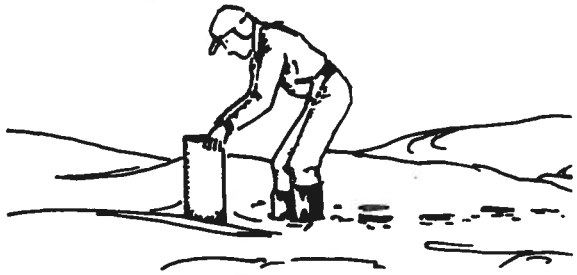
1. If the snow melts as it falls, enter a trace for snowfall.



2. Measure each new snow. Use good judgment in selecting spots where the snow is least affected by drifting.



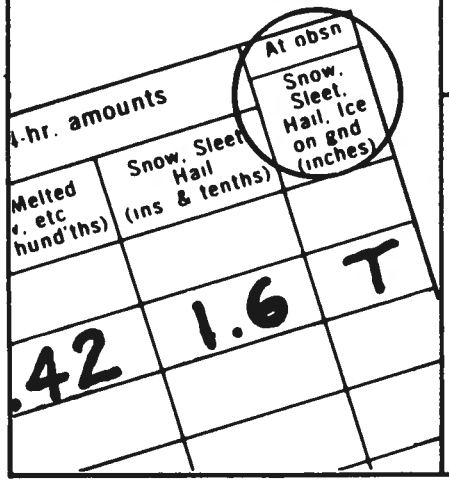
3. When possible, take several measurements where the snow is least affected by drifting (don't include deep drifts) and average.



4. If the snow has blown out of the can or the "catch" is not good, cut a "biscuit" with the can where the snow is near the average and melt the biscuit for the water equivalent.

3 SNOW DEPTH

Entry in this column is the measurement to the nearest whole inch of all snow, sleet, ice and hail remaining on the ground at your regular observation every 24 hours.



24 hr amounts		At obsn
Rain Melted Snow etc (ins & hund'ths)	Snow Sleet Hail (ins & tenths)	Snow Sleet Hail Ice on gnd (inches)
.32	T	0

Rain and snow mixed; snow melted as it fell.

24 hr amounts		At obsn
Rain Melted Snow etc (ins & hund'ths)	Snow Sleet Hail (ins & tenths)	Snow Sleet Hail Ice on gnd (inches)
		T
.16	2.0	0

2.0 inches of new snow fell, containing .16 water--snow melted before time of observation.

24-hr amounts		At obsn
Rain Melted Snow etc (ins & hund'ths)	Snow Sleet Hail (ins & tenths)	Snow Sleet Hail Ice on gnd (inches)
		T
		T
.27	1.8	2
		1
		T

1.8 inches snow and ice pellets containing .27 water. 2 inches on ground at observation time.

24 hr amounts		At obsn
Rain Melted Snow etc (ins & hund'ths)	Snow Sleet Hail (ins & tenths)	Snow Sleet Hail Ice on gnd (inches)
1.58	T	T

1.58 inches rain fell and also a trace of hail; hail had not melted at observation time.

24-hr amounts		At obsn
Rain Melted Snow etc (ins & hund'ths)	Snow Sleet Hail (ins & tenths)	Snow Sleet Hail Ice on gnd (inches)
2.31		2

Rain fell and froze causing 2 inches ice (glaze on ground at observation time).

24-hr amounts		At obsn
Rain Melted Snow etc (ins & hund'ths)	Snow Sleet Hail (ins & tenths)	Snow Sleet Hail Ice on gnd (inches)
T	T	
T	T	T

Two snows are recorded here--both are traces. The first one melted before observation time; the latter did not melt before observation time.