Winter Weather Measurements
Snow, Sleet, and Freezing Rain

Steve Hilberg
Illinois CoCoRaHS Coordinator
CoCoRaHS Project Manager
What We Will Cover

- How to measure and report daily precipitation when it is snow or sleet
- Measuring and reporting new snowfall
- Snow Water Equivalent (SWE)
- Measuring the Total Snow and Ice on the Ground
- Dealing with and reporting freezing rain
- Special situations and how to handle them
- Tips to make the job easier
Preparing for Winter Measurements

- When cold weather (temperatures <32°F) becomes persistent, it’s a good idea to remove the funnel and inner measuring tube from your rain gauge and bring them inside
  - Water freezing in the inner measuring tube may crack or break the tube
  - Also remove the funnel and inner tube if snow is expected
    - Snow will quickly clog the funnel opening preventing snow from accumulating in the rain gauge
- A simple snow measurement board can be set out near the rain gauge – provides a flat surface on which to measure snow
  - Be sure to mark the location with a flag or reflector
A Snowboard
Preparing for Winter Measurements

- You will also need a ruler or yardstick to measure the depth of snow.
- “Snow stick” – a ruler graduated in tenths of an inch is a good idea.
  - Available from weatheryourway.com
Winter Precipitation Types

- **Snow**
  - Small white ice crystals formed when supercooled cloud droplets freeze. Snow crystals can have different shapes usually dictated by the temperature at which they form.

- **Snow Pellets/Graupel**
  - White, opaque ice particles round or conical in shape. They form when supercooled water collects on ice crystals or snowflakes. They typically bounce when they fall on a hard surface and often break apart.

- **Snow Grains**
  - Very small, white opaque particles of ice, more flattened and elongated than snow pellets. Snow grains can be thought of as the solid equivalent of drizzle (snizzle)

- **Ice Pellets/Sleet**
  - Small balls of ice formed from the freezing of raindrops or the refreezing of melting snowflakes when falling through a below-freezing layer of air near the earth's surface.

*For measurement purposes these are all treated as snow*
Winter Precipitation Types

- **Freezing Rain**
  - When rain occurs and the surface temperatures is below freezing. The raindrops become supercooled as they fall through the layer of cold air near the surface and freeze upon impact with surfaces below freezing.
  
- Freezing rain is liquid precipitation and should be measured as you would measure rain, after you have melted the ice in your rain gauge.
Snow Measurements - Terminology

- **Gauge Catch**
  - The amount of water in your gauge measured after it is melted

- **24-hour snowfall**
  - The maximum depth of new snow in the past 24 hours

- **24-hour Snowfall Snow Water Equivalent (SWE)**
  - The amount of water measured from melting a core of snow obtained from the snow on the ground at the depth of the 24-hour snowfall

- **Snowpack Depth**
  - The total depth of new snow and old snow and ice at observation time

- **Snowpack Snow Water Equivalent (Snowpack SWE)**
  - The amount of water measured from melting a core of snow obtained from a location that is equal to the Snowpack Depth
Your Daily Precipitation

*Snow is precipitation, but not all precipitation is snow!*

- The most important measurement is the amount of water in your rain gauge (GAUGE CATCH)
  - If it is snow/frozen, it must be melted before you measure it
  - You may have 3 inches of snow, but that may melt down to 0.28” of water. That is your daily precipitation

![Precipitation Report Form]

Melt the frozen precip in the gauge and report it here. If you cannot melt or do not have a measurement, change to NA. Do not leave it as zero. Do not enter your snowfall here.
What is 24-hr Snowfall?

24-hr snowfall is the maximum accumulation of new snow and ice in the past 24 hours, prior to melting or settling.
When to Measure New Snow

- Measure new snowfall as soon as possible after it ends, before settling and melting occur.
- This often will not be at your regular observation time.

Note that we do not ever measure the depth of the snow in the rain gauge itself. Any frozen precipitation in the rain gauge must first be melted, then measured.
A Snow Event

Monday
7:00 am

Snow begins
9:00 a.m.

Snow ends
1:00 p.m.

Tuesday
7:00 am

2.4 inches of snow

Some melting and settling occurs

Measure snow as close to 1:00 p.m. as possible

1.2 inches

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Where to measure **24-hr snowfall**

1. Find a nice, level place to measure where drifting or melting has not occurred (like a snowboard)
2. Slide snow stick or ruler into snow until it reaches the ground/board surface
3. Read value on snow stick (value is always to nearest tenth of an inch, like 3.4 inches)
4. Make 3 or 4 measurements and average them.
5. If using snowboard, sweep it clean.
Replace the Board

After you have measured the snow on your board, clean it off and replace it on top of the newly fallen snow. Be sure to mark its location. Now you are ready for the next snow.
24-hr Snowfall

Enter your 24-hour snowfall on the Daily Report form
Measuring Snow During the Storm

- You can measure new snowfall during the storm for the purposes of a Significant Weather Report or a storm report to the National Weather Service.
- Write down the time of your measurement and the amount.
- DO NOT CLEAN OFF THE SNOWBOARD! The snowboard should be cleared only once every 24 hours, at your regular observation time.
The 10:1 Myth

Do NOT estimate snowfall by converting the liquid in your rain gauge to a snowfall amount!

- The adage that one inch of rain equals 10 inches of snow is, for the most part, a myth!
- The snow/water equivalent ratio is dependent on many factors, not just surface air temperature
- Snow to water ratios can vary from 8:1 or less to 20:1 or more!
Measuring the 24-hr Snow Water Equivalent (24-hr SWE)

- This is **NOT** the amount melted in your rain gauge!
- The measurement is obtained by first taking a core of snow using the outer cylinder, then melting and measuring it.
Taking a Snow Core of New Snow

- Use your snow board or other hard surface
- Take core after you have measured snow depth, but before you have cleared the board or surface of snow
- For example, if you determined the depth of the new snow is 4 inches, then take your core sample from an area where the depth of new snow is 4 inches.
Taking a Snow Core of New Snow

- Capture a core by inverting the outer cylinder and pushing straight down into the snow

- Use something thin and sturdy to slide under the cylinder (spatula, snow swatter, aluminum flashing)
Taking a Snow Core of New Snow

- Melt and measure the core of snow
- Enter in the correct field on the form

This is the water measured from a core of snow taken from your snow board. If you do not take a separate core leave this NA. Do not copy your precipitation into this field.
Measuring the Snowpack Depth
Total Depth of Snow and Ice on the Ground

- Report the Snowpack Depth each day there is snow on the ground
Snowpack Depth is the average depth of snow (old snow and ice as well as new) that remains on the ground at observation time.
Measuring Snowpack Depth

- Snow is rarely uniform in coverage, so take several measurements and average them to obtain your total depth of snow.
  - Write them down!
- Slide snow stick through all layers of snow (new and old).
- Read value on snow stick and record (values are to the nearest 1/2” like 4.5 or 5.0).
- Don’t measure “artificial accumulations”, such as plowed piles, large drifts, or shoveled snow.
On some days snow will only partially cover the ground. To determine the snowpack depth, determine the average snow depth in the snow covered area, and multiply it by the percent of the area the snow covers.
If 60 percent of the ground has 2.0” and the rest is bare, your total depth is 2.0*0.6, or 1.2 inches.

If more than half the ground is bare report “T” (trace) and mention the range of depths in your comments.
Snowpack: Total Snow and Ice on the Ground

This is the depth of snow and ice on the ground each day, whether or not any snow has fallen.
24-hr Snow and Snowpack Reminder

- If you are measuring your snow on a grassy surface, be careful how you measure.
- Snow may “perch” on top of the grass. Measure the layer of snow only.
Measuring Snowpack Snow Water Equivalent

- This is a measurement that is useful to hydrologists and river forecasters.
- Provides an estimate of how much water is “on the ground” that can potentially run off into rivers and streams.
- It does not have to be done every day (though you can). Measure it after a new snowfall, and then once a week.
- CoCoRaHS promotes “SWE Mondays” where we ask observers to measure and report Snowpack SWE each Monday there is snow on the ground.
How to Measure Snowpack SWE

- The basic process is the same as 24-hr Snowfall SWE
  - Take a “core” from the snow
  - Melt the core
  - Measure the amount of water in the core
First find a representative location

- The location should not have drifted, melted, or blown clear.
- For example, if you determined the total depth of the snow is 3 inches, then take your core sample from an area where the depth of snow is three inches.

“This looks like the best place!”
Steps to Taking a Core

1. Place gauge upside down and push down into the snow.
2. Clear snow from around the gauge.
Capturing the Core

Slide
Slide a spatula or other thin, flat object under gauge

Lift
Carefully lift and get ready to flip the gauge

Flip
Bring the sample inside to melt
Snowpack SWE

- Melt and measure
- Report this on your Daily Report form

<table>
<thead>
<tr>
<th>Total Snow and Ice on Ground at Observation Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.5</td>
</tr>
<tr>
<td>.43</td>
</tr>
</tbody>
</table>
Windy conditions may create a situation where the amount of snow in the rain gauge is not representative of what fell on the ground.

- In this case, we need to take a “core sample” from the snowboard or an area representative of the average new snow depth.
- Melt and measure the core sample
- If you feel this is more representative of the actual precipitation, then report this amount as your Daily Precipitation and make a note in the Comments. Include the melted amount from the snow that actually fell in the gauge in your comments.
Water melted from core is reported as the daily precipitation.

Include amount melted from gauge in comments.
What If: Snow melts as it falls and never accumulates

- Report the precipitation in your gauge (melted) as the Daily Precipitation
- Report a Trace of new snow
- In your comments write "Snow melted as it fell"
What If: Snow or sleet is mixed with rain and doesn't actually accumulate on the ground

- Report the precipitation in your gauge (melted) as the Daily Precipitation
- Report a Trace of new snow
- Make a note as above in your comments such as “Snow and sleet were mixed with rain but melted as it fell.”
What If: Snow and rain are mixed and there is snow that accumulates

- Report the precipitation in your gauge (melted) as the Daily Precipitation
- Report the maximum accumulation of the new snow as your new snowfall
  - If possible, it is best to measure the depth of the new snow as soon as possible after it ends before it has a chance to melt
  - If you cannot measure it before it melts and you have an estimate, include that in your comments. Enter “NA” for snowfall. Do not report the estimate or zero as your snowfall.
- Make a note that you had mixed precipitation in your comments
New snowfall of less than a tenth of an inch is reported as a Trace. This could be a few flurries, or a very light dusting of snow. Snow does not have to end up in the rain gauge!

In some situations you might have measurable snow of a couple of tenths, but the snow in the rain gauge only melts down to a Trace. This can happen when the snow is very dry and/or it is windy.
How do I measure freezing rain?

“Freezing rain” is rain that falls in liquid form but freezes on contact with a surface.

Do **NOT** report freezing rain as "Snow". Melt and measure the water that has accumulated **inside** your gauge and report that as your daily precipitation amount.

Report ZERO for your new snow amount (assuming that it all fell as rain, and no sleet or snow fell or accumulated).

Report the total depth of freezing rain remaining on the ground at time of observation and enter that in the "Total Snow and Ice on Ground" field. Make a note in your comments section so that we know it's freezing rain.
Snow Measurement Review

- Melt any snow/ice in your rain gauge, and report this (Gauge Catch) as your Daily Precipitation.

- Measure the 24-hr accumulation of new snow on your snowboard.

- For the 24-hr SWE, take a core from your snowboard, melt, and report in the “New Snowfall” section (optional). **If you do not cut a core, LEAVE THIS NA**

- Measure Snowpack Depth (the total snow on the ground, new snow plus old snow and ice).

- Report the Snowpack Snow Water Equivalent (optional)
Winter Measurement Tips

- An extra outer cylinder is a time-saver and worth having if you are measuring snow.
  - If it is snowing at the time of your regular observation take your extra cylinder and swap it out with the one outside. Bring it in to melt and measure without missing any precipitation.
  - The extra cylinder is also useful for cutting the core for 24-hr Snowfall SWE without having to wait for melting and measuring the one outside.
Winter Measurement Tips

- Weighing the snow in your rain gauge is a quick and accurate way to obtain the liquid equivalent.

- You first need to know the weight of your empty cylinder in grams using a digital scale (good kitchen scale works well).
  - Write that weight on the bottom with a permanent marker.

- Place the cylinder with snow (or water) in it on the scale. Write down the weight.

- Subtract the weight of the cylinder from this number.

- Divide the result by 201. This is the weight of water filled to the one inch mark on the inner measuring tube.

- This result is the amount of water in inches.
Weighing Your Precipitation

Cylinder weight: 453 g

Cylinder plus water weight: 566 g

Cylinder: 453 g

Weight of water: 113 g

Convert to inches

113g / 201g per inch =

0.56 inch of precipitation
Training Resources

The CoCoRaHS training animations on YouTube
Training Resources

Training slide presentations

“In Depth” Snow Measuring

Measuring the Water Content of Snow by Weight

Alternative Methods For Making CoCoRaHS Snow Water Content Measurements

Ice Accretion
Questions?

hberg@cocorahs.org