



# Winter Precipitation Measurements

Snow, Sleet, and Freezing Rain



# Winter Precipitation Measurements

## What We Will Cover In This Presentation

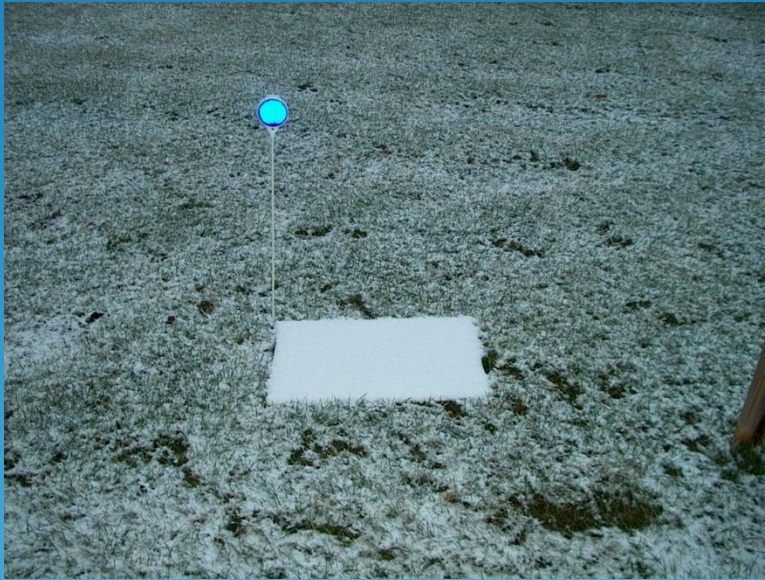
- Preparing for winter measurements
- Precipitation types and snow measurement terminology
- Measuring and reporting new snowfall
- What is Snow Water Equivalent (SWE) and how to measure it
- Measuring the Snowpack Depth
- Dealing with and reporting freezing rain
- Special situations and how to handle them
- Tips to make the job easier

# Preparing for Winter Measurements

- When cold weather (temperatures  $<32^{\circ}\text{F}$ ) 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



A snowboard can be made with a 24" x 24" or 24" x 18" (minimum) piece of  $\frac{1}{2}$ " or  $\frac{3}{4}$ " exterior plywood or other similar material, painted white on both sides and the edges.



# 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](http://weatheryourway.com)



# Winter Precipitation Types

## Frozen Precipitation

- **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 Precipitation

### ○ **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.

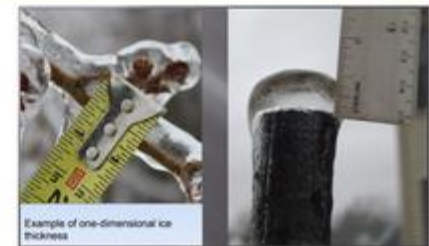


# You Can Help Measure Ice Accretion from Freezing Rain

- We have a pilot project to test a new protocol to measure and report ice accretion
- Observers install a dowel on their rain gauge post and measure ice thickness
- Measurements are reported using an online form. Photos can be submitted as well.

Category	Descriptions of Impacts
0	No ice or a trace
1	Enough to be annoying/need scraping off your car. Looks pretty on bushes, shrubs. Dangerous to walk or drive.
2	Shrubs and other non-native shrubbery weighed down, trees manage ok
3	Small tree branches start to bend
4	Small and medium branches bend, a few small branches may fail
5	Birch trees are starting to bend, minor branch damage to weak trees
6	Birch trees sag moderately, small and large limbs start to break, ~5-10% branch loss
7	Birch trees bent nearly completely, ~10-20% branch loss on small and large limbs
8	Moderate to significant tree damage, most trees have some damage

Credit: Jason Shafer, Northern Vermont University-Lyndon



Measure and report ice accretion on branches or other flat objects

For more information contact Noah Newman  
[noah.newman@colostate.edu](mailto:noah.newman@colostate.edu)



# 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. This is not your gauge catch!

# Snow Measurements - Terminology

- **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/gauge catch

**Precipitation Report Form** Submit Reset

Station Number : \_\_\_\_\_

Station Name : \_\_\_\_\_

\* Denotes Required Field

1/1/2022 \* **Observation Date** ?

7:00 AM \* **Observation Time** ?

0.23 in. \* **Gauge Catch:** Rain and Melted Snow to the nearest hundredth inch that has fallen in the gauge during the past 24 hours, or T for trace, or NA for unknown. ?

Melt the frozen precipitation 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 24-hour 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



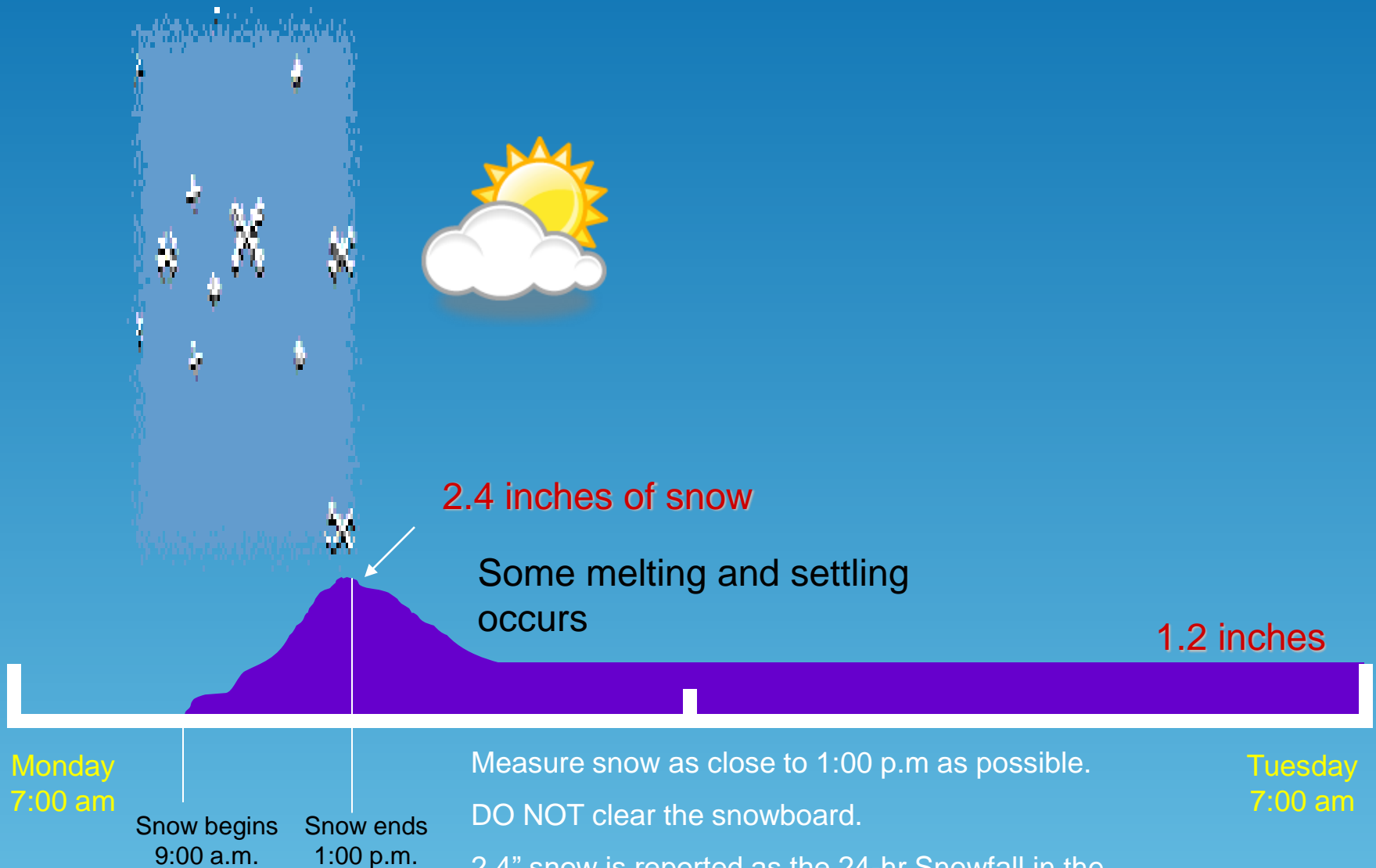


# When to Measure New Snow

- 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.
- Report the new snowfall 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

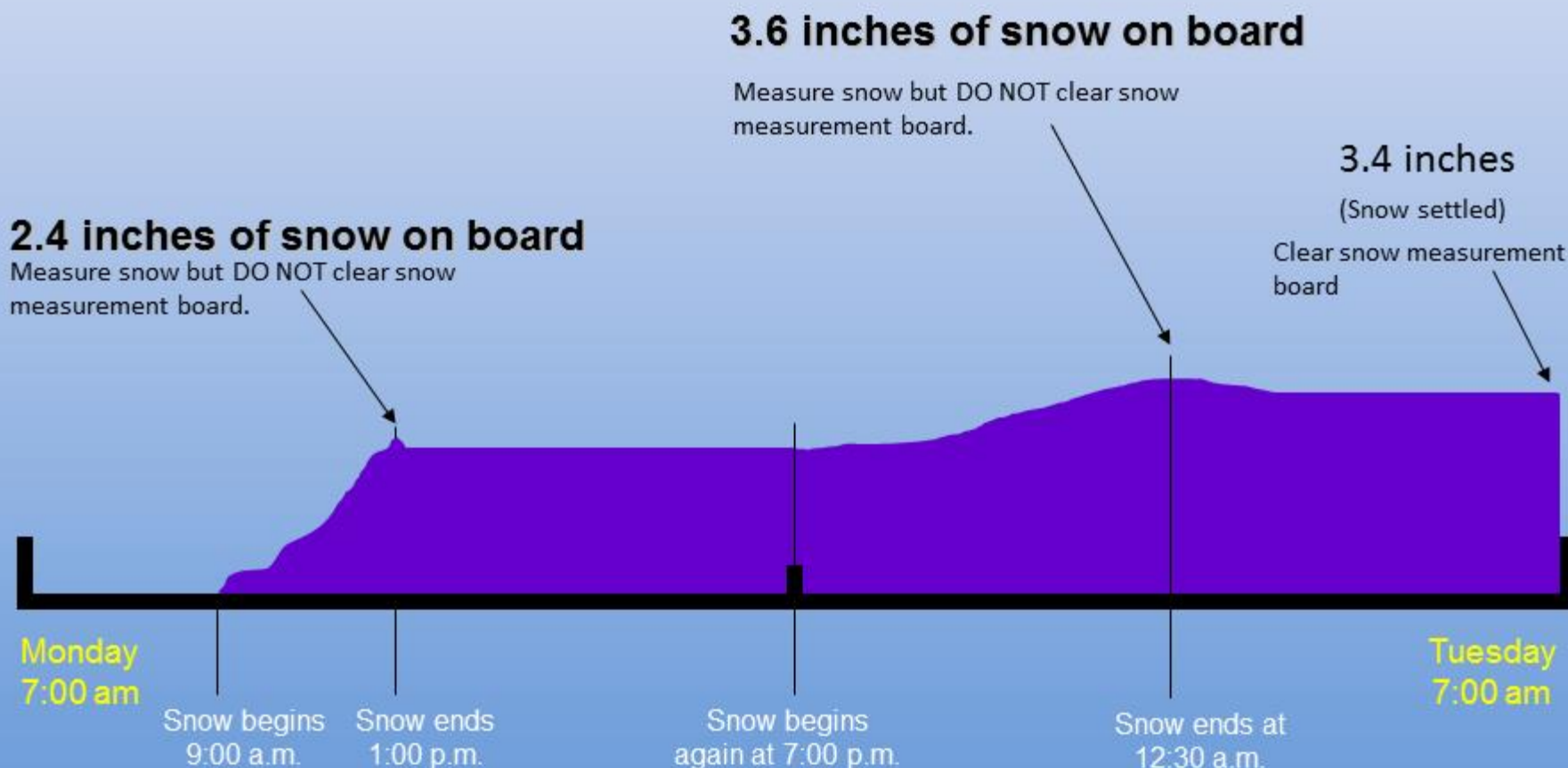


Measure snow as close to 1:00 p.m. as possible.

DO NOT clear the snowboard.

2.4" snow is reported as the 24-hr Snowfall in the Tuesday observation. 1.2" is the Snowpack Depth

# Multiple Snow Events in a 24 hour Observation Period



The maximum accumulation of new snow in the 24 hour period is 3.6 inches and should be reported as Snowfall.

# 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 if it is your regular observation time.






# 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

**Observation Notes:** (This will be available to the public) 

Not much wind with this storm - fluffy snow.

---

**24-hr Snowfall**

in. **Snowfall:** Accumulation of new snow in inches to the nearest **tenth** 


Comments are always helpful!

The depth of snow and/or sleet that fell in the past 24 hours measured on your snow board or flat, level surface is entered here.

# 24-hr Snowfall on the Mobile App

## Android

CoCoRaHS Observer

 Precipitation Report  
IL-CP-1 (english)  
Homer 2.0 N

Observation Date 2016-12-06

Observation Time 07:00

Rain/Melted Snow (in) 0.00

☒ Trace Precip

[Click To Specify Snow & Flooding Info](#)

optional notes

SUBMIT

Click this link to go to the  
snow data entry page

CoCoRaHS Observer

New Snow

Accumulation (in.) NA  
☐ Trace

Melted Core (in.) NA  
☐ Trace

Total Snow & Ice

Depth Total (in.) NA  
☐ Trace

Melted Core (in.) NA  
☐ Trace

Flooding Info

No flooding occurred

# 24-hr Snowfall on the Mobile App

iOS

The image displays two screenshots of the CoCoRaHS mobile app interface. The left screenshot shows the 'Precip Report' screen with fields for Observation Date (2022-12-01), Observation Time (07:00), and Rain/Melted Snow (NA). A yellow circle highlights the 'More Details' button, and a yellow circle highlights the 'Done' button at the bottom right. The right screenshot shows the 'Detail view' screen with sections for 'New Snow' (Accumulation and Melted Core) and 'Total Snow & Ice' (Depth Total and Melted Core). The 'New Snow' section is circled in red. Both screens have a blue header with 'Logout', 'Precip Report', and 'Details' options. The status bar at the top shows 'T-Mobile Wi-Fi', signal strength, time, and battery level.

Click DONE after entering data on first screen.

Then, click "More Details" to go to the snow data entry page



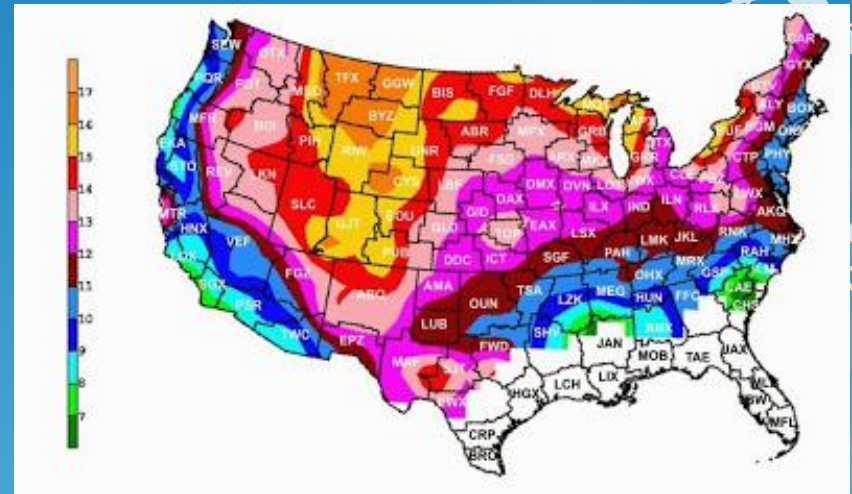
# Measuring Snow During the Storm

- 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
- It varies storm to storm, and even within the same storm
- Snow to water ratios can vary from 8:1 or less to 20:1 or more!



30-year climatology of snow-to-water ratios

# Measuring the 24-hr Snow Water Equivalent (24-hr SWE)

- The 24-hour Snowfall SWE is a distinct and separate measurement from the amount in your rain gauge.
  - This is an OPTIONAL measurement
- The melted amount from your gauge catch includes all precipitation, liquid (rain) and frozen (snow, sleet).
- The Snowfall SWE includes only that part of your total precipitation that was snow or sleet.
- The 24-hour Snowfall SWE is **NOT** the amount melted in your rain gauge (gauge catch), even if the precipitation is all snow!
- The measurement is obtained by first taking a core of snow using the outer cylinder, then melting and measuring the core.

# When to Measure 24-hr SWE

- The ideal situation is to measure the new snowfall AND do a core sample at the same time to get an accurate representation of the amount of water in the measured depth of snow.
  - This should be when the snow stops and may not be at your normal observation time
- If one waits until observation time a number of things may happen
  - It might rain, snow will melt
  - Increasing winds after a storm passes could drift over the snowboard or erode the snow depth.
  - Animals (dogs, cats, deer) could walk across the board



# 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.
- There is no need to take a core of new snow when there is only a Trace of snow.



# 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)
- Invert the cylinder while trapping the snow inside



Photo by Jon Snurka



Photo by Jon Snurka

# Taking a Snow Core of New Snow

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



24-hr Snowfall	
<input type="text" value="6.2"/> in.	Snowfall: Accumulation of new snow in inches to the nearest tenth ?
<input type="text" value="0.57"/> in.	Snowfall SWE: Melted value from core to the nearest hundredth ?

If the 24-hr Snowfall SWE is the same as your gauge catch, please include a note to that effect in your comments.

**Observation Notes:** (This will be available to the public) ?

Not much wind with this storm - fluffy snow. Snowfall SWE the same as gauge catch.

# Measuring Snowpack Depth

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

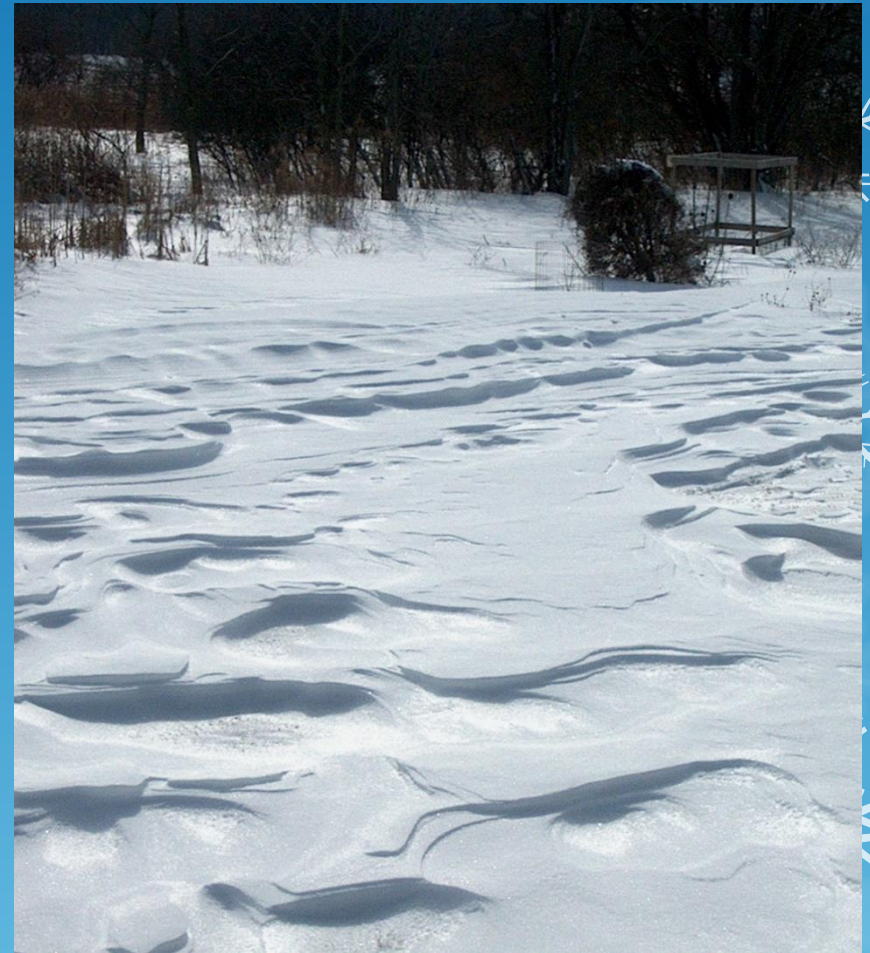


Photo by Michael Palecki

**Measuring Snowpack Depth is optional.** However, regularly reporting snowpack depth is a great benefit to hydrologists who use snow data collected by volunteers.

# Measuring Snowpack Depth

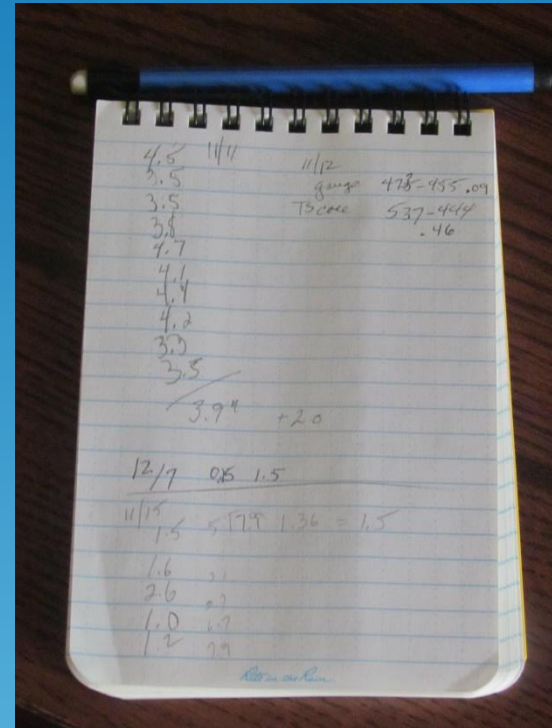
- Snowpack is rarely uniform in coverage
- Snowpack character changes in a non-uniform way
  - Compression/compacting
  - Melting occurs at different rates depending on actual snow depth, wind, sun exposure, and underlying surface
- We are looking for a representative value of the snowpack in the area
- Do not rely on a second snowboard in one location for your Snowpack Depth measurement





# Measuring Snowpack Depth

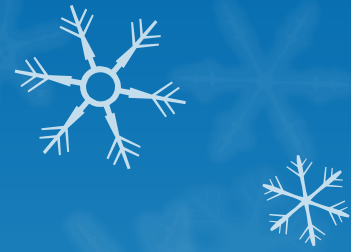
- Take **several measurements** to obtain your snowpack depth.
  - Write them down!
- Slide snow stick through all layers of snow (new and old).
- Read value on snow stick and record (values are to the nearest  $\frac{1}{2}$ " like 4.5 or 5.0).
- Don't measure "artificial accumulations", such as plowed piles, large drifts, or shoveled snow.
- Average your measurements to obtain the Snowpack Depth



# Snowpack Depth



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.





## EXAMPLE



If 60 percent of the ground has 2.0" and the rest is bare, your total depth is  $2.0 \times 0.6$ , or 1.2 inches (rounded to 1.0").



**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

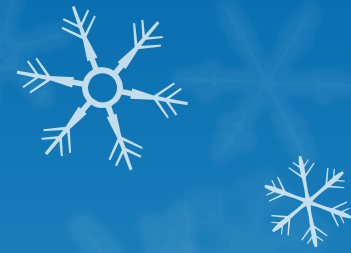
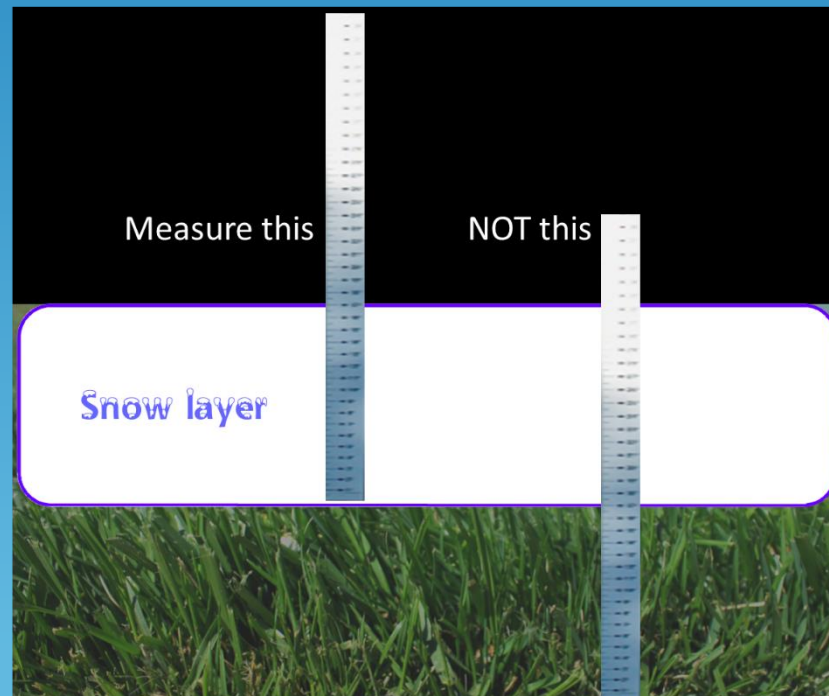
Snowpack (Total Snow and Ice on Ground at Observation Time)	
<input type="text" value="8.0"/> in.	<b>Snowpack Depth:</b> Total snow and ice (new and old) in inches to the nearest <b>half inch</b> ?
<input type="text" value="0.70"/> in.	<b>Snowpack SWE:</b> Melted value from core to the nearest <b>hundredth</b> ?

When snowpack depth is less than 0.5", enter a Trace for Snowpack Depth

Report a Trace until there is no natural snow remaining in the area.

# 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

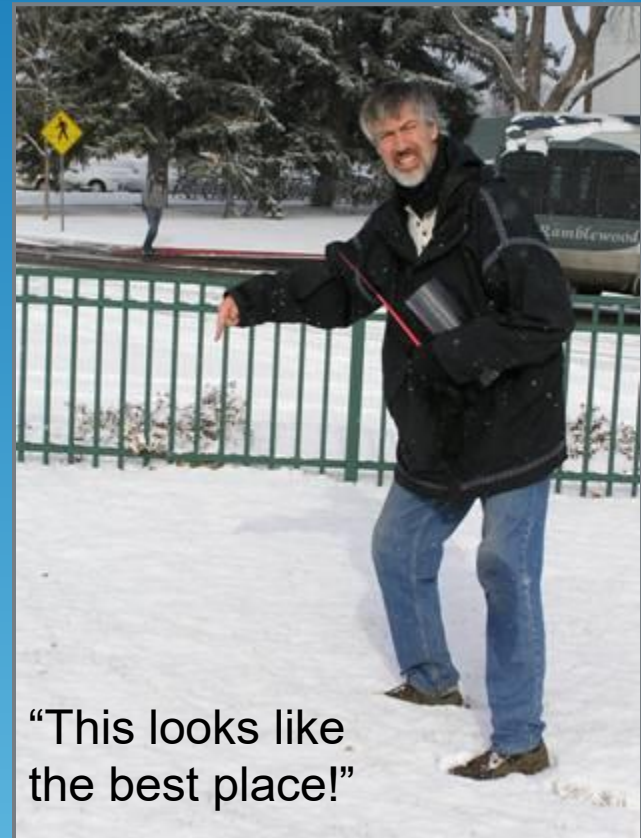
- This is a measurement that is useful to hydrologists and river forecasters
- Provides an estimate of how much water is “on the ground” that can potentially run off into rivers and streams
- It does not have to be done every day (though you can). Measure it after a new snowfall, and then once a week.
- 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 at the average representative depth of the Snowpack
  - Melt the core
  - Measure the amount of water in the core

# First find a representative location

- The location should have not 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



Place gauge upside down and push down into the snow



Clear snow from around the gauge



# Capturing the Core



Slide



Slide a spatula or other thin, flat object under gauge

Lift

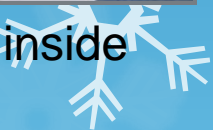


Carefully lift and get ready to flip the gauge

Flip



Bring the sample inside to melt





# Snowpack SWE

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

Snowpack (Total Snow and Ice on Ground at Observation Time)	
<input type="text" value="8.0"/> in.	<b>Snowpack Depth:</b> Total snow and ice (new and old) in inches to the nearest <b>half inch</b> ?
<input type="text" value="0.70"/> in.	<b>Snowpack SWE:</b> Melted value from core to the nearest <b>hundredth</b> ?



# Special Situations



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 “snow core” from the snowboard or an area representative of the average new snow depth.
- Melt and measure the snow core. This is your 24-hour Snow Water Equivalent (24-hour Snowfall SWE)
- If you feel this is more representative of the actual precipitation, then report this amount as your Gauge Catch and make a note in the Comments. Include the melted amount from the snow that actually fell in the gauge in your comments





Precipitation Report Form		Submit	Reset
Station Number :			
Station Name :			
* Denotes Required Field			
1/30/2022	*Observation Date ?		
7:00 AM	*Observation Time ?		
0.21 in.	*Gauge Catch: Rain and Melted Snow to the nearest hundredth inch that has fallen in the gauge during the past 24 hours, or T for trace, or NA for unknown. ?		
Observation Notes: (This will be available to the public) ? <div>             Gauge catch is amount from snow core. Poor gauge catch because of high winds - not representative of what fell. Amount melted from gauge 0.06".           </div>			
24-hr Snowfall			
3.6 in.	Snowfall: Accumulation of new snow in inches to the nearest tenth ?		
0.21 in.	Snowfall SWE: Melted value from core to the nearest hundredth ?		
Snowpack (Total Snow and Ice on Ground at Observation Time)			
4.5 in.	Snowpack Depth: Total snow and ice (new and old) in inches to the nearest half inch ?		
0.63 in.	Snowpack SWE: Melted value from core to the nearest hundredth ?		

Water melted from core is reported as the Gauge Catch

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 Gauge Catch
- 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 Gauge Catch
- Report a Trace of 24-hr New Snowfall
- 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 Gauge Catch
- Report the maximum accumulation of the new snow as your 24-hr 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

# Miscellaneous

- 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

- All snow measurements are optional, but are extremely helpful
- If you estimate snowfall or snow depth, do not enter those estimated values in the fields on the form. Instead, include any estimates in the observation comments.



# 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)

**Precipitation Report Form** [Submit] [Reset]

Station Number :  
Station Name :  
\* Denotes Required Field

1/14/2022 \*Observation Date ?  
7:00 AM \*Observation Time ?  
0.55 in. \*Gauge Catch: Rain and Melted Snow to the nearest hundredth inch that has fallen in the gauge during the past 24 hours, or T for trace, or NA for unknown. ?

**24-hr Snowfall**

6.2 in. Snowfall: Accumulation of new snow in inches to the nearest tenth ?  
0.57 in. Snowfall SWE: Melted value from core to the nearest hundredth ?

**Total Snow and Ice on Ground at Observation Time**

4.5 Depth of total snow and ice (new and old) in inches to the nearest half inch ?  
.43 Melted value from core to the nearest hundredth ?

# 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 of the Stratus gauge.
- This result is the amount of water in inches.

# Weighing Your Precipitation



Cylinder weight: 453 g



Cylinder plus water weight: 566 g

Cylinder+ water: 566 g

Cylinder: 453 g

Weight of water 113 g

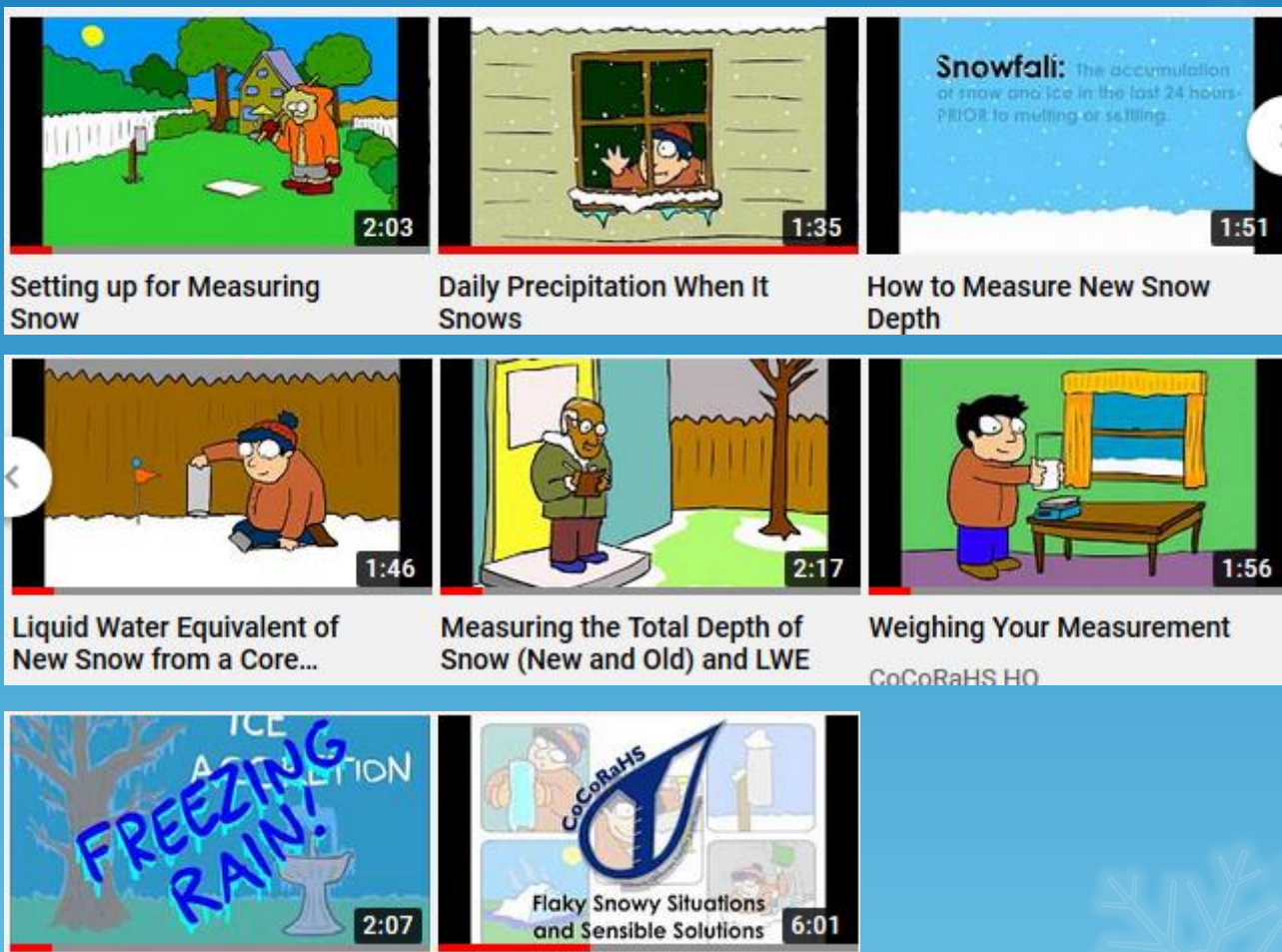
Convert to inches

$113\text{g} / 201\text{g per inch} =$

0.56 inch of precipitation

# Training Resources

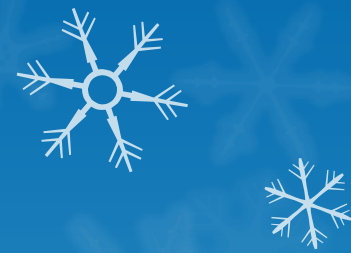
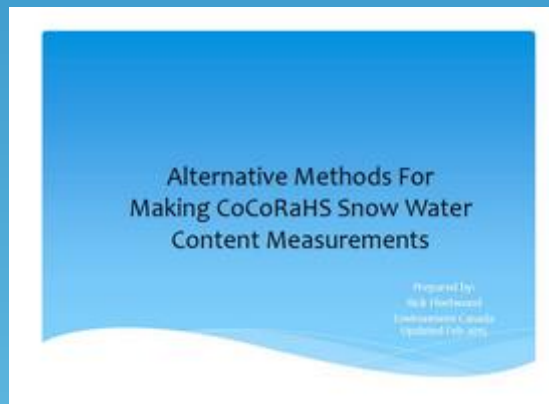
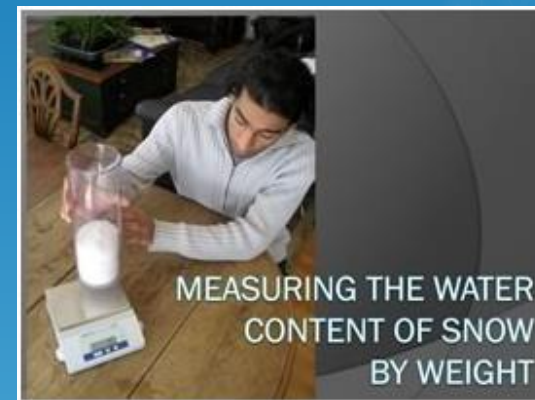
The CoCoRaHS training animations on YouTube





# Training Resources

## Training slide presentations



A photograph of a winter scene. In the foreground, there is a snow-covered lawn. Several evergreen trees of various sizes are scattered across the middle ground, all heavily laden with snow. In the background, a dense line of bare deciduous trees stands against a pale, overcast sky. On the left, a portion of a light-colored house with a snow-covered roof is visible. On the right, another part of a house, possibly brick, is partially seen. The overall atmosphere is quiet and cold.

# Questions?

[hberg@cocorahs.org](mailto:hberg@cocorahs.org)