A Practical Guide to Managing Fieldwork and Data for the Acadia Learning Snowpack Project

A collection of suggested practices and how to's for teachers, by teachers

This guide is a synthesis of field and data management practices developed by project teachers Kate Drummond, Mary Finnemore, Kara McCrimmon, Ed Lindsey, Mike Carroll, Genevieve Smith, and Deb Eustis-Grandy in Year 1 of the Snowpack project

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Introduction

The Acadia Learning Snowpack project is a Scientist-Teacher-Student partnership that relies on the collection and sharing of field data from schools across the state. The collecting, managing, uploading, downloading, and use of data in a classroom setting with students presents challenges that do not fit neatly into protocols and classroom activities. Project scientists, staff, and teachers met to share practical tips for the smooth implementation of the project—this document is the outcome of that meeting.

This Practical Guide is not a series of best practices, but rather a combination of suggested practices and how-to's. These are for you, as the teacher, to integrate into your classroom or to modify to suit your needs, goals, and cohorts of students. If you have suggestions or recommendations to share please do.

Generalized Project Timeline

September	October	November	December	January	February	March	April	May
Project introduction, modeling the system, asking research questions, setting up field sampling site(s)			Field sampling, data management, refining questions			Data integration, analysis, development and presentation of research story		

The snowpack project is a multi-month research project with collection of field data running from the first snow until the spring snowmelt. The times of greatest intensity are at the project's beginning—when students are trying to understand the system about which they will be asking research questions, and at the project's end—when students synthesize the data with regard to their research question and present their research story. Between those periods of intensity the project can "run in the background", especially when it does not mesh with the curriculum Units that you are covering in your class. Data collection and management does not have to be time consuming. To run the field portion of the project in the background, and manage it in such a way that the data are useful at the end does require a system.

This guide covers mainly field sampling and data analysis, but will touch on introducing the project and modeling the system.

Introducing the project

Start with your setting.

This project is used in classrooms across the state, thus we cannot recommend one specific way to introduce the project. Some teachers introduce the project by explaining that teachers and students will be working with researchers and other teachers and students across the state to understand spatial differences in snowfall and snowpack. They then take their students around the school to draw the setting and think about and ask questions about how the setting around the school would affect snowfall and snowpack (see Unit 2).

Start with the spread of schools across the State.

An alternative to starting with your site is to show the spread of schools involved with the project and ask students to think about how snowfall and snowpack would change across such a space, and then launch into the activities of Unit 1.

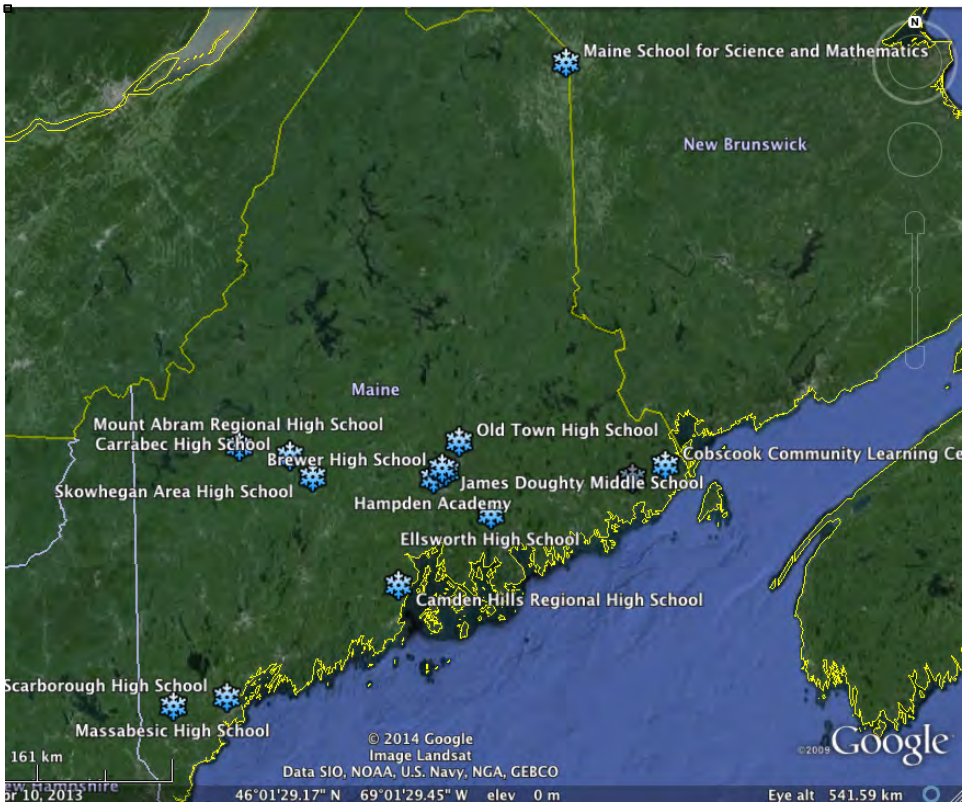


Figure 1: 2014-15 Snowpack project schools

Start with a small dataset.

If it rains in the fall deploy rain gauges at different locutions around the school (see: http://www.education.com/science-fair/article/DIY-rain-gauge/ for an easy-to-make rain gauge), measure temperature in microhabitats… Ask a small-scale question, "Is there a temperature difference depending on how close to the road you are?" Make sure that this one innocuous question would lead to critical thinking and more questions (examples: if they measured at the ground do you think the same trend would happen at chest height or head height? If they measured on a cloudy day... what about a windy day or a sunny day?)

Modeling the system

It can be challenging to take the landscape outside a classroom window and turn it into a model about the way a system works, and then use the model to think about mechanisms (variables, factors, etc.) that might affect snowfall and snowpack.

Draw

The goal is to have students define the system and then elaborate on differences within the system. They might then be able to model how those differences would affect

snowfall and snowpack (or another variable that they are interested in). Whether each student draws what s/he sees and asks questions, or whether they share their drawings and collectively question the ideas that resonate, this will take time. This process involves draw, erase, draw, talk, erase, draw, erase, talk, etc. Our goal is to go from:

Figure 2: Initial sketch of 'system'

to

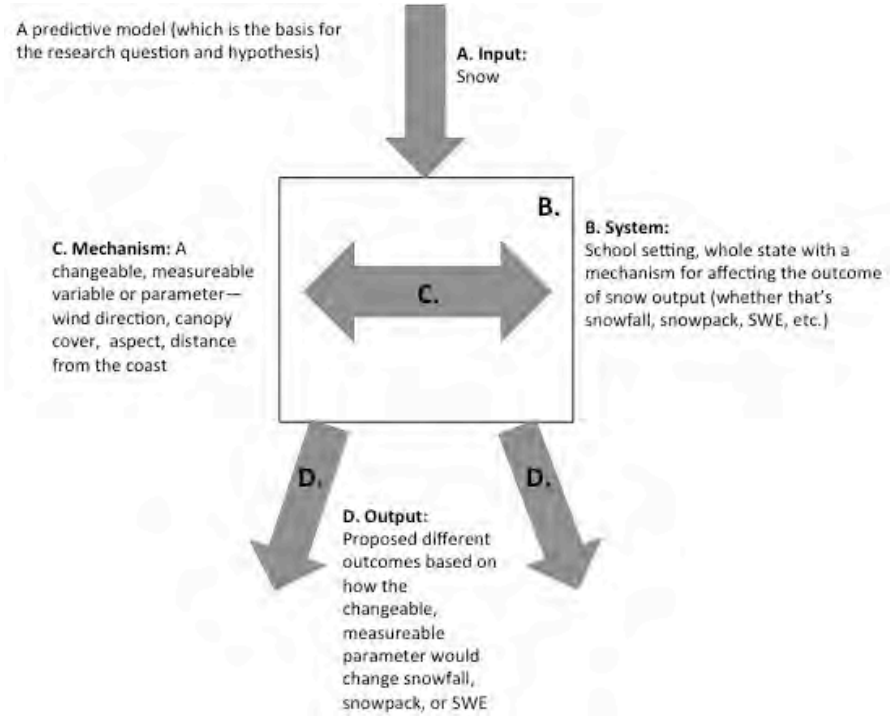


Figure 3: Predictive model of how system 'might' work

Remember, though—it does not have to be an explicit system drawing. When students are struggling ask, "What do you mean?" Ask students to draw their idea, a pictogram works and then put it into words, perhaps graduate to a system model drawing.

Walk around your schoolyard

Decide how you want to define your system/constrain the project. This can be done as a class or just by yourself or with a colleague. You can constrain to:

- a view shed "I can see all of my students from one vantage point"?
- the whole school setting "My students will not get run over getting from one field site to another"?
- a transect "I am going to constrain my students to asking questions that can be answered using data collected along this particular gradient"
- the whole town/district "My students are interested in differences across the whole town and will bring in samples from home once a month"

If you are doing this as a class endeavor make sure the students understand the snow parameters—

Snowfall: the amount of snow that fell during a particular event (snowstorm)
Snowpack: the amount of snow on the ground that has been accumulating through time
Snow-water equivalent: snow mass, technically defined as the depth of water that would result if the snow instantaneously melted

But, also allow students the opportunity to think about other parameters.

Selecting sites for sampling takes some time, but the sampling itself, once a routine has been established, does not take much time at all and can "run in the background" during other curriculum units. Thus, we recommend setting up your sites during the unit where the project makes the most sense to integrate and then continue sampling from that point onward.

Field management

NOTE: The world of data collection related to this project is much broader than CoCoRaHS collection, so you don't need to limit your project to just that suite of variables. Feel free to customize! Some teachers have added components like snow and soil temperature, solar radiation, forest characterization, etc. If you want to add components for your situation, please do! While we can't create detailed protocols for everything, Acadia Learning staff or teachers might be able to link you with other resources or local scientists who can help.

Preparing for the field

- Know your setting: how far from the building are you?

- Do a health and safety check: have a procedure. Do students have Epi pens, inhalers, etc.? Have drinking water, a sweet snack, hand warmers, a space blanket, a first aid kit. Be sure the front office (or another person) knows where you are and for how long.
- Make a kit (or kits - one for each group of students) - a basket/bucket with handle with all of the materials needed for sampling, to make getting into the field simpler and quicker. (Buckets work best—bright colors contrast with snow! Dishpans work for small items, but not for the large gear.
- Make an "extras" bucket for the teacher if you have enough materials (extra pencils/sharpeners, data sheets, thermometers, rulers, etc.) so you have them at hand if needed outside.
- Pencils - not pens! work best in the cold and wet conditions.
- If you can - laminate the protocols or put in sheet protectors.
- Use clipboards- with protocol/field sheet for the day (use rubberbands at bottom for windy days).
- Keep old jackets/hats/muck boots in the classroom for kids who forget.
- Sharp shovels (especially for snow pits).
- Rite-in-the-Rain fieldbooks (with pencil or Sharpie) (http://www.riteintherain.com/)
- Thermometers—have 2 to double check they are working properly
- Consider how you will keep a journal/log/field book/lab book. Some teachers spend time on this as part of the scientific process; others less so. Observe weather, make a sketch, notes about the samples, any calculations.
    - Discuss - why is it important for us to record this? Alternately, wait and let students discover they need an important piece of information they didn't record. http://colinpurrington.com/tips/academic/labnotebooks
    - It might help to have students read the logbook aloud at the end of the week (this may refine how the log book use gets refined through time)
- Run through the protocol - practice it in the classroom or at a site you are not using. Have kids do the demonstration. Then go out to do actual data collection right after.
- Tools—although the tools for this project are straightforward, it is helpful to have tool and measurement experts. Each student is assigned a tool and must read the protocol and explain to the other students how to use it. If they do not understand then they should query their fellow researchers to get clarification on use.

Figure 4: Student measuring snow depth

An assumption it's best NOT to make:
Don't assume that your students will know how to read and record measurements. This includes reading a thermometer, reading a rain/snow gauge, or reading how deeply a meter stick is in the snowpack by getting eye level with the snow. You can set up a practice station in your classroom—filling the rain gauge every morning and asking the

students to read and record (on separate pieces of paper) the depth. (This could also be an interesting graphing exercise in variability as one would think that the variability would decrease as practice and familiarity increases).

Group dynamics

Assign two or more students to each task, and break down tasks to enable more students to take part in data collection. Assigning jobs, as in real scientific careers, is an effective approach:

Field manager: Reads all of the directions/protocols and makes sure protocols are being followed.

Collectors/field technician: After you establish your sampling sites it may be that not everyone needs to go out. Collectors are students who want to go out in the cold and are good at measuring and recording data. These can be two or three students, or if you have multiple sites it can be two to four students per site.

Data manager/data entry: Some students are very good at entering data. Establish a time (perhaps while other students are sampling) when these students can enter data from a previous sampling event. Generally have two students per data sheet. (One to read off the data and one to put the data into the database (either Acadia Learning or CoCoRaHS)).

Equipment management: The equipment—buckets of gear—needs to be maintained with fresh data sheets, pencils, etc. And needs to always be in the same place for ease of use. Someone can have the job of equipment manager.

Quality assurance/Quality control (QA/QC): check all of the field data sheets for completeness and clarity. These are also students who may set up a checks and balances system (assigning a certain code—like a checkmark and the word 'entered'—for data that have been entered, keeping track of the data).

SWE: Give the task of bringing the snow to room temperature and measuring the volume (or depth), or getting the snow's mass (subtracting out the mass of the zipper bag) to some of your students. The QA/QC persons are in charge of this data stream also.

Some additional thoughts on group dynamics

- There are numerous trains of thought about whether or not to switch jobs.
  - If students get good at something they should stick with one job.
  - They should have the opportunity to switch around.

    - If they have to switch then students are always teaching each other (each student 'leaving' a job needs to train his or her replacement).
- Observations can be made during 'disrupted time'—while some students are away, right after or before break weeks, long weekends, testing times, etc.
- The more students are relying on each other for data, the more they will keep sloppy data from happening.

In the field

- Have students work in groups. Not too large - 3-4 students per group.
- Assigning groups - everyone has their own approach. Some teachers let students self-select; others assign groups; others have students write on a card 3 people they want to work with & 2 they don't, and they are guaranteed one in each category.
- It might work best to have students switch tasks each session, or keep the same job throughout. This depends on your class dynamic. Pulling names randomly from a stack of index cards is another approach.
- When going outside, take the whole class to one site, or keep multiple sites relatively close to one another for ease of monitoring students outdoors.
- Have time keepers to remind you when it is time to come in--kids are great at this!
- Consider a Train-the-Trainer approach. Students who did one job train the next student/group to do that task next.

Field protocol help

- Flyswatter (or laminated sheet...or metal spatula…or aluminum flashing...something rigid and thin) helps to brush off the top of the collector.
- Flag around your site to keep it from being trampled, and so you can find it! Alternately put flagging tape on a nearby tree or other upright to locate your sampling locations.
- Us a 4" diameter PVC to make snow corer - cut teeth on one end and drill holes for handle (1" diameter dowel or old broom handle that can slide in and out, which lets you use a plunger to push out the core) on other end. To extract core, clear snow around sampler and then put shovel blade, wide spatula, cookie sheet or other rigid piece of metal under core sampler and lift it out. Push snow core out into a plastic bag or bucket for easy transport.

Returning from the field

- Consider having a field data sheet/log and a permanent one in the classroom. When returning from field, transcribe data into permanent data log.
- Consider rotating the role of data entry and log writing between students to encourage ownership of data, self-monitoring and accountability.

- Logistics are key! Be organized. For example, have a designated area for all of the equipment (a counter space, cabinet).
- Designate a space and/or time for making lists of improvements to protocols as well as items needed to help make fieldwork more efficient.

Processing samples

- Secondary containment - put bagged samples in a tray or dishpan in case the bags leak.
- Date your samples if you are "saving them up" to do all of the SWE calculations later.
- Reminder: there are a couple of ways to melt snow for SWE - either melt with hot water, or allow samples to melt at room temperature, which might be overnight or longer. Plan for this.
- Allowing the snow core to come to room temperature (and melt) before measuring the volume can take some time; make sure to keep the zipper bags sealed to minimize the chance of evaporation.
- Don't put snow into a beaker and then put it on a hot plate to melt - glass may crack!

Data Management

The transition of data from the field to the database

Show examples of old field datasheets—some that have been filled out well and some that have been filled out poorly.

Ask: What from this field data sheet helps us? And what does not? The group can then decide what field datasheet effort exceeds your classroom standard, what meets your classroom standard. And what does not meet the standard and does not help the research.

Do these data make sense?

"Naked" data are data with no units. The field datasheet does have units on it; make sure the students understand the units for each measurement.

Have a second student check the data while the first student records, or have two students agree on a measurement "15.4 degrees C, do you agree?"
Alternately hand graph all of the data on sheets in the classroom and give the data the "straight-face" test—do these data make sense?

Graph-as-you-go

Put the daily or weekly data on a white board, or butcher paper, and build the data through time.

One possibility would be to put the date on the X-axis and snow water equivalent, new snow depth, day's high temperature (or temperature at time of sampling), or? "sunniness", on stacked Y-axis. This would be a good time to remind students of the importance of scale (on both axes) and that if data are not collected then that span needs to show in the running graph.

(Here's a splashy example from wunderground.com)

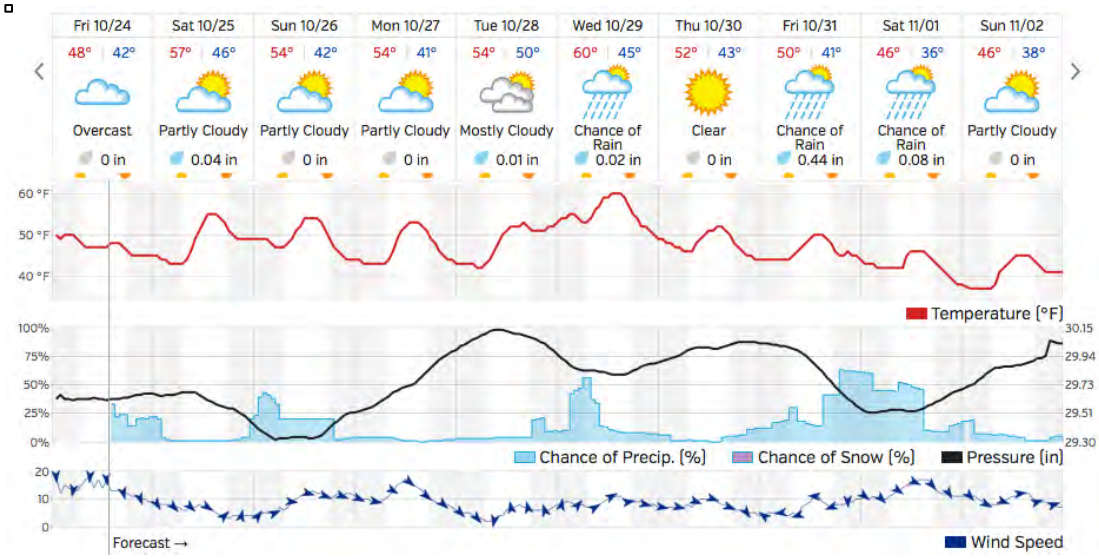


Figure 5: http://www.wunderground.com

Data entry

There are many different options for entering the data into a shared database. Remember the data are not useful if you do not share them.

- Spend a class period with everyone entering data.
- During classroom time use the "stations" method: while some people are cleaning out the sampling buckets (or whatever you are using to take gear to and from the field), and other people are melting snow to measure snow water equivalent, some people can be entering data.
- Additionally, alternately: if one student collected the data another student is in charge of entering those data—in that way one student is always checking another student's work (and potentially 'grading' that student on their data collection).
- Keep one log per field site. If students rotate (jobs or field sites that they are in charge of) then one student entering data can observe the quality of another sampler's data collection and quality management (and students can 'call each other out' on data of questionable quality).
- Play to your students' skills—if there are students who like entering data then let them enter the data.
- If you keep a 'neat' data log and one person enters the data, make sure to have another person read the log to ensure quality and legibility.

Keep a clean, original electronic copy of the data for yourself.

We use Google spreadsheet to collect all of the non-CoCoRaHS project data. If you download data from CoCoRaHS and share it with your students it may be best to do this using Google spreadsheet. But, remember that once students make changes to spreadsheets in Google spreadsheet it is hard to un-make the changes.

When you or your students access the project data always select "Make a copy"

Make this copy non-editable by students. Create a copy of your master spreadsheet to give to students. You may do this several times during the project. It may help to label your Master spreadsheet with the date that you made the copy from the project data spreadsheet. See: http://goo.gl/qYTrF1

In summary: access the project data, make a copy for yourself, make a copy of that copy, and give the copy of the copy to the students.

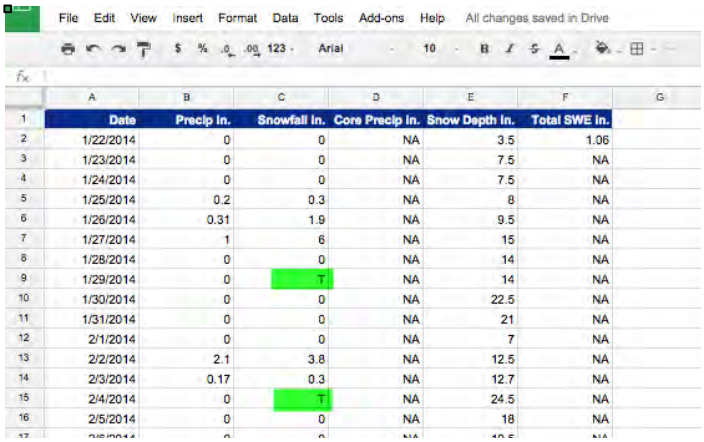
Make a subset of the data for starters

The spreadsheet of data can be overwhelming at first.
Make a mini dataset to start with. Make a copy spreadsheet of the project data.
Make a new tab on the copy.

Select only data from a particular site and only one or two parameters (or a particular date and one or two parameters). The point is to make a small dataset. Ask your students to ask questions of this dataset (How variable is the snowpack at this location? How did the snowpack change through time? What is the relationship between snowpack depth and air temperature? etc.) Graph just these data to answer the question. This gives students comfort with a small dataset before they work in the big dataset. See: http://goo.gl/JT214P This may make the data more manageable to your students.

Check for symbols of missing data or trace amounts of snow

Before plotting anything, have students carefully look through the dataset and see if there are any odd things in any of the columns or rows. For example, are there letters like "T" for trace precipitation in CoCoRaHS, or numbers (like -9 or -9999) for missing values?



	A	B	C	D	E	F
1	Date	Precip in.	Snowfall in.	Core Precip in.	Snow Depth in.	Total SWE in.
2	1/22/2014	0	0	NA	3.5	1.06
3	1/23/2014	0	0	NA	7.5	NA
4	1/24/2014	0	0	NA	7.5	NA
5	1/25/2014	0.2	0.3	NA	8	NA
6	1/26/2014	0.31	1.9	NA	9.5	NA
7	1/27/2014	1	6	NA	15	NA
8	1/28/2014	0	0	NA	14	NA
9	1/29/2014	0	T	NA	14	NA
10	1/30/2014	0	0	NA	22.5	NA
11	1/31/2014	0	0	NA	21	NA
12	2/1/2014	0	0	NA	7	NA
13	2/2/2014	2.1	3.8	NA	12.5	NA
14	2/3/2014	0.17	0.3	NA	12.7	NA
15	2/4/2014	0	T	NA	24.5	NA
16	2/5/2014	0	0	NA	18	NA

Figure 6: CoCoRaHS example with 'T" for trace

	A	B	C	D	E	F	G	H	I
1	SITEID	DATEON	DATEOFF	RGPPT	SVOL	SUBPPT	HGCONC	HGDEP	SAMPLETYPE
2	ME98	3/5/96 14:43	3/12/96 18:47	-9	232.12	19.37	1.85	35.84	W
3	ME98	3/12/96 18:54	3/19/96 18:44	13.97	130.1	13.97	3.83	53.5	W
4	ME98	3/19/96 18:57	3/26/96 14:28	34.54	349.04	34.54	4.18	144.39	W
5	ME98	3/26/96 14:36	4/2/96 18:40	10.67	74.1	10.67	8.94	95.37	W
6	ME98	4/2/96 18:45	4/9/96 15:48	13.97	137.9	13.97	3.97	55.46	W
7	ME98	4/9/96 15:54	4/16/96 18:07	-9	406.4	33.92	-9	-9	W
8	ME98	4/30/96 19:38	5/7/96 17:08	24.13	270.13	24.13	9.53	229.95	W
9	ME98	5/7/96 17:15	5/14/96 16:55	36.83	360.9	36.83	5.85	215.45	W
10	ME98	5/14/96 17:00	5/21/96 16:39	42.16	524.28	42.16	9.45	398.44	W
11	ME98	5/21/96 16:45	5/28/96 17:53	3.05	35.97	3.05	29.22	89.06	W

Figure 7: Example of using -9 for missing values

These will cause the data not to plot properly, or not plot at all. One way to find oddities is to sort each column and look at the top and bottom of the data—the oddities will fall to the bottom or rise to the top.

What to do then? You should discuss these oddities with your students; the oddities should be accounted for somewhere ("There were also 16 events where trace amounts of snow were recorded. Trace amounts of snow are not shown here as it is not possible to graph them." "There were X number of instances where there were no data.")

A measurement of ZERO versus zero measurements

Remember that no data and a recording of zero is not the same. Remind students that measuring zero (for example, no new snowfall) is not the same as not measuring (for example, running out of time and not being able to get a particular measurement). Zero is still data; not being able to collect data is not. These should be treated differently when entering the data into a database.

Students can omit zeroes if the zeroes are not important to the question they are trying to answer, but a zero is not the same as missing data.

Date and time

On the Google spreadsheet there are two columns where you will see the date and the time. One of the dates/times is the date and time when the data were added to the database. This is irrelevant to any student research question (we hope... unless the question is about data entry patterns in a multi-school, multi-site research project). The *Sample date and time* column displays the date and time as it was recorded on the field data sheet at the time of data collection and then entered into the database.

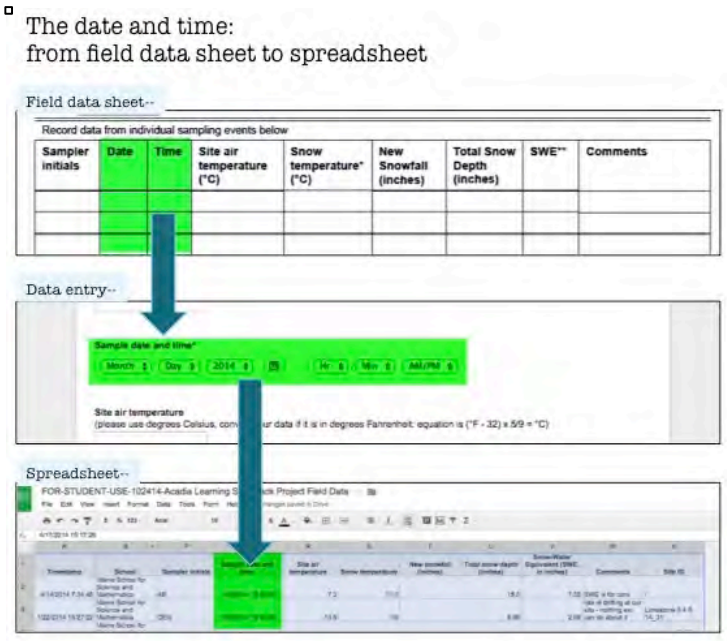


Figure 8: Flow for date and time information

In this database the date and time are in one spreadsheet cell, together – see: http://goo.gl/H5eFEl

To split them into a date column and a time column—

1. Make a duplicate column
2. In the first column--
3. Either right click (or control-click) or go to the Format menu
4. Go to "Number"
5. Select a different date format that does not include the time.
6. In the second column--
7. Either right click (or control-click) or go to the Format menu
8. Go to "Number"
9. Select a different time format that does not include the date.

Freeze column headings

Teach your students how to freeze the column headings, in this way as they are scrolling down through data they can still see what the data in each column represent.

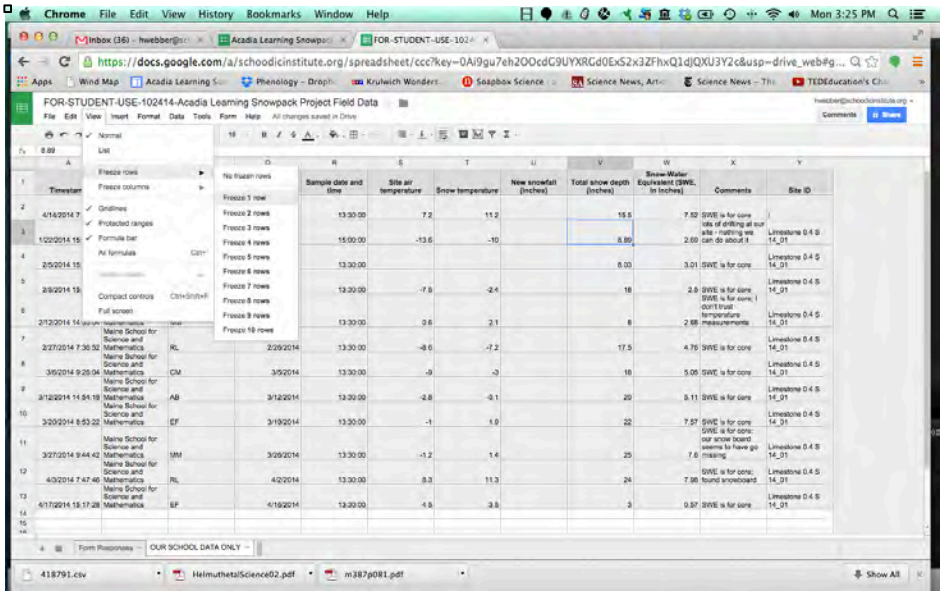


Figure 9: Freeze the column headings

Summary

This is an adventure—There will be stumbles and fumbles. The students will have different questions, different data and different graphing needs, so make sure there is room for fumbling. Many of our teachers tell their students "I don't know how to fix that within the spreadsheet software—you are going to have to figure it out and then teach me." Or "Teach me how to collect these samples." It is a process and as was mentioned at the beginning of this guide—these are suggestions and helpful hints; not best practices, but good practices. Please share with us your practical hints for smooth fieldwork and data management with your students.

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