LABORATORY 4

SNOW CRYSTAL COLLECTIONS

MOTIVATION:

Snow crystals and aggregates of crystals, called snowflakes, that fall around SPL produce the bulk of the wintertime precipitation. The falling crystals remove aerosol particles from the atmosphere, thus they help clean up the atmosphere. The crystals remove particles by forming upon the particles, by capturing them in their dendritic arms and by capturing cloud droplets which formed on other aerosol particles. Thus, the more droplets collected by the snow crystals and flakes, the more rime ice on the crystals, the more aerosol particles removed from the atmosphere. Borys, Hindman and Demott (1988, *J. Atmos. Chem.*) have shown that heavily rimed snow at SPL is generally more acidic than unrimed show due to the chemically enriched cloud droplets collected by the falling snow. Borys, et al. (2000, *Atmos. Environ.*) showed that sometimes air pollution at SPL can reduce droplet sizes, reducing the amount of rime ice on the crystals and, thus, reducing the snowfall rates. So, it is important to collect falling snow for chemical analyses and to determine the amount of rime ice on the crystals.

Here are the basic types of snow crystals (note, graupel, sleet and hail are not snow crystals):

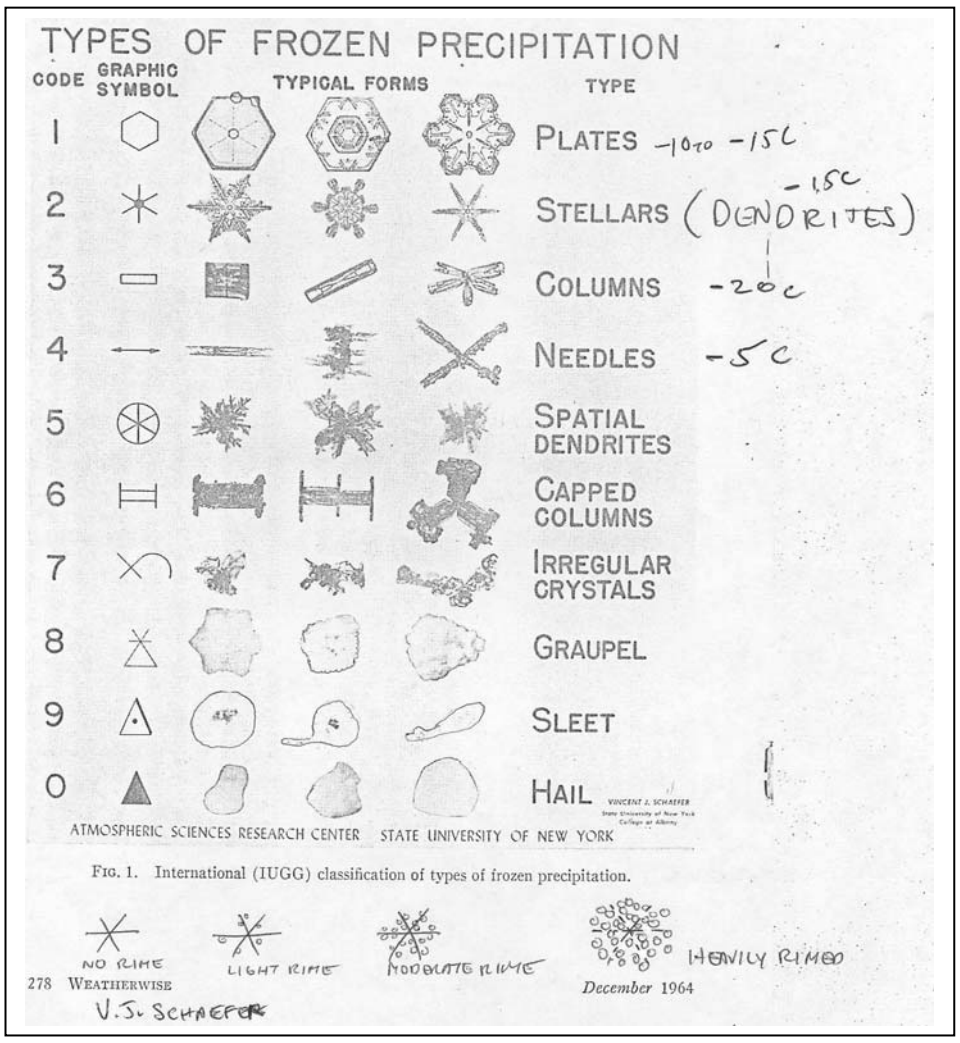
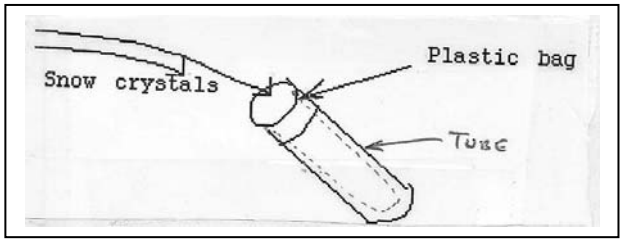


FIG. 1. International (IUGG) classification of types of frozen precipitation.

We have developed a special snowfall collector at SPL because of the high wind speeds. The design originated with Borys, Hindman and DeMott's work and was improved by the suggestion of CCNY students studying at SPL:

The device consists of two tubes aligned into the flow of the air by the big weather vane. The tubes make the device look like a mortar used by an army. The tubes are tilted to conform to the diagonal trajectory of the falling crystals blown by the wind:



Long plastic bags (devised by Prof. T. Bandosz, winter 98/99) are inserted in the tubes to catch the snow crystals. After a 10 to 15 minute collection period the bags are removed and stored in the SPL cold room for later chemical analyses.

Snow crystals can be collected and preserved. First, as shown by Hindman (1964, *J. Rech. Atmos.*) using Formvar plastic softened by chloroform vapor. Second, in a 4% solution of Formvar dissolved in ethylene dichloride (100g ethlyene dichloride, 4g Formvar, 2g Toluene) as invented by Schaefer (1964, *Weatherwise*) and improved by Hindman and Rinker (1967, *J. Appl. Meteor.*). Formvar is the plastic used for insulation on electrical wires. The cold Formvar solution flows around and encapsulates the crystals. Then, the ethylene dichloride solvent rapidly evaporates living a solid thin Formvar cast of the crystal. It's necessary to desiccate the cast in the cold temperatures where the Formvar-covered ice can sublime through the thin

Formvar shell. The cast or replica can then be brought indoors and studied under a microscope.

OBJECTIVES:

Learn to collect snow samples for chemical analyses and snow crystal replicas for morphological studies.

INSTRUMENTS:

SPL: DRI/CCNY snow fall collector, Bandosz plastic bags, rubber bands, plastic gloves. Microscope slides, Formvar solution in squeeze bottle, drying chamber, slide boxes, black felt surface, stereo-microscope.

SPLB: DRI/CCNY snow fall collector (two 2.5 lb coffee cans), plastic bags, rubber bands, plastic gloves. Microscope slides, Formvar solution in squeeze bottle, drying chamber, slide boxes, black felt surface, hand lens.

PROCEDURES:

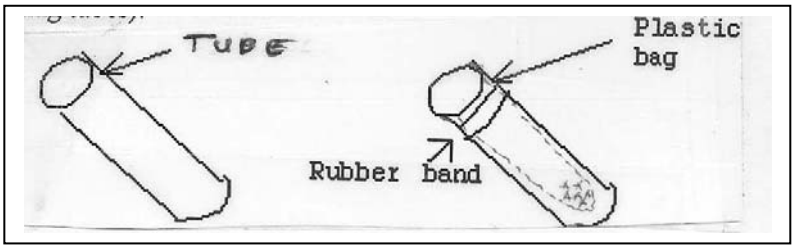
Note: If the wind speed is > 30 mph (steady), do not collect snow because too much blowing snow is in the air.

<u>Snowfall collector</u> (SPL):

1. Put on plastic gloves in cold room. Label one of two plastic bags near the bottom of the bag (SPLS##).

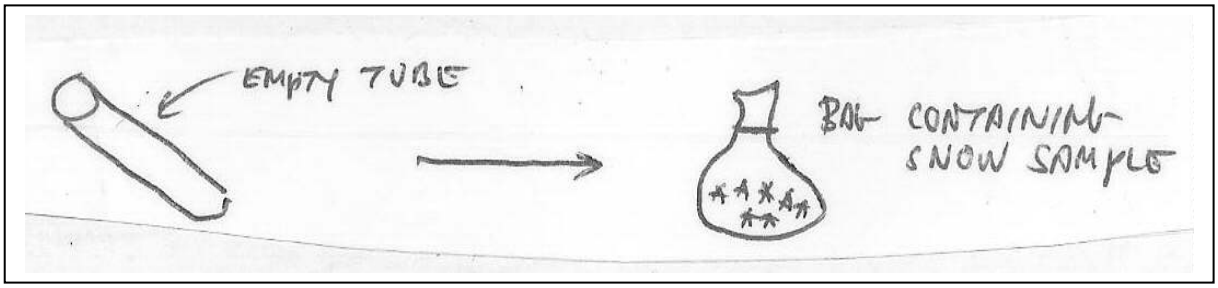
2. Bring the bags to the tubes on the roof; clean the entrance to the tubes of any rime ice.

3. Insert the bags into the tubes; hold the bags down with rubber bands; on the *SPL Outside data sheet* using a pencil, record the time and wind speed (use the hand-held anemometer adjacent to the opening of one of the sampling tubes):



4. Make a snow crystal observation and replications (described later in this lab).

5. Return to the exposed bags in 10 to 15 minutes. If the bottoms of the bags are covered with snow record the time and wind speed then remove the bags from the cylinders and return the bags to the cold room. If the bottoms are not covered with snow, return in another 15 minutes and there should be enough snow collected to remove the bags; if not, wait another 15 minutes and so on:



6. In the cold room, combine the snow into the labeled bag and weigh the bag (subtracting the weight of the empty bag, 13.6 g (Bandosz bag)). Seal and store the bag in the cold room freezer for later chemical analyses.

7. Record all values from your scratch paper on the accompanying *Snowfall Collections* form:

SNOWFALL COLLECTIONS

Location: SPL 1/3

Date 2002	Sample#	No. bags	Time out (MST)	Wind spd. (m/s)	Temp. (F)	Time in (MST)	Wind spd. (m/s)	Temp. (F)	Mass (g)
5JAN	—	—	1100	NOT ~~IN CLOUD~~			NOT SNOWING		
5Jan	—	—	1400	not snowing					
5Jan			1700	NOT snowing					
5JAN	SPLS#1	2	2000	5	—	2058	7	—	51.1
5JAN	SPLS#2	2	2322	6	—	0200	6	—	7.4
6Jan			0200	Not snowing					

Snowfall collection (SPLB):

1. Put on plastic gloves. Prepare two plastic baggies. Label one SPLBS## where ## is the sample number; leave the other unlabeled. Place the baggies into the two coffee cans. Place the plastic-bag lined coffee can on top of snow away from parked cars and snow plowed drifts. Record the time and sample number on the *SPLB Outside data sheet*.

2. Return to can at next observation (or earlier if the snow stops) with your gloved hands. Record the time.

3. Carefully remove the plastic bags with snow, pour the snow from the unmarked bag into the labeled bag, seal the bag and place in the Styrofoam container under the trailer (or in the SPLB freezer if temperatures get close to 32F). **Weigh the bags containing snow at SPL at the end of the field period!!** Subtract the weight of an empty bag (Safeway baggie = 3 g).

4. Record all data from your "portable" data sheet on the *Snowfall Collection* form:

SNOWFALL COLLECTIONS

Location: SPLB

1/3

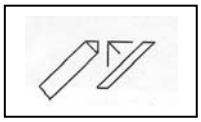
Date 2002	Sample#	No. bags	Time out (MST)	Wind spd. (m/s)	Temp. (F)	Time in (MST)	Wind spd. (m/s)	Temp. (F)	Mass (g)
4JAN	SPLBS#1	1	2030	—	—	5JAN02 0600 (NOT SNOWING)	—	—	
5Jan	SPLBS02	1	1750	CALM	20.7	2010	CALM	19.4	
5Jan	SPLBS#3	1	2020	CALM,	19.4	??	??		
6Jan		0	0218	NOT SNOWING		1 NO	SAMPLE		11.6
6Jan		0	0620	NOT SNOWING					

Snow crystal replications on microscope slides and observations on black-felt surface:

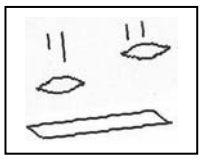
If the wind speed is > 30 mph (steady), do not replicate crystals because too much blowing snow is in the air.

Replicas:

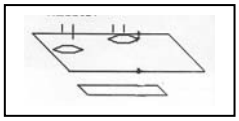
1. Put on your glove liners to handle the chilled slides.
2. At SPL, go to the Barn and load a slide holder with a pair of slides, numbered-side upside down. At SPLB, load the slide holder in the protection of the Styrofoam chest, numbered-side upside down.
3. At SPL, carry the holder and Formvar bottle to the railing covering the slide holder with your gloved hand. At SPLB, move to the edge of the parking lot.
4. With your back to the wind, remove the first slide from the holder (do not replicate if wind speed > 30 mph!).
5. Squirt Formvar onto the numbered-side-up slide below the sample number and shake off excess:



6. Expose the slide to intercept the falling and blowing crystals at a *right angle* for 10 s:



7. Replace the slide in the holder, Formvar-coated side down, and remove the second slide and repeat the procedure:



8. Return holder and bottle to the Barn (at SPL) and to the chest at SPLB.
9. At the next observation, remove the slides from the holder (watch out they may be glued in) and place them in the slide transfer box.
10. After the box is full, put the slides in the large slide box in the lab.

11. Inspect the beautiful crystals under the 3D microscope at SPL and with the hand lens at SPLB.

Observation of snow crystals/snow flakes:

The diagram on page 1 of this lab (from Schaefer, 1964, *Weatherwise*) illustrates major snow crystal types. Identify the major type by observing crystals on the black felt surface and estimate if they are rimed (look like powdered sugar) or unrimed (twinkle like little mirrors).

Write in the *Snow Crystal Observations/Replicas* form the date, time (MST) and sample (replica) number (both slides have the same sample number). On a second line, write the dominant type of crystal you observed on the black-felt surface and estimate the amount of rime ice on the crystals:

SNOW CRYSTAL OBSERVATIONS / REPLICAS 1/3

Location: SPL

Date 2002	Time (MST)	Replica no.	Dominant type	Rimed?	Remarks
5JAN	1100	–	~~NOT IN~~	NOT	SNOWING
5Jan	1400	–	not snowing		
5Jan	1700	–	Not snowing		
5JAN	2000	–	PLATE & EMBRYONIC STELLARS	UNRIMED	QUITE SMALL
11	11	Ø1			10 S EXPOSURE BEAUTIFUL ASSEMBLIDGES OF PLATES, UNRIMED *
5JAN	2300	–	STELLAR PLATES	NO RIME TO LIGHT	VERY SMALL ONY STALS
11	2300	Ø2			10 S EXPOSURE STELLARS & PLATES (ASSEMBLIDGES OF PLATES) UNRIMED TO LIGHT RIME