SENSOR PLACEMENT FOR SNOW & ICE MELT APPLICATIONS

By: Dave Mays

A great number of service calls come in with the common problem of the heaters not coming on even though it is snowing outside or there is ice buildup. After trouble- shooting the system it is discovered that the equipment is fine but there is no snow or ice on the sensor.

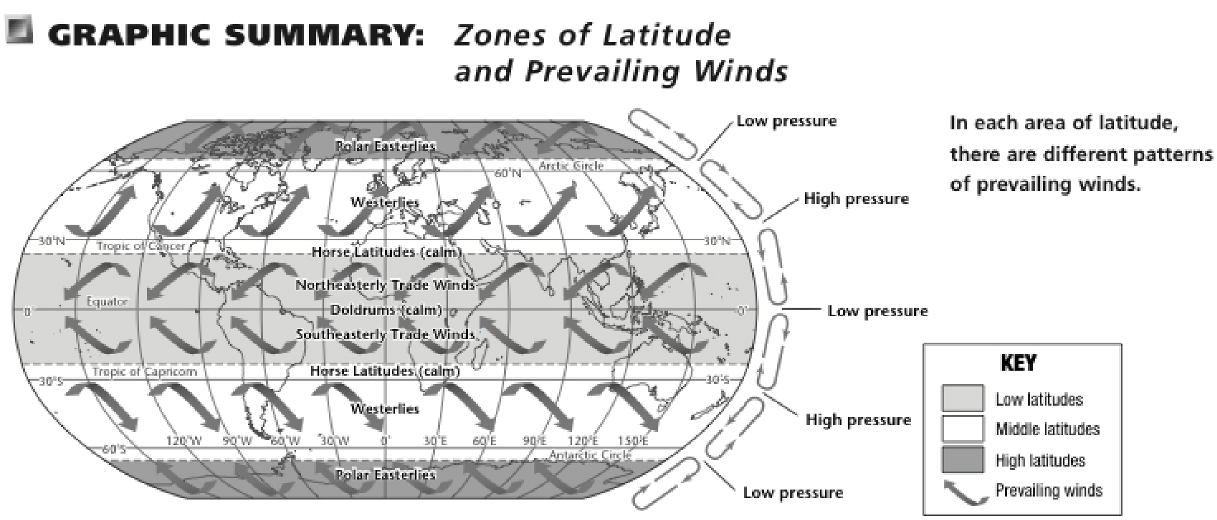
The proper placement of sensors is critical for the snowmelt system to operate. This is especially true if only one sensor is used, multiple sensors can be a little more forgiving for incorrect placement but to get the most out of the system it would be advisable to locate as many sensors in the "sweet spot" as possible.

The best person to determine the sweet spots for the sensors is the installer but to do so the installer needs to consider a number of parameters when considering the site and the final location of the sensor or sensors. These include but are not limited to:
1. Prevailing winds
2. The movement of high and low pressure systems through the area
3. Local wind patterns during the day versus patterns at night
4. Snow types and how they interact with sensors
5. Obstructions
6. How buildings affect wind and snow

1. PREVAILING WINDS

Simply put this tells us the general direction that the wind comes from at any given place. For instance in South Bend, Indiana where ETI is headquartered the prevailing wind is from the West and varies from the North West or South West. It does not mean that the wind never comes from the East, just that most of the time it comes from the West.

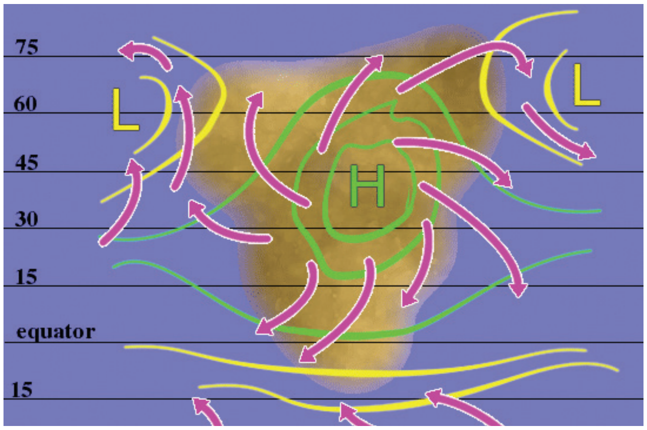
Below is a map that shows the prevailing winds at different zones of latitude and you can see that in the United States the winds generally blow from South West to North East. Checking your local weather station should give you information on your prevailing winds.

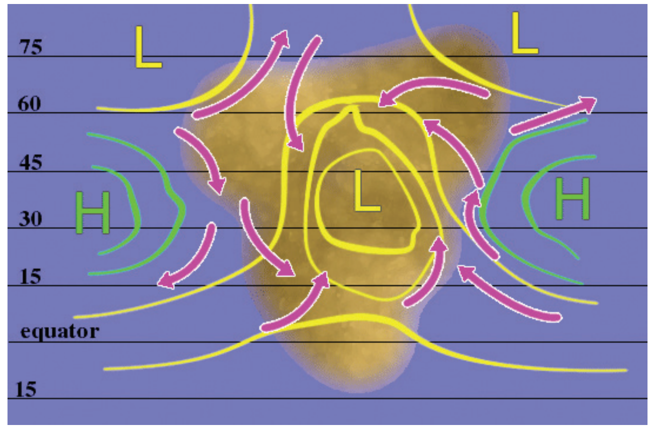


2. THE MOVEMENT OF HIGH AND LOW PRESSURE SYSTEMS THROUGH THE AREA

Below you will see how wind rotates around a high pressure system and a low pressure system. Winds circulate in a clockwise direction around a high pressure area and counter clockwise around a low pressure area.

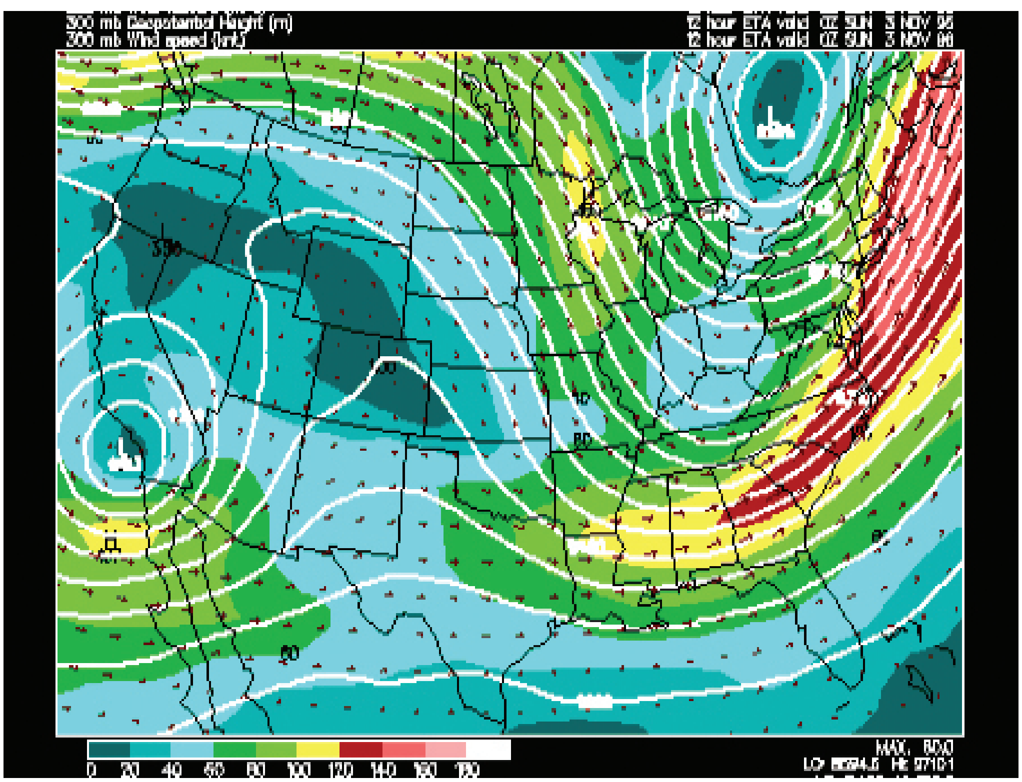
Wind direction then depends on if the low or high pressure center tracks to the north of your location or the south. A high pressure center tracking north will give you winds from the north east or east while a low pressure center tracking to your south will give you winds from the same direction.





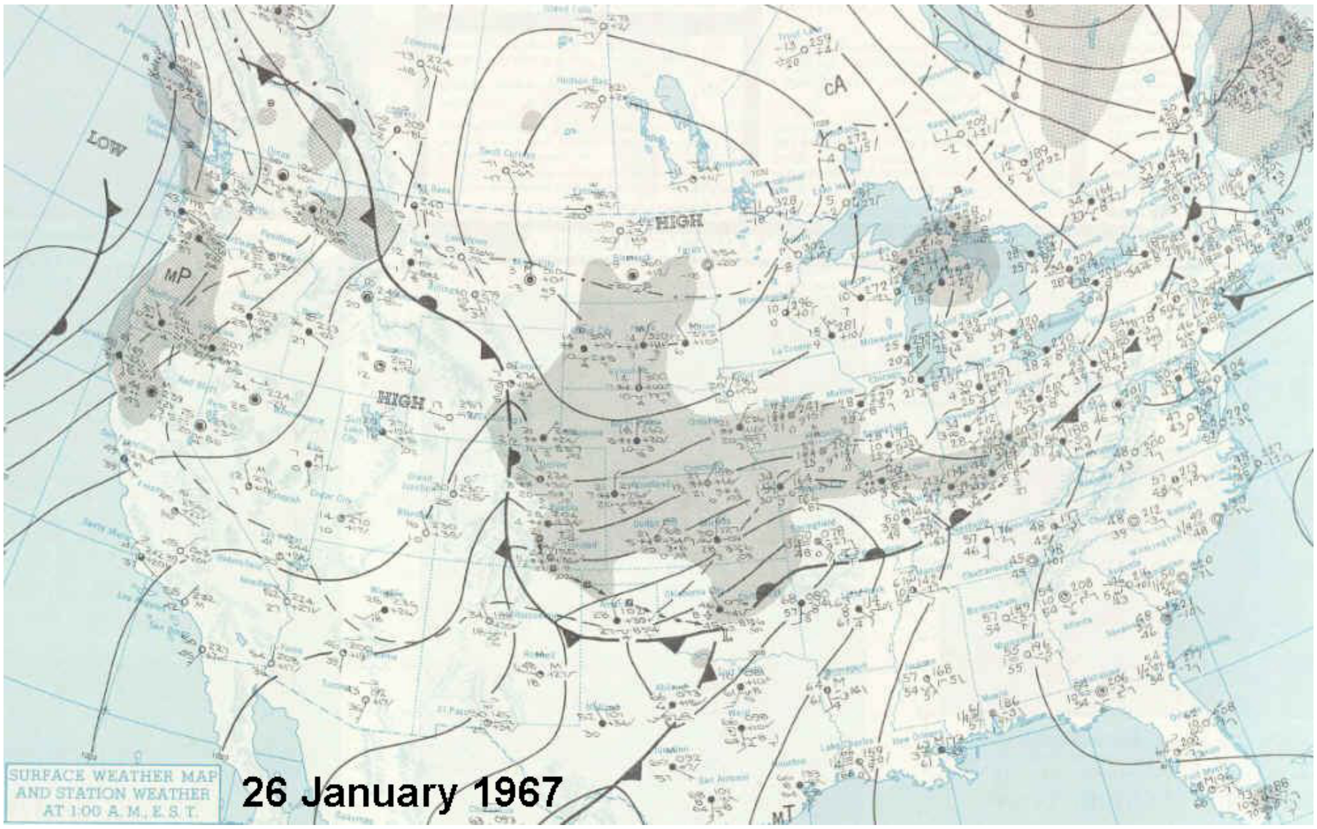
THE AFFECTS OF THE JET STREAM

The image below shows a representation of the jet stream on a particular day. This shows the direction and speed in the upper altitudes of the atmosphere. It is not uncommon for these winds to be in excess of 100 MPH and they are important because they act as steering currents for low and high pressure centers. As such they can help in determining if the pressure center is going to track relative to your location.



PRESSURE SYSTEMS DURING THE BLIZZARD THAT HIT CHICAGO ON JANUARY 26, 1967

Below is a weather map showing the pressure centers and fronts during the blizzard that hit Chicago on 26 January 1967. It shows the very large and cold high pressure center over North Dakota which with its clockwise circulation of air brought winds from the east with lake effect snow into Chicago. Although I am unable to locate a jet stream map for the same date it, would have looked very similar to the image on the bottom of page 2, but drawing from higher in the Arctic Circle.



3. LOCAL WIND PATTERNS DURING THE DAY VERSUS PATTERNS AT NIGHT

The uneven heating of the earth's surface by solar heating during the day causes an unbalanced warming of the air above it resulting in more wind. The Wind at night tends to be calmer because without he heating by the sun the air temperature becomes more balanced. Because of this phenomenon, it is important to take into account how your local wind patterns act in the day and night.

A wind rose is a chart of local wind patterns and how the winds may change at night verses during the day. These can be generated for any given day or night by using the information from the national weather service for your local area.

weather.gov

Weather observations for the past three days

South Bend Regional Airport

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metric en español

Date	Time (est)	Wind (mph)	Vis. (mi.)	Weather	Sky Cond.	Temperature (ºF)				Relative Humidity	Wind Chill (°F)	Heat Index (°F)	Pressure		Precipitation (in.)		
						Air	Dwpt	6 hour Max.	6 hour Min.				altimeter (in)	sea level (mb)	1 hr	3 hr	6 hr
23	12:54	SW 12	10.00	Overcast	OVC055	15	4	15	11	61%	1	NA	30.19	1024.0			
23	11:54	SW 10	10.00	Overcast	OVC060	15	2			56%	3	NA	30.23	1025.4			
23	10:54	SW 10	10.00	Overcast	OVC065	14	2			58%	1	NA	30.24	1025.6			
23	09:54	SW 12 G 18	10.00	Overcast	FEW070 OVC090	12	1			61%	-2	NA	30.25	1026.0			
23	08:54	SW 12	10.00	Overcast	FEW070 OVC085	11	-0			61%	-4	NA	30.25	1026.1			
23	07:54	SW 9	10.00	Overcast	OVC090	11	-1			58%	-2	NA	30.25	1026.3			
23	06:54	SW 10	10.00	Overcast	FEW034 OVC090	11	-1	11	9	58%	-2	NA	30.25	1026.2			
23	05:54	SW 10	10.00	Overcast	FEW023 BKN034 OVC095	10	-0			63%	-4	NA	30.26	1026.5			
23	04:54	SW 13	7.00	Overcast	OVC034	10	-0			63%	-5	NA	30.26	1026.6			
23	03:54	SW 13	10.00	Overcast	OVC038	9	-2			61%	-7	NA	30.28	1027.1			
23	02:54	SW 9	9.00	Overcast	OVC040	9	-0			66%	-4	NA	30.28	1027.0			
23	01:54	SW 13	2.50	Light Snow	FEW024 OVC042	9	1			70%	-7	NA	30.28	1027.2			
23	00:54	SW 14	3.00	Light Snow	OVC040	9	2	9	7	73%	-7	NA	30.29	1027.5			
22	23:54	SW 14	3.00	Light Snow	BKN025 OVC044	9	2			73%	-7	NA	30.29	1027.6			
22	22:54	SW 14	6.00	Overcast with Haze	FEW032 OVC046	9	1			70%	-7	NA	30.28	1027.4			
22	21:54	SW 12	4.00	Light Snow	OVC022	9	1			70%	-6	NA	30.28	1027.3			
22	20:54	SW 10	2.00	Light Snow	OVC018	8	-1			66%	-6	NA	30.28	1027.2			
22	19:54	SW 9	10.00	Overcast	BKN028 OVC047	8	-4			57%	-5	NA	30.28	1027.4			
22	18:54	SW 6	10.00	Mostly Cloudy	SCT036 BKN047	7	-4	9	6	60%	-4	NA	30.29	1027.6			0.03

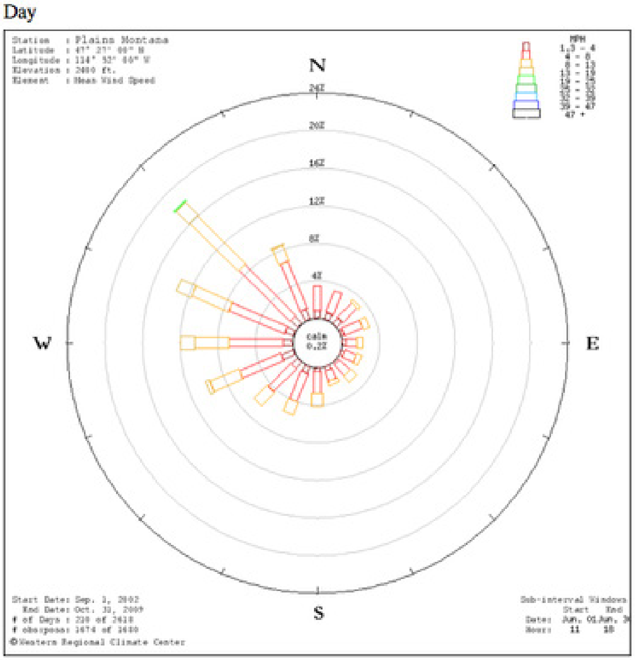
HOW TO READ A WIND ROSE

- The wind rose shows directional angle, with North being up, South being down, etc…
- Data is binned into various directional angles. For each directional bin, the amount of time the winds were in that direction is shown by the overall length of the bar shown.
- Additionally, the distribution of wind speeds are shown within each directional bar by color coding the wind speed into bins. Both the relative proportion of the wind speed categories, as well as the absolute % time in that wind speed and directional bin can be determined.

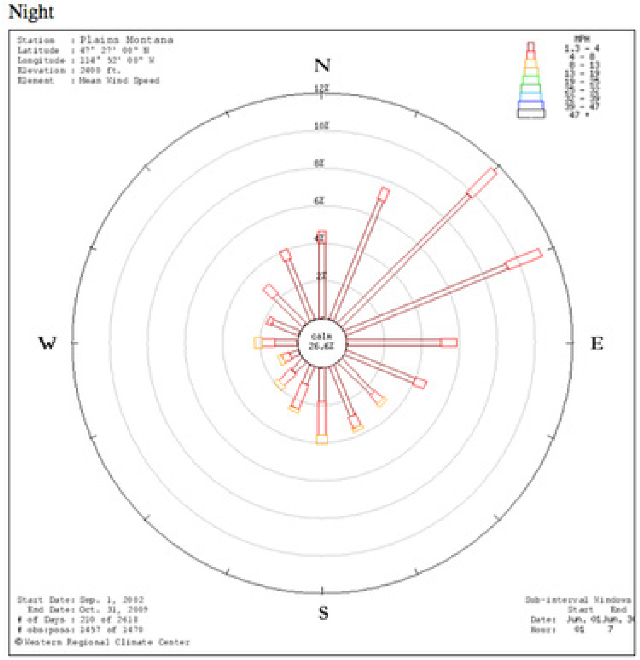
NAVIGATING A WIND ROSE

- The left wind rose shows the “day” winds.
- The right wind rose shows the “night” winds.
- The station name and location information are shown in the upper left corner of each wind rose.
- The period of data shown is listed in the lower left corner of each wind rose.
- The wind rose scale is shown in the upper right corner.
- The calendar month shown is listed in the lower right corner, as is the hour period shown.

Day



Night



4. SNOW TYPES AND HOW THEY INTERACT WITH SENSORS

Columns .... A class of snowflakes that is shaped like a six sided column. One of the 4 classes of snowflakes.

Dendrites........................... A class of snowflakes that has 6 points, making it somewhat star shaped. The classic snowflake shape. One of the 4 classes of snowflakes.

Graupel.............................. Precipitation formed when freezing fog condenses on a snowflake, forming a ball of rime ice. Also known as snow pellets.

Ground blizzard.................. Occurs when a strong wind drives already fallen snow to create drifts and whiteouts.

Lake-effect snow................ Produced when cold winds move across long expanses of warmer lake water, picking up water vapor which freezes and is deposited on the lake's shores.

Needles .... A class of snowflakes that are acicular in shape (their length is much longer than their diameter, like a needle). One of the 4 classes of snowflakes.

Rimed snow....................... Snowflakes that are partially or completely coated in tiny frozen water droplets called rime. Rime forms on a snowflake when it passes through a super-cooled cloud. One of the 4 classes of snowflakes.

Sleet.................................. In Canada and Britain, rain mixed with snow; Some people refer to this as sleet, while others refer to sleet as ice pellets formed when snowflakes pass through a layer of warm air, partially or completely thaw, then refreeze upon passing through sufficiently cold air during further descent.

Snow pellets...................... See graupel.

Soft hail............................. See graupel.

How these various types of snow interact with a snow sensor basically depends on the size and moisture content of the snow and how it is transported on the wind.

The moisture grid of a sensor is a flat disk approximately one inch in diameter while the snow flake can be of various sizes. The odds of landing a 1/8 inch snow flake on the grid in a 20 mph wind are about like landing a 747 on an aircraft carrier in a hurricane.

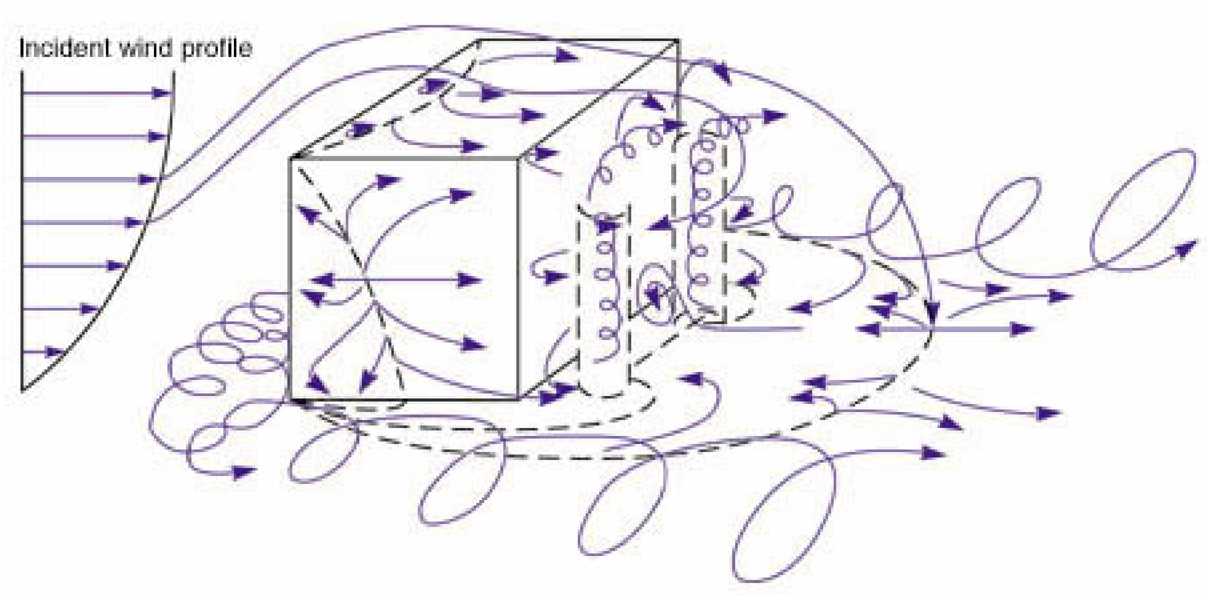
To increase the odds we need to consider how wind patterns change as it meets objects and buildings.

5. OBSTRUCTIONS

Obviously trees, bushes, walls, vehicles and buildings can block precipitation from coming in contact with the sensor. What may not be obvious is that this blocking effect could be several feet away depending on the velocity and direction of the wind.

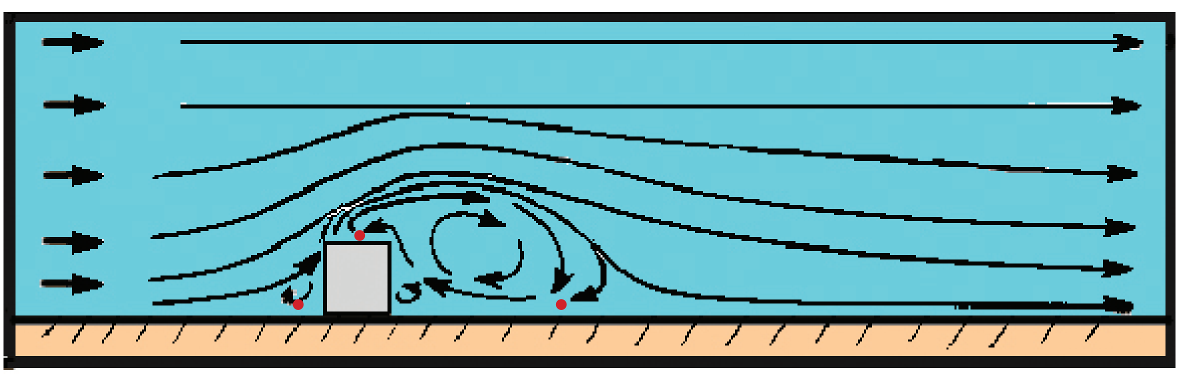
6. HOW BUILDINGS AFFECT WIND AND SNOW

Here is an example of how air flows around an object such as a building and creates vortices that allow snow to accumulate in drifts. These drift zones are the correct location for positioning snow sensors.

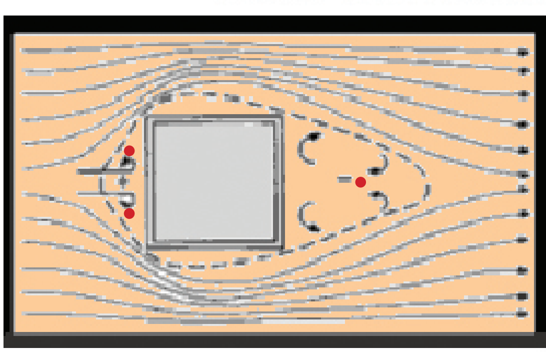


SENSOR PLACEMENT

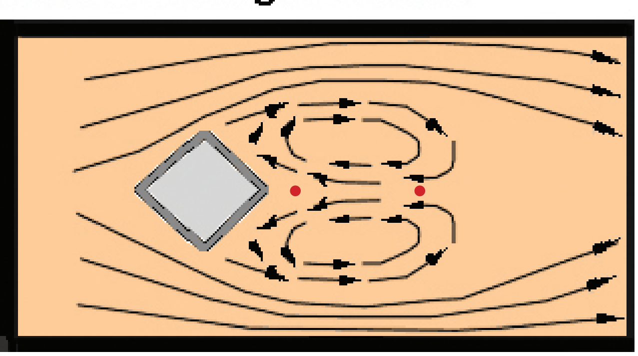
Below are some representations of air flow around buildings. The red dots represent areas where the air turbulence tends to deposit snow. Air turbulence will cause the snow to swirl in many different directions including up it also allows gravity to pull it to a resting place. These points should be considered for sensor location.



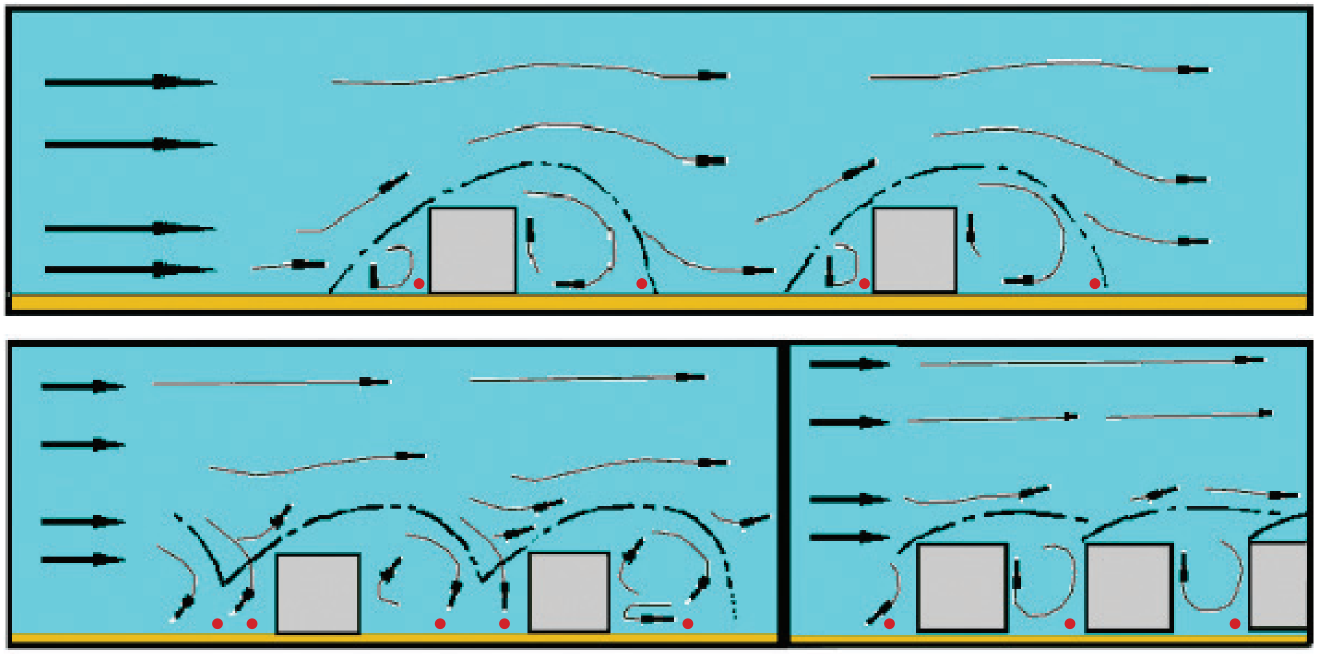
Flow Pattern: Side View Wind Against Face



Flow Pattern: Top View Wind Against Face

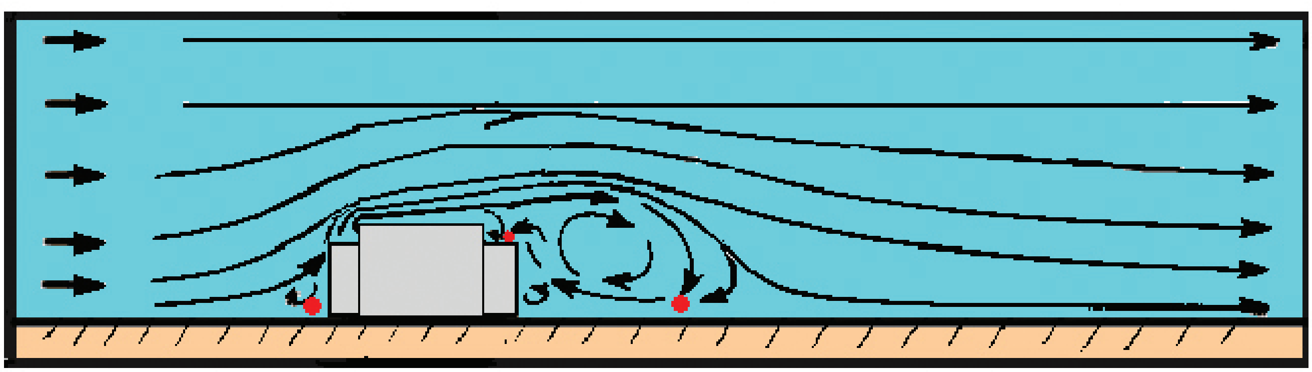


Flow Pattern: Top View Wind Against Edge



Urban Wind Flow Patterns With Various Simple Building Shapes and Spacings

The drawing below illustrates a multilevel peaked roof and how the snow will accumulate along the lower roof on the leeward side of the elevated peak.



IN CONCLUSION

As you can now see selecting the correct location for a single sensor depends on a great number of variables and needs to be carefully considered, even then the activation of the sensor may be affected by unexpected wind patterns. For this reason it is advantageous to place several sensors in locations that not only account for the "normal" wind patterns but also for that occasional "Nor Easter" that comes along.

Regardless of the number of sensors each snow sensor should be installed so that it will be higher than the maximum depth of anticipated drifts so the sensor will not be buried. Burying a sensor can cause it to be non responsive due to the igloo effect. This is caused when the moisture grid heaters melt snow above it causing a cave above the buried sensor. At this point no further moisture can reach the grid to be detected.

While this paper cannot give you exact locations to place your snow sensors it is the authors hope that by providing the informational tools you will have a better understanding and will be able through observation to select the best location possible.

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REFERENCES

codymcdougald09-10.wikispaces.com/Geography+Units+ (latitude and wind)
jc.tech-galaxy.com/bricka/climate_cookbook.html (Highs and Lows)
www.islandnet.com/~see/weather/graphics/photos0708/map1.jpg (snow of 67)
ww2010.atmos.uiuc.edu/(Gh)/guides/mtr/cyc/upa/jet.rxml (jet stream)
w1.weather.gov/data/obhistory/KSBN.html (national weather service)
plone.airfire.org/wfdss-aq/help/raws-wind-roses (wind roses)
en.wikipedia.org/wiki/Types_of_snow (snow types)
www.llnl.gov/str/October01/Lee.html (building effects)
www.islandnet.com/~see/weather/elements/citywind.htm

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