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SNOW (PART I)

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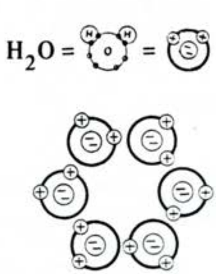
Introduction

When most of us think of snow, we think of snowmobiling, skiing, shovelling or poor driving, but there is much more to snow than this. Have you ever really looked at snow? Do you know how many sides a snowflake has? In 1611, Johannes Kepler, the famous mathematician, observed snow and wrote the following:

> "Just then, by happy chance, water-vapor was condensed by the cold into snow, and specks of down fell here and there on my coat, all with six corners and feathered radii.
>
> There must be some definite cause why, whenever snow begins to fall, its initial formations invariably display the shape of a six-cornered starlet. For if it happens by chance, why do they not fall as well with five corners or with seven? Why always six, so long as they are not tumbled and tangled in masses of irregular drifting, but still remain widespread and scattered?"

Johannes Kepler never solved the mystery of six-sided snowflakes. Later, closer observation indicated that the hexagonal shape is an outward, macroscopic manifestation of the internal arrangement of the atoms of ice. This arrangement is caused by a special force known as hydrogen bonding (Fig. 1). This is just one of several things that can be learned by observing snow. Other questions such as, "How is snow produced?" and "What physical factors affect snowfall?" are topics to be discussed in the remainder of this article.



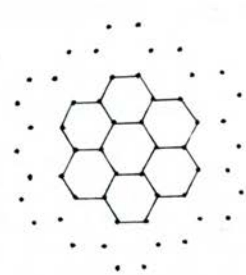


Fig. 1.

Hydrogen Bonding — Leads To — Hexagonal Arrangements

The Birth of a Snowflake

Snow crystals grow within a cloud that has been formed by the convection of warm air rising through a layer of cold, dry air (Fig. 2). Ascending air, however, does not condense into ice upon reaching the ice condensation level of the cloud, since foreign particles must be present to act as a nucleus of growth for a water droplet. Instead, the water vapor continues to rise to the water condensation level where it condenses into ice on dust particles and a crystal is formed. Other water-vapor molecules coming into contact with the ice crystal condense causing the dendritic branchings of the snowflake and increasing its size.

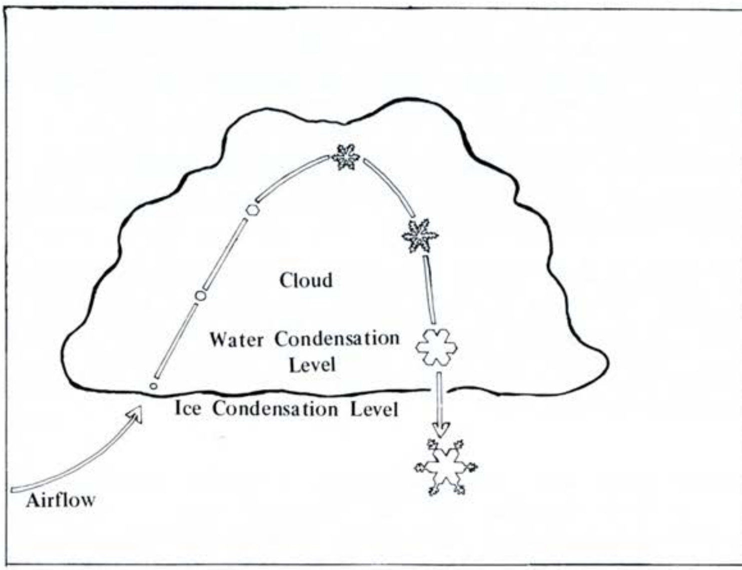


Fig. 2. Birth of a snowflake.

Not all snowflakes are exactly the samė shape, but if it is a white snow crystal, the face of the snow crystal can be oriented only with respect to the hexagonal lattice of the ice molecules of which it is composed (Fig. 3).

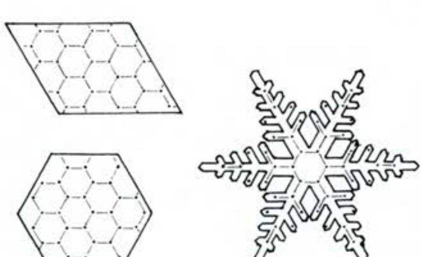


Fig. 3. Crystalline arrangement.

As the snowflake enlarges, it falls and begins to collide with other water molecules increasing its size. The average speed of fall for a snowflake is approximately 2.0 to 3.5 mph under windless conditions. The largest snow crystal known to man was 15 inches wide and 8 inches thick. On the average, however, it takes about 5000 snowflakes to fill a two-inch cube.

The growth process is called *riming*. As the crystal continues to grow it drops below the condensation level of the cloud on its way to the ground. Depending upon environmental conditions the ice crystals can take on many different forms. Some forms are shown in Fig. 4.

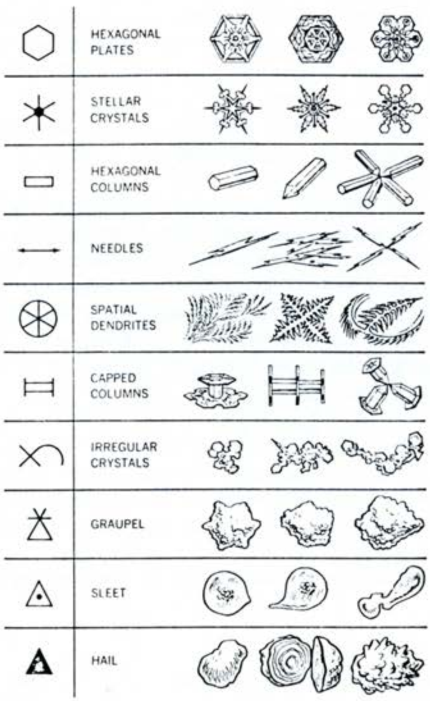


Fig. 4. International Snow Crystal Classification System.

Eventually the snowflake rests upon the ground. The most snow recorded during a single storm was 175.4 inches, (Dec. 26-31, 1955) at Thompson Pass, Alaska. The most snow cover ever recorded was 300 ft. at Tavy Cleave, England. The most snowfall in a season was 1014 inches, during the 1970-71 winter, at Mr. Rainer Park, Washington.

Factors Affecting Snowfall

Snowflakes seldom sit still for observation when they strike the ground. Like other particles on the earth's crust they are subject to the physical forces within their environment.

Wind

Wind plays an important role in the movement and deposition of snow. Three distinct types of wind effects have been identified; they are wind erosion, wind transport and wind deposition.

Wind erosion is caused by *deflation, abrasion* or *attrition*. Deflation reduces snow cover in an area by lifting and entraining loose particles of snow from an exposed area. *Abrasion* involves the sandblasting of snow carried by the wind, etching elongated grooves or furrows in snow structures in the direction of the prevailing winds. *Attrition* involves the mutual wear of particles being carried by the wind. Attrition is next to impossible to observe, while deflation and abrasion are easily observed.

Wind transports snow by *suspension, saltation* and *surface creep*. *Suspension* occurs when snowflakes are lifted upwards in a twisting fashion via turbulent eddies. Such transport is usually associated with deflation and is the primary method of snow transport. *Saltation* is the rebounding a snowflakes off of the snow surface. High winds are required for this type of transport. *Surface creep* results when a saltating particle strikes another surface particle causing it to move forward. Surface creep results in a rippled surface on some snow structures.

Snowflakes deposited by the wind can be deposited in such a manner as to form several types of snow structures. As mentioned before *ripples* (Fig. 5) are produced by surface creep. The ripples have crests and troughs that run at right-angles to the wind. The ripple length (which is measured from crest to crest) depends upon wind velocity. At 15 mph, ripple length will measure from 25.0 – 30.0 cm, while at 30 mph the distance increases to between 2.4 to 3.0 meters.

Fig. 5. Snow ripples.

Snow shadows are produced when snow accumulates in the lee of an obstruction (Fig. 6) such as a shrub or a car. The maximum height of a snow shadow will be the height of the obstruction.

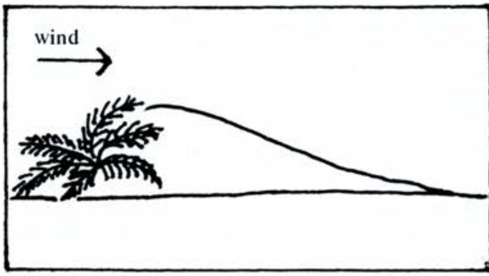


Fig. 6. Snow shadow.

Snow drifts are formed in the lee between two obstacles. The gap serves as a funnel through which snow trails out to the lee forming a drift which gradually grows downwind to become a long-tapered, sharp-crested ridge (Fig. 7). The crest is at right-angles to the wind and bends away from the wind.

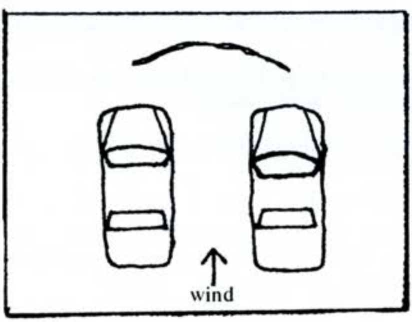
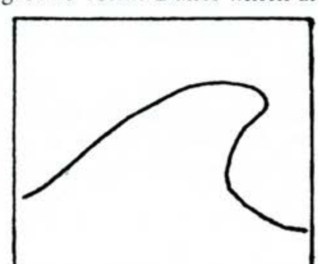


Fig. 7. Snow drift.

Snow dunes, unlike snow drifts and snow shadows, are not formed as a result of an obstruction. They are mobile heaps of snow (Fig. 8) which are produced independent of ground form. Dunes which are crescent shaped and

Fig. 8.
Snow dune.



have their tips extending leeward are called *Barchan dunes*. Dunes with their curvature to the windward direction are called *parabolic dunes*.

Light

Light is another factor which influences snow cover. Freshly fallen snow is white and reflects 90% of the incident light. If snow is covered by dust or other dark particles, light is absorbed and heat is produced. The heat produced is transferred to the snow causing it to melt.

Pressure

Pressure also influences snow cover. When pressure is placed on snow, the compressed snow turns to ice. This can be observed in driveways where car tires have been driven over the snow.

Suggested Activities

Some activities that can be done to demonstrate the principles discussed in this article are as follows:

1. Cut hexagonal snowflakes from white paper folded in sixths.

2. Study snow crystals under a microscope (see page 24).

3. Photograph various kinds of snow structures. Predict the direction of the wind that produced these structures.

4. Take a field trip and note the ways human activities affect the snowcover.

5. Take two fruit juice cans of the same size. Spray one with black paint and the other with white. Place the cans on snow cover on a sunny day and observe what happens. Explain.

Conclusion

Hopefully, as a result of this article, your next encounter with snow will be more meaningful. As you walk through snow cover you should realize that you, also, are an important agent in its change. This is particularly true if you are riding in a snowmobile.

The alterations in snow characteristics brought about by snowmobiling are significant. For example, the average depth of snow beneath a snowmobile tread is reduced significantly, and the heat conductivity of the ice formed is from four to nine times greater than the original snow cover. Underlying vegetation can be damaged directly and indirectly by altering the insulative blanket of snow. Mice and vole populations are reduced for the same reasons. This, in turn, affects the wildlife dependent upon these creatures for food. It should be evident that alterations of the snow cover can affect animal and plant life, a topic to be discussed in greater detail in Snow (Part II). Until then, avoid driving snowmobiles in parks and natural areas unless trails have been approved for this purpose. Thoughtless use of these areas in the winter will spoil them for enjoyment in the summer.

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Iowa Snow Facts

Heaviest 13 Hour Snowfall: 24.0 in. – Northboro (Page County)

Heaviest Single Storm: 30.8 in. – Rock Rapids – February 17-21, 1962

Snowiest Month: 42.0 in. – Osage and Northwood – March 1951

Snowiest Month (State Average): 23.2 in. – March 1951

Snowiest Season: 90.4 in. – Northwood – 1908-09

Snowiest Season (State Average): 59.0 in. – 1961-62

Iowa's earliest snowfall was September 25, 1942 – amounts upward to 4 inches were measured at Mason City, Forest City, Allison and Millerton

Iowa's latest snowfall was May 28, 1947 – amounts up to 8 inches at Cherokee and 7.5 inches at Waukon

The word blizzard first appeared in print in the *Estherville Vindicator* to describe a storm that swept across the Dakotas and Iowa March 14, 1870

Worst Snowfall in Western Iowa: January 12, 1888

Worst Snowfall in Eastern Iowa: December 31, 1863 – January 1, 1864

From the pamphlet *Iowa's Weather* (1977) by Paul Waite, State Climatologist