SNOW FACTS SHEET

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Have you ever looked at a snowflake and wondered how it formed or
Why it looks different from other snow you might have seen?

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1. Formation

Snowflakes are a particular form of water ice. Snowflakes form in clouds, which consist of water vapor. When the temperature is 0° C or colder, water changes from its liquid form into ice.

Several factors affect snowflake formation: temperature, air currents, and humidity all influence shape and size. Dirt and dust particles can get mixed up in the water and affect crystal weight and durability. The dirt particles make the snowflake heavier, and can cause cracks and breaks in the crystal and make it easier to melt. Snowflake formation is a dynamic process. A snowflake may encounter many different environmental conditions, sometimes melting it, sometimes causing growth, always changing its structure.

The life of a snowflake begins high in Earth's atmosphere and if the snowflake is very lucky it might reach the ground. We'll see the requirements in the next section.

A snowflake begins when a tiny dust or pollen particle comes into contact with water vapour high in Earth's atmosphere. The water vapour coats the tiny particle and freezes into a tiny crystal of ice. This tiny crystal will be the "seed" from which a snowflake will grow.

Water molecules join together in a rigid pattern – a tiny ice structure that's the heart of a snow crystal. The crystal grows by continuing to collect water vapour and by the attachment of water droplets to its surface.

The newly-formed ice crystal (snowflake) is heavier than the surrounding air and it begins falling. As it falls towards Earth through humid air more water vapour freezes onto the surface of the tiny crystal. This freezing process is very systematic. The water molecules of the vapour arrange themselves so that the hexagonal crystal structure of ice is repeated.

2. Will it be snow, sleet or freezing rain?

The formation of snowflakes high in the atmosphere does not guarantee snowfall on the surface.
The type of precipitation reaching the surface depends on the temperature profile of the atmosphere.

a. Snow

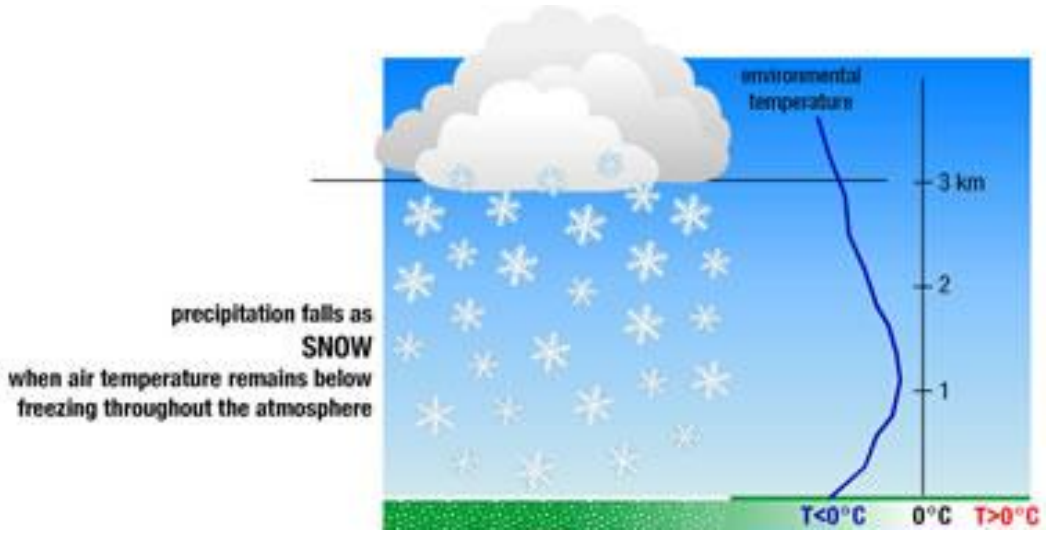


Figure 1: Temperature profile leading to snow

Snowflakes will reach the ground if air temperatures are below freezing all the way down.

b. Sleet

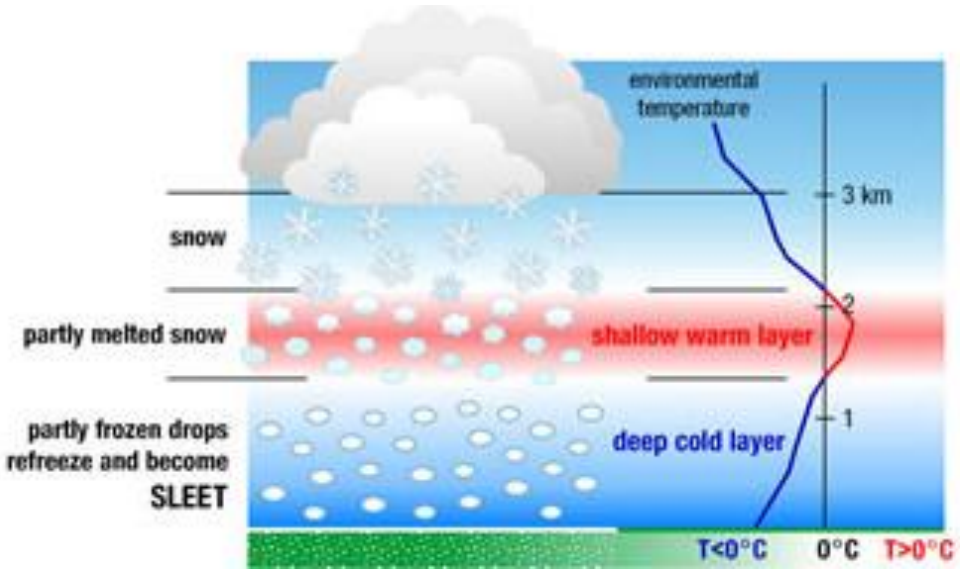


Figure 2: Temperature profile leading to sleet

If the snowflakes pass through a thin warm layer of air they could experience partial melting. When they exit the warm air they will refreeze on the way down in the form of tiny ice pellets.

c. Freezing rain

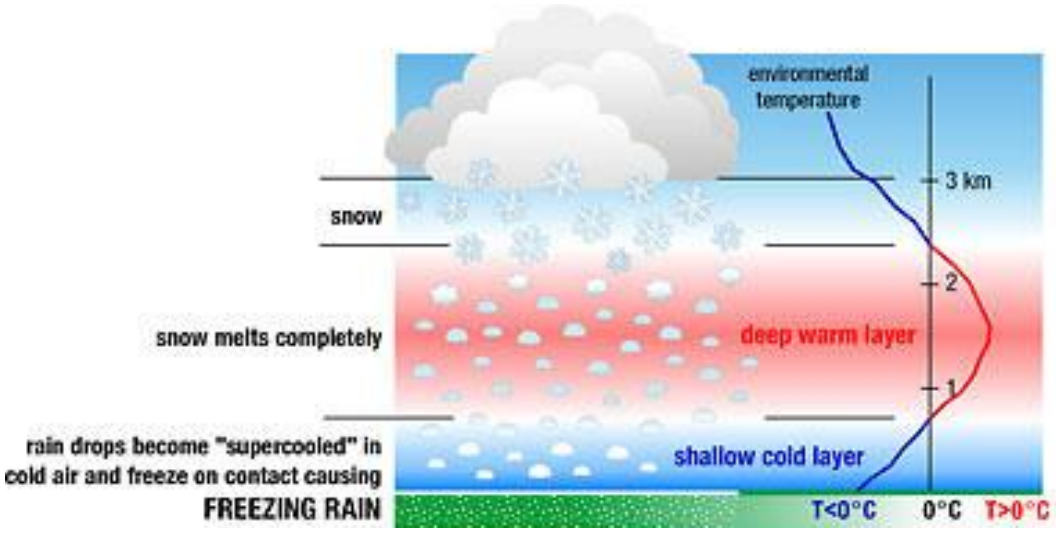


Figure 3: Temperature profile leading to freezing rain

If the snowflakes pass through a layer of warm air that is thick enough to melt them completely and then land on a cold surface, the result could be freezing rain.

3. Shape

a. Moisture, temperature dependency

The shape of snowflakes is influenced by the temperature and humidity of the atmosphere. The unlimited number of variations results in a myriad of different shapes.

Observations show that the most intricate snowflake patterns are formed when there the air is moist. Snowflakes produced in drier conditions tend to have simpler shapes.

Temperature also has a large effect on the formation of snowflakes. Snowflakes formed in temperatures below –22° C consist primarily of simple crystal plates and columns whereas snowflakes with extensive branching patterns are formed in warmer temperatures.

The following figure illustrates this:

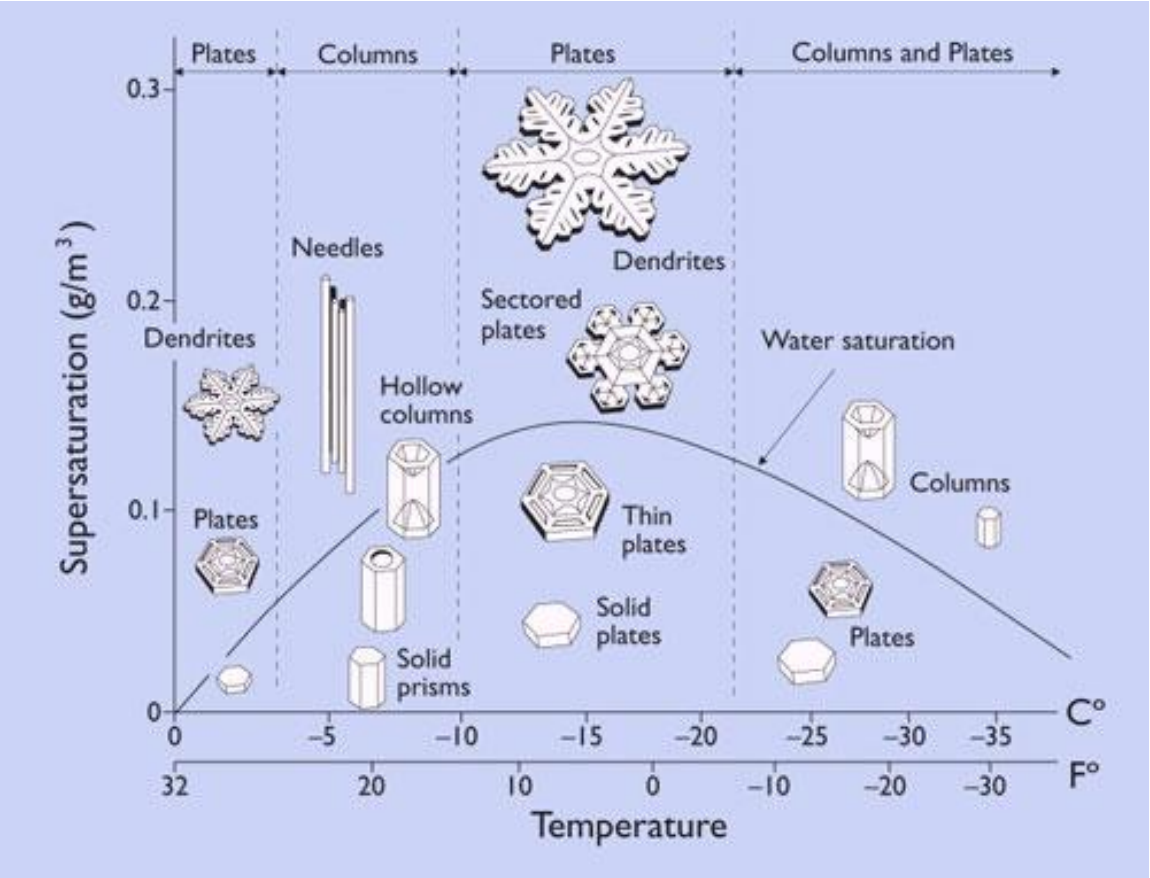


Figure 4: Effects of temperature and humidity on snowflake formation

The most intricate snowflake patterns are then typically formed during warm and wet conditions.

A collection of snowflakes is shown below. Notice how very different they can be:

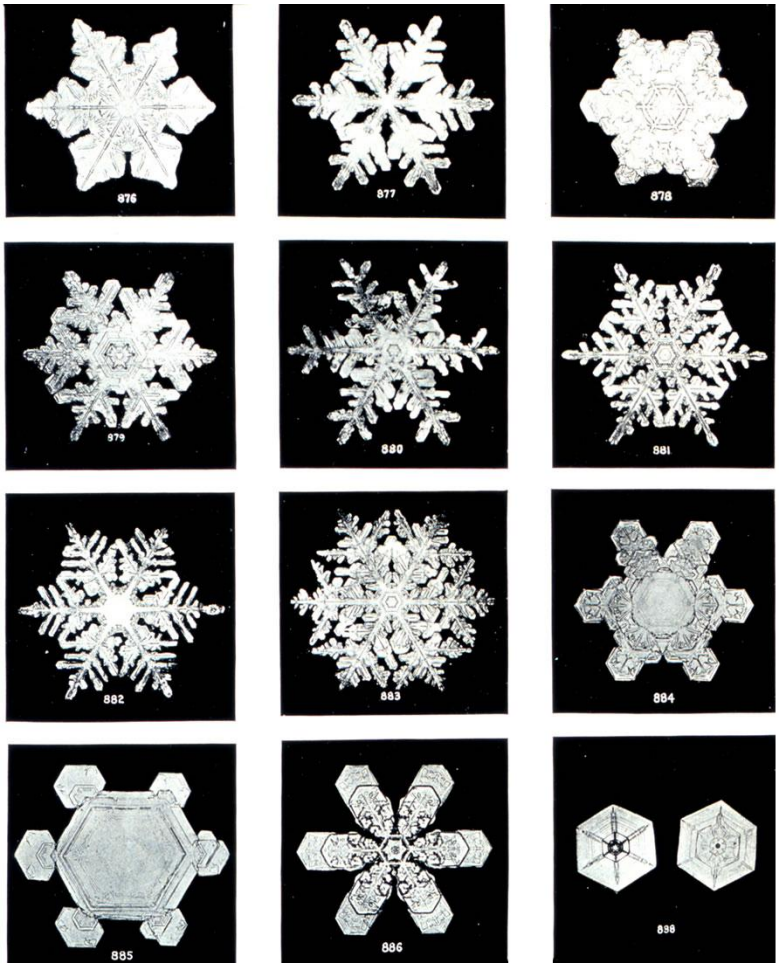


Figure 5: Snow flake shape

b. Why are snowflakes symmetrical?

Not all snowflakes are the same on all sides. Uneven temperatures, presence of dirt, and other factors may cause a snowflake to be lop-sided. Yet it is true that many snowflakes are symmetrical and intricate. This is because a snowflake's shape reflects the internal order of the water molecules.

Water molecules in the solid state, such as in ice and snow, form weak bonds (called hydrogen bonds) with one another. These ordered arrangements result in the symmetrical, hexagonal shape of the snowflake. During crystallization, the water molecules align themselves to maximize attractive forces and minimize repulsive forces. Consequently, water molecules arrange themselves in predetermined spaces and in a specific arrangement. Water molecules simply arrange themselves to fit the spaces and maintain symmetry.

c. Is it true that no two snowflakes are identical?

Yes and no. Technically, no two snowflakes are *exactly* identical, down to the precise number of water molecules, spin of electrons, isotope abundance of hydrogen and oxygen, etc.

On the other hand, it is possible for two snowflakes to look exactly alike and any given snowflake probably has had a good match at some point in history. Since so many factors affect the structure of a snowflake and since a snowflake's structure is constantly changing in response to environmental conditions, it is improbable that anyone would see two identical snowflakes.

d. If water and ice are clear, then why does snow look white?

The short answer is that snowflakes have so many light-reflecting surfaces they scatter the light into all of its colors, so snow appears white. The longer answer has to do with the way the human eye perceives color. Even though the light source might not be truly 'white' light (e.g., sunlight, fluorescent, and incandescent all have a particular color), the human brain compensates for a light source. Thus, even though sunlight is yellow and scattered light from snow is yellow, the brain sees snow as white because the whole picture received by the brain has a yellow tint that is automatically subtracted.

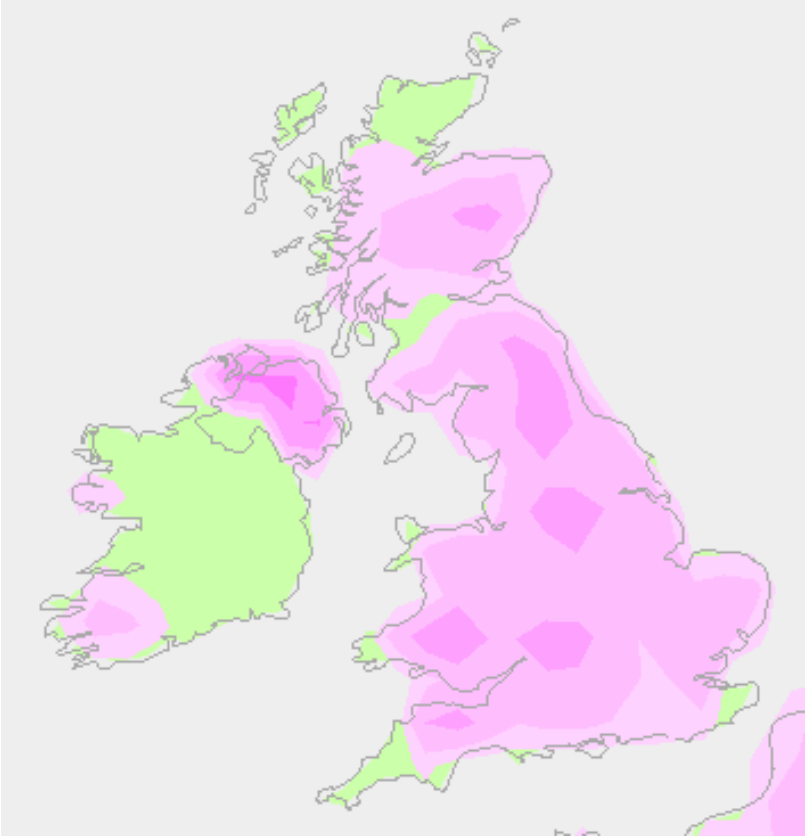
e. 'Wet' snow vs. 'dry' snow

Snowflakes that fall through dry, cool air will be small, powdery snowflakes that don't stick together. This 'dry' snow is ideal for snow sports but is more likely to drift in windy weather.

When the temperature is slightly warmer than 0 °C, the snowflakes will melt around the edges and stick together to become big, heavy flakes. This creates 'wet' snow which sticks together easily and is good for making snow men.

4. What is the mass of snow that actually falls?

Let's assume that most of the UK is covered by an average of 1 cm snow depth:



The UK has an area of 229,848 km^2. That gives a volume of 2.298×10^9 m^3
The snow has an average density that is $1/10^{th}$ that of water, hence 100 kg/m^3

The total mass is therefore: 2.298×10^{11} kg or **230 million tons**! That is a lot of snowflakes!
