The Nature of Winter: The Artistry of Jack Frost

Winter is here once again, and the beauty of nature has become more subtle and fleeting. For those with a careful, curious eye, nature provides a canvas of feathery, crystalline designs in the form of frost.

Photo by RC Grimsley, 2009

Hoar frost, or plain frost, forms when water vapor changes from its gaseous state directly to its solid state of ice when it comes into contact with surfaces that are below 32 degrees. Once a "seed" has been established on a surface, super-cooled water vapor particles are slowly deposited as crystals. Frost frequently forms a delicate white film on the outside of car hoods and windshields, as well as on the inside surface of houses with old windows. (If your house windows have a lot of frost, you probably need to replace your windows, as they are inefficient and letting in a lot of cold from the outside.) Rime frost is a thicker, less organized form of ice build-up. Rime frost occurs when very humid air encounters very cold surfaces. It is typically white and lumpy due to its relatively quick formation. Rime frost is much more common in conditions of high wind. (Think about the towers at Mt. Washington.)

Frost is different from dew and black ice in that frost does not pass through a liquid state as it adheres to a surface. Dew forms when there is more water vapor than air hold at a certain temperature, so it condenses out of the air and onto a surface. Warm air can hold more water vapor, while cool or cold air has a lower capacity. Black ice forms when rain, melted snow, mist, or fog freezes onto a surface. Unlike benign hoar frost, black ice can be treacherous for drivers and pedestrians who try to move across its slick surface.

Part of the beauty of frost comes from the fact that the crystalline patterns are fractals. Fractals are repeating units that are the same regardless of the level of magnification. Zooming in closely on a small piece of a fractal pattern looks the same as seeing the pattern on a large scale. Fractals are common in nature: snowflakes, frost, tree branching, nautilus shells in cross section, blood vessels in lungs, jagged coastlines, and watershed drainage patterns. In all these examples, the big picture looks very similar to its smaller parts.

One easy and common fractal in math is Koch's snowflake. Starting with an equilateral triangle, (step 1) divide one side of the triangle into three equal parts and remove the middle section. Replace it with two lines the same length as the

section you removed. Do this to all three sides of the triangle (step 2). Repeat this process for the sides of the six-sided star that results (step 3). Repeat for steps 4 and 5. (From Cynthia Lanius, http://math.rice.edu/~lanius/frac/koch.html, Copyright 1996-2007. This is also an excellent site for students who wish to learn more about fractals.)

step 1	step 2	step 3	step 4	step 5
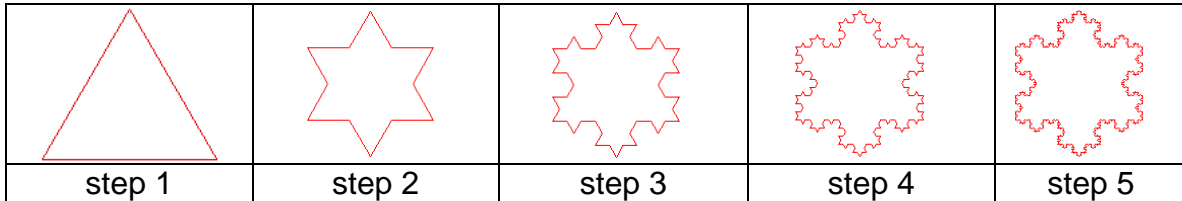
The next time you see a patch of frost, take a moment to look more closely at the intricate patterns. Use a magnifying glass to see if the big pattern appears at a smaller scale. Use your camera to record Jack Frost's work and send someone some warm greetings.

Sent with warm greetings from the Lamprey River Advisory Committee, advocates of the coolest and only Wild and Scenic River in southern New Hampshire, the Lamprey River. For more information, please visit us at www.lampreyriver.org.

Helping communities protect the Lamprey River