

## Snow Cover

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Snow cover is the term used to describe the accumulation of snow on the ground from snowfall. Snow cover is encountered over most of the middle and high latitudes of the northern hemisphere during the winter season and over many mountainous regions of the world for extended periods.

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The length of the snow-cover period varies each year and is dominated by the seasonal cycle. The extent of the snow-covered area in the northern hemisphere ranges each year from an average minimum of 3.6 million square kilometres in August, to an average maximum of 46.8 million square kilometres in late January (refer to the animation of the monthly snow cover extent in the northern hemisphere located at the bottom of this text).

### Importance of Snow Cover

Snow cover is important for several reasons. First, it represents a major storage of water, which is released during the spring-melt period. Knowledge of how much water is contained in snow cover (the snow water equivalent, or SWE) and the rate at which it melts is critical information for flood forecasting, agriculture and optimal management of water resources (for more information on *Freshwater*, see our maps on this subject). Semiarid regions, such as the Prairies and interior valleys of British Columbia, are especially dependent on snowmelt runoff, which can supply in excess of 80% of annual total runoff. Second, snow is an essential ingredient of many Canadian ecosystems because it provides an insulating layer and nutrient source that supports biological activity during the winter season. To give an example of how well snow insulates the ground, the mean January air temperature at Goose Bay, Labrador is -16.4 degrees Celsius, while the mean January soil temperature at 5 cm depth is only -2.1 degrees Celsius. Third, because of its high surface reflectivity (80 to 90% for new snow) and insulation properties, snow cover dramatically changes the energy exchange between the Earth's surface and the atmosphere. For example, studies have shown that mean air temperatures are typically 5 to 10 degrees Celsius colder when snow cover is present. This means that snow cover exerts a positive feedback on the climate system when a cold winter with an above-average snow-cover extent will act to reinforce the cold air temperatures. The converse is true for warm winters with less snow cover.

In Canada, the seasonal and spatial distribution of snow cover and its properties (snow depth, snow density and snow water equivalent) are related to a number of factors, such as the duration of the period with below-freezing air temperatures, the amount and characteristics of winter precipitation, and land-surface interactions involving terrain and vegetation cover.

## Properties of Snow Cover

### Snow Depth

Daily observations of the depth of snow on the ground have been made at most Canadian synoptic stations since the 1950s and at most climate stations since 1980. Unfortunately, the stations in the snow-depth network are mainly located in southern Canada (Figure 1) and do not adequately sample mountainous regions or high latitudes.

Snow-depth data are used extensively in applications such as regional climate monitoring, evaluation of climate models, roof snow load calculations for the National Building Code, snow-clearing contracts, winter survival of crops, biological studies and calculation of forest-fire severity.

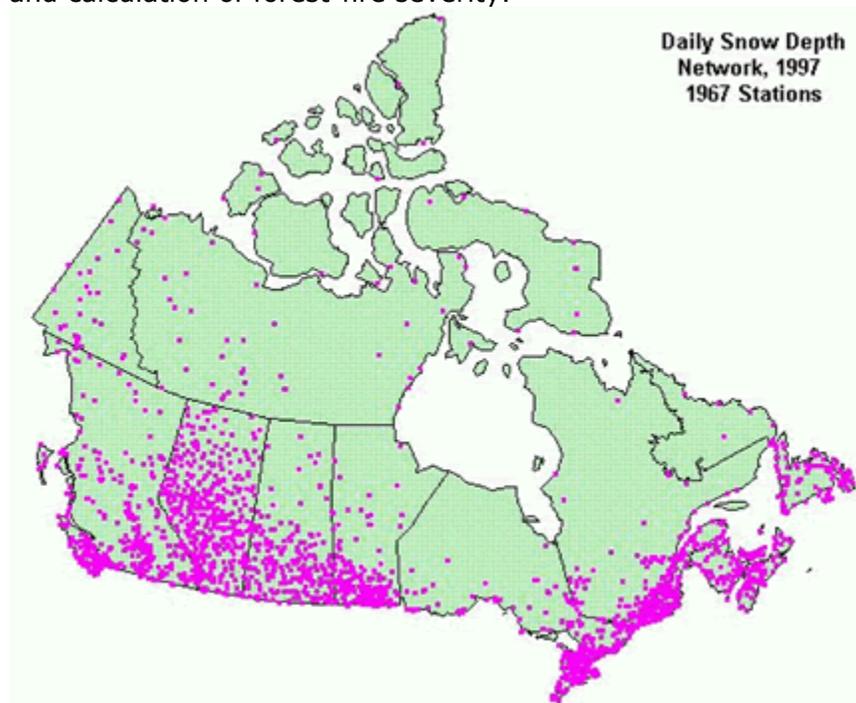


Figure 1: Canadian Snow Depth Observing Network in 1997  
Source: Environment Canada Meteorological Service.

## Snow Density

The density of snow (usually expressed in units of kilogram per cubic metre) is a measure of the mass per unit volume of snow, and is an indicator of the compactness of a snowpack. New snowfall typically has a density of around 100 kilograms per cubic metre, but this increases rapidly once snow is on the ground; winter snowpacks typically have mean densities in the 200 to 300 kilogram per cubic metre range. The density of a snowpack reflects the characteristics of the various snowfall events, as well as various processes, such as snow compaction and snow melt and refreeze cycles. Information on mean snow density is essential for determining the snow water equivalent of a snowpack, and knowledge of the vertical density structure is critical for avalanche-risk forecasting. Information on the density of the snow surface layer is important for assessing snow trafficability and potential for blowing snow.

Figure 2 shows mean snow density for March from available snow observations. The spatial pattern is characterized by higher snowpack densities in warmer coastal regions and lowest densities over the boreal forest zone.

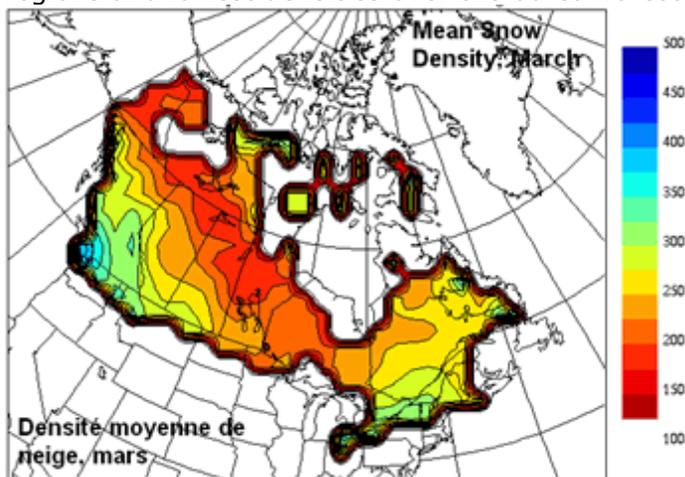


Figure 2. Mean Snowpack Density for March from Snow Course Data. Areas in white had no data or insufficient data to compute a mean.

Source: R.D. Brown, Meteorological Service of Canada, Environment Canada.

## Snow Water Equivalent

Snow water equivalent (SWE) is defined as the depth of water (in millimetres) of snow cover on a horizontal surface area if that snow cover is completely melted. SWE is related to snow depth and density by

$$\text{SWE (millimetres)} = \text{depth (metres)} \times \text{density (kilogram per cubic metre)}.$$

The conversion of SWE (millimetres) from a mass of snow per surface area to a depth of water is based on the fact that 1 millimetre of water spread over an area of 1 square metre weighs 1 kilogram.

A variety of surface-based and satellite methods can be used to measure SWE. The most commonly used approach for determining SWE is the gravimetric method, which involves taking a vertical core through the snowpack and weighing or melting the core to obtain the SWE.

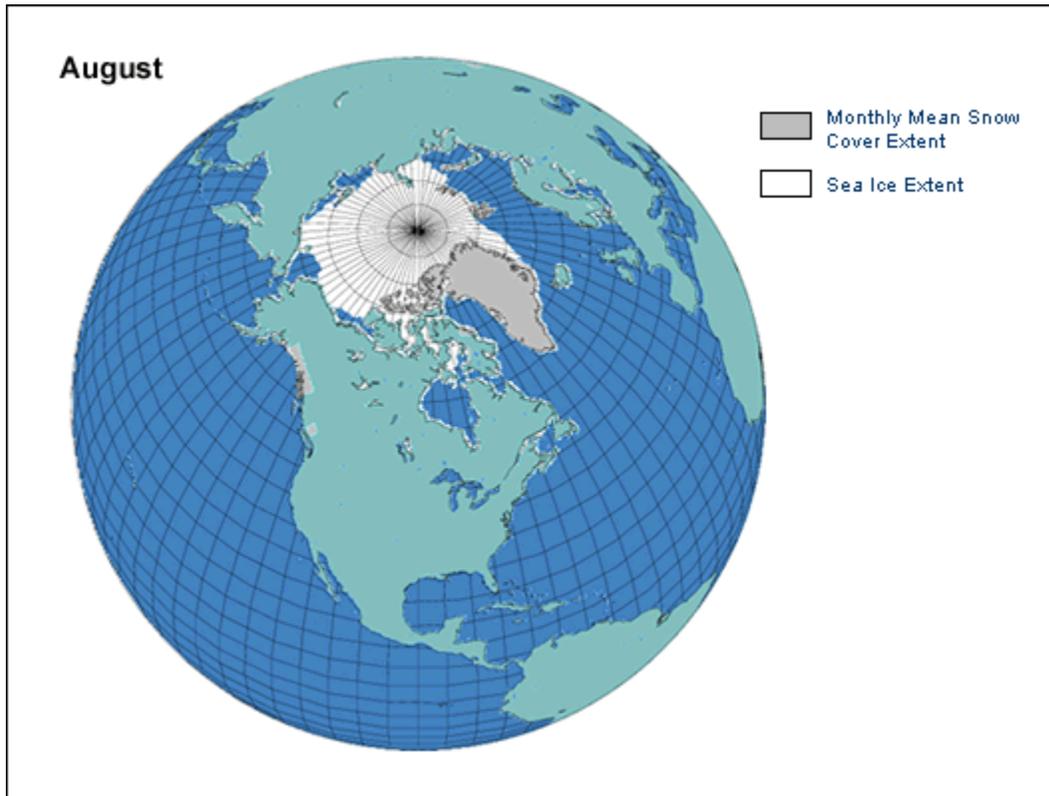


Figure 3. Scientist Using a Weighing Snow Sampler. The spring balance gives a direct reading of water equivalent in millimetres. The sample is bagged and subsequently weighed indoors when wind makes weighing difficult.  
Source: Barry Goodison, Meteorological Service of Canada, Environment Canada.

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## Animation of Monthly Mean Snow Cover

The animation, *snow\_cover\_extent\_animation\_e.gif* is located in the animated gif folder.



Animation of Monthly Mean Snow Cover Extent (grey) and Sea Ice Extent (white). Data derived from weekly snow and sea-ice cover data for the period 1971 to 1995. The data were taken from a dataset compiled by Armstrong and Brodzik (2002). The animation runs from August to August, which is the month with minimum snow cover extent in the northern hemisphere.

Source: R.D. Brown. 2002. Meteorological Service of Canada. Environment Canada.

## Definitions of underlined terms

**Snow depth:** The thickness of accumulated snowfall on the ground.

**Snowpack:** A horizontally layered accumulation of snow from snowfall events that remains on the ground for some period of time.

**Snow water equivalent:** The depth of water if a snow cover is completely melted, expressed in millimetres, on a corresponding horizontal surface area. (Colbeck, S., Akitaya, E., Armstrong, R., Gubler, H., Lafeuille, J., Lied, K., McClung, D. and Morris, E., 1990: The International Classification for Seasonal Snow on the Ground. International Commission on Snow and Ice (IAHS), World Data Center A for Glaciology, U. of Colorado, Boulder, CO, USA, 23 pp.)

**Synoptic stations:** Stations carrying out regular surface-weather observations on a 6-hourly or more frequent basis. Synoptic stations are usually located at airports and differ from climate stations in the greater number of variables observed and in the greater frequency of observations (climate stations usually make observations once or twice per day).

**Trafficability:** Capability of terrain to bear traffic. It refers to the extent to which the terrain will permit continued movement of any or all types of traffic. Source: McGraw-Hill Dictionary of Scientific and Technical Terms, Lapedes, D.N. (ed.). : McGraw-Hill, New York, Montréal, 1976.