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# Recent Variations in Northern Hemisphere Snow Cover Extent

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## Abstract

No consistent trends in Northern Hemisphere winter snow cover extent are evident in a two decade NOAA record of satellite derived data (figures). However, several periods of positive and negative departures from the 20-year average are found across the middle and high latitudes, an area encompassing over half of the land in the Northern Hemisphere. The mid- to late-1970s and the mid-1980s had large snow cover areas. The early 1980s and the period since 1987 are characterized by low snow cover extent. General snow cover retreat during the second half of the hydrologic year (April-September) has been observed during the past 20 years.

## Relevance

Across the middle and high latitudes of the Northern Hemisphere, the impact of snow on humans and the environment is considerable. Falling snow or snow on the ground influences hydrologic, biologic, chemical, and geologic processes at and near the surface of the earth. Snow impacts activities as diverse as engineering, agriculture, travel, recreation, commerce, and safety. For instance, an excessive amount of water held in a regional snow pack may lead to spring flooding, while conversely, a meager snowpack may result in subsequent water shortages for drinking, industry and agriculture.

## Results

Of the 68 months between August 1987 and March 1993, only 8 had above normal snow extent (three of these 8 were September, November and December 1992). Negative departures during the recent prolonged period of low extent have been most pronounced in spring, and winter cover has shown the least variation. Year-to-year anomalies in snow extent over Eurasia are similar to those in North America.

The reduced snow extent in recent years has coincided with some of the warmest temperatures of the past century. A striking relationship between hemispheric snow extent and surface air temperature has been observed over the past two decades. Correlations are strongest over North America and western Europe. Spring (April-May) snow extent appears to have an exceptional influence on the radiation balance over Northern Hemisphere extratropical land areas. It is also interesting to note that last fall's above average snow extent occurred during a period of below normal surface air temperature (the temperatures are likely to be associated with the earlier eruption of Mt. Pinatubo).

## Data Quality

In 1966, NOAA began to map snow areas in the Northern Hemisphere on a weekly

basis. Charts are based on a visual interpretation of photographic copies of shortwave imagery by trained meteorologists. Charting improved considerably in 1972 with increased spatial resolution in the satellite sensors commonly used to measure snow; chart quality has remained relatively consistent since that time.

Most studies of snow extent use monthly values computed from weekly totals. An undocumented change in the procedure used by NOAA to calculate monthly extent occurred in 1981. At Rutgers University, a new, consistent methodology was developed that calculates weekly areas and weights them according to the number of days of a chart week falling in the given month. A chart week is considered to center on the fifth day of the published chart week. The Rutgers methodology is currently the only one that employs this weighting and has a standard land grid throughout the period of record. NOAA implements much simpler procedures for operational work, but the difference in data processing between the Rutgers and NOAA is negligible.

## Pre-satellite Data and the Future

In order to place recent fluctuations of snow cover extent into historical perspective, one must rely on station observations. Ongoing efforts are leading to the creation of historical snow cover data sets covering many portions of the Northern Hemisphere extratropical lands. Analyses of such data over the Great Plains of the U.S. find considerable variability in the duration of seasonal (September-May) snow cover during the last century. A statistically significant trend towards a greater duration of snow cover from 1910-1988 shows a region-wide average of 29 days early in the century increasing to 38 days in recent decades. Variability of snow cover duration from year to year has also increased, and fluctuations appear to be associated with changes in both snowfall and temperature.

In addition to examining past data, attention must be paid to improved techniques for snow cover monitoring now and in the future. Efforts should focus on the development of methodologies that integrate visible and microwave satellite and station data into snow extent and snow water equivalent products. However, it is imperative that the current weekly NOAA snow charts continue to be produced in their present form until such time that intensive intercomparisons with any new product have been completed.

## Illustrations


**Use the scroll bar and arrow buttons to view the images.**

Figure 1. 1972-1992 Northern Hemisphere snow cover climatology. The percent of time with snow cover is indicated by red (5-25), yellow (25-50), green (50-75), light blue (75-95), and dark blue (more than 95).


**Use the scroll bar and arrow buttons to view the images.**

Figure 2. Interannual standard deviations of the probability of the presence of snow on the ground. Green, .15-.20; light blue, .20-.25; violet, more than .25.


**Use the scroll bar and arrow buttons to view the images.**

**A**


**Use the scroll bar and arrow buttons to view the images.**

**B**

Figure 3. Differences in the percent of time with snow cover between a) 10 cold minus 10 warm years in northern extratropical lands and b) the 5 coldest minus 5 warmest years in northern extratropical lands. The years are from the period October 1972 to September 1992. Red, less than -5; light blue, 5-15; dark blue, more than 15.

## References

Barnett, T.P., L. Dumenil, U. Schlese, E. Roeckner, and M. Latif, 1989: The effect of Eurasian snow cover on regional and global climate variations. J. Atmos. Sci., **46**, 661-685.

Barry, R.G., 1985: The cryosphere and climate change. Detecting the climatic effects of increasing carbon dioxide. DOE/ER 0235, U.S. Dept. of Energy, pp., 109-148.

Dewey, K.F. and R.R. Heim, Jr., 1982: A digital archive of Northern Hemisphere snow cover, November 1966 through December 1980. Bull. Amer. Meteor. Soc., **63**, 1132-1141.

Gutzler, D.S., and R.D. Rosen, 1992: Interannual variability of wintertime snow cover across the Northern Hemisphere, J. Clim., **5**, 1441-1447.

Karl, T.R., P.Y. Groisman, R.W. Knight, and R.R. Heim, Jr., 1993: Recent variations of snow cover and snowfall in North America and their relation to precipitation and temperature variations. J. Clim., **6**, 1327-1344.

Robinson, D.A., K.F. Dewey and R.R. Heim, Jr., 1993: Global snow cover monitoring: An update. Bull. Amer. Meteor. Soc., **74**, 1689-1696.

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## See Also

Climatological Aspects of the Large-Scale U.S. Hydrologic Cycle

Precipitation Increase in the Northern Hemisphere Extratropics

Regional Temporal Trends of U.S. Precipitation

Spatial Comparability of the Palmer Drought Severity Index