Acquisition and Use of Snow Water Equivalent Data at the Northeast River Forecast Center

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ABSTRACT

Snow Water Equivalent (SWE) data is a critical element in the operations at the Northeast River Forecast Center (NERFC). It is used to update the snow model states within the river forecast model. The river model is used to forecast river levels across the Northeastern United States. The SWE is also used to generate graphical displays, which are used for many purposes, including, assessing the flood potential during the spring freshet. The collection of the SWE data requires a collaborative effort amongst many cooperating agencies at various levels of government, private businesses and civic-minded citizens. Measurement techniques vary from airborne snow surveys to point measurements. The following paper will further describe the snow data network in the Northeastern United States, and how the data is utilized by the NERFC.

INTRODUCTION

The Northeast River Forecast Center is responsible for the issuance of river stage forecasts and flood guidance for a large portion of New York State and all of New England. During the winter and spring seasons, a snow observation network is essential for NERFC operations. The snow observations, collected by many sources, aid in the preparation of river forecasts and guidance. Snow Water Equivalent data is very useful in allowing the NERFC to update model states within its snow simulation computer model. Other snow parameters like recent snowfall and snow depth also play an important role.

Snow data is posted on a daily basis on NERFC's website. The snow maps not only help water agencies in their planning purposes but are also used by many other interested citizens.

THE NORTHEAST RIVER FORECAST CENTER

The NERFC is one of thirteen River Forecast Centers (RFC) (figure 1) established by the Federal Government within the National Weather Service (NWS). RFCs throughout the country prepare hydrologic forecasts for all the major rivers within the Nation, and also issue guidance for small streams. The NERFC located in Taunton, Massachusetts has the responsibility for issuing hydrologic forecasts and guidance for the St. Lawrence River drainage within New York State and New England; the Hudson River Basin above the Passaic River of New Jersey; and all of the remaining drainages within the New England States.

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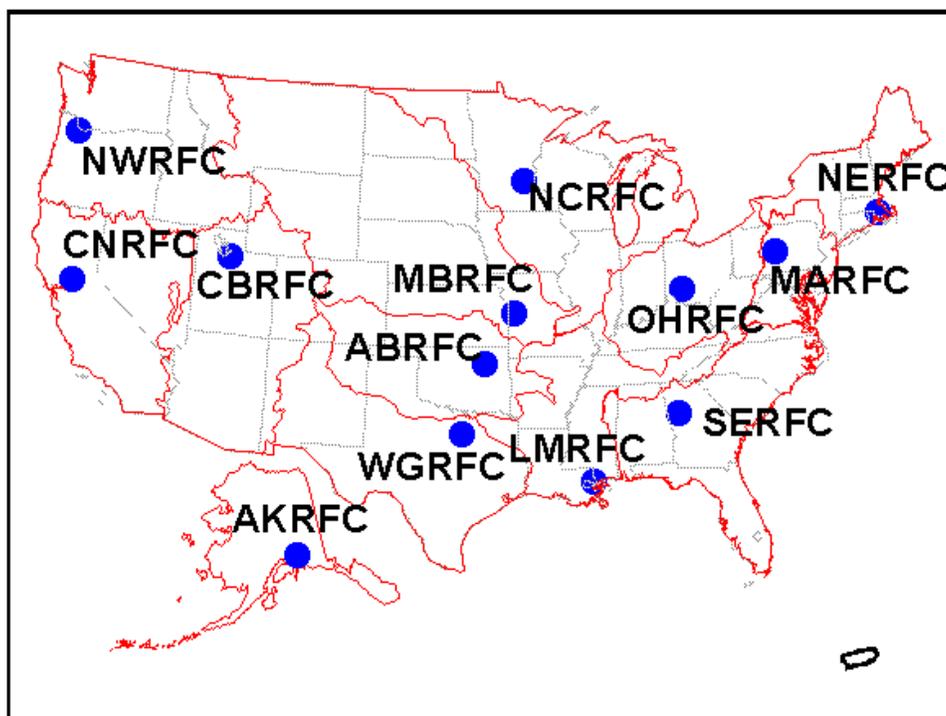email: Thomas.Econopouly@noaa.gov

Figure 1. The Nation's River Forecast Centers.

NWSRFS AND SNOW-17

The NERFC, like all RFCs, relies on the National Weather Service River Forecast System (NWSRFS) to perform its forecast function. NWSRFS is a suite of programs and techniques that is used for data preparation, model calibration, and modeling/forecasting of river basins.

SNOW-17 (Anderson, 1973) is a component within NWSRFS that simulates the accumulation and ablation of snow. SNOW-17 uses surface air temperature as the sole index for energy exchange at the snow–air interface. Although the energy exchange at the snow–air surface is greatly simplified by SNOW-17, surface air temperature has been shown to be a reliable index for aerial snow cover energy exchange. Other advantages of using air temperature are that it is very easily measured and does not vary across the landscape as much as other meteorologic variables.

There are situations when air temperature is not a good index of energy exchange at the snow–air surface. They include: (1) clear, cool periods after the snow has ripened, (2) windy periods with dew points well above 0° C, (3) abnormally warm, but calm periods. The first two cases under-forecast snowmelt; and the last case over-forecasts it.

Precipitation type, whether it's rain or snow, is determined in SNOW-17 by a threshold temperature. If the temperature is greater than the threshold, usually 0.6^o C, the precipitation is considered to be rain, otherwise it's snow. This simplification often causes the mistyping of the precipitation.

NWSRFS allows forecasters at the NERFC to make modifications to model states when they are in error. For example, if SNOW-17 is simulating 5.0 inches of water equivalent over a basin, and measurements reveal the water equivalent is really 2.0 inches, the forecaster can update the water equivalent in that basin and make it equal to 2.0 inches. Likewise, if the model determines that precipitation has fallen as rain and observations indicate that it was snow, then forecasters can make the appropriate adjustment to change the model precipitation to snow.

SNOW DATA COLLECTION

To regularly check and update SNOW-17, measurements of snow fall, snow depth and SWE need to be made across the Northeastern United States. The NERFC has access to over 300 daily reports of snowfall and snow depth (figure 2). Reports come from NWS Cooperative Observers and Spotters. Most of the observers make their measurements at 7 am. Snow fall measurements are for the 24 hour period ending at the time of observation.

SWE is measured by many local, state, and federal water agencies along with electric utilities, industry, and civic-minded citizens. In total, there are approximately 550 such locations within the NERFC area of responsibility (figure 3). The major cooperators in this endeavor along with the NWS are the: Army Corps of Engineers–New England Division; Maine Geological Survey; United States Geologic Survey; Pacific Gas and Electric; Hudson River–Black River Regulating District; New York State Canal Corporation; and the Northeast Regional Climate Center.

SWE measurements are made at least biweekly beginning in January and continue until there is no longer a significant amount of snow on the ground. Measurements are made in the beginning of the week from Monday through Wednesday. A graphic of the SWE is also posted on the NERFC website.
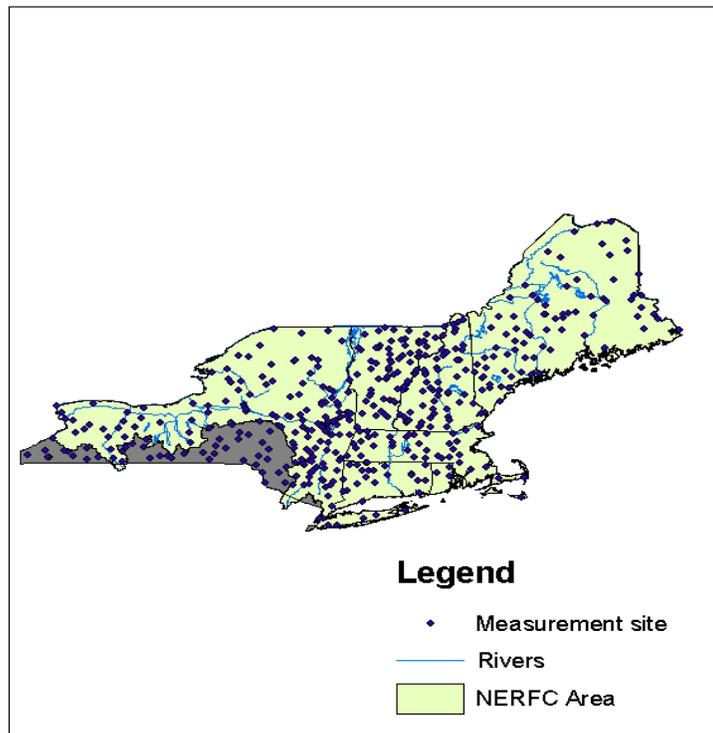

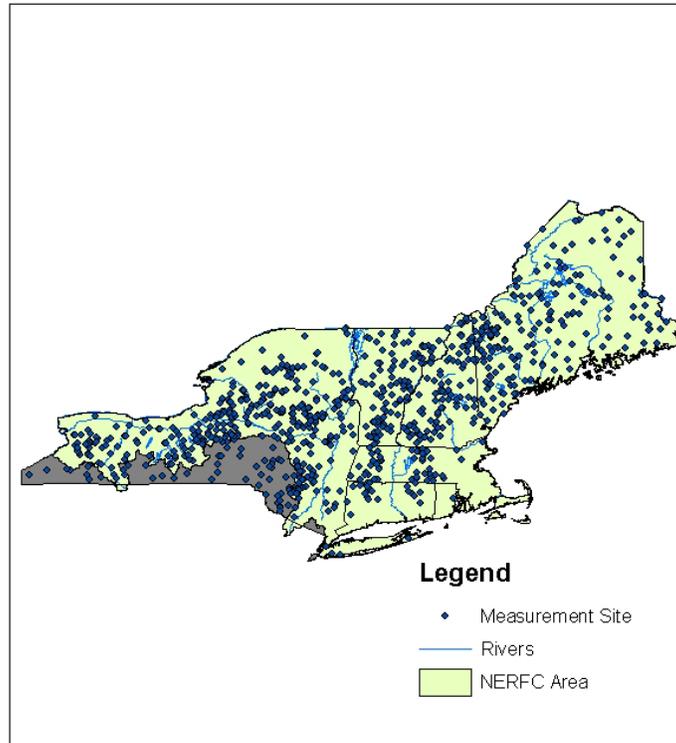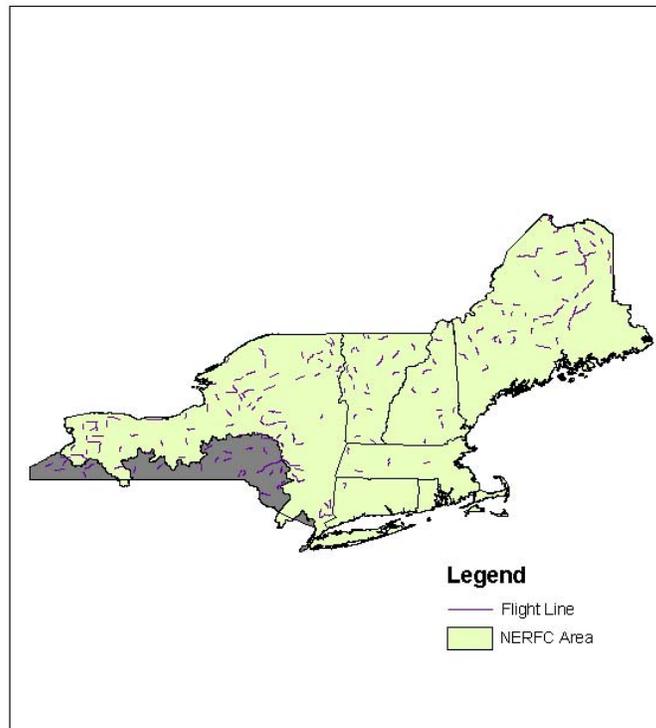Figure 2. Daily snow depth measurement sites.

Figure 3. SWE measurement sites.

Figure 4. Location of flight lines.

NATIONAL OPERATIONAL HYDROLOGIC REMOTE SENSING CENTER

The NWS's National Operational Hydrologic Remote Sensing Center (NOHRSC) generates many products which are used by the NERFC in its daily operations during the snow season. NOHRSC maintains an Airborne Gamma Radiation Snow Survey Program to make near real-time SWE measurements over a network of 1,900 flight lines covering portions of 29 states and 7 Canadian provinces. There are over 160 flight lines in New York and the New England States (figure 4). Terrestrial gamma radiation is detected from an aircraft flying 150 m above the snow covered ground. Since the water mass in the snow cover attenuates the terrestrial radiation signal, the difference between the terrestrial measurements over the bare ground and snow covered ground can be used estimate the mean aerial SWE over the approximately 4.5–6 km^2 area of the flight line (Carroll and Schaake, 1983).

The NOHRSC supplies the nation with many other useful products including satellite derived aerial extent of snow cover maps. Additional maps supplied by NOHRSC include daily surface temperature, cumulative freezing degree–days, thawing degree days and snow depth maps.

NOHRSC is in the process of developing the Snow Data Assimilation System (SNODAS). The purpose of SNODAS is to provide a physically consistent framework for integrating the variety of snow data. SNODAS includes both data ingest functions and a spatially distributed energy-and-mass balance snow model that has high spatial (1 km) and temporal (1 hr) resolutions (Carroll, et al., 2001).

NERFC SNOW WEBSITE

The NERFC maintains a website with graphics of snow data on a daily basis or when the data are available. Daily snow fall and snow depth, and seasonal snowfall to date maps are issued daily during the snow season. SWE maps are prepared biweekly when the data is available. Storm total snowfall maps are issued after major snow events.

The posting of the data has become useful in many ways. NWS Meteorologists use the data to verify forecasts and to use in local studies. Hydrologists and Water Managers can use the information to access the winter snow pack. Winter enthusiasts even use the site to plan their winter outings. The site's usefulness is revealed by the fact that it gets 800 "hits" per week during the snow season.

The snow website can be navigated to through its link to the NERFC's home page which is located at **www.erh.noaa.gov/er/nerfc**.

SUMMARY

Collection of snow data is a collaborative effort amongst civic-minded citizens, industry and local, state and federal government. The snow data, especially SWE data, is essential for the NERFC in its preparation of its river forecasts and flood guidance. The data which is posted on the NERFC website is widely used by water managers and the public to make a wide range of decisions, from determining the seasonal flood threat to planning recreational activities.

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