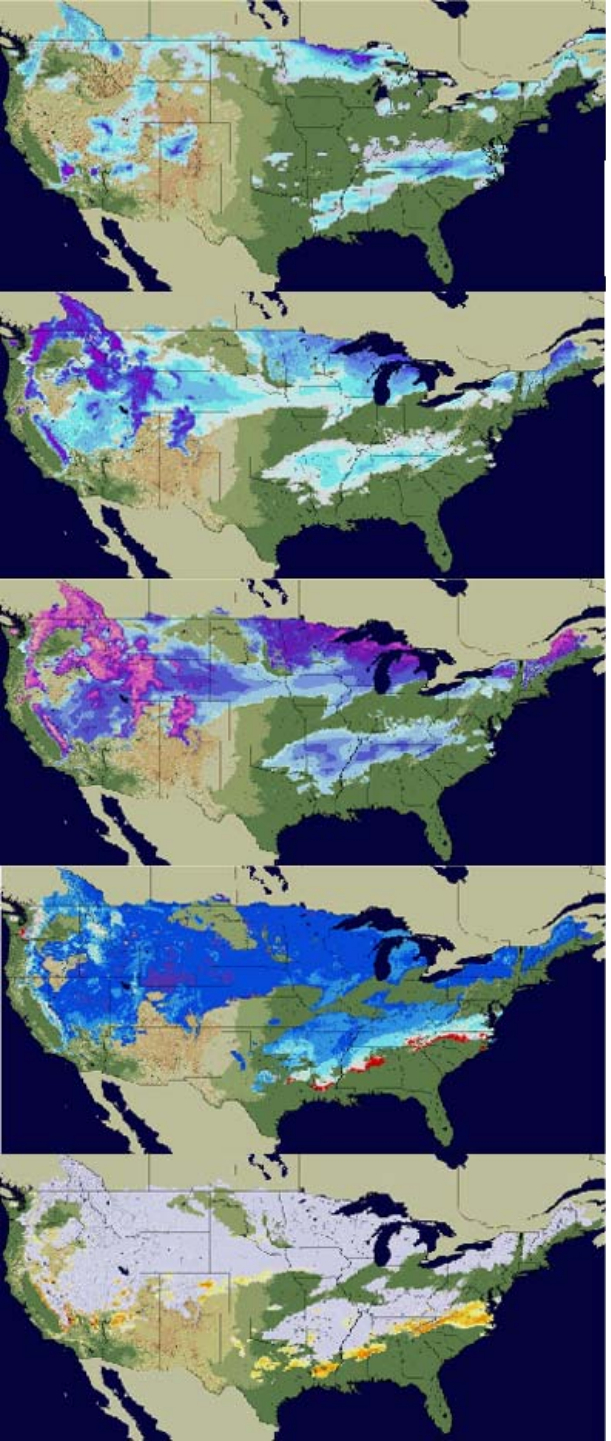


National Snow Analyses

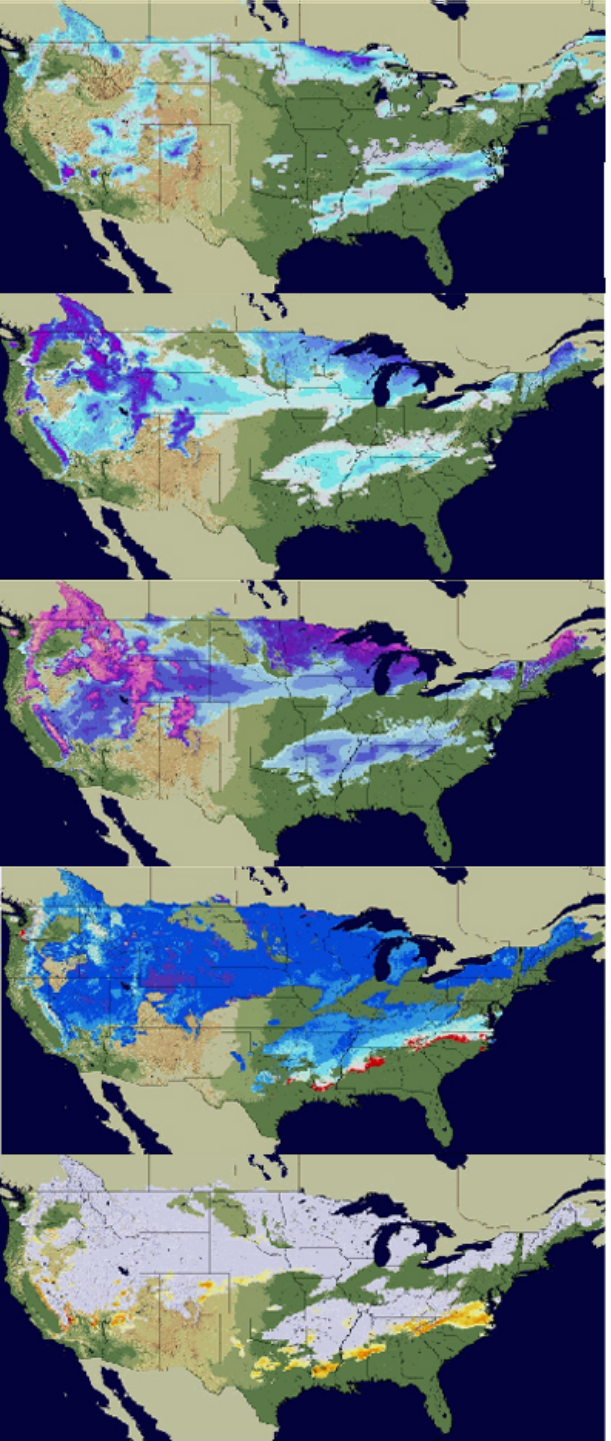
Don Cline

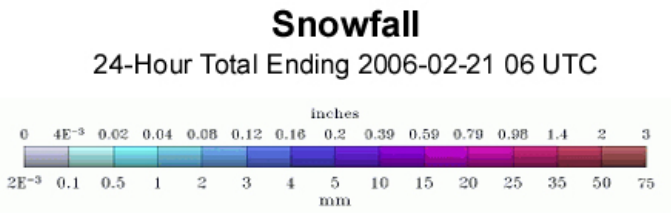
National Operational Hydrologic Remote Sensing Center

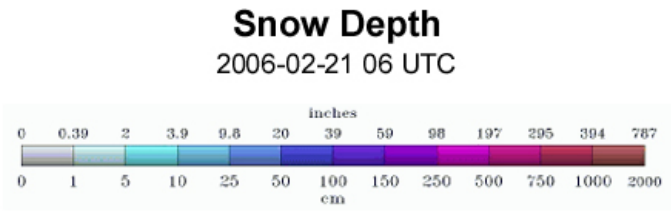
Office of Climate, Water, and Weather Services
National Weather Service, NOAA
U.S. Department of Commerce

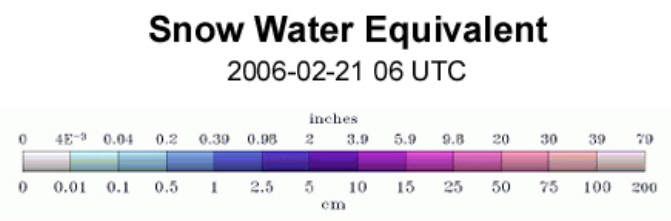
www.nohrsc.noaa.gov

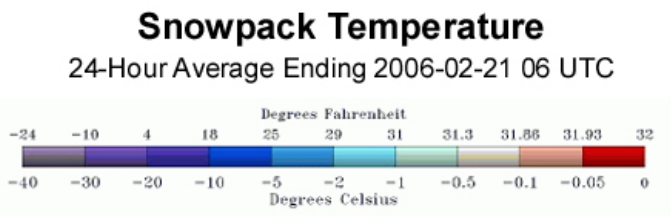
Donald.Cline@noaa.gov

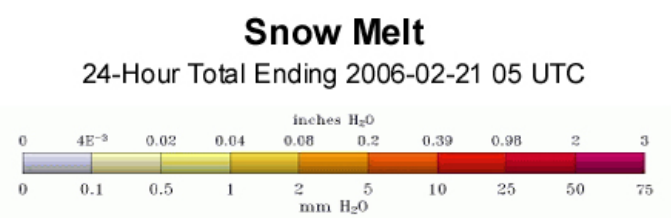






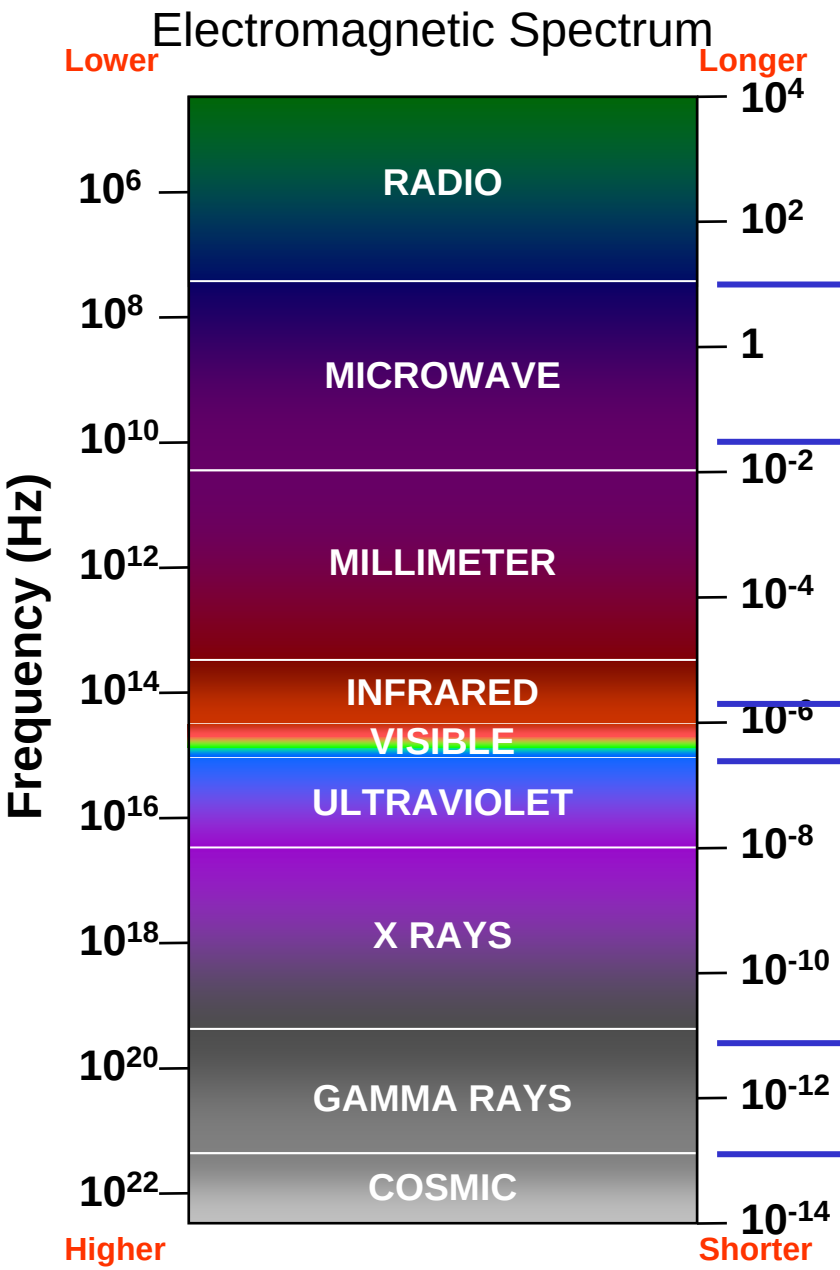






- **PRODUCTS**
  - Hourly and Daily
  - 1 km^2 Resolution
- **INTERNET**
  - Interactive Maps
  - 3D Visualization
    - e.g. Google Earth
  - Time-series loops
  - National/Regional Discussions
  - Text summaries by watershed
  - Point Queries
- **DIRECT FEED**
  - Push or Pull
  - Gridded Data
  - Flat Binary or GIS-ready

Remote Sensing of Snow



Snow Sensors

- **AMSR-E** (Passive)
- **SSM/I** (Passive)
- **QuikSCAT** (Active)
- **TerraSAR X** (Active – Europe)
- **SCLP** (Future Active/Passive)

- **GOES** (Geostationary)
- **GOES-R** (Future Geostationary)
- **AVHRR** (Polar Orbiting)
- **MODIS** (Polar Orbiting)
- **VIIRS** (Future Polar Orbiting)
- **Landsat** (Polar Orbiting)

- **Gamma** (Airborne Only)

Used in NSA

National Snow Analyses (NSA)

Multi-sensor Snow Observations

- Ground
- Airborne
- Satellite

Snow Modeling and Data Assimilation

Numerical Weather Prediction Model Forcings

Gridded Snow Characteristics

U.S.

1-km^2

Hourly

Snow Information Products

- Data Products
- Interactive Maps
- Time Series Plots
- Text Discussions

National Snow Analyses (NSA)

Multi-sensor Snow Observations

Ground

Airborne

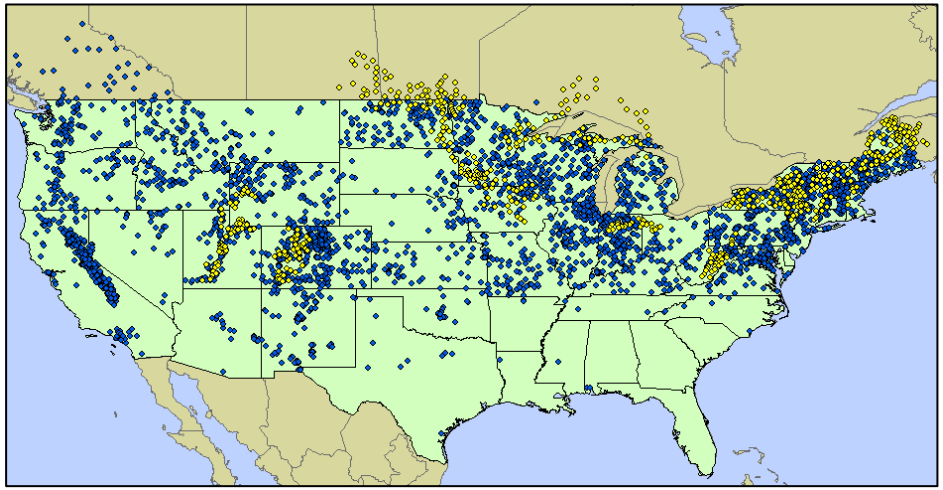
Satellite

- **National Weather Service**
  - First-order Stations
  - Cooperatives
- **Federal and State Agencies**
  - NRCS SNOTEL and Snow Courses
  - USACE New England District Snow Surveys
  - Federal Aviation Administration
  - California Dept. of Water Resources
- **Regional Mesonets and Surveys**
  - State Mesonets
  - CoCoRAHS
  - MesoWest (150 smaller mesonets)
- **International Agencies**
  - St. John River Basin
  - Environment Canada
  - BC Hydro

16,000 Snow Reporting Stations

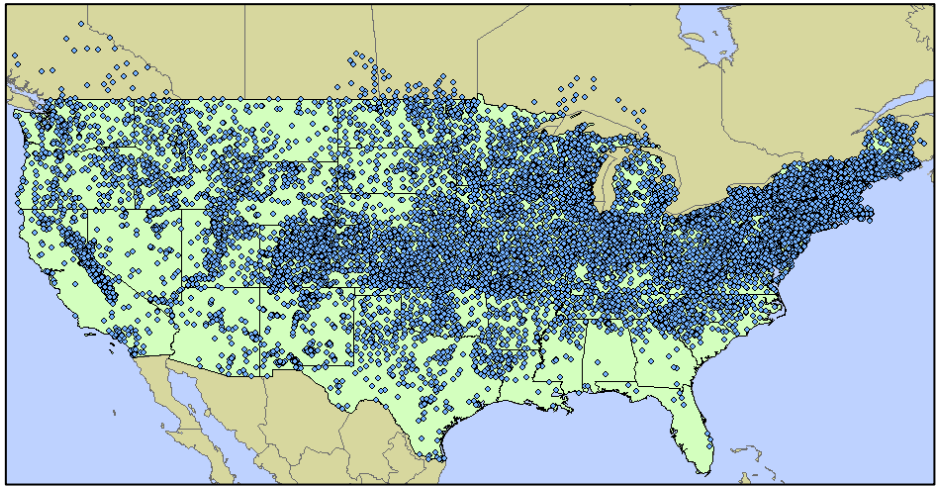
Ground Observations

Snow Season 2006-2007



Snow Water Equivalent

Typical Day: 850 Observations from 3,000 stations



All Snow Observations

Typical Day: 3500 Observations from 16,000 stations

National Snow Analyses (NSA)

Multi-sensor Snow Observations

Ground

Airborne

Satellite

NWS Airborne Snow Survey Program

- **Snow Water Equivalent Measurement**
  - Attenuation of natural terrestrial gamma radiation by water in snow

National Snow Analyses (NSA)

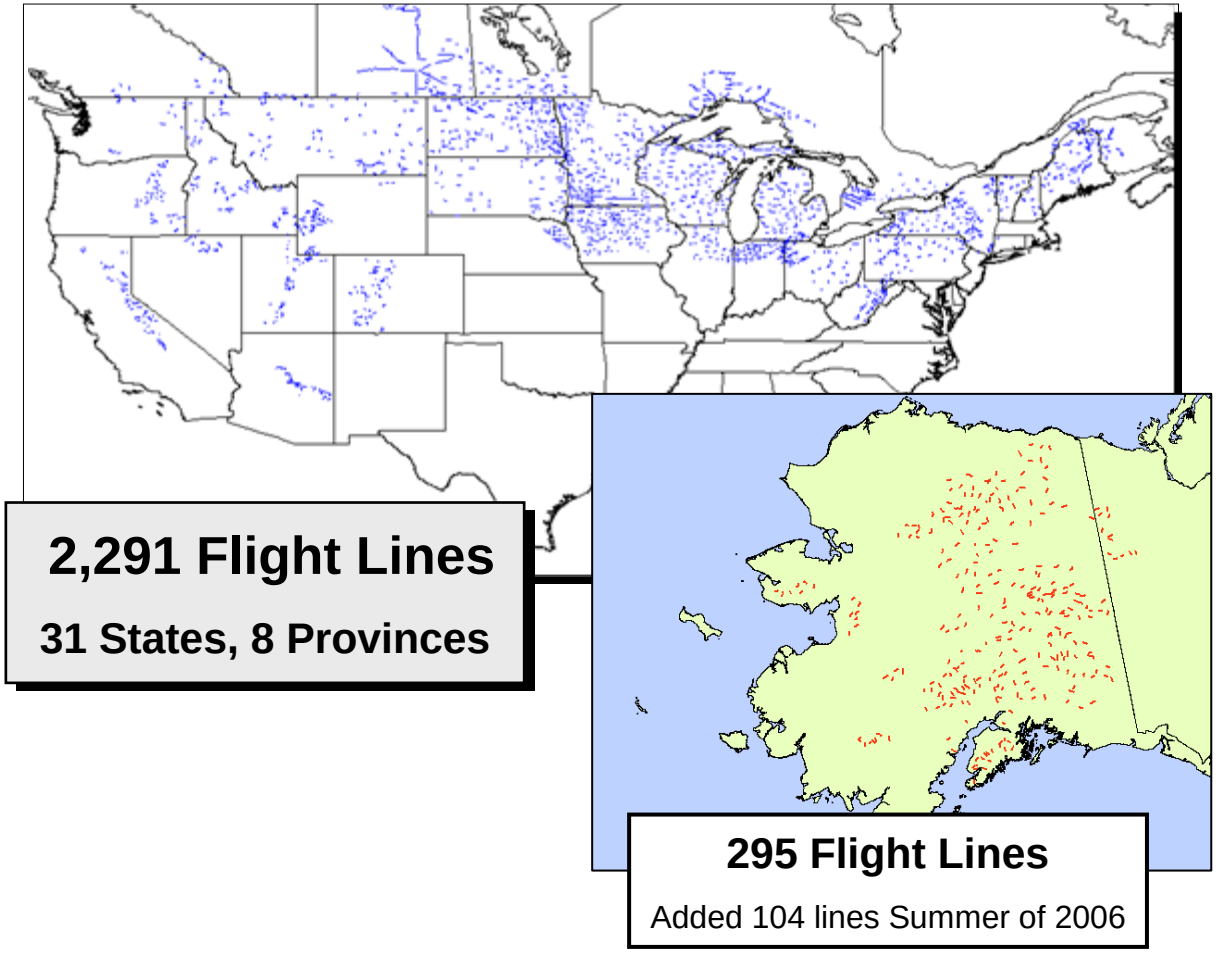
Multi-sensor Snow Observations

Ground

Airborne

Satellite

Airborne Snow Survey Program Flight Line Network

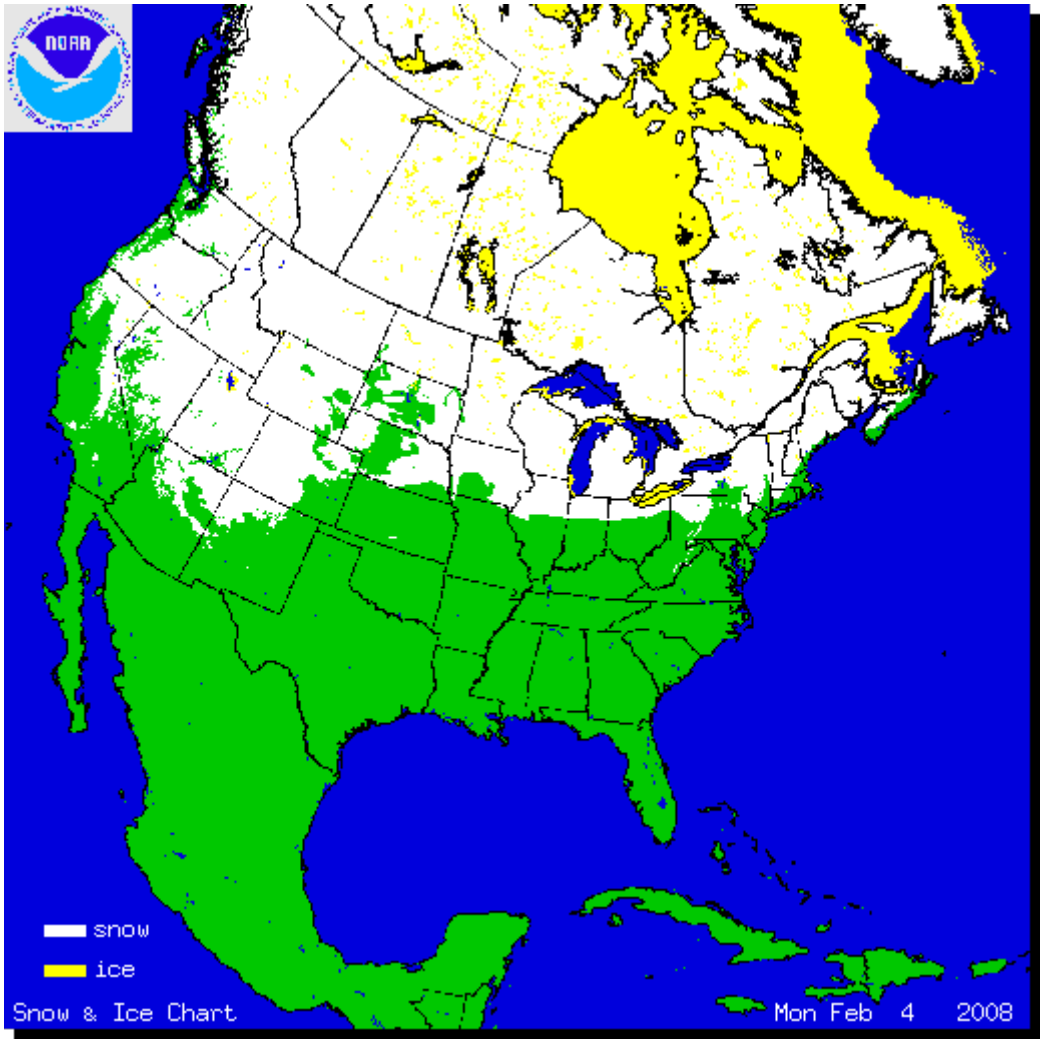


National Snow Analyses (NSA)

Multi-sensor Snow Observations

- Ground
- Airborne
- **Satellite**

Binary Snow Cover



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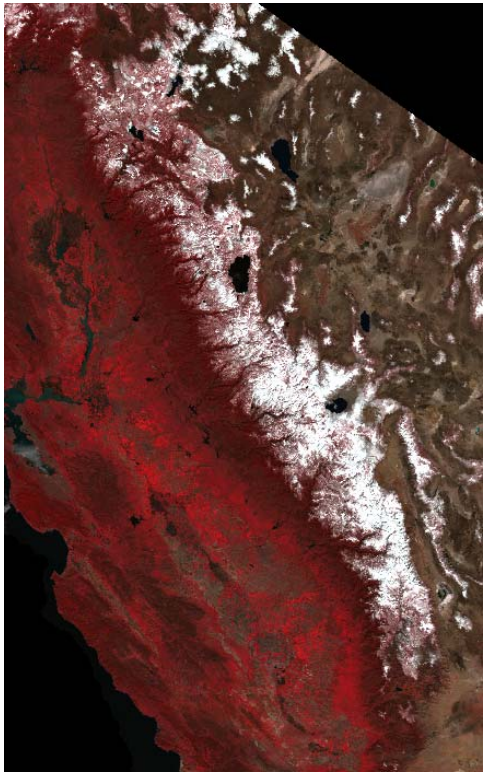
National Snow Analyses (NSA)

Multi-sensor Snow Observations

Ground

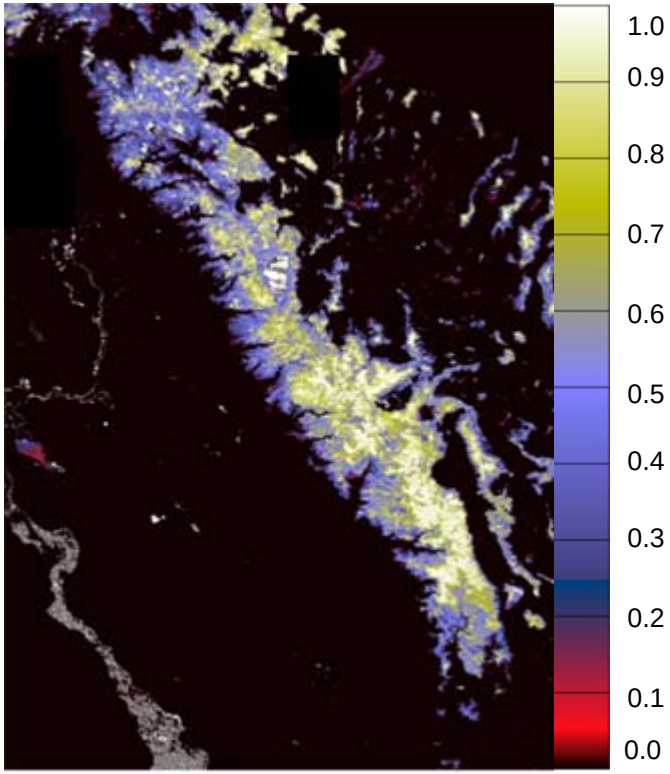
Airborne

Satellite



EOS Terra MODIS

Sierra Nevada, Mar 7 2004



Fractional Snow Cover

$SCA_{frac} = 0.5$

MODSCAG Algorithm, images courtesy of T. Painter, U. Utah

National Snow Analyses (NSA)

Multi-sensor Snow Observations

- Ground
- Airborne
- Satellite

Snow Modeling and Data Assimilation

Numerical Weather Prediction Model Forcings

Gridded Snow Characteristics

U.S.

1-km^2

Hourly

Snow Information Products

- Data Products
- Interactive Maps
- Time Series Plots
- Text Discussions

Snow Modeling Framework

Hourly Input Numerical Weather Models (1 km)

Temperature
Relative Humidity
Wind Speed
Solar Radiation
Atmos. Radiation
Precipitation
Precipitation Type

GIS Data (1 km)

Soils Properties
Land Use/Cover
Forest Properties

1

1

Snow Energy and Mass Balance Model

Blowing Snow Model

Radiative Transfer Model

State Variables for Multiple Vertical Snow & Soil Layers

Snow Water Equivalent
Snow Depth
Snow Temperature
Liquid Water Content
Snow Sublimation
Snow Melt

2

Data Assimilation

Snow Observations

Snow Water Equivalent

Snow Depth

Snow Cover

3

NSA Product Generation

Interactive Maps
Digital Data
Discussions

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NOAA's Source for Snow Information

The National Operational Hydrologic Remote Sensing Center provides comprehensive snow observations, analyses, data sets and map products for the Nation.

- National Snow Observation Database
- Airborne Snow Surveys
- Satellite Snow Cover Mapping
- Snow Modeling and Data Assimilation
- Analyses, Maps, and Interactive Visualization Tools
- Integrated Snow Datasets for Geospatial Applications
- Applied Snow Research

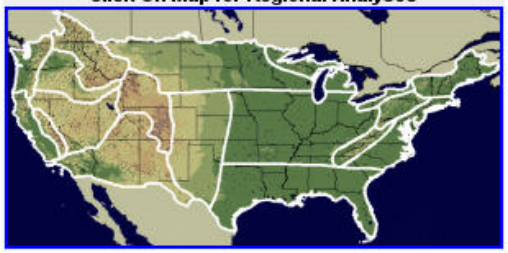
NOHRSC products and services support a wide variety of government and private-sector applications in water resource management, disaster emergency preparedness, weather and flood forecasting, agriculture, transportation and commerce.

SNOW = WATER = LIFE

National Snow Analyses

Snow Reports | Model Assimilation Schedule | Snow Survey Schedule

Click On Map for Regional Analyses



Automated Model Discussion:
February 5, 2008

Area Covered By Snow:	47.5%
Area Covered Last Month:	40.3%
Snow Depth	
Average:	7.8 in
Minimum:	0.0 in
Maximum:	643.8 in
Std. Dev.:	17.3 in
Snow Water Equivalent	
Average:	1.7 in
Minimum:	0.0 in
Maximum:	272.7 in
Std. Dev.:	4.2 in

more... Metric Units...

Select Region and Date

National | 2008 | February | 5 | - | + | Go

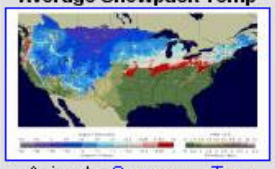
Snow Water Equivalent

Animate: Season --- Two weeks --- One Day

Snow Depth

Animate: Season --- Two weeks --- One Day

Average Snowpack Temp



Animate: Season --- Two weeks --- One Day

SWE Change

Animate: Season --- Two weeks --- One Day

Snow Precipitation

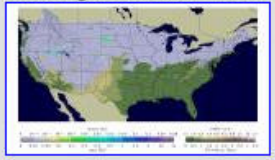
Animate: Season --- Two weeks --- One Day

Snow Melt

Click for a larger image of Snow

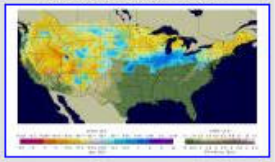
Animate: Season --- Two weeks --- One Day

Blowing Snow Sublimation



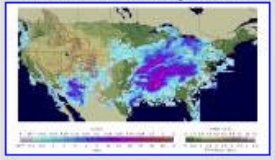
Animate: Season --- Two weeks --- One Day

Surface Sublimation



Animate: Season --- Two weeks --- One Day

Non-Snow Precipitation



Animate: Season --- Two weeks --- One Day

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National Snow Headlines

www.nohrsc.noaa.gov

National Operational Hydrologic Remote Sensing Center

Quick Query Links

Get Time Series for Station ID: Go Listing

Get Time Series for Basin ID: ABRFC Go Listing

Get Basin Averages for RFC Go Listing

Get Climatology for Station ID: Go Listing

Interactive Snow Information

Home News Organization Search Enter Search Here Go

Query Station Time Series

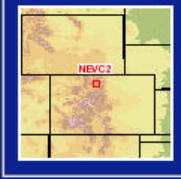
Station SHEF ID: NEVC2

300 px width

200 px height

Submit

Reference Map

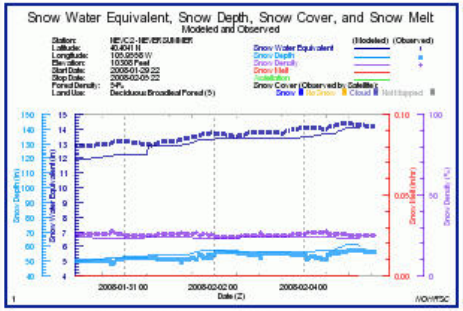


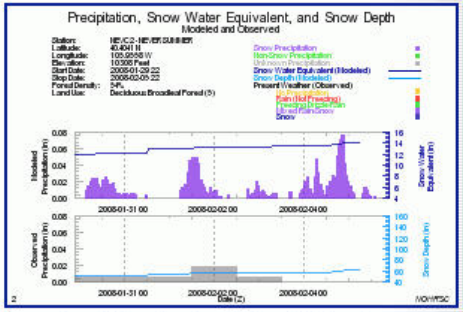
Links

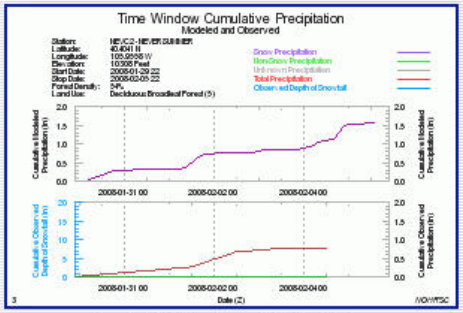
- Plot 1 image
- Plot 2 image
- Plot 3 image
- Plot 4 image
- Plot 5 image
- Plot 6 image
- Plot 7 image
- Plot 8 image

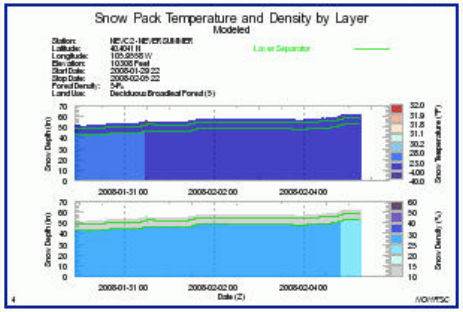
Start Date: 2008 January 29 22:00 Z to Stop Date: 2008 February 5 22:00 Z

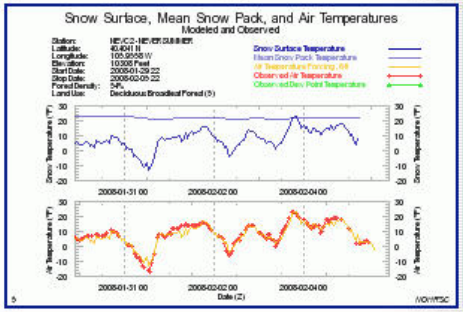
All Images | English Units | Refresh screen | More information on station NEVC2

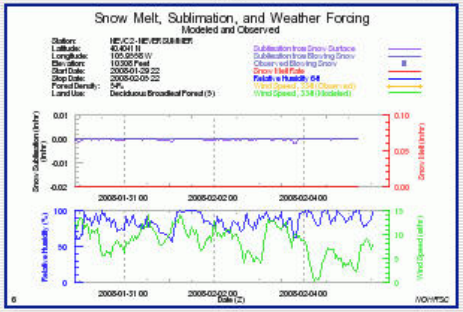


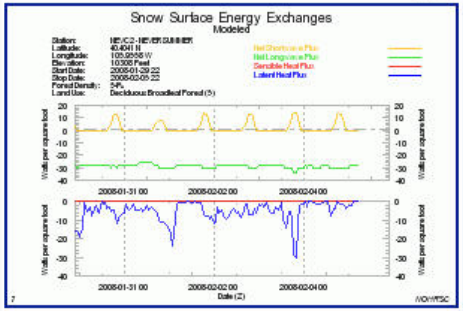


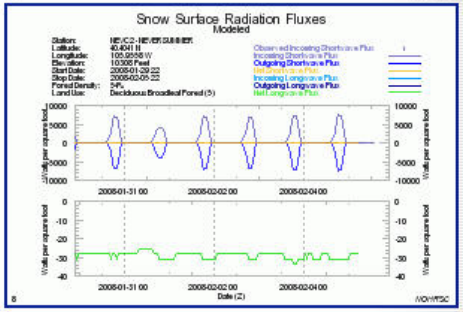












- Select a physical element to view, select a date, select overlays, and click "Redraw Map."

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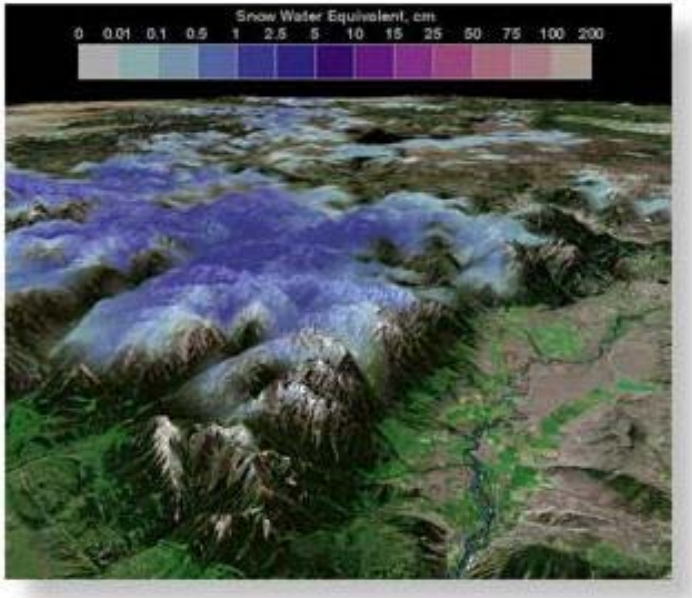
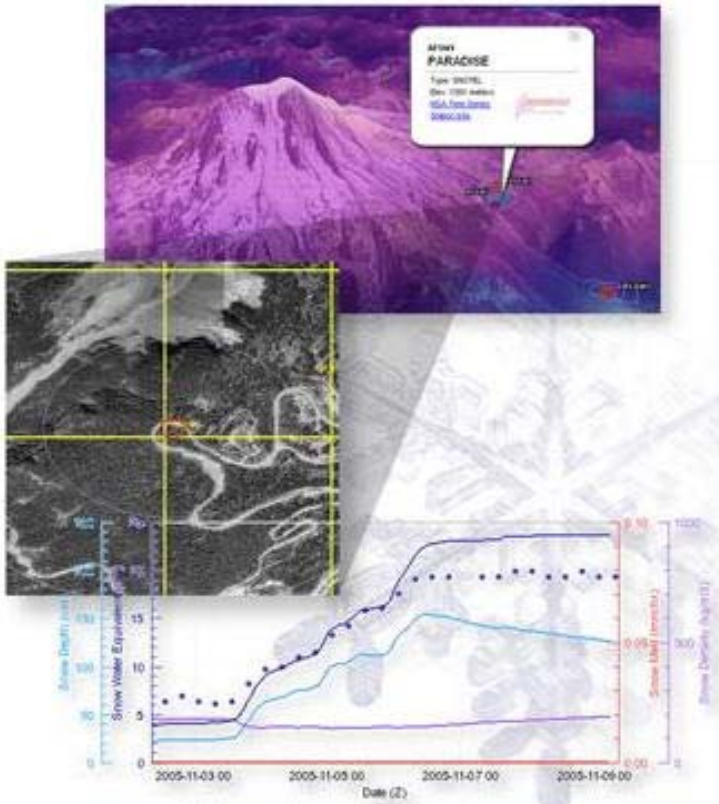
NATIONAL SNOW ANALYSES IN 3D

3D visualization - it's a key to understanding the National Snow Analyses.

- Fly over terrain
- Explore snow reporting stations
- Get the latest snow observations





Visualize Snow

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AIRBORNE SNOW SURVEY PROGRAM

The NOHRSC measures snow water equivalent and soil moisture using gamma radiation remote sensing. This unique observing system includes two low-flying aircraft to conduct surveys in 31 states, including Alaska, as well as in 8 Canadian provinces. Four NOAA Corps officers pilot the aircraft and operate the remote sensing systems. The data are incorporated into the National Snow Analyses.

You'll find survey data, schedules, flight line locations, aerial photos, and information about the program here.

Observe Snow

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NORTHERN HEMISPHERE SNOW COVER

The areal extent of snow cover is mapped daily using polar-orbiting and geostationary satellite imagery. Maps are provided for the U.S. and the northern hemisphere.

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- Snowmelt flooding
- Blizzard Warnings
- Winter Weather Advisories
- Frost Advisories
- Weather Forecasts
- Precipitation Forecasts

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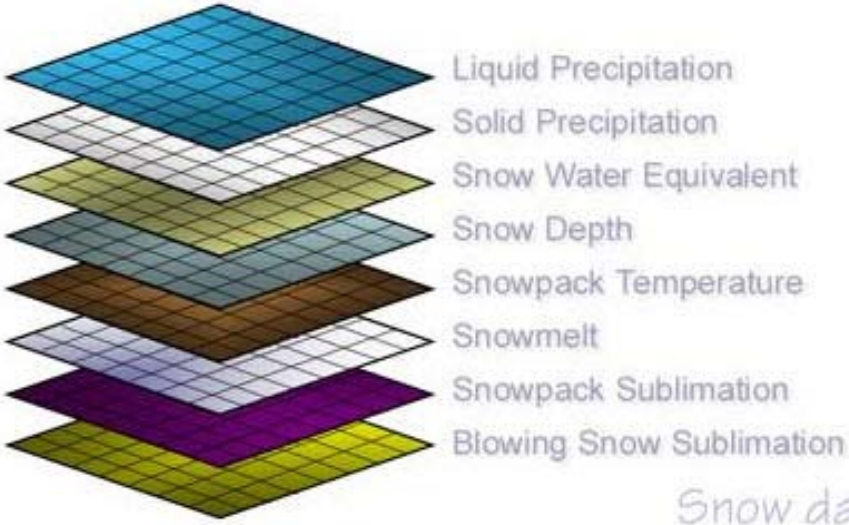
NATIONAL SNOW ANALYSES DATA ARCHIVE

Download gridded National Snow Analyses data sets for geospatial applications.

- National, or subset regions of interest
- 8 snow themes
- Georegistered raster data
- 30 arc-second (1 km²) resolution
- Portable data format



Snow data for the continental U.S.

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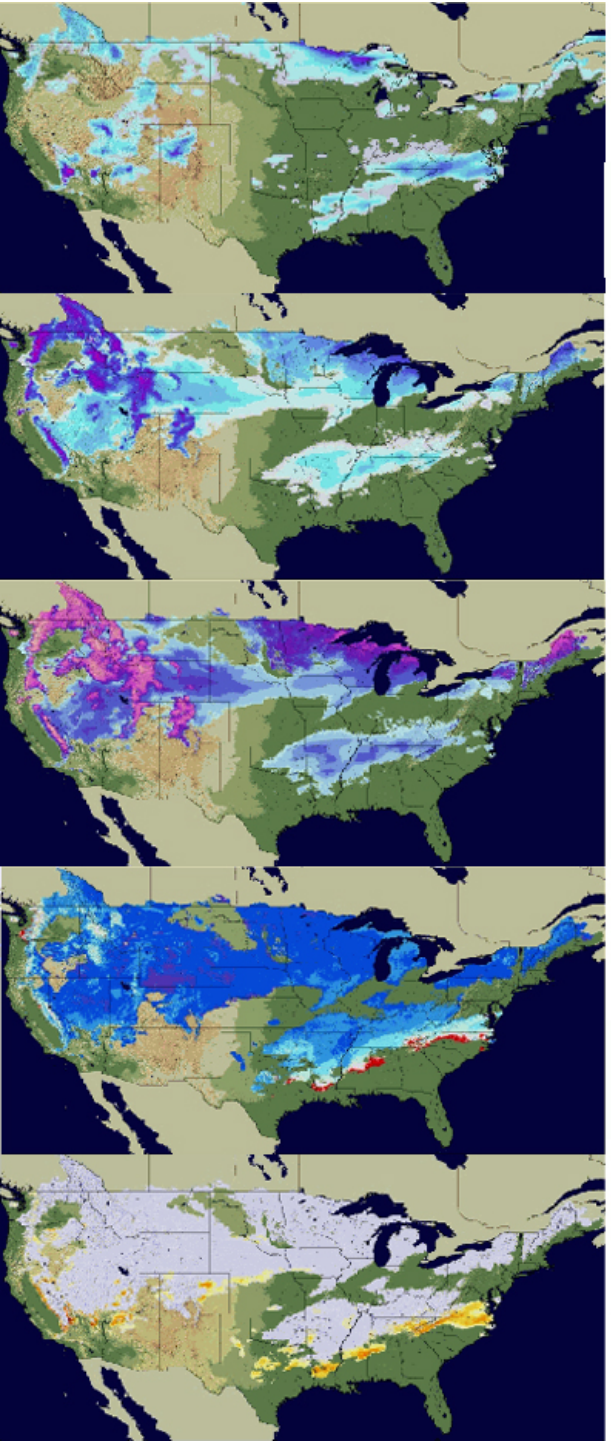
ALPHANUMERIC DATA PRODUCTS

Information from the National Snow Analyses is summarized by basins and by basin elevation zones, and is provided here in Standard Hydrologic Exchange Format (SHEF).

S H E F

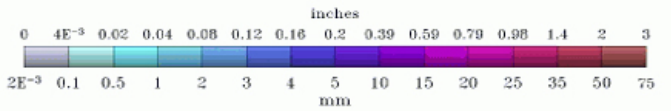
```
SRUS43 KMSR 041050
SCVPTR

.BR MSP 051104 DM110406/DC11041050 /SDIPZ
:
:-------------------------------------------------------
:National Weather Service
:Office of Climate, Water, and Weather Services
:National Operational Hydrologic Remote Sensing Center
:Chanhassen, Minnesota                    (952) 361-6610
:-------------------------------------------------------
:
:Modeled Snow Depth Over Land by Elevation Zones
:Modeled 05110406
:
:LITTLE PRICKLY PEAR CR. AT WOLF CR MT
2801          1.5 : Avg (inches) Entire Basin
:             1.5 ; Avg (inches) Base  to 6998'
:             2.2 ; Avg (inches) 6998' to Top
:
:GIBSON RES. MT
2806          1.9 : Avg (inches) Entire Basin
:             1.7 ; Avg (inches) Base  to 6998'
:             2.3 ; Avg (inches) 6998' to Top
:
:TETON RIVER NR DUTTON MT
```

Basin Averages



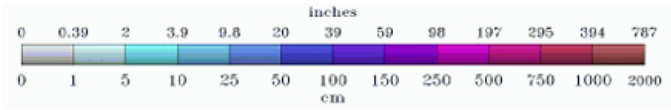
Snowfall

24-Hour Total Ending 2006-02-21 06 UTC



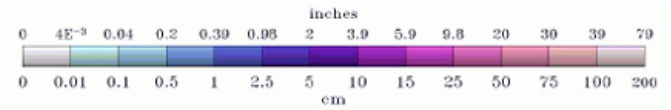
Snow Depth

2006-02-21 06 UTC



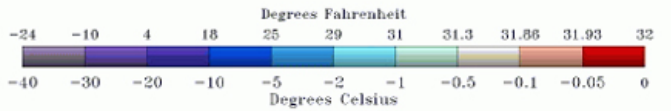
Snow Water Equivalent

2006-02-21 06 UTC



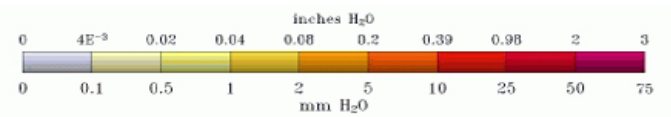
Snowpack Temperature

24-Hour Average Ending 2006-02-21 06 UTC



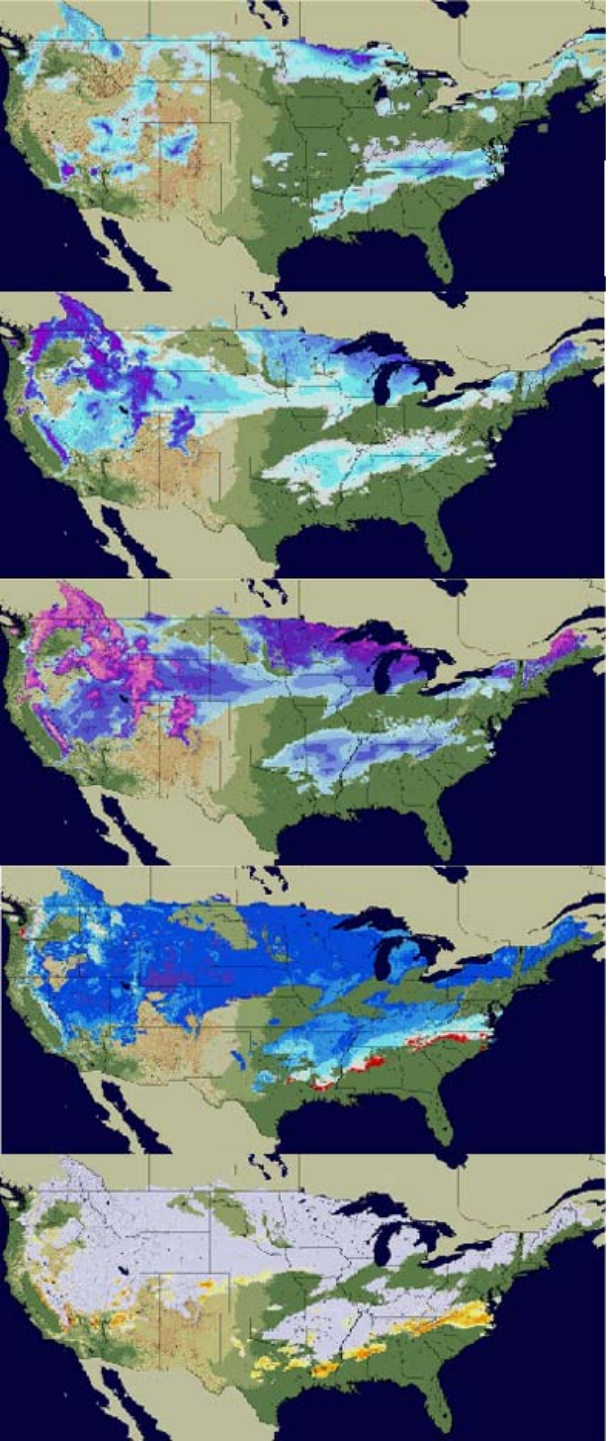
Snow Melt

24-Hour Total Ending 2006-02-21 05 UTC



- **ARCHIVE (DAILY)**
  - National Snow and Ice Data Center (NSIDC)
  - Starting 2003
  - nsidc.org
- **ARCHIVE (HOURLY)**
  - National Climate Data Center (NCDC)
  - Starting 2003
  - Contact NOHRSC for information
- **DIRECT FEED**
  - Contact NOHRSC

Donald.Cline@noaa.gov



National Snow Analyses

Don Cline

National Operational Hydrologic Remote Sensing Center

Office of Climate, Water, and Weather Services
National Weather Service, NOAA
U.S. Department of Commerce

www.nohrsc.noaa.gov

Donald.Cline@noaa.gov

NOHRSC Interactive Snow Information

National Operational Hydrologic Remote Sensing Center

Interactive Snow Information

Get Time Series for Station I
Get Time Series for Basin ID:
Get Basin Averages for
Get Climatology for Station I

Help
Comments

Navigation Tools

Zoom Control

Lon: -112.6 Lat: 32.9

Recenter map at coordinates

Query

Station (2002-present)

Redraw Map

Select Physical Element

Snow Water Equivalent

Select Date

2006 January

26 10:00 Z

Snap to nearest time

Select Overlays

Hydrologic Features
- Basins
- HUCs (6-digit)
- RFC Boundaries
- Major Rivers
- Rivers and Streams
- Lakes and Reservoirs

Political Features
- County Boundaries
- CWA Boundaries
- State Boundaries
- National Boundaries

Point Features
- Stations Label
- Cities Label
- Flight Lines Label
- Climate Stns. Label
- Alpine Skiing Label
- XC Skiing Label

Transportation Features
- Highways

Other features
- NSA Disc. Regions
- NSA Disc. Subregions
- NSA Modelling Tiles

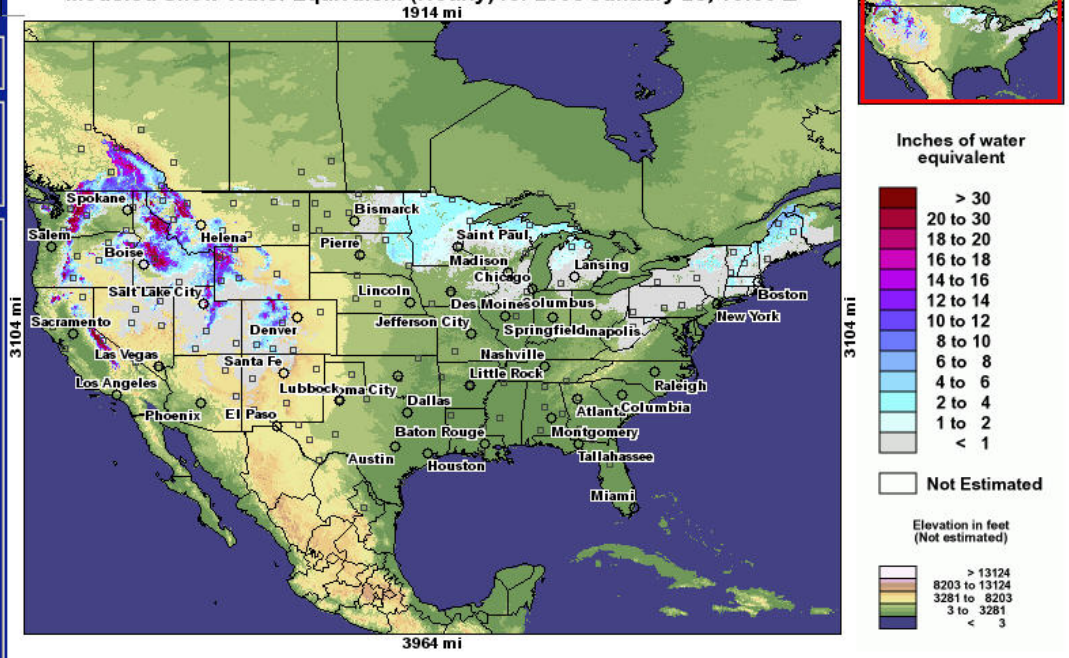
Map Preferences

English units

- Legend below map
- Background image
- High-contrast palette
- Minimize top banner

600 pixels map width
450 pixels map height

Modeled Snow Water Equivalent (Hourly) for 2006 January 26, 10:00 Z



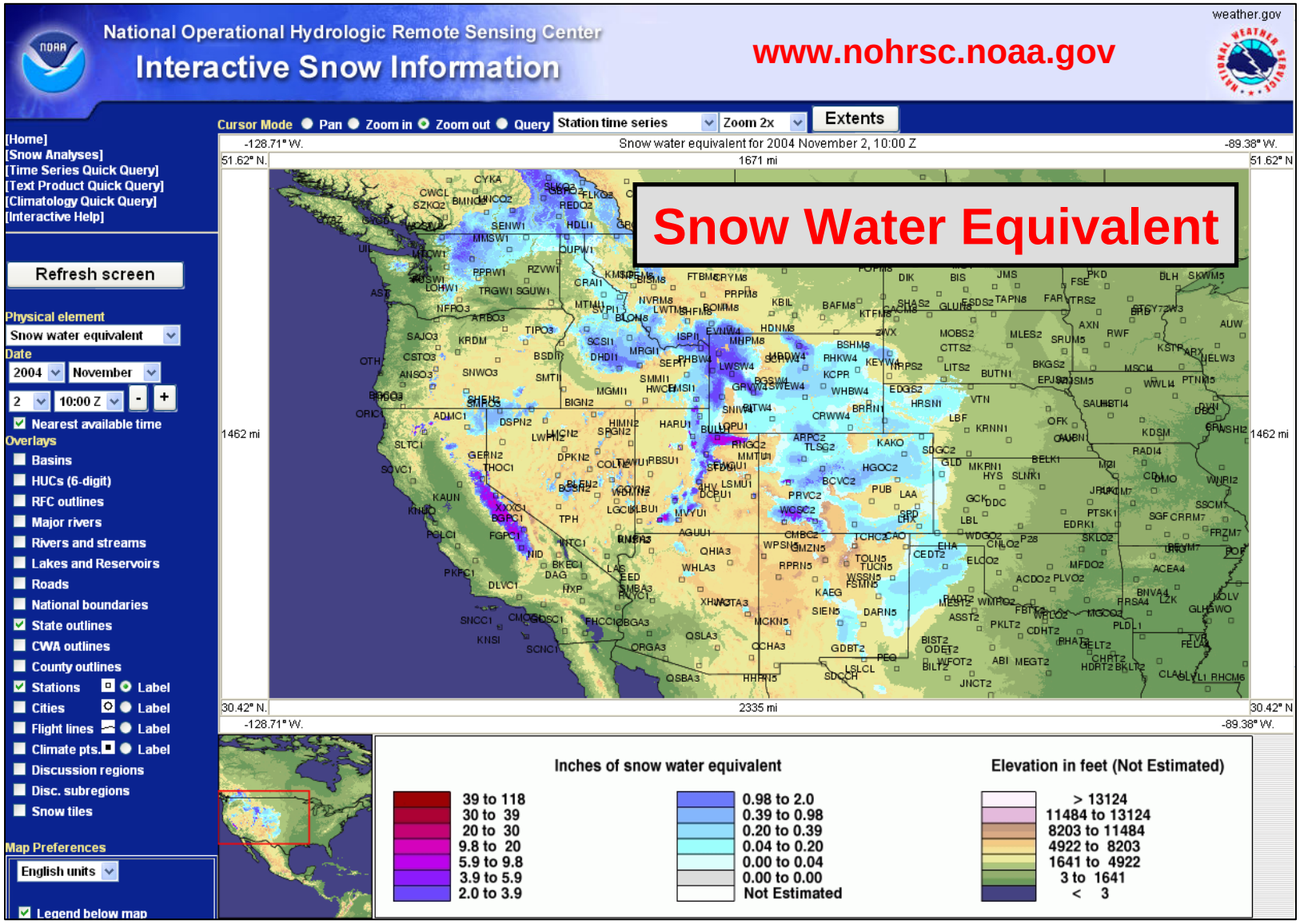
Directions:

- Select a physical element to view, select a date, select overlays, and click "Redraw Map."
- Clicking on the map while the Recenter button is selected (red) will recenter the map on that point.
- Clicking on the Zoom Control slider will zoom into or out of the map.
- Clicking and dragging with the button held down while the Recenter button is selected (red) will zoom to a rectangle when the button is released.
- Stations and regions can be queried using the Query button and menu.

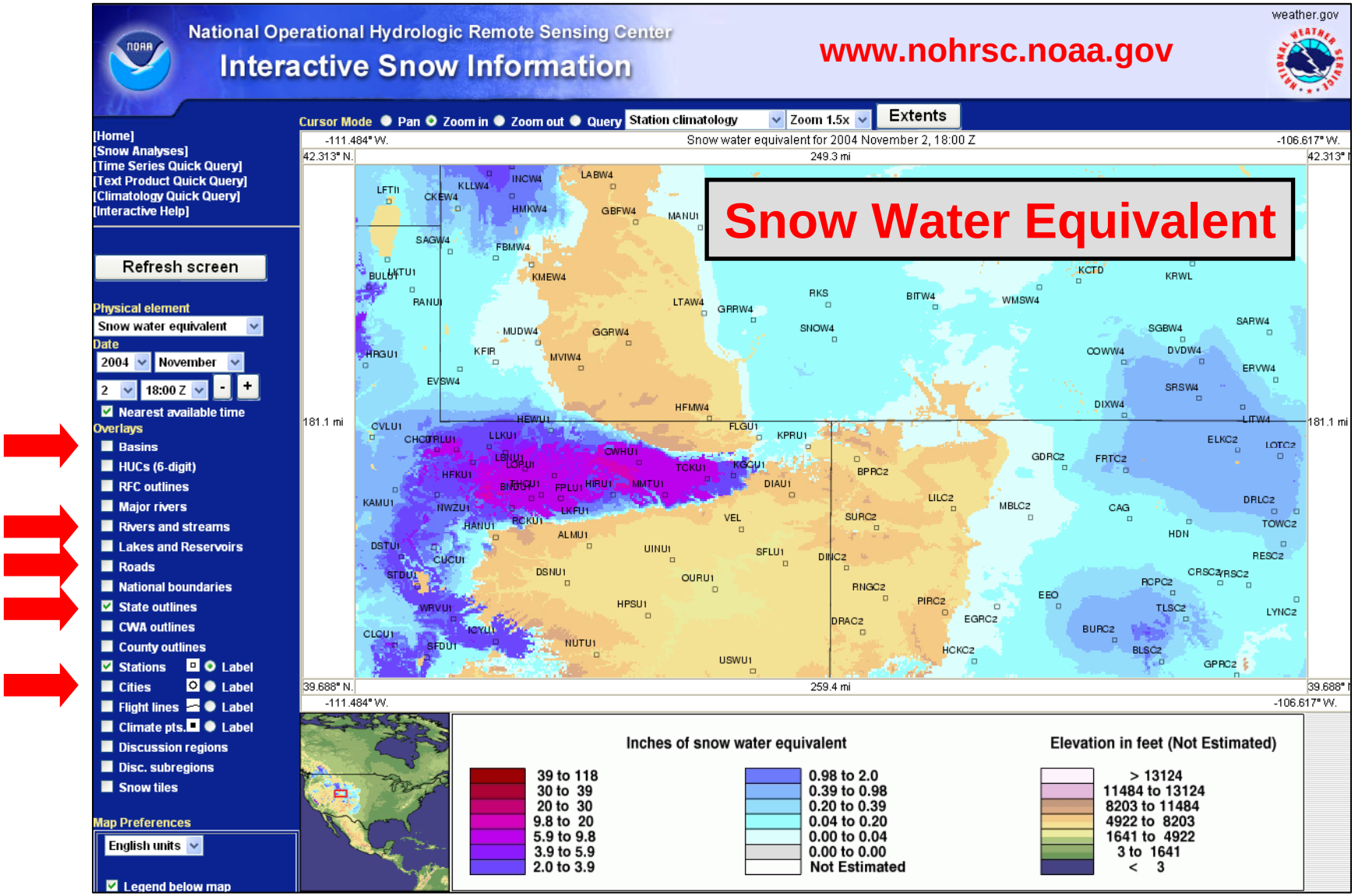
New features for the 2005-2006 snow year

NOHRSC | Home
Snow Information | National Analyses | Interactive Maps | 3D Visualization | Airborne Surveys | Satellite Obs | Forecasts | Data Archive | SHEF Products
Science/Technology | NOHRSC | GIS Data Sets

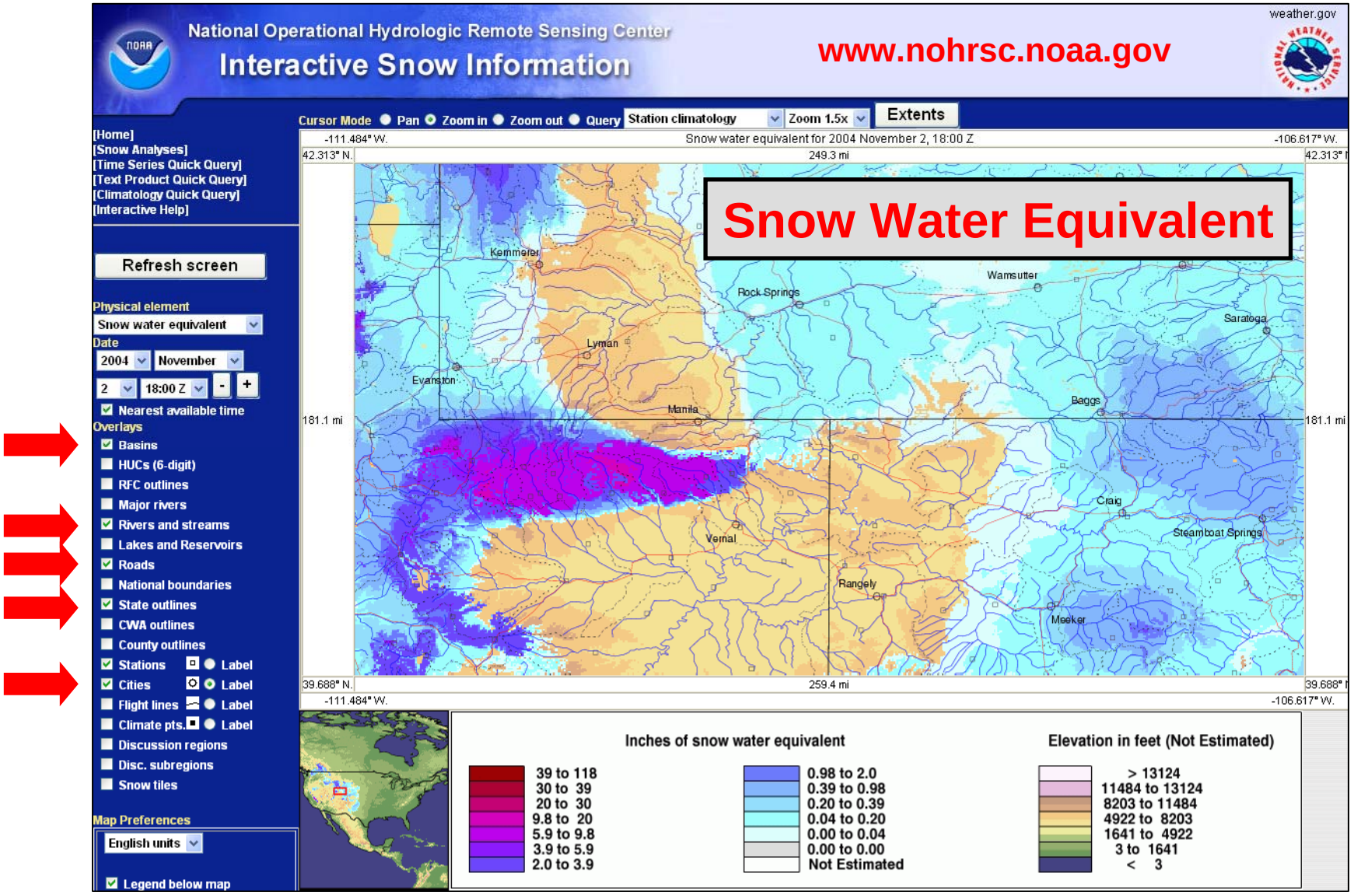
Interactive Snow Information System



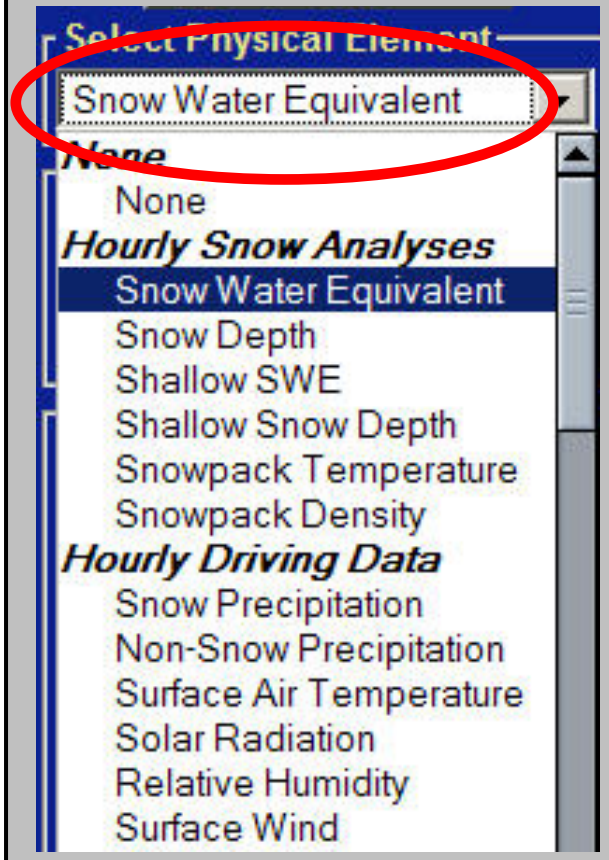
Interactive Snow Information System

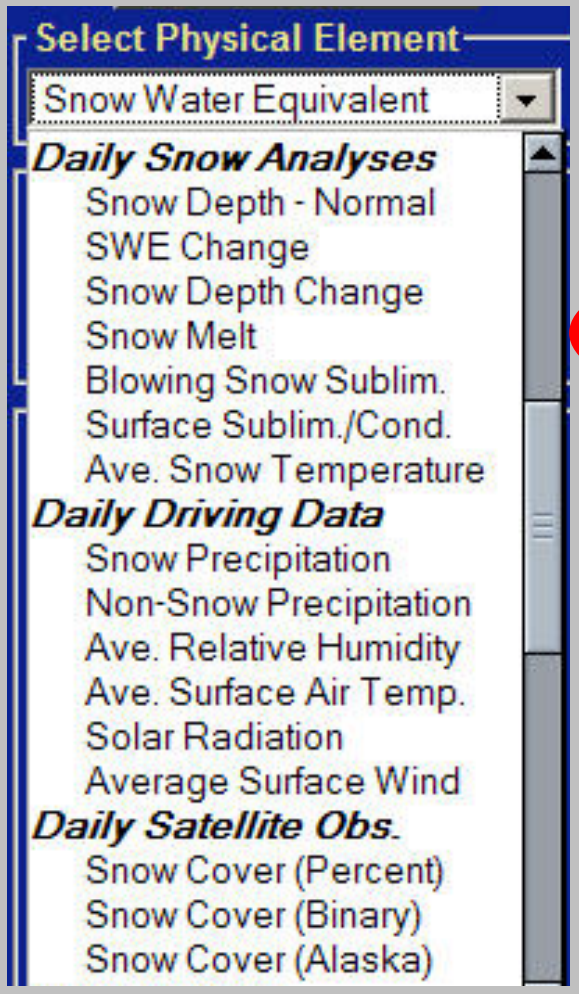


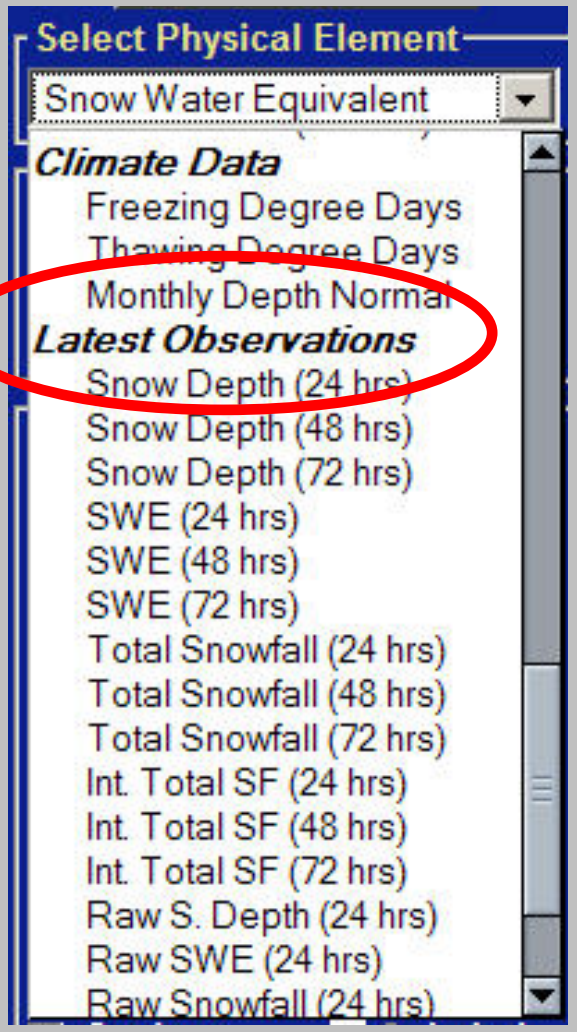
Interactive Snow Information System



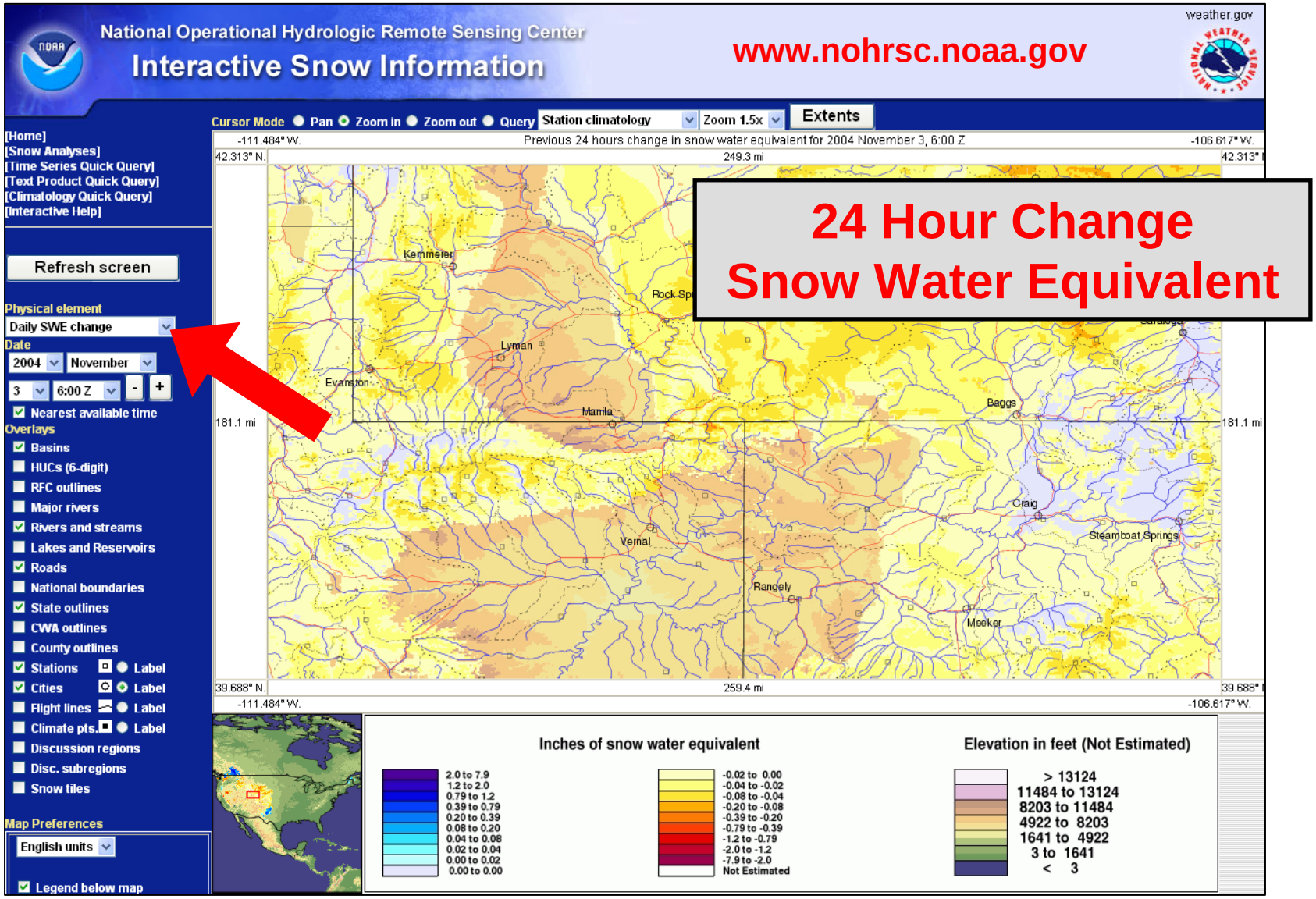
Physical Element Map Options



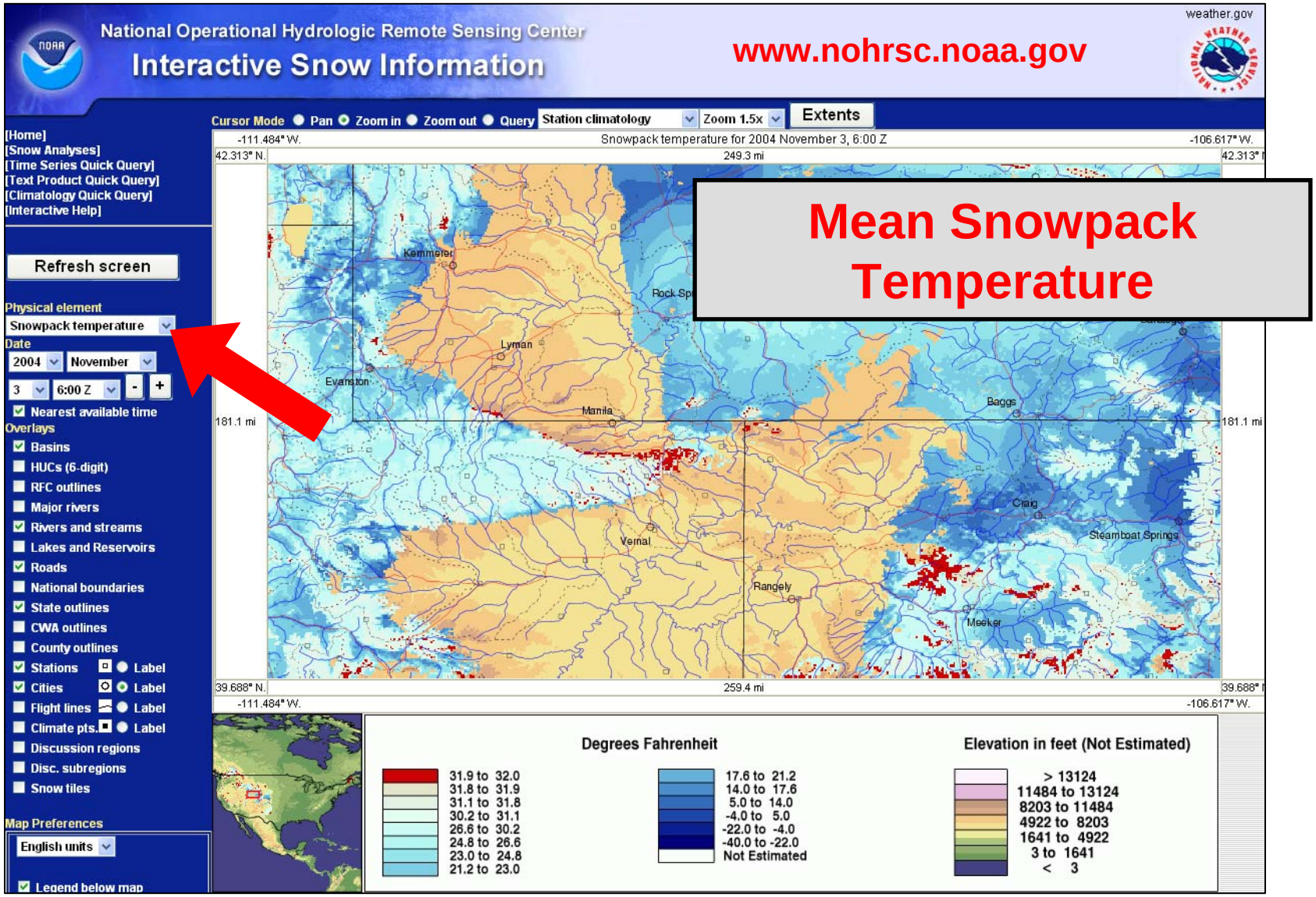




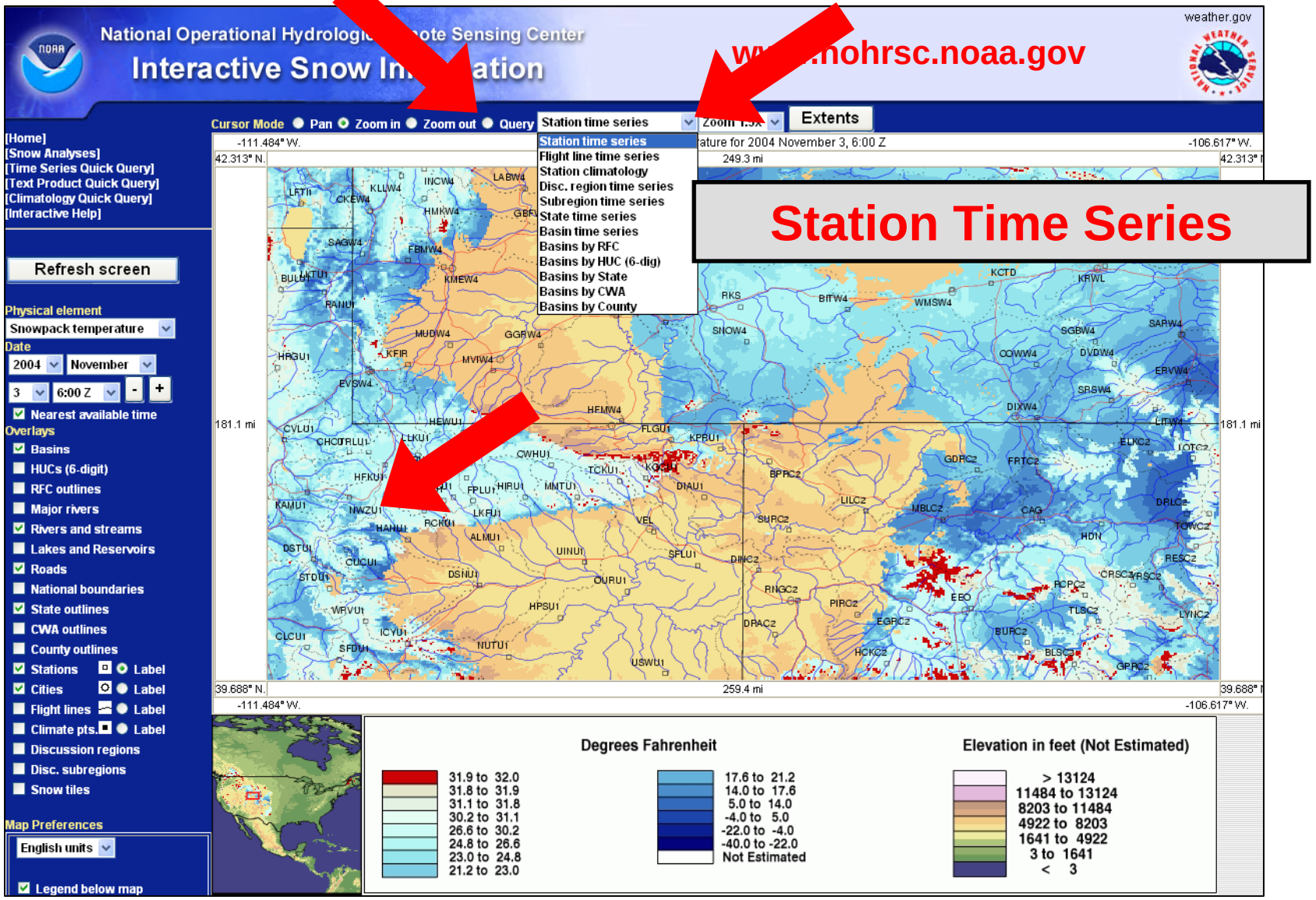
Interactive Snow Information System



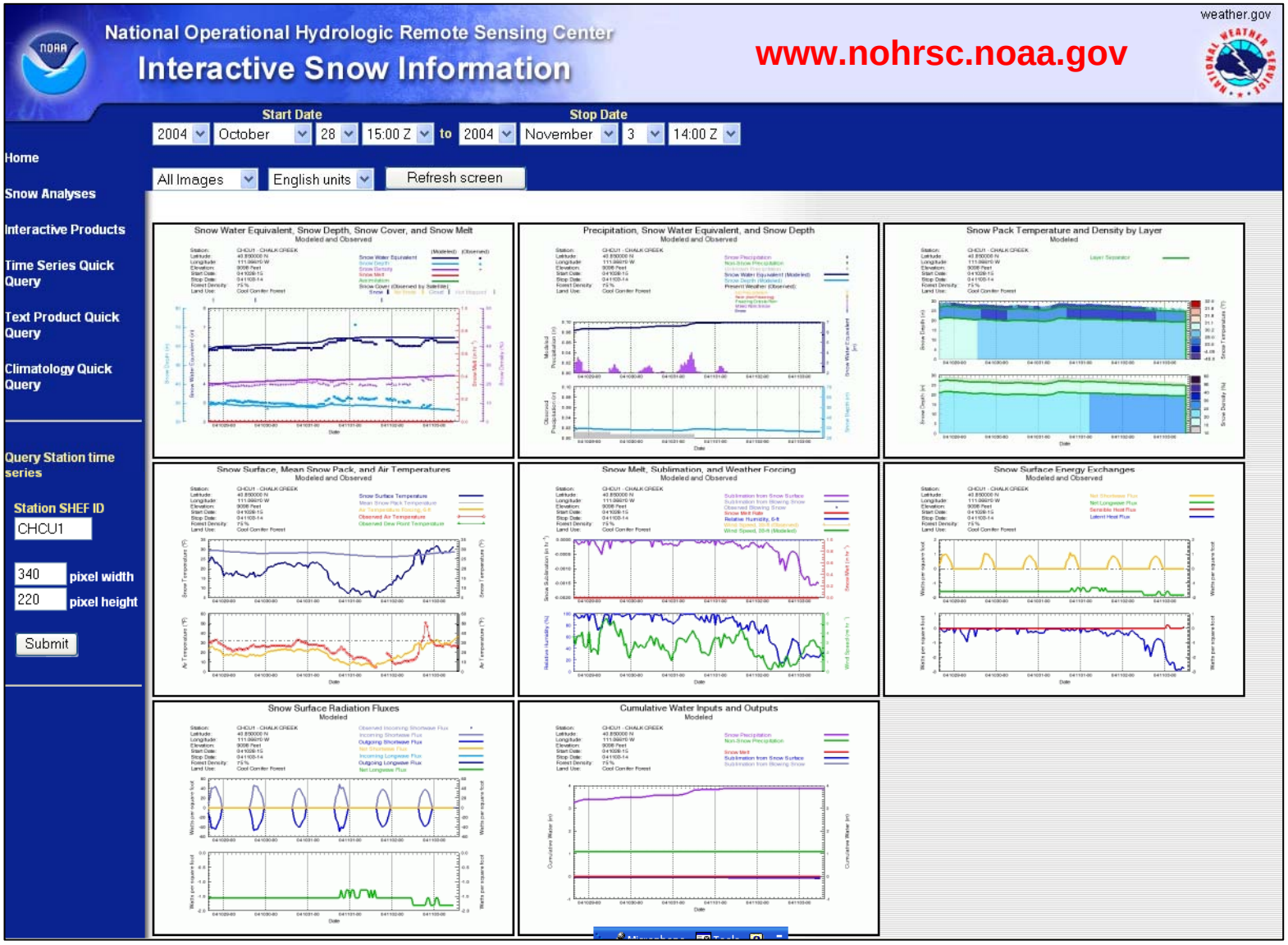
Interactive Snow Information System



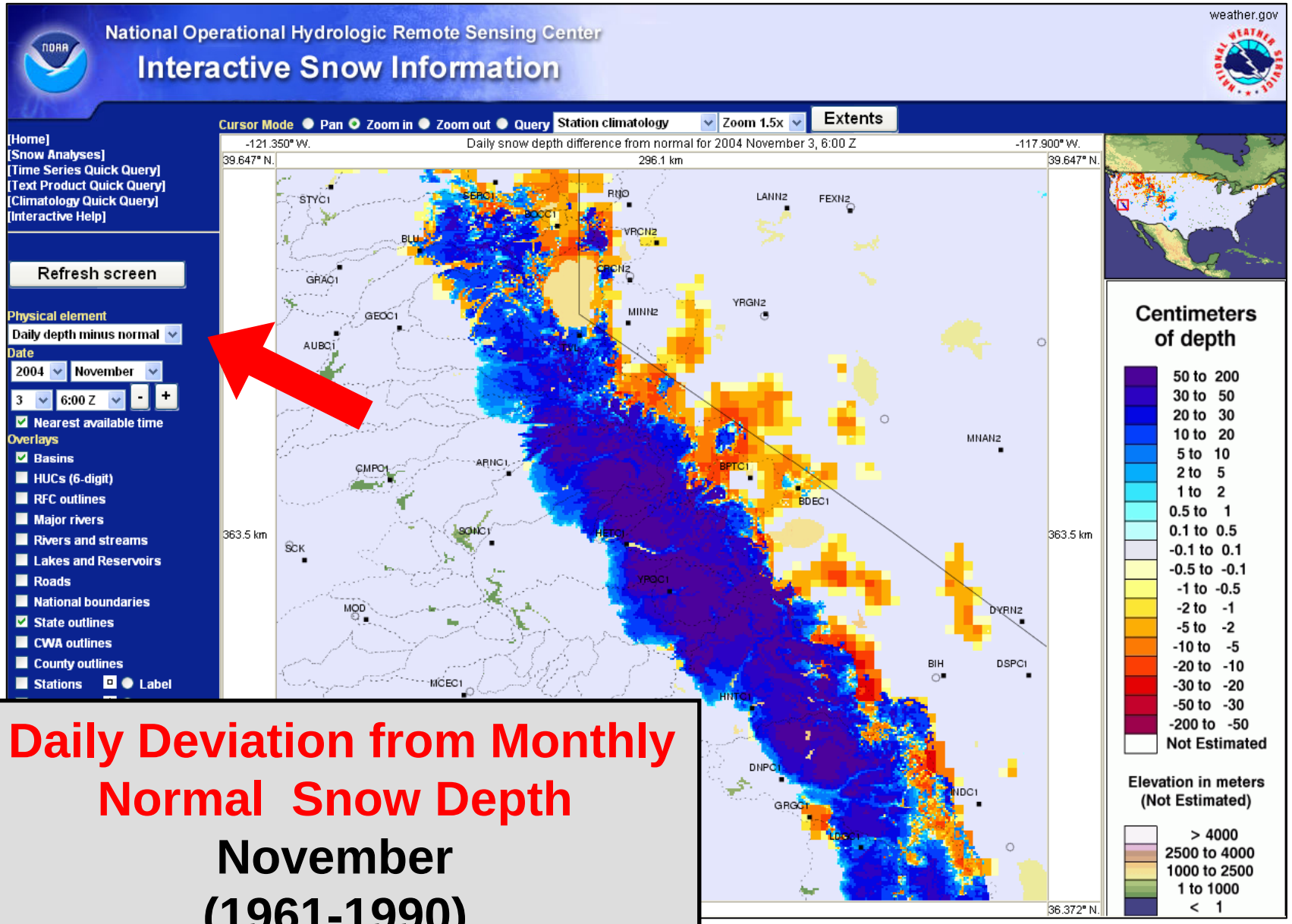
Interactive Snow Information System



Interactive Snow Information System



Climate Diagnostic Tools



Daily Deviation from Monthly Normal Snow Depth

November

(1961-1990)

www.nohrsc.noaa.gov