

National Operational Hydrologic  
Remote Sensing Center



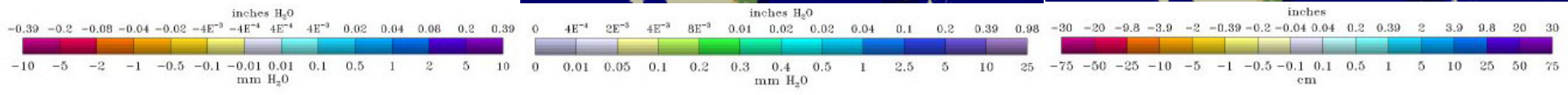
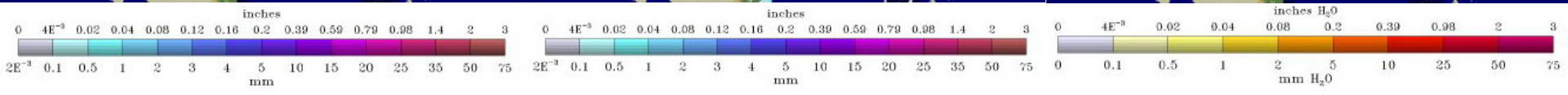
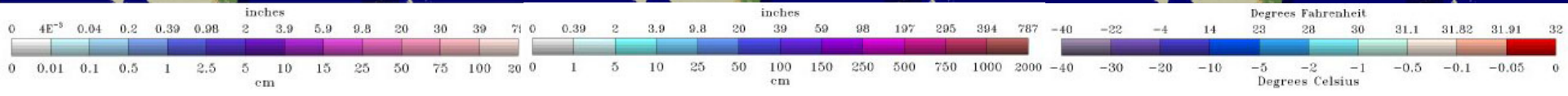
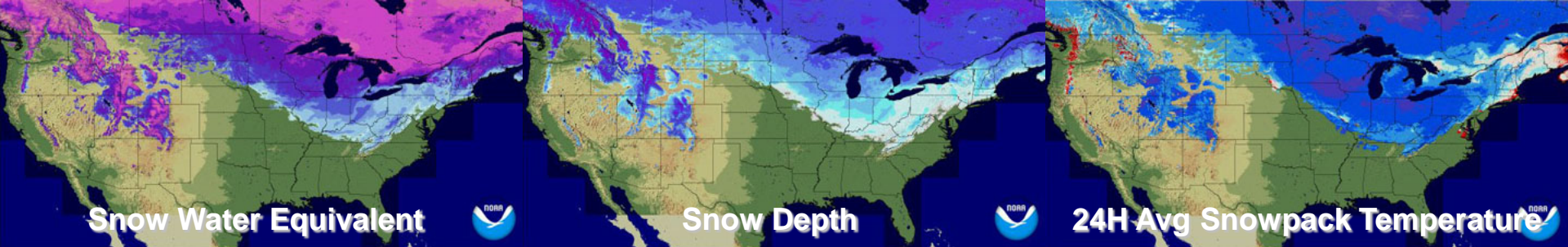
# National Snow Analyses

Don Cline

Chief, National Weather Service Hydrology Laboratory  
*National Oceanic and Atmospheric Administration  
U.S. Department of Commerce*

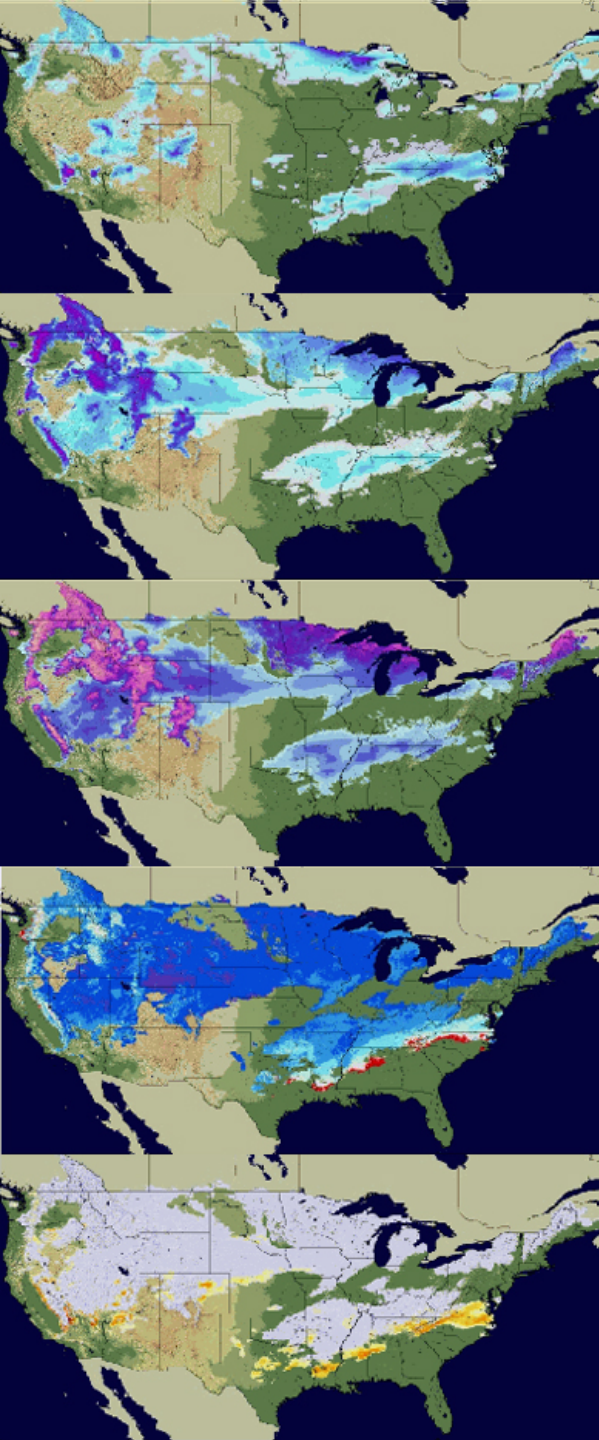
[www.nohrsc.noaa.gov](http://www.nohrsc.noaa.gov)

[Donald.Cline@noaa.gov](mailto:Donald.Cline@noaa.gov)



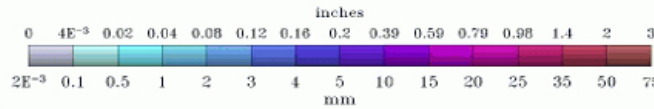
# National Snow Analyses

January 19, 2014 06 UTC



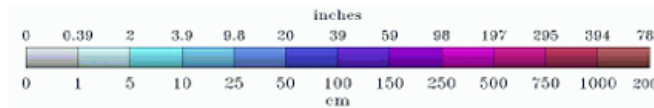
## Snowfall

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



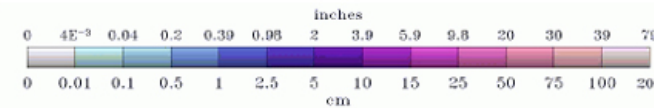
## Snow Depth

2006-02-21 06 UTC



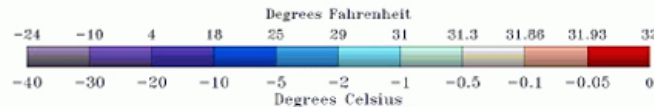
## Snow Water Equivalent

2006-02-21 06 UTC



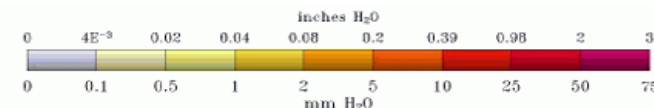
## Snowpack Temperature

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



## Snow Melt

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



## • PRODUCTS

- Hourly and Daily
- 1 km<sup>2</sup> 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

# National Snow Analyses (NSA)

**Multi-sensor  
Snow Observations**

**Snow Modeling and  
Data Assimilation**

**Snow Information  
Products**

**Ground**

**Airborne**

**Satellite**

**Numerical Weather  
Prediction Model  
Forcings**

**Gridded Snow  
Characteristics**

**U.S.**

**1-km<sup>2</sup>**

**Hourly**

**Data Products**

**Interactive  
Maps**

**Time Series  
Plots**

**Text  
Discussions**

# National Snow Analyses (NSA)

## Multi-sensor Snow Observations



**Ground**



**Airborne**



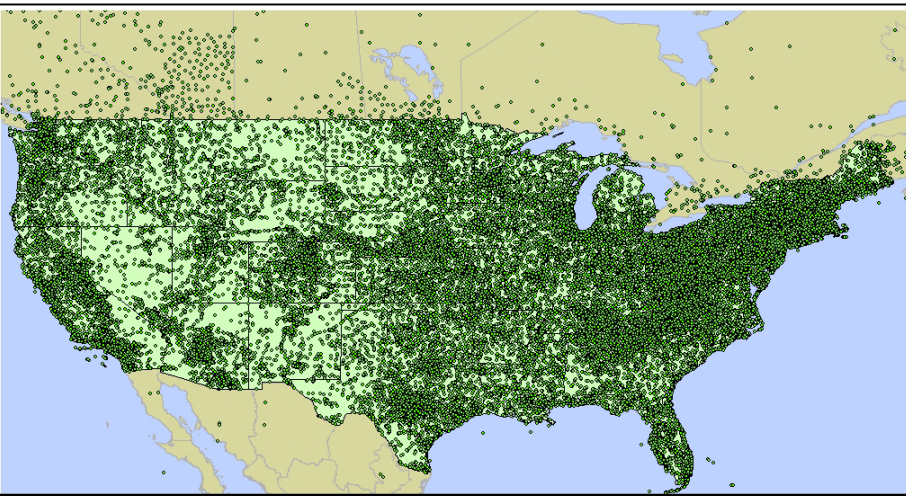
**Satellite**

- **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**

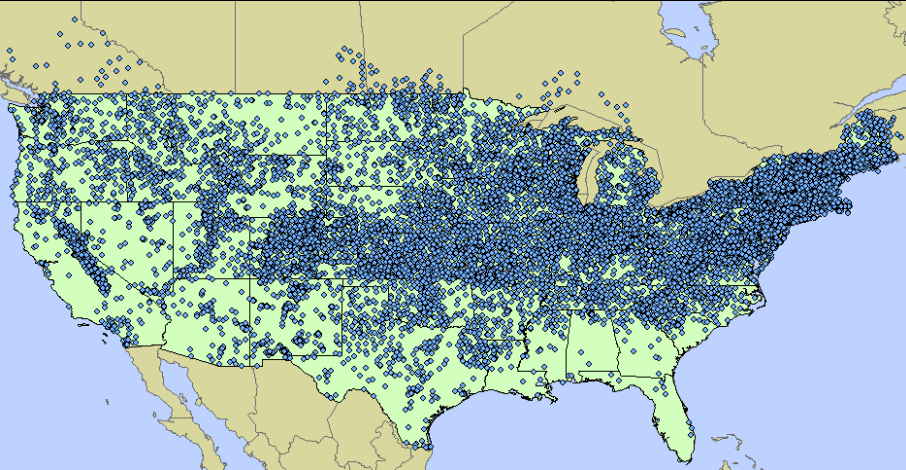
# Ground Observations

All Reporting Stations



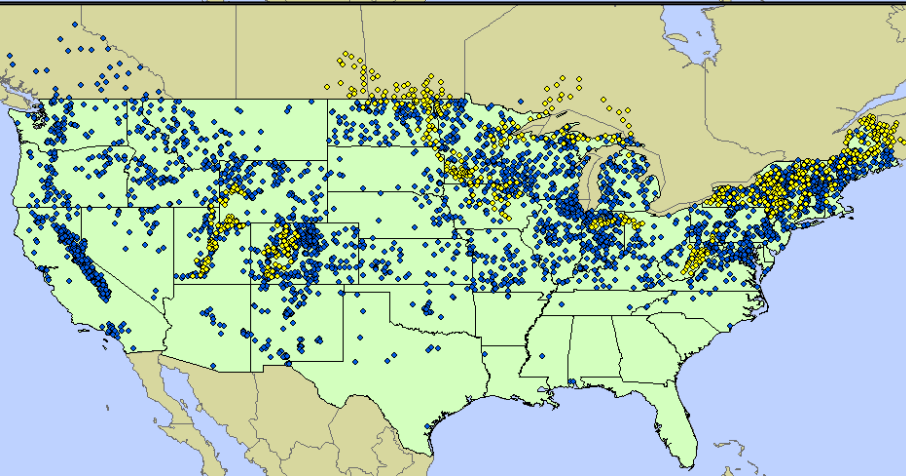
## All Snow Observations

Typical Day: 3500 Observations  
from 16,000 stations



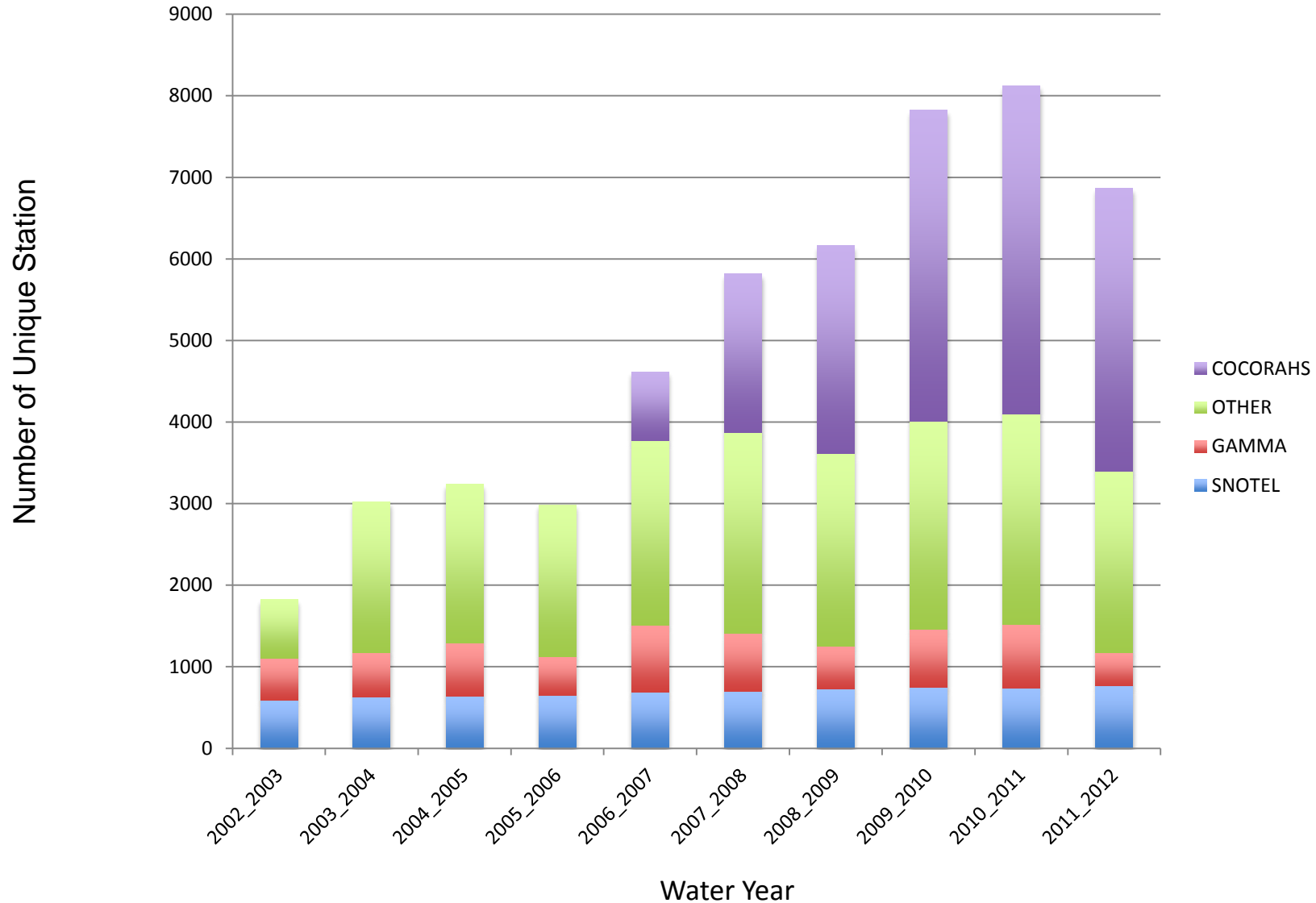
## Snow Water Equivalent

Typical Day: 850 Observations  
from 3,000 stations



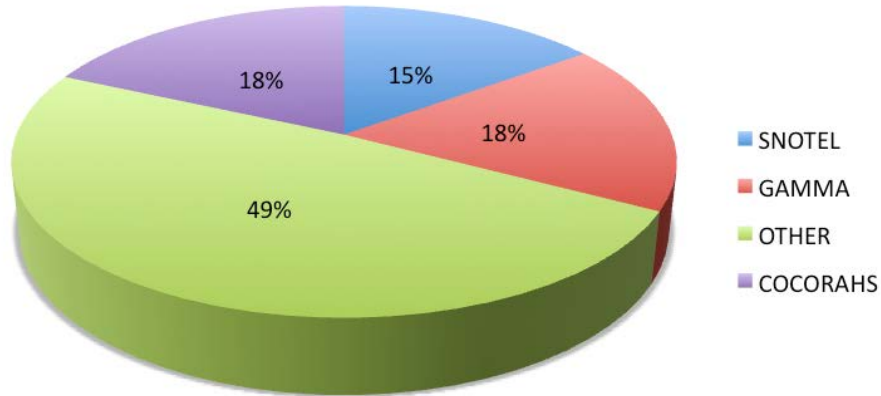
In 2012 NOHRSC received 6,370,790  
SWE observations and 8,234,088 Snow  
Depth observations

# Snow Water Equivalent Stations

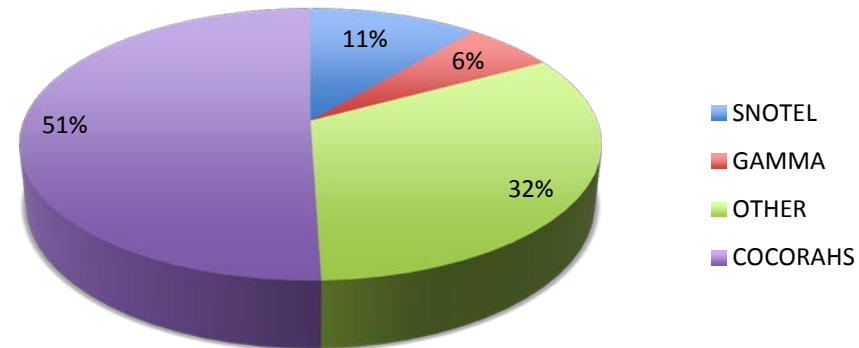


# Snow Water Equivalent Stations

Unique SWE Stations 2006-2007



Unique SWE Stations 2011-2012



- NOHRSC started ingesting CoCoRaHS data in 2006
- Since 2006 the number of SWE stations has increase from ~4000 to more than ~8000 stations.
- The total contribution of SWE reporting stations from CoCoRaHS has increased from 18% to 51% !

# National Snow Analyses (NSA)

## Multi-sensor Snow Observations

Ground

Airborne

Satellite

## NWS Airborne Snow Survey Program



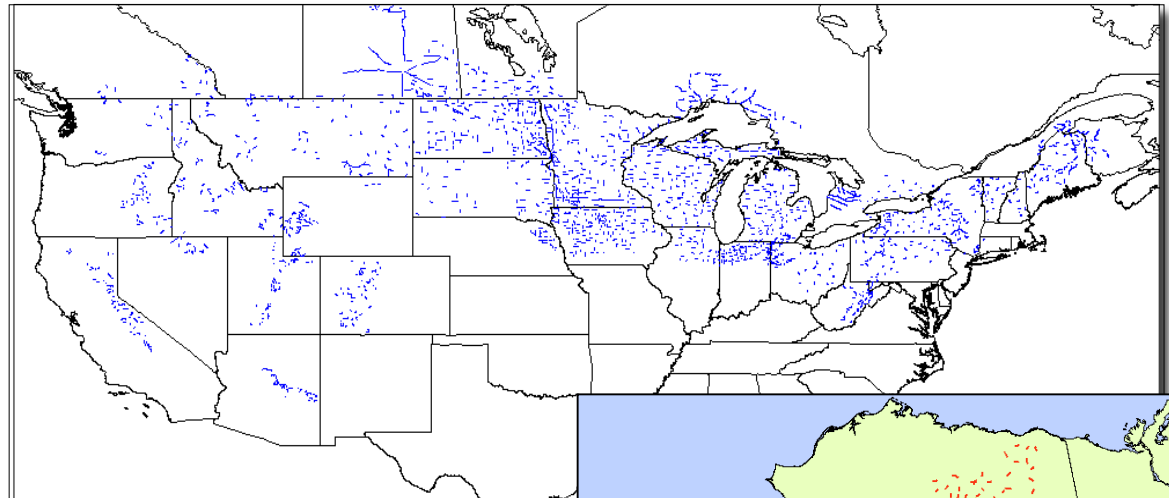
- **Snow Water Equivalent Measurement**
  - Attenuation of natural terrestrial gamma radiation by water in snow

# National Snow Analyses (NSA)

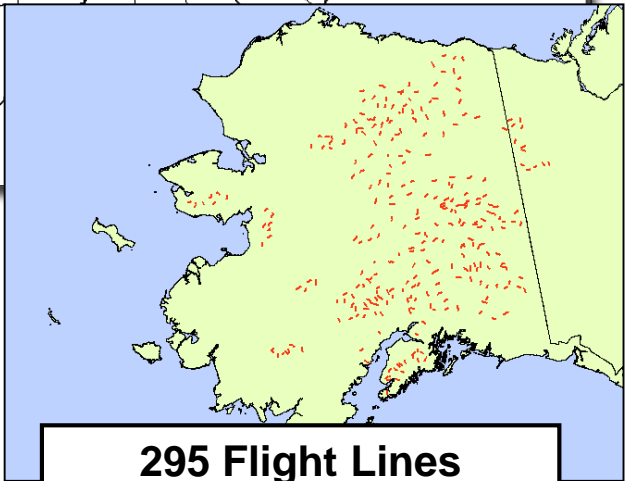
## Multi-sensor Snow Observations



## Airborne Snow Survey Program Flight Line Network



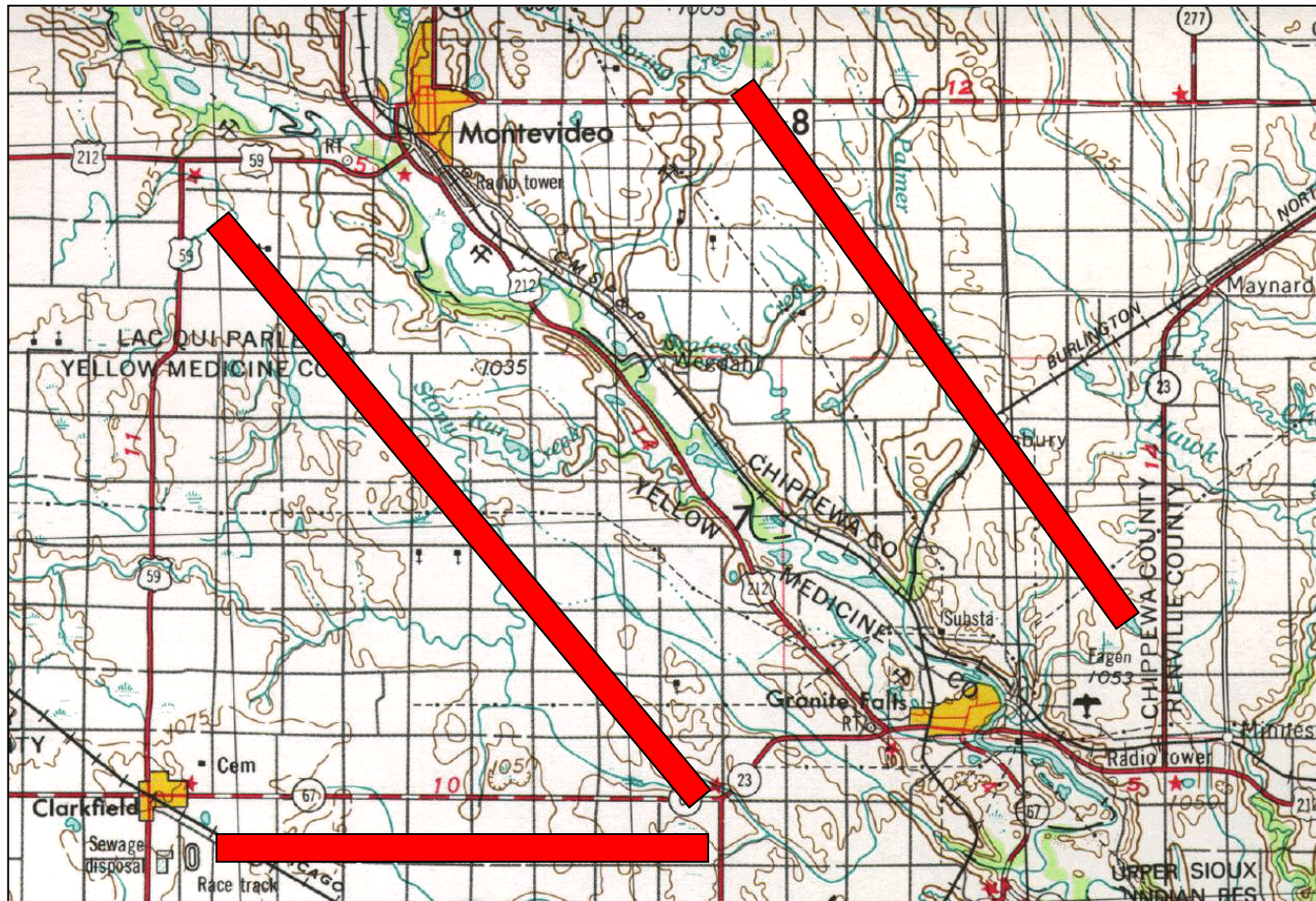
**2,291 Flight Lines**  
31 States, 8 Provinces



**295 Flight Lines**  
Added 104 lines Summer of 2006

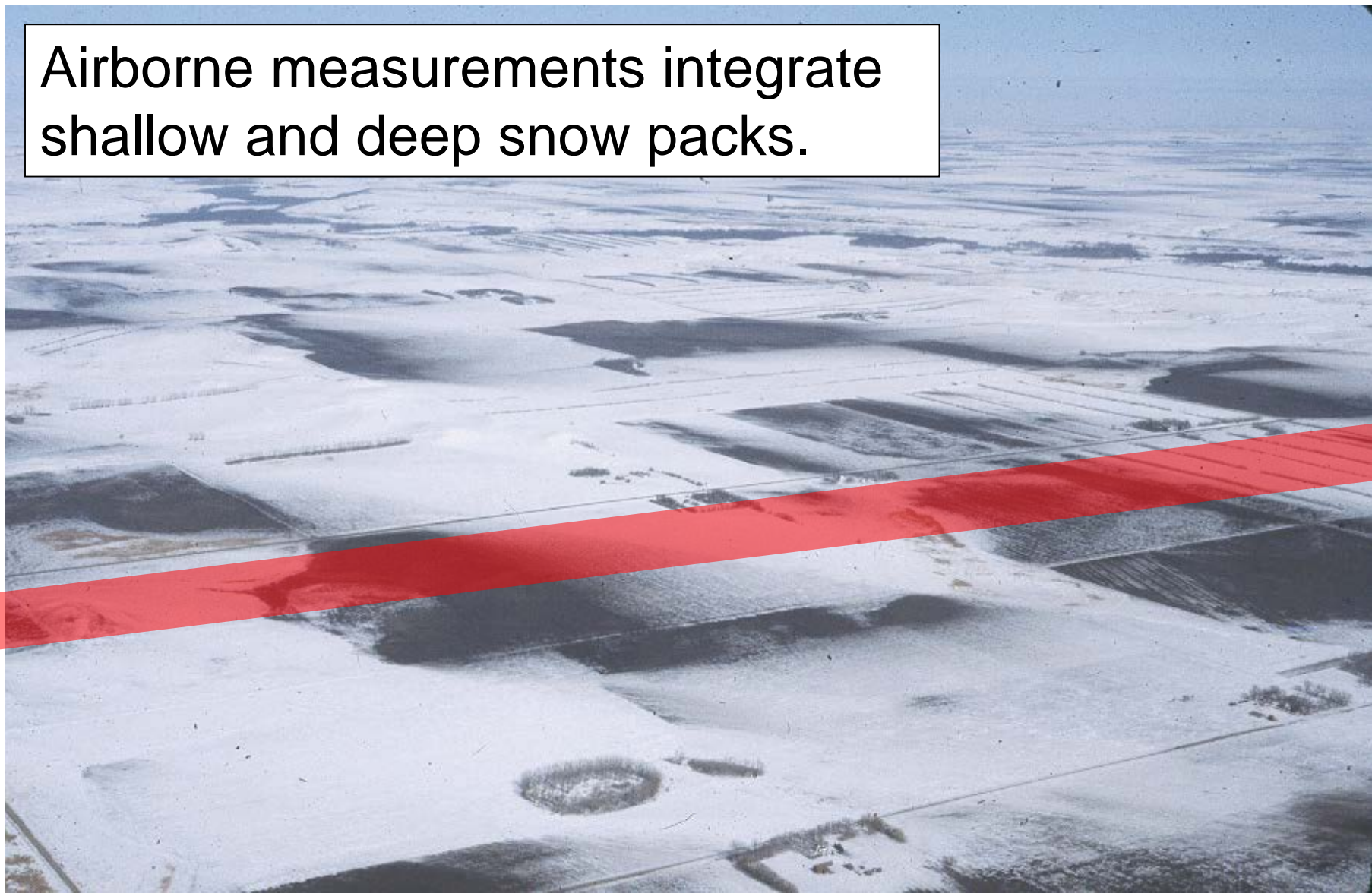
- Integrated SWE over ~5-10 km<sup>2</sup> (robust mean)
- Sample over elevation range
- Upper SWE limit ~ 1 m

# Typical Flight Line

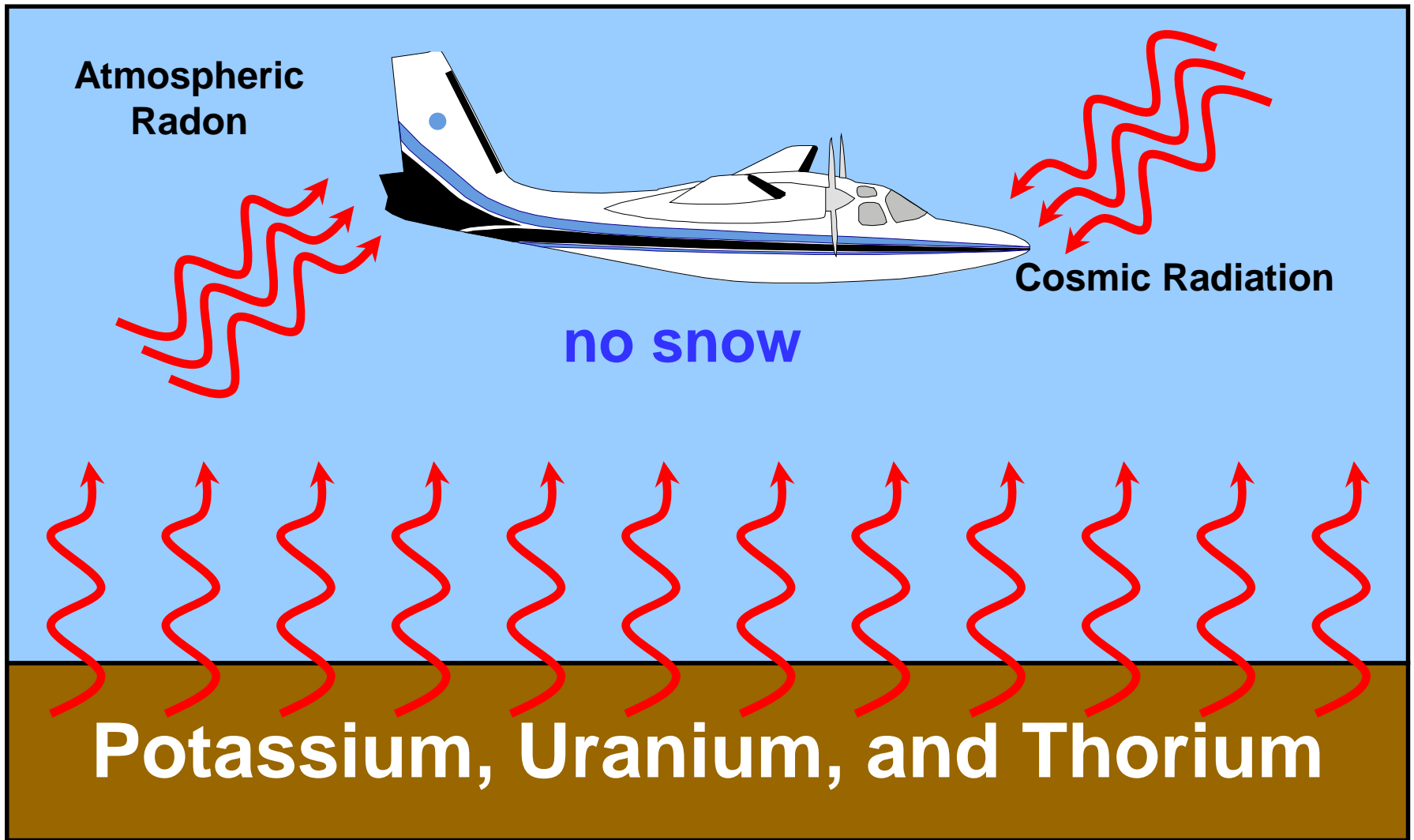


**25 km long by 0.3 km wide  
(7.5 km<sup>2</sup> area)**

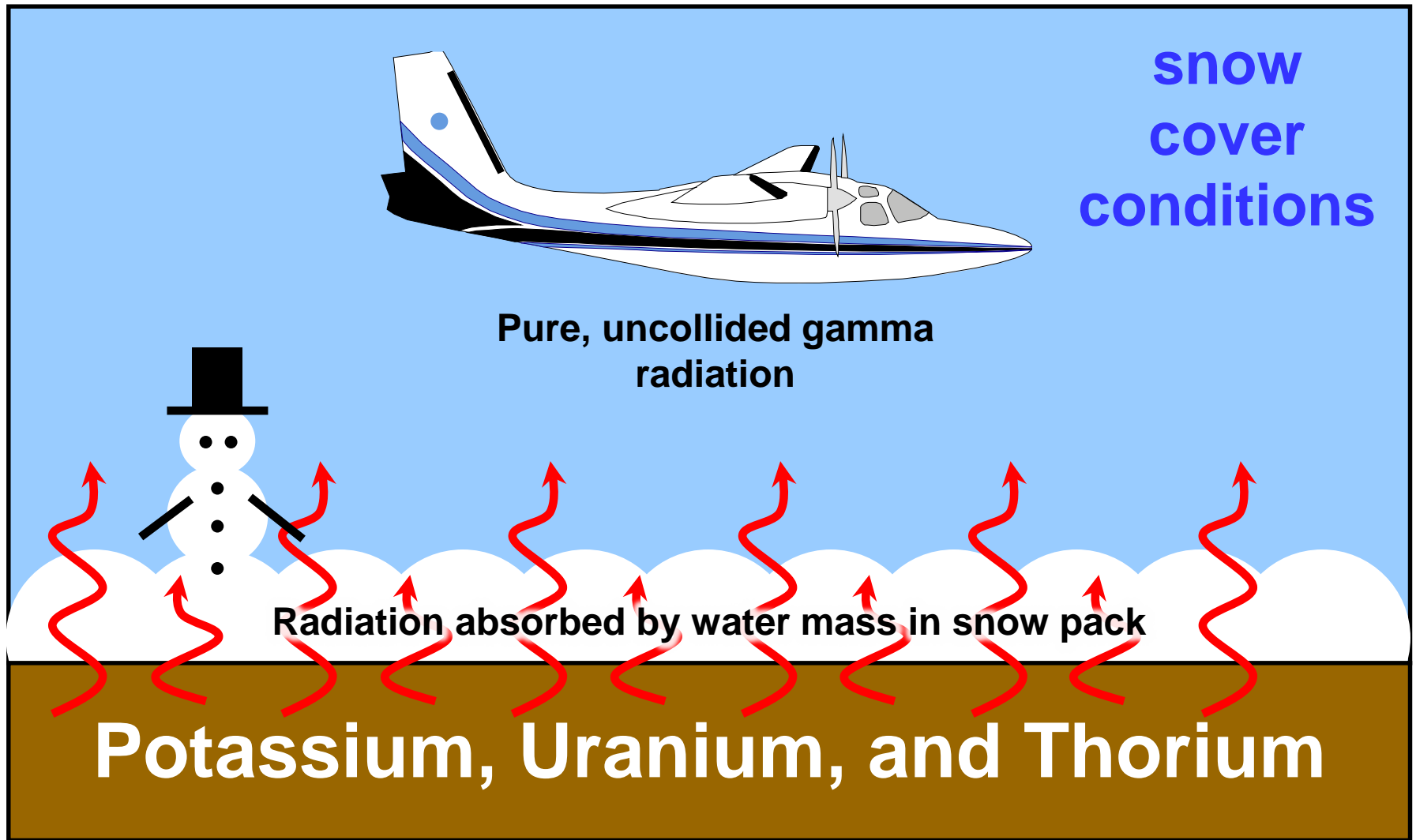
Airborne measurements integrate shallow and deep snow packs.



# Natural Terrestrial Gamma Radiation



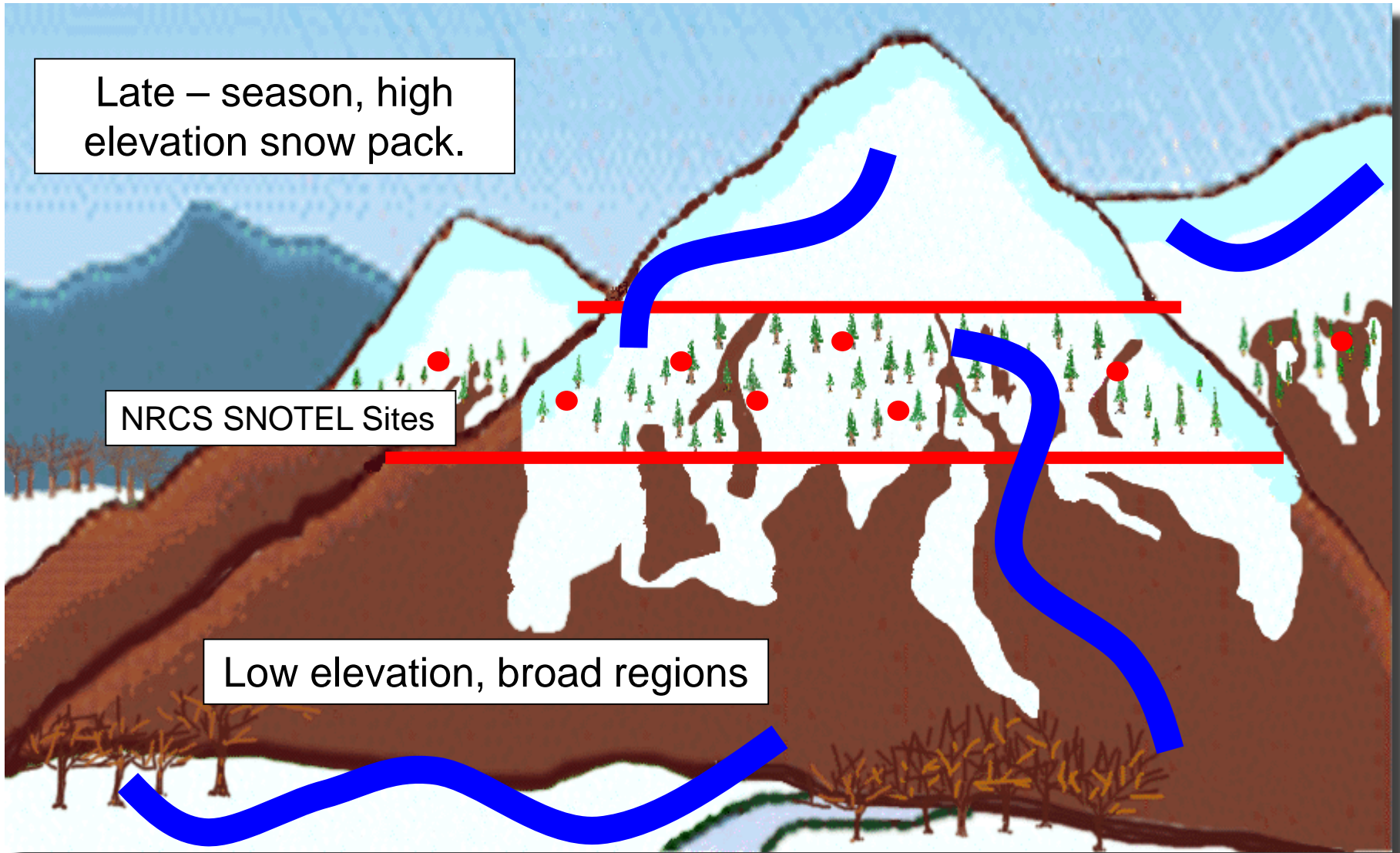
# Natural Terrestrial Gamma Radiation



Ground ice 5-10 cm thick is hydrologically important and observed as snow water equivalent.



# Airborne Flight Line Network



# National Snow Analyses (NSA)

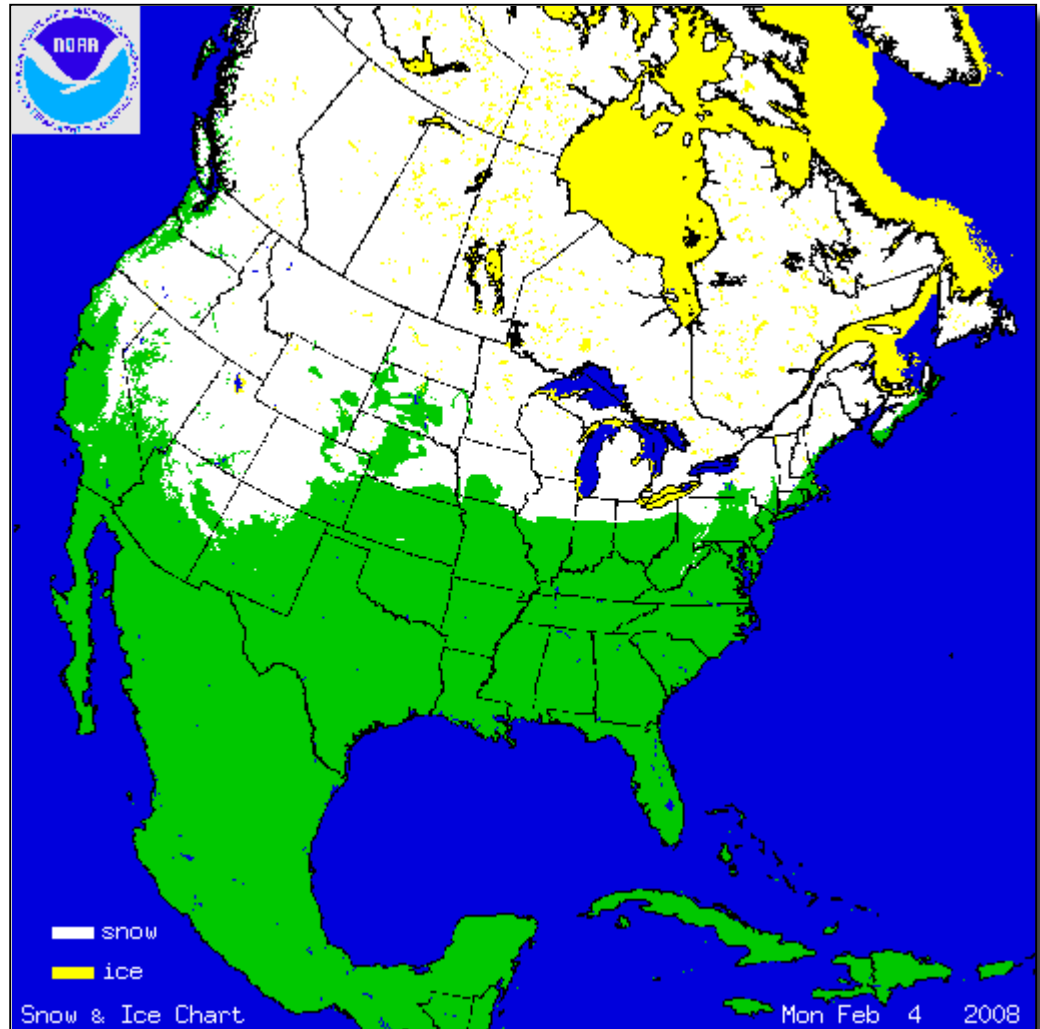
## Binary Snow Cover

### Multi-sensor Snow Observations

Ground

Airborne

Satellite



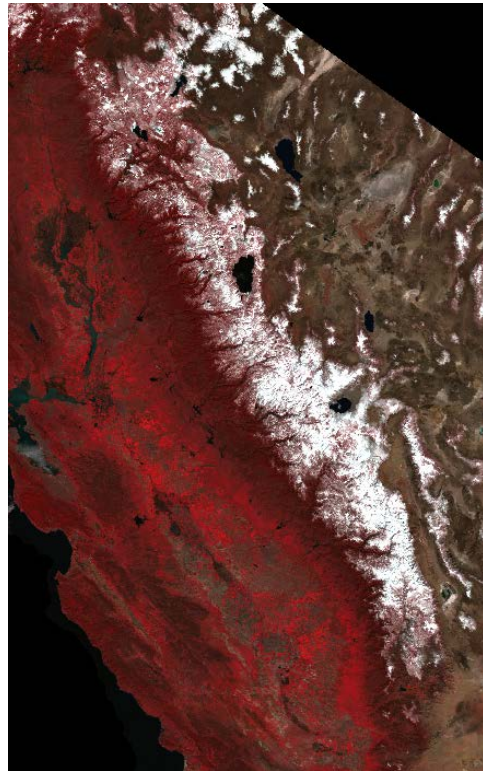
# National Snow Analyses (NSA)

## Multi-sensor Snow Observations

Ground

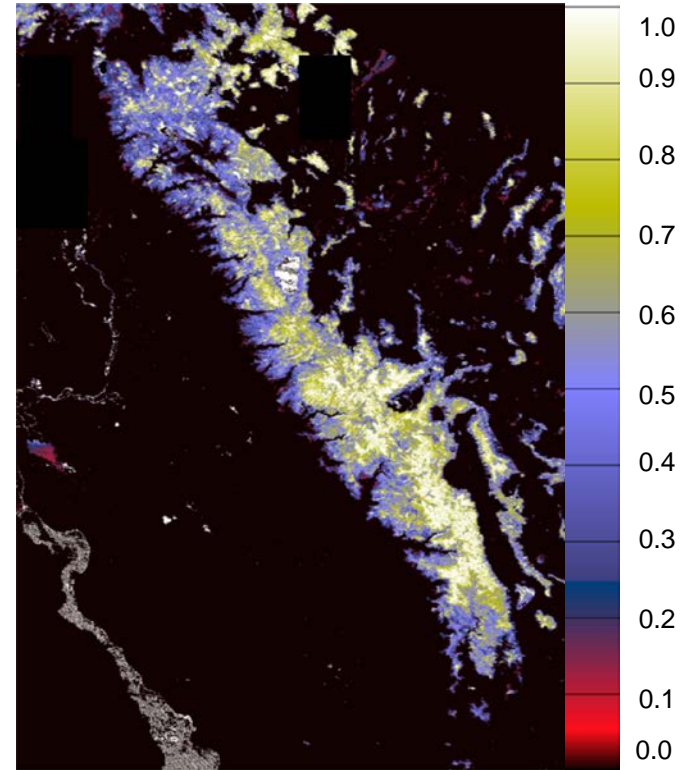
Airborne

Satellite

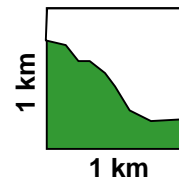


EOS Terra  
MODIS

Sierra Nevada, Mar 7 2004



Fractional Snow Cover



$SCA_{frac} = 0.5$

# National Snow Analyses (NSA)

**Multi-sensor  
Snow Observations**

**Snow Modeling and  
Data Assimilation**

**Snow Information  
Products**

**Ground**

**Airborne**

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**Numerical Weather  
Prediction Model  
Forcings**

**Gridded Snow  
Characteristics**

**U.S.**

**1-km<sup>2</sup>**

**Hourly**

**Data Products**

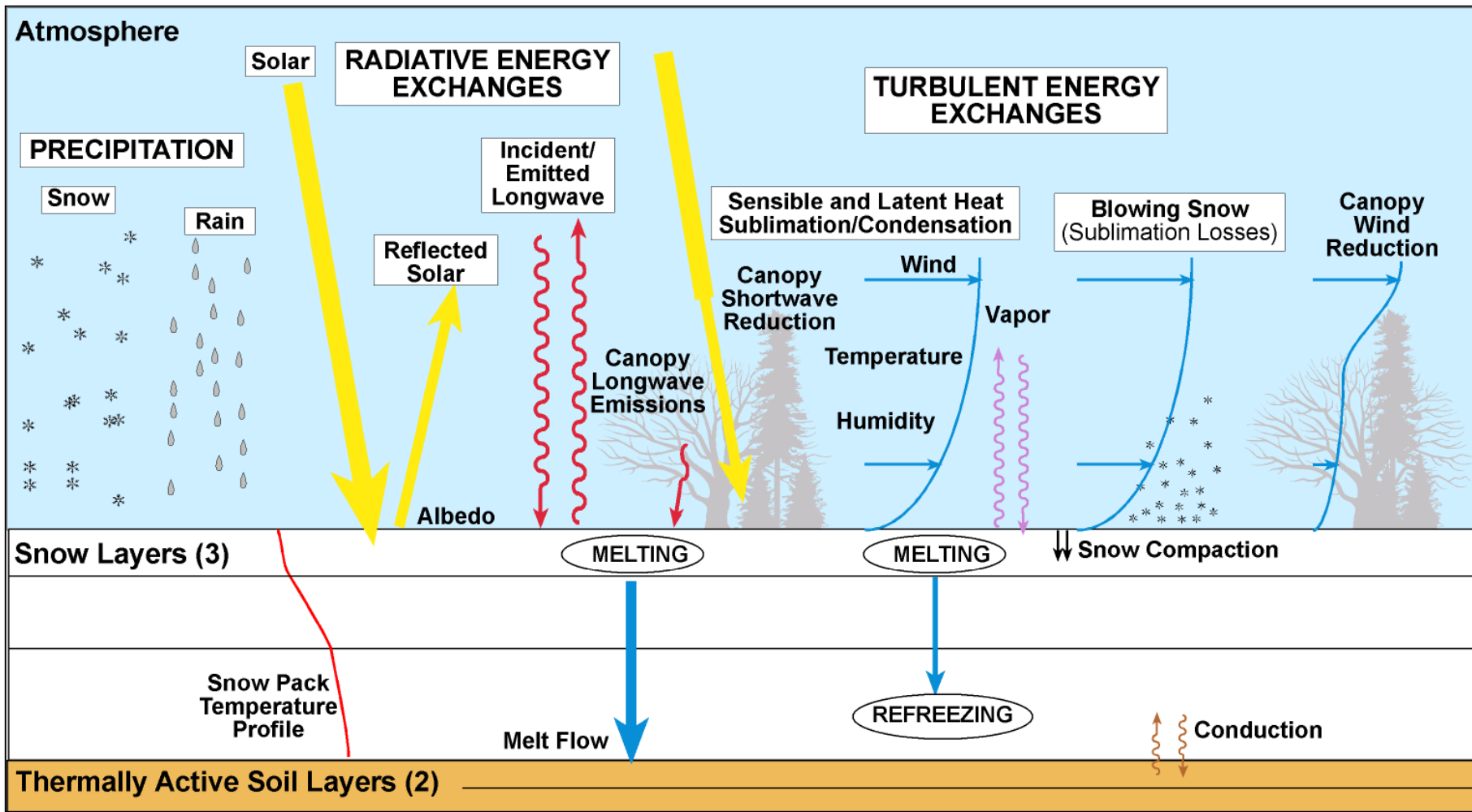
**Interactive  
Maps**

**Time Series  
Plots**

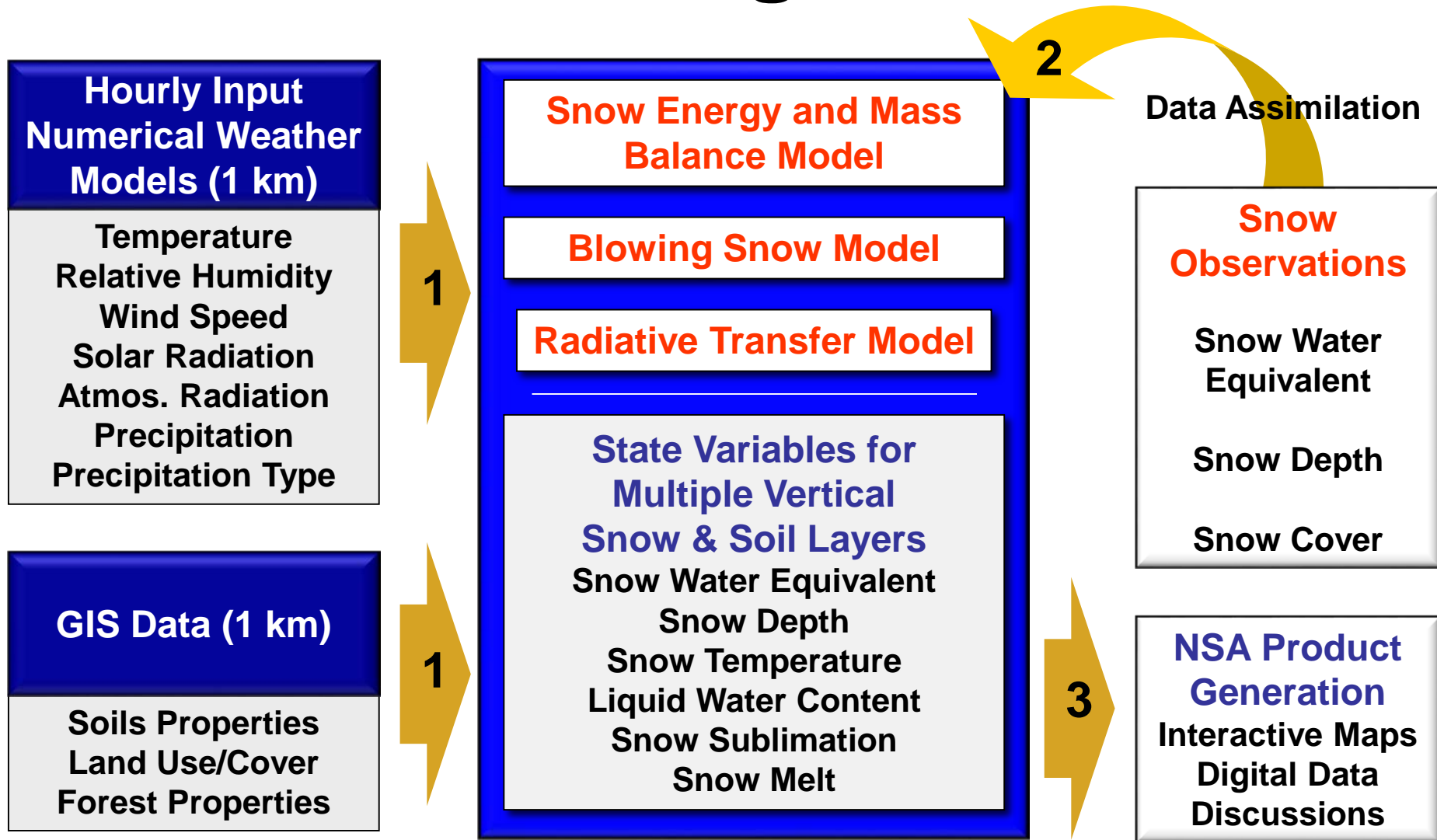
**Text  
Discussions**

# NOHRSC Snow Model Physics

$$(K\downarrow - K\uparrow) + (L\downarrow - L\uparrow) + Q_e + Q_h + Q_g + Q_p = \Delta Q$$



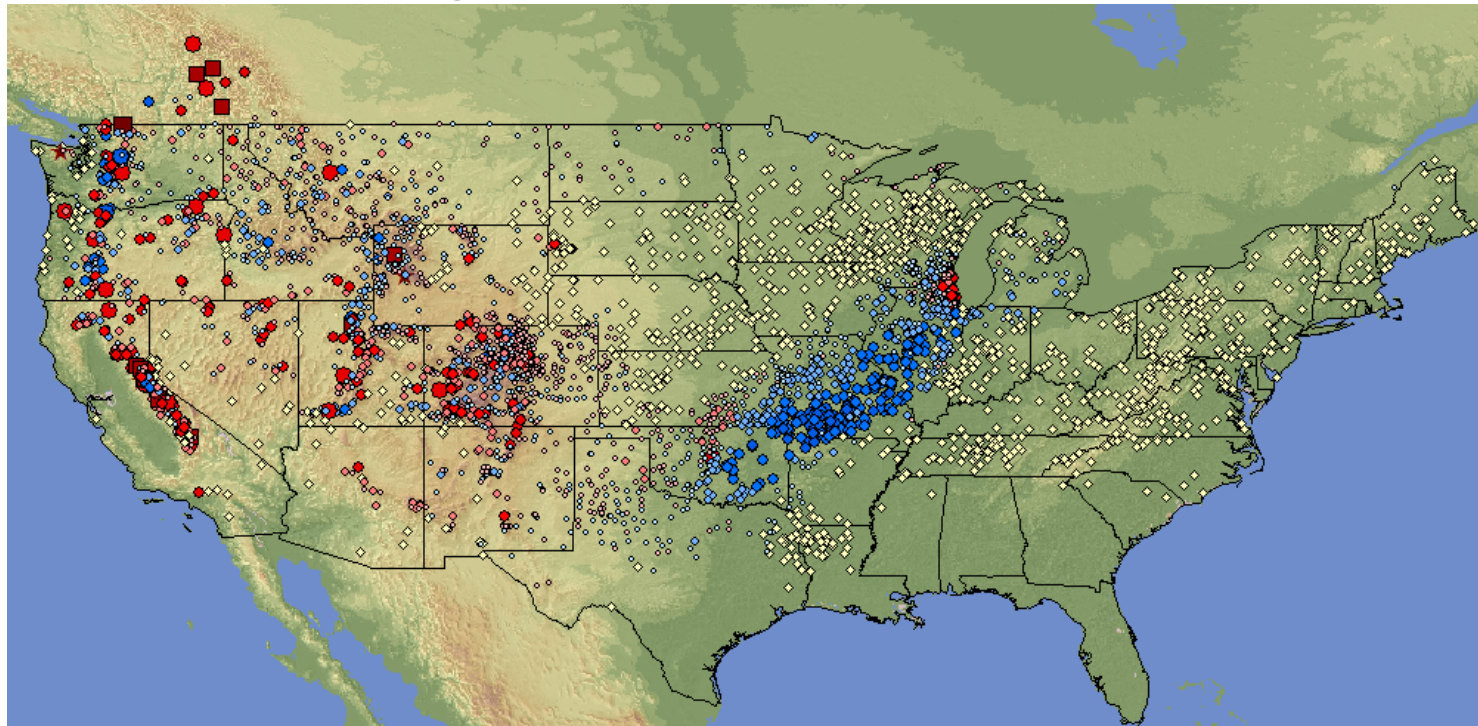
# Snow Modeling Framework



# Snow Observation Assimilation

*Daily SWE, Snow Depth and Snow Cover Observations  
are used to update the model*

If pattern of differences is explainable, an update field is generated and used to nudge the model toward observed states



- **Uncertainties in driving data**

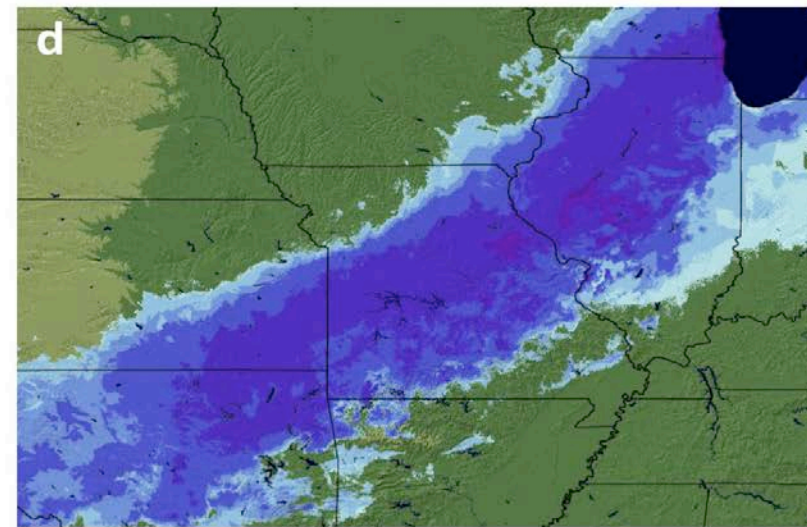
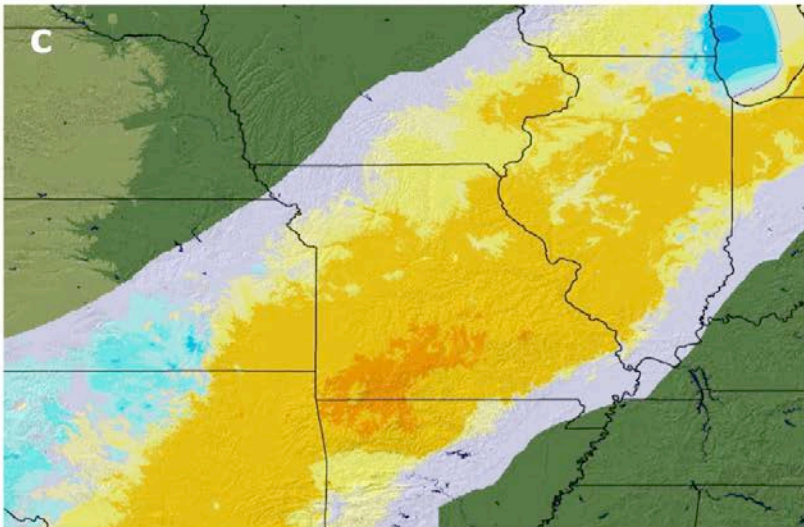
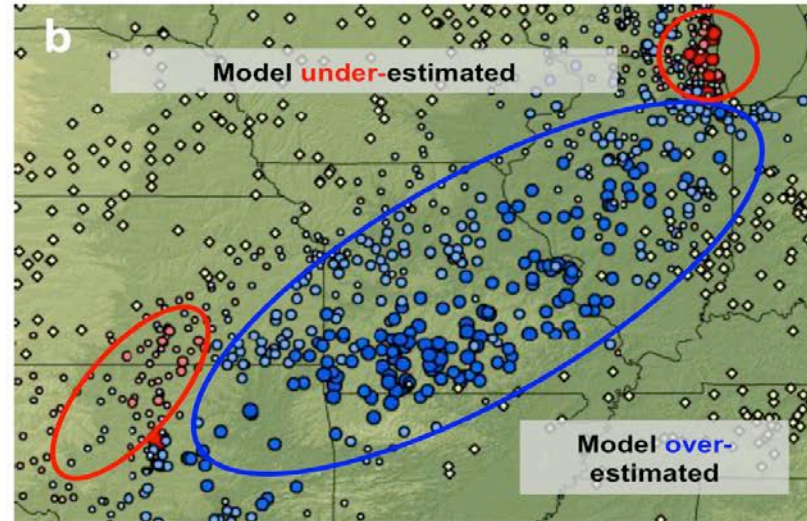
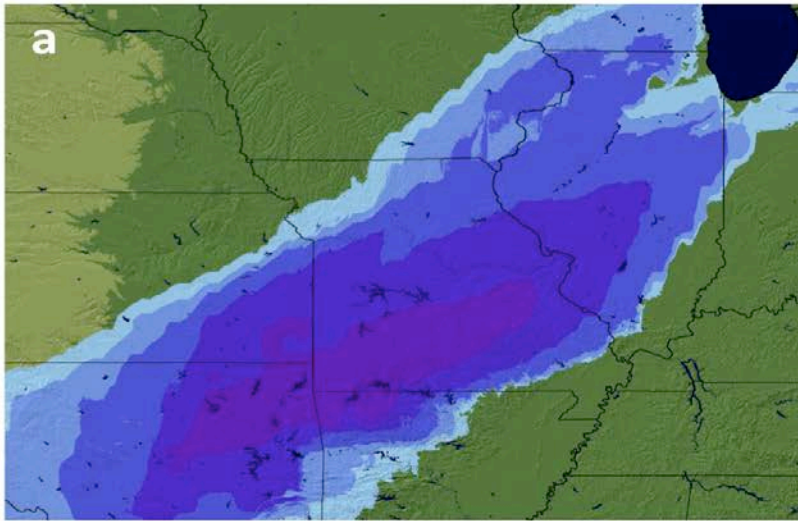
- RUC2 precipitation under/over estimation
- Typing issue; rain/ snow
- Placement of storm track

- **Uncertainties due to model physics**

- Melt problems due to temperature bias
- Sublimation rates

# Assimilation Example

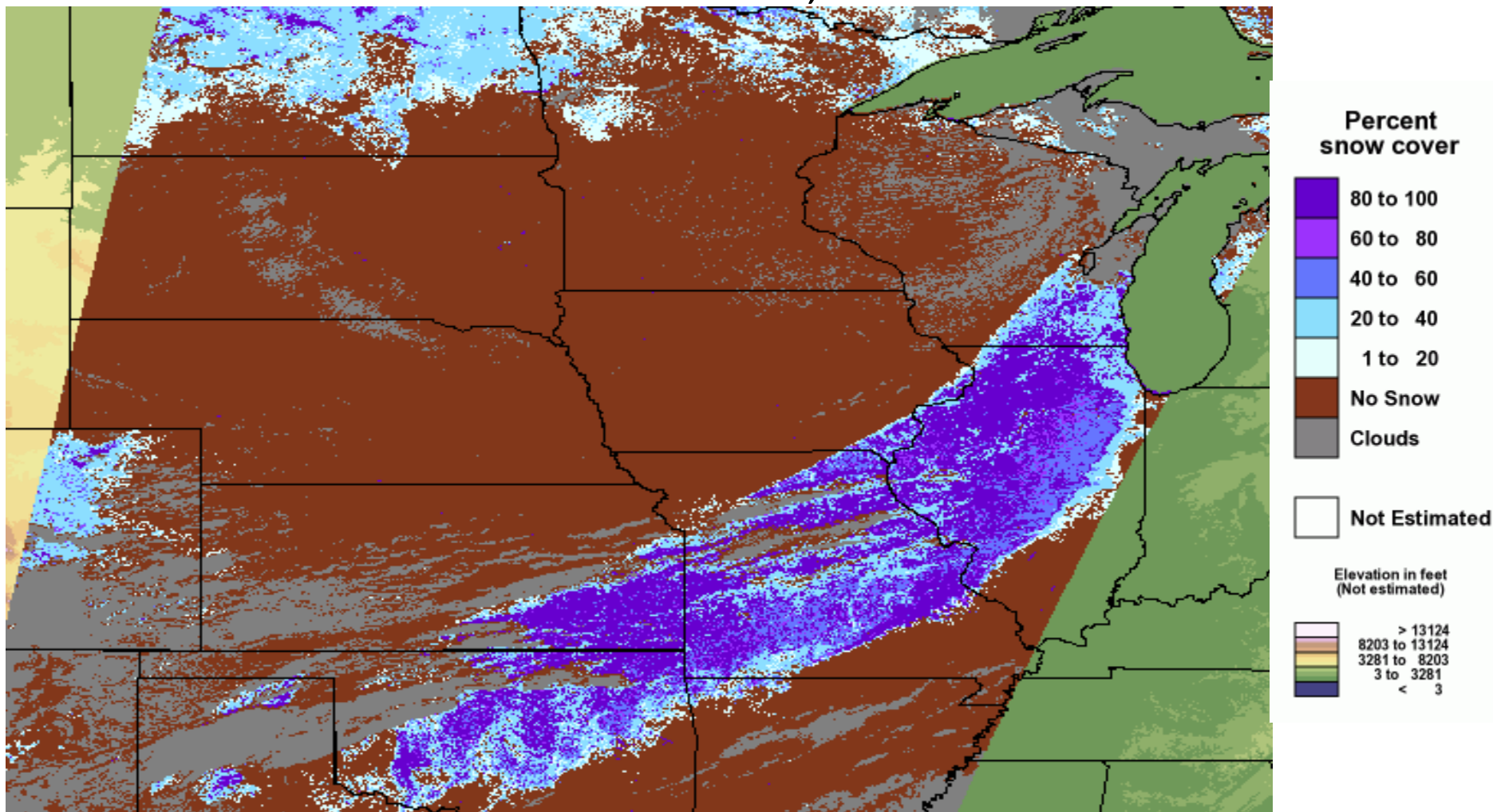
Following a November 30 2006 Storm



# Assimilation Example

## Satellite-Derived Fractional Snow Cover

December 2, 2006





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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



# Nati

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## NA

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Snow Reports



Select Region and Date  
National



Animate: Season — Two weeks — One Day



Animate: Season — Two weeks — One Day



Animate: Season — Two weeks — One Day

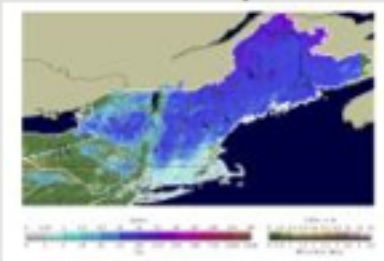
### Select Region and Date

#### Snow Water Equivalent



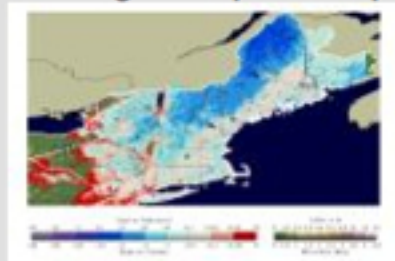
Animate: Season — Two weeks — One Day

#### Snow Depth



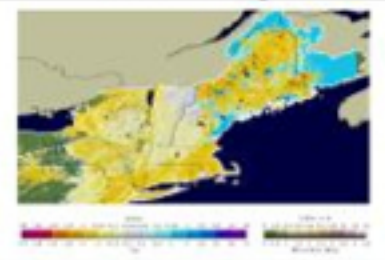
Animate: Season — Two weeks — One Day

#### Average Snowpack Temp



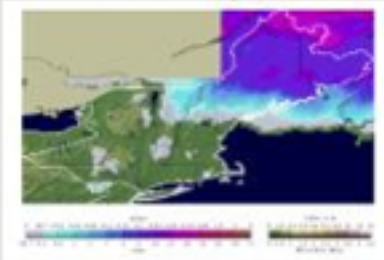
Animate: Season — Two weeks — One Day

#### SWE Change



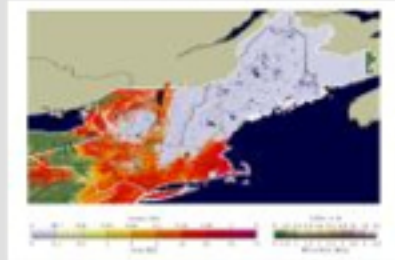
Animate: Season — Two weeks — One Day

#### Snow Precipitation



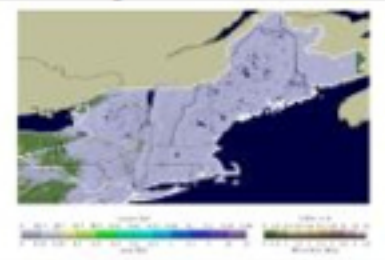
Animate: Season — Two weeks — One Day

#### Snow Melt



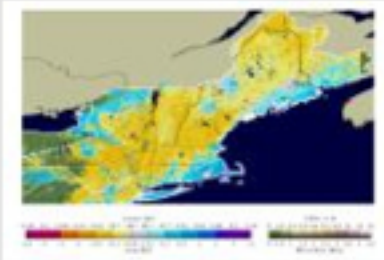
Animate: Season — Two weeks — One Day

#### Blowing Snow Sublimation



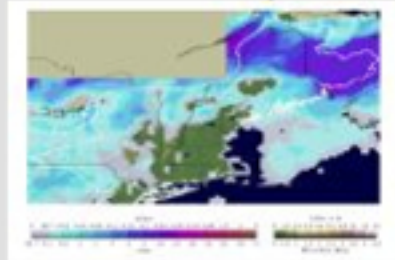
Animate: Season — Two weeks — One Day

#### Surface Sublimation



Animate: Season — Two weeks — One Day

#### Non-Snow Precipitation



Animate: Season — Two weeks — One Day



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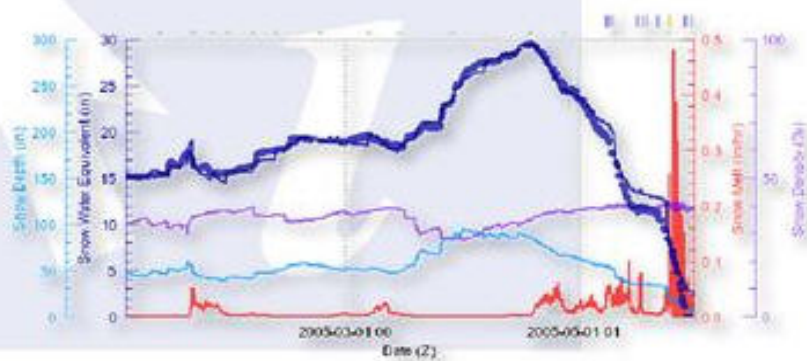
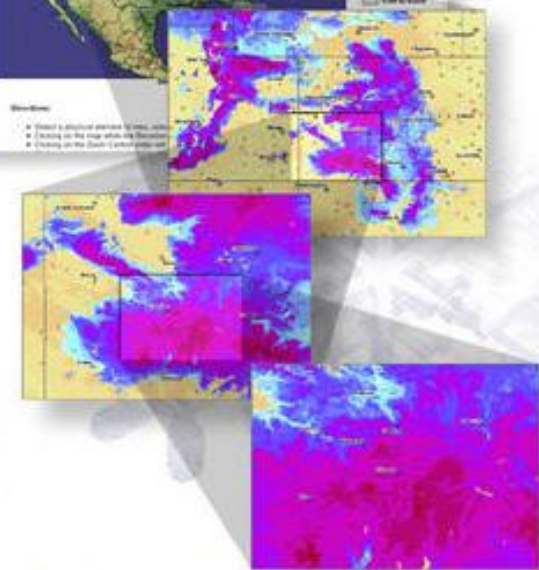
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## INTERACTIVE SNOW MAPS

Explore our online GIS for comprehensive snow information.

- Build custom maps for your region of interest
- Choose from over 40 snow themes
- Overlay roads, cities, rivers, etc.
- Query detailed conditions at over 20,000 locations

Get detailed snowpack conditions at over 4000 stations nationwide using the query tool.



Explore Snow





National Operational Hydrologic Remote Sensing Center

Interactive Snow Information

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Get Time Series for Basin ID:  ABRFC  [Listing](#)

Get Basin Averages for  RFC  [Listing](#)

Get Climatology for Station ID:  Go [Listing](#)

Navigation Tools

Home Help Comments

Query

Redraw Map

Select Physical Element

Snow Water Equivalent

Select Date

2012  December

18  3:00 Z

Snap to nearest time

Select Overlays

Hydrologic Features

- RFC Basins  Label
- Other Basins  Label
- HUCs (6-digit)
- RFC Boundaries
- 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
- Skiing  Label

Transportation Features

- Roads and Highways

Other features

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

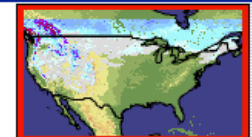
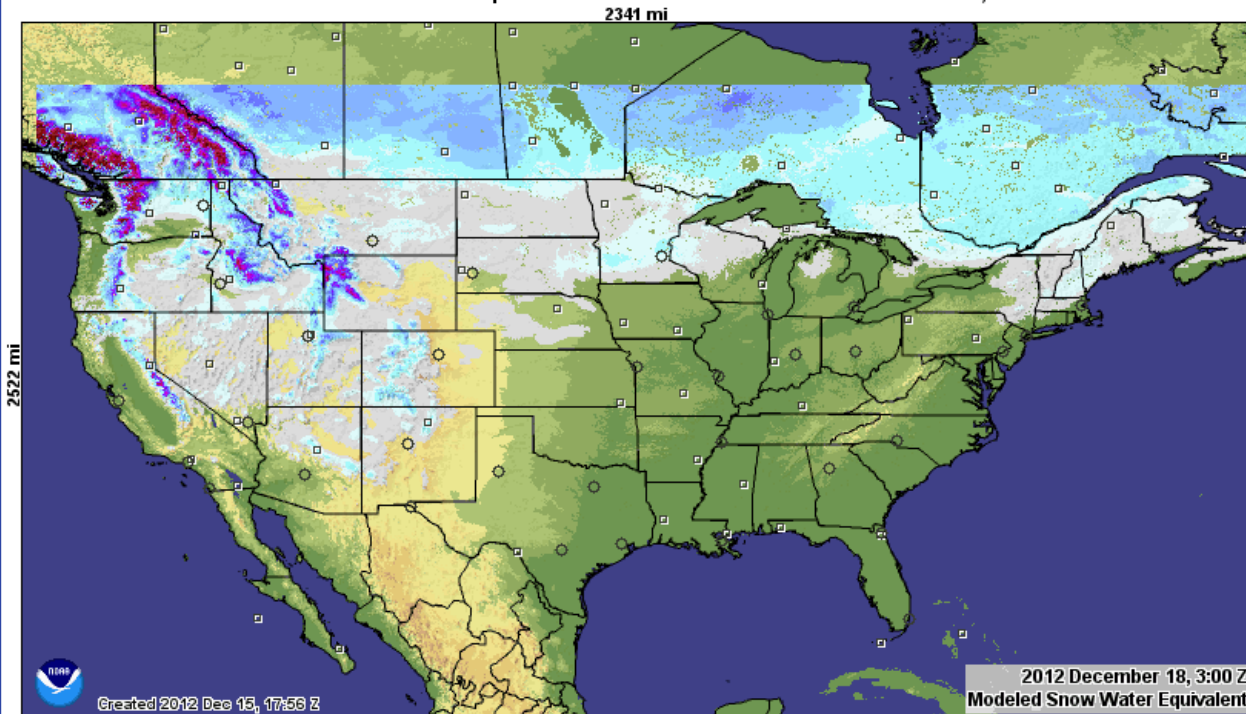
Map Preferences

English units

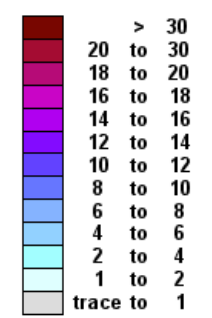
Legend below map

Background image

Modeled Snow Water Equivalent forecasted for 2012 December 18, 3:00 Z



Inches of water equivalent



Not Estimated

Elevation in feet



SNODAS Model Adjustments:

An assimilation was performed December 13, 2012 over the western United States and Canada. Throughout the Sierra Nevada and Cascade Range up to 1.5 inches of water was added to the snowpack to adjust the model for over estimating snow melt. In the Yellowstone region and across eastern Montana, up to an inch of water was removed from the snow pack. Additionally, another assimilation was performed over Arkansas and Mississippi to correct the model for precipitation that was misclassified due to temperatures being reported incorrectly. This inconsistency will be monitored and adjusted accordingly as the model continues to run.



National Operational Hydrologic Remote Sensing Center

Interactive Snow Information

Quick Query Links

Get Time Series for Station ID:  Go [Listing](#)  
 Get Time Series for Basin ID:  ABRFC  [Listing](#)  
 Get Basin Averages for  RFC  [Listing](#)  
 Get Climatology for Station ID:  Go [Listing](#)

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- Skiing  Label

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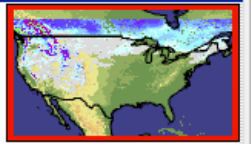
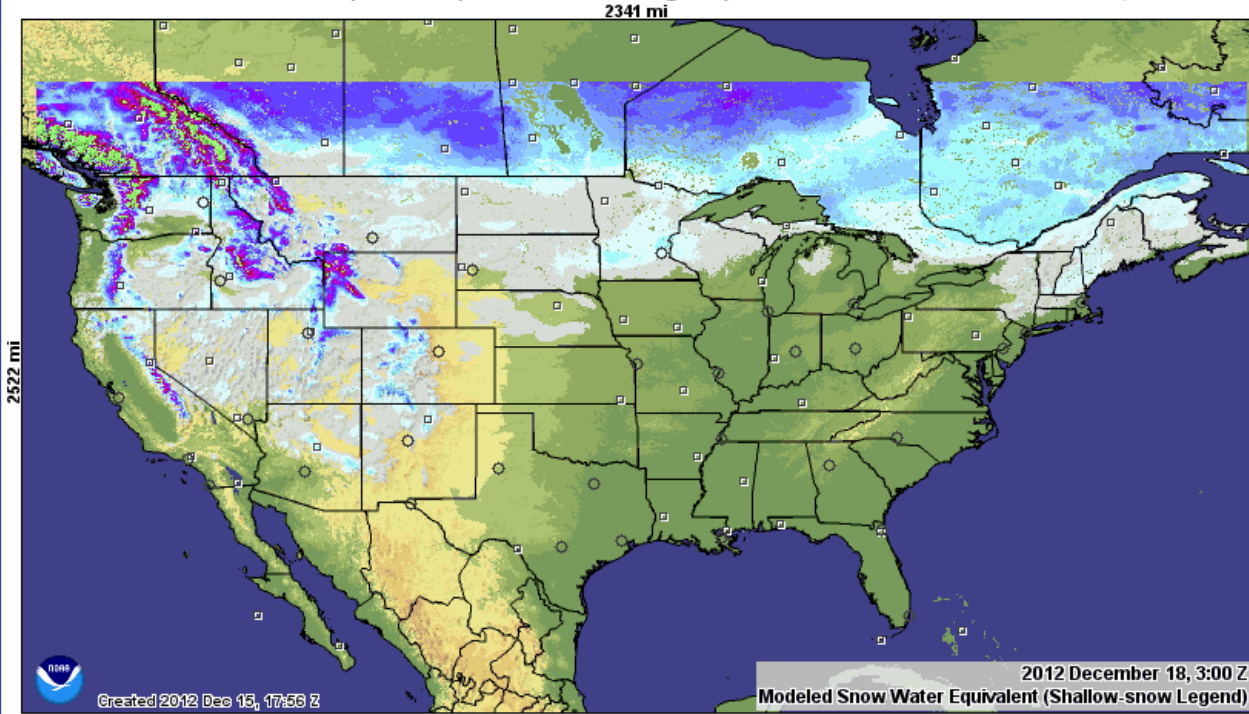
Other features

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

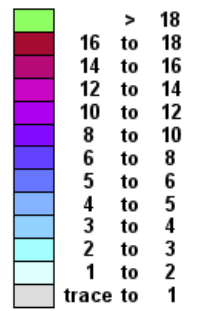
Map Preferences

- Legend below map
- Background image

Modeled Snow Water Equivalent (Shallow-snow Legend) forecasted for 2012 December 18, 3:00 Z

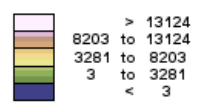


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Get Time Series for Station ID:   [Listing](#)  
 Get Time Series for Basin ID:  ABRFC  [Listing](#)  
 Get Basin Averages for  RFC  [Listing](#)  
 Get Climatology for Station ID:   [Listing](#)

Navigation Tools

Query

Redraw Map

Select Physical Element

SWE Change

Select Date

2012 December 17 6:00 Z  
   
 Snap to nearest time

Select Overlays

Hydrologic Features

- RFC Basins  Label
- Other Basins  Label
- HUCs (6-digit)
- RFC Boundaries
- 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
- Skiing  Label

Transportation Features

- Roads and Highways

Other features

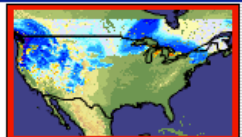
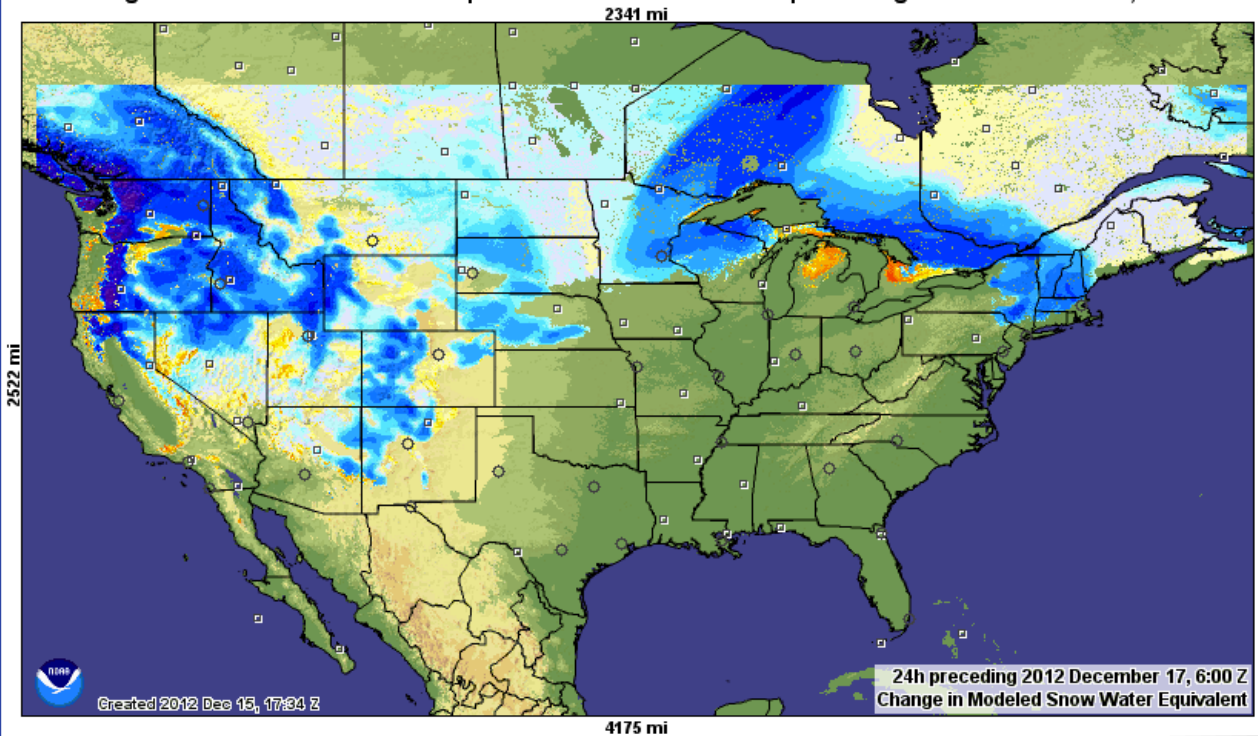
- NSA Disc. Regions
- NSA Disc. Subregions
- NSA Modelling Tiles

Map Preferences

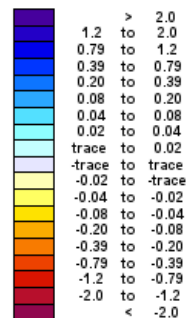
English units

- Legend below map
- Background image

Change in Modeled Snow Water Equivalent forecasted for 24h preceding 2012 December 17, 6:00 Z

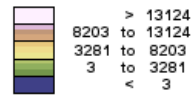


Inches of water equivalent



Not Estimated

Elevation in feet



SNODAS Model Adjustments:

An assimilation was performed December 13, 2012 over the western United States and Canada. Throughout the Sierra Nevada and Cascade Range up to 1.5 inches of water was added to the snowpack to adjust the model for over estimating snow melt. In the Yellowstone region and across eastern Montana, up to an inch of water was removed from the snow pack. Additionally, another assimilation was performed over Arkansas and Mississippi to correct the model for precipitation that was misclassified due to temperatures being reported incorrectly. This inconsistency will be monitored and adjusted accordingly as the model continues to run.



National Operational Hydrologic Remote Sensing Center

# Interactive Snow Information

## 24 hour Total Melt

Quick Query Links

Get Time Series for Station ID:   [Listing](#)  
 Get Time Series for Basin ID:  ABRFC  [Listing](#)  
 Get Basin Averages for  RFC  [Listing](#)  
 Get Climatology for Station ID:   [Listing](#)

Navigation Tools

Home Help Comments

Query

Redraw Map

Select Physical Element

Select Date

Snap to nearest time

Select Overlays

Hydrologic Features

- RFC Basins  Label
- Other Basins  Label
- HUCs (6-digit)
- RFC Boundaries
- 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
- Skiing  Label

Transportation Features

- Roads and Highways

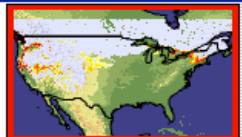
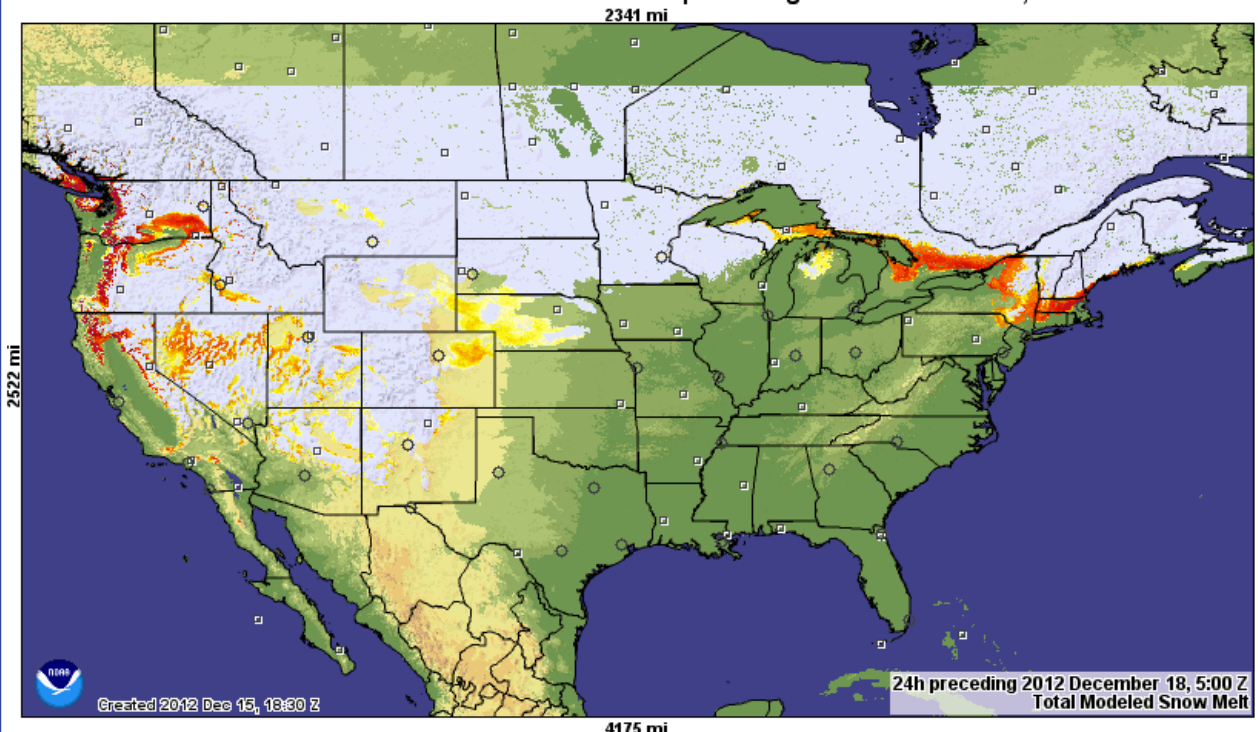
Other features

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

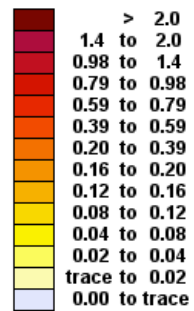
Map Preferences

- Legend below map
- Background image

Total Modeled Snow Melt forecasted for 24h preceding 2012 December 18, 5:00 Z

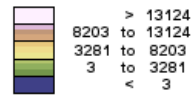


Inches of water equivalent



Not Estimated

Elevation in feet



SNODAS Model Adjustments:

An assimilation was performed December 13, 2012 over the western United States and Canada. Throughout the Sierra Nevada and Cascade Range up to 1.5 inches of water was added to the snowpack to adjust the model for over estimating snow melt. In the Yellowstone region and across eastern Montana, up to an inch of water was removed from the snow pack. Additionally, another assimilation was performed over Arkansas and Mississippi to correct the model for precipitation that was misclassified due to temperatures being reported incorrectly. This inconsistency will be monitored and adjusted accordingly as the model continues to run.



National Operational Hydrologic Remote Sensing Center

# Interactive Snow Information

## 48 hour Total Melt

Quick Query Links

Get Time Series for Station ID:   [Listing](#)  
 Get Time Series for Basin ID:  ABRFC  [Listing](#)  
 Get Basin Averages for  RFC  [Listing](#)  
 Get Climatology for Station ID:   [Listing](#)

Home Help Comments

Navigation Tools

Query

### Redraw Map

Select Physical Element

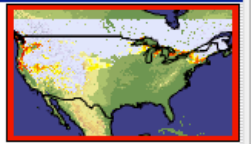
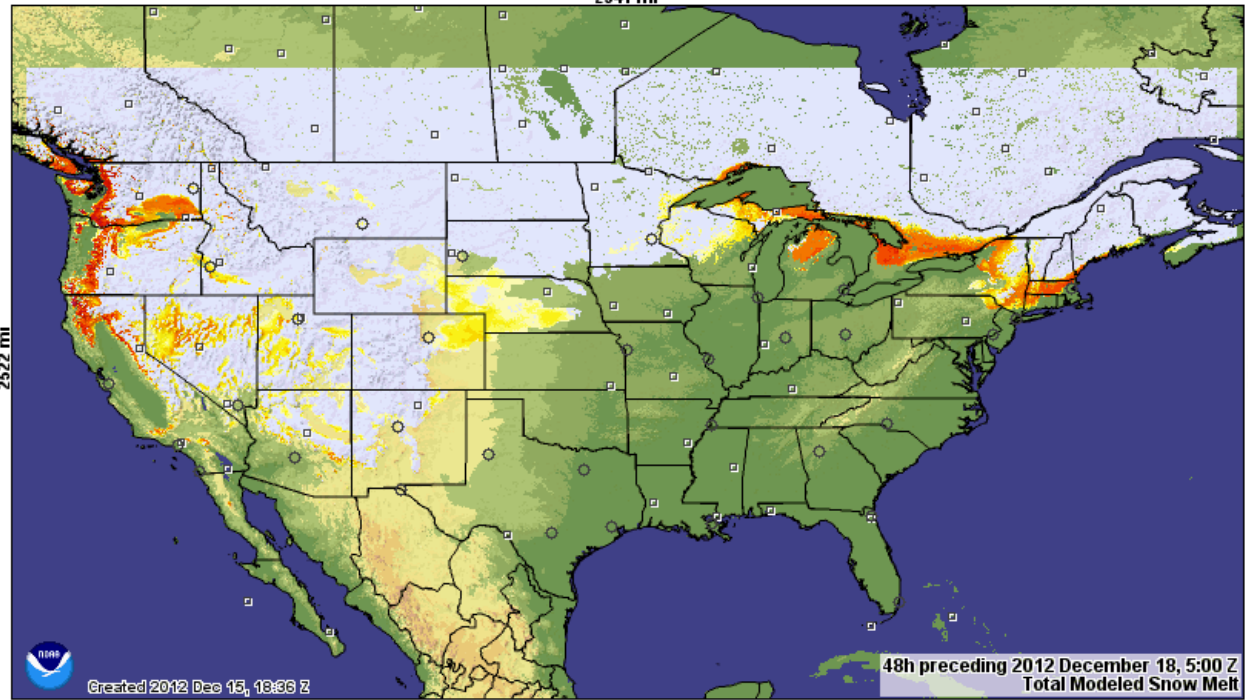
Select Date  
   
   
   
 Snap to nearest time

- Select Overlays
- Hydrologic Features**
- RFC Basins  Label
  - Other Basins  Label
  - HUCs (6-digit)
  - RFC Boundaries
  - 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
  - Skiing  Label
- Transportation Features**
- Roads and Highways
- Other features**
- NSA Disc. Regions
  - NSA Disc. Subregions
  - NSA Modelling Tiles

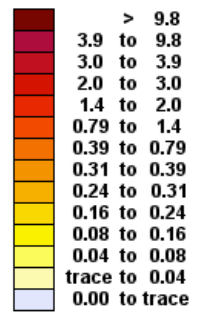
Map Preferences

Legend below map  
 Background image

Total Modeled Snow Melt forecasted for 48h preceding 2012 December 18, 5:00 Z

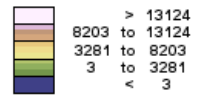


Inches of water equivalent



Not Estimated

Elevation in feet



### SNODAS Model Adjustments:

An assimilation was performed December 13, 2012 over the western United States and Canada. Throughout the Sierra Nevada and Cascade Range up to 1.5 inches of water was added to the snowpack to adjust the model for over estimating snow melt. In the Yellowstone region and across eastern Montana, up to an inch of water was removed from the snow pack. Additionally, another assimilation was performed over Arkansas and Mississippi to correct the model for precipitation that was misclassified due to temperatures being reported incorrectly. This inconsistency will be monitored and adjusted accordingly as the model continues to run.



National Operational Hydrologic Remote Sensing Center

Interactive Snow Information

72 hour Total Melt

Quick Query Links  
 Get Time Series for Station ID:  Go [Listing](#)  
 Get Time Series for Basin ID:  ABRFC  [Listing](#)  
 Get Basin Averages for  RFC  [Listing](#)  
 Get Climatology for Station ID:  Go [Listing](#)

Home Help Comments

Navigation Tools

Query

Redraw Map

Select Physical Element

Select Date  
   
   
   
 Snap to nearest time

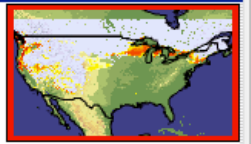
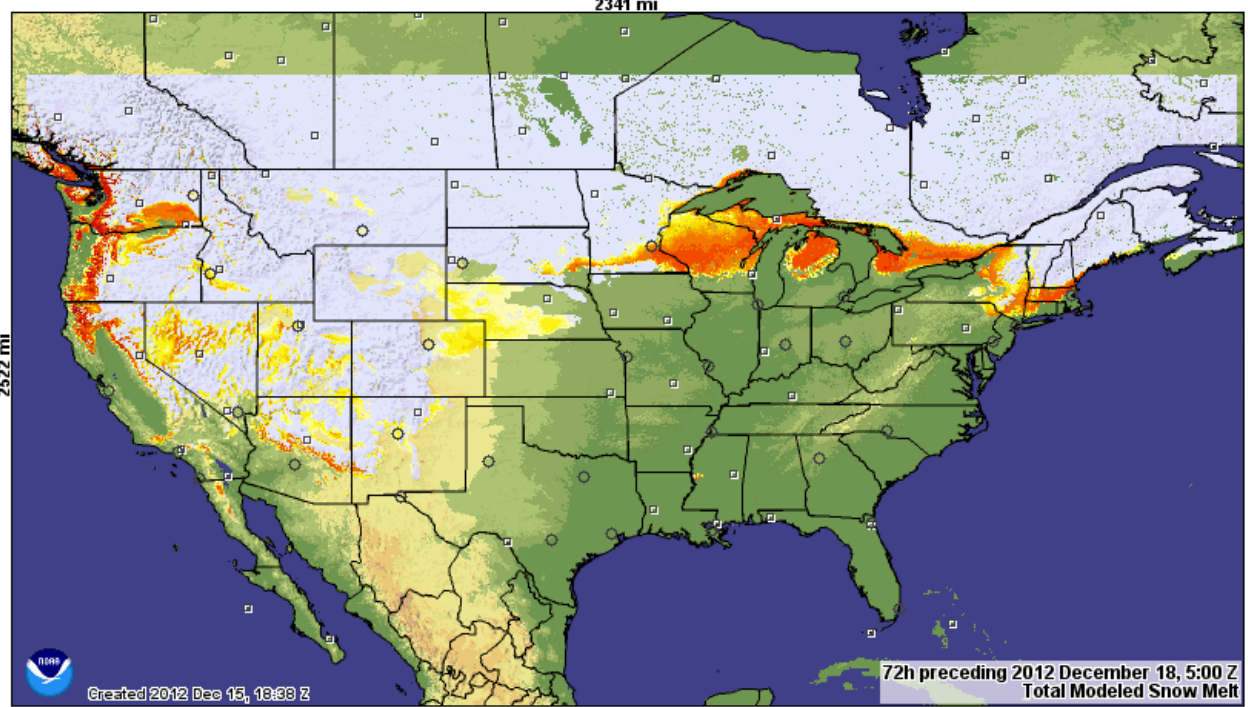
- Select Overlays
- Hydrologic Features**
- RFC Basins  Label
  - Other Basins  Label
  - HUCs (6-digit)
  - RFC Boundaries
  - Rivers and Streams
  - Lakes and Reservoirs
- Political Features**
- County Boundaries
  - CWA Boundaries
  - State Boundaries
  - National Boundaries
- Point Features**
- Stations  Label
  - Cities  Label
  - Flight Lines  Label
  - Climate Stns.  Label
  - Skiing  Label
- Transportation Features**
- Roads and Highways
- Other features**
- NSA Disc. Regions
  - NSA Disc. Subregions
  - NSA Modelling Tiles

Map Preferences

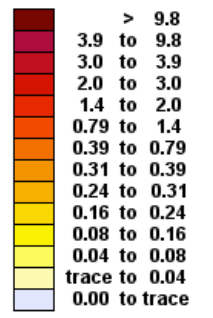
Legend below map

Background image

Total Modeled Snow Melt forecasted for 72h preceding 2012 December 18, 5:00 Z

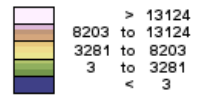


Inches of water equivalent



Not Estimated

Elevation in feet



SNODAS Model Adjustments:

An assimilation was performed December 13, 2012 over the western United States and Canada. Throughout the Sierra Nevada and Cascade Range up to 1.5 inches of water was added to the snowpack to adjust the model for over estimating snow melt. In the Yellowstone region and across eastern Montana, up to an inch of water was removed from the snow pack. Additionally, another assimilation was performed over Arkansas and Mississippi to correct the model for precipitation that was misclassified due to temperatures being reported incorrectly. This inconsistency will be monitored and adjusted accordingly as the model continues to run.

**National Operational Hydrologic Remote Sensing Center**

# Interactive Snow Information

Quick Query Links  
 Get Time Series for Station ID:  Go [Listing](#)  
 Get Time Series for Basin ID:  ABRFC  [Listing](#)  
 Get Basin Averages for  RFC  [Listing](#)  
 Get Climatology for Station ID:  Go [Listing](#)

Navigation Tools: Home Help Comments

Map navigation: 21.97 N, 97.14 W  Query: Station (2002-present)

**Redraw Map**

Select Physical Element

Select Date  
 2012 December 17 6:00 Z  
   
 Snap to nearest time

Select Overlays

**Hydrologic Features**

- RFC Basins  Label
- Other Basins  Label
- HUCs (6-digit)
- RFC Boundaries
- 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
- Skiing  Label

**Transportation Features**

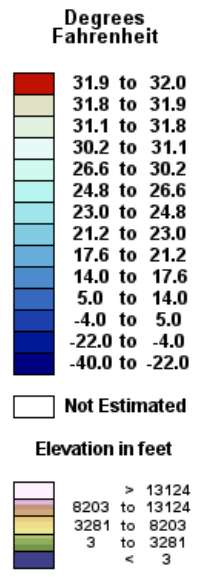
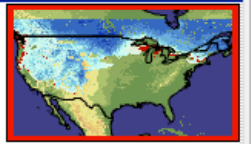
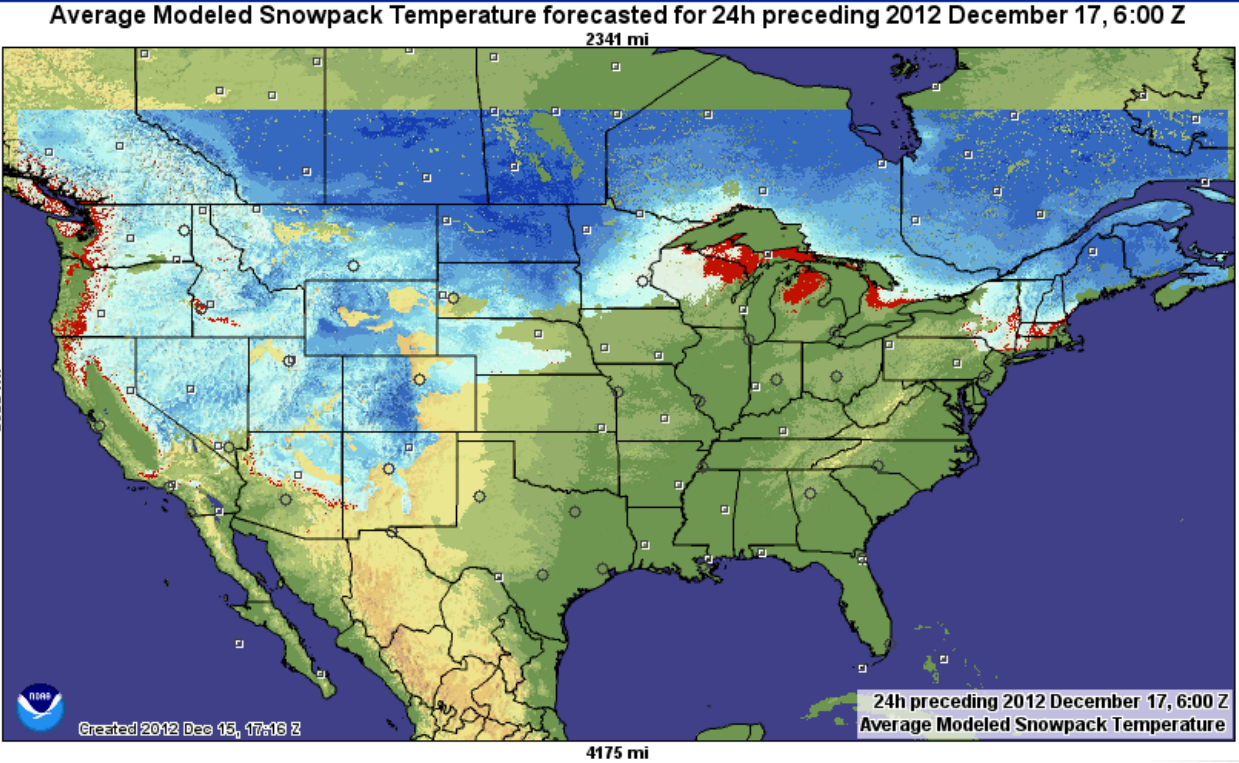
- Roads and Highways

**Other features**

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

**Map Preferences**

Legend below map  
 Background image



**SNODAS Model Adjustments:**

An assimilation was performed December 13, 2012 over the western United States and Canada. Throughout the Sierra Nevada and Cascade Range up to 1.5 inches of water was added to the snowpack to adjust the model for over estimating snow melt. In the Yellowstone region and across eastern Montana, up to an inch of water was removed from the snow pack. Additionally, another assimilation was performed over Arkansas and Mississippi to correct the model for precipitation that was misclassified due to temperatures being reported incorrectly. This inconsistency will be monitored and adjusted accordingly as the model continues to run.

Navigation Tools: Home, Help, Comments, 22.30 N, 81.05 W  Query: Station (2002-present)

**Redraw Map**

Select Physical Element  
 Snow Temperature

Select Date  
 2012 December 18 6:00 Z  
 Snap to nearest time

Select Overlays

**Hydrologic Features**

- RFC Basins  Label
- Other Basins  Label
- HUCs (6-digit)
- RFC Boundaries
- 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
- Skiing  Label

**Transportation Features**

- Roads and Highways

**Other features**

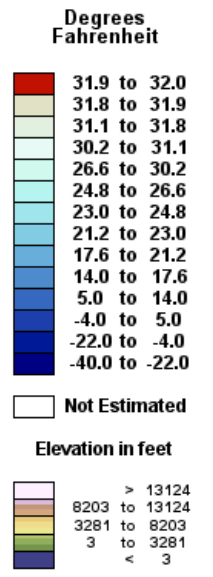
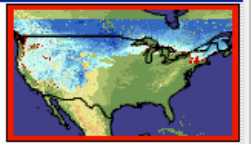
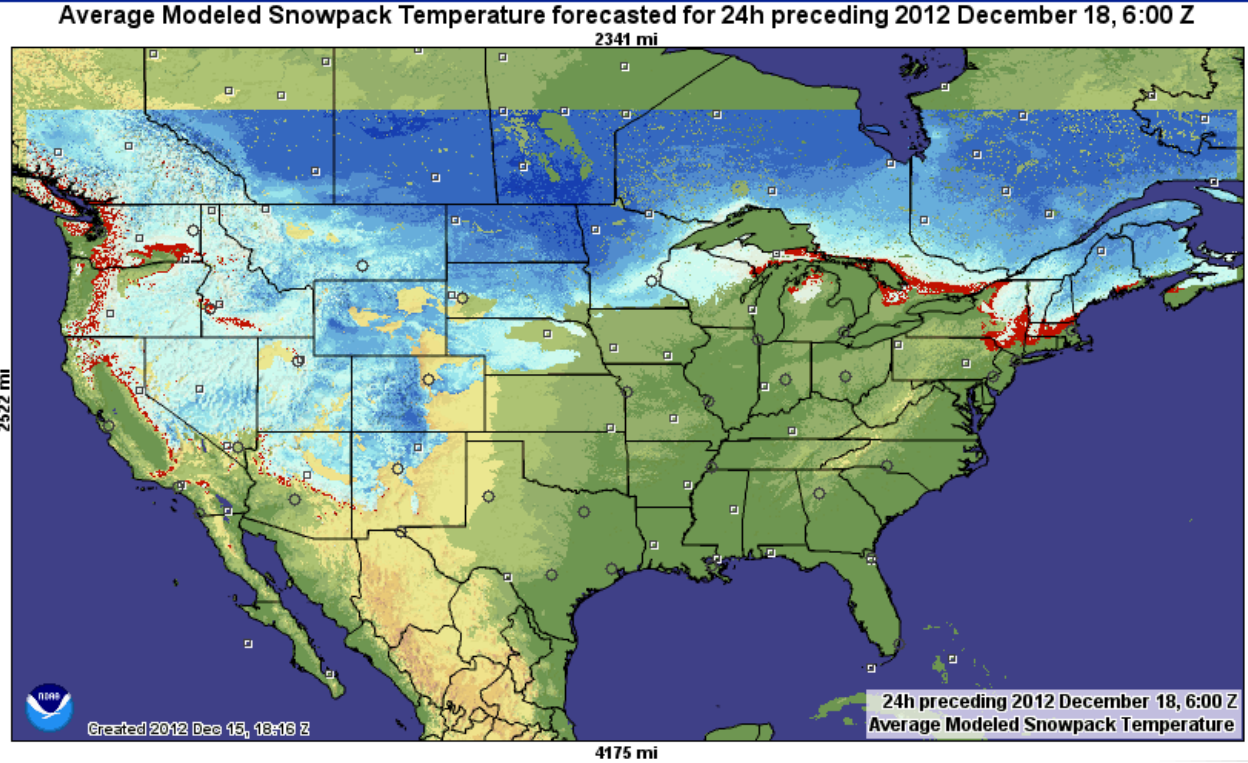
- NSA Disc. Regions
- NSA Disc. Subregions
- NSA Modelling Tiles

**Map Preferences**

English units

Legend below map

Background image



**SNODAS Model Adjustments:**

An assimilation was performed December 13, 2012 over the western United States and Canada. Throughout the Sierra Nevada and Cascade Range up to 1.5 inches of water was added to the snowpack to adjust the model for over estimating snow melt. In the Yellowstone region and across eastern Montana, up to an inch of water was removed from the snow pack. Additionally, another assimilation was performed over Arkansas and Mississippi to correct the model for precipitation that was misclassified due to temperatures being reported incorrectly. This inconsistency will be monitored and adjusted accordingly as the model continues to run.



National Operational Hydrologic Remote Sensing Center

Interactive Snow Information

Quick Query Links

Get Time Series for Station ID:  Go [Listing](#)

Get Time Series for Basin ID:  ABRFC  [Listing](#)

Get Basin Averages for  RFC  [Listing](#)

Get Climatology for Station ID:  Go [Listing](#)

Navigation Tools

Home Help Comments 22.21 N, 91.69 W

Query

Station (2002-present)

Redraw Map

Select Physical Element

Snow Precipitation

Select Date

2012  December

17  6:00 Z

Snap to nearest time

Select Overlays

Hydrologic Features

- RFC Basins  Label
- Other Basins  Label
- HUCs (6-digit)
- RFC Boundaries
- 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
- Skiing  Label

Transportation Features

- Roads and Highways

Other features

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

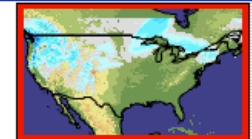
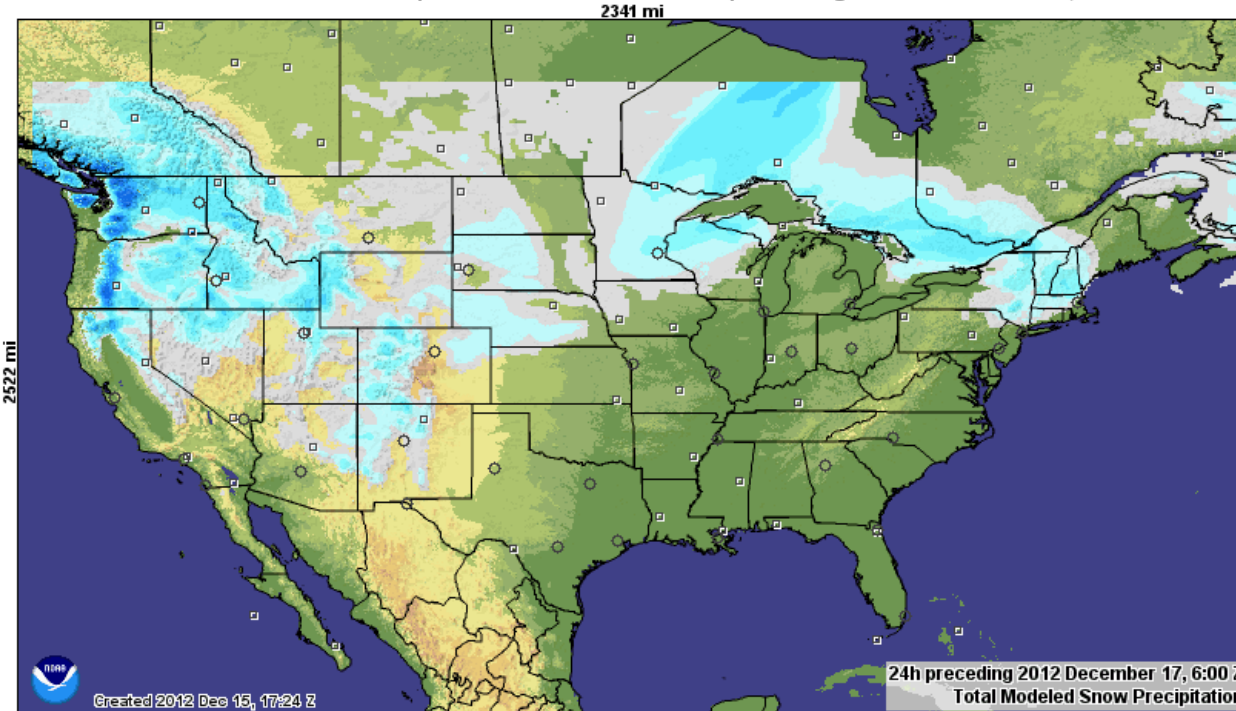
Map Preferences

English units

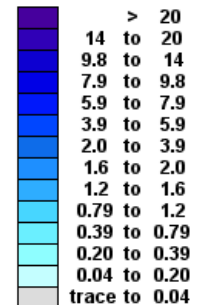
Legend below map

Background image

Total Modeled Snow Precipitation forecasted for 24h preceding 2012 December 17, 6:00 Z



Inches of water equivalent



Not Estimated

Elevation in feet



SNODAS Model Adjustments:

An assimilation was performed December 13, 2012 over the western United States and Canada. Throughout the Sierra Nevada and Cascade Range up to 1.5 inches of water was added to the snowpack to adjust the model for over estimating snow melt. In the Yellowstone region and across eastern Montana, up to an inch of water was removed from the snow pack. Additionally, another assimilation was performed over Arkansas and Mississippi to correct the model for precipitation that was misclassified due to temperatures being reported incorrectly. This inconsistency will be monitored and adjusted accordingly as the model continues to run.

**Navigation Tools**

Home Help Comments

**Redraw Map**

Select Physical Element  
 Snow Precipitation

Select Date  
 2012 December 18 6:00 Z  
 Snap to nearest time

Select Overlays

**Hydrologic Features**

- RFC Basins  Label
- Other Basins  Label
- HUCs (6-digit)
- RFC Boundaries
- 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
- Skiing  Label

**Transportation Features**

- Roads and Highways

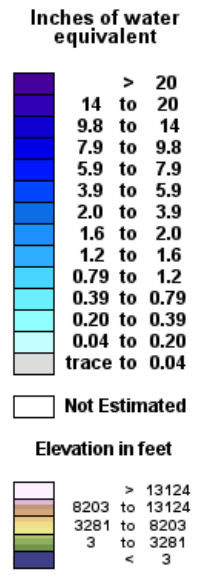
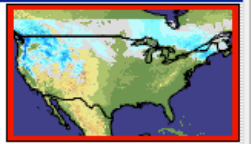
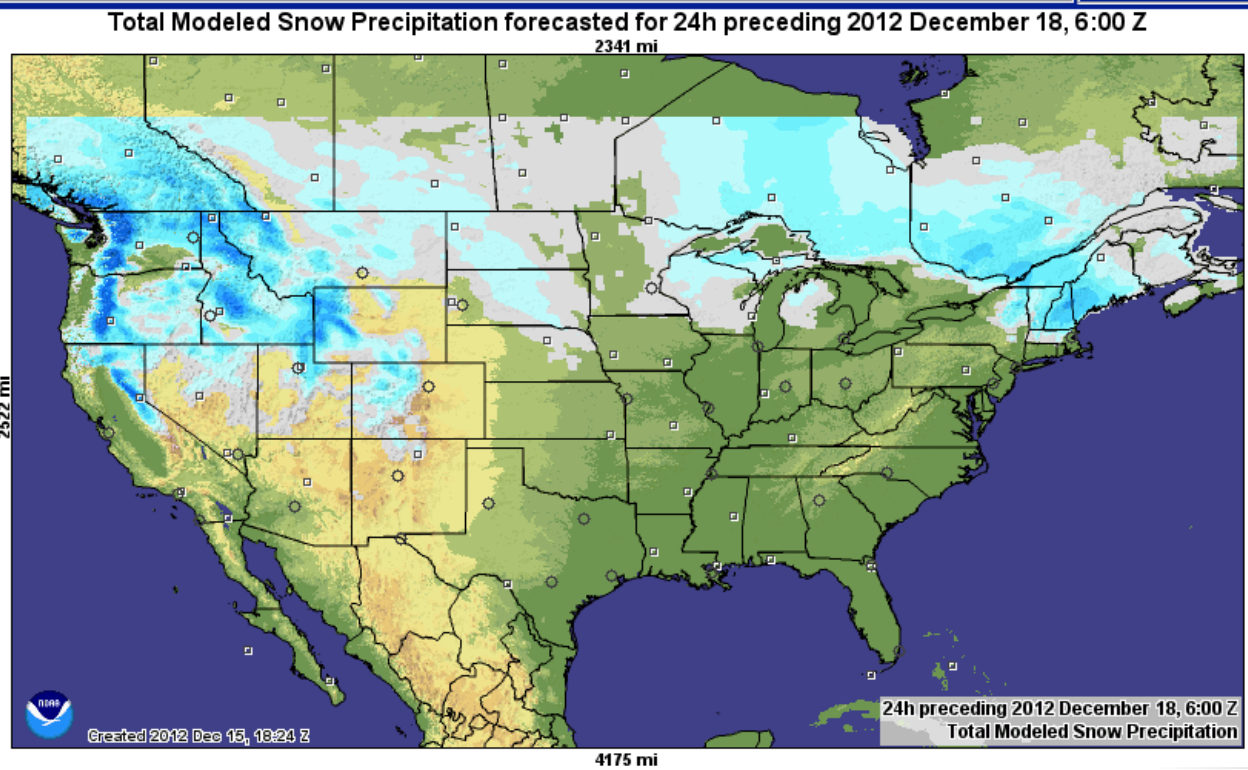
**Other features**

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

**Map Preferences**

English units

Legend below map  
 Background image



**SNODAS Model Adjustments:**

An assimilation was performed December 13, 2012 over the western United States and Canada. Throughout the Sierra Nevada and Cascade Range up to 1.5 inches of water was added to the snowpack to adjust the model for over estimating snow melt. In the Yellowstone region and across eastern Montana, up to an inch of water was removed from the snow pack. Additionally, another assimilation was performed over Arkansas and Mississippi to correct the model for precipitation that was misclassified due to temperatures being reported incorrectly. This inconsistency will be monitored and adjusted accordingly as the model continues to run.



# National Snow Analyses 3D Interface

## Instructions

Below are several links to ".kmz" files suitable for viewing with [KML](#) interpreters. Software and plugin information can be found [here](#). More information on these products can be found [below](#).

*Information for Internet Explorer users*

Home

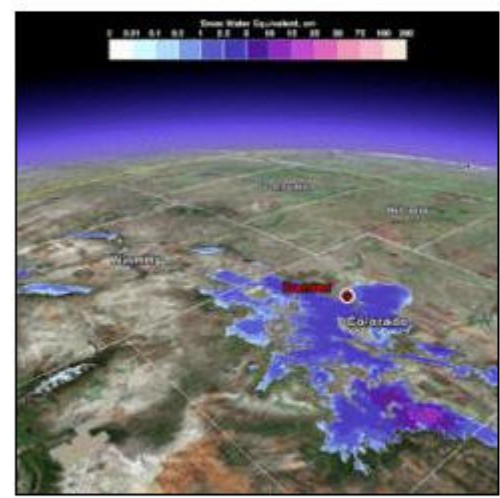
# NATION

3D visualization  
Analyses.

- Fly over
- Explor
- Get th



## Snow Analyses Overlays



<a href="#">November 19, 2008</a>	2 KB
<a href="#">November 18, 2008</a>	2 KB
<a href="#">November 17, 2008</a>	2 KB
<a href="#">November 16, 2008</a>	1 KB
<a href="#">November 15, 2008</a>	2 KB
<a href="#">November 14, 2008</a>	2 KB

[Latest Snow Analyses Overlays](#)

[Archive](#)

## Snow Reports and Stations



<a href="#">November 19, 2008</a>	385 KB
<a href="#">November 18, 2008</a>	368 KB
<a href="#">November 17, 2008</a>	355 KB
<a href="#">November 16, 2008</a>	348 KB
<a href="#">November 15, 2008</a>	345 KB
<a href="#">November 14, 2008</a>	338 KB

[Latest Snow Reports and Stations](#)

[Archive](#)

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Snow Climatology

Related Links

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Please Send Us

Comments!





NY305 Susquehanna River Bainbridge, NY SWE 2.8"



N 42° 15.252' W 075° 29.378'

02/10/2009 8:24:56 AM

HARDCOPY to SH)  
opolis, Minnesota  
a.gov  
TA

090214165900

11 %SM Pilot  
te (F) Remarks

118 , 32 field stubble  
118 , 30 mohawk rvr p-open  
118 , 35 swgi  
118 , 37

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NY214	DY090214	/	95	/	2.0	:	2.0,
NY215	DY090214	/	100	/	1.3	:	2.3,
NY216	DY090214	/	100	/	1.2	:	0.8,
NY304	DY090214	/	100	/	0.9	:	0.8,
NY501	DY090214	/	80	/	1.5	:	1.7,
NY503	DY090214	/	100	/	1.7	:	1.6,
NY505	DY090214	/	40	/	1.2	:	1.5,
NY507	DY090214	/	60	/	0.8	:	1.1,
NY509	DY090214	/	20	/	1.1	:	1.2,
NY510	DY090214	/	100	/	2.0	:	2.3,
NY512	DY090214	/	100	/	1.7	:	1.9,
NY513	DY090214	/	60	/	1.1	:	1.4,
.END							

Snow cover varied from below 50 per  
at higher elevations. Most creeks o  
ponds remain frozen. Standing water  
about 10 percent.

NNNN



N 44° 54.402' W 072° 48.760'

03/20/2009 10:41:09 AM



# Interactive Snow Information

Quick Query Links

Get Time Series for Station ID:   [Listing](#)

Get Time Series for Basin ID:  ABRFC  [Listing](#)

Get Basin Averages for  RFC  [Listing](#)

Get Climatology for Station ID:   [Listing](#)

### Navigation Tools

Home Help Comments



Lon: -88.1 Lat: 17.8

### Query

Station (2002-present)

### Redraw Map

Select Physical Element

Snow Water Equivalent

Select Date

2008 February

5 6:00 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
- Skiing  Label

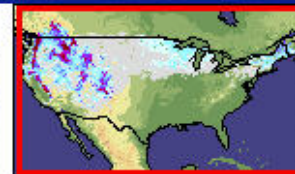
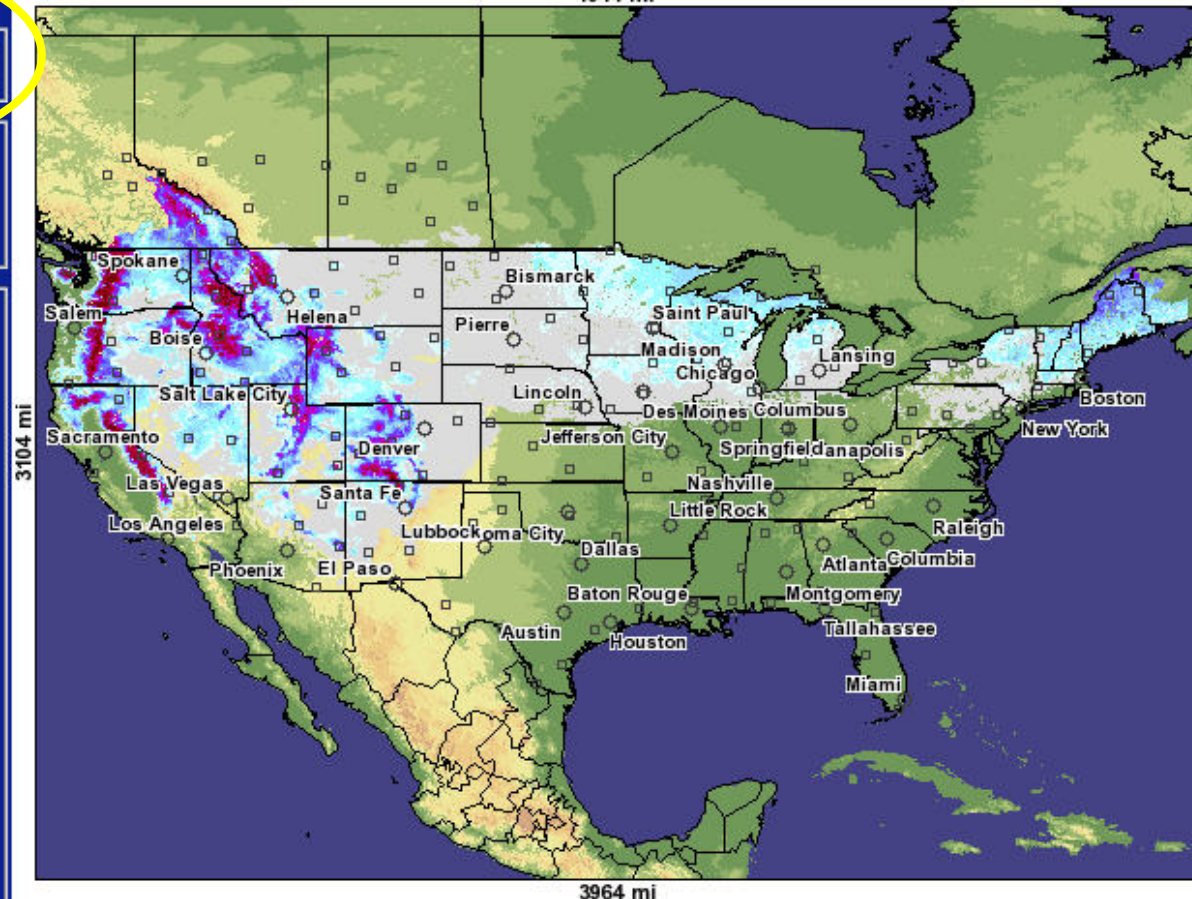
#### Transportation Features

- Highways

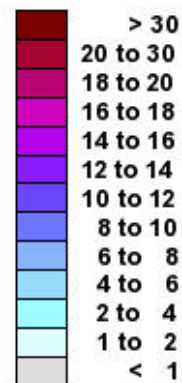
#### Other features

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

### Modeled Snow Water Equivalent (Hourly) for 2008 February 5, 6:00 Z



### Inches of water equivalent



Not Estimated

### Elevation in feet (Not estimated)



### Directions:

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

# Physical Element Map Options

The image displays three screenshots of a 'Select Physical Element' menu, each showing a different set of options. The first screenshot shows a list of options with 'Snow Water Equivalent' highlighted in blue and circled in red. The second screenshot shows a list of options with 'Snow Water Equivalent' at the top and several categories below. The third screenshot shows a list of options with 'Snow Water Equivalent' at the top and several categories below, with 'Snow Depth (24 hrs)' circled in red.

**Select Physical Element**

- Snow Water Equivalent
- None
- Hourly Snow Analyses**
- Snow Water Equivalent
- Snow Depth
- Shallow SWE
- Shallow Snow Depth
- Snowpack Temperature
- Snowpack Density
- Hourly Driving Data**
- Snow Precipitation
- Non-Snow Precipitation
- Surface Air Temperature
- Solar Radiation
- Relative Humidity
- Surface Wind

**Select Physical Element**

- Snow Water Equivalent
- Daily Snow Analyses**
- Snow Depth - Normal
- SWE Change
- Snow Depth Change
- Snow Melt
- Blowing Snow Sublim.
- Surface Sublim./Cond.
- Ave. Snow Temperature
- Daily Driving Data**
- Snow Precipitation
- Non-Snow Precipitation
- Ave. Relative Humidity
- Ave. Surface Air Temp.
- Solar Radiation
- Average Surface Wind
- Daily Satellite Obs.**
- Snow Cover (Percent)
- Snow Cover (Binary)
- Snow Cover (Alaska)

**Select Physical Element**

- Snow Water Equivalent
- Climate Data**
- Freezing Degree Days
- Thawing Degree Days
- Monthly Depth Normal
- Latest Observations**
- Snow Depth (24 hrs)
- Snow Depth (48 hrs)
- Snow Depth (72 hrs)
- SWE (24 hrs)
- SWE (48 hrs)
- SWE (72 hrs)
- Total Snowfall (24 hrs)
- Total Snowfall (48 hrs)
- Total Snowfall (72 hrs)
- Int. Total SF (24 hrs)
- Int. Total SF (48 hrs)
- Int. Total SF (72 hrs)
- Raw S. Depth (24 hrs)
- Raw SWE (24 hrs)
- Raw Snowfall (24 hrs)



# Interactive Snow Information

Quick Query Links

Get Time Series for Station ID:   [Listing](#)

Get Time Series for Basin ID:    [Listing](#)

Get Basin Averages for    [Listing](#)

Get Climatology for Station ID:   [Listing](#)

### Navigation Tools

Home Help Comments

Lon:  Lat:

### Query

Station (2002-present)

### Redraw Map

Select Physical Element

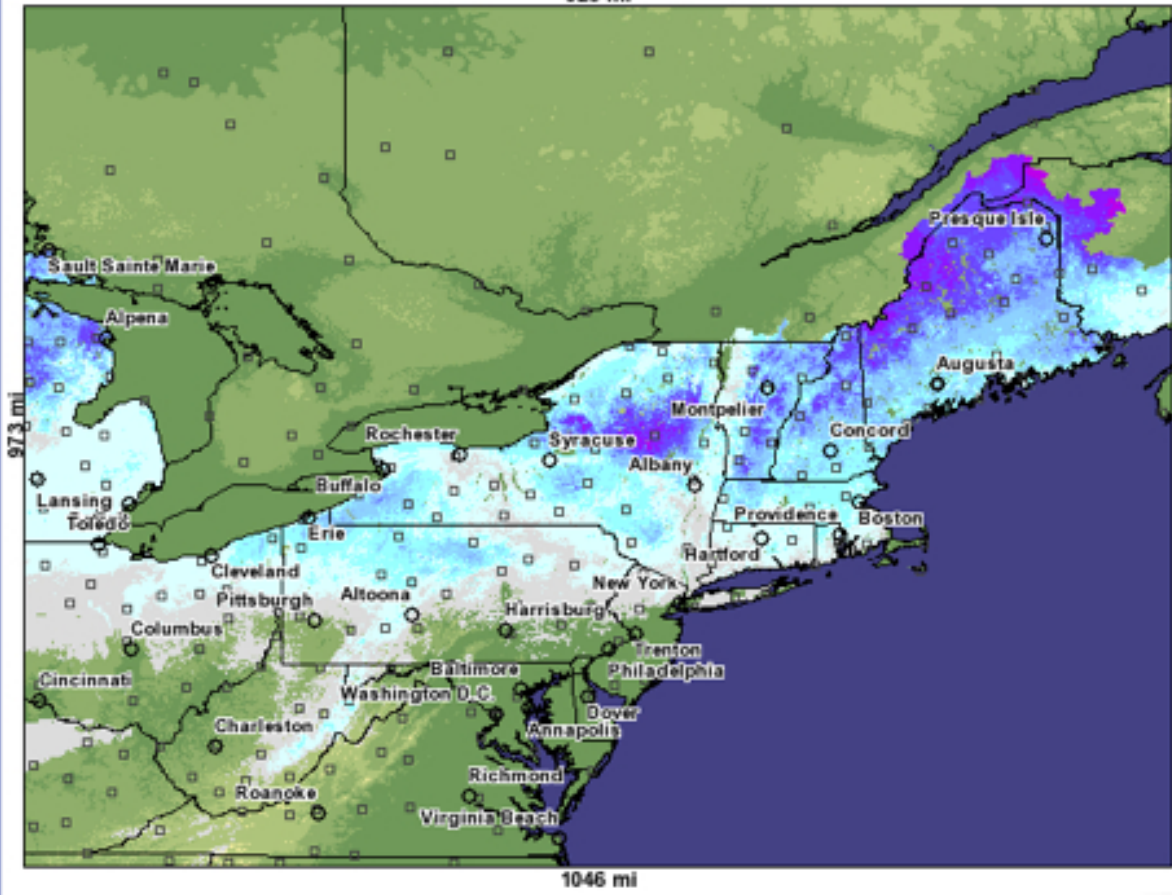
Select Date

2009 January 24 12:00 Z

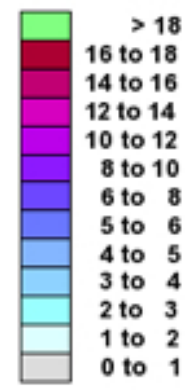
Snap to nearest time

- 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
  - Skiing  Label
- Transportation Features**
- Roads and Highways
- Other features**
- NSA Disc. Regions
  - NSA Disc. Subregions

Modeled Snow Water Equivalent (Shallow-snow Legend, Hourly) for 2009 January 24, 12:00 Z

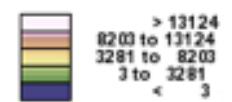


### Inches of water equivalent



Not Estimated

### Elevation in feet (Not estimated)





# Interactive Snow Information

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](#)

### Navigation Tools

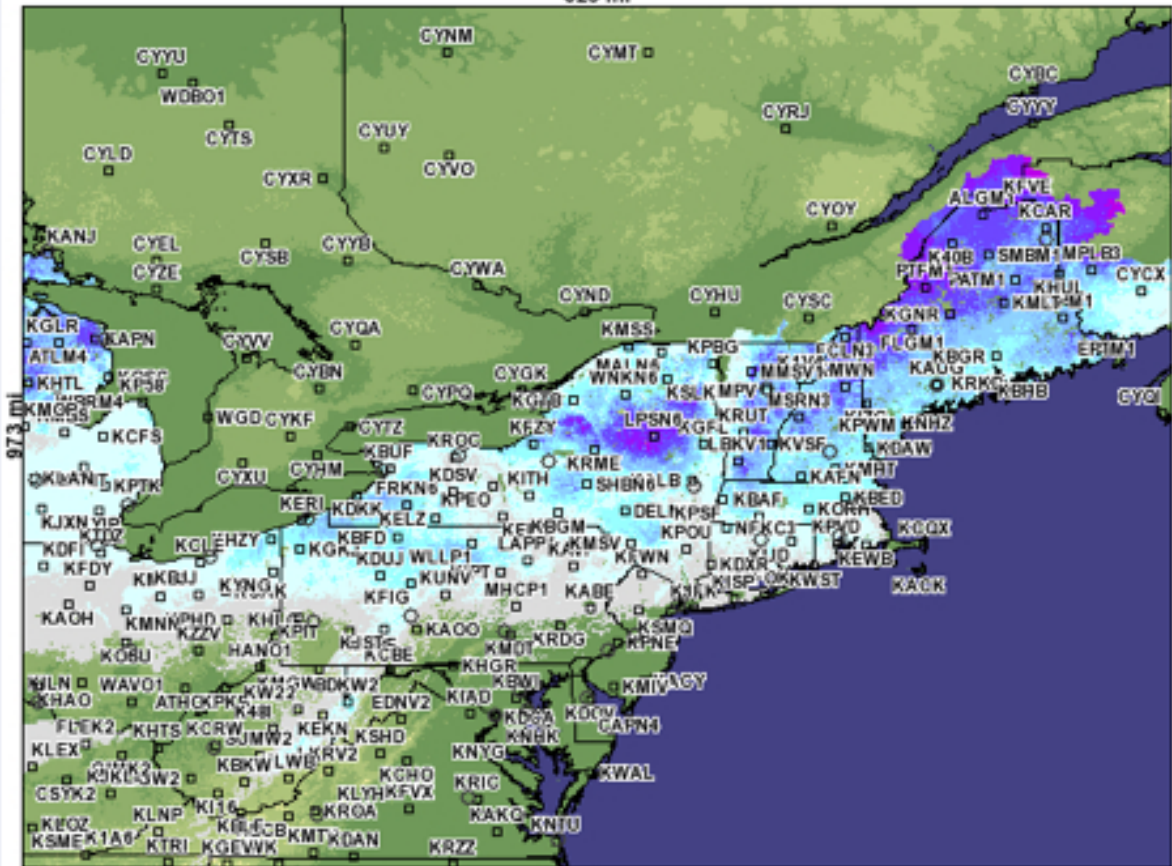
Home Help **Lon: -84.35 Lat: 37.41** [Recenter map at coordinates](#)

### Query

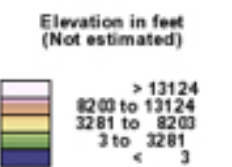
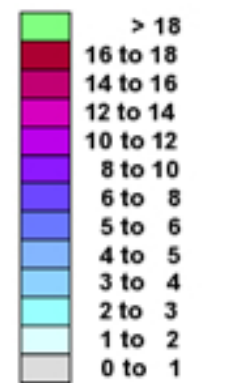
### Redraw Map

- Select Physical Element
- Shallow SWE
- Select Date
- 2009 January 24 12:00 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
  - Skiing  Label
- Transportation Features**
- Roads and Highways
- Other features**
- NSA Disc. Regions
  - NSA Disc. Subregions

Modeled Snow Water Equivalent (Shallow-snow Legend, Hourly) for 2009 January 24, 12:00 Z  
826 mi



Inches of water equivalent



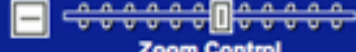


# Interactive Snow Information

Quick Query Links  
 Get Time Series for Station ID:   [Listing](#)  
 Get Time Series for Basin ID:    [Listing](#)  
 Get Basin Averages for    [Listing](#)  
 Get Climatology for Station ID:   [Listing](#)

### Navigation Tools

Home Help Comments



Lon:  Lat:

### Query

Station (2002-present)

### Redraw Map

Select Physical Element

Select Date

2009 January

24 12:00 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
- Skiing  Label

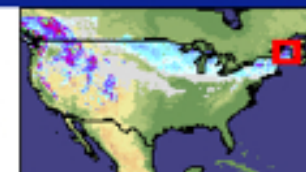
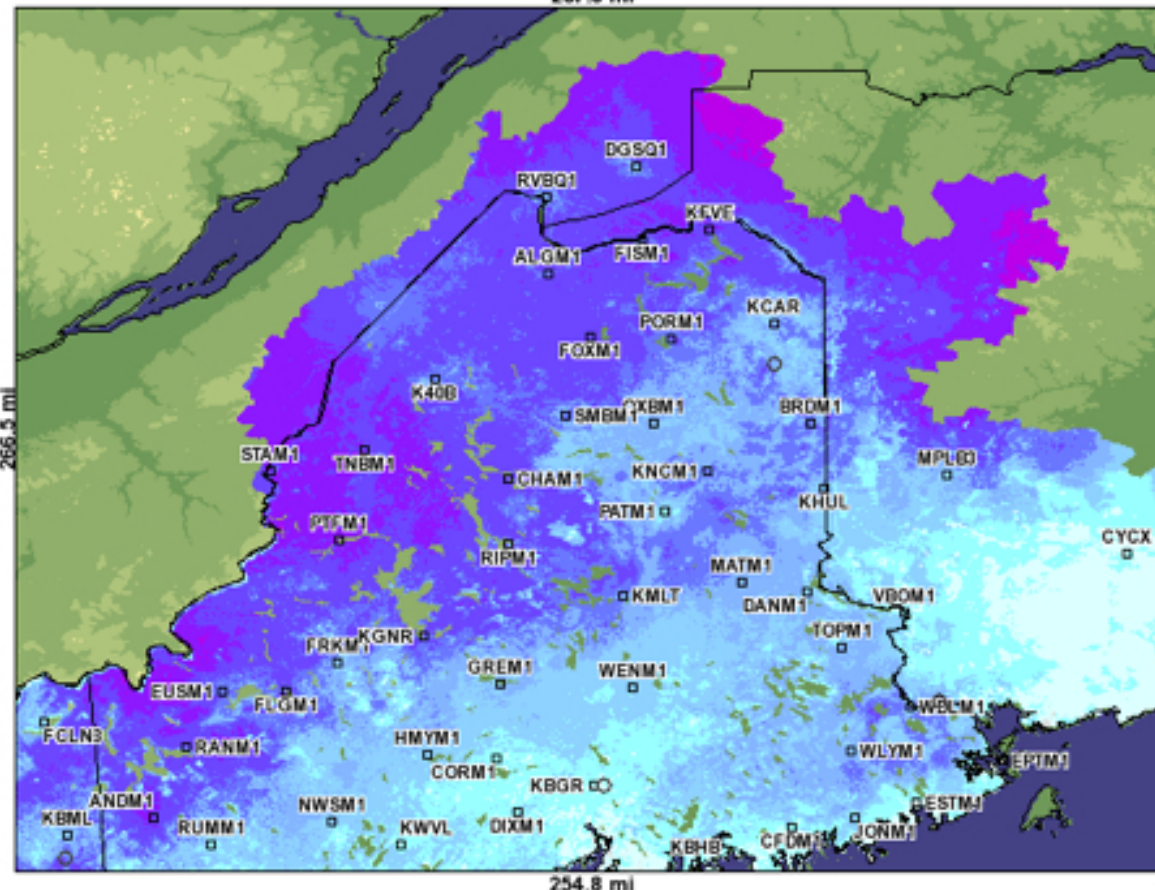
#### Transportation Features

- Roads and Highways

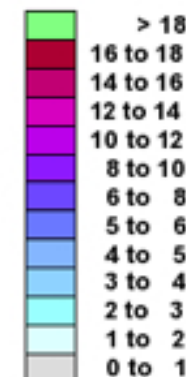
#### Other features

- NSA Disc. Regions
- NSA Disc. Subregions

Modeled Snow Water Equivalent (Shallow-snow Legend, Hourly) for 2009 January 24, 12:00 Z  
237.5 mi

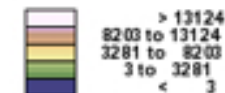


### Inches of water equivalent



Not Estimated

### Elevation in feet (Not estimated)





# Interactive Snow Information

Get Time Series for Station ID:   [Listing](#)

Get Time Series for Basin ID:    [Listing](#)

Get Basin Averages for    [Listing](#)

Get Climatology for Station ID:   [Listing](#)

### Navigation Tools

Home Help

Zoom Control

Lon:  Lat:

### Query

Station (2002-present)

### Redraw Map

Select Physical Element

Select Date

2009

24

### 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
- Skiing  Label

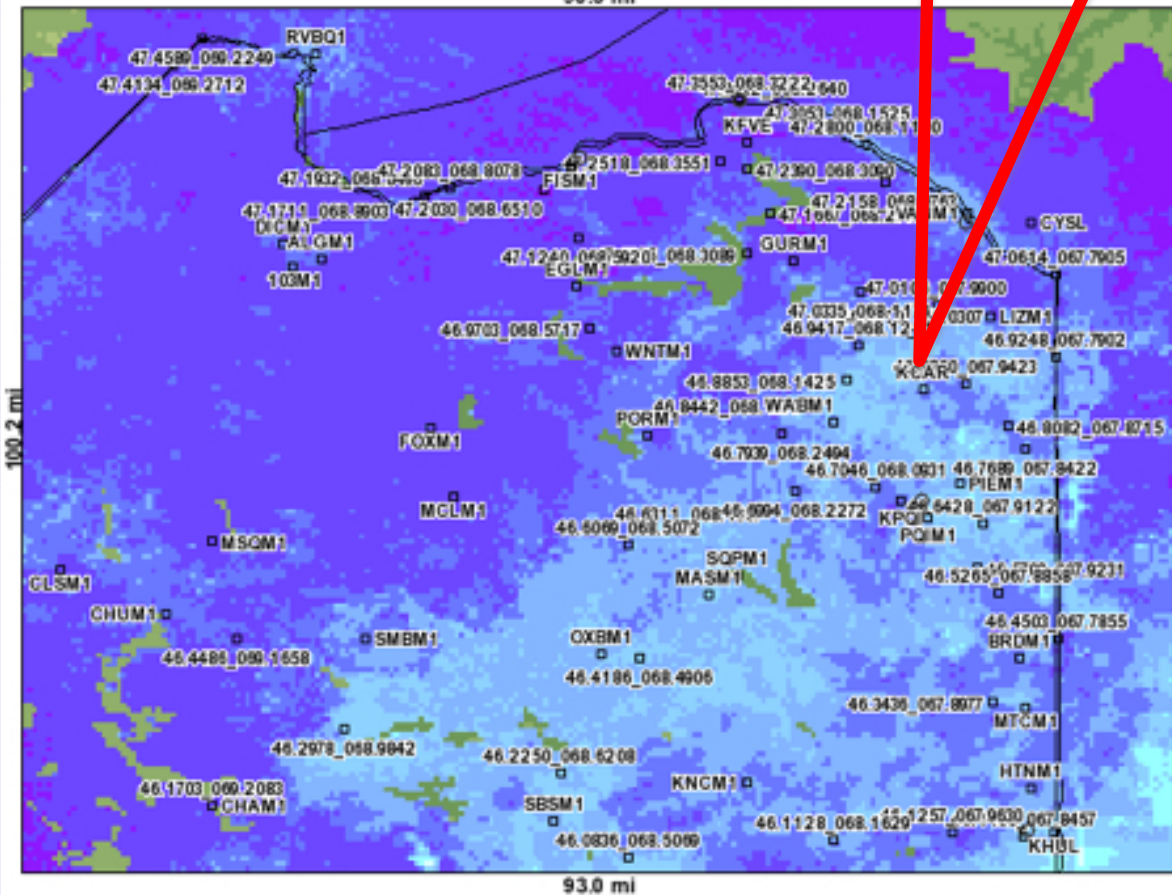
#### Transportation Features

- Roads and Highways

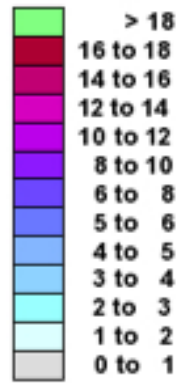
#### Other features

- NSA Disc. Regions
- NSA Disc. Subregions

Modeled Snow Water Equivalent (Shallow-snow Legend, Hourly, 2009 January 24, 12:00 Z



### Inches of water equivalent



### Not Estimated

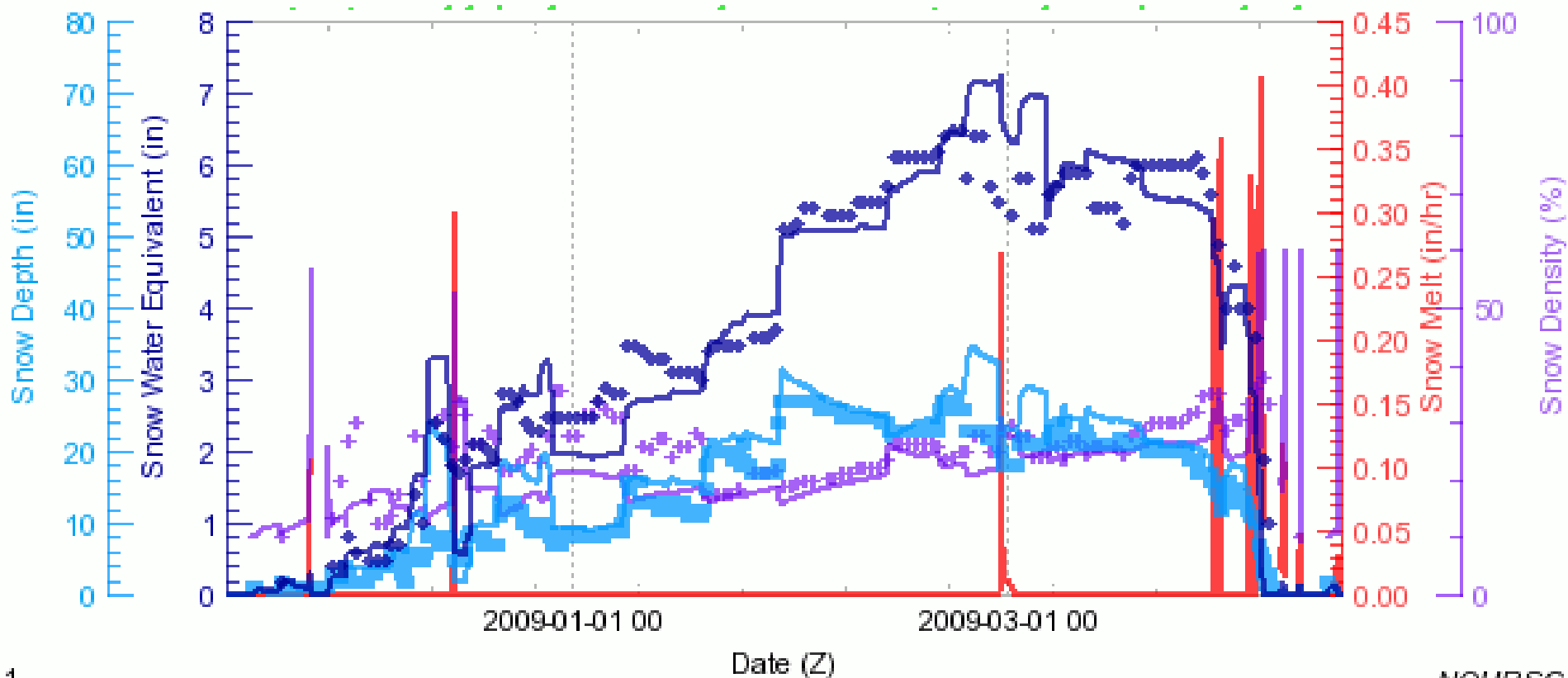
### Elevation in feet (Not estimated)



# Snow Water Equivalent, Snow Depth, Snow Cover, and Snow Melt

Modeled and Observed

Station: KCAR - CARIBOU, CARIBOU MUNICIPAL AIRPORT (Modeled) (Observed)  
Latitude: 46.86722222 N Snow Water Equivalent — ◆  
Longitude: 68.01333333 W Snow Depth — ■  
Elevation: 623 Feet Snow Density — +  
Start Date: 2008-11-15 07 Snow Melt —  
Stop Date: 2009-04-15 07 Assimilation —  
Forest Density: 6% Snow Cover (Observed by Satellite):  
Land Use: Conifer Boreal Forest Snow No Snow Cloud Not Mapped



1

NOHRSC

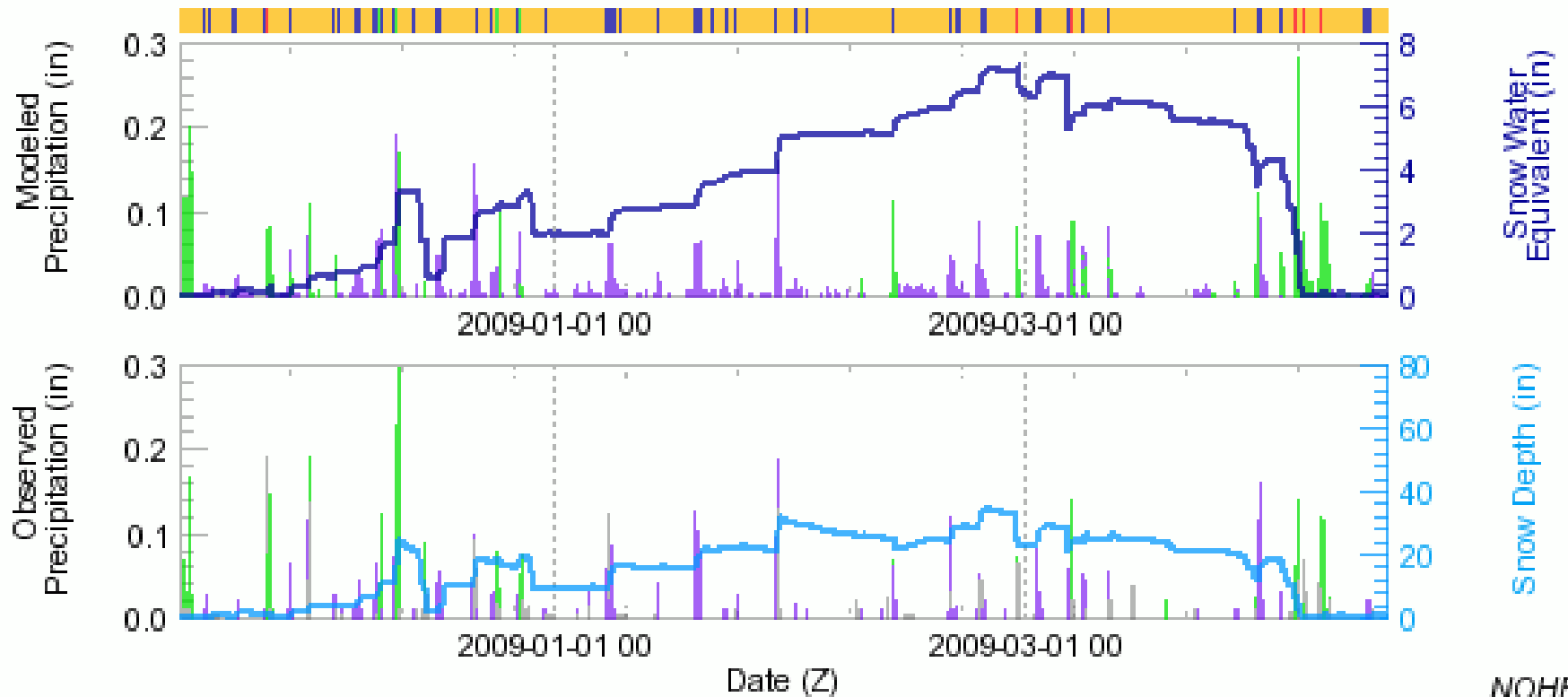


# Precipitation, Snow Water Equivalent, and Snow Depth

Modeled and Observed

Station: KCAR - CARIBOU, CARIBOU MUNICIPAL AIRPORT  
Latitude: 46.86722222 N  
Longitude: 68.01333333 W  
Elevation: 623 Feet  
Start Date: 2008-11-15 07  
Stop Date: 2009-04-15 07  
Forest Density: 6%  
Land Use: Conifer Boreal Forest

Snow Precipitation  
Non-Snow Precipitation  
Unknown Precipitation  
Snow Water Equivalent (Modeled)  
Snow Depth (Modeled)  
Present Weather (Observed)  
No Precipitation  
Rain (Not Freezing)  
Freezing Drizzle/Rain  
Mixed Rain/Snow  
Snow



NOHRSC

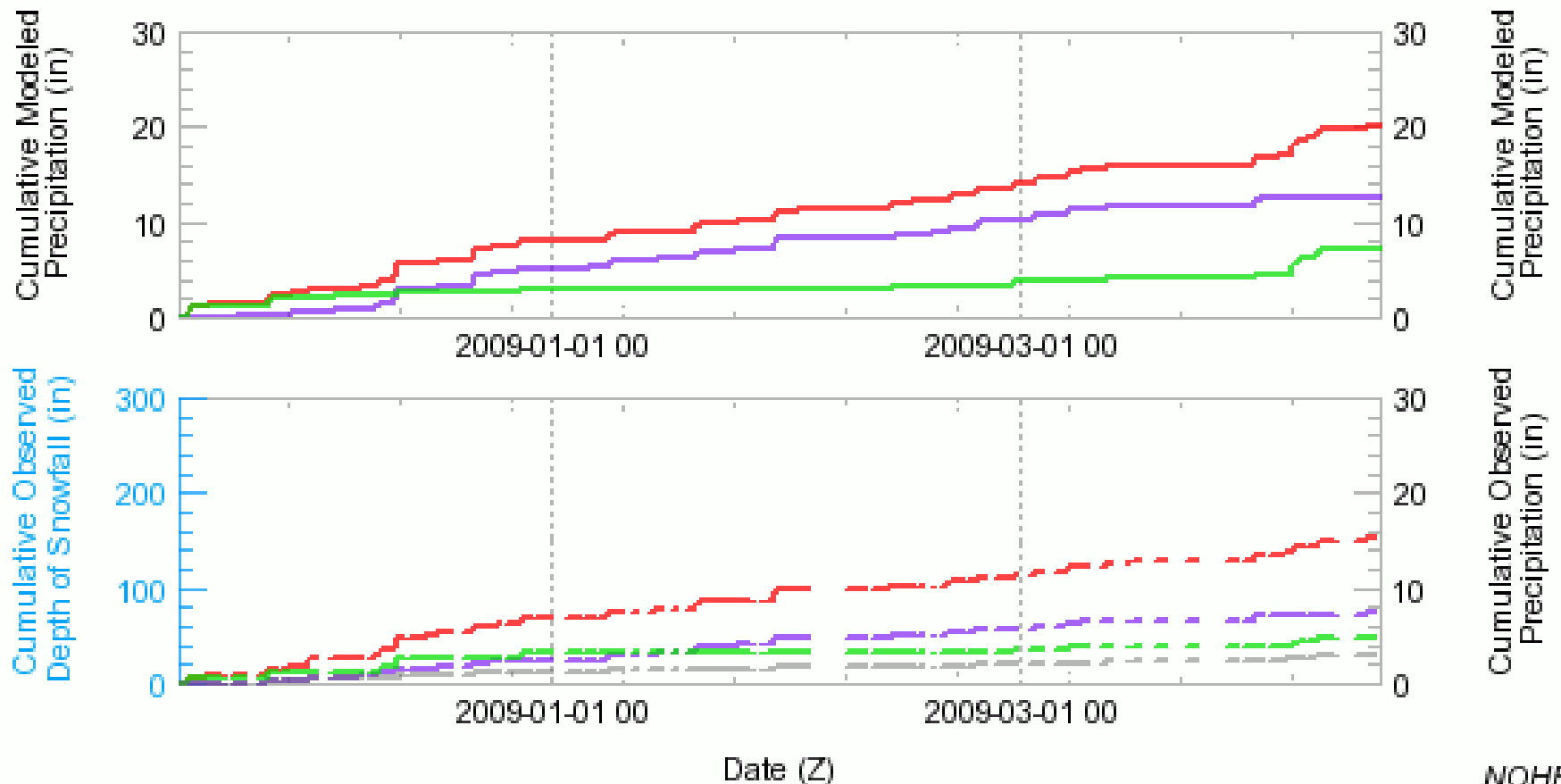


# Time Window Cumulative Precipitation

## Modeled and Observed

Station: KCAR - CARIBOU, CARIBOU MUNICIPAL AIRPORT  
Latitude: 46.86722222 N  
Longitude: 68.01333333 W  
Elevation: 623 Feet  
Start Date: 2008-11-15 07  
Stop Date: 2009-04-15 07  
Forest Density: 6%  
Land Use: Conifer Boreal Forest

Snow Precipitation  
Non-Snow Precipitation  
Unknown Precipitation  
Total Precipitation  
Observed Depth of Snowfall



NOHRSC

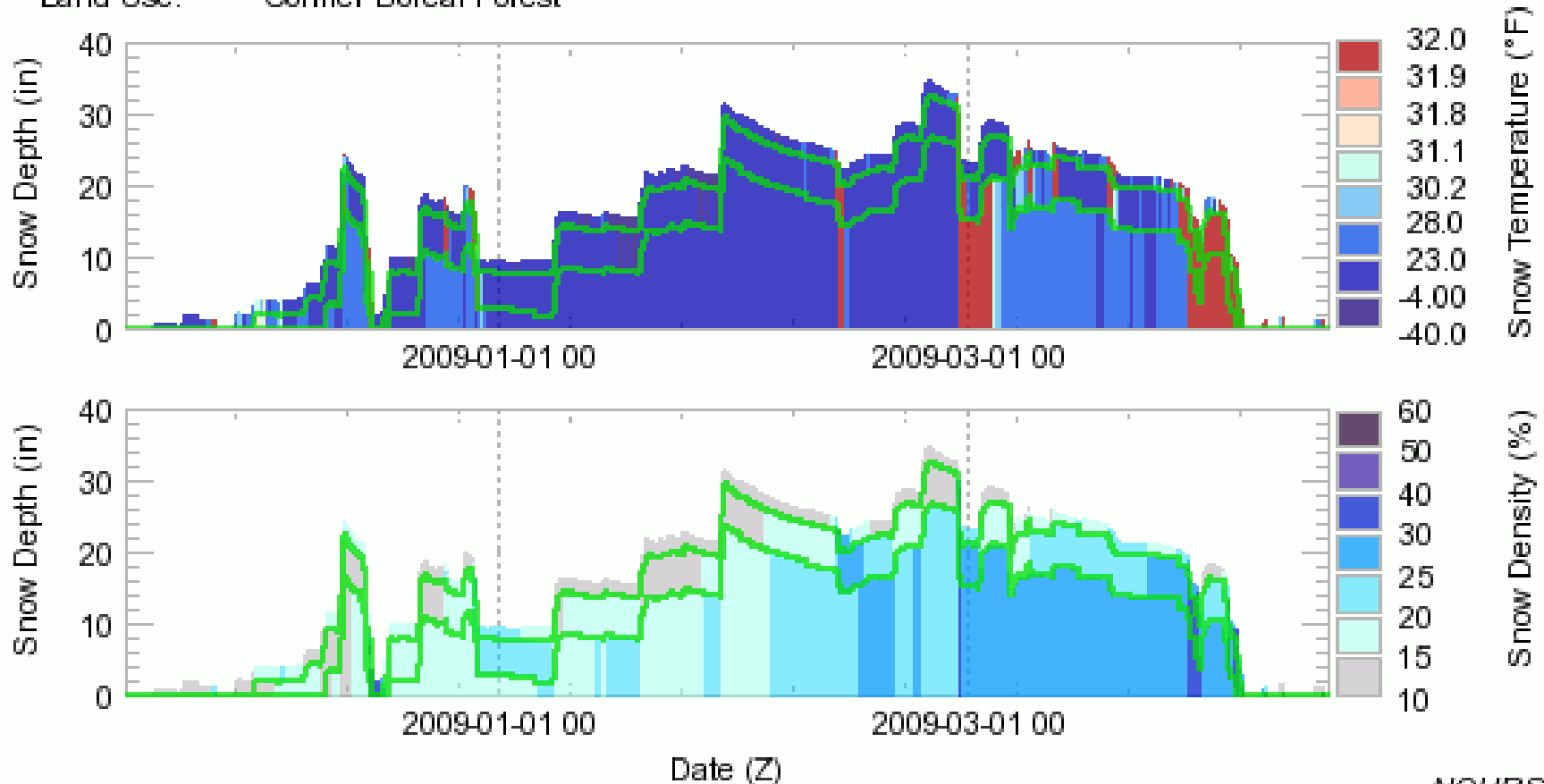


# Snow Pack Temperature and Density by Layer

Modeled

Station: KCAR - CARIBOU, CARIBOU MUNICIPAL AIRPORT  
Latitude: 46.86722222 N  
Longitude: 68.01333333 W  
Elevation: 623 Feet  
Start Date: 2008-11-15 07  
Stop Date: 2009-04-15 07  
Forest Density: 6%  
Land Use: Conifer Boreal Forest

Layer Separator



NOHRSC

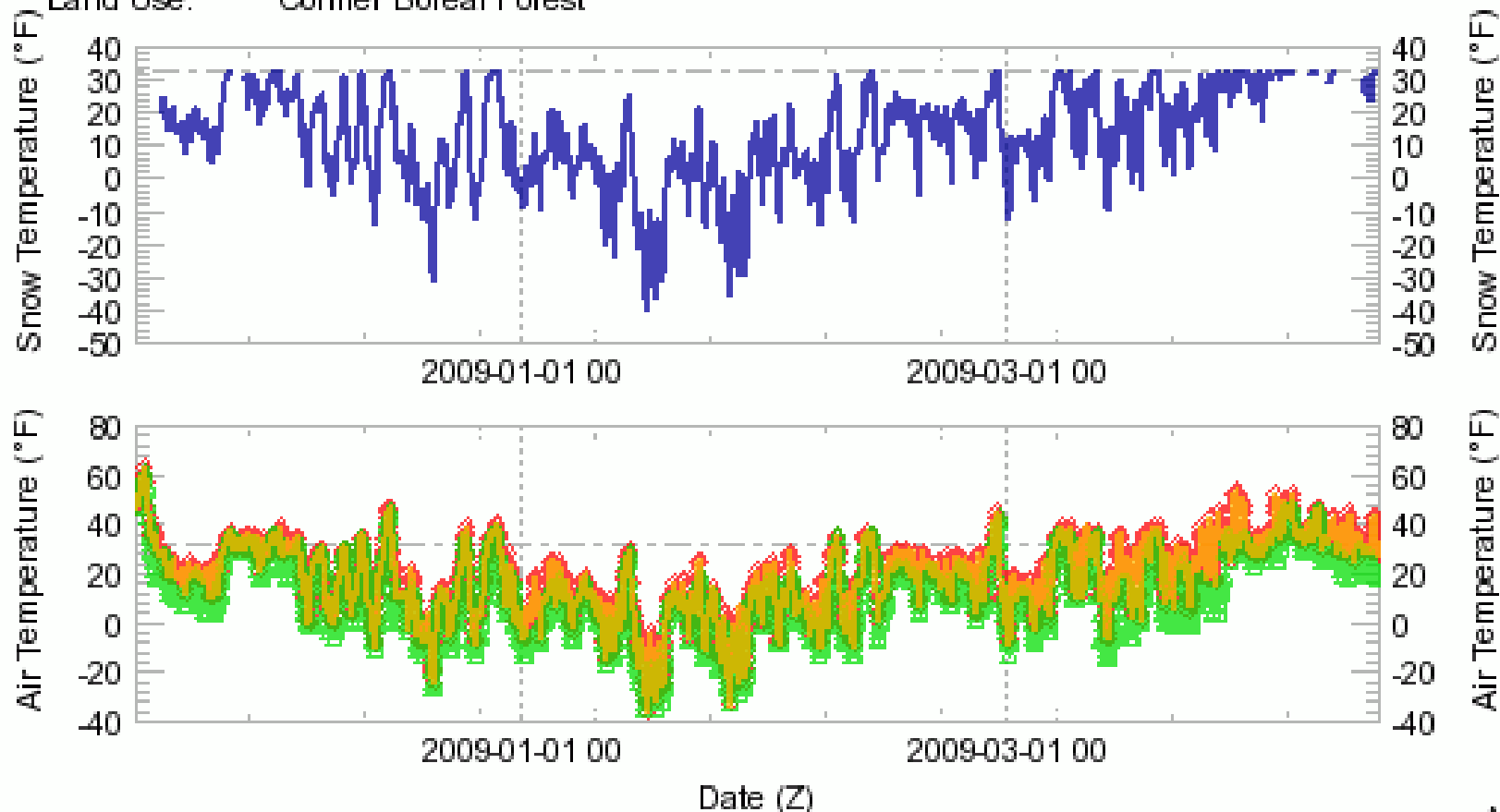


# Snow Surface, Mean Snow Pack, and Air Temperatures

Modeled and Observed

Station: KCAR - CARIBOU, CARIBOU MUNICIPAL AIRPORT  
Latitude: 46.86722222 N  
Longitude: 68.01333333 W  
Elevation: 623 Feet  
Start Date: 2008-11-15 07  
Stop Date: 2009-04-15 07  
Forest Density: 6%  
Land Use: Conifer Boreal Forest

Snow Surface Temperature ———  
Mean Snow Pack Temperature ———  
Air Temperature Forcing, 6-ft ———  
Observed Air Temperature ◊—◊—  
Observed Dew Point Temperature ▲—▲—

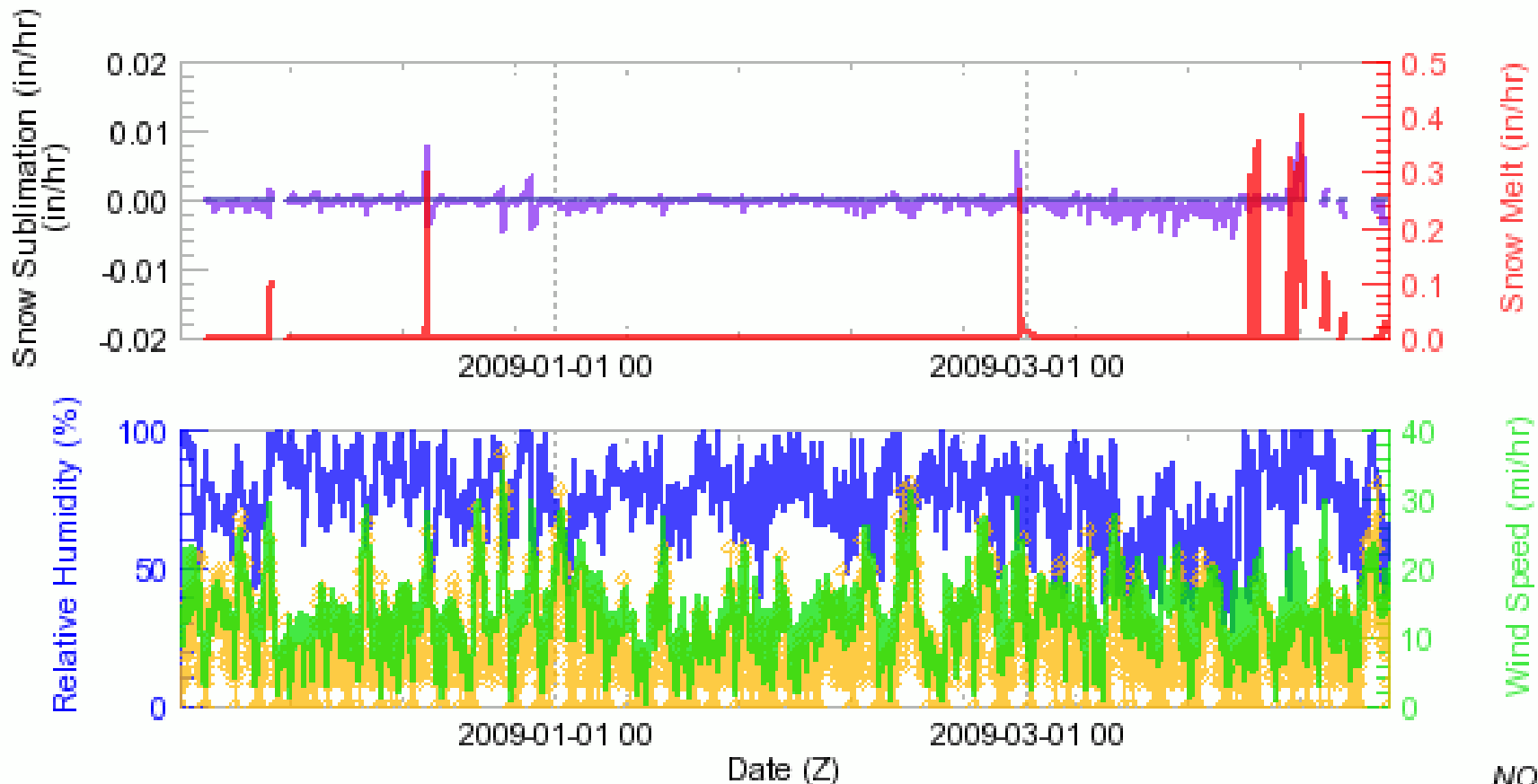
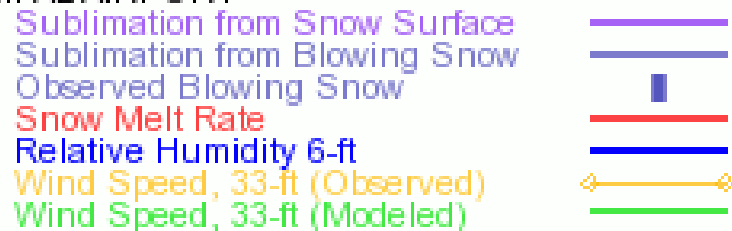


# Snow Melt, Sublimation, and Weather Forcing

Modeled and Observed

Station: KCAR - CARIBOU, CARIBOU MUNICIPAL AIRPORT  
Latitude: 46.86722222 N  
Longitude: 68.01333333 W  
Elevation: 623 Feet  
Start Date: 2008-11-15 07  
Stop Date: 2009-04-15 07  
Forest Density: 6%  
Land Use: Conifer Boreal Forest

Sublimation from Snow Surface  
Sublimation from Blowing Snow  
Observed Blowing Snow  
Snow Melt Rate  
Relative Humidity 6-ft  
Wind Speed, 33-ft (Observed)  
Wind Speed, 33-ft (Modeled)



NOHRSC



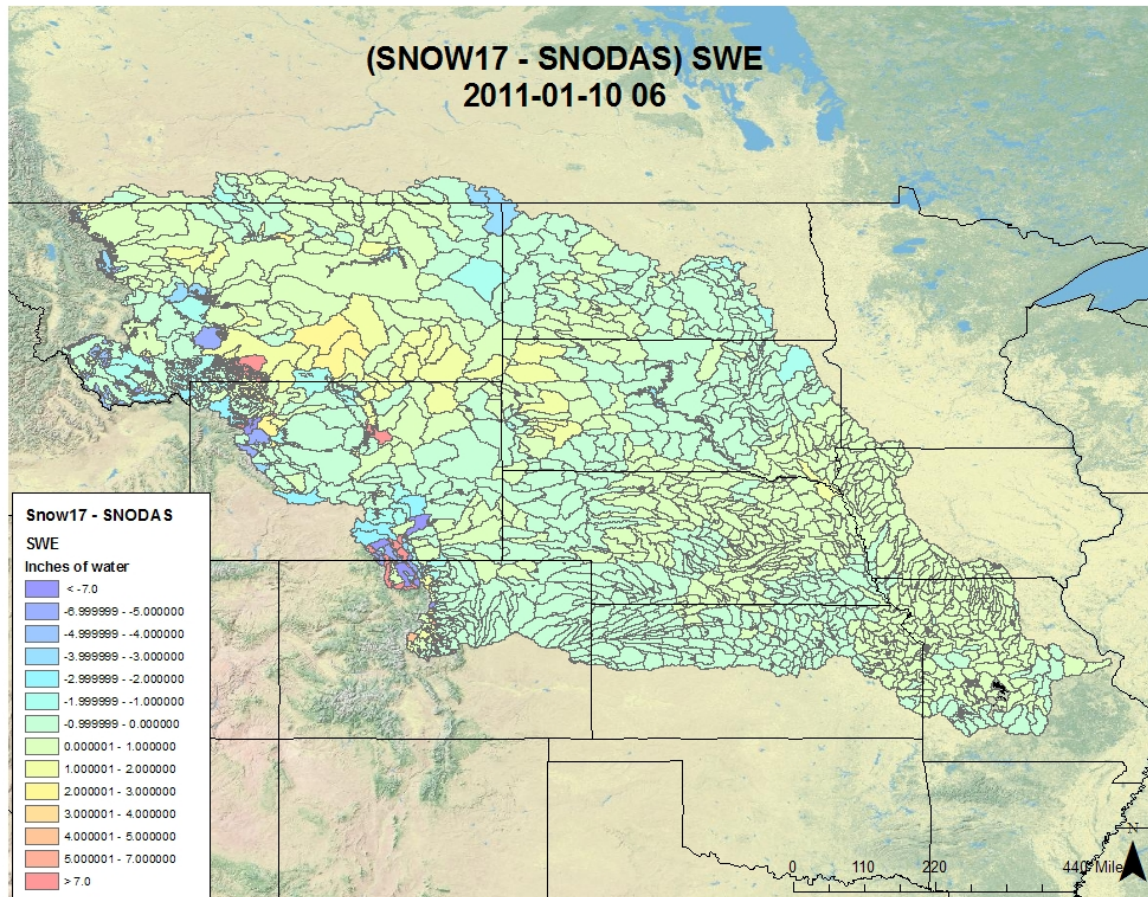
# Recent Additions

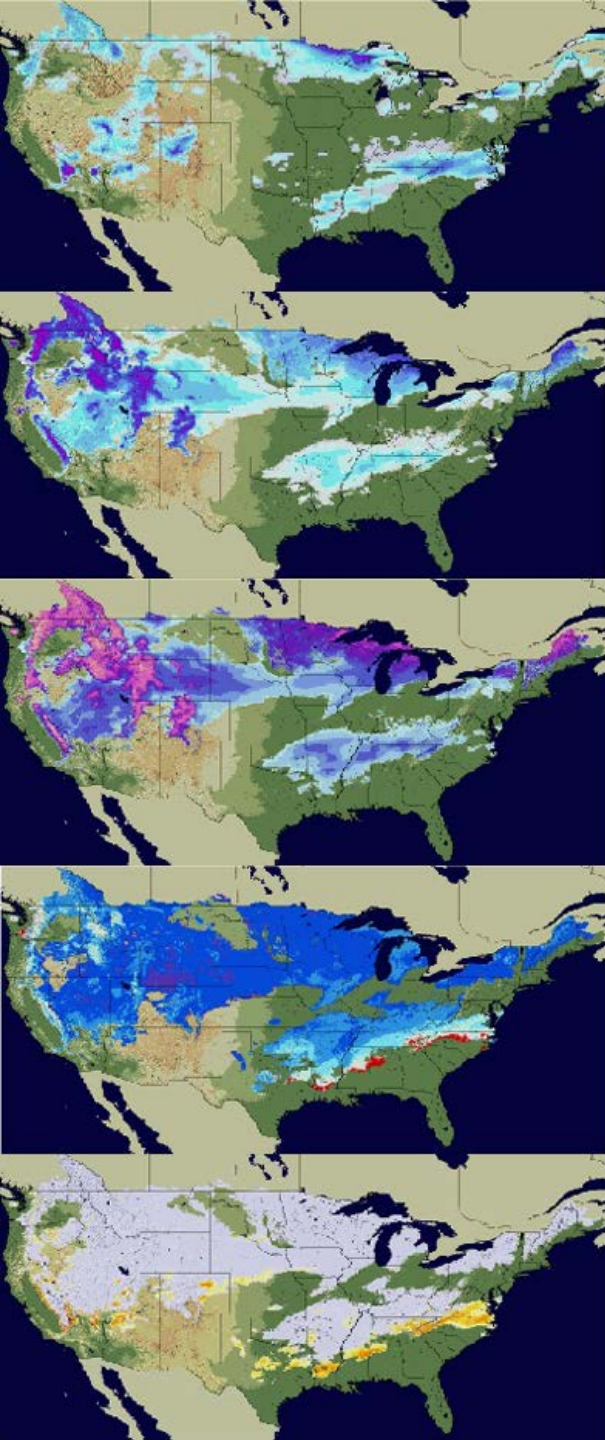
- Forecast products are now operational from 24 to 72 hours
- Adding basin average SHEF products, including forecasts.
  - We are now generating 6 hourly products per RFC request.
  - These are available over AWIPS or web
- Accumulated Melt Grids and SHEF products.
- Additional Snow Data ingestion to support assimilation in Southern Canada including portions of Quebec, The Great Lakes Drainage, The Souris, and the Red River Valley.



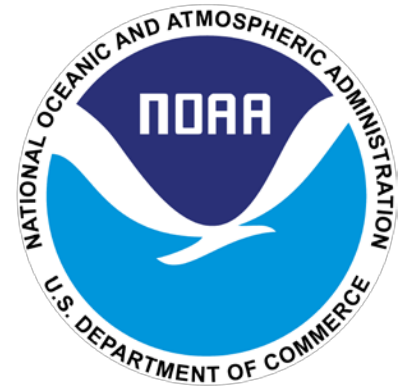
# RFC Forecast Support

- Comparative analyses of National Snow Analyses (1-km gridded) vs. RFC snow model states (lumped basin or sub-basin)
- Weekly teleconferences with RFC forecasters
- Objective is to understand differences and adjust forecast processes as needed





National Operational Hydrologic  
Remote Sensing Center



# National Snow Analyses

Don Cline

Chief, National Weather Service Hydrology Laboratory

*National Oceanic and Atmospheric Administration*

*U.S. Department of Commerce*

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[Donald.Cline@noaa.gov](mailto:Donald.Cline@noaa.gov)