

A large, light blue circular watermark of the NOAA logo is centered in the background. The letters 'NOAA' are visible in white within the circle.

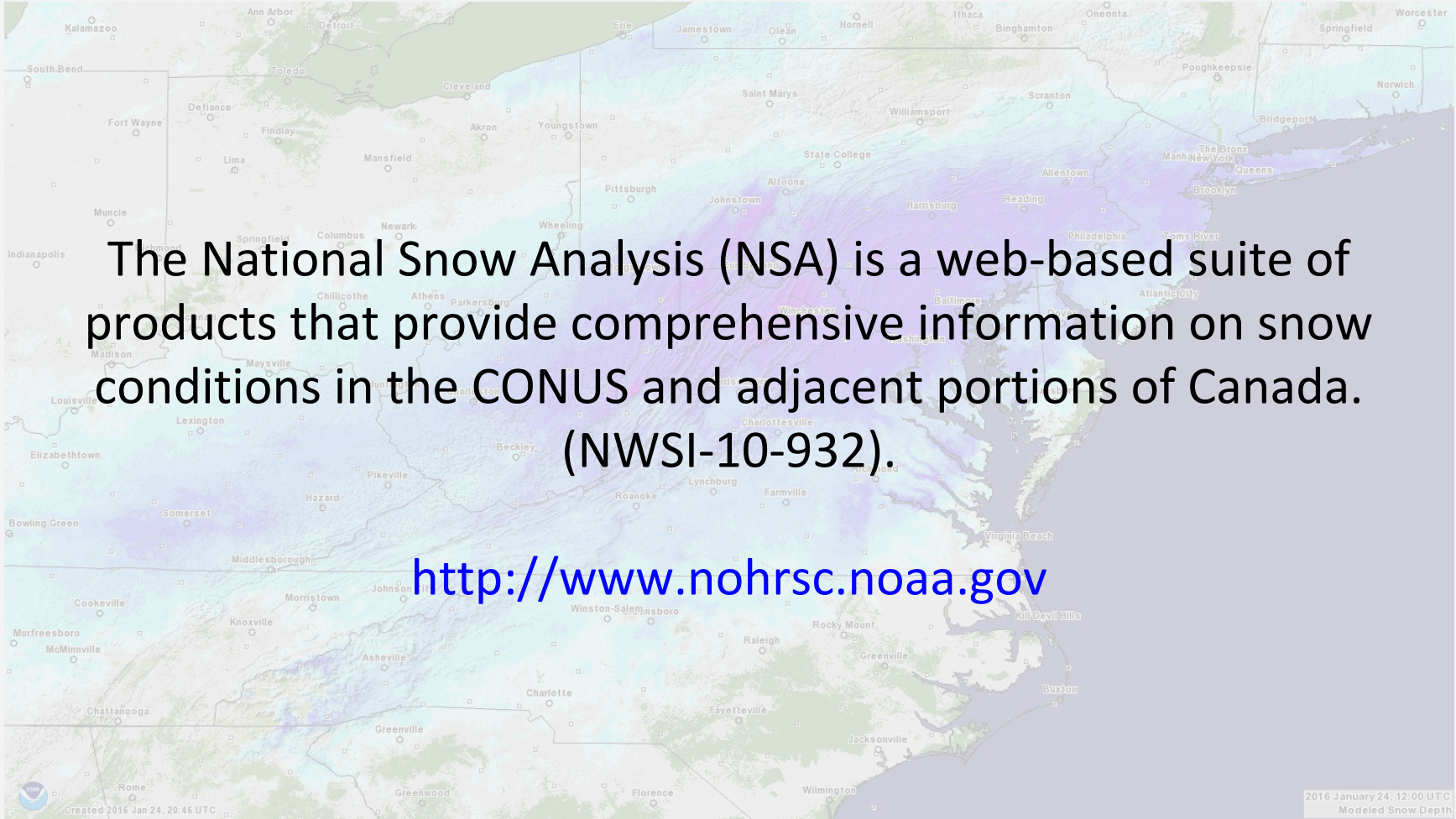
National Snow Analysis: 13 Years of Operations

Greg Fall, NSA Operations Lead

Office of Water Prediction—Chanhassen, MN (NOHRSC)

NSA Operations Team:

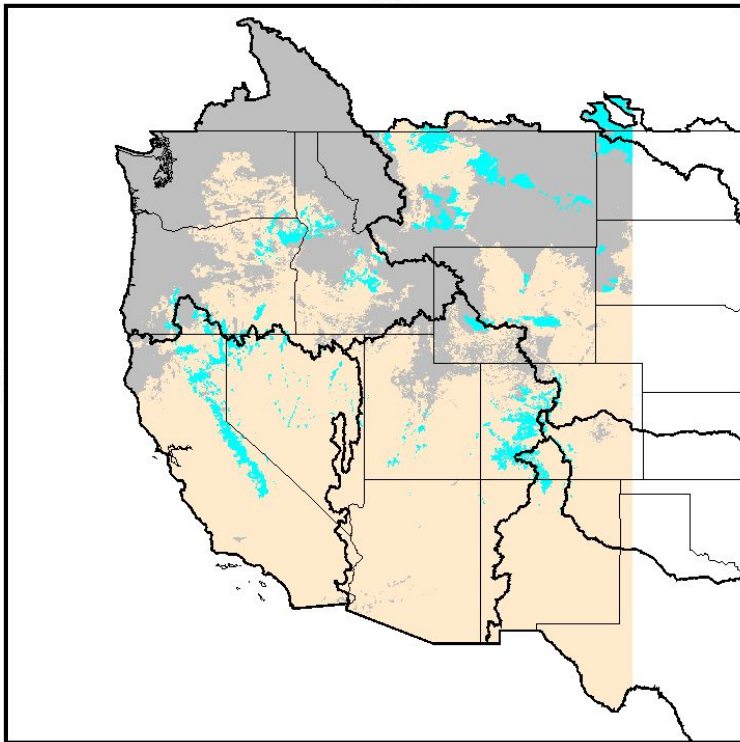
Shawn Carter, Sanian Gaffar, Anders Nilsson, Carrie Olheiser,
Kent Sparrow, Tim Szeliga



The National Snow Analysis (NSA) is a web-based suite of products that provide comprehensive information on snow conditions in the CONUS and adjacent portions of Canada. (NWSI-10-932).

<http://www.nohrsc.noaa.gov>

53.3 N



129.6 W

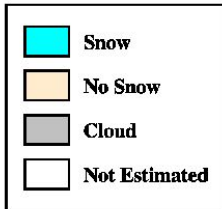
127.1 W

27.9 N

SATELLITE SNOW COVER

19-22 Nov 1998

North America

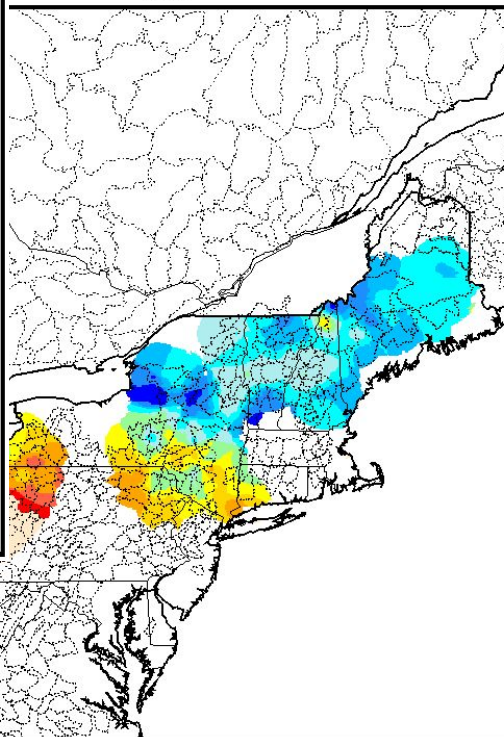


National Operational Hydrologic Remote Sensing Center

Office of Hydrology
National Weather Service, NOAA
Chanhassen, Minnesota

nar96326

51.1 N

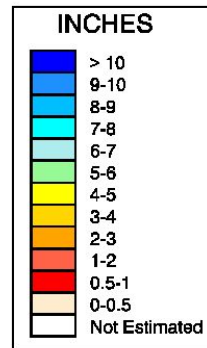


76.9 W

SNOW WATER EQUIVALENT

Mar 14, 2001 to Mar 18, 2001

Analysis Limits

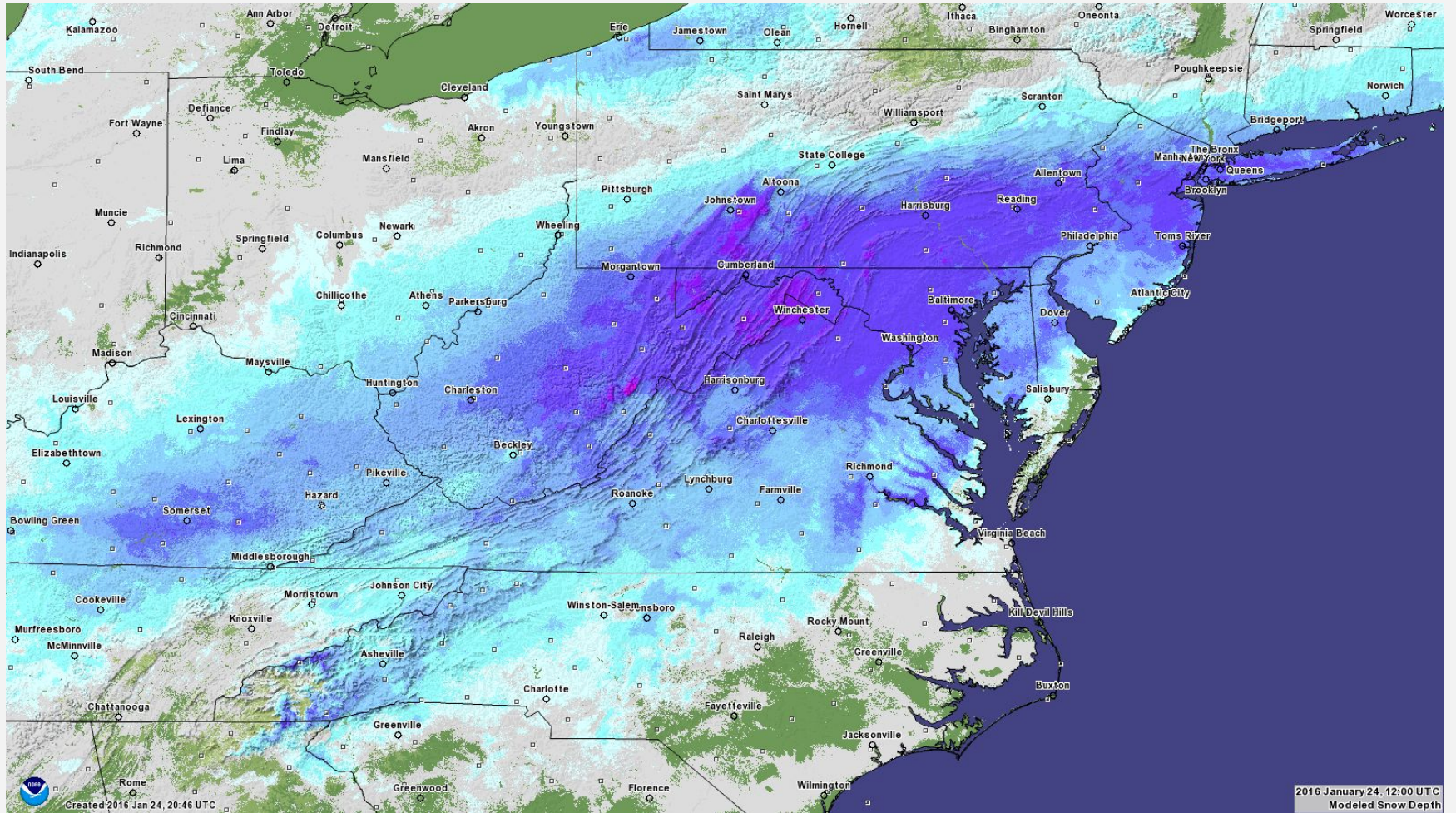


National Operational Hydrologic Remote Sensing Center



zz101077

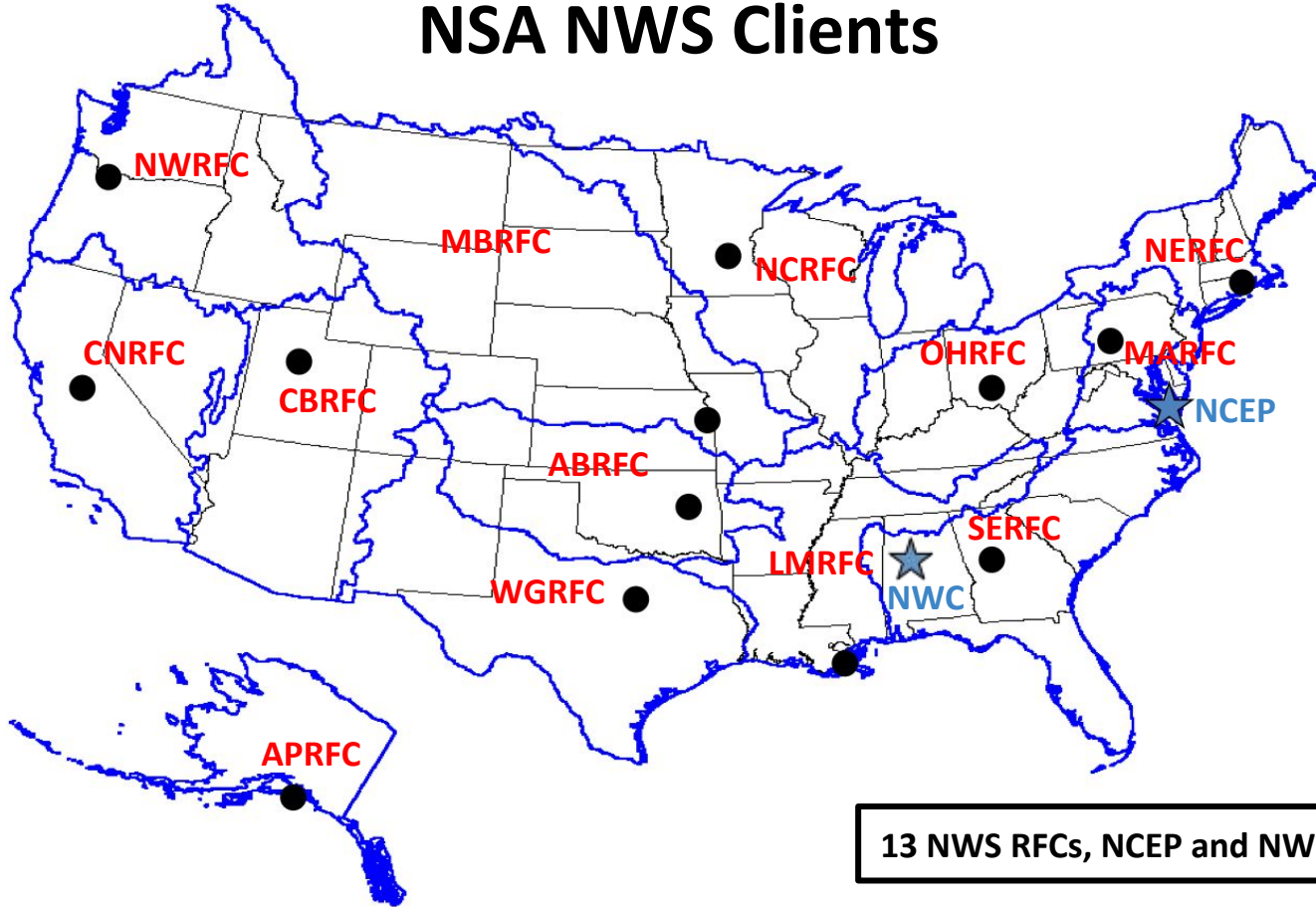
36.5 N



Created 2016 Jan 24, 20:46 UTC

2016 January 24, 12:00 UTC
Modeled Snow Depth

NSA NWS Clients



NSA Stakeholders

National Weather Service

- River Forecast Centers
- Weather Forecast Offices
- Weather Prediction Center
- National Water Center

Federal and State Agencies

- U.S. Army Corps of Engineers
- Bureau of Reclamation
- New York Department of Environmental Protection
- Natural Resources Conservation Service
- Department of Transportation
- Montana Department of Emergency Services
- San Francisco Public Utilities Commission
- University of Albany ASRC/CESTM
- University of Wisconsin Sea Grant Institute
- National Snow and Ice Data Center
- Federal Emergency Management Administration

Private Sector

- Baron Advanced Meteorological Systems, LLC
- The Weather Channel
- Meteorlogix, Inc.
- WeatherBell
- Merrill Lynch
- Weather Decision Technologies, Inc.
- SnowStreet
- AccuWeather
- Snow Plot Operators
- Oppenheimer
- Campbell Soup Company
- Snowmobile outfitters
- Mountaineers
- Skiers
- General Public

International (Canada)

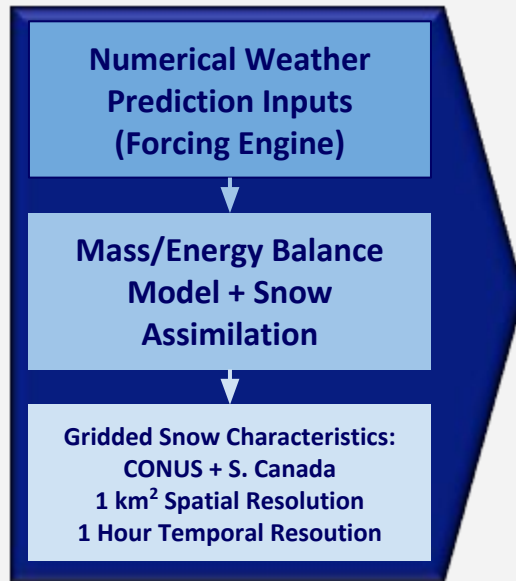
- Manitoba Department of Natural Resources
- New Brunswick Department of Natural Resources
- Alberta Environment
- BC Hydro
- British Columbia Ministry of Environment
- Environment Canada
- Saint John River Basin Commission

National Snow Analysis

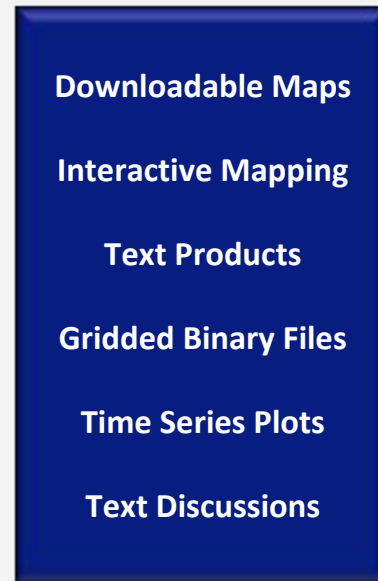
Multisensor Snow Observations



Snow Modeling and Data Assimilation (SNODAS)

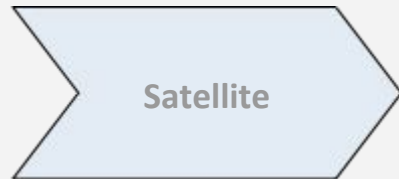
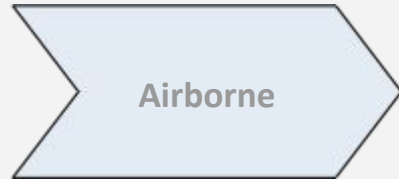


Snow Information (Products)



National Snow Analysis

Multisensor Snow Observations



- **National Weather Service**

- First-order stations
- Cooperative observers

- **Federal and State Agencies**

- NRCS SNOTEL and Snow Courses
- USACE New England District Snow Surveys
- Federal Aviation Administration
- California Department of Water Resources

- **Regional Mesonets and Surveys**

- State Mesonets
- CoCoRaHS
- MesoWest

- **International Agencies**

- St. John River Basin
- Environment Canada
- BC Hydro

Ingest:

Data from IDS/DDPLUS (LDM);
HADS; MADIS; METAR



Processing:

SHEF/MADIS/METAR
decoders; SNODAS grid
sampling

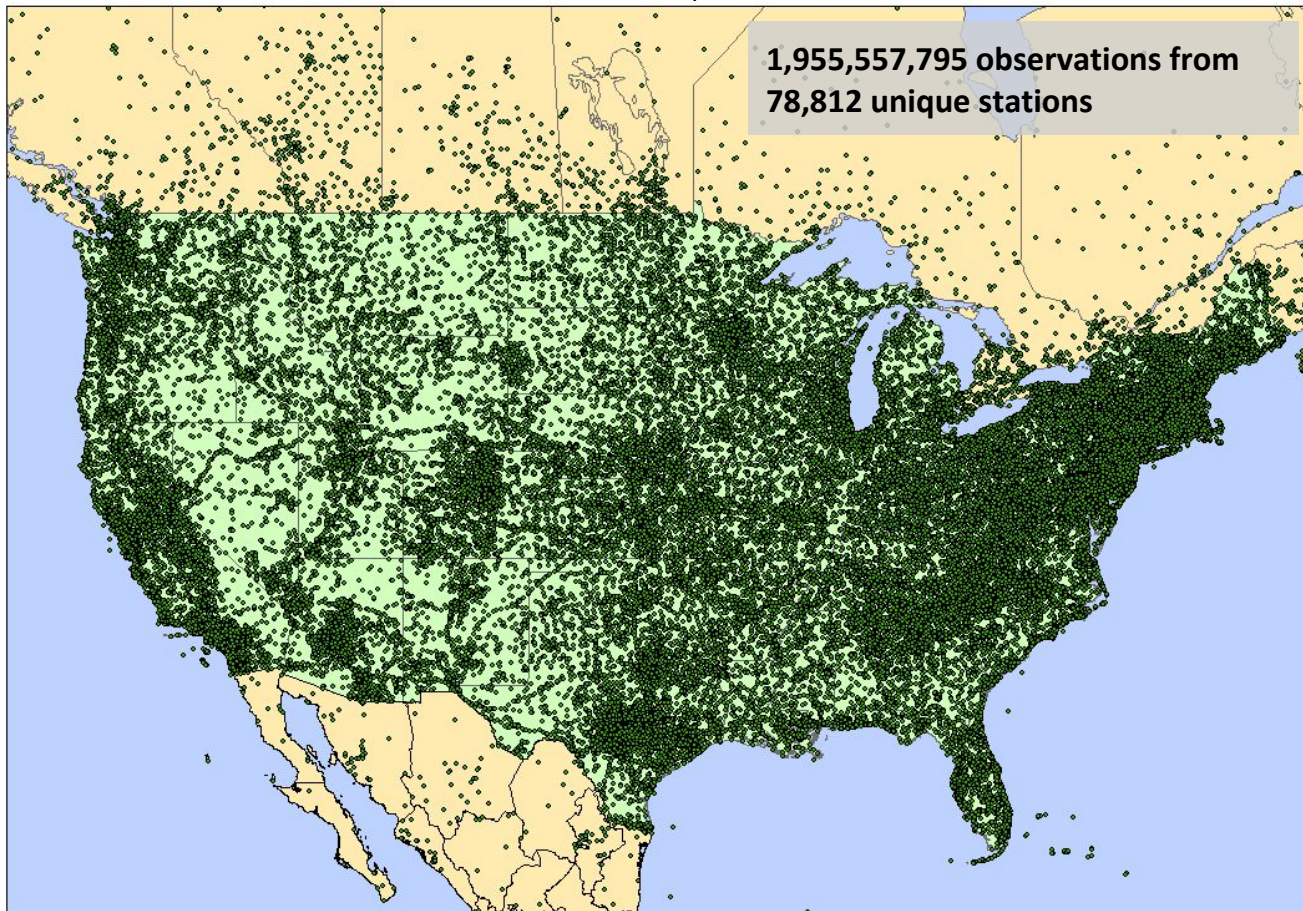


Storage:

PostgreSQL databases (data
from ~2002, >75,000
reporting stations)

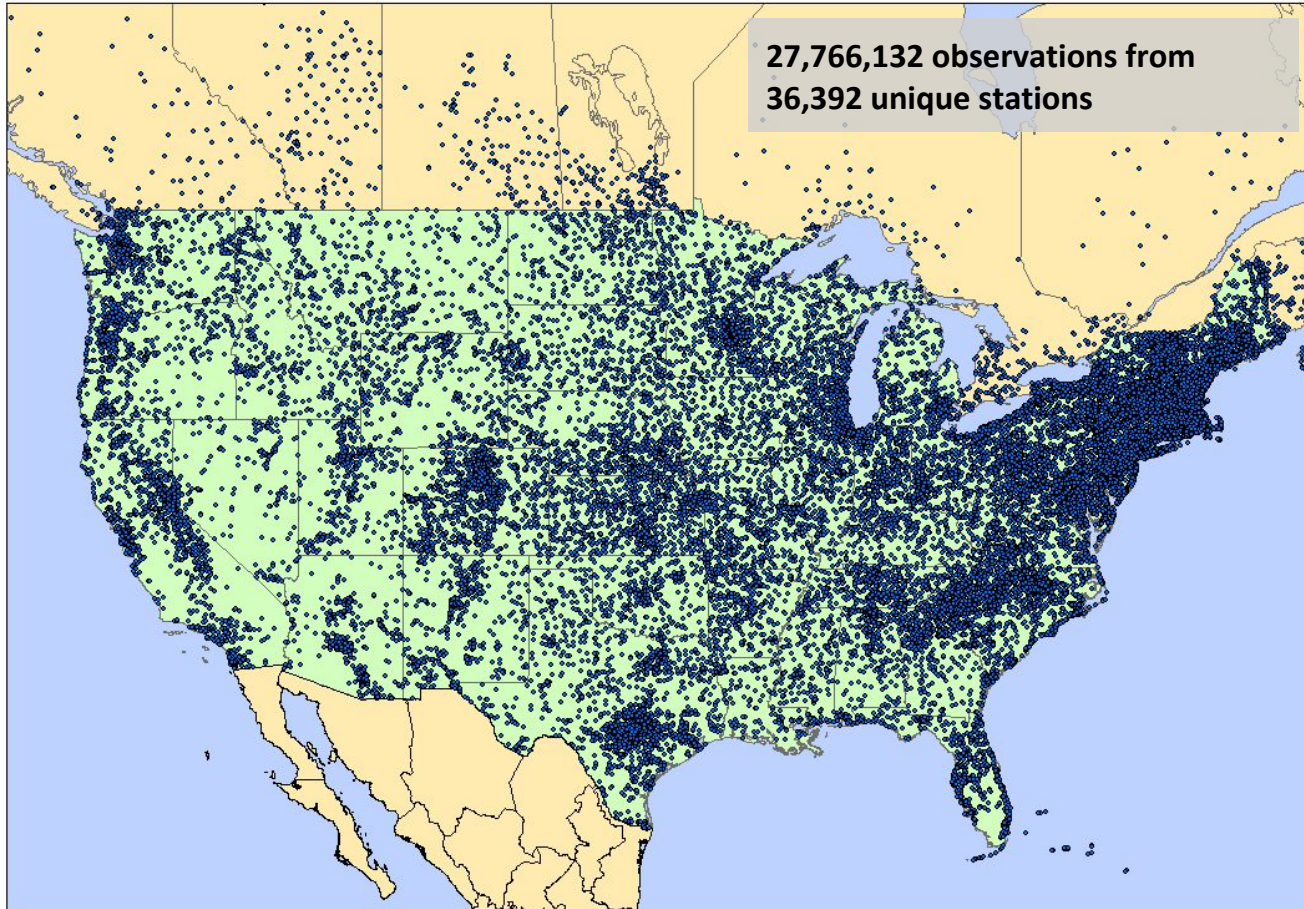
Reporting Stations: All Fields

Oct 1, 2016 - Sept 20, 2017



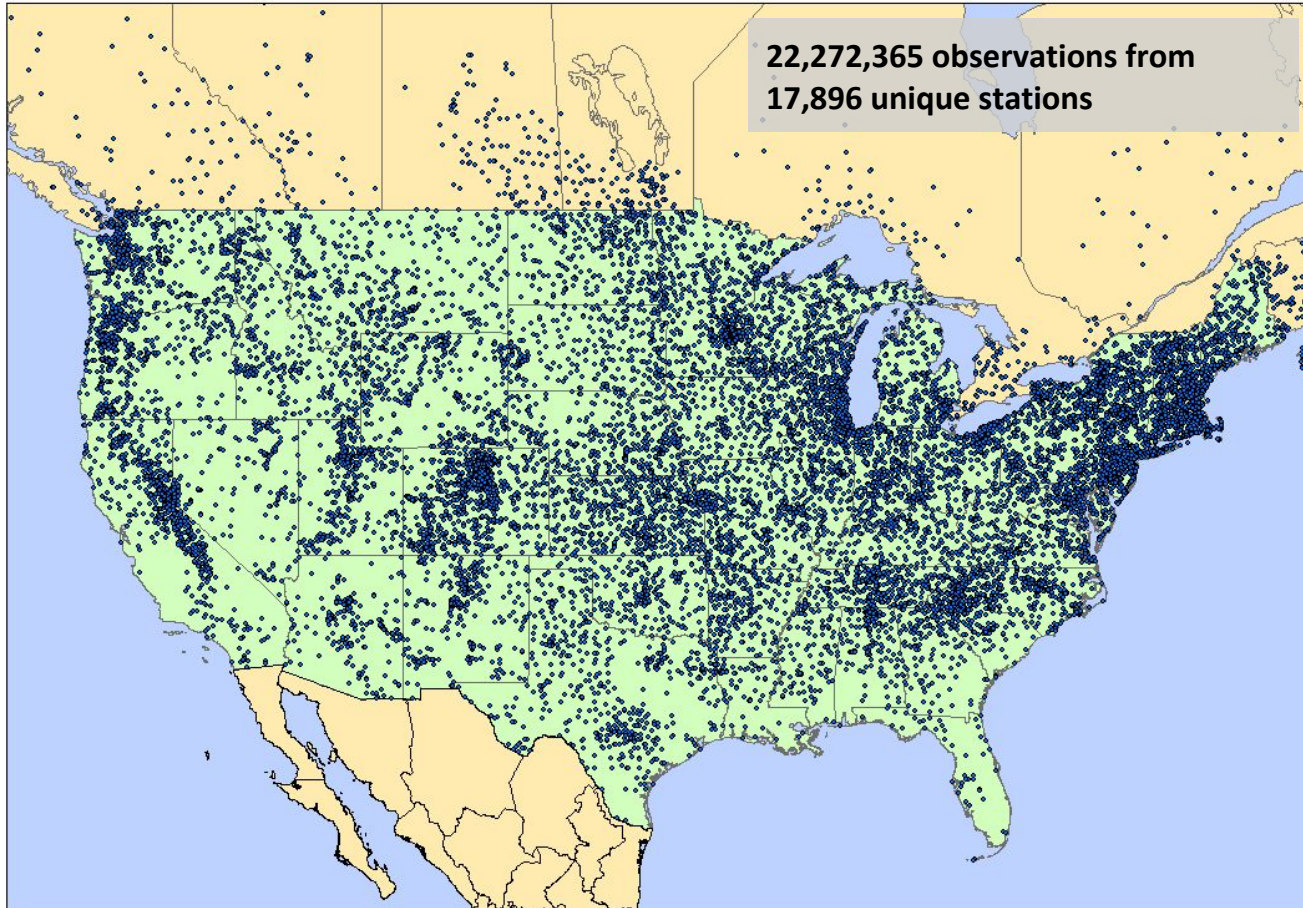
Reporting Stations: **SWE, Snow Depth, and Snowfall**

Oct 1, 2016 - Sept 20, 2017



Reporting Stations: SWE and Snow Depth

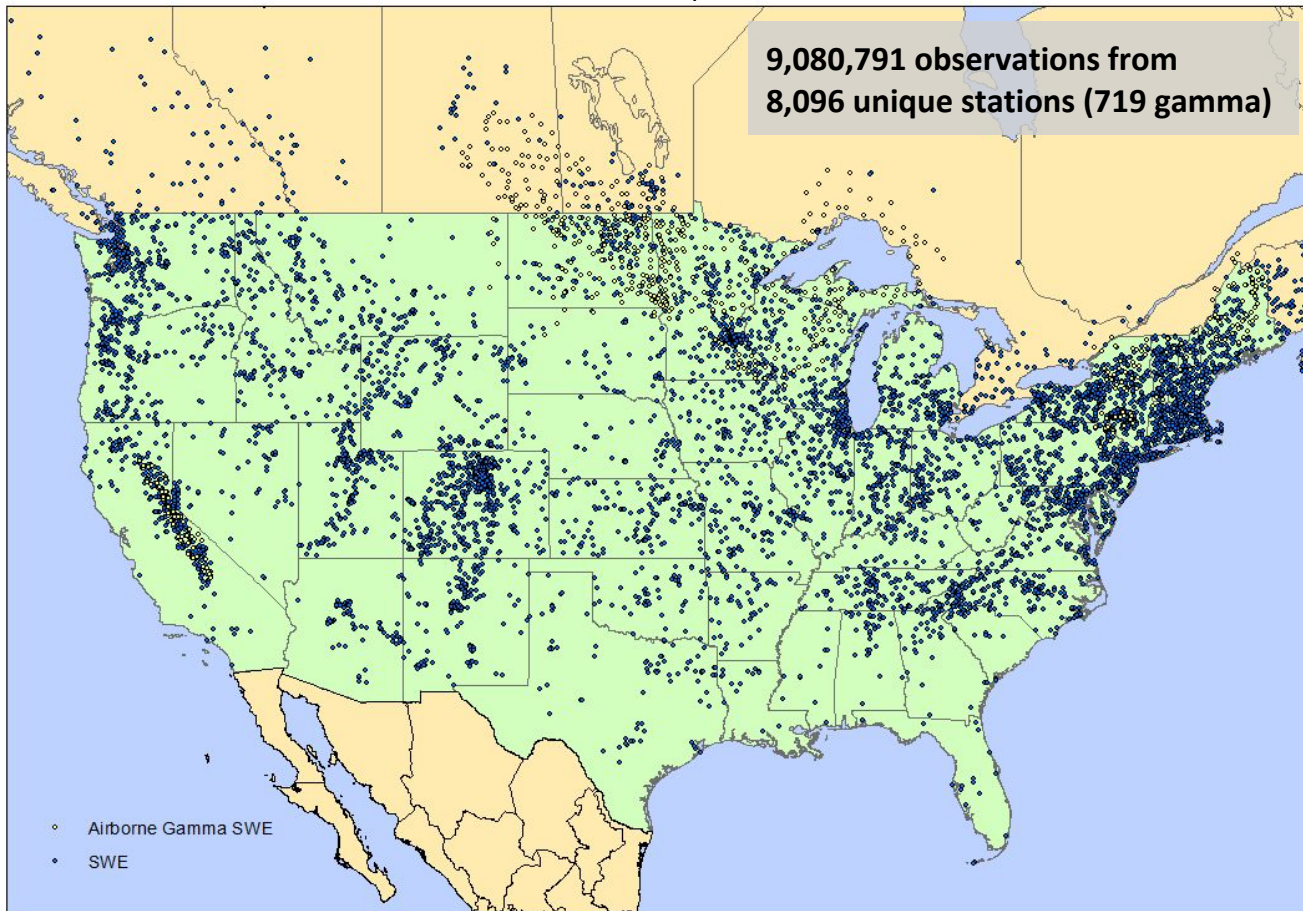
Oct 1, 2016 - Sept 20, 2017



Reporting Stations: SWE

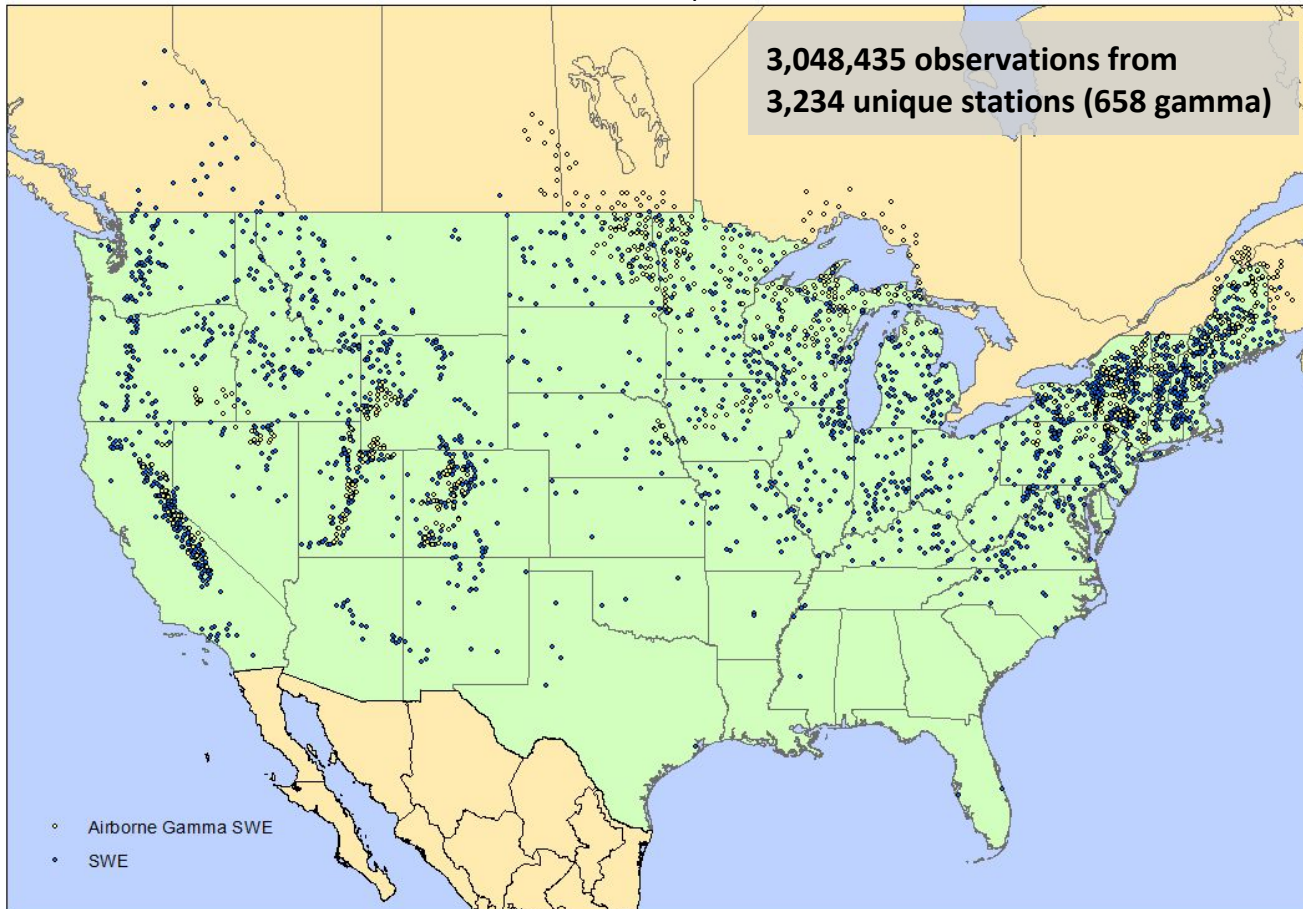
Oct 1, 2016 - Sept 20, 2017

9,080,791 observations from
8,096 unique stations (719 gamma)



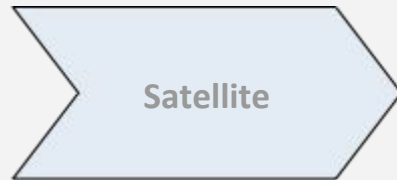
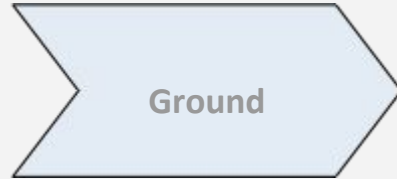
Reporting Stations: SWE

Oct 1, 2014 - Sept 20, 2005



National Snow Analysis

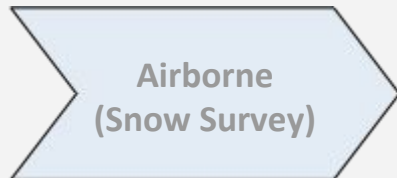
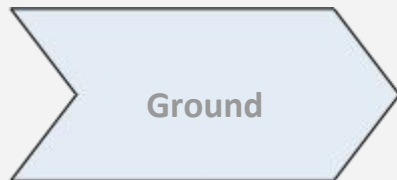
Multisensor Snow Observations



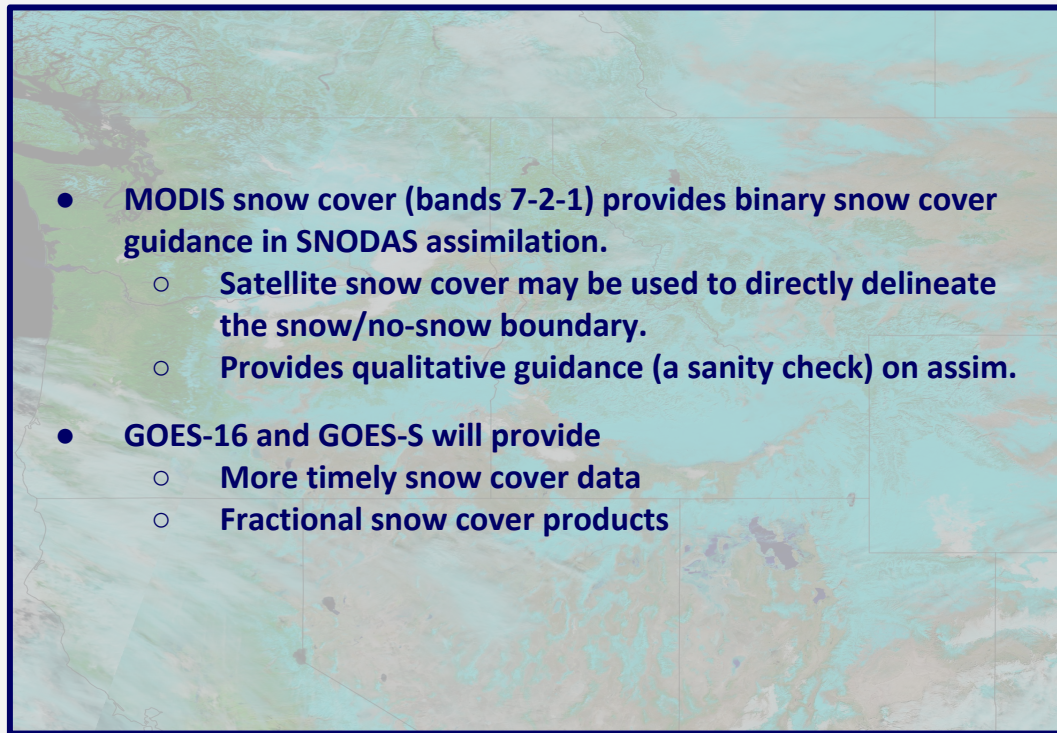
- The Airborne Snow and Soil Moisture program estimates snow water equivalent (SWE) and soil moisture by measuring the attenuation by water of naturally occurring terrestrial gamma radiation (K, U, Th isotopes).
- Uses 3 gamma detection systems deployed in NOAA aircraft.
- Primary motivations for Airborne surveys:
 - Augmenting gaps in surface networks and surveys;
 - Measuring snow where no surface observations exist.
- Uses of Airborne SWE observations:
 - Assimilated directly into SNODAS;
 - Guidance for RFC flood forecast models;
 - Key users include USACE, NYC DEP, APRFC
- Coverage includes 2,568 flight lines in 37 states and 9 provinces.
- Typically 1,500 lines are flown each year.

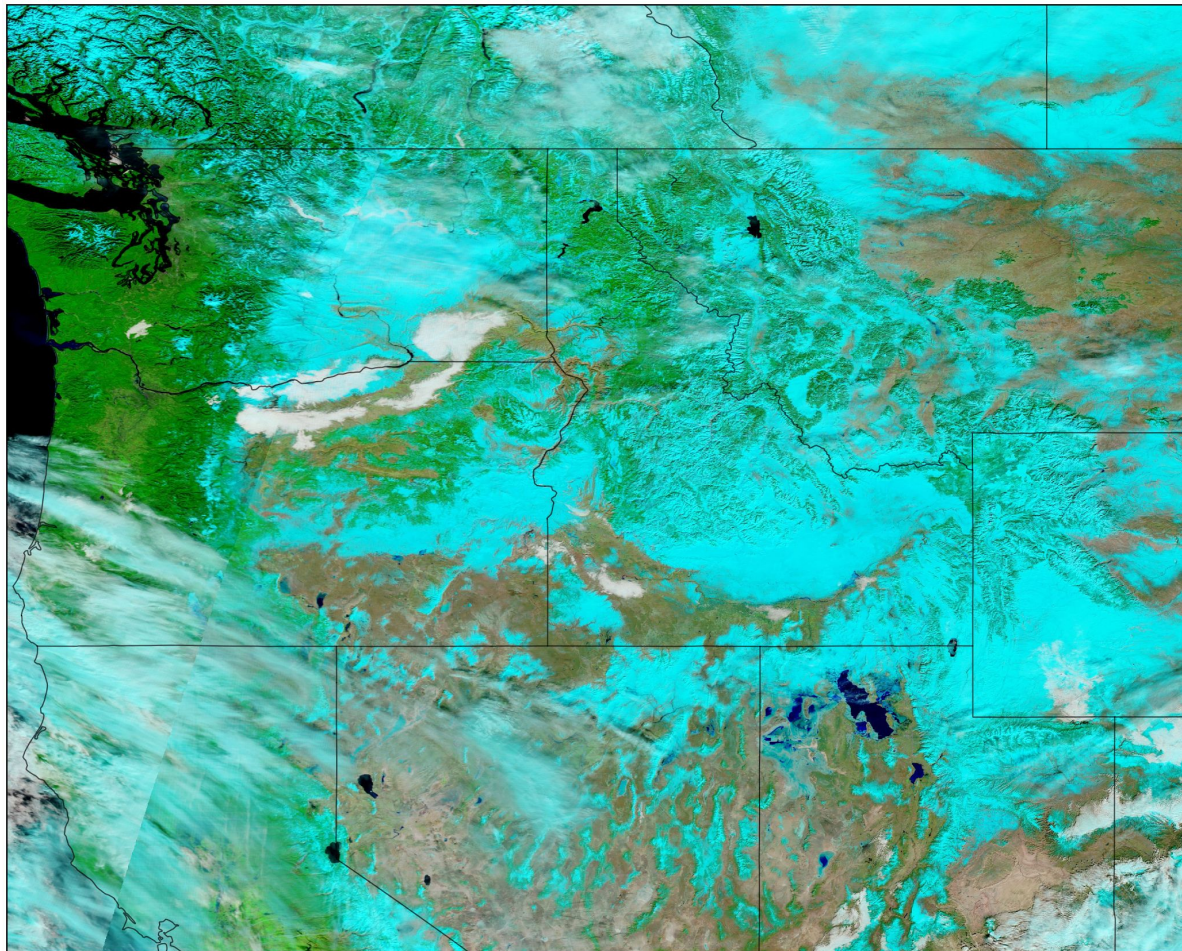
National Snow Analysis

Multisensor Snow Observations

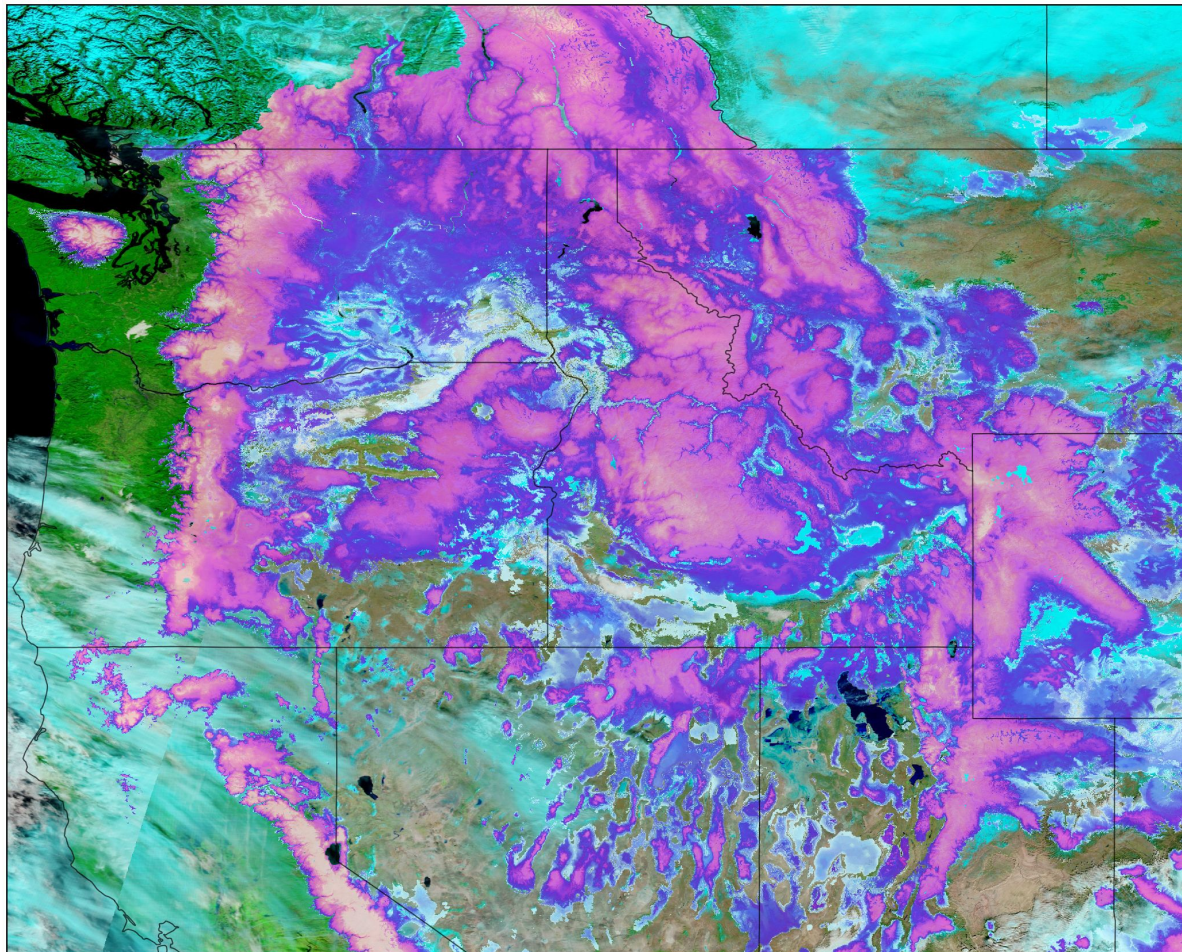


- **MODIS snow cover (bands 7-2-1) provides binary snow cover guidance in SNODAS assimilation.**
 - Satellite snow cover may be used to directly delineate the snow/no-snow boundary.
 - Provides qualitative guidance (a sanity check) on assim.
- **GOES-16 and GOES-S will provide**
 - More timely snow cover data
 - Fractional snow cover products





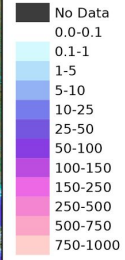
MODIS Imagery
(Bands 7-2-1)
20170213

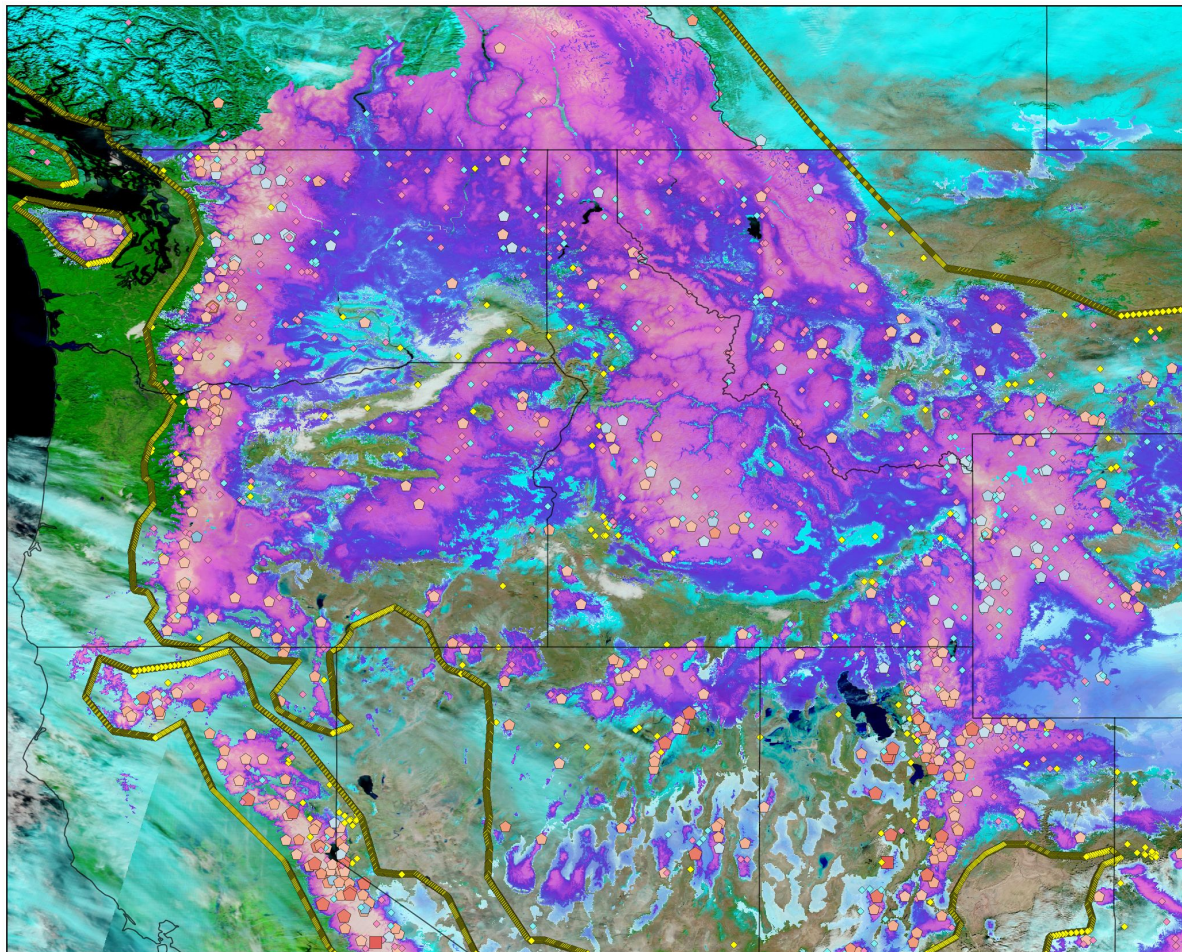


MODIS Imagery
(Bands 7-2-1)
20170213

SNODAS SWE (mm)

20170213





MODIS Imagery
(Bands 7-2-1)
20170213

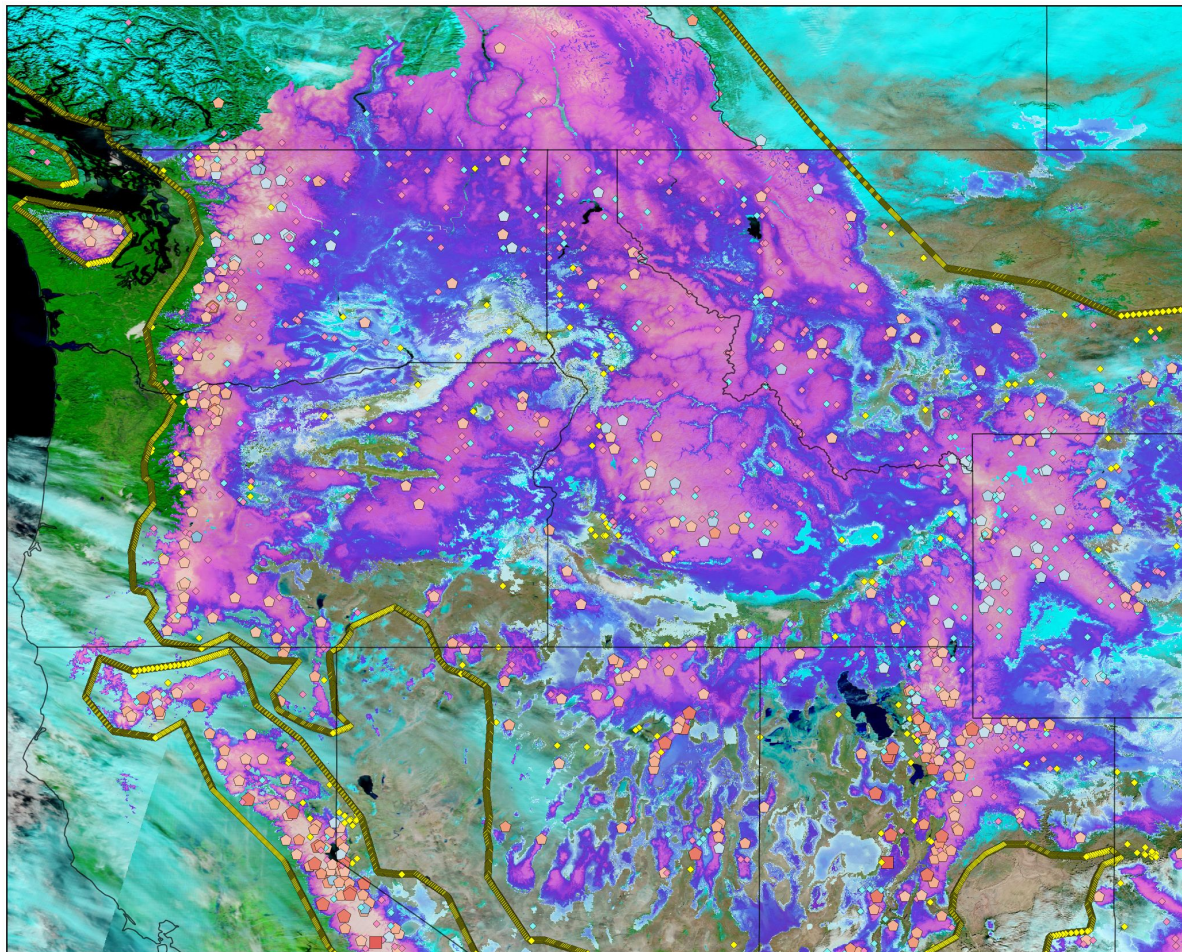
SNODAS SWE (mm)

20170213

- No Data
- 0.0-0.1
- 0.1-1
- 1-5
- 5-10
- 10-25
- 25-50
- 50-100
- 100-150
- 150-250
- 250-500
- 500-750
- 750-1000

Delta Obs-Modeled

- ★ < -1 meter
- -50 cm to -1 meter
- -25 to 50 cm
- -10 to 25 cm
- -7.5 to -10 cm
- -5 to -7.5 cm
- -2.5 to -5 cm
- -1 to -2.5 cm
- 0 to -1 cm
- ◆ No Snow / Perfect Match
- ◆ 0 to 1 cm
- ◆ 1 to 2.5 cm
- ◆ 2.5 to 5 cm
- ◆ 5 to 7.5 cm
- ◆ 7.5 to 10 cm
- ◆ 10 to 25 cm
- ◆ 25 to 50 cm
- ◆ 50 cm to 1 meter
- ★ > 1 meter
- < 10% Error
- 10-25% Error
- 25 -50% Error
- >50% Error

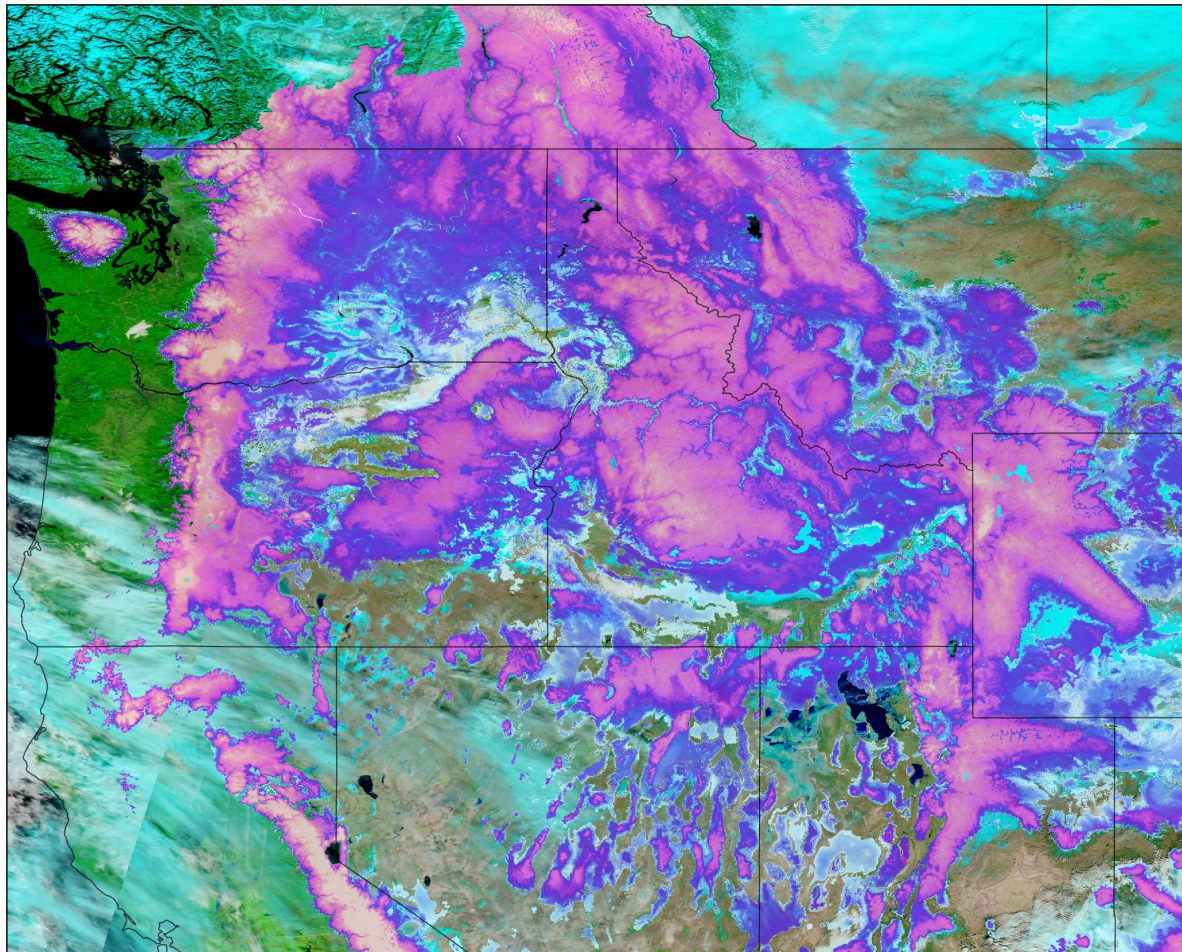


MODIS Imagery
(Bands 7-2-1)
20170213

SNODAS SWE (mm)

20170214

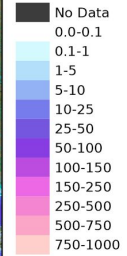
- No Data
- 0.0-0.1
- 0.1-1
- 1-5
- 5-10
- 10-25
- 25-50
- 50-100
- 100-150
- 150-250
- 250-500
- 500-750
- 750-1000



MODIS Imagery
(Bands 7-2-1)
20170213

SNODAS SWE (mm)

20170214

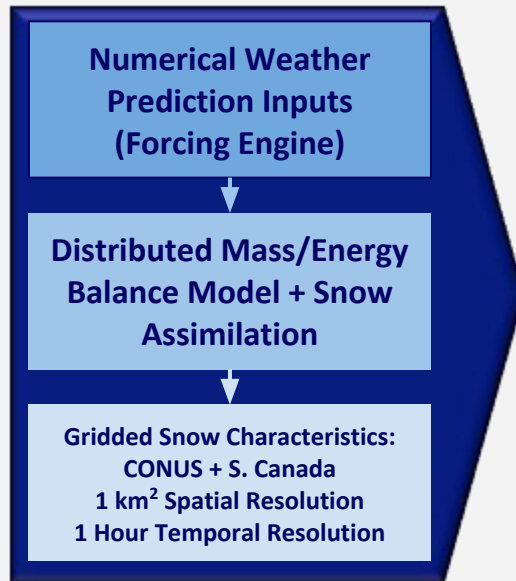


National Snow Analysis

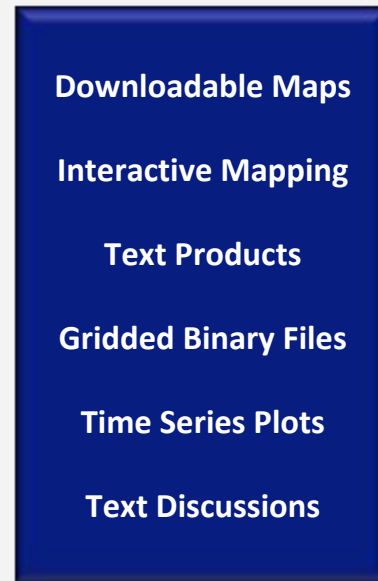
Multisensor Snow Observations



Snow Modeling and Data Assimilation (SNODAS)



Snow Information (Products)



National Snow Analyses - NOHRC

www.nohrsc.noaa.gov/nsa/index.html?region=National&year=2017&month=2&...

National Weather Service
National Operational Hydrologic Remote Sensing Center

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3D Visualization
Airborne Surveys
Snowfall Analysis
Satellite Obs
Forecasts
Data Archive
SHEF Products

Observations near
City, ST Go

Science/Technology
NOHRSC
GIS Data Sets
Special Purpose
Imagery

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Staff

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Snow Climatology
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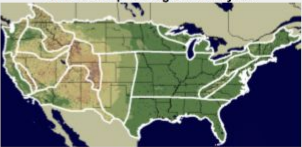
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Please Send Us
Comments!

USA.gov

National Snow Analyses

Snow Reports Model Assimilation Schedule Snow Survey Schedule

Click On Map for Regional Analyses

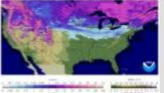
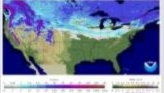
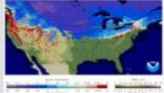








Automated Model Discussion:
February 9, 2017
Area Covered By Snow: 40.8%
Area Covered Last Month: 59.7%

Snow Depth
Average: 6.5 in
Minimum: 0.0 in
Maximum: 1726.0 in
Std. Dev.: 16.0 in

Snow Water Equivalent
Average: 1.6 in
Minimum: 0.0 in
Maximum: 969.8 in
Std. Dev.: 4.4 in
more... Metric Units...

Select Region and Date
National 2017 February 9 - + Go

<p>Snow Water Equivalent</p>  <p>Animate: Season --- Two weeks --- One Day</p>	<p>Snow Depth</p>  <p>Animate: Season --- Two weeks --- One Day</p>	<p>Average Snowpack Temp</p>  <p>Animate: Season --- Two weeks --- One Day</p>
<p>SWE Change</p>  <p>Animate: Season --- Two weeks --- One Day</p>	<p>Snow Precipitation</p>  <p>Animate: Season --- Two weeks --- One Day</p>	<p>Snow Melt</p>  <p>Animate: Season --- Two weeks --- One Day</p>
<p>Blowing Snow Sublimation</p>  <p>Animate: Season --- Two weeks --- One Day</p>	<p>Surface Sublimation</p>  <p>Animate: Season --- Two weeks --- One Day</p>	<p>Non-Snow Precipitation</p>  <p>Animate: Season --- Two weeks --- One Day</p>

SWCW1 - NOHRSC Graph plot x

www.nohrsc.noaa.gov/interactive/html/graph.html?station=SWCW1&w=340&h...

National Operational Hydrologic Remote Sensing Center

Interactive Snow Information

Home News Organization Search Enter Search Here Go

Query Station Time Series
Station SHEF ID: SWCW1
340 width
170 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

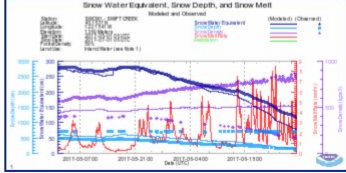
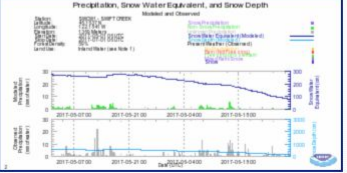
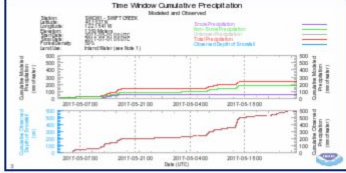
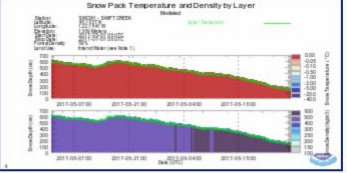
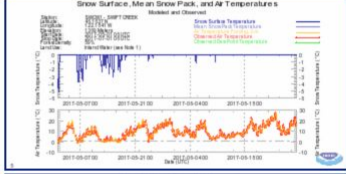
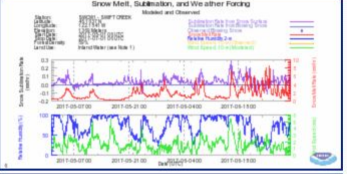
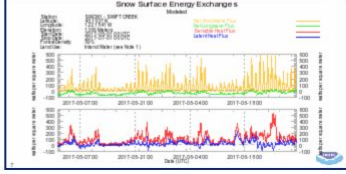
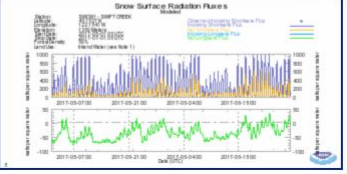
Latest page

Preferences
Cookies off

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

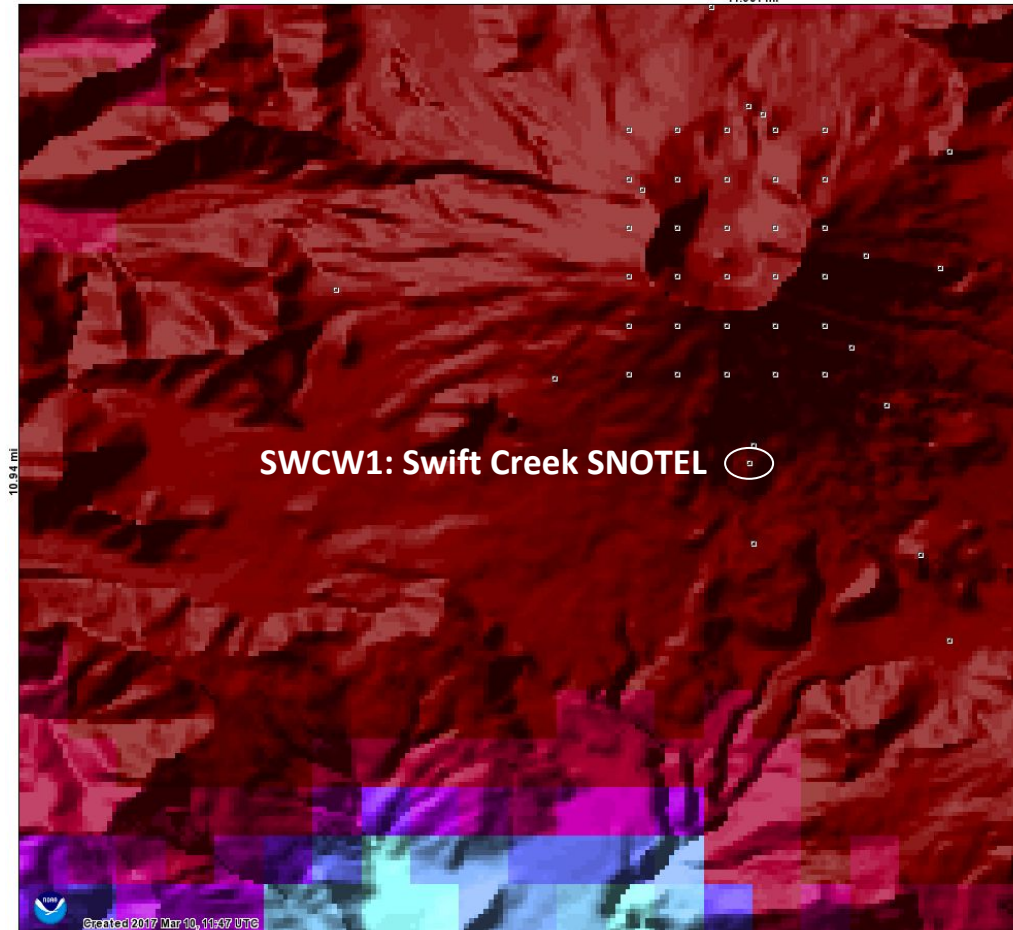
Start Date: 2017 May 1 6:00 Z to Stop Date: 2017 July 1 6:00 Z

All Graphs Metric Units Refresh screen

<p>Snow Water Equivalent, Snow Depth, and Snow Melt</p> 	<p>Precipitation, Snow Water Equivalent, and Snow Depth</p> 
<p>Time Window Cumulative Precipitation</p> 	<p>Snow Pack Temperature and Density by Layer</p> 
<p>Snow Surface, Me an Snow Pack, and Air Temperature</p> 	<p>Snow Melt, Sublimation, and Wet Other Floking</p> 
<p>Snow Surface Energy Exchanges</p> 	<p>Snow Surface Radiation Fluxes</p> 

Modeled Snow Water Equivalent for 2017 March 10, 6:00 UTC

11.981 mi



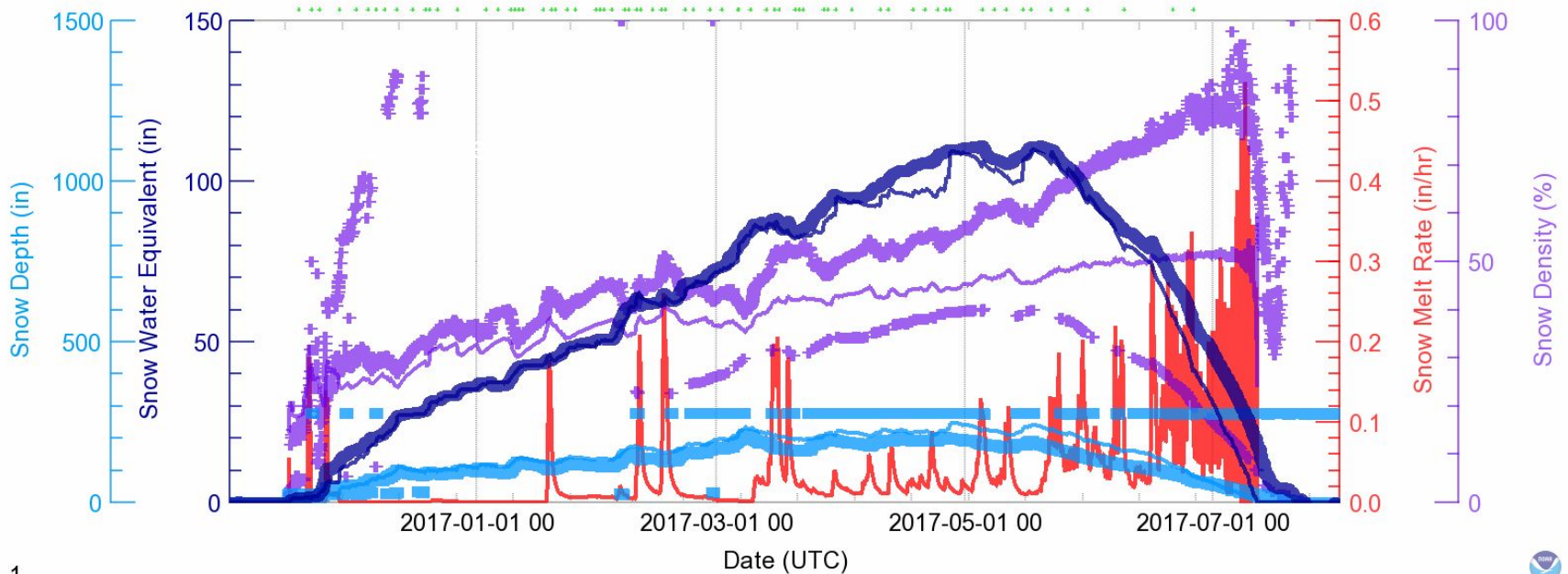
12.015 mi

Snow Water Equivalent, Snow Depth, and Snow Melt

Modeled and Observed

Station: SWCW1 - SWIFT CREEK
 Latitude: 46.1637 N
 Longitude: 122.1841 W
 Elevation: 4491 Feet
 Start Date: 2016-11-01 06 UTC
 Stop Date: 2017-08-01 06 UTC
 Forest Density: 59%
 Land Use: Inland Water (see Note 1)

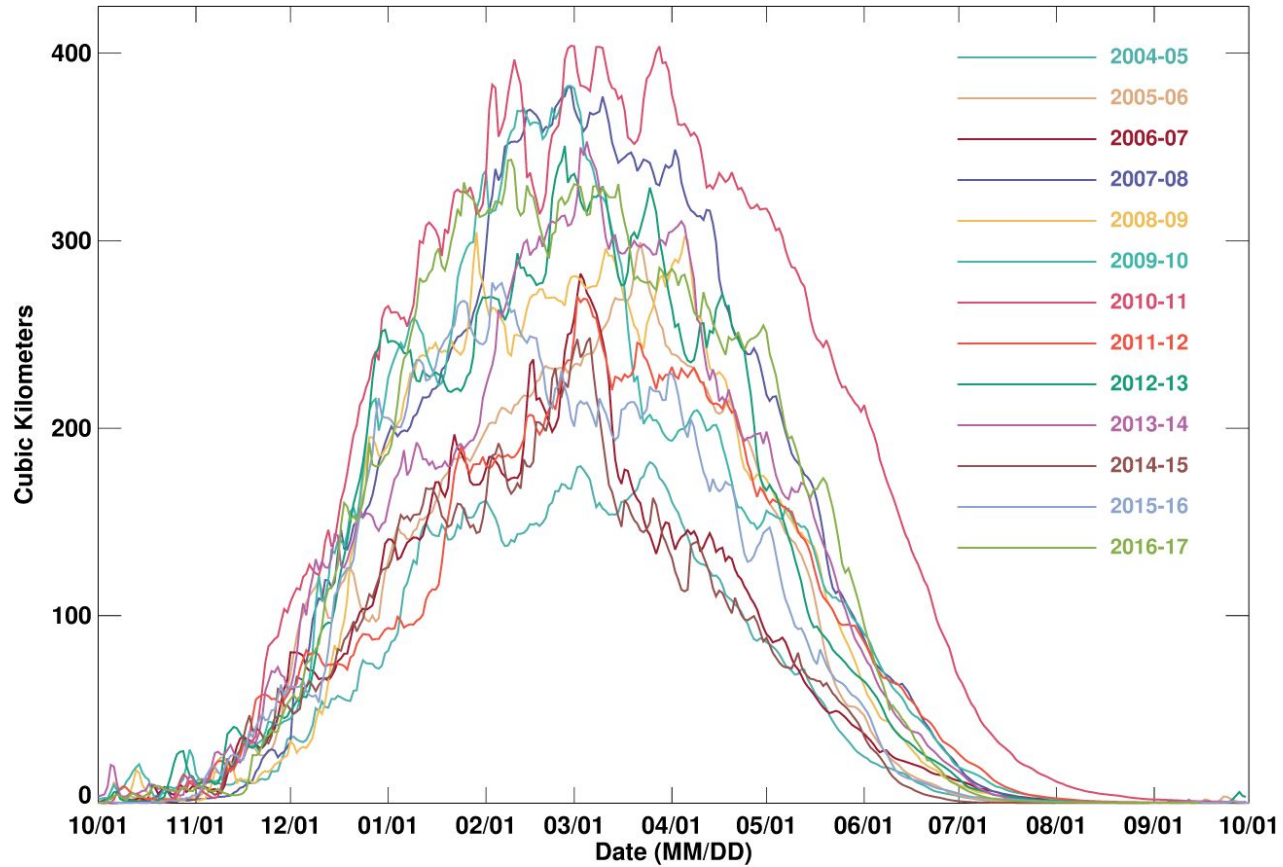
Snow Water Equivalent	(Modeled)	(Observed)
Snow Depth	—	■
Snow Density	—	+
Snow Melt Rate	—	
Assimilation	—	



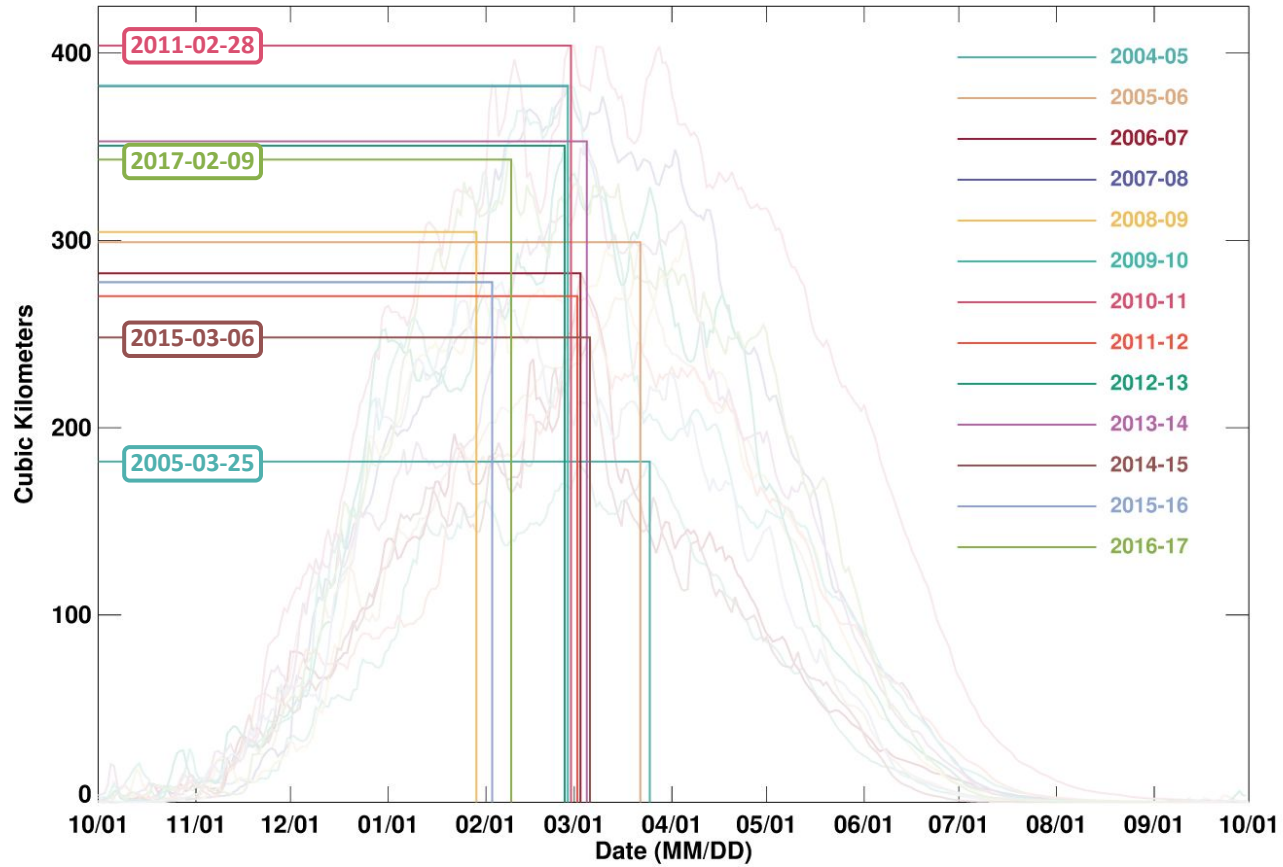
National Snow Analysis Period of Record: 2004-2017



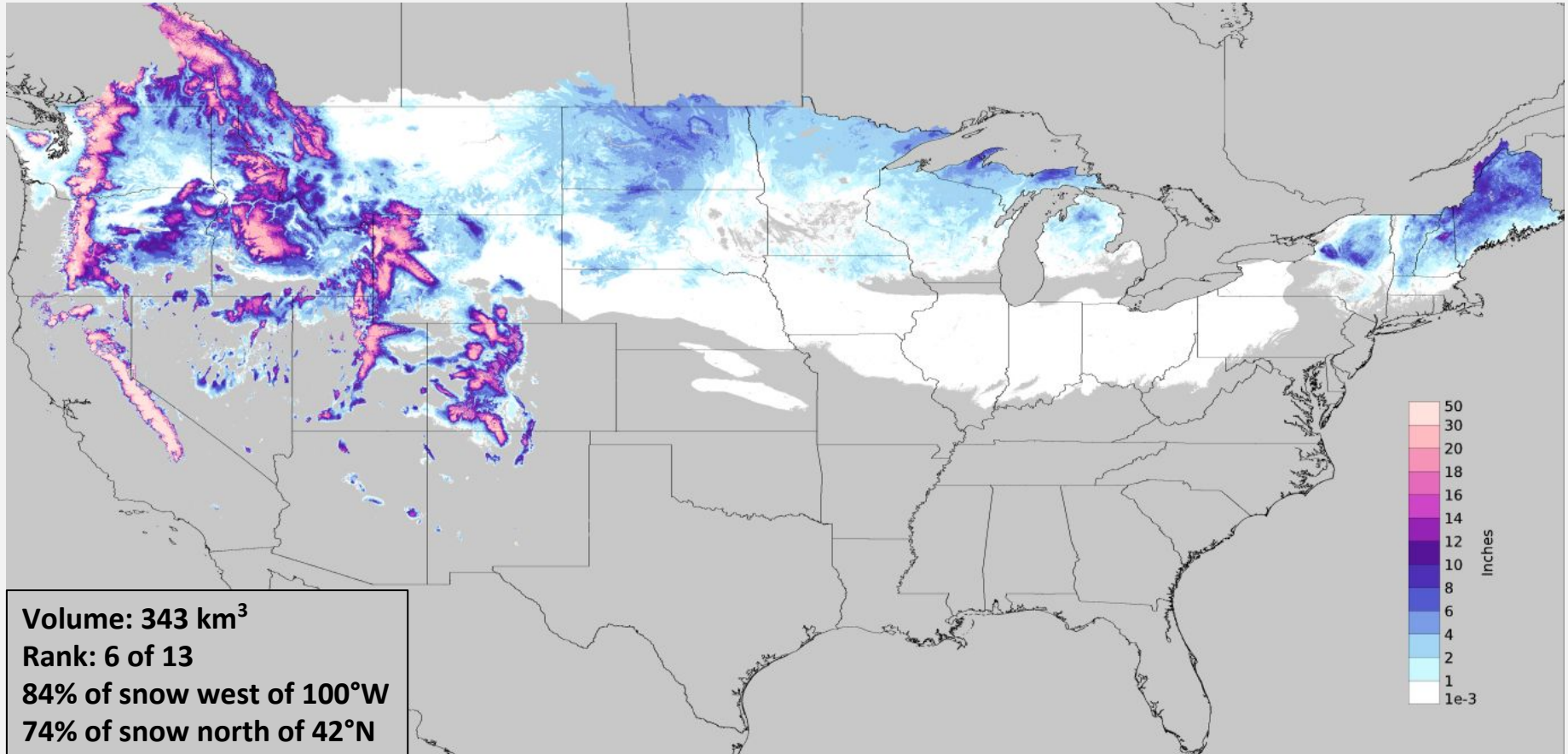
Total CONUS SWE Volume



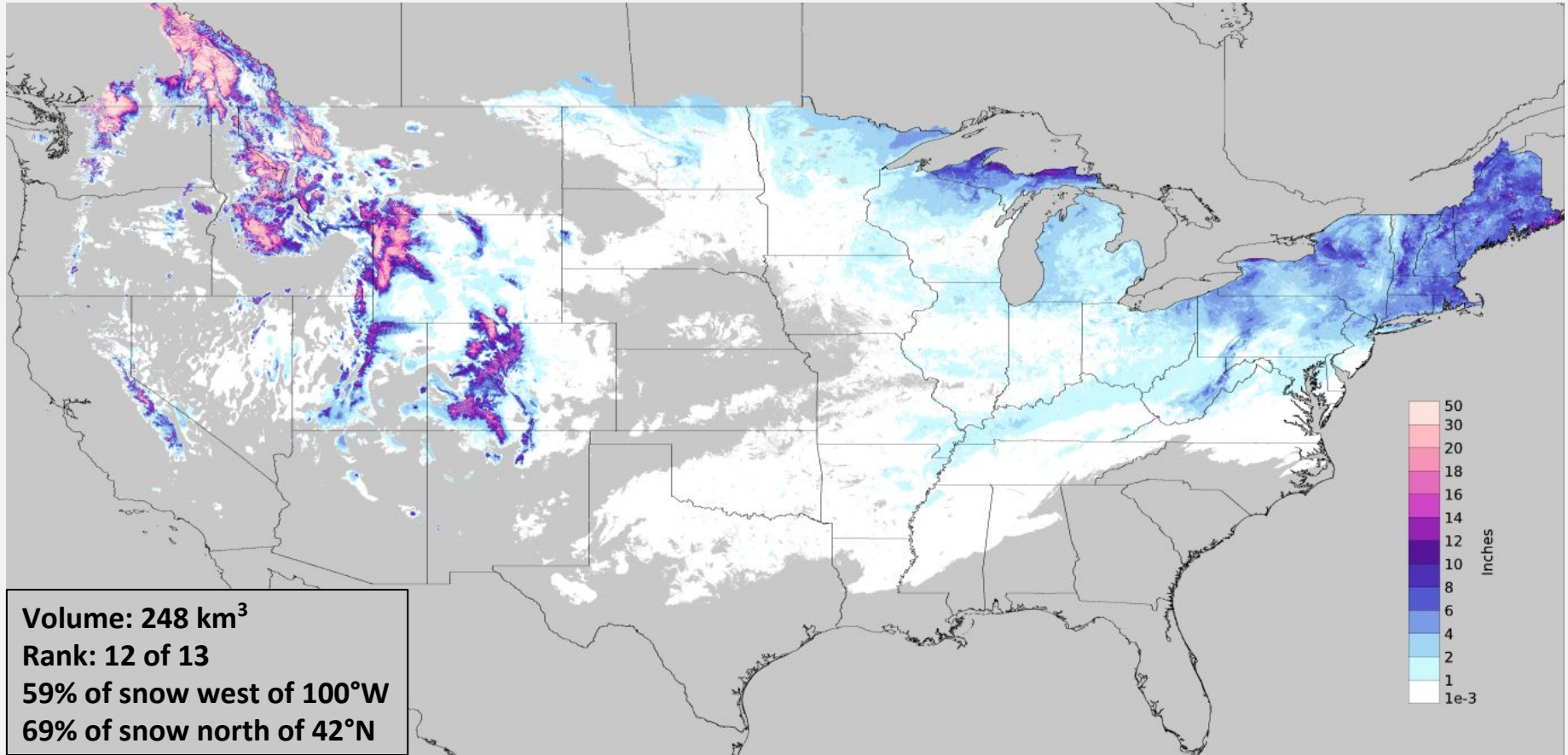
Total CONUS SWE Volume



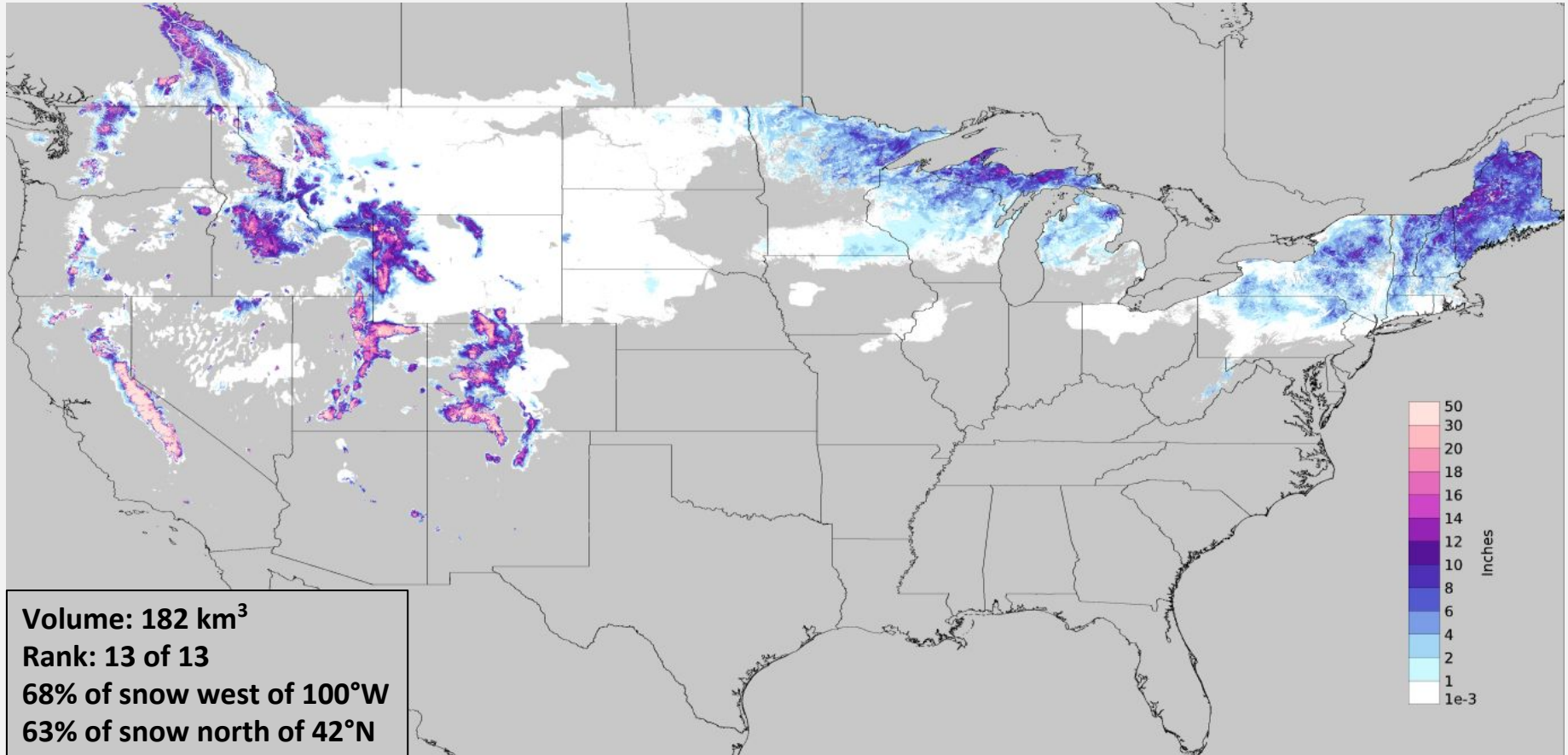
Modeled SWE, 2017-02-09



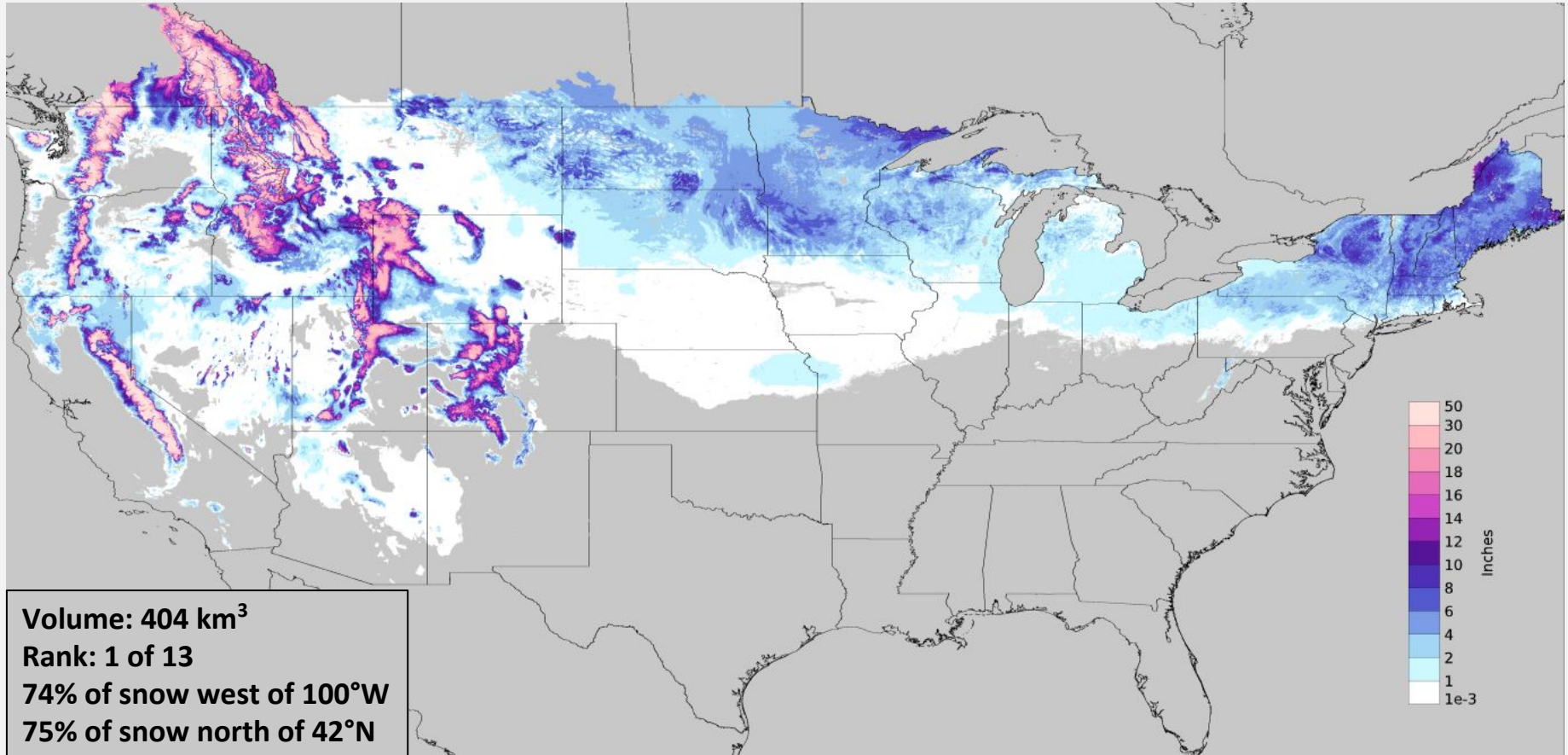
Modeled SWE, 2015-03-06



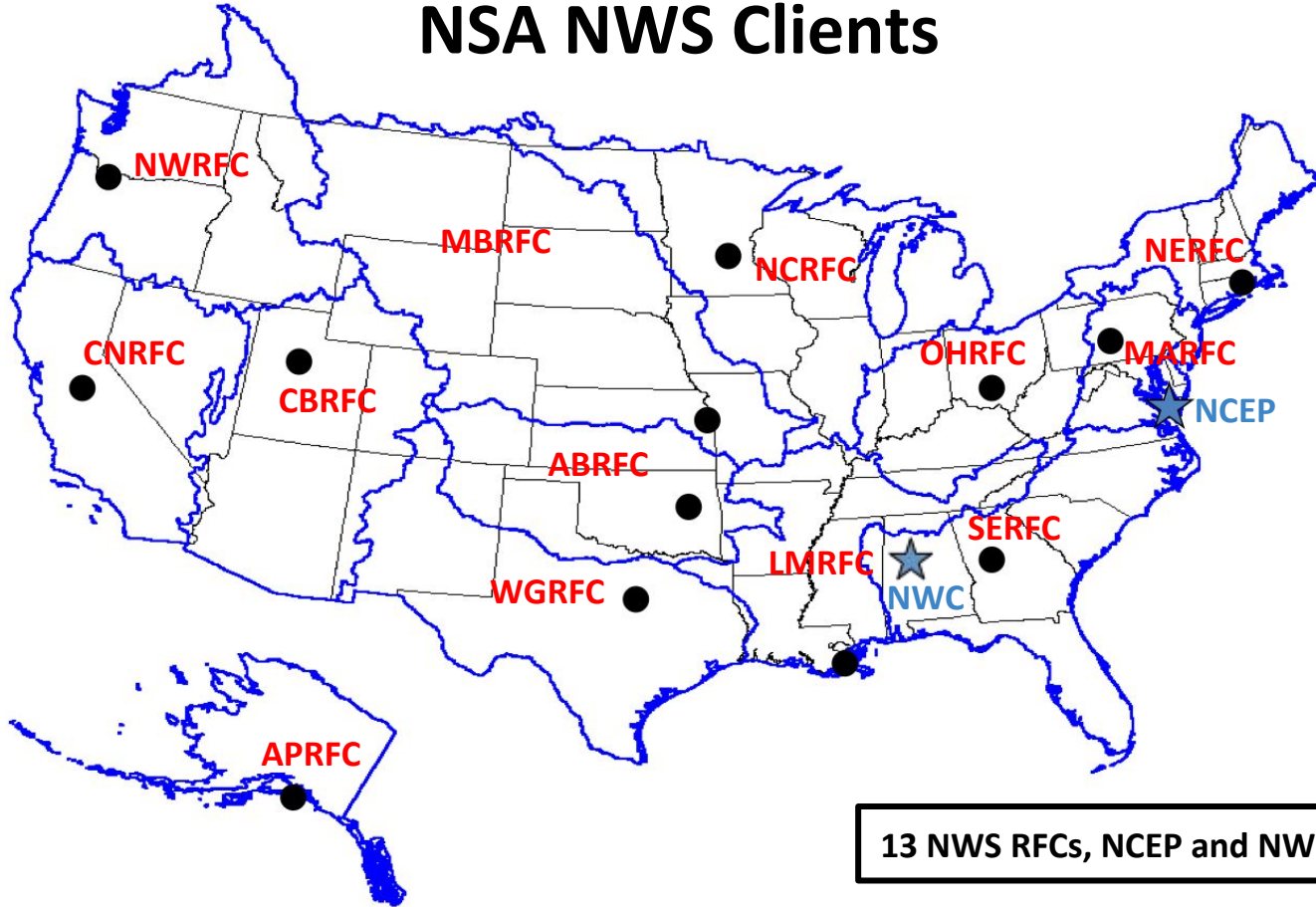
Modeled SWE, 2005-03-25



Modeled SWE, 2011-02-28

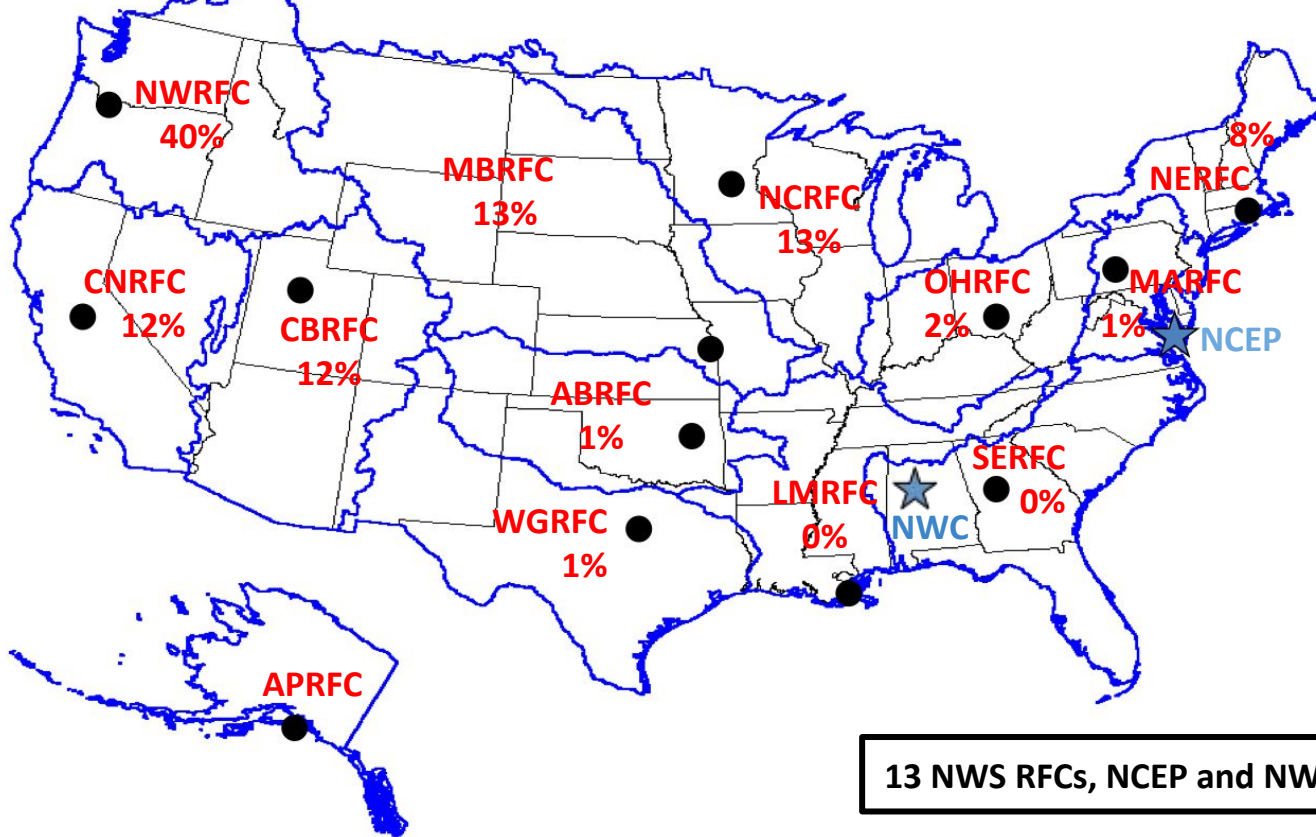


NSA NWS Clients



13 NWS RFCs, NCEP and NWC

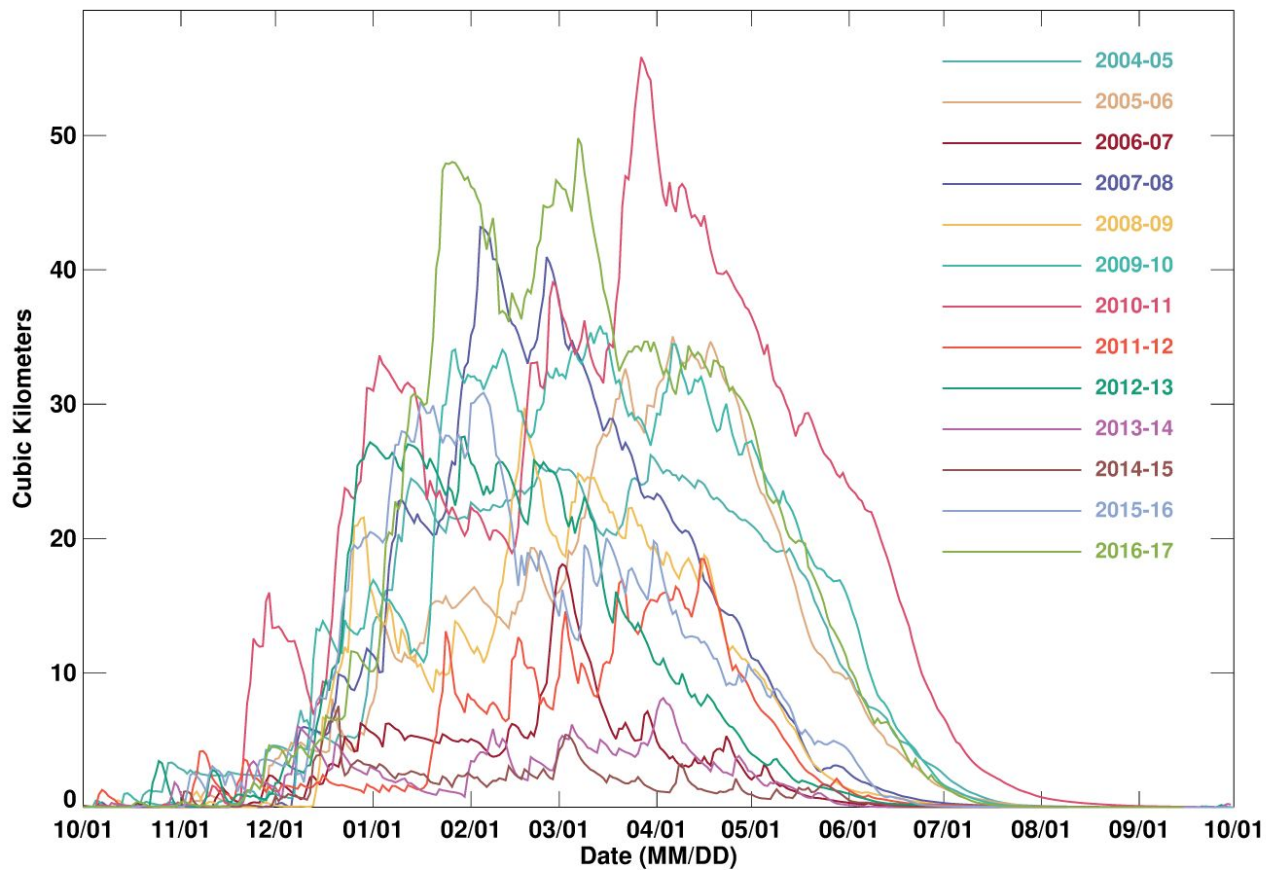
Percent of Maximum SWE by RFC



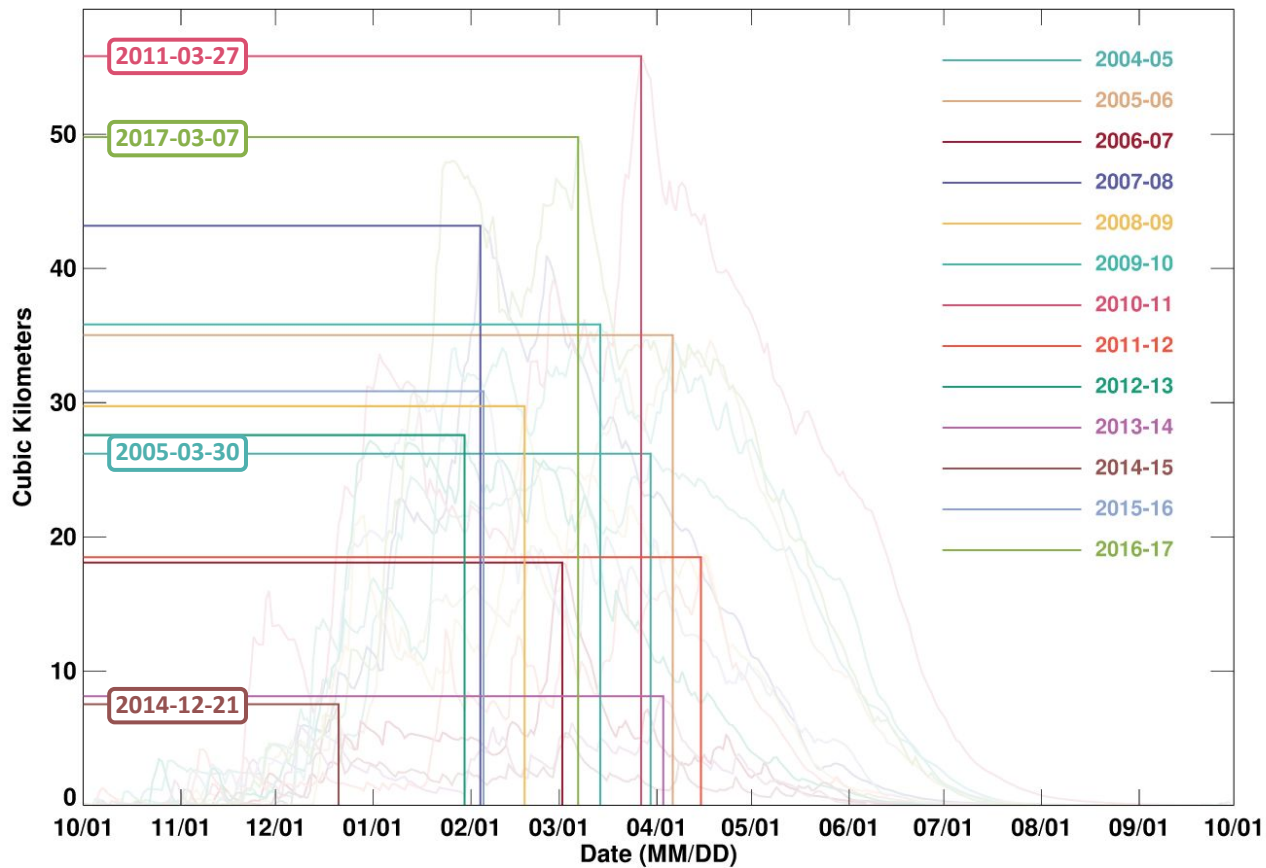
13 NWS RFCs, NCEP and NWC

Rank	National			CNRFC			NWRFC		
	Year	Max. SWE (km ³)	Date	Year	Max SWE (km ³)	Date	Year	Max SWE (km ³)	Date
1	2010-11	404	02/28	2010-11	56	03/27	2010-11	198	04/22
2	2009-10	383	02/27	2016-17	50	03/07	2016-17	181	03/10
3	2007-08	382	02/27	2007-08	43	02/04	2011-12	179	04/07
4	2013-14	353	03/05	2009-10	36	03/14	2007-08	173	04/01
5	2012-13	351	02/26	2005-06	35	04/06	2013-14	156	04/02
6	2016-17	343	02/09	2015-16	31	02/05	2008-09	155	04/04
7	2008-09	305	01/29	2008-09	30	02/18	2005-06	152	03/20
8	2005-06	299	03/22	2012-13	28	01/30	2012-13	149	03/24
9	2006-07	282	03/03	2004-05	26	03/30	2015-16	143	03/30
10	2015-16	278	02/03	2011-12	18	04/14	2006-07	128	03/03
11	2011-12	270	03/01	2006-07	18	03/02	2009-10	117	04/14
12	2014-15	248	03/06	2013-14	8	04/03	2014-15	86	03/03
13	2004-05	182	03/25	2014-15	8	12/21	2004-05	51	03/31

Total CNRFC SWE Volume

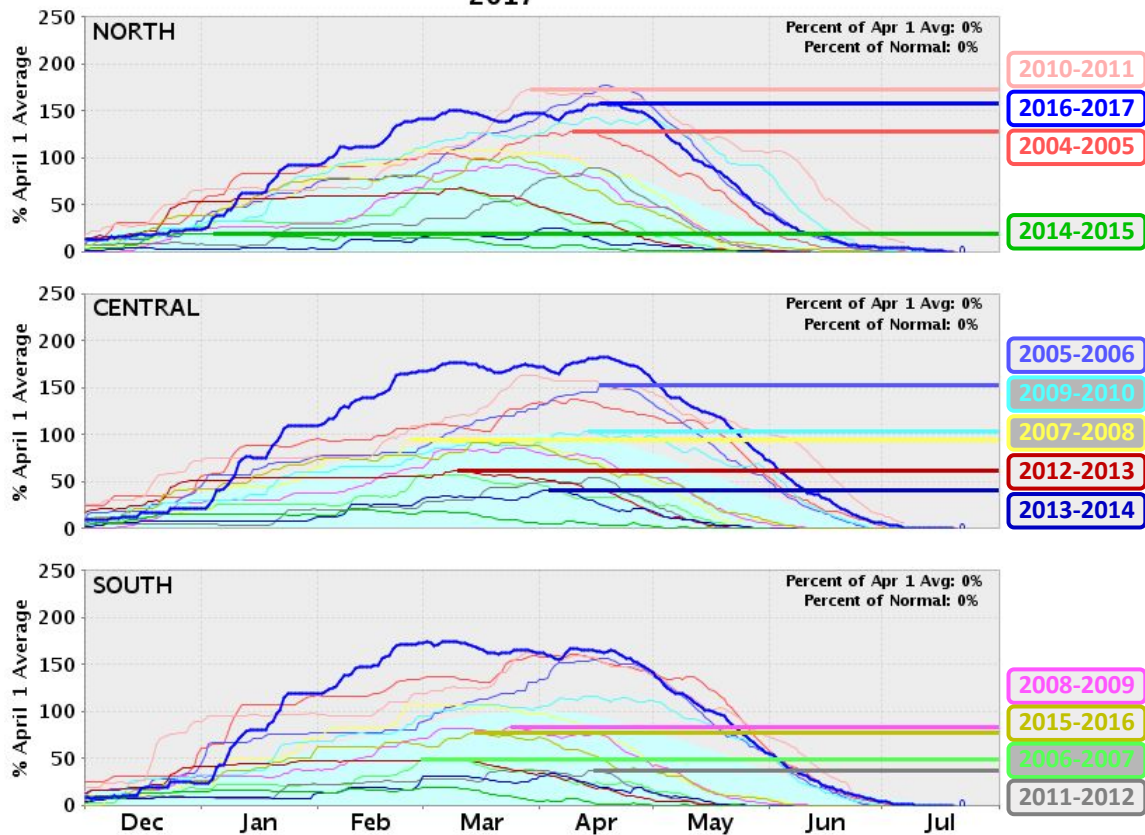


Total CNRFC SWE Volume



Rank	CNRFC		
	Year	Max SWE (km ³)	Date
1	2010-11	56	03/27
2	2016-17	50	03/07
3	2007-08	43	02/04
4	2009-10	36	03/14
5	2005-06	35	04/06
6	2015-16	31	02/05
7	2008-09	30	02/18
8	2012-13	28	01/30
9	2004-05	26	03/30
10	2011-12	18	04/14
11	2006-07	18	03/02
12	2013-14	8	04/03
13	2014-15	8	12/21

California Snow Water Content - Percent of April 1 Average For: 20-Jul-2017



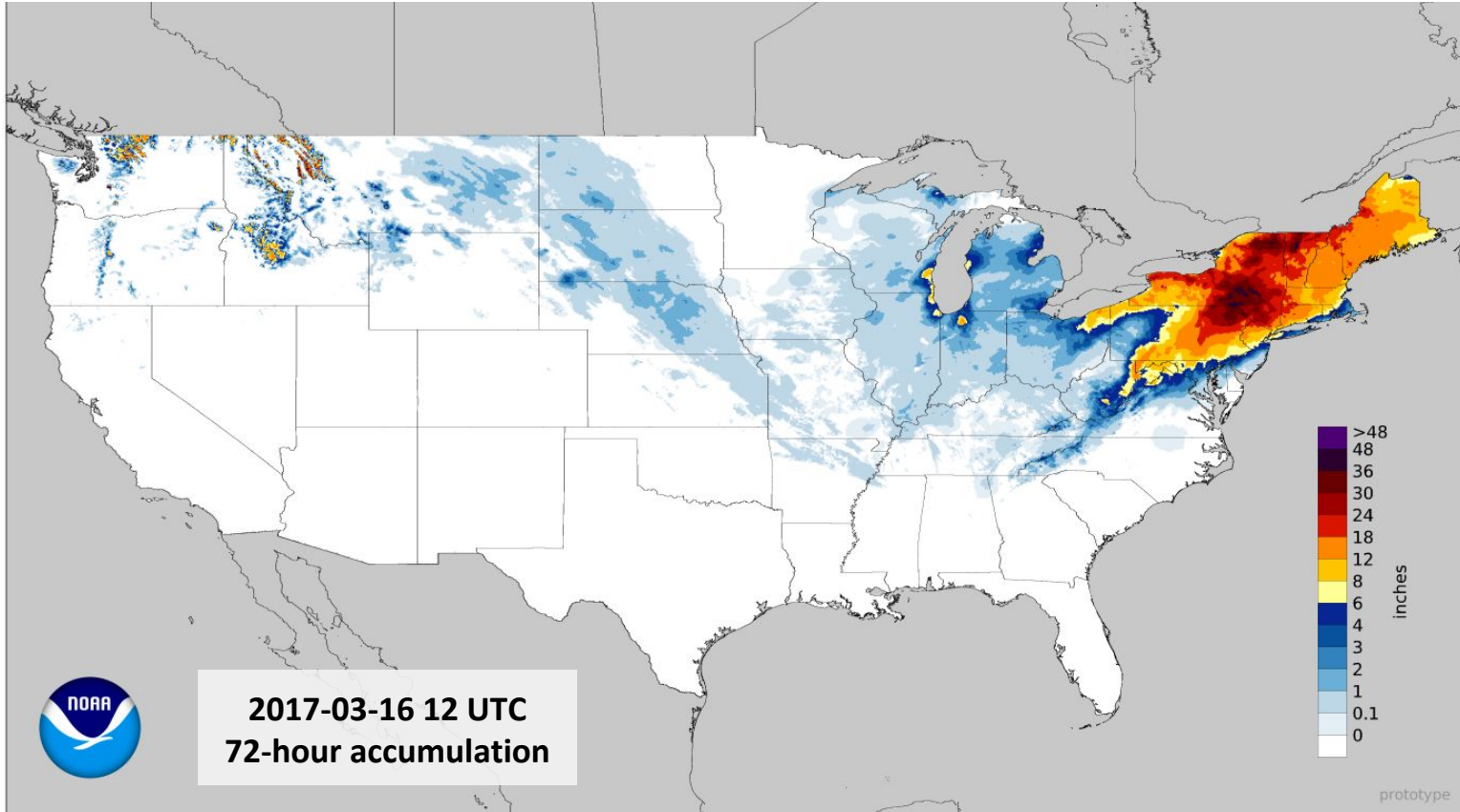
<http://cdec.water.ca.gov/snowapp/swcchart.action>

National Snowfall Analysis

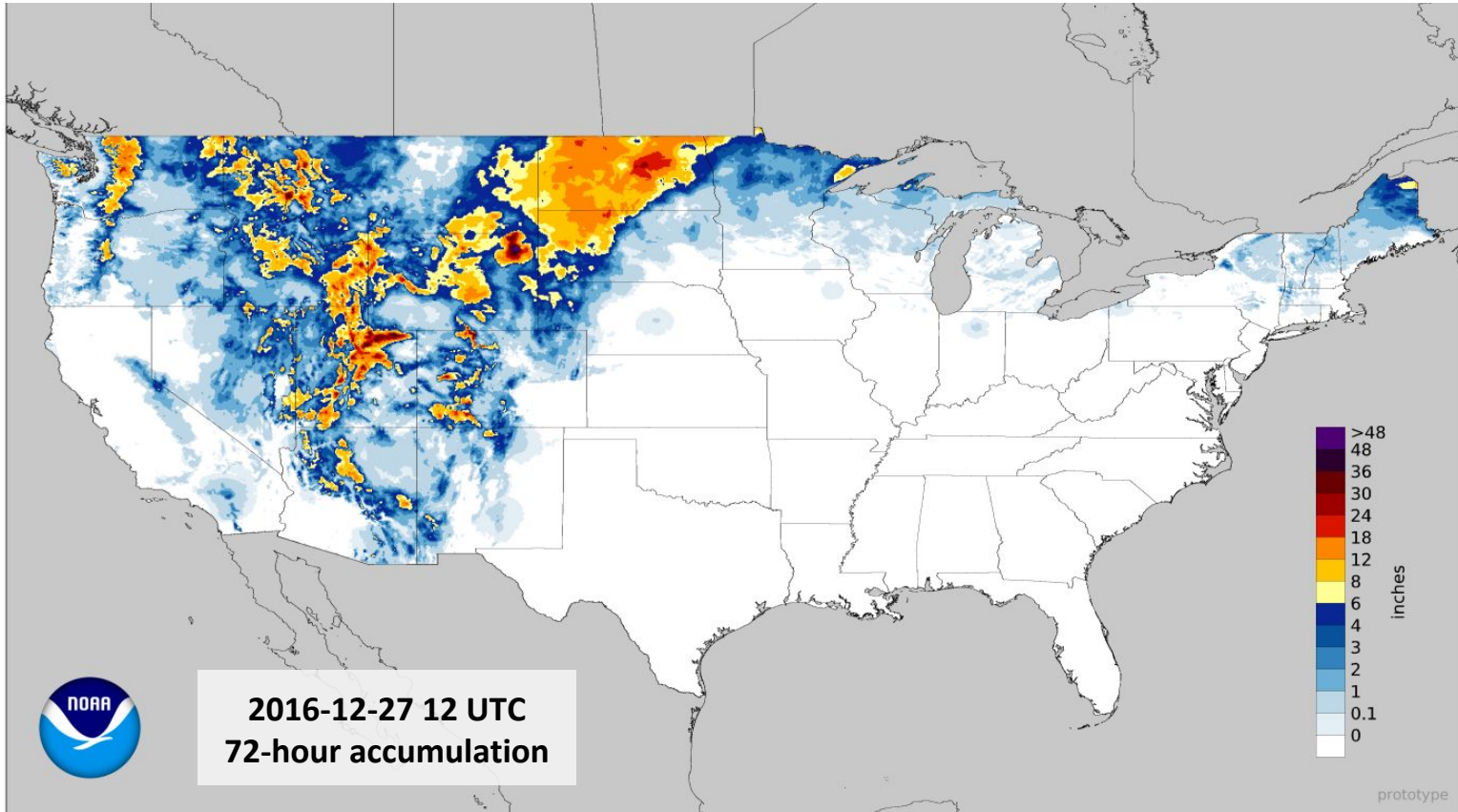
- Unsupported; “pre-experimental;” currently leverages NSA operations.
- 2x-daily (00 and 12 UTC), 4 km gridded variational analysis of observed 24-hour snowfall accumulation.
- Background analysis:
 - HRRR f03 snow:precipitation (WEASD:APCP) ratio;
 - Stage IV QPE;
 - Climatological Snowfall to liquid ratio (SLR) based on GHCN-D 1986-2015.
- Gauge QC module and subdivision module enable analyses outside of 12Z.
- Two ordinary kriging passes assimilate observed snowfall.
- First issuance appears about 45 minutes after the analysis time (00:45 or 12:45 UTC); repeated hourly for 96 following hours.
- 48-hour, 72-hour, and seasonal aggregations are performed in post-processing.
- Formats: PNG, GeoTIFF, NetCDF, GRIB2.
- Did I mention the analysis is unsupported?



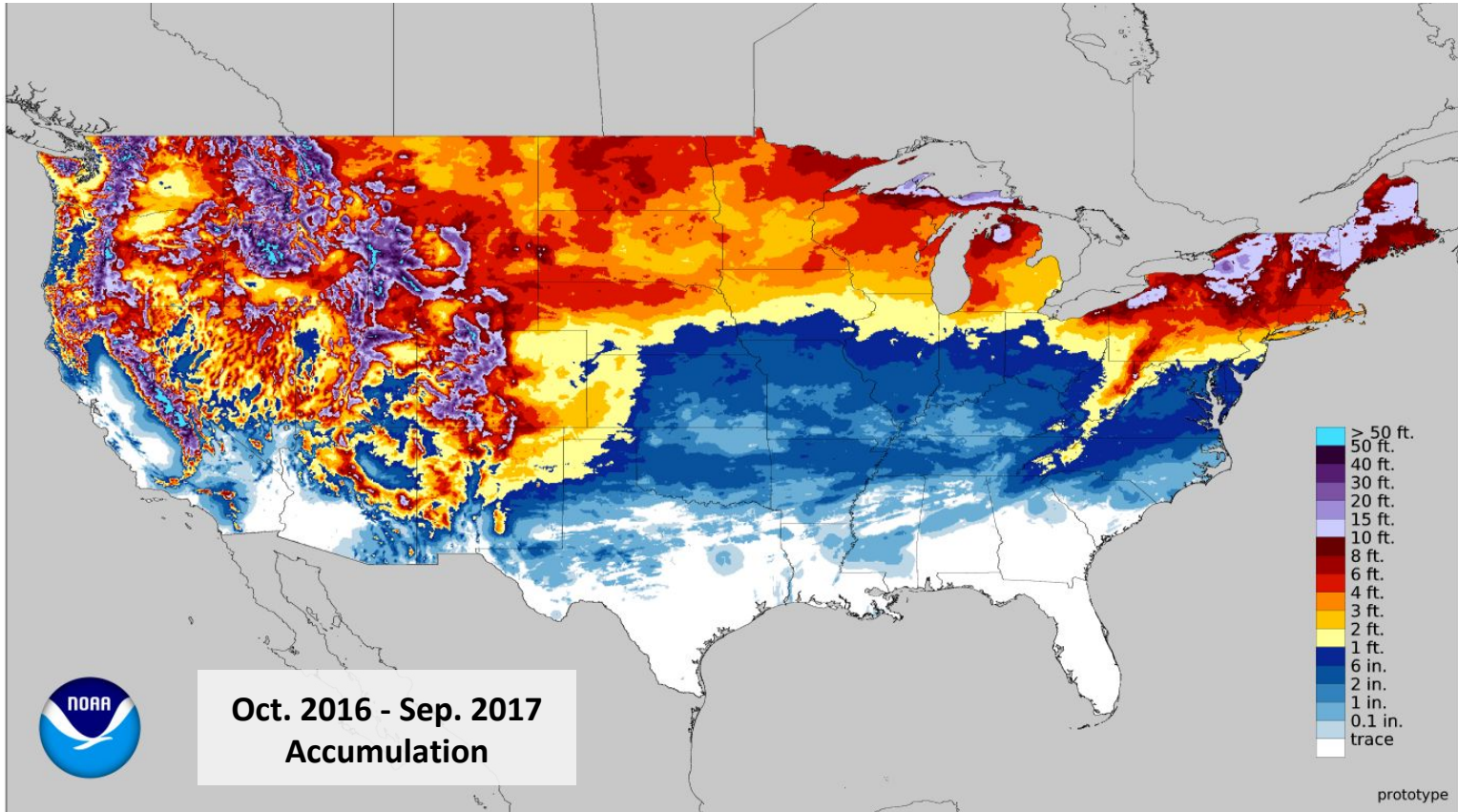
National Snowfall Analysis



National Snowfall Analysis



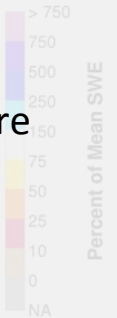
National Snowfall Analysis



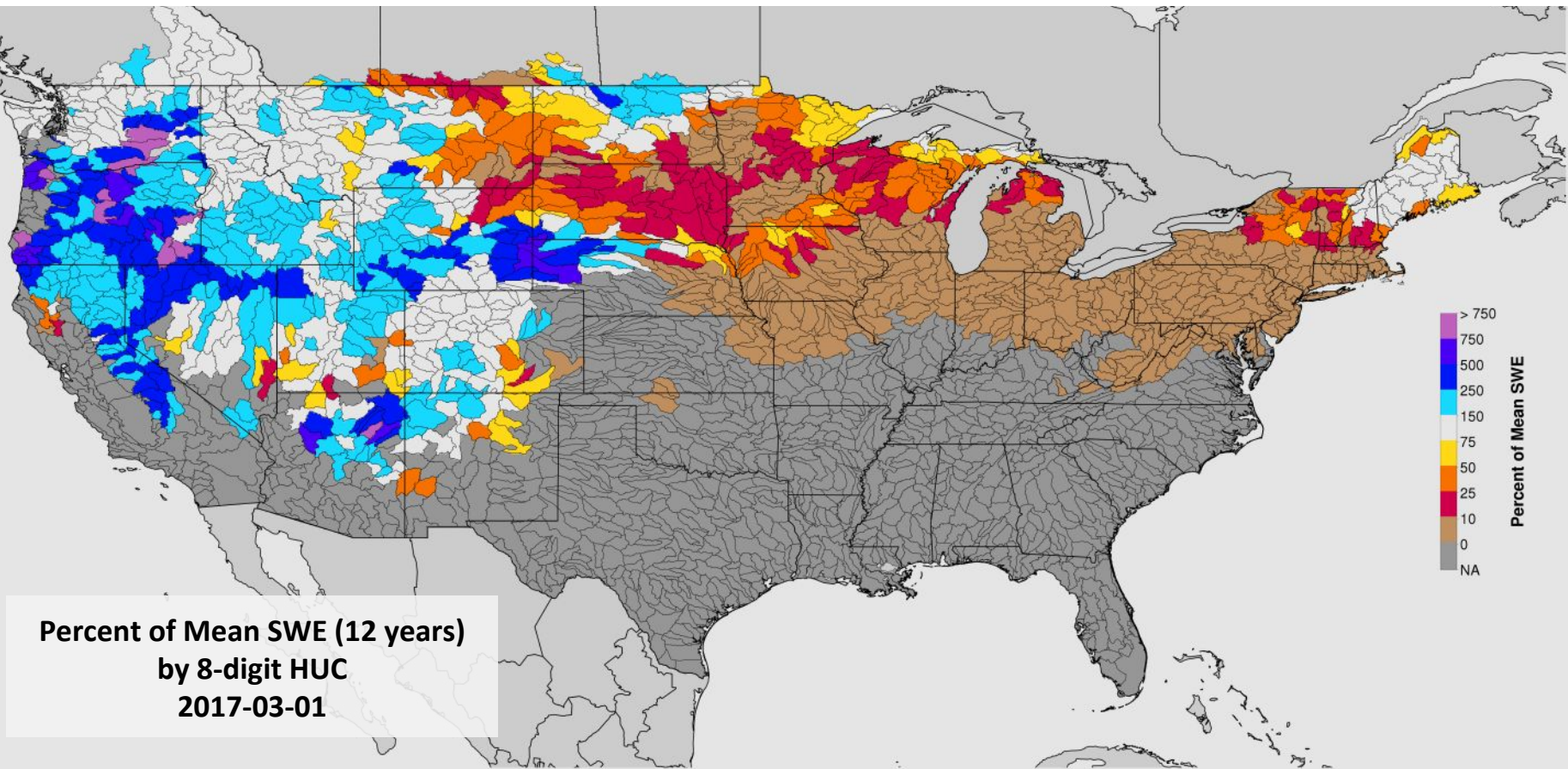
NSA Period of Record Normals

- Current period of record begins in October 2004 (full SNODAS operations) and includes all completed water years (currently 13).
- The period of record is not a climatology (yet).
- For each day of the water year (DOWY), period-of-record statistics (mean, median, etc.) are calculated, and present conditions are compared with those normals.
- Comparisons between daily SNODAS model states and period of record normals provides valuable situational awareness.

Percent of Mean SWE (12 years)
by 8-digit HUC
2017-02-09



NSA Period of Record Normals



THANKS