

New Software Tools for Snowpack Water Supply Analysis

AWRA Colorado, February 27, 2018



openwater
FOUNDATION

Steve Malers, Open Water Foundation
steve.malers@openwaterfoundation.org
www.openwaterfoundation.org

Open Water Foundation

Social enterprise 501(c)3 nonprofit focusing on developing open source software and open data tools to help make better decisions about water resources. Water is a public resource, and water data and software tools should also be public.



open data | **open software** | **open decisions**

openwaterfoundation.org

Snow and Ice



Snow and ice behave differently under different conditions

CDSS SNODAS Tools Project Overview

- Colorado Water Conservation Board (CWCB) Severance Tax Project
- Team led by the Open Water Foundation
- Main goals of project, from scope of work:
 - Improve water resources data access and transparency
 - Help water managers visualize data for their supply basins
 - Improve information for water providers and their customers

Project Need

- Some basins do not have snow monitoring stations (SNOTEL)
- Existing monitoring stations are not representative of snow conditions across the entire watershed
- Water managers lack late-season information because snow has melted out at observing stations

Context - Climate Change



Latest

Related

NASA Pinpoints Cause of Earth's Recent Record Carbon Dioxide Spike
3 months ago

NASA, NOAA Data Show 2016 Warmest Year on Record Globally
a year ago

NASA, NOAA to Announce 2016 Global Temperatures, Climate Conditions
a year ago

NASA Plans Another Busy Year for Earth Science Fieldwork
a year ago

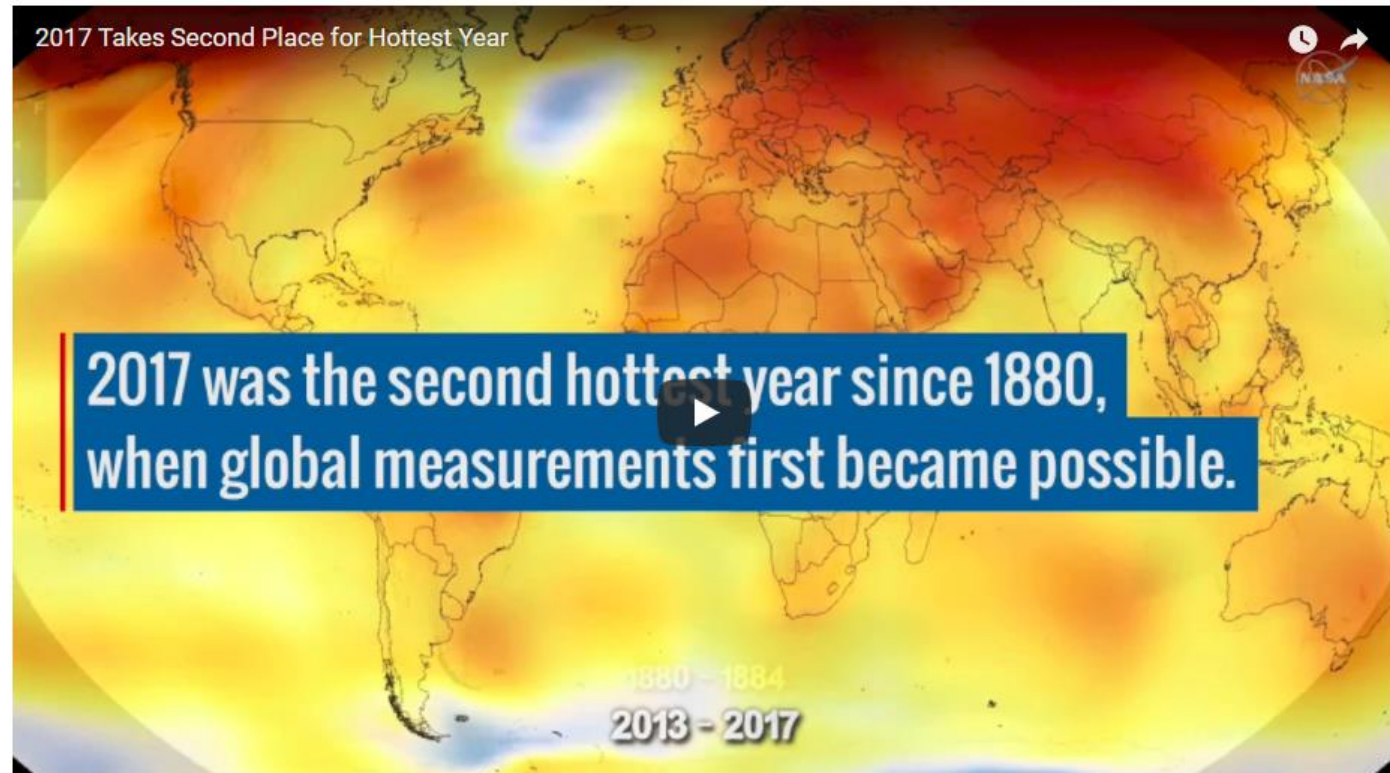
NASA Successfully Launches NOAA Advanced Geostationary Weather Satellite
a year ago

From NYC to Rio: NASA Helps Cities Address Climate Risks
a year ago

Climate

Jan. 18, 2018
RELEASE 18-003

Long-Term Warming Trend Continued in 2017: NASA, NOAA

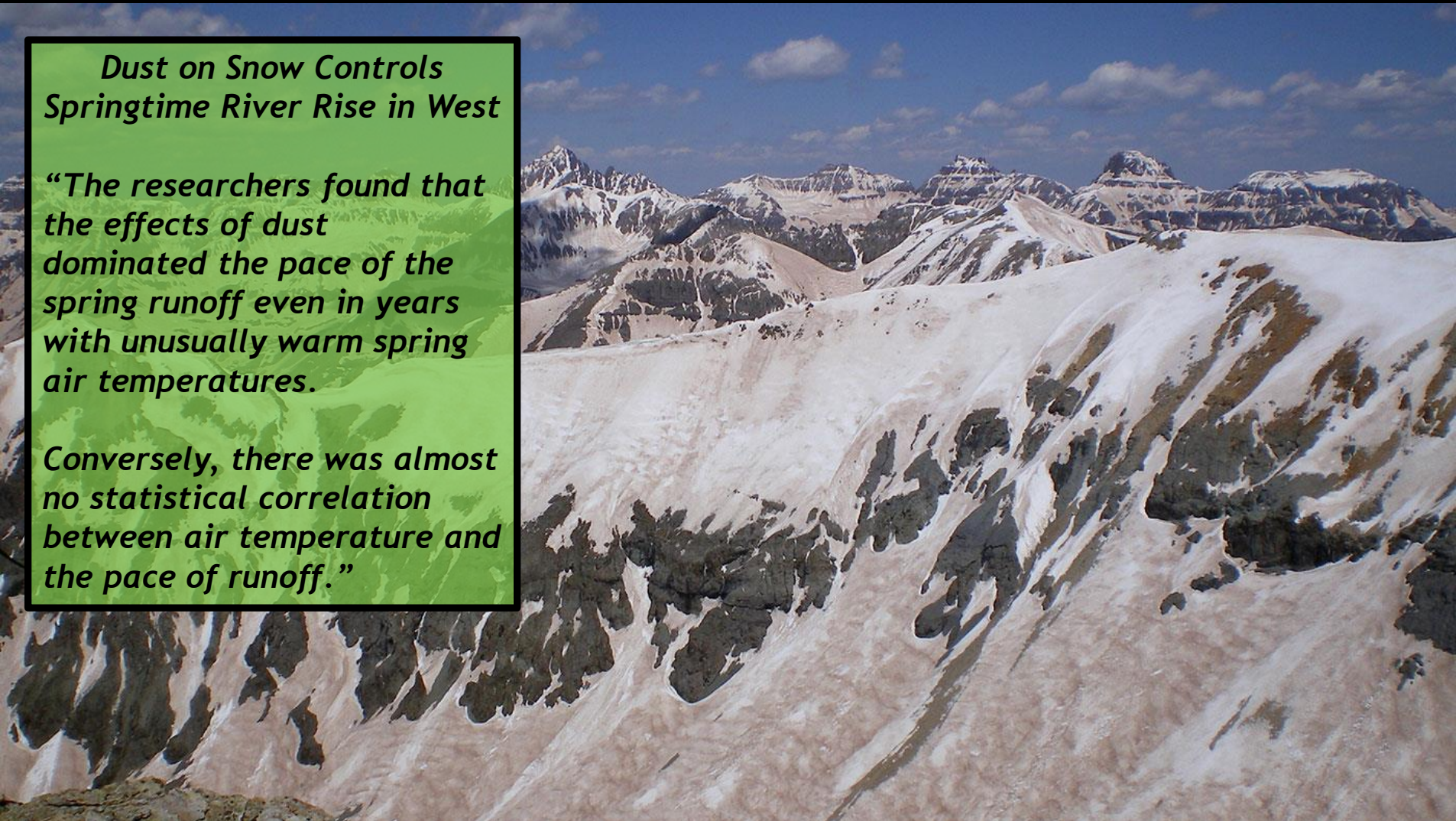


Context - Dust on Snow

Dust on Snow Controls Springtime River Rise in West

“The researchers found that the effects of dust dominated the pace of the spring runoff even in years with unusually warm spring air temperatures.

Conversely, there was almost no statistical correlation between air temperature and the pace of runoff.”



<https://www.jpl.nasa.gov/news/dust-on-snow-controls-springtime-river-rise-in-west>

Photo credit: NASA

Context - World Risks

“Climate and tech pose the biggest risks to our world in 2018”



World Economic Forum:

<https://www.weforum.org/agenda/2018/01/the-biggest-risks-in-2018-will-be-environmental-and-technological>

Photo by [Ross Stone](#) on [Unsplash](#)

Context - Natural Disasters

abcnews.go.com/US/federal-report-2017-shattered-us-damage-record-natural/story?id=52507313

Federal report says 2017 shattered US damage record for natural disasters

\$306.2B (does not consider loss of work?)

By BILL HUTCHINSON · Jan 21, 2018, 7:37 PM ET

Share Tweet



2016 State GDP

14	14	 Washington	476,770	2.58
15	15	 Maryland	382,437	2.07
16	16	 Indiana	347,249	1.88
17	17	 Minnesota	339,096	1.83
18	18	 Tennessee	331,868	1.79
19	19	 Colorado	322,644	1.74
20	20	 Wisconsin	313,088	1.69
21	21	 Arizona	305,849	1.65
22	22	 Missouri	299,113	1.62
23	23	 Connecticut	259,918	1.40
24	24	 Louisiana	236,999	1.28
25	25	 Oregon	227,286	1.24
26	26	 South Carolina	209,859	1.18
27	27	 Alabama	205,625	1.11
28	28	 Kentucky	196,681	1.06

CO 2017 budget: \$26.8 B
CO Water Plan Needs: \$40B ?
Amazon HQ2 = \$5B construction

Context - Agriculture

Perennial Crop Solutions to Annual Agricultural Challenges

Perennial plants do not have to be reseeded or replanted every year, so they do not require annual plowing or herbicide applications to establish.

Perennial crops are robust; they protect soil from erosion and improve soil structure. They increase ecosystem nutrient retention, carbon sequestration, and water infiltration, and can contribute to climate change adaptation and mitigation. Overall, they help ensure food and water security over the long term.

Many fruit, forage and some vegetable crops, including fruit trees, alfalfa, grapes, asparagus, and olive trees, are perennials that have been grown for thousands of years. The Land Institute is working to add perennial grains, legumes, and oilseed crops to the list.

Perennial grains, legumes and oilseed varieties represent a paradigm shift in modern agriculture and great potential for truly sustainable production systems. In addition to breeding annual crops and perennial food crops, The Land Institute also conducts ecological intensification research in order to put those crop plants into diverse mixtures called polycultures that mimic the benefits found in native and natural ecosystems.



Annual wheat on the left, and Kernza® on the right.

How will changes in climate, hydrology, and agriculture interact?

<https://landinstitute.org/our-work/perennial-crops/>

We are using two approaches to breed perennial grain, pulse, and oilseed crops:

What is SNODAS?

Secure | https://www.nohrsc.noaa.gov/interactive/html/map.html?ql=station&zoom=&loc=37.57+N%2C+102.42+W&var=ssm_swe&d

National Operational Hydrologic Remote Sensing Center
Interactive Snow Information

Navigation Tools | 37.012 N, 107.013 W

Home Help Comments

Redraw Map

Select Physical Element
Snow Water Equivalent

Select Date
2017 April 18 07:00 UTC
 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
- Hill shading
- High-contrast palette
- Title on image

800 pixels map width
450 pixels map height

Modeled Snow Water Equivalent forecasted for 2017 April 18, 7:00 UTC

Inches of water equivalent

> 30
20 to 30
18 to 20
16 to 18
14 to 16
12 to 14
10 to 12
8 to 10
6 to 8
4 to 6
2 to 4
1 to 2
trace to 1
Not Estimated

Elevation in feet

> 13124
8203 to 13124
3281 to 8203
3 to 3281
< 3

Created 2017 Apr 17, 13:45 Z

Gridded observed snowfall images, seasonal totals, and data downloads in several formats can now be found on the [National Snowfall Analysis](#) page.

Directions: <https://www.nohrsc.noaa.gov/interactive/html/map.html>

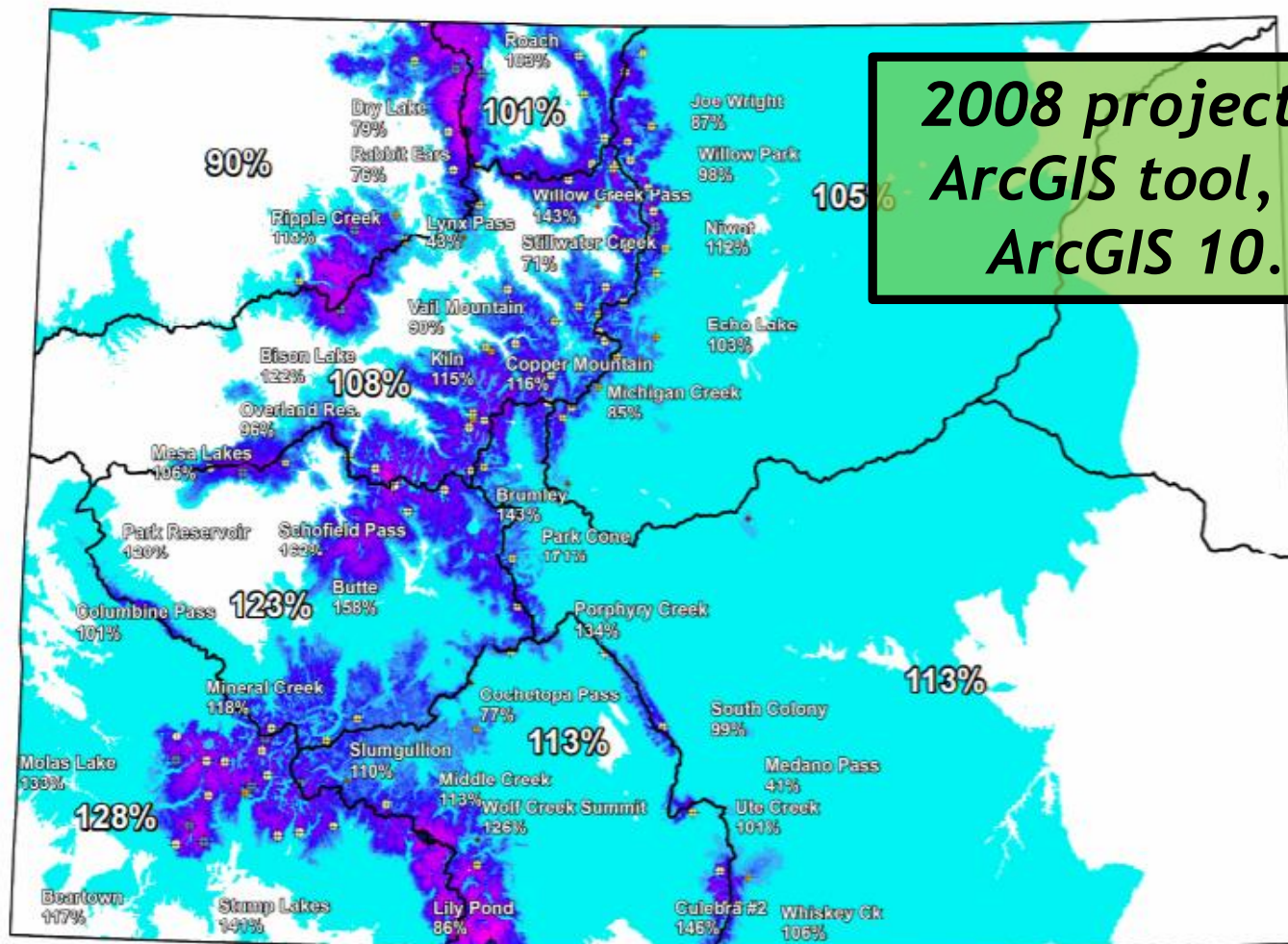
- Select a physical element to view, select a date, select overlays, and click "Redraw Map."
- Clicking on the map while the Recenter button is selected (red) will recenter the map on that point.
- Clicking on the Zoom Control slider will zoom into or out of the map.
- Clicking on the map and dragging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

Snow Data Assimilation System

Vector GIS Datasets used by this page
Raster GIS Datasets used by this page

Previous CWCB SNODAS Projects

Colorado - 2017 SNOTEL and SNODAS Snow Water Equivalent (SWE) 4/1/2017



2008 project to develop ArcGIS tool, updated to ArcGIS 10.1 in 2014

Legend

Snow Water Equivalent (Inches)

- 10-15
- 15-20
- 20-25
- 25-30
- 30-35
- 35-40
- 40-45
- 45-50
- 50-55
- 55-60
- 60-65
- 65-70
- 70-75
- 75-80
- 80-85
- 85-90
- 90-95
- 95-100
- 100-105
- 105-110
- 110-115
- 115-120
- 120-125
- 125-130
- 130-135
- 135-140
- 140-145
- 145-150
- 150-155
- 155-160
- 160-165
- 165-170
- 170-175
- 175-180
- 180-185
- 185-190
- 190-195
- 195-200
- 200-205
- 205-210
- 210-215
- 215-220
- 220-225
- 225-230
- 230-235
- 235-240
- 240-245
- 245-250
- 250-255
- 255-260
- 260-265
- 265-270
- 270-275
- 275-280
- 280-285
- 285-290
- 290-295
- 295-300
- 300-305
- 305-310
- 310-315
- 315-320
- 320-325
- 325-330
- 330-335
- 335-340
- 340-345
- 345-350
- 350-355
- 355-360
- 360-365
- 365-370
- 370-375
- 375-380
- 380-385
- 385-390
- 390-395
- 395-400
- 400-405
- 405-410
- 410-415
- 415-420
- 420-425
- 425-430
- 430-435
- 435-440
- 440-445
- 445-450
- 450-455
- 455-460
- 460-465
- 465-470
- 470-475
- 475-480
- 480-485
- 485-490
- 490-495
- 495-500

0 10 20 40 Miles

SNODAS Snow Water Equivalent data courtesy of the National Snow and Ice Data Center (NSIDC). SNOTEL data courtesy of the National Resources Conservation Service (NRCS). Data is provisional and subject to revision. The CWCB and USRA provide SNODAS data at the following link: <http://www.cwcb.gov/eh/ehviewer/ehviewer.asp?table=SNODAS>

<http://cwcb.state.co.us/water-management/flood/pages/snodassnowpackmaps.aspx>

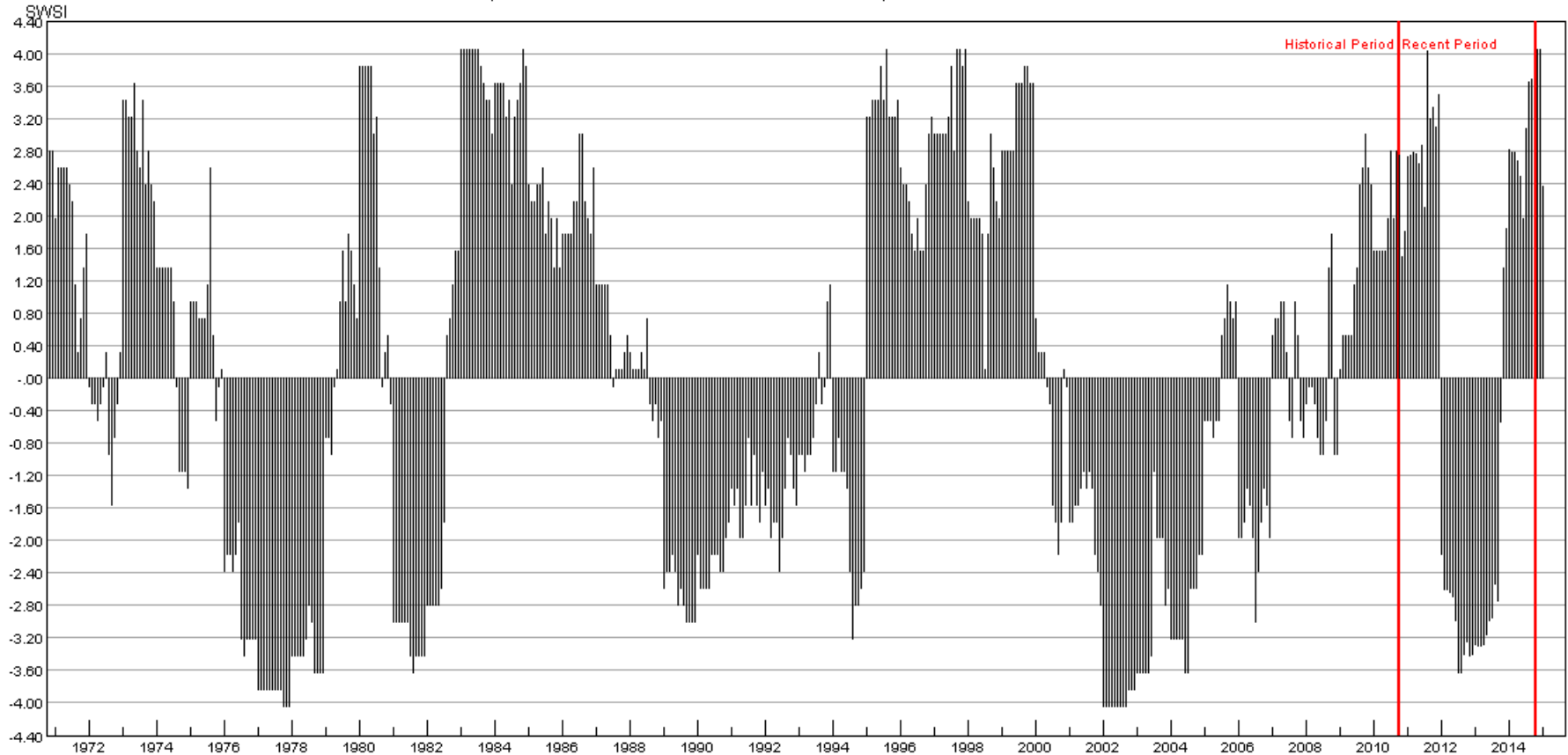
Previous CWCB Projects

- SNODAS:
 - 2008-2009 - SNODAS map products for Rio Grande Water Conservation District
 - 2012-2013 - SNODAS map products for Dolores Water Conservancy District
- Surface Water Supply Index (SWSI):
 - 2015 - Open Water Foundation updated Colorado Surface Water Supply Index (SWSI) process used by CWCB and Division of Water Resources (DWR).

Surface Water Supply Index (SWSI) in a Highly Managed Basin

South Platte Basin SWSI History

Historical period SWSI values establish the SWSI distribution to lookup recent and current SWSI values.

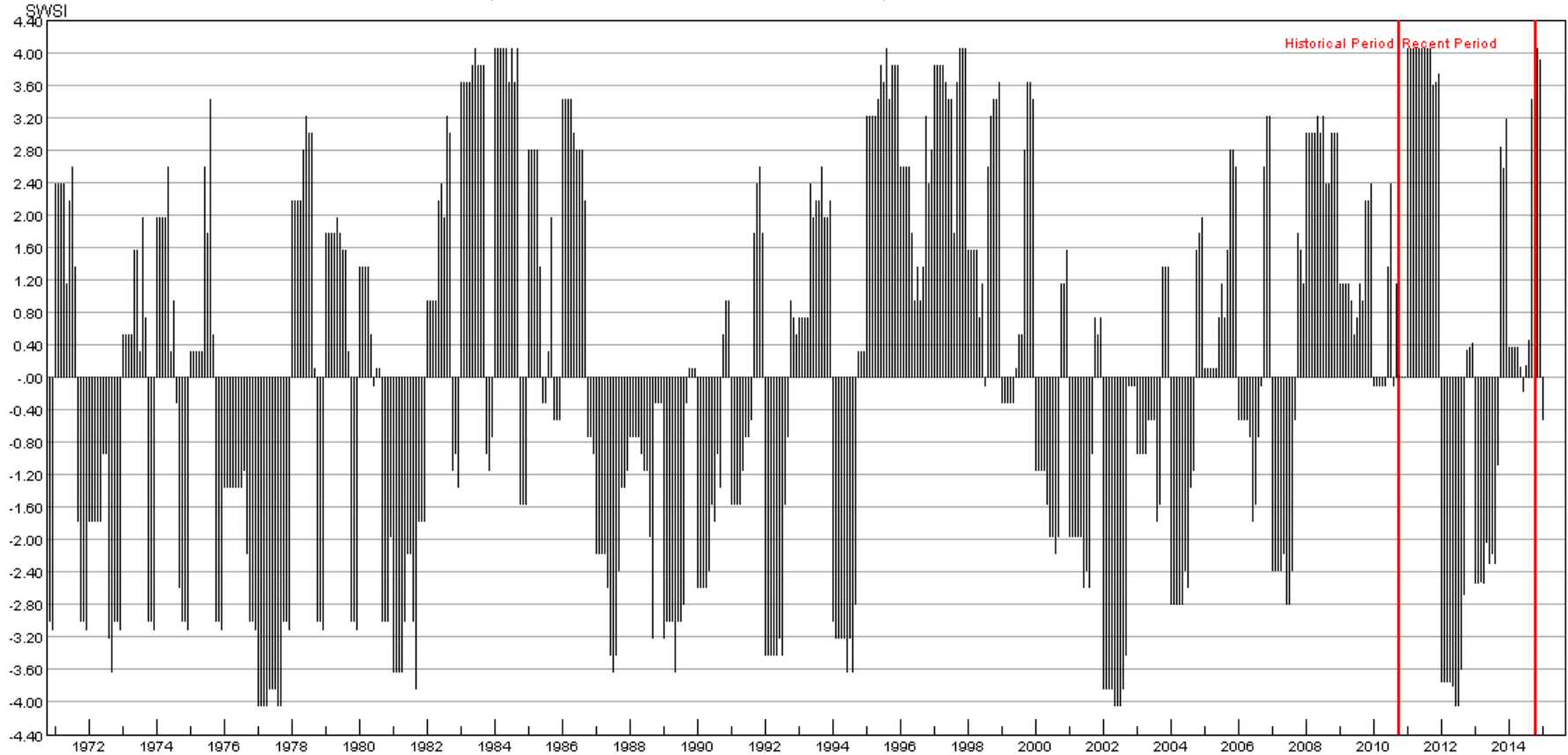


South Platte-DataComposite-SWSI

SWSI in a Less-Managed Basin

Yampa-White Basin SWSI History

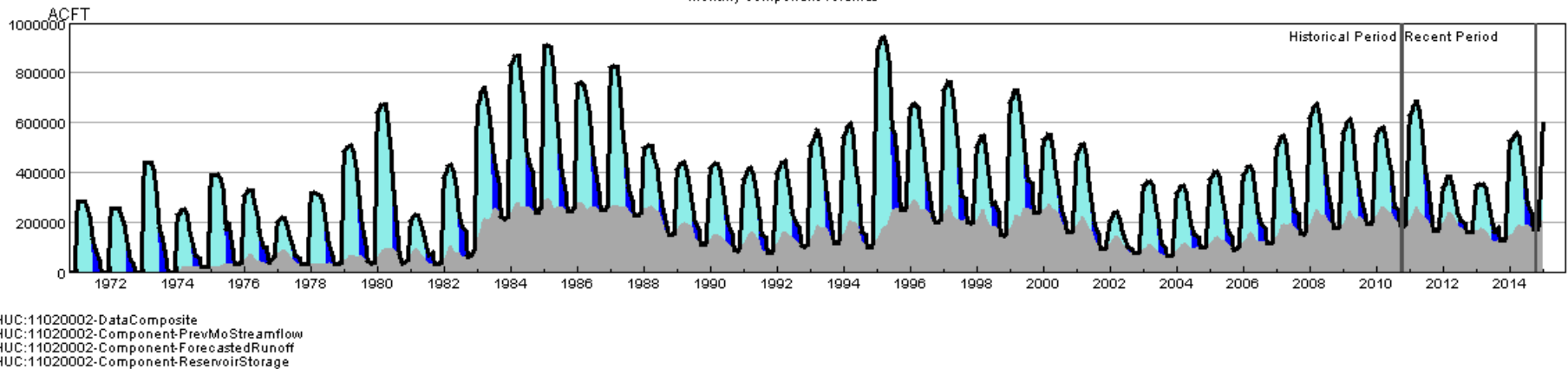
Historical period SWSI values establish the SWSI distribution to lookup recent and current SWSI values.



Yampa-White-DataComposite-SWSI

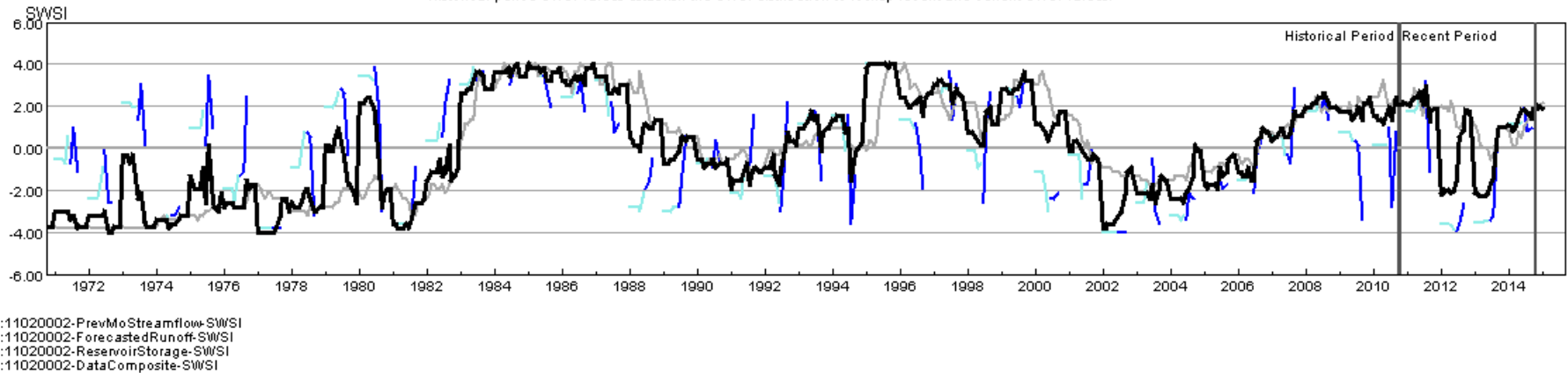
SWSI at Hydrologic Unit Code Scale

HUC 11020002 (Upper Arkansas) Surface Water Supply
Monthly component volumes



HUC 11020002 (Upper Arkansas) SWSI

Historical period SWSI values establish the SWSI distribution to lookup recent and current SWSI values.



CDSS SNODAS Tools Approach

1. Download daily SNODAS SWE grid (national)
2. Clip to Colorado water supply basins
3. Calculate statistics for basins
4. Output to CSV, GeoJSON, Shapefile.
5. Process CSV files into time series graph products using TSTool software.
6. Publish to the web (80 GB total for 2003-2017)

Software:

- *QGIS, PyQGIS, GDAL for spatial processing*
- *Leaflet for web mapping*
- *TSTool for time series products*

Downloadable Data Files

About **Data** Analysis

[The national SNODAS data are available from the Snow Data Assimilation System \(SNODAS\)](#). The SNODAS data are processed into statistical data products by the CDSS SNODAS Tools. The output consists of comma-separated-value (CSV) files **ByDate** (basin data for each day) and **ByBasin** (historical period for each basin). Data files can be downloaded by accessing the following URL resources. The zip file contains a shapefile with daily statistics in the attribute table (attribute names have been truncated to adhere to shapefile limit).

<http://projects.openwaterfoundation.org/owf-proj-co-cwcb-2016-snodas/prototype/SnowpackStatisticsByBasin/Snowpack>

<http://projects.openwaterfoundation.org/owf-proj-co-cwcb-2016-snodas/prototype/SnowpackStatisticsByDate/Snowpack>

<http://projects.openwaterfoundation.org/owf-proj-co-cwcb-2016-snodas/prototype/SnowpackStatisticsByDate/Snowpack>

<http://projects.openwaterfoundation.org/owf-proj-co-cwcb-2016-snodas/prototype/SnowpackStatisticsByDate/Snowpack>

The following static resources are also available:

http://projects.openwaterfoundation.org/owf-proj-co-cwcb-2016-snodas/prototype/json/CO_boundary.geojson (State of Colorado rectangular boundary)

[json/SNODAS_CO_BasinBoundaries.geojson](#) (basin boundaries, same as daily boundaries)

[StaticData/SNODAS_CO_BasinBoundaries.zip](#) (input basin boundary layer shapefile)

[StaticData/Watershed_Connectivity_v3.xlsx](#) (input basin

- *Comma-separated-value (CSV)*
- *Shapefile*
- *GeoJSON*

- *Static data for basins*

Developer and User Documentation

software.openwaterfoundation.org/cdss-app-snodas-tools-doc-user/process/processing-steps/#1-download-snodas-data



SNODAS Tools Process / Processing Steps

Search

SNODAS Tools (User Manual)

Home

SNODAS Tools Data ▾

SNODAS Tools Process ▲

Overview

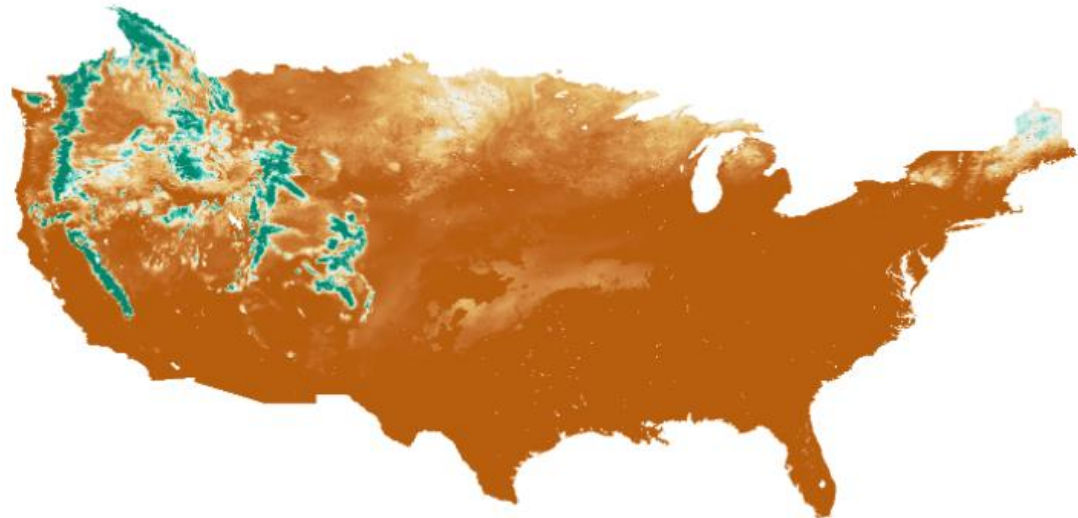
Processing Steps

Additional Details

SNODAS Tools Products ▾

National SNODAS grids are downloaded to the SNODAS Tools computer for processing into products that are relevant to Colorado.

Daily SNODAS data grids are national grids representing a variety of snowpack parameters. They are developed by NOAA National Weather Service's National Operational Hydrologic Remote Sensing Center (NOHRSC) and hosted by the National Snow and Ice Data Center (NSIDC). NSIDC stores the daily grids, dating back to September 30th, 2003, in a public FTP site that is updated every day. Although, as mentioned before, the SNODAS products contain many grids of snowpack parameters, the SNODAS Tools are designed to specifically calculate snowpack statistics in regards to the Snow Water Equivalent (SWE) grid. Below is an image of a daily SNODAS grid representing SWE values across the nation. The areas of higher SWE are represented by blue while the areas with lower, or no SWE values, are represented by brown.



Enhanced Snowpack Products

projects.openwaterfoundation.org/owf-proj-co-cwcb-2016-snodas/prototype/index.html

Colorado's Decision Support Systems (CDSS) SNODAS Tools

About Data Documentation

Daily SNODAS Snowpack Products for Colorado Water Supply Basins

This website provides access to a historical archive of SNODAS data products for Colorado water supply basins. Snow Data Assimilation System (SNODAS) data from the National Operational Hydrologic Remote Sensing Center (NOHRSC) are processed daily to calculate Snow Water Equivalent (SWE) and Snow Coverage statistics for water supply basins in Colorado. Snow Water Equivalent is the estimate of the depth of liquid water contained within the snowpack. Snow coverage is a percent of the basin land surface covered by snow (water bodies in the basin are ignored). The national SNODAS gridded dataset has been processed to provide data products for Colorado. Mean SWE is displayed in the map using a legend similar to the National Weather Service. The SNODAS Tools website provides access to an archive of daily products.

- The website is best viewed on a widescreen display. If the layout does not clearly show a left panel with tabs, a center panel with map, and a right panel with date and basin selectors, try maximizing to fill the display. **Ctrl** and **minus** can be used to zoom out until the layout shows all components.
- Hover over a basin to see the daily mean SWE value and other daily statistics.
- Use the **Select Date** button to display historical data for a specified day.
- Enter animation start and end dates, press **Submit**, and then press the play button to view the animation of daily SWE data.
- Click on a basin in the map to select the basin or use the **Select Basin** to select from the basin list. Then click on buttons in the lower right to display graphs.
- Once a graph has been opened, click anywhere on the screen to close the graph view and return to the main screen.
- Reposition the map by holding the mouse button down and dragging.
- Zoom in and out of the map using the control

Mean SWE (in)

0-0.02
0.02-0.04
0.04-0.2
0.2-0.4
0.4-1
1-2
2-4
4-6
6-10
10-20
20-30
30-40
40-80
80+

Select Date **SNODAS Date: 2018-02-26**

SNODAS Animation

Starting Date: (earliest available date: 2003-09-30) YYYY-MM-DD

Ending Date: (latest available date: 2018-02-26) YYYY-MM-DD

Increment (days): (Default is set to 1) value between 1 and 10

Submit

Select Basin

SNODAS Snow Cover Graph

SNODAS SWE Graph

SNODAS SWE Volume Graph

SNODAS SWE Upstream Total Volume Graph

SNODAS SWE 1 Week Change Graph

SNODAS SWE Volume Gain, Cumulative Volume Gain, Total Volume Gain, SWE Graph

2018-02-26

Daily Basin Statistics
Hover over a basin

50 mi
Amarillo 38.636°N : 100.94°W

Leaflet | Map data © OpenStreetMap contributors, CC-BY-SA, Imagery ©Mapbox

<http://projects.openwaterfoundation.org/owf-proj-co-cwcb-2016-snodas/prototype>

Working to deploy to new State of CO server.

Enhanced Snowpack Products

projects.openwaterfoundation.org/owf-proj-co-cwcb-2016-snodas/prototype/index.html

Colorado's Decision Support Systems (CDSS) SNODAS Tools

About Data Documentation

Daily SNODAS Snowpack Products for Colorado Water Supply Basins

This website provides access to a historical archive of SNODAS data products for Colorado water supply basins. Snow Data Assimilation System (SNODAS) data from the National Operational Hydrologic Remote Sensing Center (NOHRSC) are processed daily to calculate Snow Water Equivalent (SWE) and Snow Coverage statistics for water supply basins in Colorado. Snow Water Equivalent is the estimate of the depth of liquid water contained within the snowpack. Snow coverage is a percent of the basin land surface covered by snow (water bodies in the basin are ignored). The national SNODAS gridded dataset has been processed to provide data products for Colorado. Mean SWE is displayed in the map using a legend similar to the National Weather Service. The SNODAS Tools website provides access to an archive of daily products.

- The website is best viewed on a widescreen display. If the layout does not clearly show a left panel with tabs, a center panel with map, and a right panel with date and basin selectors, try maximizing to fill the display. **Ctrl** and **minus** can be used to zoom out until the layout shows all components.
- Hover over a basin to see the daily mean SWE value and other daily statistics.
- Use the **Select Date** button to display historical data for a specified day.
- Enter animation start and end dates, press **Submit**, and then press the play button to view the animation of daily SWE data.
- Click on a basin in the map to select the basin or use the **Select Basin** to select from the basin list. Then click on buttons in the lower right to display graphs.
- Once a graph has been opened, click anywhere on the screen to close the graph view and return to the main screen.
- Reposition the map by holding the mouse button down and dragging.
- Zoom in and out of the map using the control

Mean SWE (in)

- 0-0.02
- 0.02-0.04
- 0.04-0.2
- 0.2-0.4
- 0.4-1
- 1-2
- 2-4
- 4-6
- 6-10
- 10-20
- 20-30
- 30-40
- 40-80
- 80+

Select Date SNODAS Date: 2017-02-26

SNODAS Animation

Starting Date: (earliest available date: 2003-09-30) YYYY-MM-DD

Ending Date: (latest available date: 2018-02-26) YYYY-MM-DD

Increment (days): (Default is set to 1) value between 1 and 10

Submit

Select Basin

Selected Basin ID: GPSC2L_F
Basin Name: EAGLE - BLO GYPSUM

SNODAS Snow Cover Graph

SNODAS SWE Graph

SNODAS SWE Volume Graph

SNODAS SWE Upstream Total Volume Graph

SNODAS SWE 1 Week Change Graph

SNODAS SWE Volume Gain, Cumulative Graph

2017-02-26

Daily Basin Statistics
Hover over a basin

WEF_GRR18_Report.pdf LivestockWx_Resp....doc clouds-it_s_gonna....zip cygwin-32.png git-bash-32.png Show all

Enhanced Snowpack Products

projects.openwaterfoundation.org/owf-proj-co-cwcb-2016-snodas/prototype/index.html

Colorado's Decision Support Systems (CDSS) SNODAS Tools

About Data Documentation

Daily SNODAS Snowpack Products for Colorado Water Supply Basins

This website provides access to a historical archive of SNODAS data products for Colorado water supply basins. Snow Data Assimilation System (SNODAS) data from the National Operational Hydrologic Remote Sensing Center (NOHRSC) are processed daily to calculate Snow Water Equivalent (SWE) and Snow Coverage statistics for water supply basins in Colorado. Snow Water Equivalent is the estimate of the depth of liquid water contained within the snowpack. Snow coverage is a percent of the basin land surface covered by snow (water bodies in the basin are ignored). The national SNODAS gridded dataset has been processed to provide data products for Colorado. Mean SWE is displayed in the map using a legend similar to the National Weather Service. The SNODAS Tools website provides access to an archive of daily products.

- The website is best viewed on a widescreen display. If the layout does not clearly show a left panel with tabs, a center panel with map, and a right panel with date and basin selectors, try maximizing to fill the display. **Ctrl** and **minus** can be used to zoom out until the layout shows all components.
- Hover over a basin to see the daily mean SWE value and other daily statistics.
- Use the **Select Date** button to display historical data for a specified day.
- Enter animation start and end dates, press **Submit**, and then press the play button to view the animation of daily SWE data.
- Click on a basin in the map to select the basin or use the **Select Basin** to select from the basin list. Then click on buttons in the lower right to display graphs.
- Once a graph has been opened, click anywhere on the screen to close the graph view and return to the main screen.
- Reposition the map by holding the mouse button down and dragging.
- Zoom in and out of the map using the control

Mean SWE (in)

0-0.02
0.02-0.04
0.04-0.2
0.2-0.4
0.4-1
1-2
2-4
4-6
6-10
10-20
20-30
30-40
40-80
80+

Select Date **SNODAS Date: 2016-02-26**

SNODAS Animation

Starting Date: (earliest available date: 2003-09-30)
YYYY-MM-DD

Ending Date: (latest available date: 2018-02-26)
YYYY-MM-DD

Increment (days): (Default is set to 1)
value between 1 and 10

Submit

Select Basin

SNODAS Snow Cover Graph

SNODAS SWE Graph

SNODAS SWE Volume Graph

SNODAS SWE Upstream Total Volume Graph

SNODAS SWE 1 Week Change Graph

SNODAS SWE Volume Gain, Cumulative Graph

2016-02-26

Leaflet | Map data © OpenStreetMap contributors, CC-BY-SA, Imagery © Mapbox

WEF_GRR18_Report.pdf LivestockWx_Resp....doc clouds-it_s_gonna....zip cygwin-32.png git-bash-32.png Show all

Start Online Demonstration

viz.openwaterfoundation.org/co/owf-viz-co-snodas-gapminder/

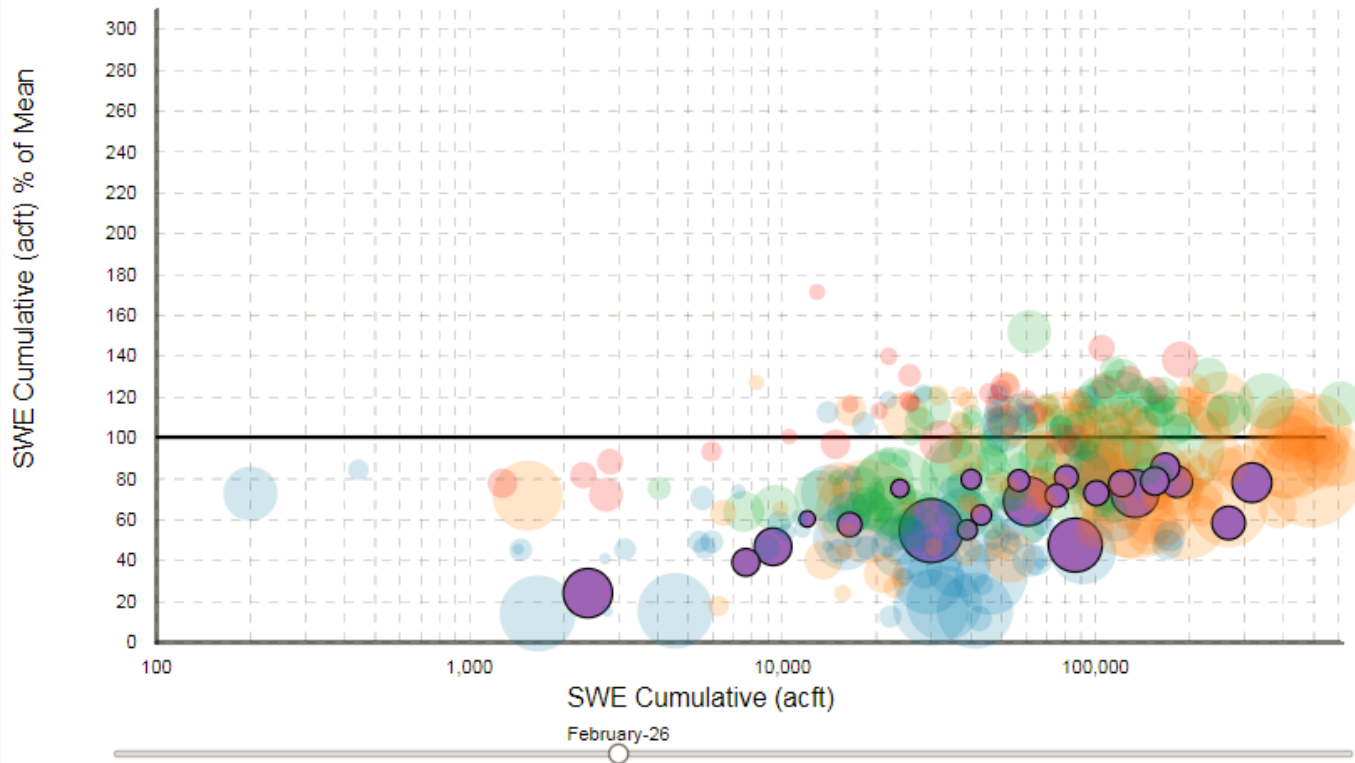


Gapminder Documentation Data Sources

SNODAS Data

Feb-2018

SWE Cumulative(x), SWE Cumulative % of Mean(y), SWE Cumulative Upstream Total(size), Basin(color)



- Basin
- ABRFC
 - CBRFC
 - MBRFC
 - NCWCD
 - WGRFC

Select All Markers

Select Individual LOCAL_ID

Turn Tracer On

Turn Annotations Off

Water Year: 2018

Oct-2017 Nov-2017 Dec-2017 Jan-2018 Feb-2018 Mar-2018 Apr-2018 May-2018 Jun-2018 Jul-2018 Aug-2018 Sep-2018



LOCAL_ID:
Date:
SWE_Cumulative:
SWE_Cumulative_Percent_of_Mean:

See <http://viz.openwaterfoundation.org>
Will be available on State of CO server soon.

Enhanced Snowpack Products

projects.openwaterfoundation.org/owf-proj-co-cwcb-2016-snodas/prototype/index.html

Colorado's Decision Support Systems (CDSS) SNODAS Tools

About Data Documentation

Daily SNODAS Snowpack Products for Colorado Water Supply Basins

This website provides access to a historical archive of SNODAS data products for Colorado water supply basins. Snow Data Assimilation System (SNODAS) data from the National Operational Hydrologic Remote Sensing Center (NOHRSC) are processed daily to calculate Snow Water Equivalent (SWE) and Snow Coverage statistics for water supply basins in Colorado. Snow Water Equivalent is the estimate of the depth of liquid water contained within the snowpack. Snow coverage is a percent of the basin land surface covered by snow (water bodies in the basin are ignored). The national SNODAS gridded dataset has been processed to provide data products for Colorado. Mean SWE is displayed in the map using a legend similar to the National Weather Service. The SNODAS Tools website provides access to an archive of daily products.

- The website is best viewed on a widescreen display. If the layout does not clearly show a left panel with tabs, a center panel with map, and a right panel with date and basin selectors, try maximizing to fill the display. **Ctrl** and **minus** can be used to zoom out until the layout shows all components.
- Hover over a basin to see the daily mean SWE value and other daily statistics.
- Use the **Select Date** button to display historical data for a specified day.
- Enter animation start and end dates, press **Submit**, and then press the play button to view the animation of daily SWE data.
- Click on a basin in the map to select the basin or use the **Select Basin** to select from the basin list. Then click on buttons in the lower right to display graphs.
- Once a graph has been opened, click anywhere on the screen to close the graph view and return to the main screen.
- Reposition the map by holding the mouse button down and dragging.
- Zoom in and out of the map using the control

Mean SWE (in)

0-0.02
0.02-0.04
0.04-0.2
0.2-0.4
0.4-1
1-2
2-4
4-6
6-10
10-20
20-30
30-40
40-80
80+

Select Date SNODAS Date: 2018-02-26

SNODAS Animation

Starting Date: (earliest available date: 2003-09-30) YYYY-MM-DD

Ending Date: (latest available date: 2018-02-26) YYYY-MM-DD

Increment (days): (Default is set to 1) value between 1 and 10

Submit

Select Basin

- SNODAS Snow Cover Graph
- SNODAS SWE Graph
- SNODAS SWE Volume Graph
- SNODAS SWE Upstream Total Volume Graph
- SNODAS SWE 1 Week Change Graph
- SNODAS SWE Volume Gain, Cumulative Graph
- SNODAS SWE Upstream Total Volume Gain, Cumulative Graph

Leaflet | Map data © OpenStreetMap contributors, CC-BY-SA, Imagery © Mapbox

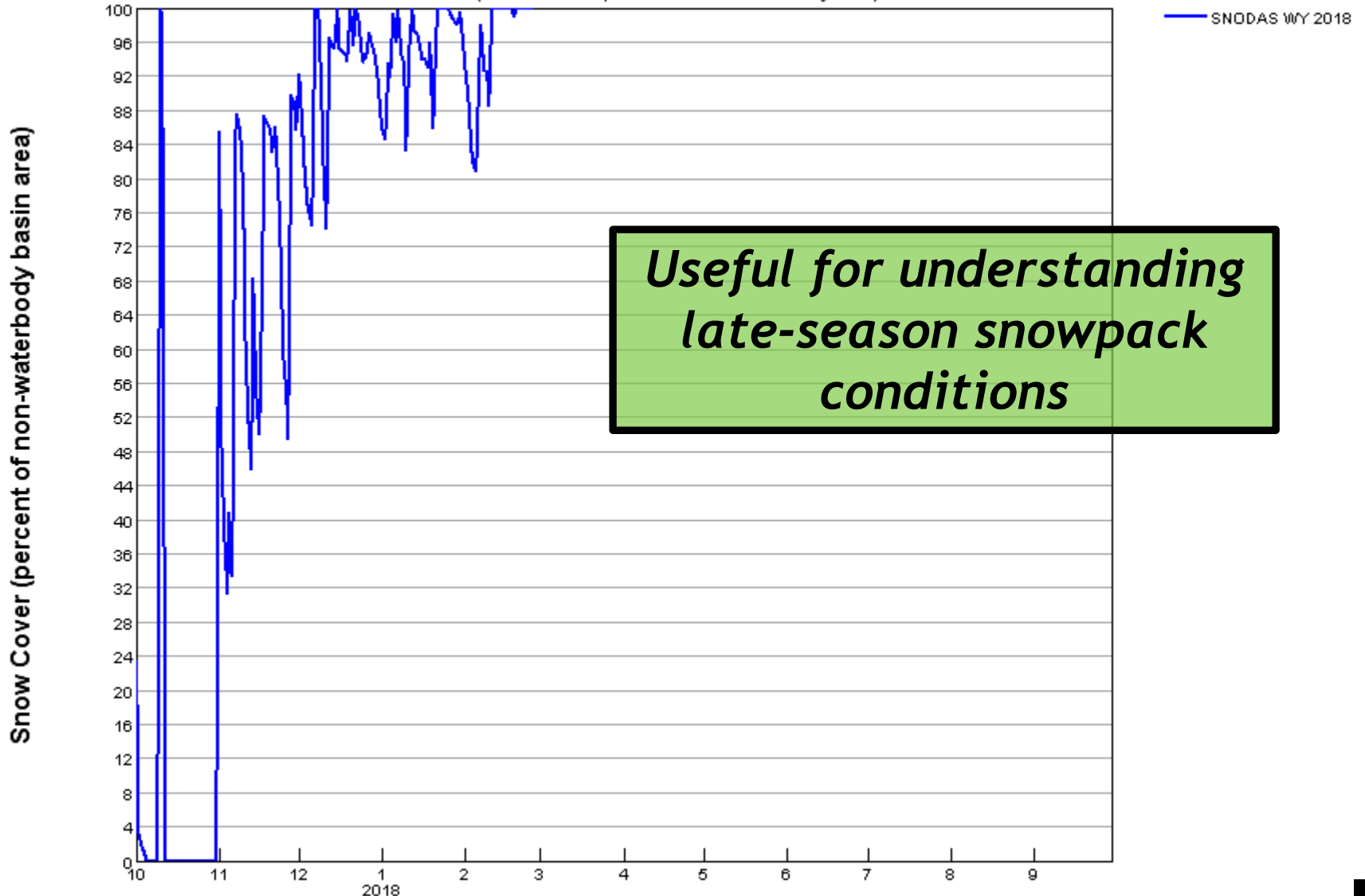
<http://projects.openwaterfoundation.org/owf-proj-co-cwcb-2016-snodas/prototype>

Interactive map shows Colorado water supply basins.

Snow Cover (Percent)

CONEJOS RIVER NEAR MOGOTE, CO. (MOGC2) SNODAS Snow Cover

(Each line corresponds to a Water Year starting Oct 1)

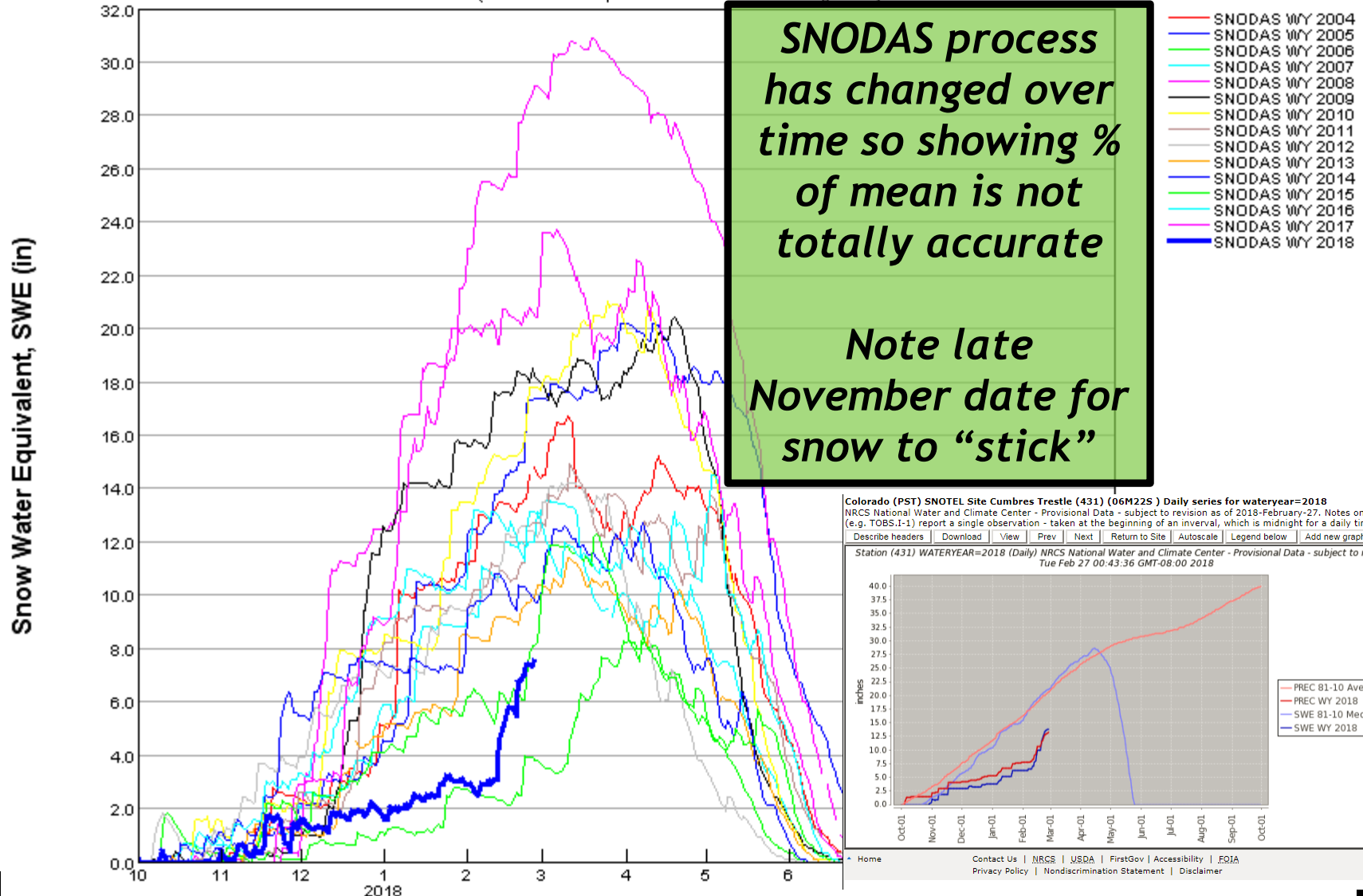


*Useful for understanding
late-season snowpack
conditions*

SNODAS Snow Water Equivalent

CONEJOS RIVER NEAR MOGOTE, CO. (MOGC2) SNODAS SWE

(Each line corresponds to a Water Year starting Oct 1)



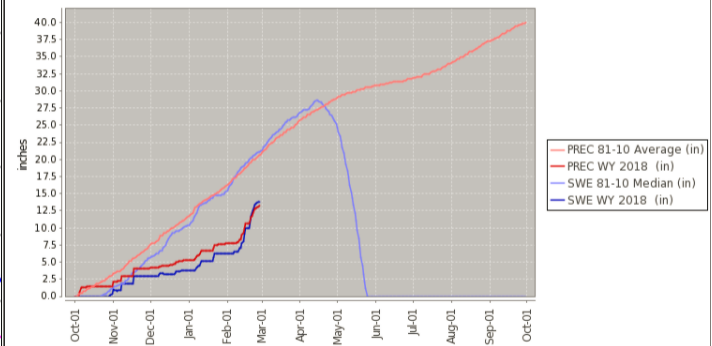
SNODAS process has changed over time so showing % of mean is not totally accurate

Note late November date for snow to "stick"

- SNODAS WY 2004
- SNODAS WY 2005
- SNODAS WY 2006
- SNODAS WY 2007
- SNODAS WY 2008
- SNODAS WY 2009
- SNODAS WY 2010
- SNODAS WY 2011
- SNODAS WY 2012
- SNODAS WY 2013
- SNODAS WY 2014
- SNODAS WY 2015
- SNODAS WY 2016
- SNODAS WY 2017
- SNODAS WY 2018

Colorado (PST) SNOTEL Site Cumbres Trestle (431) (06M225) Daily series for wateryear=2018
 NRC's National Water and Climate Center - Provisional Data - subject to revision as of 2018-February-27. Notes on dates - Data (e.g. TOBS.I-1) report a single observation - taken at the beginning of an interval, which is midnight for a daily timeseries report.

Describe headers | Download | View | Prev | Next | Return to Site | Autoscale | Legend below | Add new graph



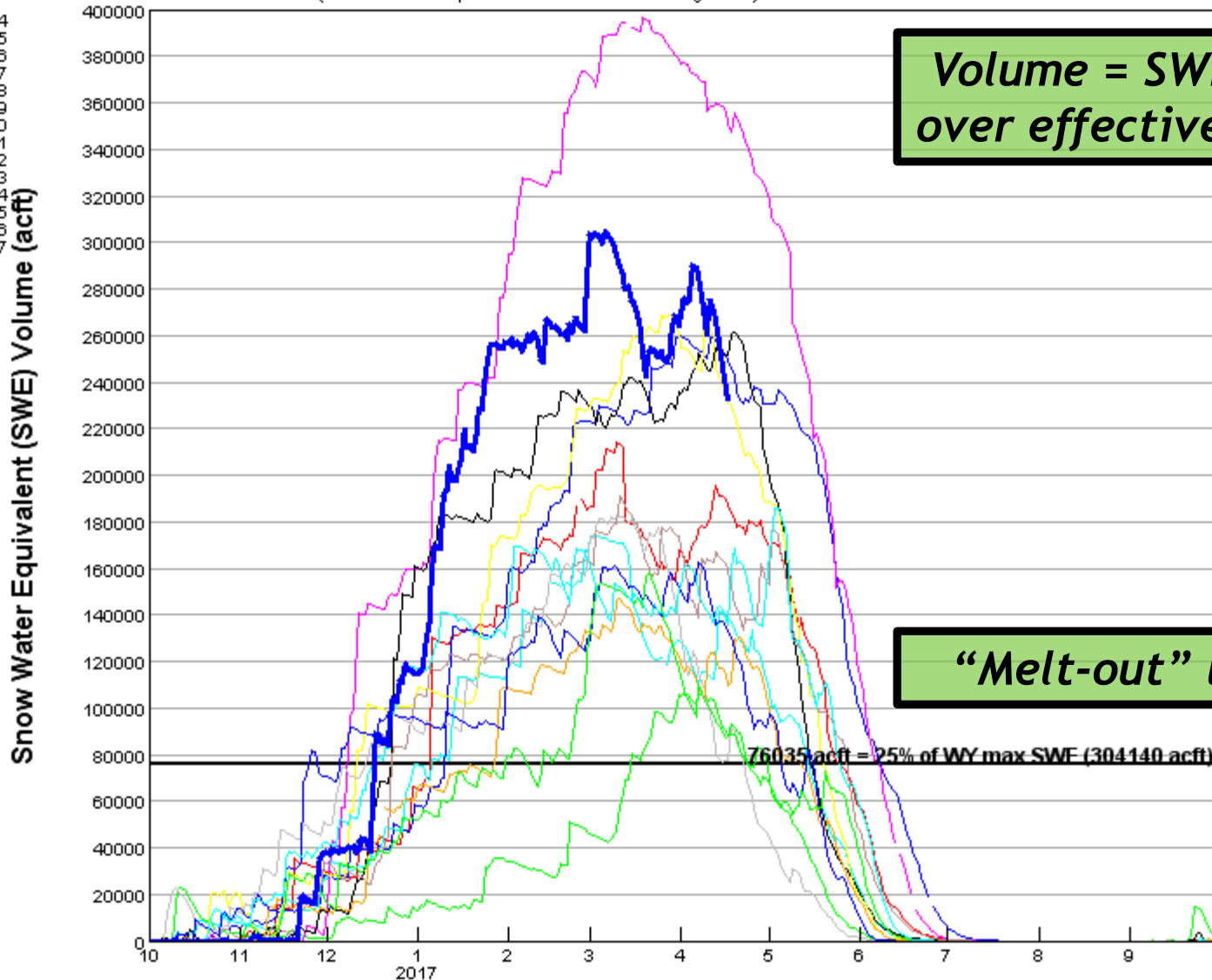
Home | Contact Us | NRC | USDA | FirstGov | Accessibility | FOIA | Privacy Policy | Nondiscrimination Statement | Disclaimer

SNODAS SWE Volume

CONEJOS RIVER NEAR MOGOTE, CO. (MOGC2) SNODAS SWE Volume

(Each line corresponds to a Water Year starting Oct 1)

- SNODAS WY 2004
- SNODAS WY 2005
- SNODAS WY 2006
- SNODAS WY 2007
- SNODAS WY 2008
- SNODAS WY 2009
- SNODAS WY 2010
- SNODAS WY 2011
- SNODAS WY 2012
- SNODAS WY 2013
- SNODAS WY 2014
- SNODAS WY 2015
- SNODAS WY 2016
- SNODAS WY 2017



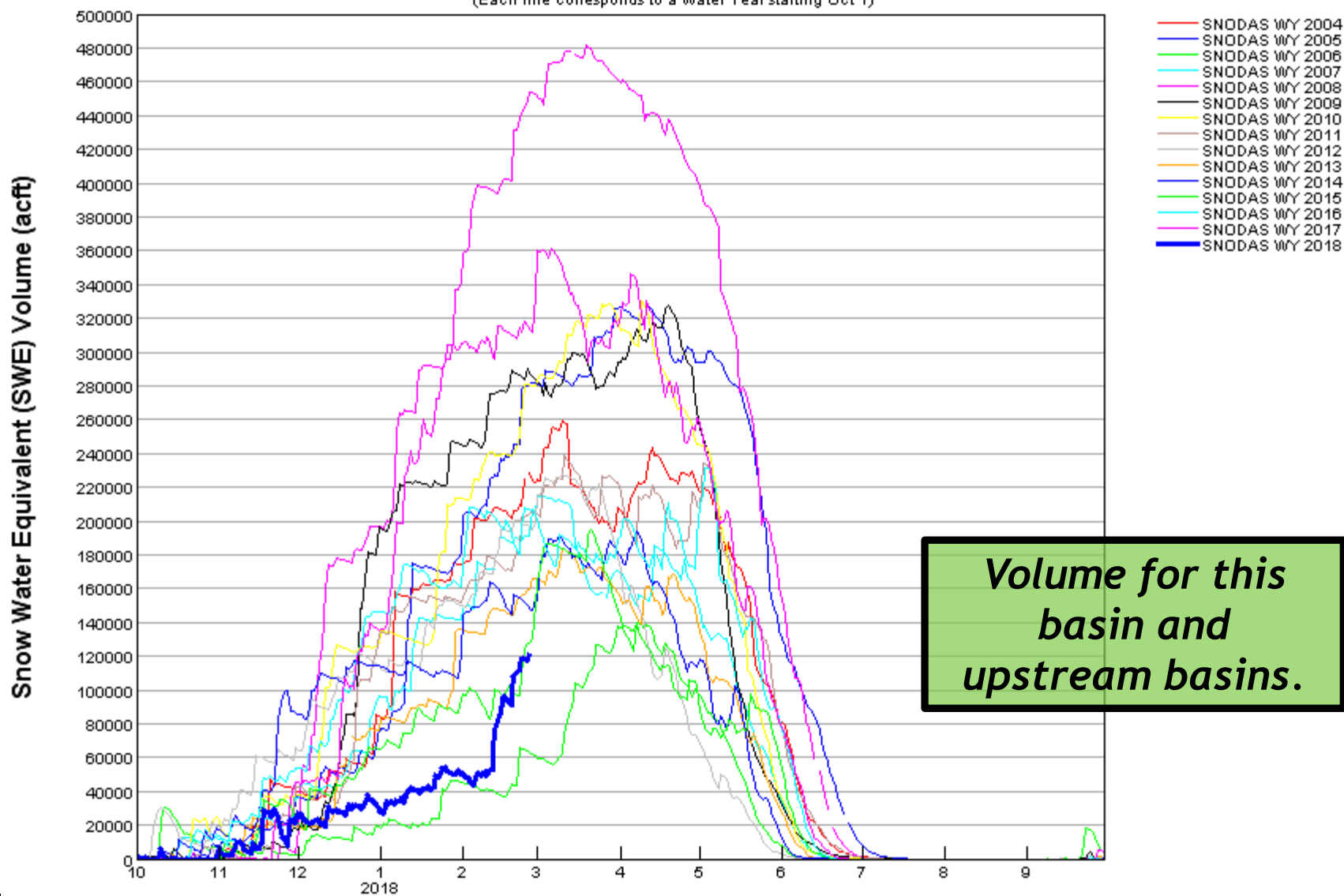
*Volume = SWE (in)
over effective area*

"Melt-out" line.

76035 acft = 25% of WY max SWE (304140 acft)

SNODAS Total Upstream SWE Volume

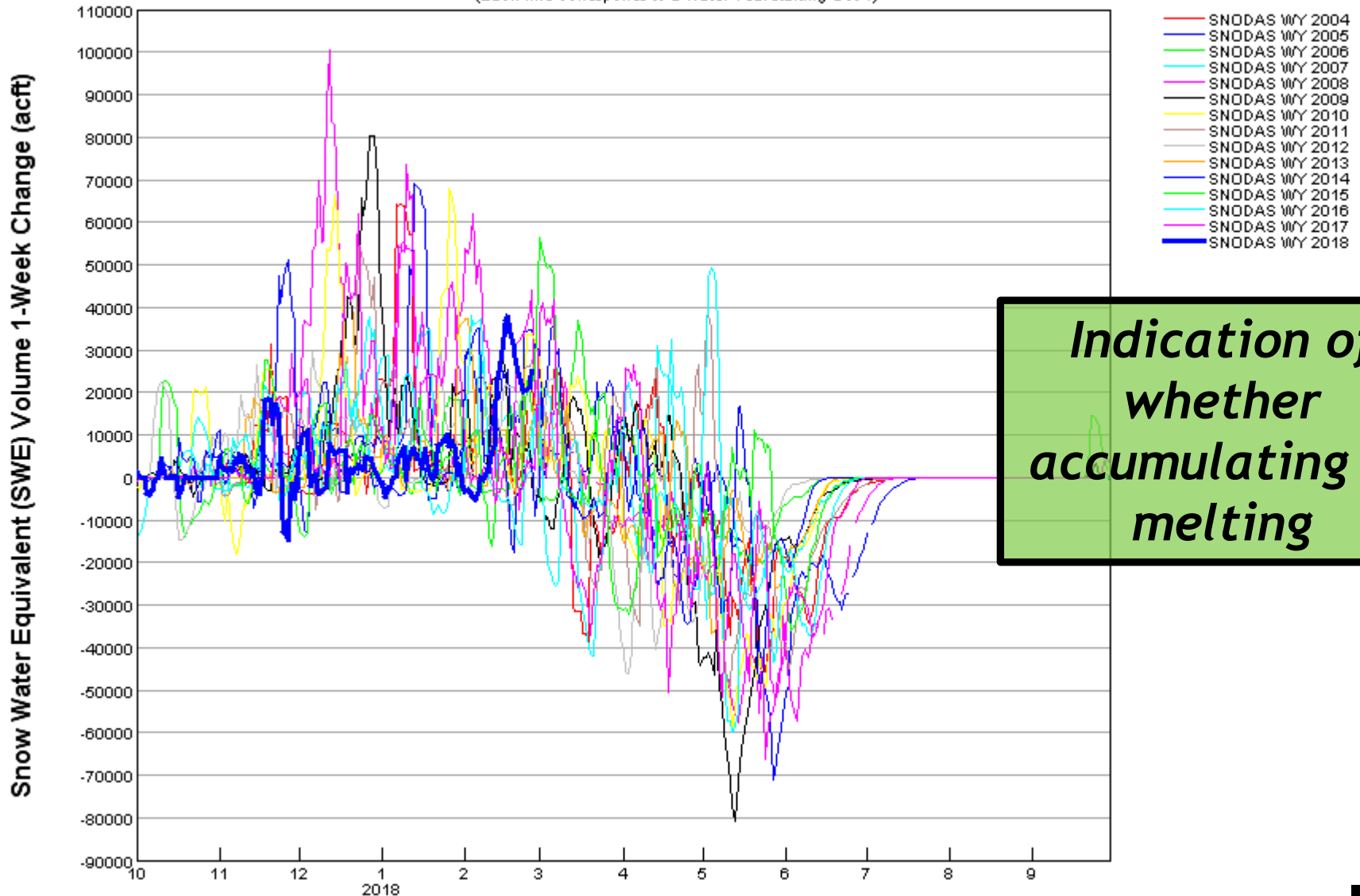
CONEJOS RIVER NEAR MOGOTE, CO. (MOGC2) Upstream Total SNODAS SWE Volume
(Each line corresponds to a Water Year starting Oct 1)



SNODAS SWE Volume 1-Week Change

CONEJOS RIVER NEAR MOGOTE, CO. (MOGC2) SNODAS SWE Volume 1-Week Change

(Each line corresponds to a Water Year starting Oct 1)

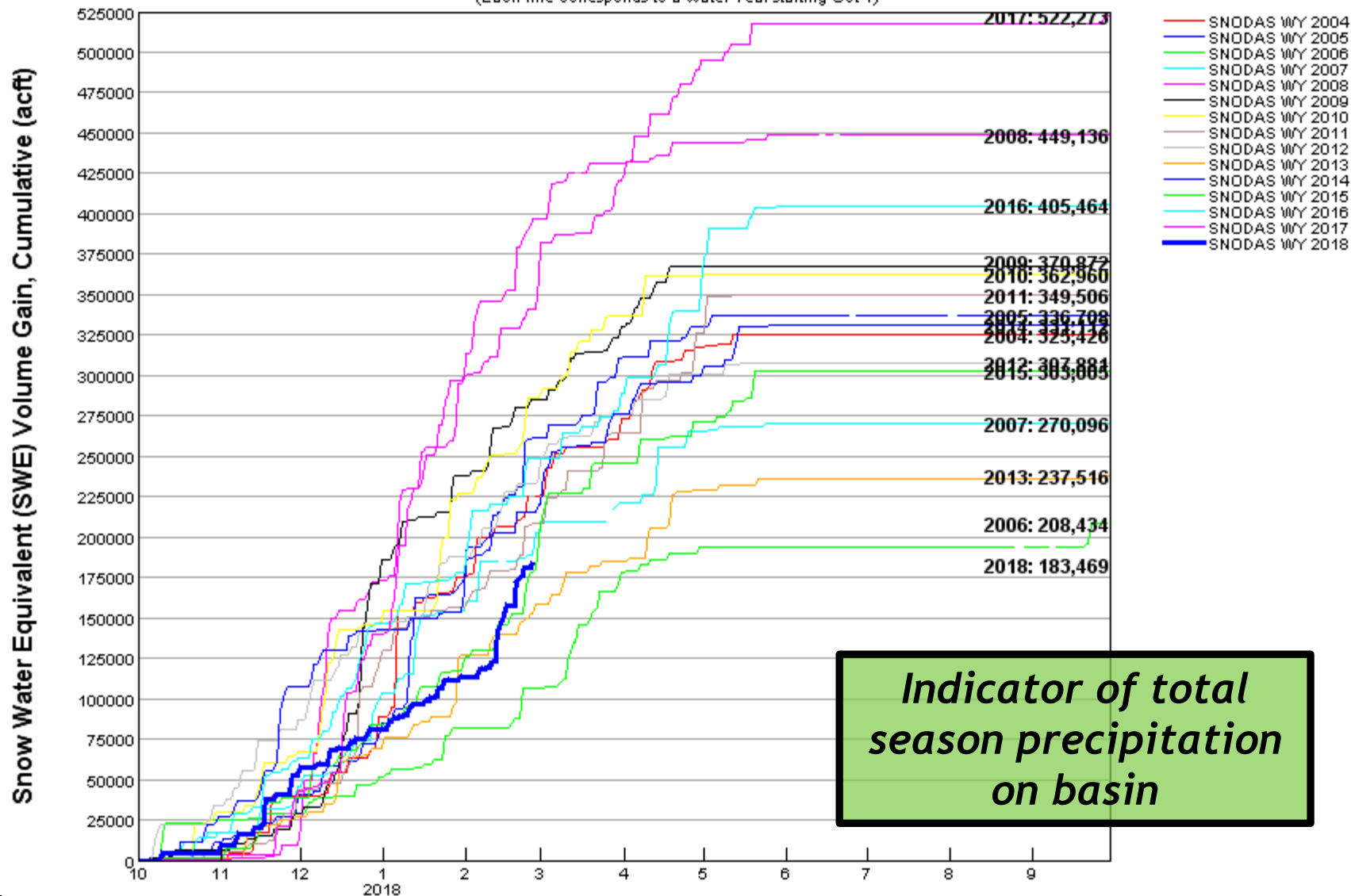


Indication of whether accumulating or melting

SNODAS SWE Volume Gain, Cumulative

CONEJOS RIVER NEAR MOGOTE, CO. (MOGC2) SNODAS SWE Volume Gain, Cumulative

(Each line corresponds to a Water Year starting Oct 1)

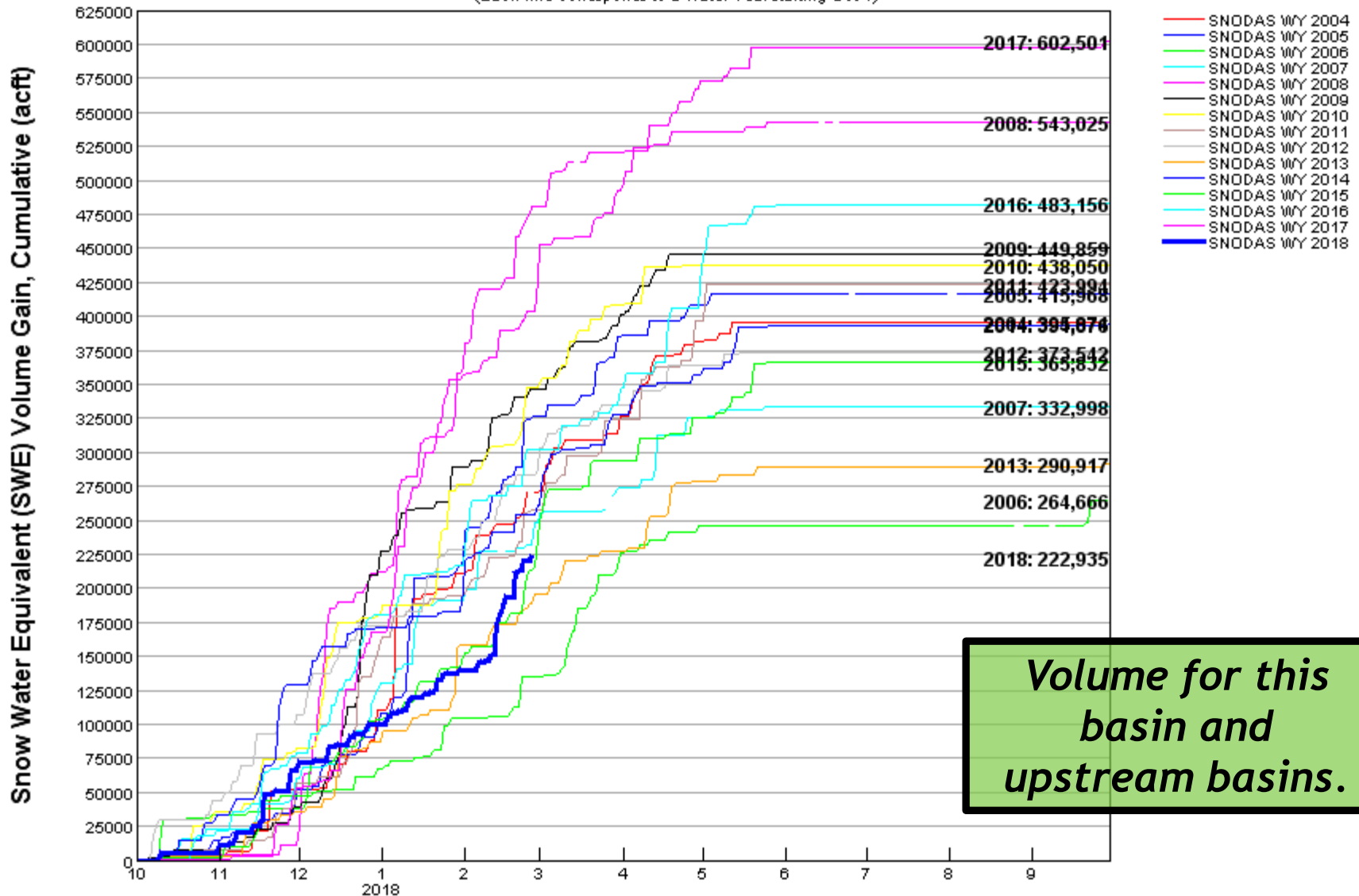


Indicator of total season precipitation on basin

SNODAS SWE Upstream Total Volume Gain, Cumulative


CONEJOS RIVER NEAR MOGOTE, CO. (MOGC2) Upstream Total SNODAS SWE Volume Gain, Cumulative

(Each line corresponds to a Water Year starting Oct 1)





Volume for this basin and upstream basins.


Daily SWE Map Animation

Select Date  SNODAS Date: 2018-02-25

SNODAS Animation

Starting Date: (earliest available date: 2003-09-30)
 

Ending Date: (latest available date: 2018-02-26)
 

Increment (days): (Default is set to 1)
 

2018-02-25

- *It is pretty cool!*
- *Can see storm events*
- *Can see when snow started to accumulate and melt out*

“Gapminder”

viz.openwaterfoundation.org/co/owf-viz-co-snodas-gapminder/



Gapminder

Documentation

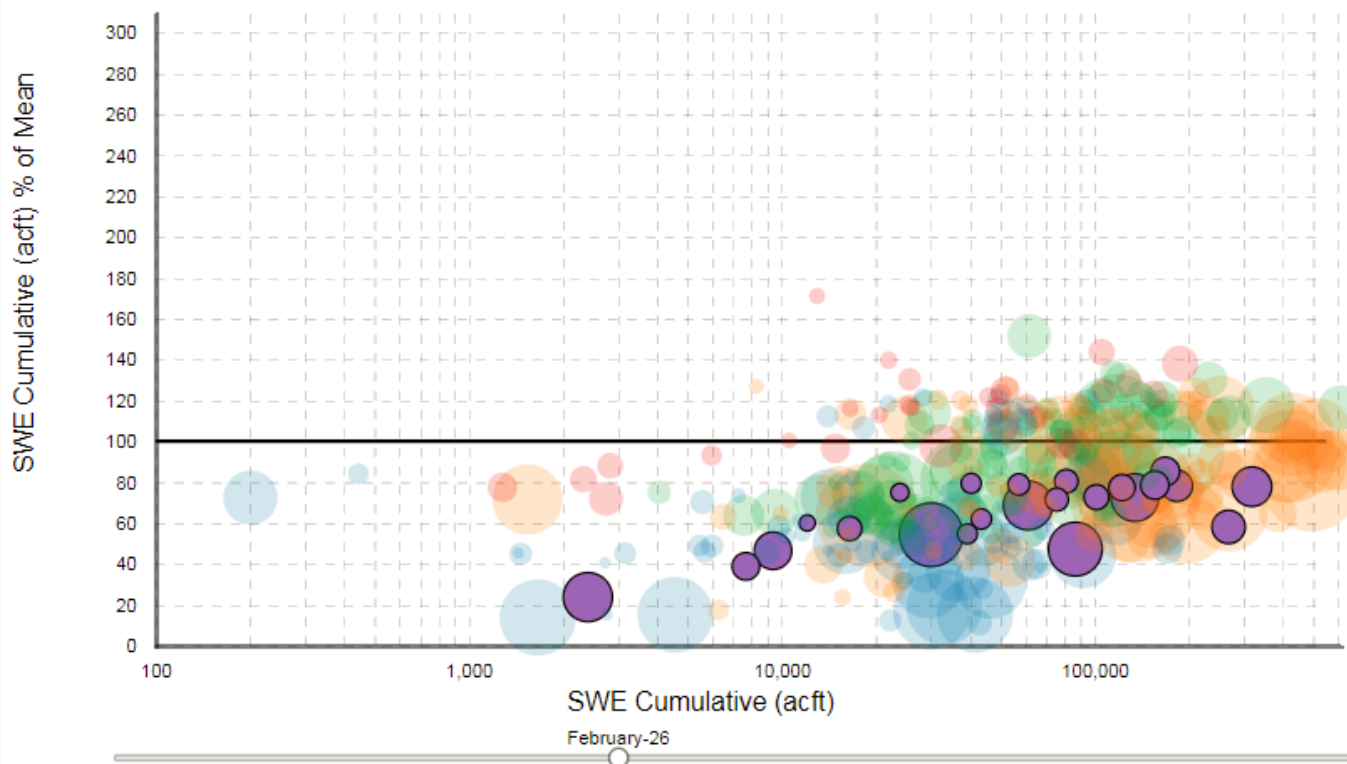
Data

Sources

SNODAS Data

Feb-2018

SWE Cumulative(x), SWE Cumulative % of Mean(y), SWE Cumulative Upstream Total(size), Basin(color)



Basin

- ABRFC
- CBRFC
- MBRFC
- NCWCD
- WGRFC

Select All Markers

Select Individual LOCAL_ID

Turn Tracer On

Turn Annotations Off

Water Year: 2018

Oct-2017 Nov-2017 Dec-2017 Jan-2018 Feb-2018 Mar-2018 Apr-2018 May-2018 Jun-2018 Jul-2018 Aug-2018 Sep-2018



Speed:

LOCAL_ID:

Date:

SWE_Cumulative:

SWE_Cumulative_Percent_of_Mean:

End Online Demonstration

See <http://viz.openwaterfoundation.org>
Will be available on State of CO server soon.

Observations

- It seems to take longer for snow to “stick”
- Snow events are often followed by melt periods - more of an issue at lower elevations
- Does snow that melts at higher elevations cause the snowpack to “harden” into ice? - could actually prolong runoff season
- Lots of variability - snowpack as a storage reservoir does not have carryover
- Need to understand water supply as a system

Challenges and Successes

- Open source approach: software, data, documentation
- Processing a lot of data
- Software works on Windows (desktop) and Linux
- Integrated spatial and temporal displays

Next Steps and Opportunities

- Finish moving system to State's Google Cloud Platform Server
- Training webinars
- Respond to feedback - Improve User Experience (UX)
- Continue adding new tools to understand snowpack for water resources planning
- Integrate SNODAS and SNOTEL data
- Need funding

See also: <http://viz.openwaterfoundation.org>

New software - GeoProcessor

- “TSTool for spatial”
- Automate geospatial data processing
- QGIS and ArcGIS versions (QGIS is current focus)
- Developed in Python

Share It

The content of this presentation is licensed under the Creative Commons Attribution NonCommercial License:
<http://creativecommons.org/licenses/by-nc/4.0>



open data | **open software** | **open decisions**
openwaterfoundation.org