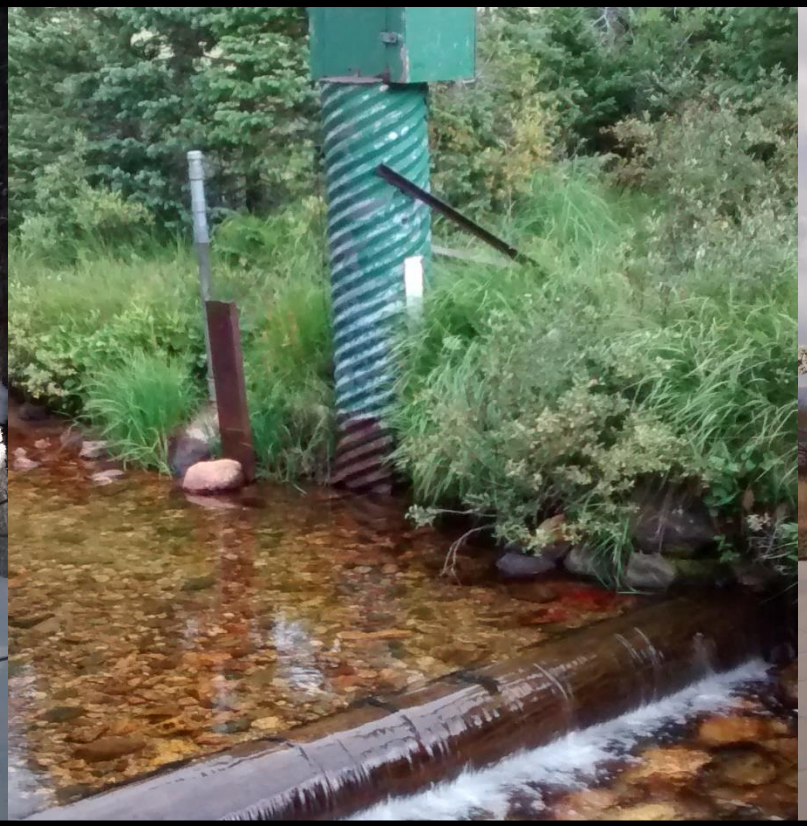
New Software Tools for Snowpack Water Supply Analysis

AWRA Colorado, February 27, 2018



openwater FOUNDATION

Steve Malers, Open Water Foundation
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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

open water

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

Secure | https://www.nasa.gov/press-release/long-term-warming-trend-continued-in-2017-nasa-noaa

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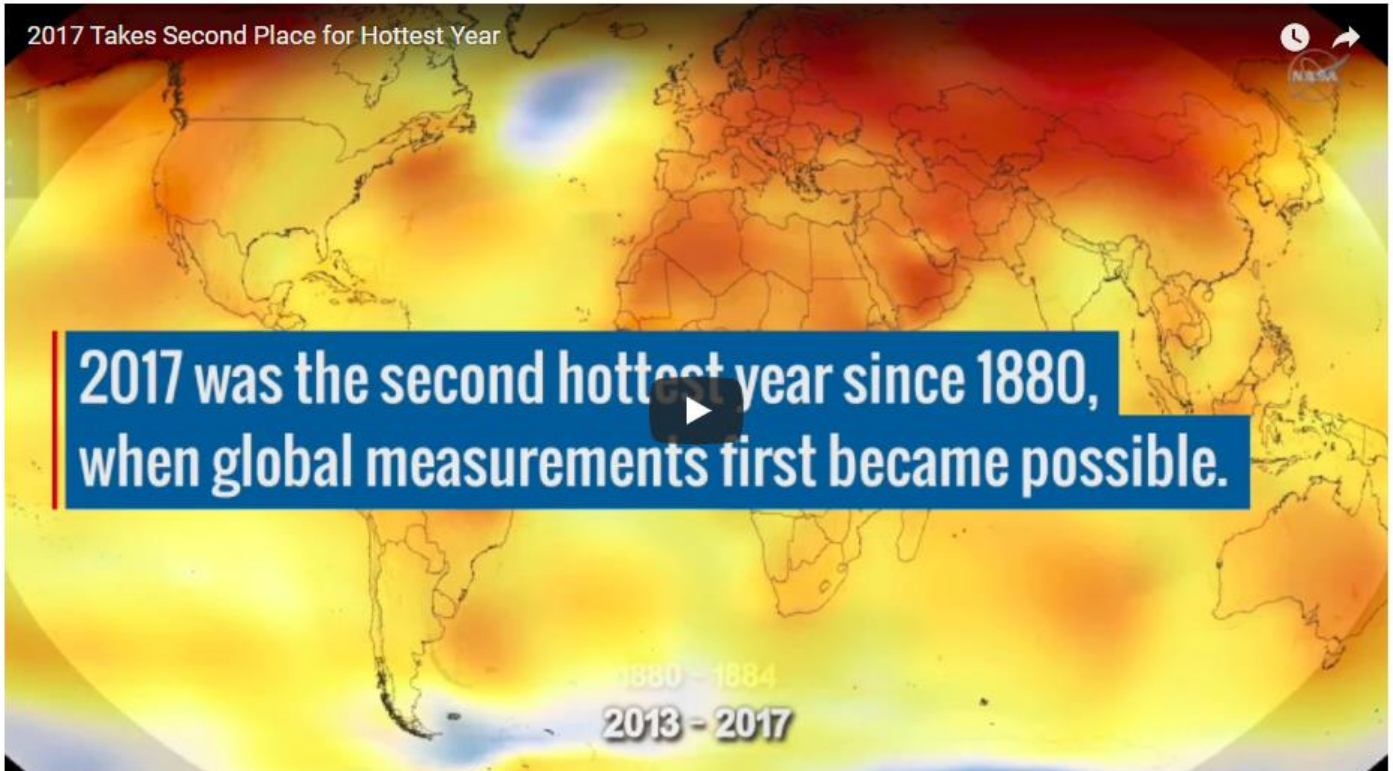
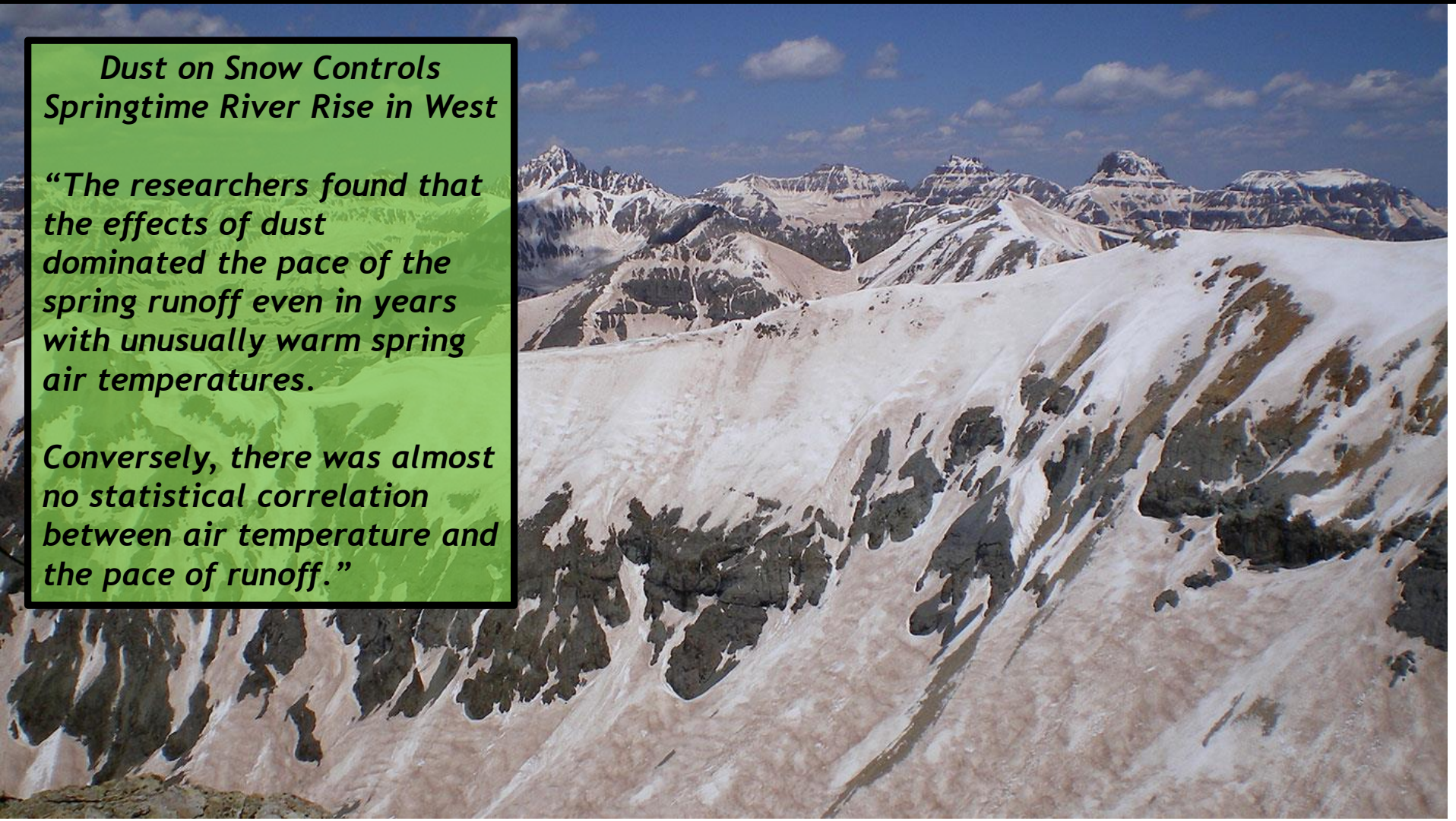
Climate

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

abc NEWS VIDEO LIVE SHOWS

https://en.wikipedia.org/wiki/List_of_U.S._states_and_territories_by_GDP

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

WATCH | Federal report says 2017 shattered US damage record for natural

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	230,982	1.24
26	26	South Carolina	209,859	1.13
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.

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

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 hold great potential for truly sustainable production systems. In addition to breeding and developing 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.

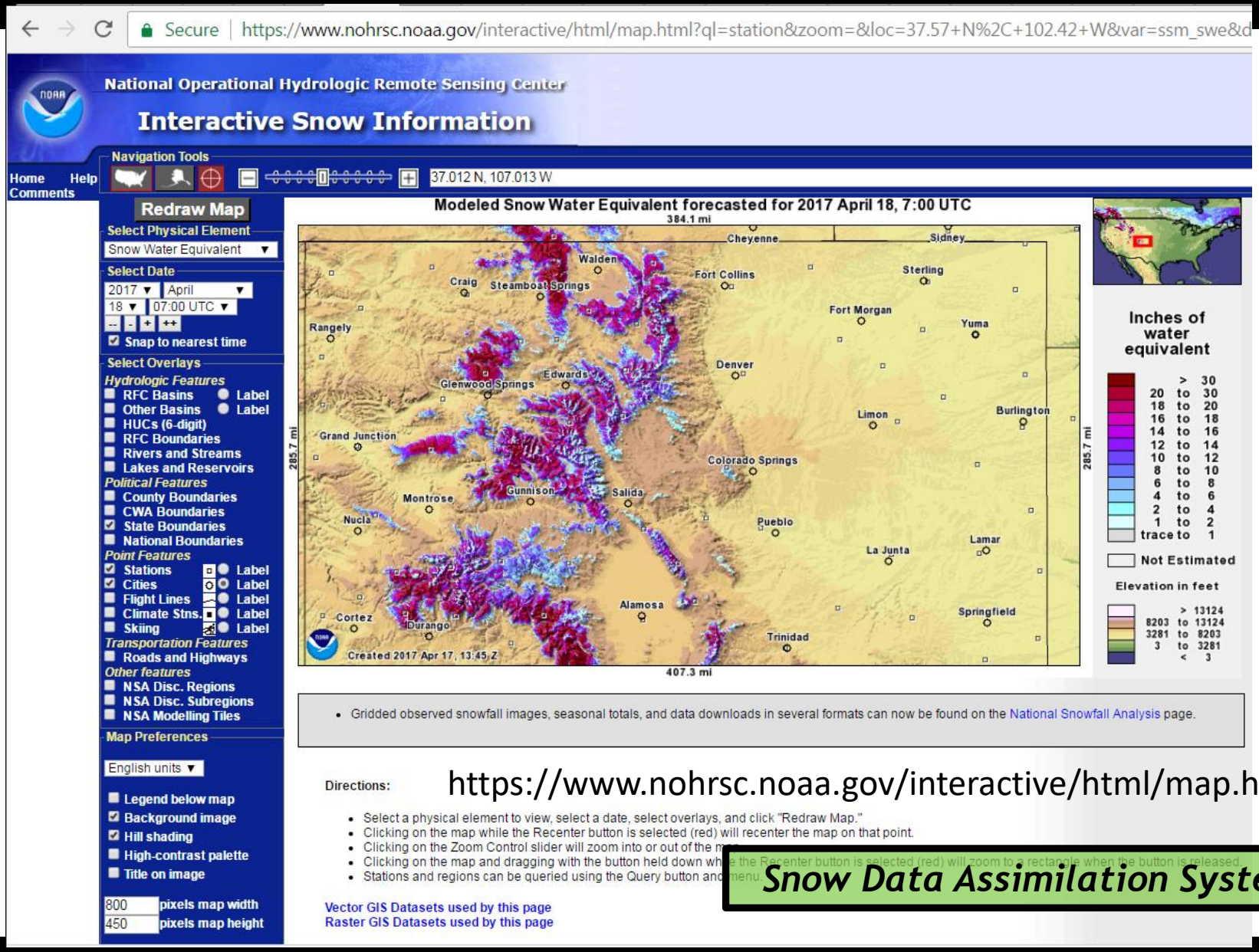
How will changes in climate, hydrology, and agriculture interact?

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

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

ope

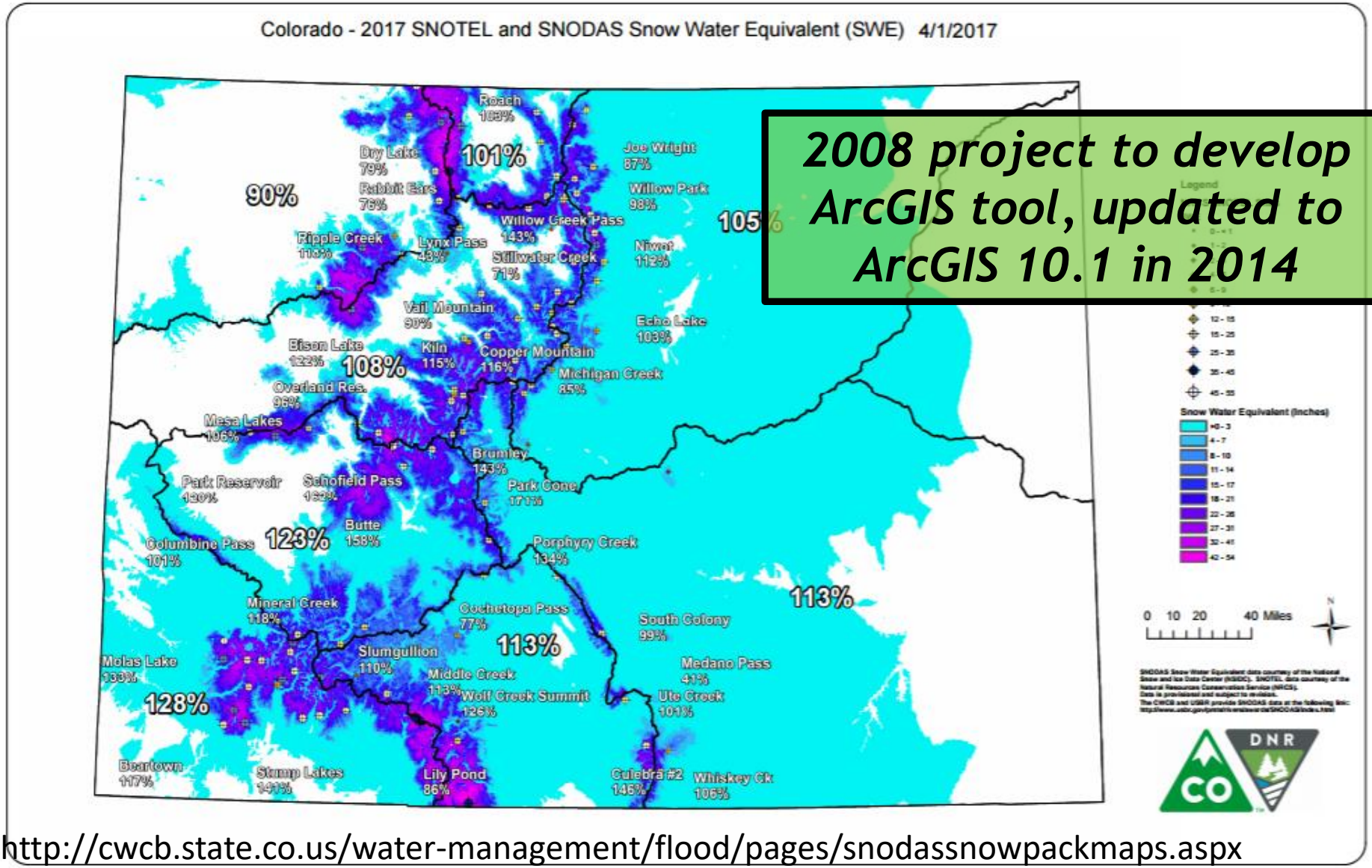
What is SNODAS?



https://www.nohrsc.noaa.gov/interactive/html/map.html

Snow Data Assimilation System

Previous CWCB SNODAS Projects

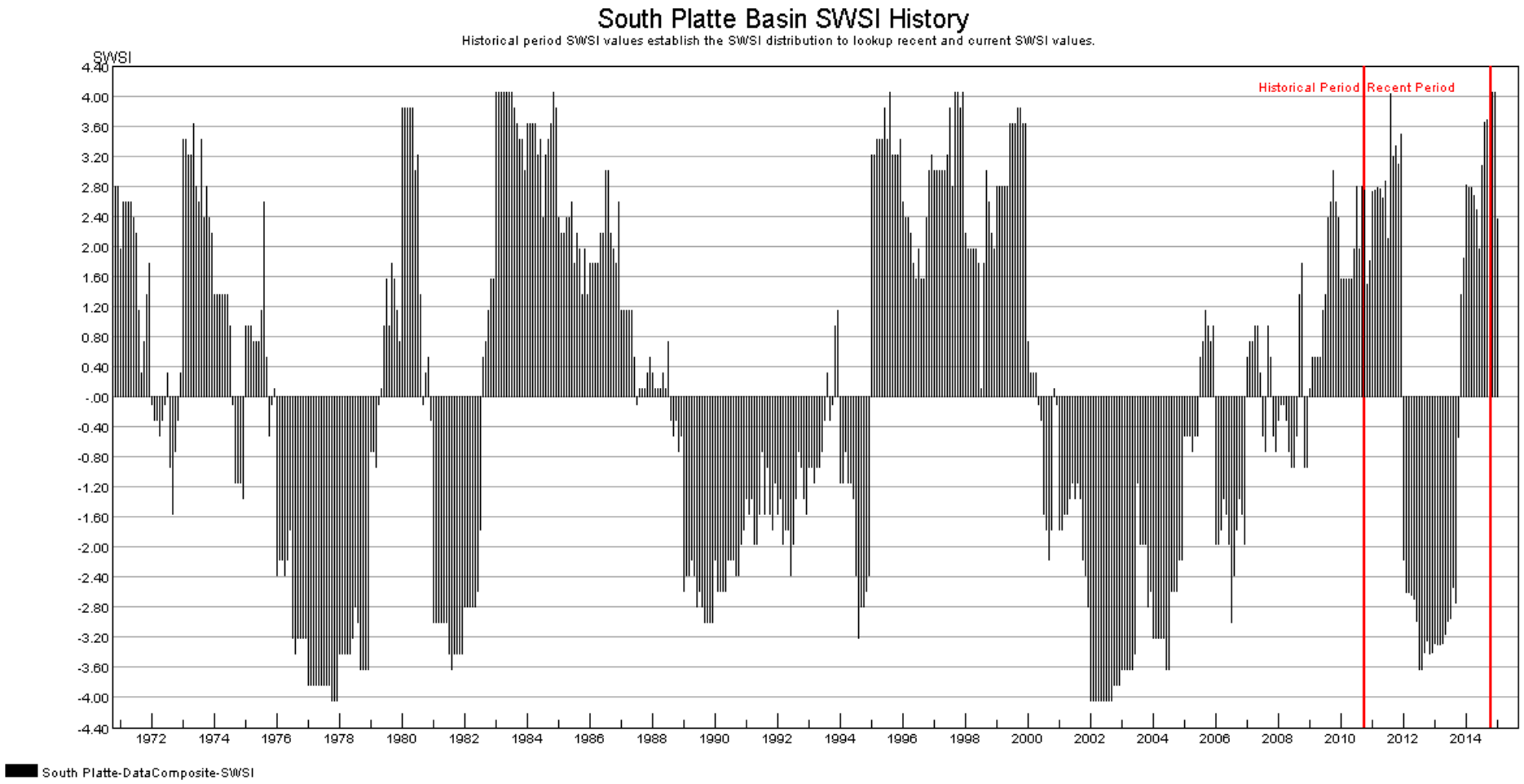


http://cwcb.state.co.us/water-management/flood/pages/snodassnowpackmaps.aspx

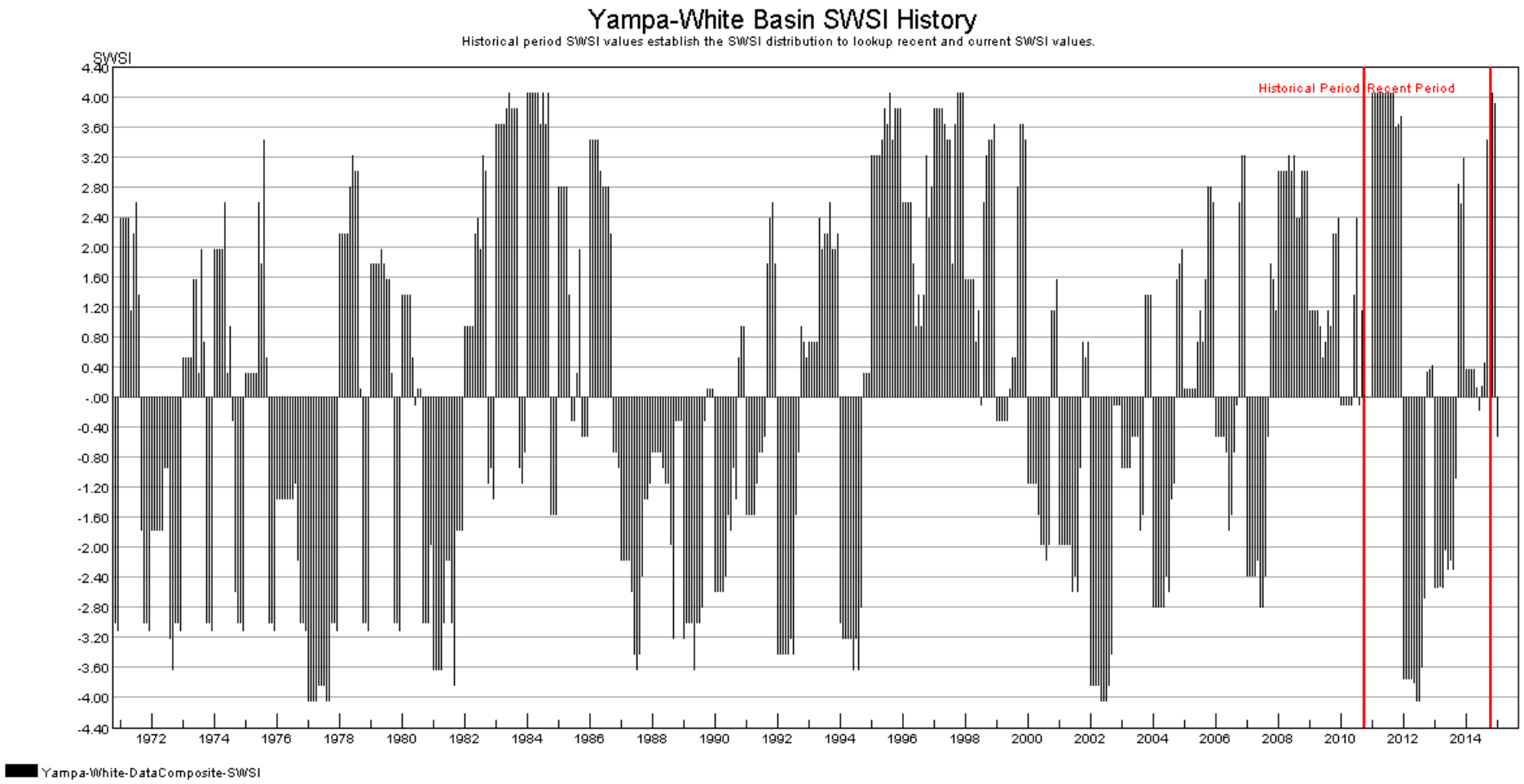
Previous CWCB Projects

- 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).

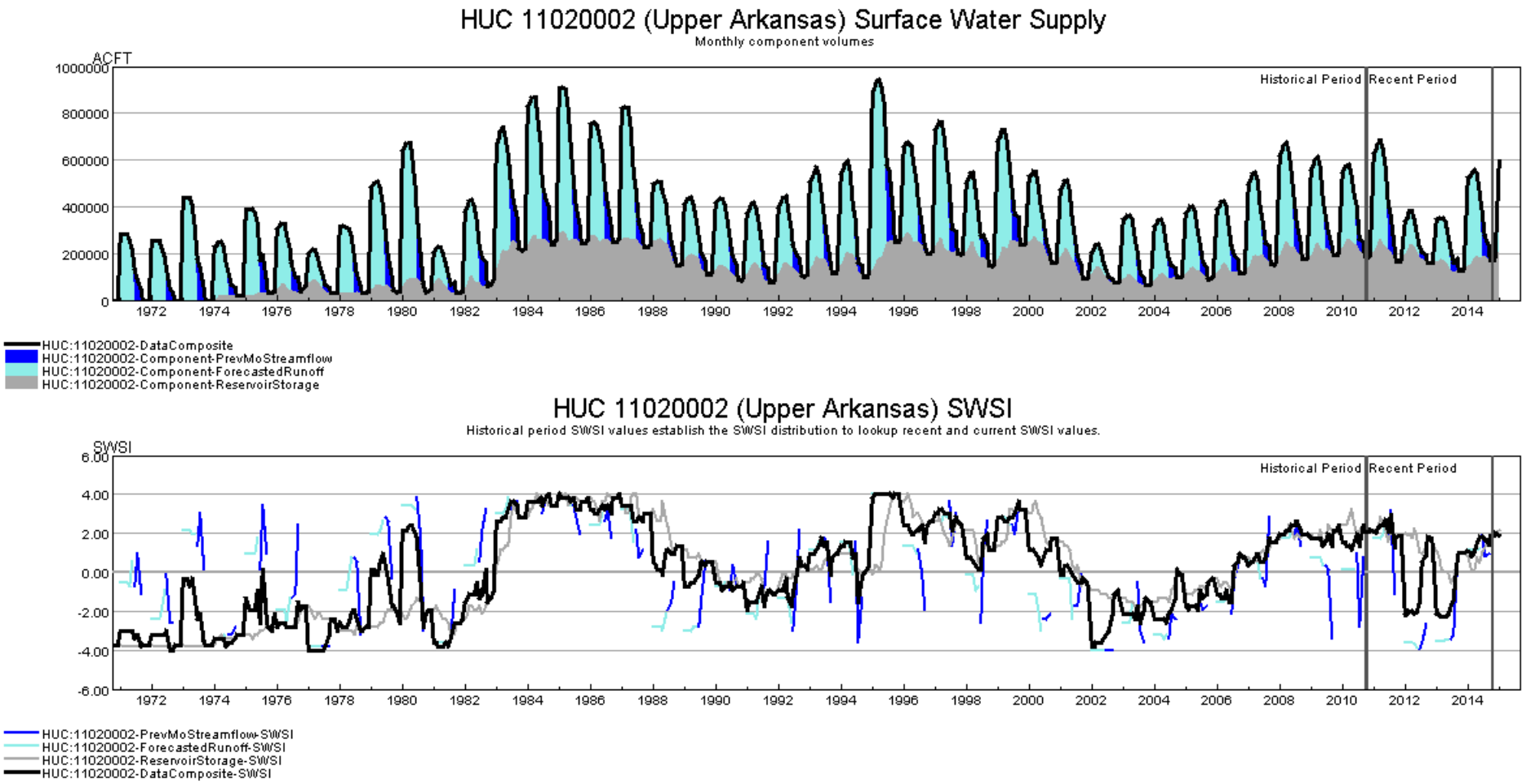
Surface Water Supply Index (SWSI) in a Highly Managed Basin



SWSI in a Less-Managed Basin



SWSI at Hydrologic Unit Code Scale



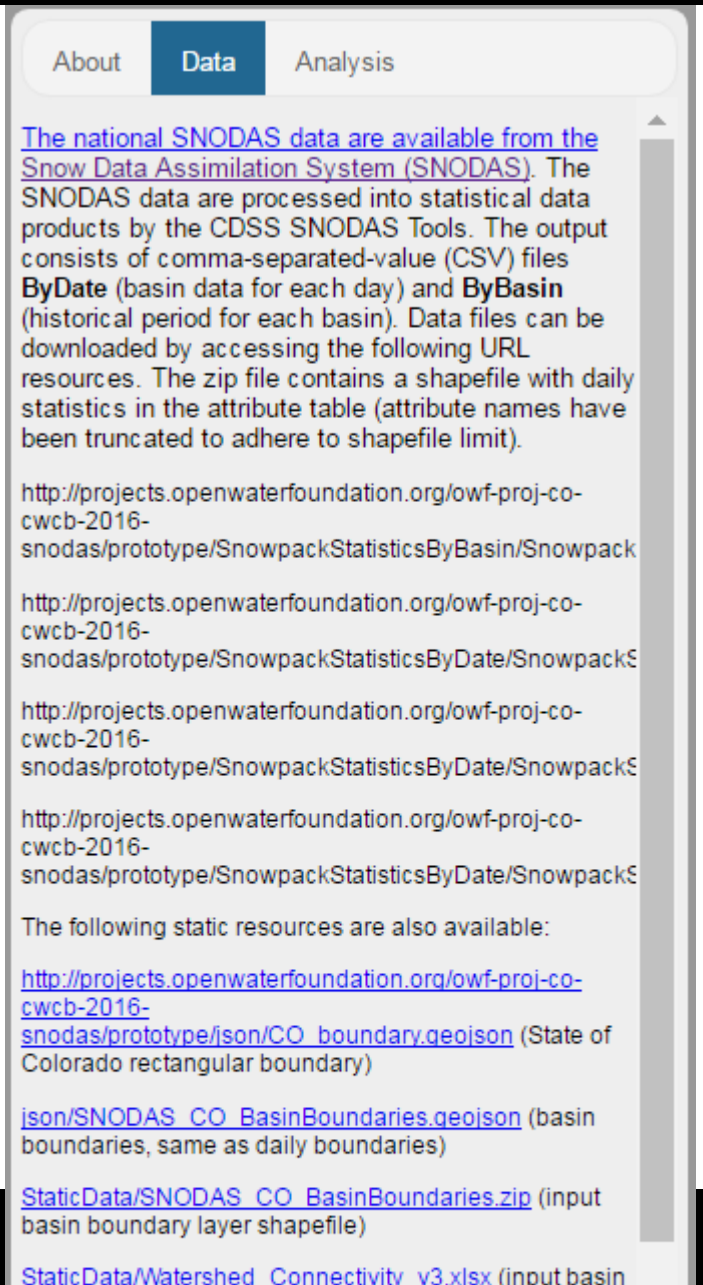
CDSS SNODAS Tools Approach

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



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

- *Static data for basins*

Developer and User Documentation

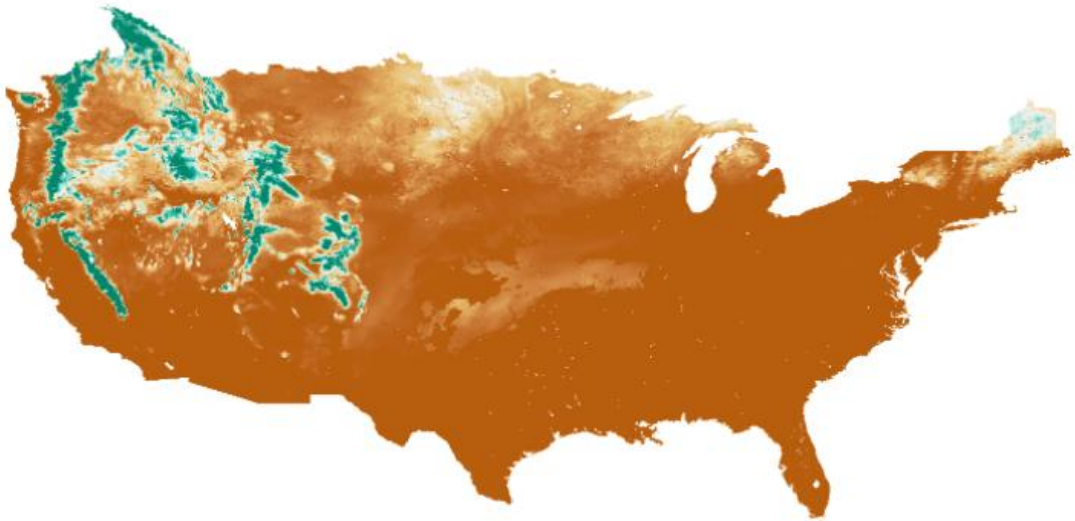
software.openwaterfoundation.org/cdss-app-snodas-tools-doc-user/process/processing-steps/#1-download-snodas-data

SNODAS Tools Process / Processing Steps

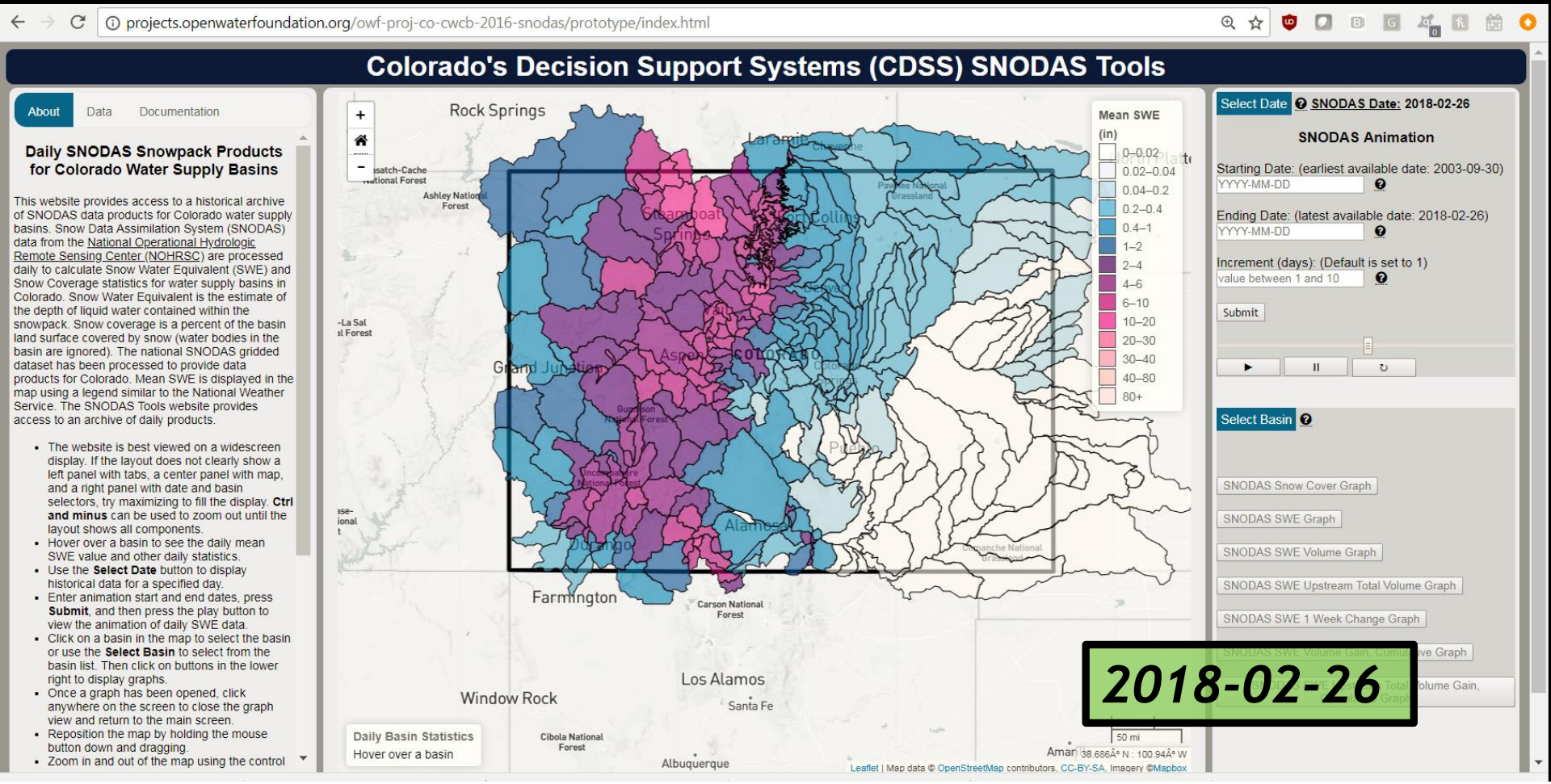
Search

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.



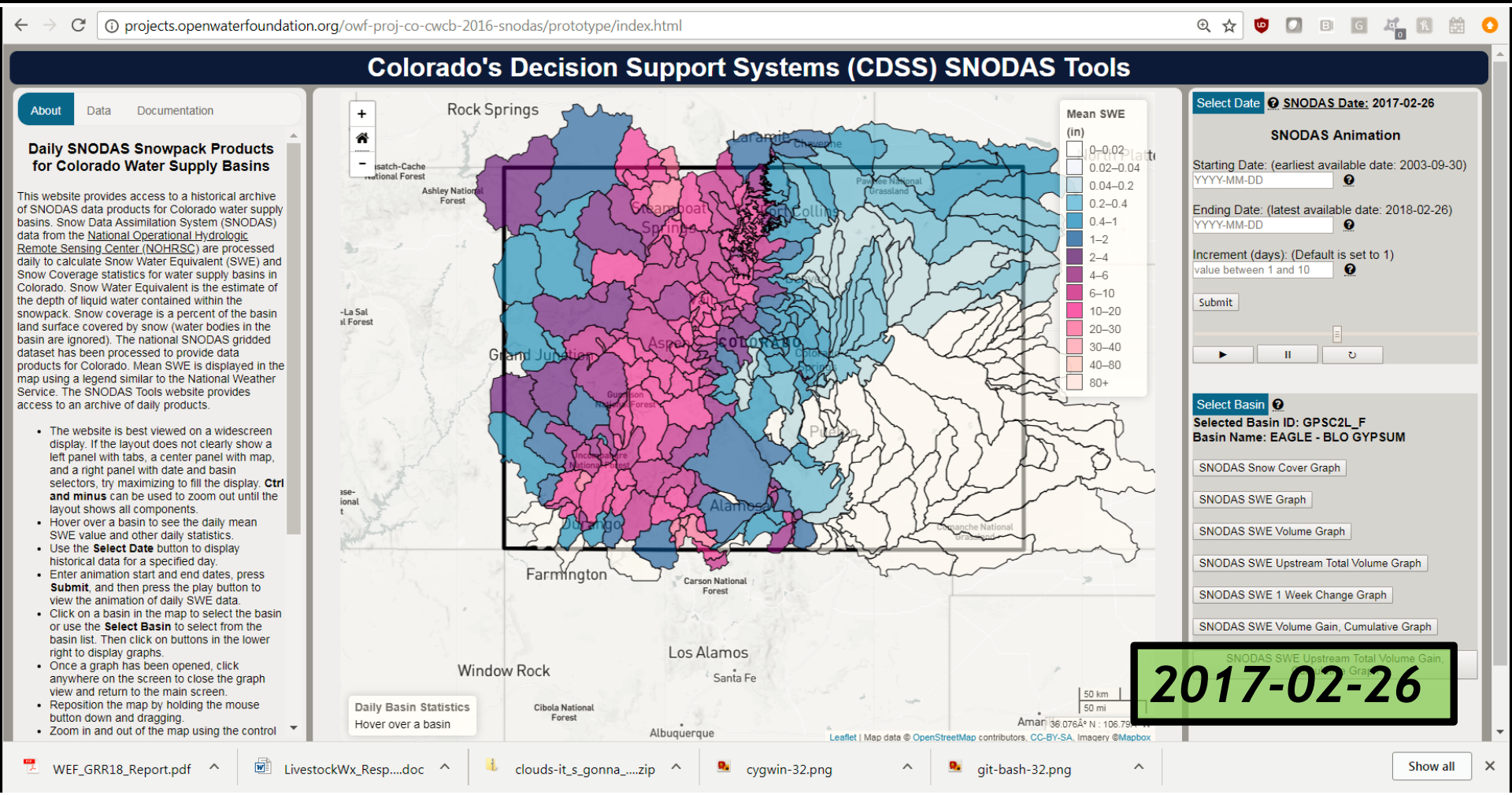
Enhanced Snowpack Products



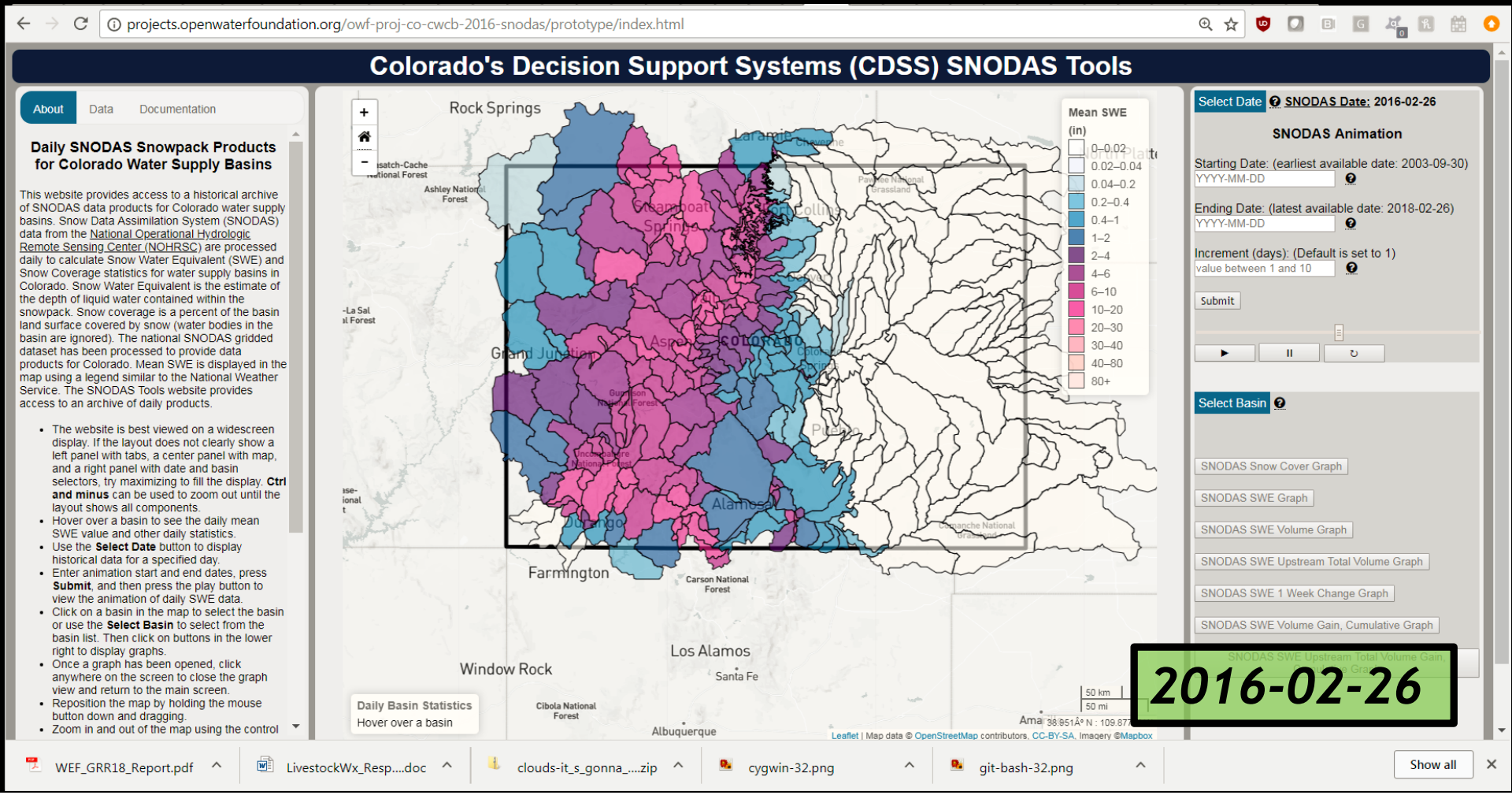
http://projects.openwaterfoundation.org/owf-proj-co-cwcb-2016-snodas/prototype

Working to deploy to new State of CO server.

Enhanced Snowpack Products



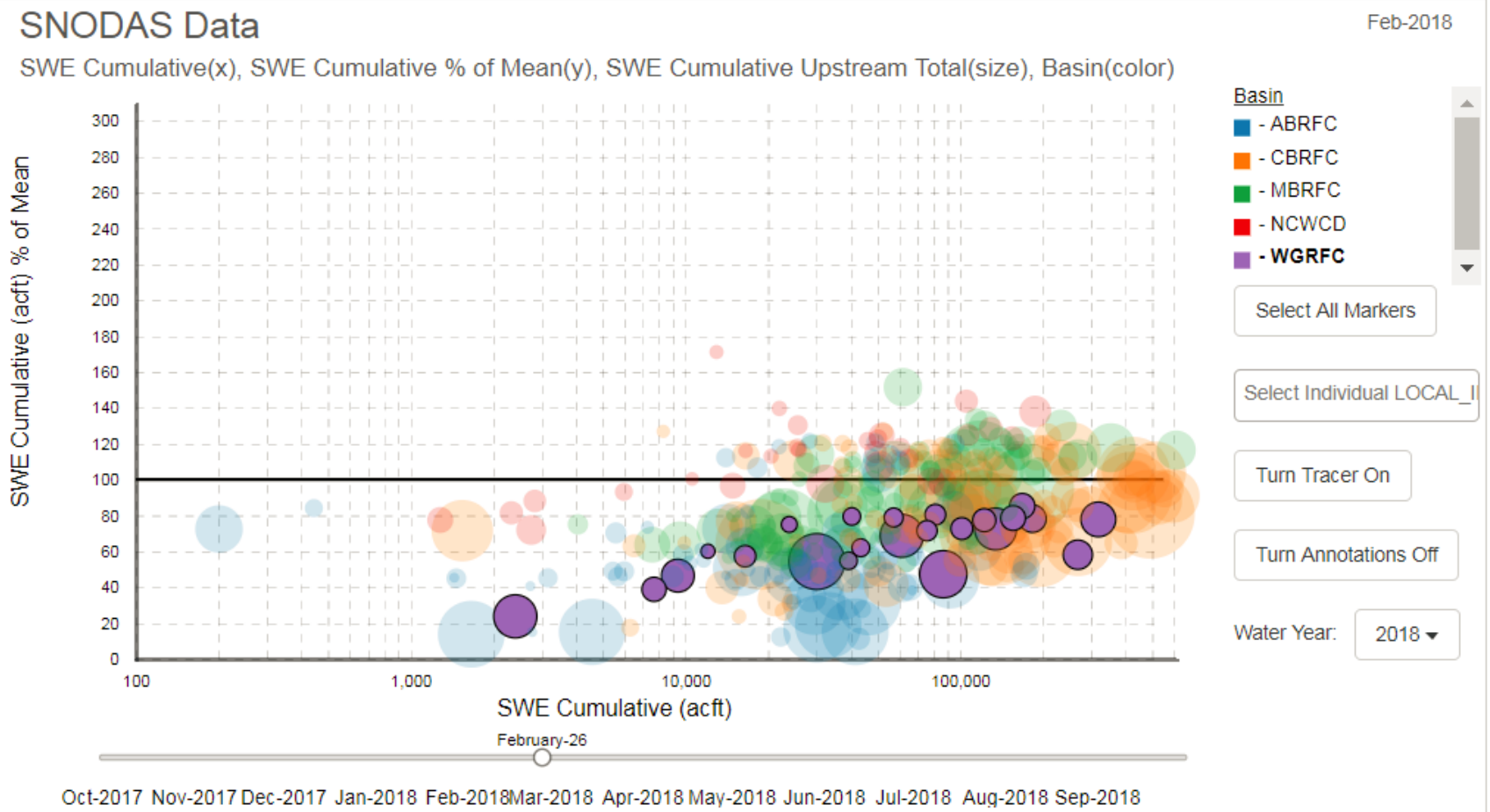
Enhanced Snowpack Products



Start Online Demonstration

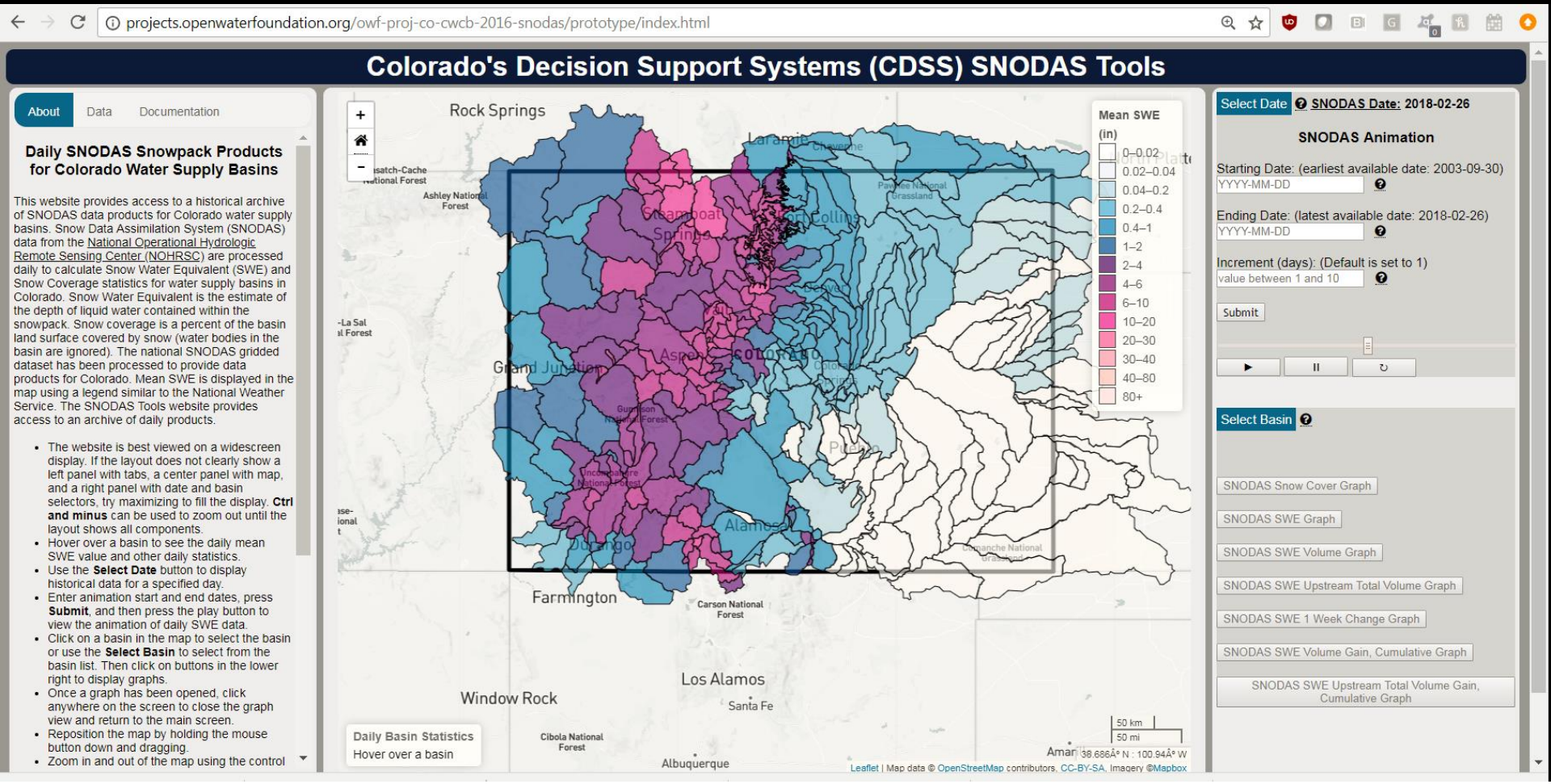
viz.openwaterfoundation.org/co/owf-viz-co-snodas-gapminder/

Gapminder | Documentation | Data | Sources



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

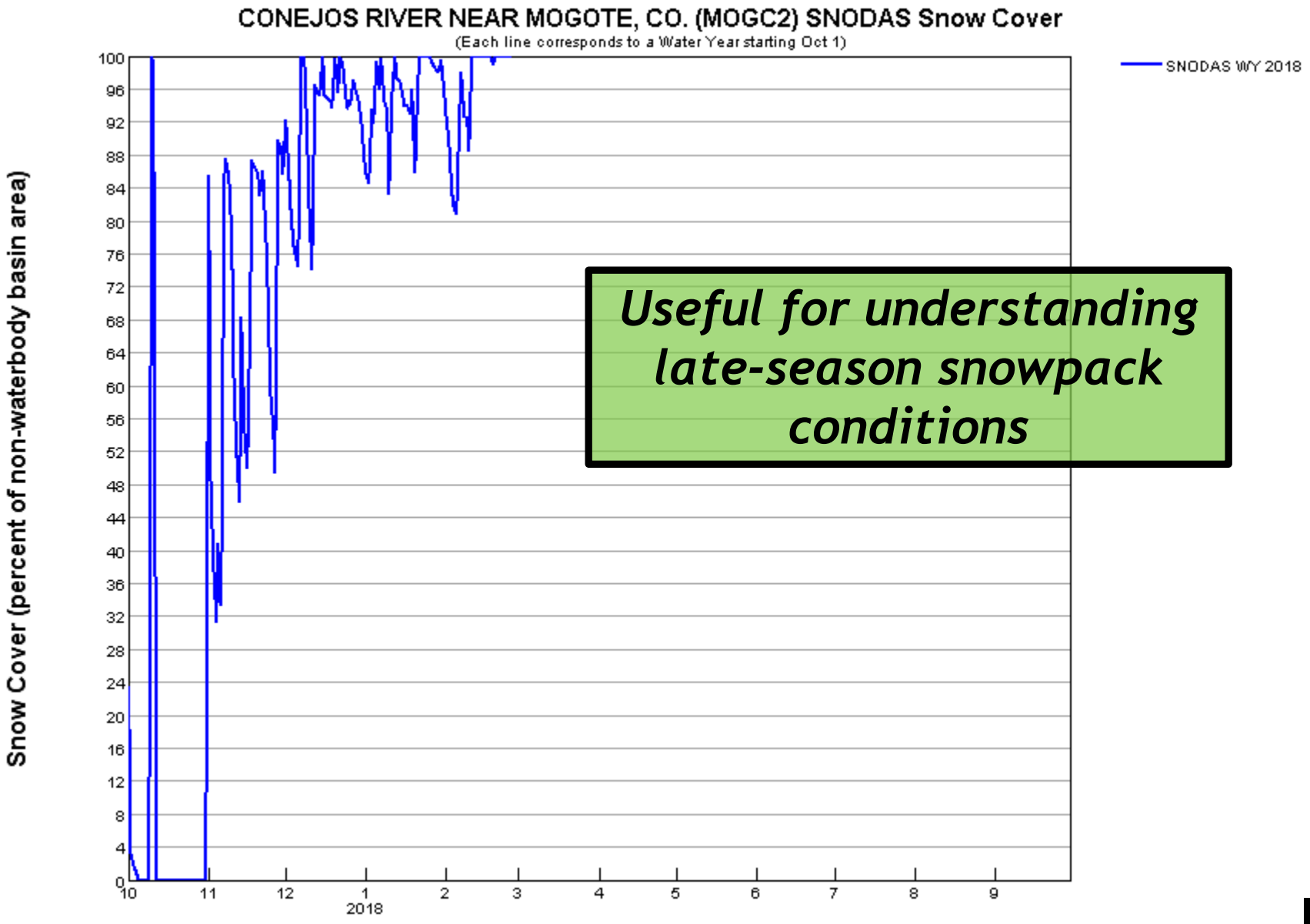
Enhanced Snowpack Products



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

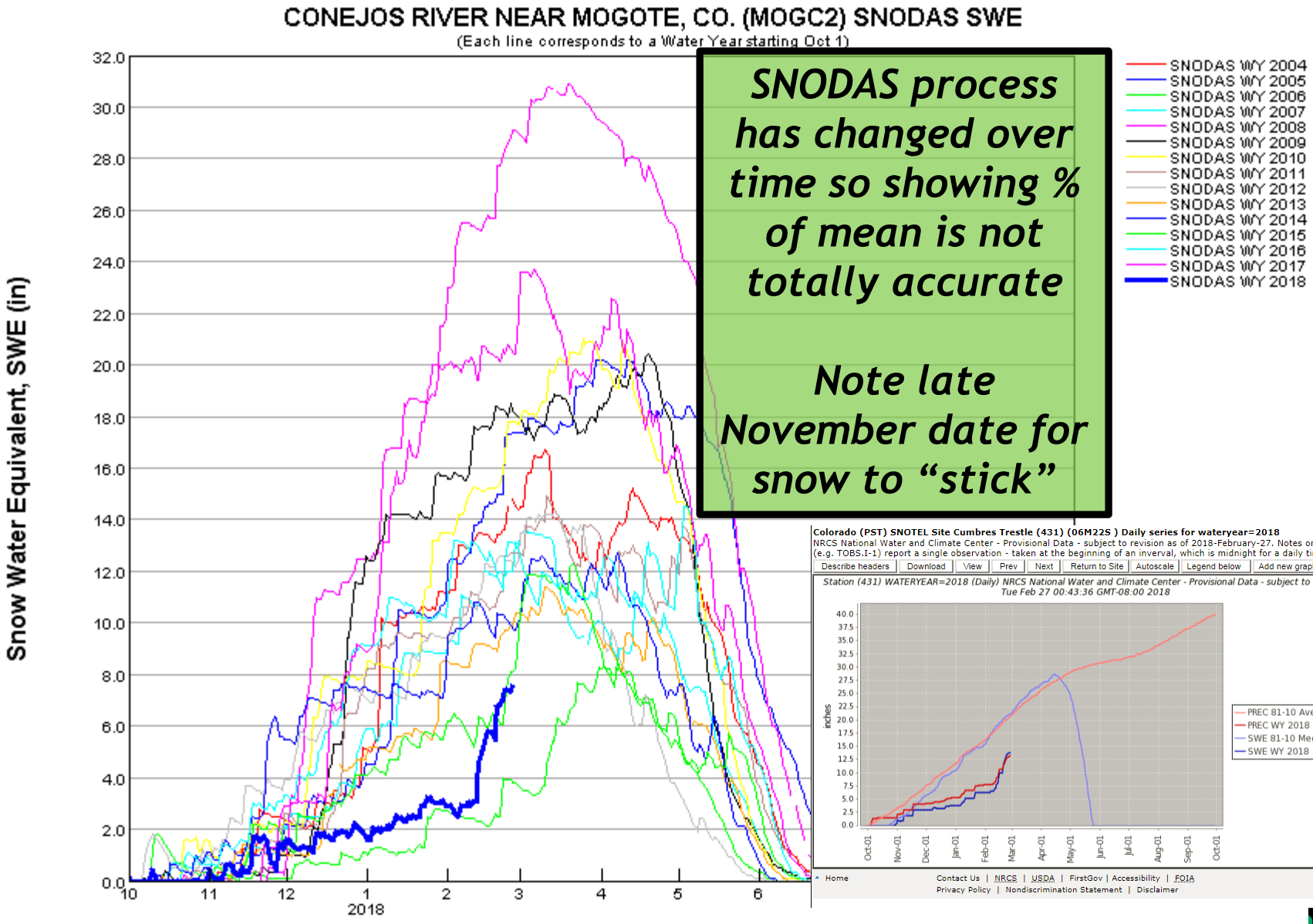
Interactive map shows Colorado water supply basins.

Snow Cover (Percent)

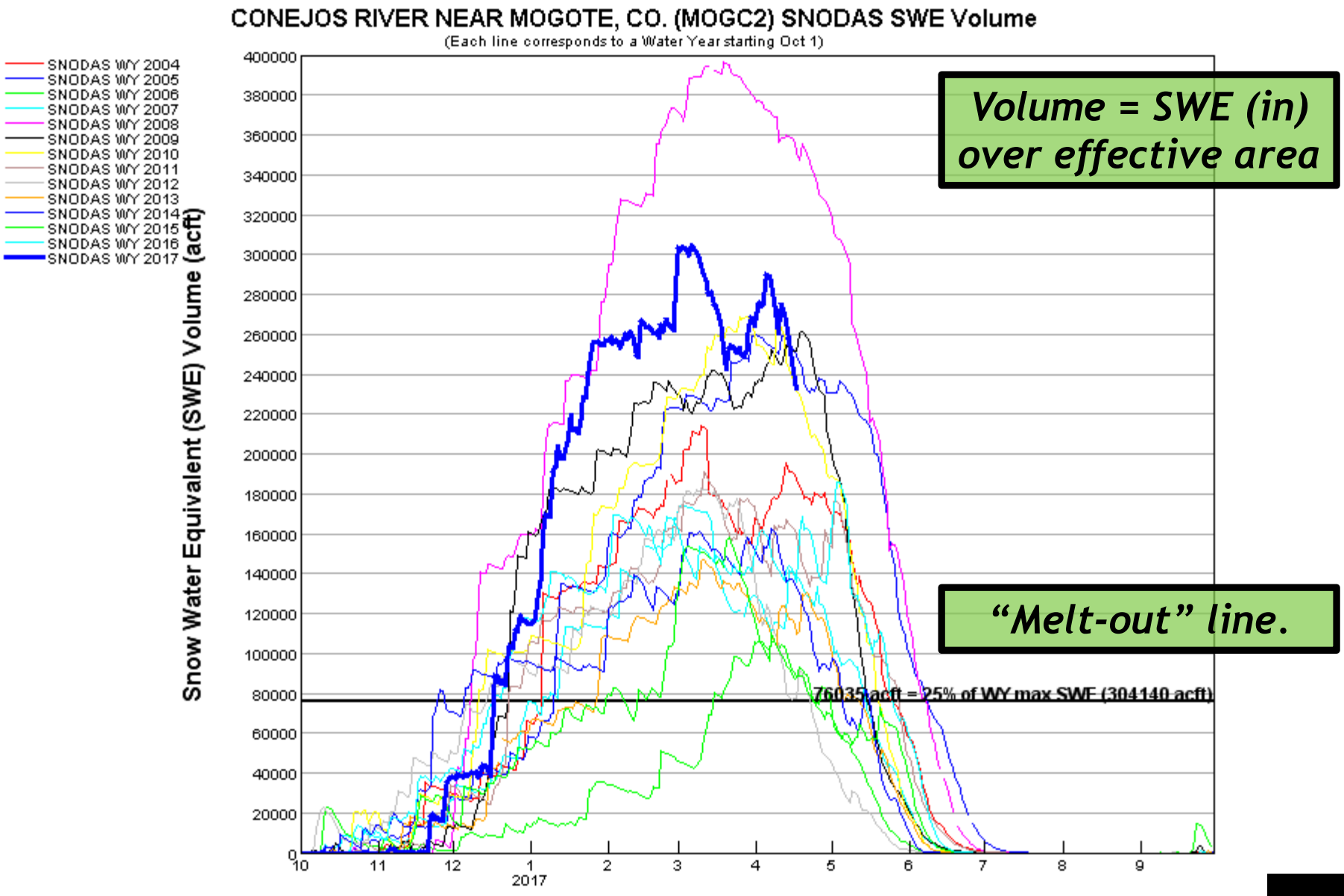


Useful for understanding late-season snowpack conditions

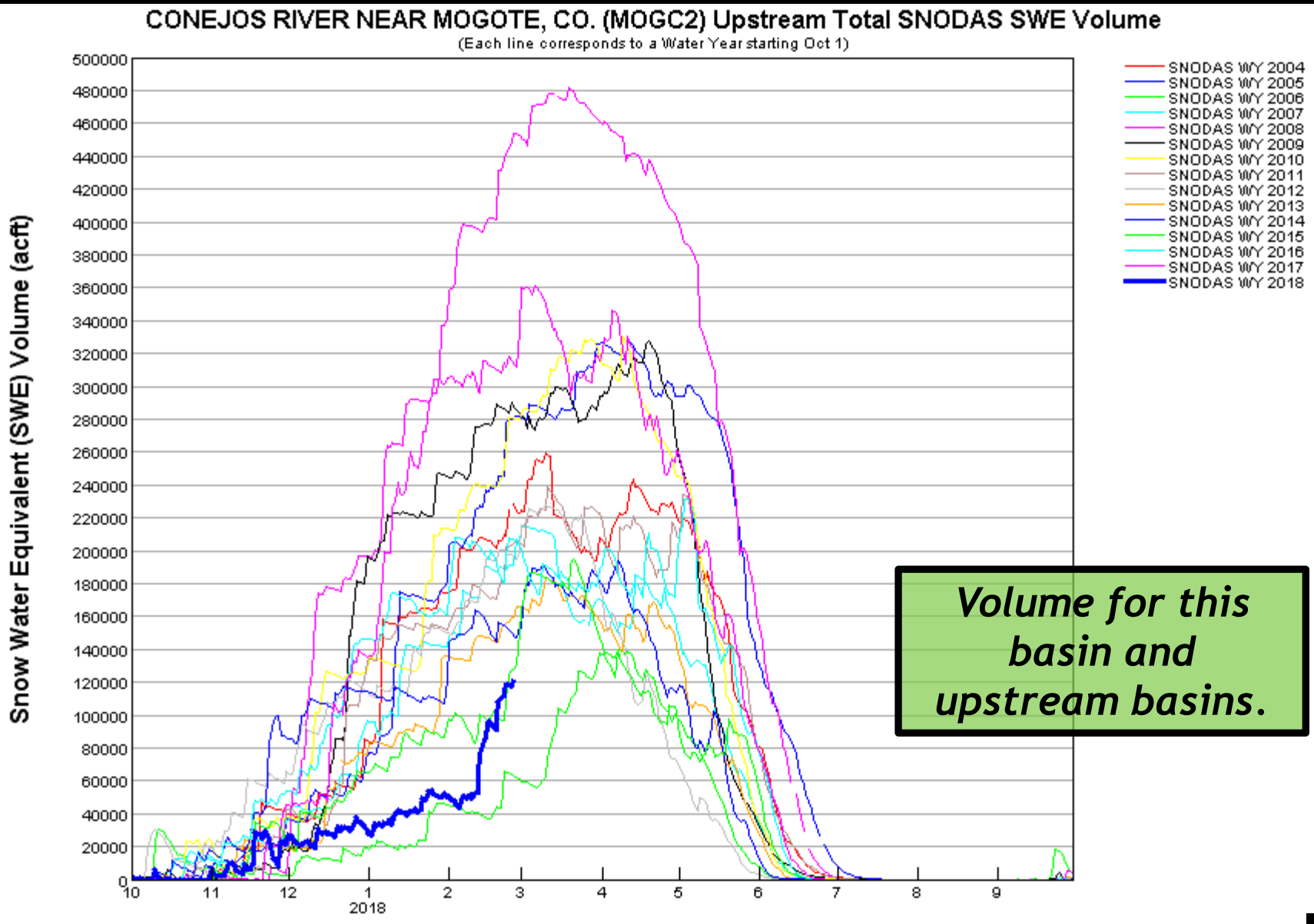
SNODAS Snow Water Equivalent



SNODAS SWE Volume

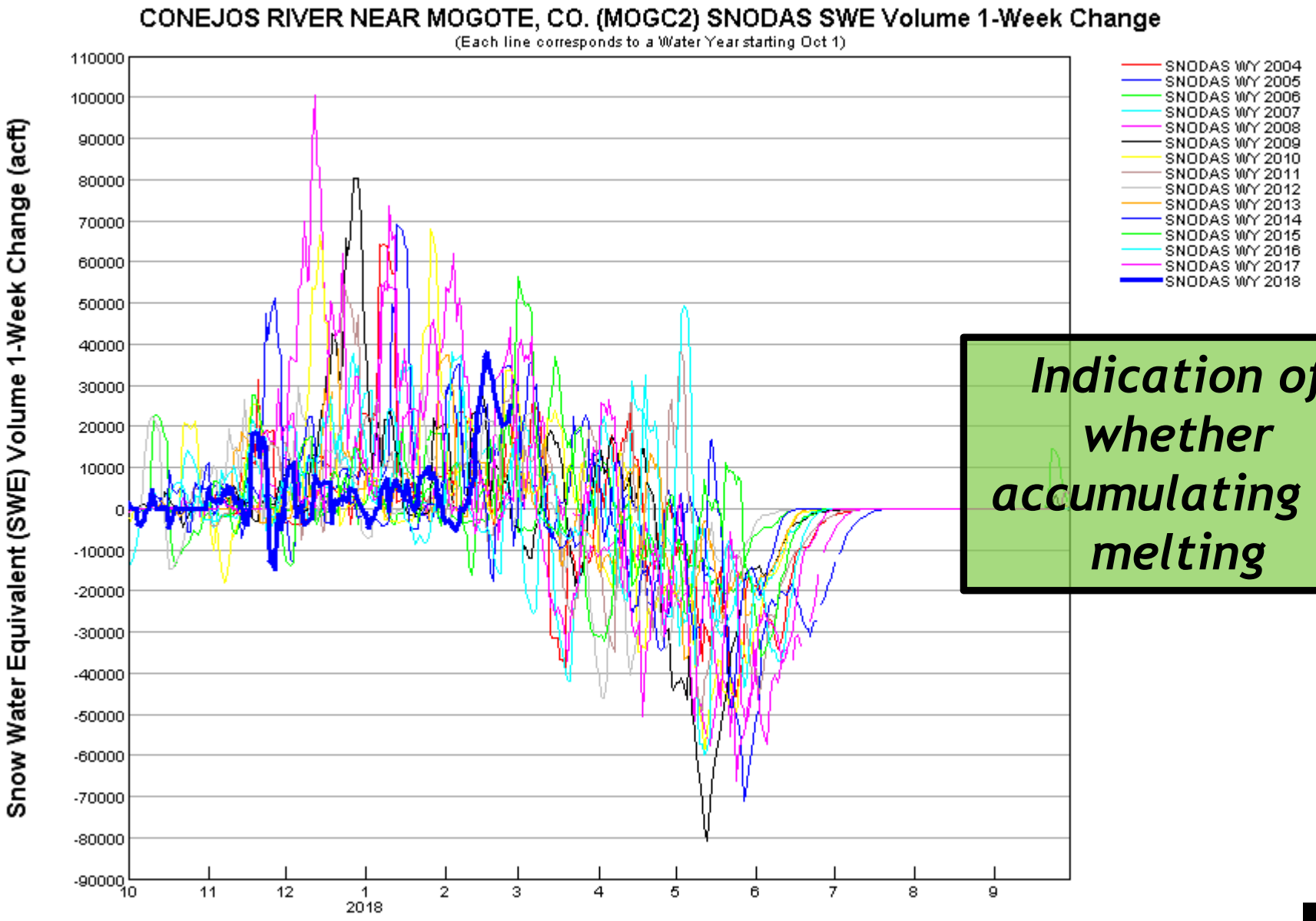


SNODAS Total Upstream SWE Volume



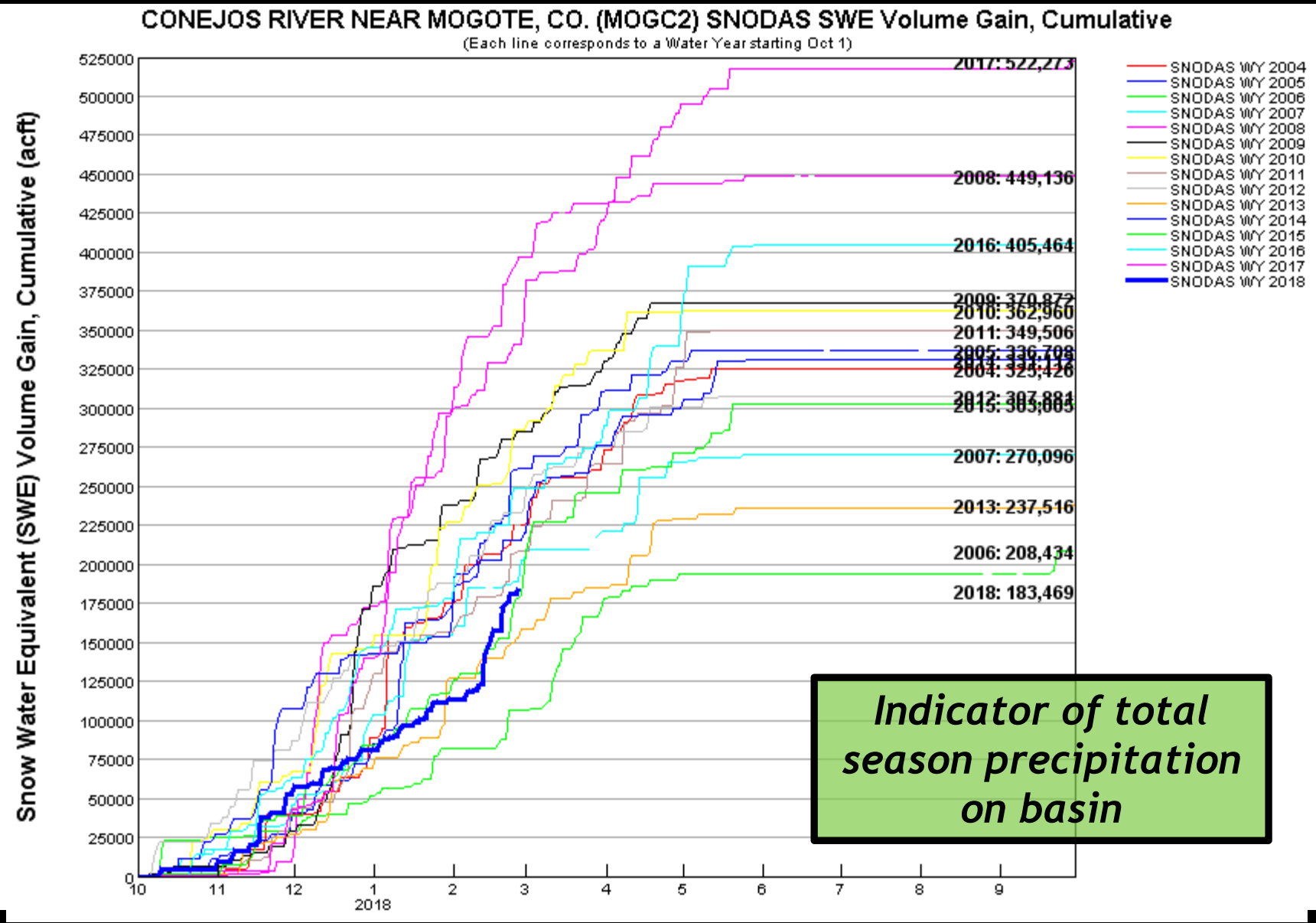
Volume for this basin and upstream basins.

SNODAS SWE Volume 1-Week Change



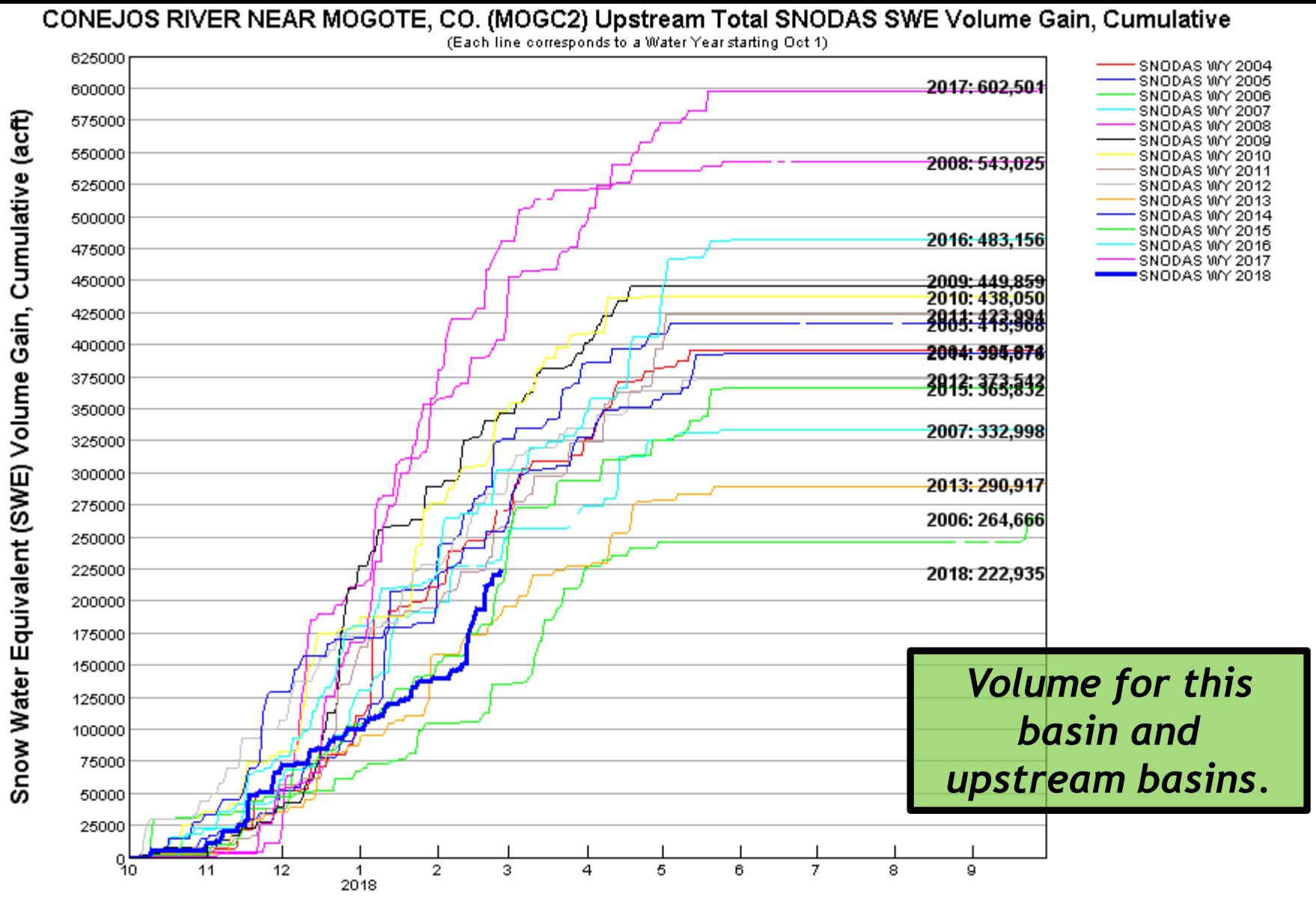
Indication of whether accumulating or melting

SNODAS SWE Volume Gain, Cumulative



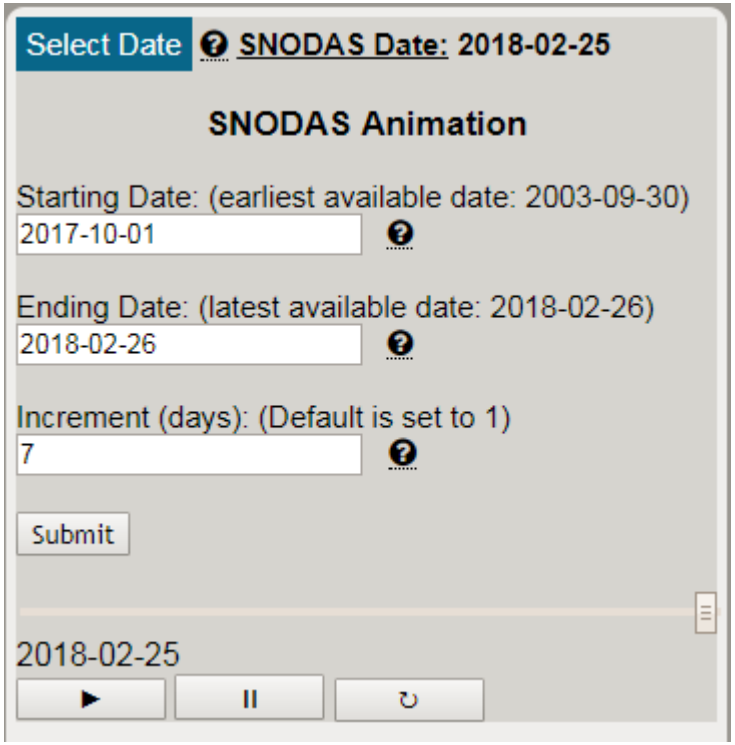
Indicator of total season precipitation on basin

SNODAS SWE Upstream Total Volume Gain, Cumulative



Volume for this basin and upstream basins.

Daily SWE Map Animation



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

"Gapminder"

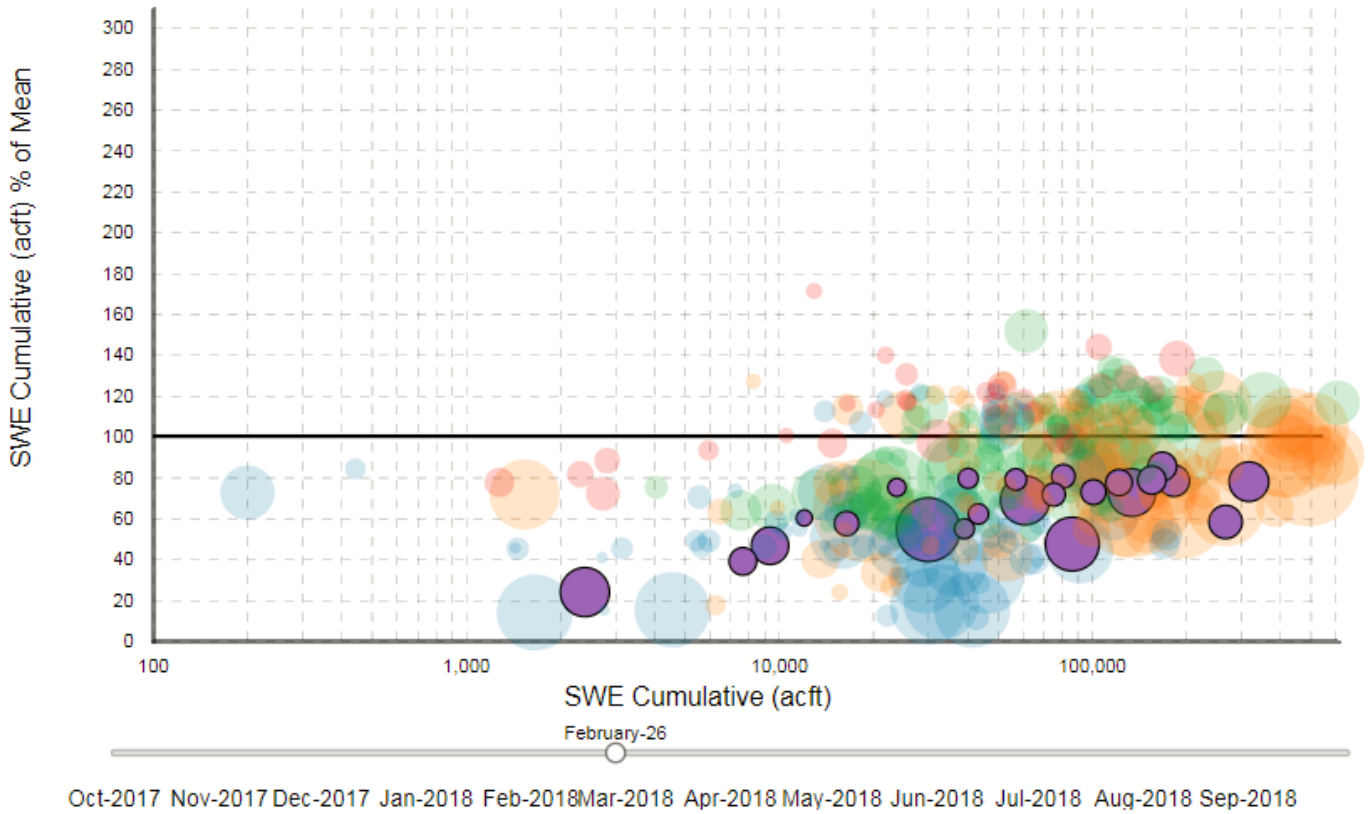
viz.openwaterfoundation.org/co/owf-viz-co-snodas-gapminder/

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_I

Turn Tracer On

Turn Annotations Off

Water Year: 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

open data | open software | open decisions
openwaterfoundation.org