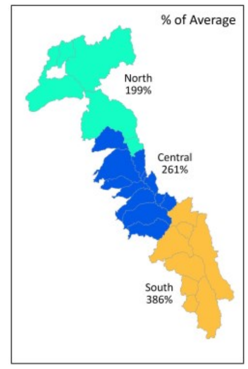
Real-Time Spatial Estimates of Snow-Water Equivalent (SWE)

Sierra Nevada Mountains, California

April 15, 2023



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Summary of current conditions

The regional summary map above shows the mean SWE above 5000’ elevation for three major regions of the Sierra Nevada, percent of average is calculated from a long-term average of 2001-2021. As of April 1, percent of average SWE is highest in the south (386%), then central (261%) and lowest in the north (199%). This snow year has produced sporadic percent of averages, especially in low-elevation areas, and will be higher than historical averages. **NEW this year, scroll down for comparison maps of CU SWE versus ASO SWE**. Detailed SWE maps (in JPG format) and summaries of SWE (in Excel format) by individual basin and elevation band accompany the report and are publicly available on our website **[here](#)**.

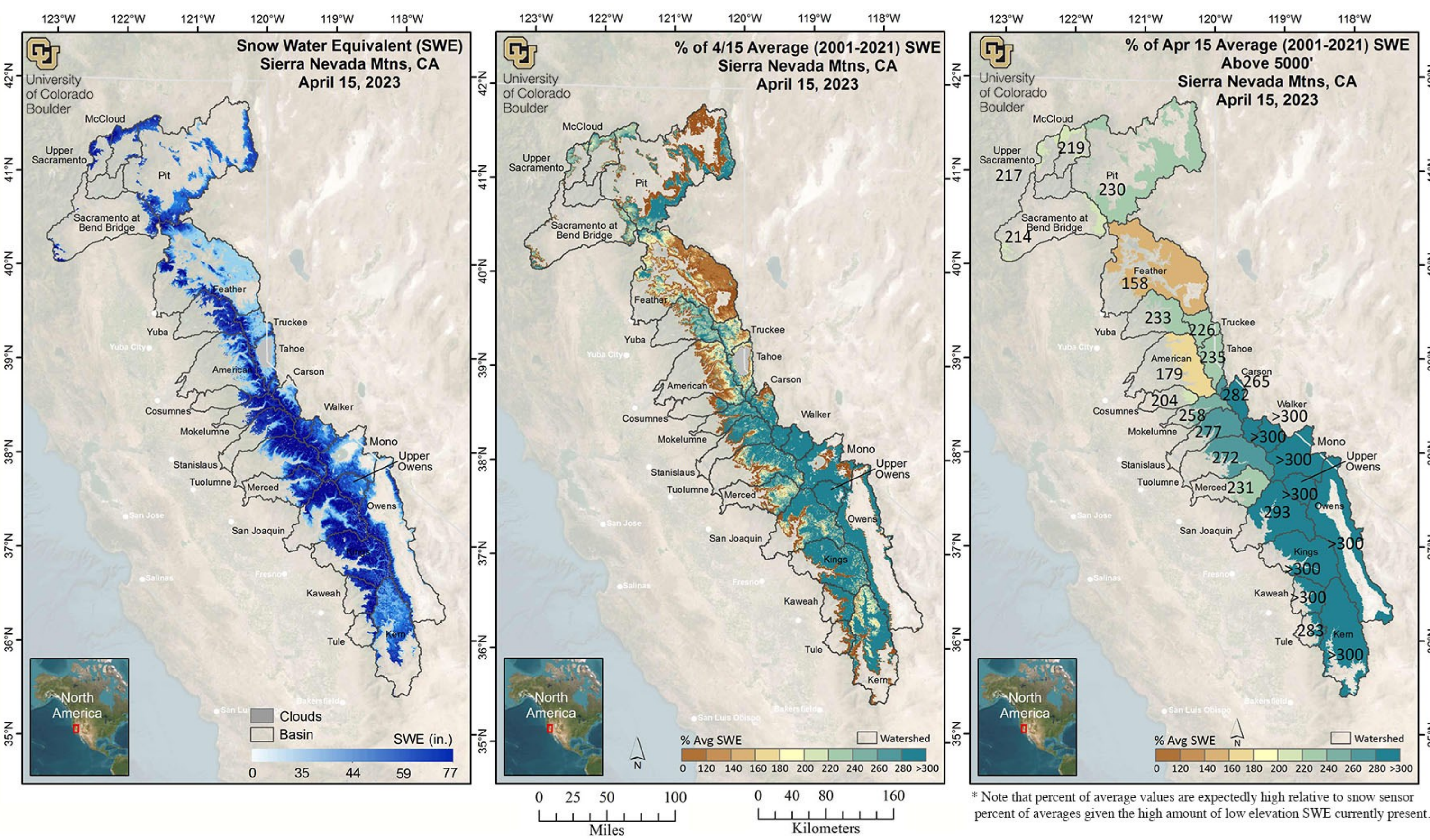

Figure 1. Estimated SWE and % of Average SWE across the Sierra Nevada. SWE amounts for April 15, 2023 (left), and percent of average (2001-2021) SWE for April 15, 2023 for the Sierra Nevada, calculated for each pixel (middle) and basin-wide (right). Basin-wide percent of average is calculated across all model pixels >5000’ elevation.

Location of Reports and Excel Format Tables

https://www.colorado.edu/instaar/research/labs-groups/mountain-hydrology-group/sierra-nevada-swe-reports

About this report

This is an experimental research product that provides near-real-time estimates of snow-water equivalent (SWE) at a spatial resolution of 500 m for the Sierra Nevada in California from mid-winter through the melt season. The report is typically released within a week of the date of data acquisition at the top of the report. A similar report covering the Intermountain West is available and is distributed to water managers in Colorado, Utah and Wyoming.

The spatial SWE analysis method for the Sierra Nevada uses the following data as inputs:

- In-situ SWE from all operational CA and NV snow pillow sensor sites and CoCoRaHS SWE values when available and applicable
- MODSCAG fractional snow-covered area (fSCA) data from recent cloud-free MODIS satellite images
- Physiographic information (elevation, latitude, upwind mountain barriers, slope, etc.)
- Historical daily SWE patterns (1985-2016) retrospectively generated using historical MODSCAG data and an energy-balance model that back-calculates SWE given the fSCA time-series and meltout date for each pixel.
- Satellite-observed daily mean fractional snow-covered area (DMFSCA).

For more details on the estimation method see the *Methods* section below. Please be sure to read the *Data Issues / Caveats* section for a discussion of persistent challenges or flagged uncertainties of the SWE product.

Data availability for this report

93 snow pillow sites in the Sierra Nevada network were recording SWE values out of a total of 128 sites, 35 were offline, and we used 13 CoCoRaHS measurements (shown in black, red and green, respectively, in Figure 5, left map).

The value of spatially explicit estimates of SWE

Snowmelt makes up the large majority (~60-85%) of the annual streamflow in the Sierra Nevada. The spatial distribution of snow-water equivalent (SWE) across the landscape is complex. While broad aspects of this spatial pattern (e.g., more SWE at higher elevations and on north-facing exposures) are fairly consistent, the details vary a lot from year to year, influencing the magnitude and timing of snowmelt-driven runoff.

SWE is operationally monitored at over a hundred and thirty snow pillow sensor sites spread across the Sierra Nevada, providing a critical first-order snapshot of conditions, and the basis for runoff forecasts from the CA DWR, NRCS, and NOAA. However, conditions at snow pillow sites (e.g., percent of normal SWE) may not be representative of conditions in the large areas between these point measurements, and at elevations above and below the range of the sensor sites. The spatial snow analysis creates a detailed picture of the spatial pattern of SWE using snow sensors, satellite, and other data, extending beyond the snow sensor sites to unmonitored areas.

Interpreting the spatial SWE estimates in the context of snow pillows

The spatial product estimates SWE for every pixel where the MODSCAG product identifies snow-cover. Comparatively, snow sensor samples 8-20 points per basin within a narrower elevation range. Thus, the basin-wide percent of average from the spatial SWE estimates is not directly comparable with the snow sensor basin-wide percent of average. A better comparison might be made with the % of average in the elevation bands (Table 2) that contain snow sensor sites.

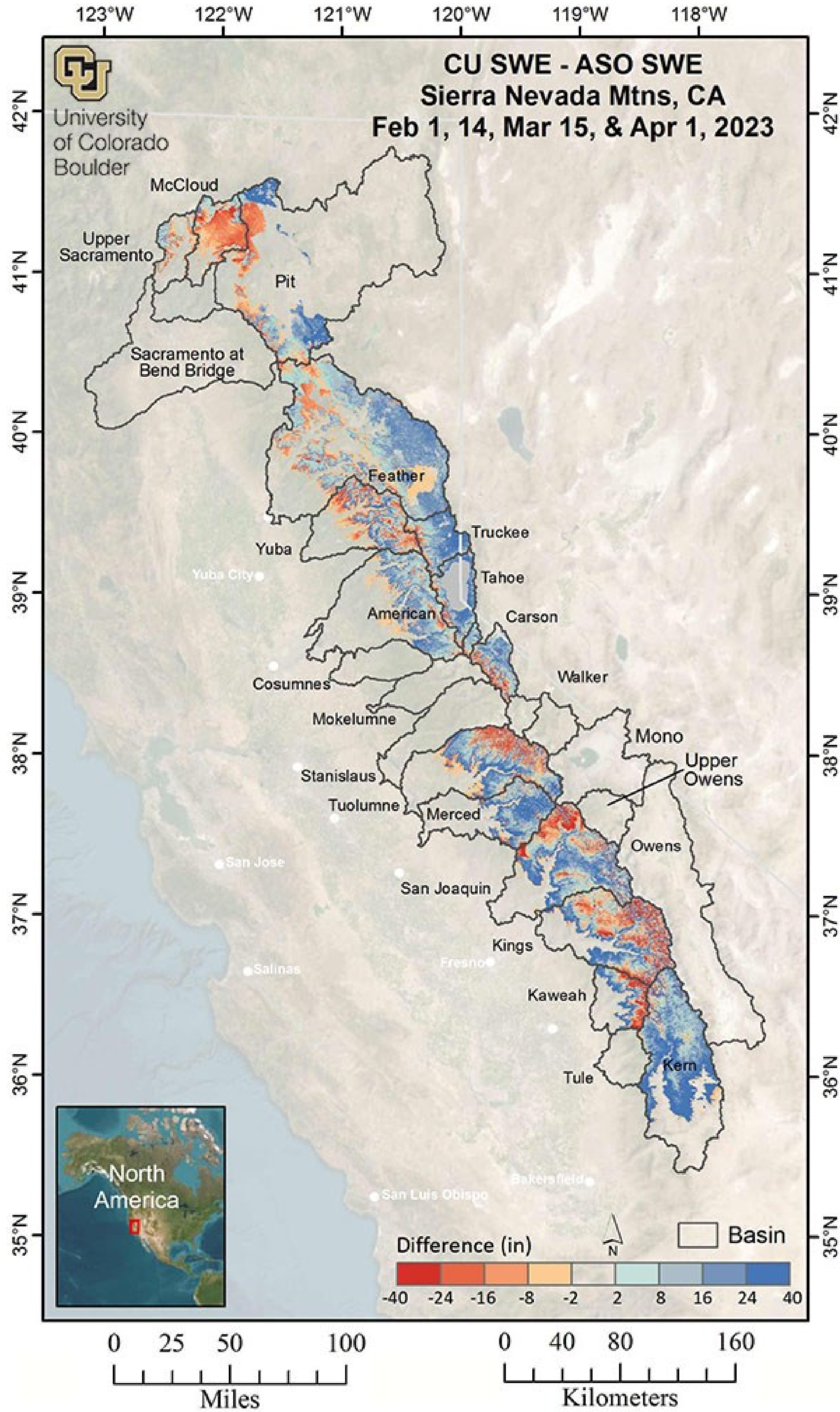

Figure 2. Comparison to ASO, Sierra Nevada. The difference in SWE amounts between the February 1, February 14, March 1, April 1, and April 15, 2023 CU SWE model run and Airborne Snow Observatories (ASO) lidar-derived SWE are shown for available basins. Red colors show where CU SWE is lower than ASO SWE and blue colors show where CU SWE is higher than ASO SWE. The CU SWE model runs are only for areas above 5000', so any snow imaged by ASO below 5000' will show up as light red colors. This map will be updated as new ASO data becomes available.

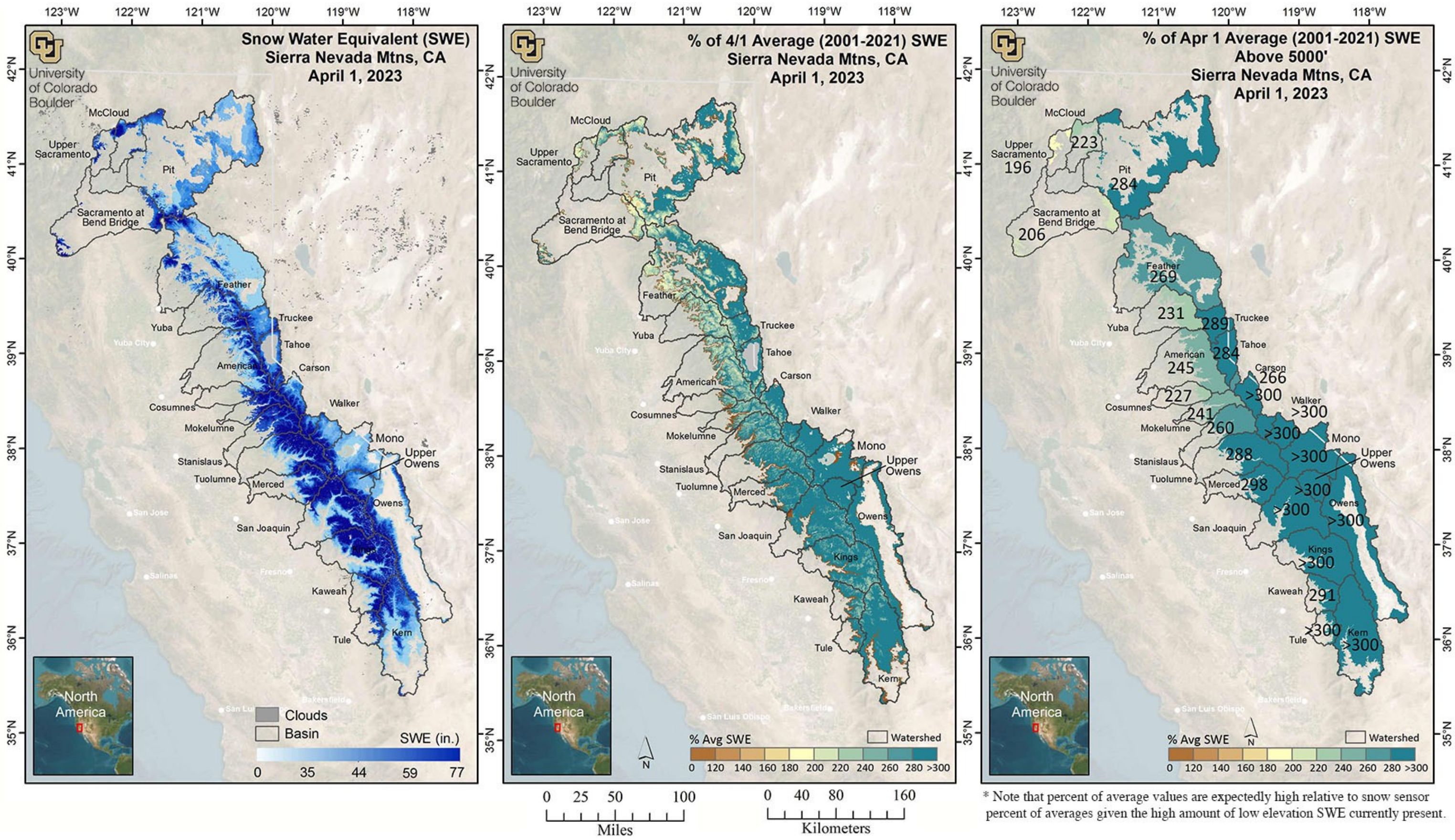

Figure 3. Estimated SWE and % of Average SWE across the Sierra Nevada. SWE amounts for April 1, 2023 (left), and percent of average (2001-2021) SWE for April 1, 2023 for the Sierra Nevada, calculated for each pixel (middle) and basin-wide (right). Basin-wide percent of average is calculated across all model pixels >5000' elevation.

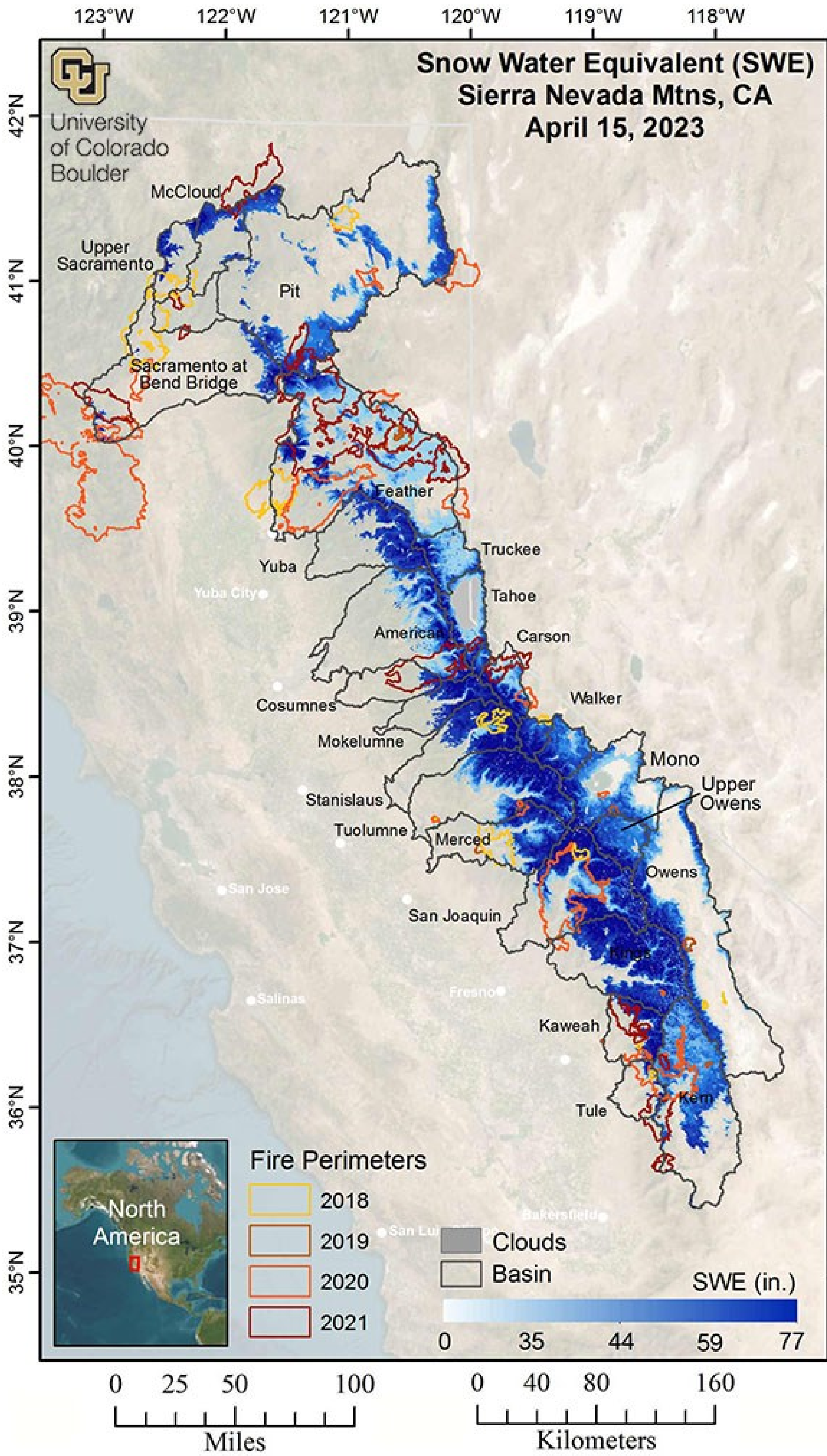

Figure 4. Estimated SWE with Fire Perimeters, Sierra Nevada. SWE amounts for April 15, 2023 are shown with fire perimeters from 2018-2021 (colored from yellow to red).

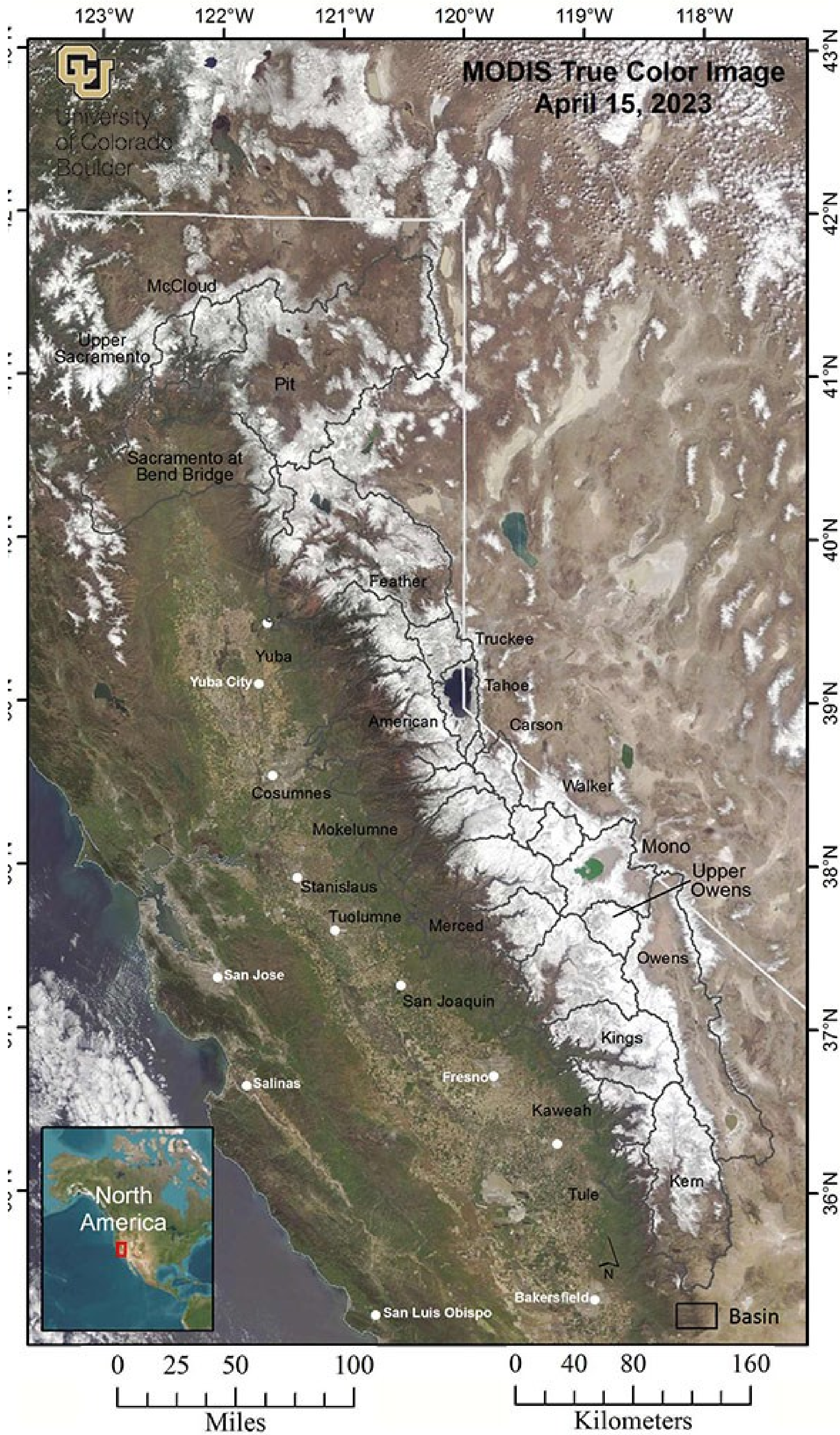

Figure 5. MODIS image, Sierra Nevada. A mostly cloud-free true color MODIS image, showing the image that used for the April 15, 2023 regression model run.

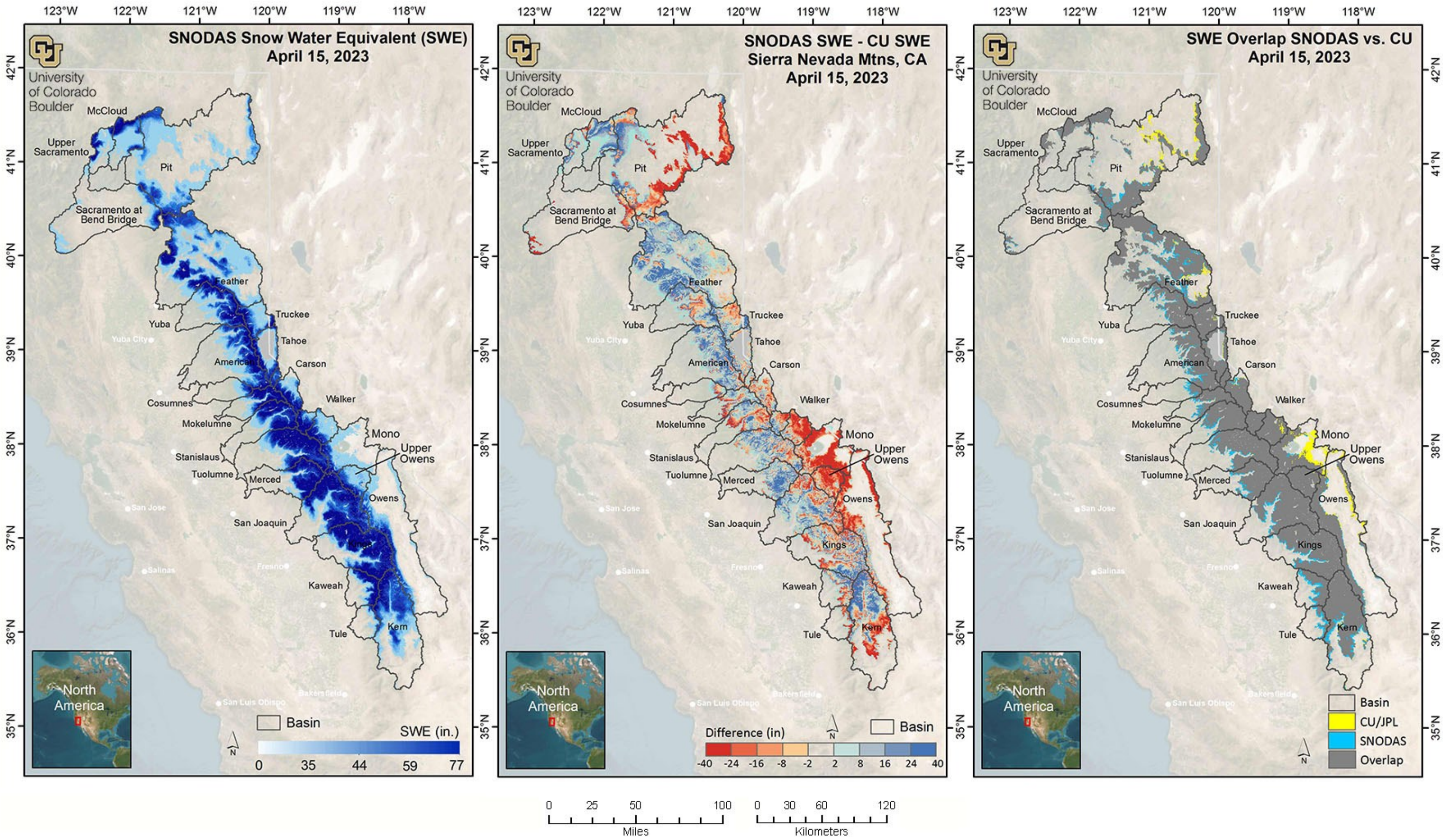

Figure 6. Comparison of CU regression SWE product and SNODAS SWE for the Sierra Nevada. The map on the left shows estimated SWE for April 15th from the NOAA National Weather Service's National Operational Hydrologic Remote Sensing Center (NOHRSC) SNOw Data Assimilation System (SNODAS). The middle map shows the difference between the April 15th SNODAS SWE estimate and CU regression SWE estimate. Red pixels denote areas where SNODAS SWE is less than CU SWE and blue pixels show areas where SNODAS SWE is higher than CU SWE. Light blue areas in low elevations are below 5000' where the CU SWE model doesn't calculate SWE estimates. The map on the right shows the snow-cover extent of SNODAS and CU SWE estimates. Yellow pixels show where the location of CU snow extends beyond the location of the SNODAS snow extent. Blue pixels show where the SNODAS snow extends beyond the CU snow extent. Gray areas indicate regions where both products agree on the snow-cover extent.

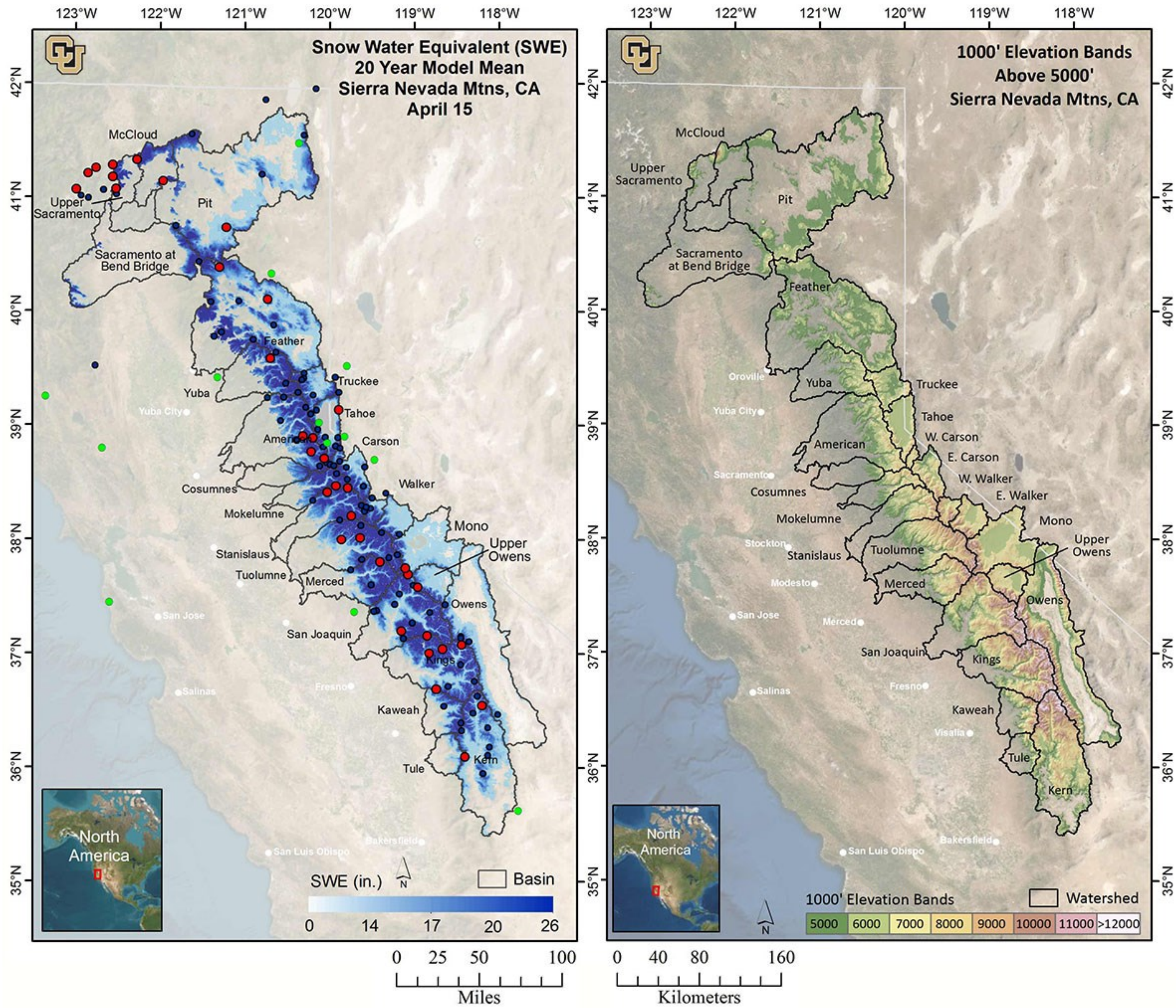

Figure 7. Historical average April 15th and Elevation Bands for the Sierra Nevada. Average SWE (2001-2021) for April 15th (left), and the Banded Elevation map (right) identifies basins used in this report (black boundaries) and 1000' elevation bands (colored shading) that match those used in Table 1 and Table 2. Map on left shows snow pillow sensor sites recording SWE on April 15th (black), sites that were offline are shown in red, and CoCoRaHS sites are shown in green. Note the average SWE map is using a different color ramp than the April 1 modeled SWE map shown in Figure 1.

Methods

The spatial SWE estimation method is described in Yang, et al. (2022) and Schneider and Molotch (2016). The method uses linear regression in which the dependent variable is derived from the operationally measured in situ SWE from all online snow pillow sensor sites in the domain. The snow pillow sensor SWE observations are scaled by the fractional snow-covered area (fSCA) across the 500 m pixel containing that snow pillow sensor site before being used in the linear regression model. The fSCA is a combination of a near-real-time cloud-free MODIS satellite image which has been processed using the MODIS Snow Cover and Grain size (MODSCAG) fractional snow-covered area algorithm program (Painter, et al. 2009) and the Snow Today fSCA image when necessary (Rittger, et al. 2019, https://nsidc.org/snow-today).

The following independent variables (predictors) enter into the linear regression model:

- Physiographic variables that affect snow accumulation, melt, and redistribution, including elevation, latitude, upwind mountain barriers, slope, and others. See Table 1 in Yang, et al. (2022) for the full set of these variables.
- The historical daily SWE pattern (1985-2016) retrospectively generated using historical MODSCAG data, and an energy-balance model that back-calculates SWE given the fractional Snow-Covered Area (fSCA) time series and meltout date for

each pixel. See Margulis, et al. (2016) for details. (For computational efficiency, only one image during the 1985-2016 period that best matches the real-time snow pillow-observed pattern is selected as an independent variable.)
- Satellite-observed daily mean fractional snow-covered area (DMFSCA) derived from Rittger, et. al., 2019 data.

The real-time regression model for this date has been validated by cross-validation, whereby 10% of the snow pillow data are randomly removed and the model prediction is compared to the measured value at the removed snow pillow stations. This is repeated 30 times to obtain an average R-squared value, which denotes how closely the model fits the snow pillow data. During development of this regression method, the model was also validated against independent historical SWE data collected in snow surveys at 9 locations in Colorado, and an intensive field survey in north-central Colorado. Data utilized to generate this report change to optimize model performance. To maintain consistency across the historical record, the percent of average values are based on our baseline algorithm and therefore there can be discrepancies between absolute SWE values and corresponding percent of averages.

Data Issues/Caveats for* April 15, 2023 *– IMPORTANT – READ THIS!

- ANOMALOUS SNOW PATTERNS – Anomalous snow years or snow distributions may cause SWE error due to the model design to search for similar SWE distributions from previous years. If no close seasonal analogue exists, the model is forced to find the most similar year, which may result in error.
- PERCENT OF AVERAGE CALCULATIONS - Data utilized to generate this report change to optimize model performance. To maintain consistency across the historical record, the percent of average values are based on our baseline algorithm and therefore there can be discrepancies between absolute SWE values and corresponding percent of averages.
- MODELING METHODS - We work to generate the best SWE estimates for each reporting date. Our methods can change from one report to another. Sometimes data changes between reports is an artifact of method changes.
- LIMITED SNOW PILLOW DATA – When snow at the snow pillow sites melts out, but remains at higher elevations, the model tends to underestimate SWE at the under-monitored upper elevations. This issue typically occurs late in the melt season, resulting in less accurate SWE prediction at higher elevations compared to earlier in the snow season.

List of All Known Data Issues/Caveats

- NEW AVERAGE CALCULATIONS – Average calculations are based on 2001-2021 model values, this includes the drought years (2012-2016) which brings our overall average SWE down considerably, thereby increasing percent of averages.
- RECENT SNOWFALL – There are occasionally problems with lower-elevation SWE estimates due to recent snowfall events that result in extensive snow-cover extending to valley locations where measurements are not available. This scenario results in an over-estimation of lower- elevation SWE.
- LIMITED SNOW PILLOW DATA – When snow at the snow pillow sites melts out, but remains at higher elevations, the model tends to underestimate SWE at the under-monitored upper elevations. This issue typically occurs late in the melt season, resulting in less accurate SWE prediction at higher elevations compared to earlier in the snow season.
- CLOUD COVER – Cloud cover can obscure satellite measurements of snow-cover. While careful checks are made, occasionally the misclassification of clouds as snow or *vice versa* may result in the mischaracterization of SWE or bare-ground.
- LOW LOOK ANGLE – When a satellite does not pass directly over a region but the area is still included within the satellite sensor's field of view, this is referred to as a low "look angle". The resulting image has lower effective resolution – this "blurry" MODSCAG data still contains useful information but may lead to overestimation of SWE near the margins of the snow-cover extent.
- POOR QUALITY SNOW SENSOR DATA – Although data QA/QC is performed, occasional sensor malfunction may result in localized SWE errors.
- ANOMALOUS SNOW PATTERNS – Anomalous snow years or snow distributions may cause SWE error due to the model design to search for similar SWE distributions from previous years. If no close seasonal analogue exists, the model is forced to find the most similar year, which may result in error.
- DENSE FOREST COVER – Dense forest cover at lower elevations where snow-cover is discontinuous can cause the satellite to underestimate the snow-cover extent, leading to underestimation of SWE.
- MISSING SWE VALUES - Volume calculations for the Kings, Kaweah, Kern, and Tule basins are based on place-holder values for SWE in the lower elevations. Place-holder values are based on average SWE accumulation values at higher elevations where we have higher confidence in the SWE estimates.
- PERCENT OF AVERAGE CALCULATIONS - Data utilized to generate this report change to optimize model performance. To maintain consistency across the historical record, the percent of average values are based on our baseline algorithm and therefore there can be discrepancies between absolute SWE values and corresponding percent of averages.
- MODELING METHODS - We work to generate the best SWE estimates for each reporting date. Our methods can change from one report to another. Sometimes data changes between reports is an artifact of method changes.

Table 1. Estimated SWE by basin. *The basin-wide SWE values and averages, are across all pixels at elevations >5000'. Shown are April 1st percent of April 1st average SWE, April 15th percent of April 15th average SWE (between 2001-2021 as derived from the regression model), April 1st mean SWE, April 15th mean SWE, April 15th percent of snow-covered area, April 15th water volume (acre-feet), the area (mi^2) inside each basin that contains data pixels (not including cloud-covered pixels, lakes or other satellite no data pixels), April 1st snow pillow data, and April 15th snow pillow data for those areas collected, summarized for each basin. The last column shows April 15th mean SWE from SNODAS*.*

Basin	4/1/23 % 4/1 Avg.	4/15/23 % 4/15 Avg.	4/1/23 SWE (in)	4/15/23 SWE (in)	4/15/23 % SCA	4/15/23‡ Vol (af)	Area (mi2) > 5000'	4/1/23 Pillows	4/15/23 Pillows	4/15/23 SNODAS* (in)
Upper Sacramento§	196	217	52.1	56.5	97.9	385,183	127.8	73.6 (1)	83.2 (1)	60.1
McCloud§	223	219	60.2	54.5	97.7	517,835	178.2	NA	NA	65.0
Pit§	>250†	230	30.6	26.4	65.2	3,227,545	2288.8	40.9 (4)	40.2 (4)	15.9
Sac at Bend Bridge	206	214	57.0	47.8	89.4	653,866	256.7	NA	NA	34.3
Feather§	>250†	158	27.0	24.2	80.4	2,934,117	2,271.2	68.5 (5)	67.5 (5)	32.6
Yuba§	231	233	46.5	52.7	92.2	1,561,706	555.5	81.6 (3)	82.8 (3)	58.8
American§	245	179	40.0	37.5	90.0	1,702,291	851.6	52.8 (8)	51.9 (9)	49.6
Cosumnes	227	204	43.4	38.0	70.1	191,112	94.4	NA	NA	38.2
Mokelumne	241	258	60.3	55.6	88.7	999,117	336.8	72.8 (1)	73.2 (1)	56.5
Stanislaus	>250†	277	61.1	58.3	90.2	1,837,735	591.5	73.2 (4)	73.7 (3)	57.9
Tuolumne§	>250†	272	60.0	55.5	90.6	2,842,516	961.1	74.2 (5)	72.2 (5)	61.0
Merced§	>250†	231	51.5	47.1	89.6	1,421,835	565.8	72.3 (3)	69.6 (2)	59.0
San Joaquin§	>250†	293	59.5	55.5	91.4	3,765,169	1,272.7	70.8 (8)	69.2 (8)	57.5
Kings§	>250†	>300†	58.2	61.1	92.7	4,107,790	1,260.1	72.3 (2)	77.9 (3)	62.1
Kaweah§	>250†	>300†	48.5	51.6	75.7	895,174	325.2	83.5 (1)	56.3 (2)	54.4
Tule	>250†	283	47.1	29.2	46.5	222,399	142.6	NA	NA	22.7
Kern§	>250†	>300†	26.8	27.7	64.3	2,573,809	1,745.3	49.4 (5)	56.0 (7)	28.5
Truckee	>250†	226	45.5	36.9	96.5	885,769	450.0	44.1 (5)	42.1 (5)	38.9
Tahoe	>250†	235	52.2	42.1	93.0	751,040	334.7	57.0 (7)	54.7 (6)	44.5
W Carson	>250†	265	58.6	53.5	98.3	200,147	70.2	65.1 (2)	65.3 (2)	52.5
E Carson	>250†	282	46.5	41.2	79.6	839,056	382.0	54.3 (5)	50.2 (5)	37.7
W Walker	>250†	>300†	60.4	63.2	96.7	645,104	191.4	68.4 (3)	67.2 (3)	61.3
E Walker	>250†	>300†	43.5	49.4	96.1	993,974	377.6	53.8 (1)	54.8 (1)	31.5
Mono	>250†	>300†	28.8	27.7	69.7	1,579,975	1,068.4	NA	NA	11.8
Upper Owens	>250†	>300†	44.6	51.5	97.6	1,092,158	397.6	NA	NA	31.8
Owens	>250†	>300†	23.1	20.9	42.6	2,070,828	1,854.0	50.2 (5)	49.7 (5)	12.5

§ Data in all ASO-collected basins have been bias-corrected using ASO data and therefore the SWE changes might not represent snowmelt but rather an update to the SWE estimates based on airborne data.

† Deep, and particularly low-elevation snow in areas that typically are snow-free can report exceptionally high percent of average for this date because the mean 2001-2021 regression-derived SWE for that area is low or 0.

‡ For volume totals above Shasta Lake add Upper Sac, McCloud and Pit volumes. For volume totals above Bend Bridge add Upper Sac, McCloud, Pit and Sac at Bend Bridge volumes.

* This is a comparison to the SNODAS (SNOw Data Assimilation System) nationwide product from the National Weather Service.

Table 2. Estimated SWE by basin and elevation band. *The basin-wide SWE values and averages, are across all pixels at elevations >5000'. Elevation bands begin at 5000' and extend past the highest point in the basin. Note that the area of the highest 2-5 bands is typically much smaller than the lower bands. Shown are April 1st percent of April 1st average SWE, April 15th percent of April 15th average SWE (between 2001-2021 as derived from the regression model), April 1st mean SWE, April 15th mean SWE, April 15th percent of snow-covered area, April 15th water volume (acre-feet), the area (mi^2) inside each basin that contains data pixels (not including cloud-covered pixels, lakes or other satellite no data pixels), April 1st snow pillow data, and April 15th snow pillow data for those areas collected, summarized for each 1000' elevation band inside each basin. The last column shows April 15th mean SWE from SNODAS*.*

Basin	Elevation Band	4/1/23 % 4/1 Avg.	4/15/23 % 4/15 Avg.	4/1/23 SWE (in)	4/15/23 SWE (in)	4/15/23 % SCA	4/15/23‡ Vol (af)	4/15/23 Area (mi2)	4/1/23 Pillows	4/15/23 Pillows	4/15/23 SNODAS* (in)
Upper Sacramento§	5000-6000'	211	226	44.8	51.8	96.3	200,413	72.5	73.6 (1)	83.2 (1)	54.4
	6000-7000'	191	219	56.6	61.2	100.0	126,173	38.6	NA	NA	69.8
	7000-8000'	176	195	68.2	60.8	100.0	29,402	9.1	NA	NA	63.7
	8000-9000'	153	181	80.4	65.7	100.0	10,755	3.1	NA	NA	64.7
	9000-10,000'	151	201	83.4	83.4	99.7	9,310	2.1	NA	NA	63.5
	10,000-11,000'	152	185	86.4	86.4	100.0	5,787	1.3	NA	NA	56.7
	> 11,000'	105	118	52.9	52.9	97.6	3,344	1.2	NA	NA	48.2
McCloud§	5000-6000'	237	226	46.4	47.9	96.3	270,852	105.9	NA	NA	58.6
	6000-7000'	214	218	65.3	56.4	100.0	131,429	43.7	NA	NA	76.0
	7000-8000'	219	213	106.6	64.7	100.0	49,098	14.2	NA	NA	73.2
	8000-9000'	214	235	103.7	79.8	99.8	28,776	6.8	NA	NA	75.4
	>9,000'	194	265	98.0	98.0	99.8	16,411	3.1	NA	NA	72.5
Pit§	5000-6000'	>300†	224	27.4	18.3	50.7	1,535,340	1,569.2	63.7 (1)	64.9 (1)	10.1
	6000-7000'	210	244	34.6	41.7	96.2	1,237,273	556.9	35.6 (2)	34.4 (2)	25.7
	7000-8000'	192	232	45.6	51.2	99.0	381,389	139.6	28.6 (1)	27.1 (1)	39.6
	>8,000'	191	229	56.5	57.6	98.9	65,585	21.3	NA	NA	35.5
Sac at Bend Bridge	5000-6000'	214	213	50.1	40.8	85.3	369,075	169.8	NA	NA	26.8
	6000-7000'	199	219	64.4	57.8	96.8	201,094	65.3	NA	NA	44.9
	>7,000'	194	210	86.1	69.2	99.4	60,768	16.5	NA	NA	60.7
Feather§	5000-6000'	296	136	22.7	17.9	72.5	1,294,513	1,355.8	78.5 (1)	76.8 (1)	28.8
	6000-7000'	245	174	31.2	31.3	91.0	1,313,137	786.2	70.7 (3)	70.9 (3)	36.6
	7000-8000'	211	204	46.0	47.0	98.3	312,548	124.7	52.0 (1)	48.1 (1)	48.8
	8000-9000'	192	211	57.4	58.5	100.0	13,919	4.5	NA	NA	51.2
Yuba§	5000-6000'	237	205	32.3	38.1	80.6	414,866	204.1	NA	NA	41.7
	6000-7000'	234	248	47.6	57.8	98.5	707,066	229.4	68.9 (2)	67.9 (2)	61.6
	7000-8000'	220	243	67.7	67.2	99.8	421,430	117.6	106.9 (1)	112.7 (1)	81.3
	8000-9000'	207	238	81.4	77.1	99.7	18,344	4.5	NA	NA	97.2
American§	5000-6000'	257	100	19.6	15.8	75.5	265,049	313.6	37.0 (3)	31.7 (3)	28.6
	6000-7000'	245	173	36.1	37.0	97.8	554,672	281.3	55.0 (1)	54.1 (1)	50.4
	7000-8000'	239	229	60.3	58.1	99.4	548,601	176.9	61.3 (3)	58.0 (3)	73.2
	8000-9000'	228	264	82.7	76.7	99.3	288,578	70.6	72.7 (1)	71.8 (2)	76.6
	9000-10,000'	217	283	104.3	93.2	97.2	45,391	9.1	NA	NA	77.1
Cosumnes	5000-6000'	219	159	35.6	26.3	54.8	87,517	62.5	NA	NA	27.0
	6000-7000'	239	273	55.3	59.1	99.9	78,444	24.9	NA	NA	56.0
	7000-8000'	238	259	71.2	67.6	100.0	25,152	7.0	NA	NA	75.2
Mokelumne	5000-6000'	190	187	33.7	26.9	61.2	127,083	88.4	NA	NA	18.3
	6000-7000'	257	281	55.9	54.5	95.5	199,006	68.4	NA	NA	52.5
	7000-8000'	256	276	70.8	66.9	99.7	325,714	91.2	NA	NA	75.8
	8000-9000'	247	264	78.7	72.3	99.9	308,868	80.1	72.8 (1)	73.2 (1)	78.1
	9000-10,000'	234	273	84.8	83.4	98.7	38,447	8.6	NA	NA	76.3
Stanislaus	5000-6000'	230	231	37.4	30.8	70.5	184,119	111.9	NA	NA	19.7
	6000-7000'	269	284	51.4	51.6	90.7	388,752	141.3	60.6 (1)	58.6 (1)	52.4
	7000-8000'	272	281	65.1	62.2	95.7	504,679	152.2	NA	NA	69.8
	8000-9000'	264	280	76.3	72.0	98.3	455,057	118.6	82.9 (2)	95.9 (1)	74.9
	9000-10,000'	249	290	84.3	84.1	95.5	241,502	53.8	66.3 (1)	66.7 (1)	76.5
	10,000-11,000'	245	285	87.6	87.6	95.3	61,918	13.3	NA	NA	75.2
	> 11,000'	242	298	91.8	91.8	95.4	1,708	0.3	NA	NA	73.0

Basin	Elevation Band	4/1/23 % 4/1 Avg.	4/15/23 % 4/15 Avg.	4/1/23 SWE (in)	4/15/23 SWE (in)	4/15/23 % SCA	4/15/23‡ Vol (af)	4/15/23 Area (mi2)	4/1/23 Pillows	4/15/23 Pillows	4/15/23 SNODAS* (in)
Tuolumne§	5000-6000'	290	134	17.3	13.7	60.0	130,549	179.2	NA	NA	17.3
	6000-7000'	295	240	36.0	38.7	94.8	303,978	147.2	NA	NA	49.7
	7000-8000'	299	284	60.3	58.5	98.8	491,435	157.4	74.7 (1)	72.9 (1)	71.1
	8000-9000'	299	>300†	83.6	74.5	99.5	687,956	173.2	75.4 (2)	72.2 (2)	77.7
	9000-10,000'	281	>300†	89.3	80.0	98.5	784,533	183.8	72.6 (2)	71.8 (2)	81.1
	10,000-11,000'	266	260	77.2	72.2	96.4	352,324	91.5	NA	NA	76.0
	11,000-12,000'	264	209	60.1	58.7	91.5	80,813	25.8	NA	NA	61.2
	> 12,000'	269	236	70.5	69.9	85.9	10,926	2.9	NA	NA	49.5
Merced§	5000-6000'	292	89	10.9	8.0	39.1	32,190	75.0	NA	NA	11.4
	6000-7000'	>300†	192	28.8	29.6	87.4	130,893	82.9	NA	NA	39.6
	7000-8000'	>300†	241	49.2	48.0	99.0	363,737	142.1	55.8 (1)	54.4 (1)	64.8
	8000-9000'	>300†	252	67.0	59.3	99.8	394,539	124.7	80.5 (2)	84.9 (1)	75.0
	9000-10,000'	>300†	252	74.1	64.2	99.8	300,911	87.9	NA	NA	74.9
	10,000-11,000'	278	243	76.1	70.3	98.5	149,518	39.9	NA	NA	78.7
	11,000-12,000'	266	215	72.8	68.0	96.4	42,725	11.8	NA	NA	74.3
	> 12,000'	276	245	88.0	85.6	94.7	7,323	1.6	NA	NA	66.1
San Joaquin§	5000-6000'	>300†	95	12.0	7.1	46.0	54,673	143.5	NA	NA	17.3
	6000-7000'	>300†	243	30.2	30.5	90.3	304,480	187.0	66.7 (2)	64.0 (2)	43.1
	7000-8000'	>300†	295	50.4	49.2	98.5	583,114	222.3	73.1 (4)	71.5 (4)	60.8
	8000-9000'	>300†	>300†	78.5	69.3	99.7	751,034	203.1	NA	NA	69.4
	9000-10,000'	>300†	>300†	88.1	77.0	99.6	851,957	207.5	79.6 (1)	77.6 (1)	71.7
	10,000-11,000'	296	>300†	81.8	77.4	99.2	668,683	162.0	61.5 (1)	61.8 (1)	72.9
	11,000-12,000'	277	274	68.5	72.3	96.1	459,049	119.0	NA	NA	60.3
	12,000-13,000	268	219	57.4	60.8	90.6	87,504	27.0	NA	NA	44.4
	> 13,000	273	223	51.4	59.9	86.4	4,675	1.5	NA	NA	30.3
Kings§	5000-6000'	>300†	255	10.4	15.1	40.9	81,126	100.5	NA	NA	12.1
	6000-7000'	>300†	>300†	24.7	42.5	86.9	310,798	137.1	NA	NA	33.6
	7000-8000'	>300†	>300†	46.2	55.7	98.0	526,746	177.3	NA	NA	56.5
	8000-9000'	>300†	>300†	68.5	64.5	99.2	760,044	221.1	NA	NA	73.6
	9000-10,000'	297	>300†	77.0	76.8	99.6	908,960	221.8	74.5 (1)	84.2 (1)	78.3
	10,000-11,000'	284	>300†	75.0	75.0	99.2	773,848	193.4	70.1 (1)	74.7 (2)	76.5
	11,000-12,000'	270	291	69.3	69.4	97.5	575,760	155.6	NA	NA	70.2
	12,000-13,000	264	241	60.4	60.5	94.2	158,694	49.2	NA	NA	57.7
	>13,000'	265	221	53.3	53.8	88.0	11,813	4.1	NA	NA	45.7
Kaweah§	5000-6000'	>300†	43	8.7	2.1	6.1	6,679	60.7	NA	NA	9.1
	6000-7000'	>300†	293	21.9	33.4	68.5	108,084	60.7	NA	32.6 (1)	32.8
	7000-8000'	293	>300†	42.6	57.7	96.9	192,441	62.5	NA	NA	57.0
	8000-9000'	271	>300†	70.3	66.1	99.7	203,935	57.8	NA	NA	72.1
	9000-10,000'	262	>300†	84.4	84.3	99.4	196,690	43.7	83.5 (1)	80.0 (1)	87.9
	10,000-11,000'	256	>300†	88.7	88.7	98.7	146,407	31.0	NA	NA	92.6
	>11,000'	253	>300†	86.7	87.4	98.8	40,937	8.8	NA	NA	86.4
Tule	5000-6000'	>300†	27	33.6	1.0	3.1	2,824	55.1	NA	NA	3.4
	6000-7000'	>300†	224	47.5	24.5	51.7	54,133	41.4	NA	NA	17.6
	7000-8000'	291	>300†	56.9	59.4	90.0	85,039	26.8	NA	NA	41.3
	8000-9000'	275	>300†	69.7	78.0	98.7	61,525	14.8	NA	NA	57.8
	9000-10,000'	263	>300†	77.4	78.1	98.0	18,877	4.5	NA	NA	80.6
Kern§	5000-6000'	>300†	101	1.6	0.6	2.2	8,002	256.4	NA	NA	1.1
	6000-7000'	>300†	>300†	9.2	10.7	25.7	204,503	357.8	NA	NA	8.1
	7000-8000'	>300†	>300†	20.0	33.1	71.1	598,863	339.5	33.1 (1)	26.0 (1)	20.0
	8000-9000'	>300†	>300†	35.3	42.0	98.4	729,454	325.8	54.1 (2)	58.1 (3)	39.5
	9000-10,000'	>300†	254	47.0	37.0	99.9	381,165	193.2	NA	65.2 (1)	54.9
	10,000-11,000'	>300†	215	57.5	37.7	99.8	267,481	133.1	52.8 (2)	54.4 (1)	59.9
	11,000-12,000'	271	234	60.4	49.4	98.6	249,856	94.9	NA	72.1 (1)	64.0
	12,000-13,000	251	245	54.0	55.7	94.1	113,541	38.2	NA	NA	53.6
	>13,000'	236	267	43.8	61.9	87.3	20,944	6.3	NA	NA	38.4

Basin	Elevation Band	4/1/23 % 4/1 Avg.	4/15/23 % 4/15 Avg.	4/1/23 SWE (in)	4/15/23 SWE (in)	4/15/23 % SCA	4/15/23‡ Vol (af)	4/15/23 Area (mi2)	4/1/23 Pillows	4/15/23 Pillows	4/15/23 SNODAS* (in)
Truckee§	5000-6000'	>300†	213	32.9	15.0	86.9	55,940	69.9	NA	NA	11.1
	6000-7000'	>300†	215	40.5	30.5	97.7	359,836	221.3	44.1 (5)	42.1 (5)	29.9
	7000-8000'	242	241	55.5	53.5	99.2	341,398	119.7	NA	NA	60.8
	8000-9000'	222	237	64.8	63.5	100.0	103,926	30.7	NA	NA	72.7
	9000-10,000'	226	206	68.1	55.4	99.6	23,495	8.0	NA	NA	72.5
	10,000-11,000'	233	184	71.2	52.6	100.0	1,174	0.4	NA	NA	67.5
Tahoe§	6000-7000'	>300†	191	40.1	22.5	84.6	156,919	130.7	45.0 (2)	41.4 (2)	24.3
	7000-8000'	272	240	54.1	46.2	98.2	278,612	113.2	62.8 (4)	63.0 (3)	53.4
	8000-9000'	238	262	66.1	64.3	99.6	250,429	73.0	57.8 (1)	56.6 (1)	62.4
	9000-10,000'	224	251	72.8	68.8	98.8	62,431	17.0	NA	NA	64.9
	10,000-11,000'	212	229	77.5	64.8	95.3	2,650	0.8	NA	NA	54.1
W. Carson§	5000-6000'	>300†	4	18.5	0.2	10.3	2	0.2	NA	NA	4.1
	6000-7000'	>300†	150	39.6	13.6	77.8	1,623	2.2	NA	NA	27.2
	7000-8000'	292	267	52.5	47.3	99.4	81,041	32.2	NA	NA	50.6
	8000-9000'	247	274	63.8	61.7	99.9	91,770	27.9	65.1 (2)	65.3 (2)	55.5
	9000-10,000'	225	242	73.0	62.7	97.0	23,556	7.0	NA	NA	59.0
	10,000-11,000'	220	252	64.5	64.4	95.6	2,155	0.6	NA	NA	54.1
E. Carson§	5000-6000'	>300†	51	13.9	1.0	8.4	2,689	50.2	NA	NA	1.2
	6000-7000'	>300†	204	32.7	15.7	67.9	65,566	78.1	21.5 (1)	8.6 (1)	13.2
	7000-8000'	>300†	299	46.0	42.8	96.7	238,993	104.7	NA	NA	36.7
	8000-9000'	266	>300†	60.0	64.5	99.1	349,472	101.5	62.5 (4)	60.6 (4)	61.2
	9000-10,000'	242	284	73.4	73.3	95.8	142,566	36.5	NA	NA	69.9
	>10,000'	235	238	81.3	67.7	93.8	39,769	11.0	NA	NA	63.6
W. Walker	6000-7000'	>300†	>300†	32.3	35.4	86.3	14,755	7.8	NA	NA	20.3
	7000-8000'	>300†	>300†	37.1	48.1	97.3	104,554	40.7	38.9 (1)	34.6 (1)	31.3
	8000-9000'	>300†	>300†	55.0	56.5	99.1	144,892	48.1	57.7 (1)	56.1 (1)	60.1
	9000-10,000'	277	>300†	72.8	72.8	97.5	253,260	65.2	108.8 (1)	110.9 (1)	79.0
	10,000-11,000'	252	292	81.3	81.4	93.2	118,358	27.3	NA	NA	77.0
	> 11,000'	254	287	79.9	78.0	86.9	9,285	2.2	NA	NA	66.3
E. Walker	6000-7000'	>300†	>300†	27.1	33.5	91.0	108,120	60.5	NA	NA	12.6
	7000-8000'	>300†	>300†	32.0	43.7	98.0	280,329	120.2	NA	NA	14.6
	8000-9000'	>300†	>300†	41.9	46.1	98.8	236,709	96.2	NA	NA	33.2
	9000-10,000'	>300†	>300†	62.3	62.2	97.1	189,751	57.2	53.8 (1)	54.8 (1)	58.6
	10,000-11,000'	272	>300†	77.0	77.0	92.5	142,592	34.7	NA	NA	66.4
	>11,000'	272	>300†	77.2	77.2	84.2	36,472	8.9	NA	NA	58.8
Mono	6000-7000'	>300†	>300†	13.6	7.3	27.7	125,732	321.5	NA	NA	2.2
	7000-8000'	>300†	>300†	24.1	24.9	81.7	553,962	417.4	NA	NA	4.6
	8000-9000'	>300†	>300†	35.2	38.5	97.5	381,162	185.6	NA	NA	13.2
	9000-10,000'	>300†	>300†	57.1	57.1	98.3	197,548	64.9	NA	NA	41.3
	10,000-11,000'	>300†	>300†	74.2	74.2	95.3	191,766	48.5	NA	NA	63.5
	11,000-12,000'	280	>300†	79.7	79.6	86.6	111,874	26.4	NA	NA	57.5
	> 12,000'	283	289	76.4	76.5	80.2	17,931	4.4	NA	NA	46.6
Upper Owens	6000-7000'	>300†	>300†	24.6	39.1	98.2	137,609	66.0	NA	NA	21.5
	7000-8000'	>300†	>300†	33.4	44.2	97.5	360,075	152.7	NA	NA	19.6
	8000-9000'	>300†	>300†	50.5	52.4	98.8	224,485	80.3	NA	NA	35.8
	9000-10,000'	>300†	>300†	65.6	65.6	98.3	154,256	44.1	NA	NA	49.9
	10,000-11,000'	>300†	>300†	73.1	73.1	96.9	134,919	34.6	NA	NA	60.9
	11,000-12,000'	290	>300†	77.4	77.7	91.4	66,490	16.0	NA	NA	54.8
	> 12,000'	282	>300†	71.7	72.7	86.4	14,323	3.7	NA	NA	40.2
Owens	5000-6000'	>300†	0	0.0	0.0	0.0	0	444.5	NA	NA	0.0
	6000-7000'	>300†	>300†	4.3	1.0	5.6	18,860	353.3	NA	NA	1.1
	7000-8000'	>300†	>300†	17.8	12.6	42.5	223,747	334.3	NA	NA	4.8
	8000-9000'	>300†	>300†	31.0	24.9	70.5	251,641	189.2	NA	NA	14.4
	9000-10,000'	>300†	>300†	44.3	44.2	91.8	362,720	153.9	49.1 (3)	49.4 (3)	27.5
	10,000-11,000'	>300†	>300†	54.2	54.3	96.6	486,276	168.0	51.8 (2)	50.1 (2)	37.9
	11,000-12,000'	>300†	>300†	63.4	63.4	91.7	456,137	134.8	NA	NA	40.4
	12,000-13,000	292	>300†	66.1	66.3	85.5	236,372	66.8	NA	NA	33.0
	>13,000'	270	288	60.6	61.6	82.3	35,075	10.7	NA	NA	24.7

§ Data in all ASO-collected basins have been bias-corrected using ASO data and therefore the SWE changes might not represent snowmelt but rather an update to the SWE estimates based on airborne data.

‡ For volume totals above Shasta Lake add Upper Sac, McCloud and Pit volumes. For volume totals above Bend Bridge add Upper Sac, McCloud, Pit and Sac at Bend Bridge volumes.

† Deep, and particularly low-elevation snow in areas that typically are snow-free can report exceptionally high percent of average for this date because the mean 2001-2021 regression-derived SWE for that area is low or 0.

* This is a comparison to the SNODAS (SNOw Data Assimilation System) nationwide product from the National Weather Service.

Location of Reports and Excel Format Tables

https://www.colorado.edu/instaar/research/labs-groups/mountain-hydrology-group/sierra-nevada-swe-reports

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