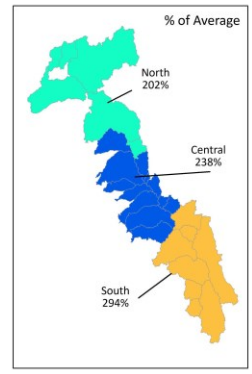
Real-Time Spatial Estimates of Snow-Water Equivalent (SWE)

Sierra Nevada Mountains, California

February 1, 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 Feb 1, percent of average SWE is highest in the south (294%), then central (238%) and lowest in the north (202%). This is a time of year when sporadic percent of average especially in low-elevation areas 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**.

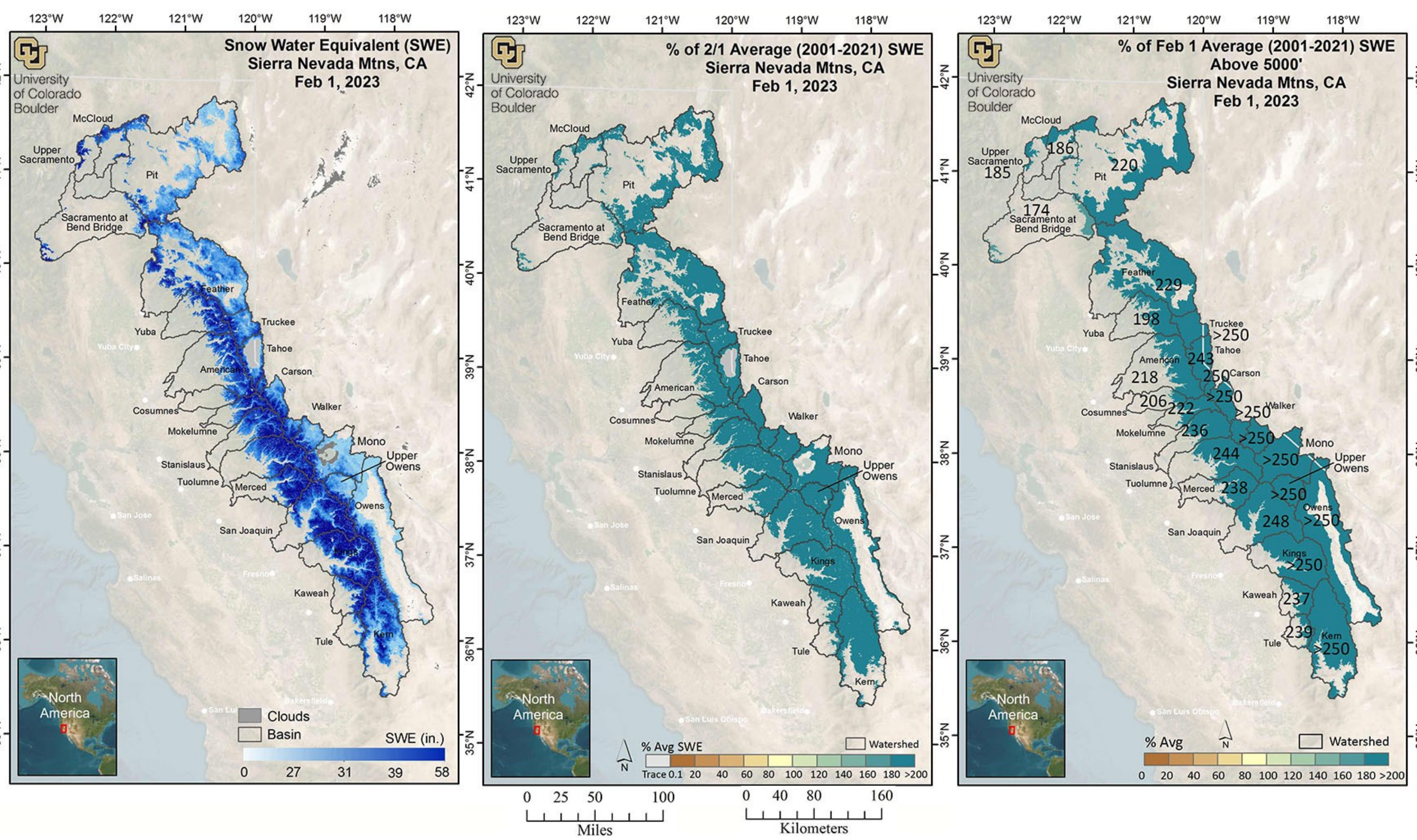

Figure 1. Estimated SWE and % of Average SWE across the Sierra Nevada. SWE amounts for February 1, 2023 (left), and percent of average (2001-2021) SWE for February 1, 2023 for the Sierra Nevada, calculated for each pixel (middle) and basin-wide (right). Basin-wide percent of average is calculated across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

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

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

114 snow pillow sites in the Sierra Nevada network were recording SWE values out of a total of 132 sites, 14 were offline, and 14 CoCoRaHS were used (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.

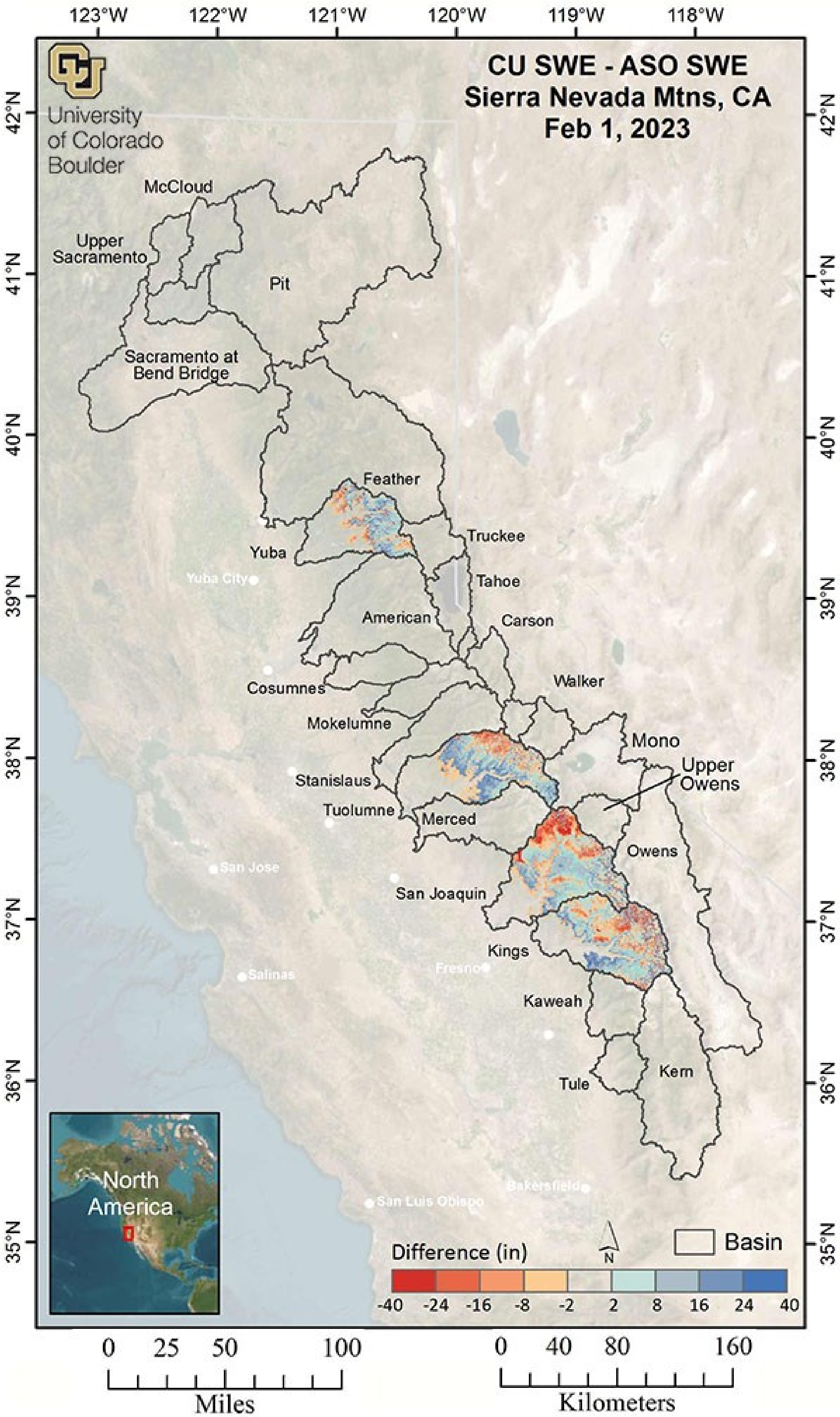

Figure 2. Comparison to ASO, Sierra Nevada. The difference in SWE amounts between the February 1, 2023 CU SWE model run and Airborne Snow Observatories (ASO) lidar-derived SWE are shown for available basins. Red colors show where CU SWE is lower than ASO SWE and blue colors show where CU SWE is higher 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.

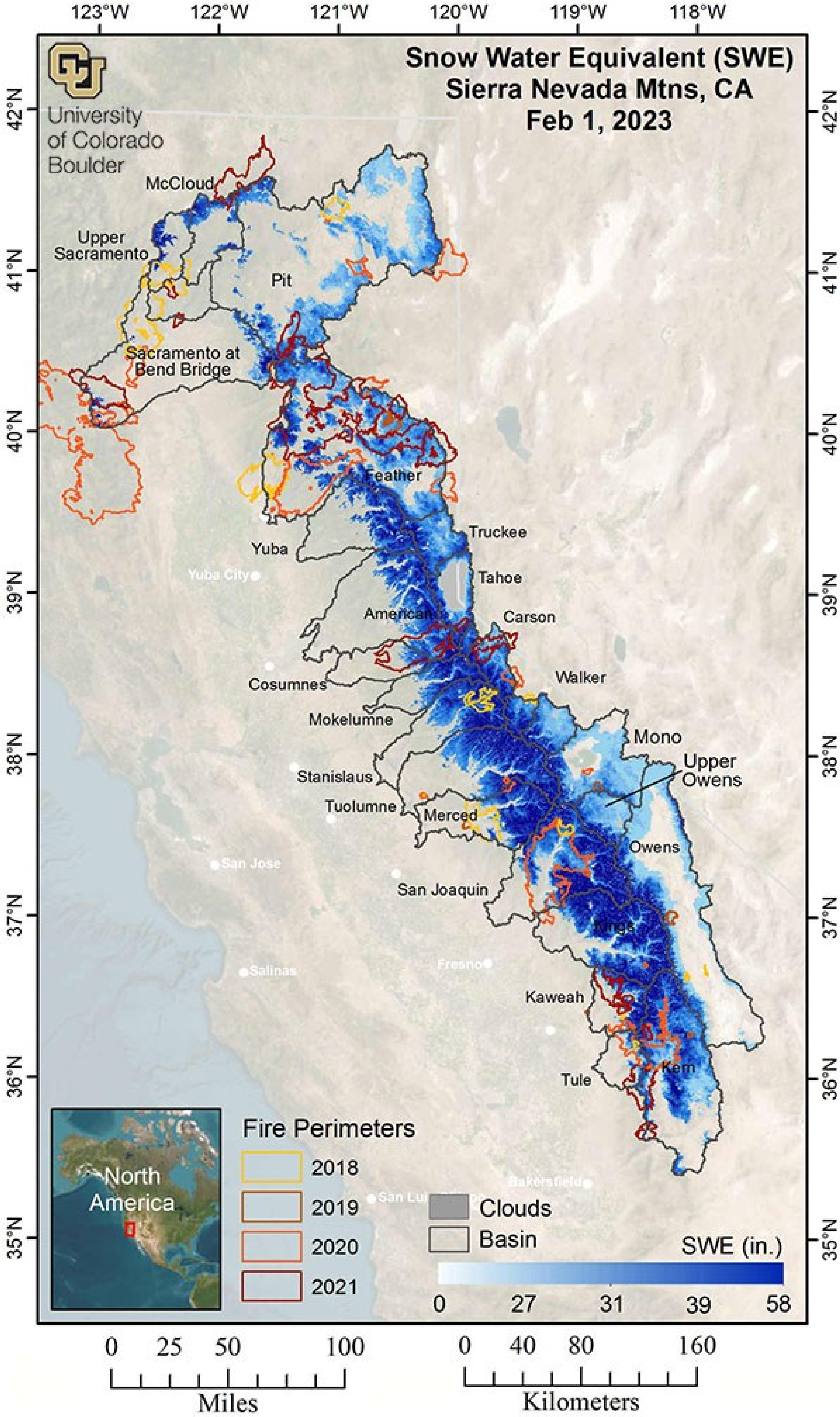

Figure 3. Estimated SWE with Fire Perimeters, Sierra Nevada. SWE amounts for February 1, 2023 are shown with fire perimeters from 2018-2021 (colored from yellow to red).

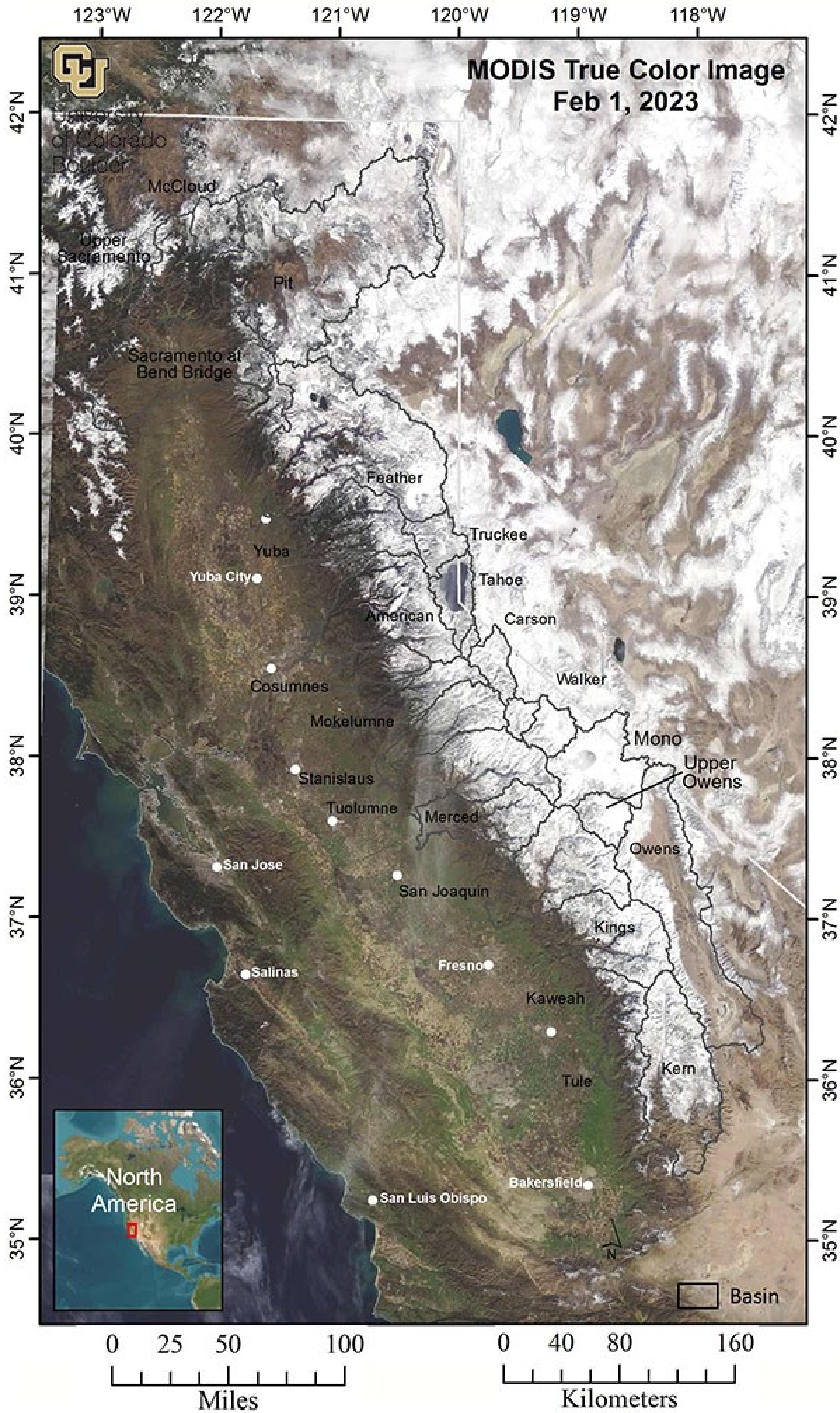

Figure 4. MODIS image, Sierra Nevada. A mostly cloud-free true color MODIS image, showing the composited image that was used for the February 1, 2023 regression model run.

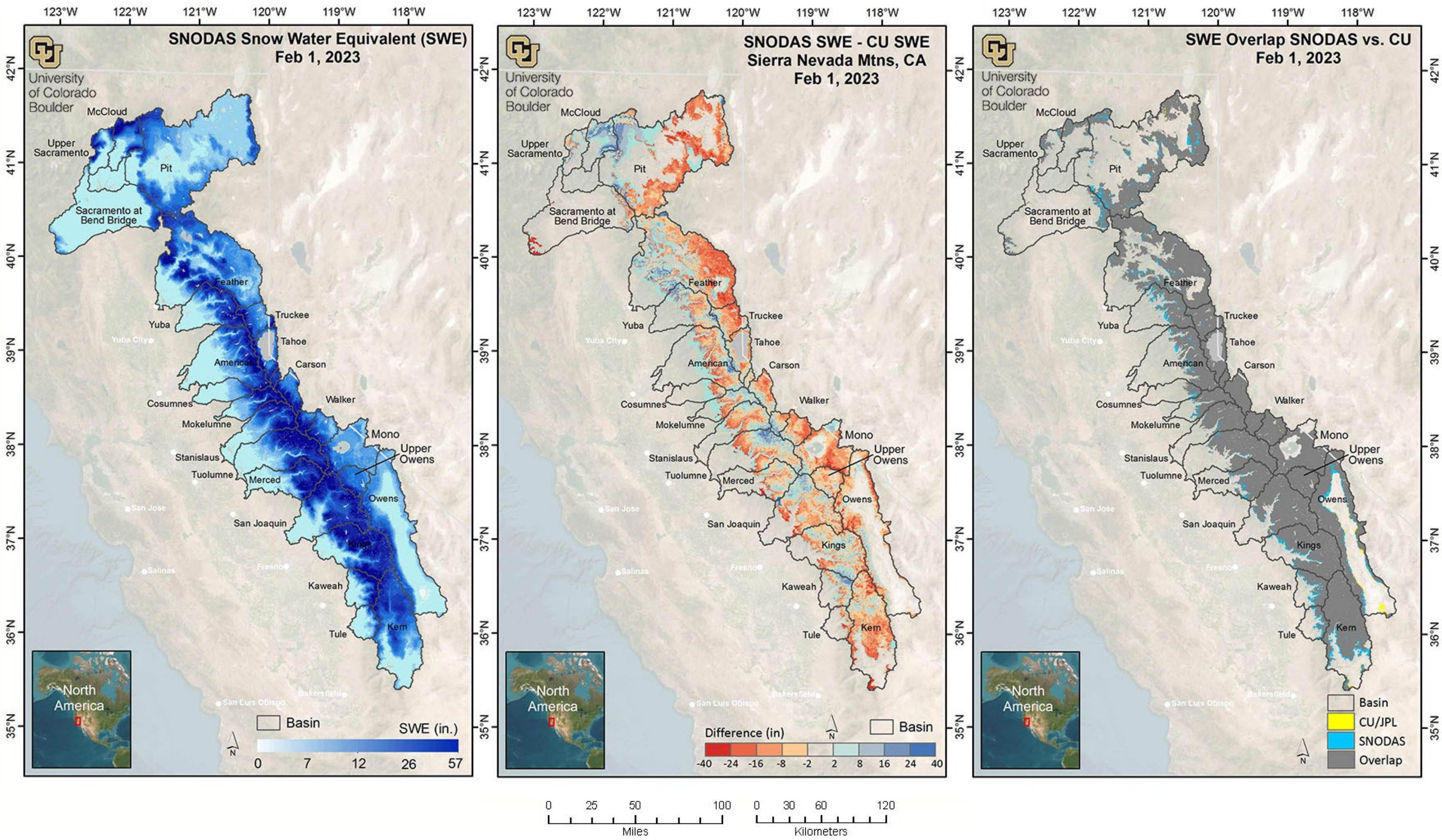

Figure 5. Comparison of CU regression SWE product and SNODAS SWE for the Sierra Nevada. The map on the left shows estimated SWE for February 1st from the NOAA National Weather Service's National Operational Hydrologic Remote Sensing Center (NOHRSC) SNOw Data Assimilation System (SNODAS). The middle map shows the difference between the February 1st 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. 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.

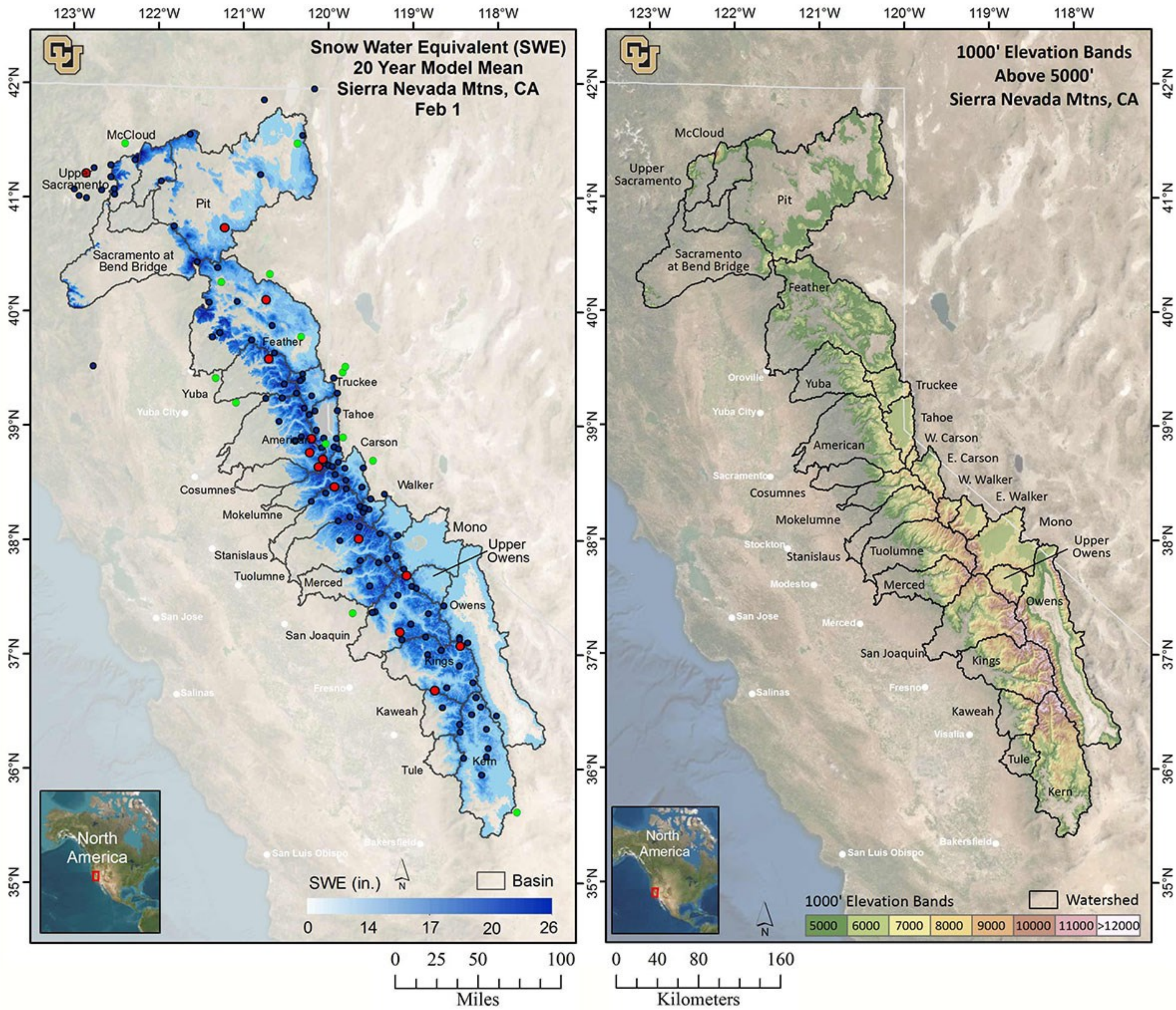

Figure 6. Historical average February 1st and Elevation Bands for the Sierra Nevada. Average SWE (2001-2021) for February 1st (left), and the Banded Elevation map (right) identifies basins used in this report (black boundaries) and 1000' elevation bands (colored shading) that match those used in Table 1 and Table 2. Map on left shows snow pillow sensor sites recording SWE on February 1st (black), sites that were offline are shown in red, and CoCoRaHS sites recording are shown in green.

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 from either the 1st or 15th of

each month during the 1985-2016 period that best matches the real-time snow pillow-observed pattern is selected as an independent variable.)

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* February 1, 2023 *– IMPORTANT – READ THIS!

- 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.
- 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.
- 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.
- 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.

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 February 1st percent of February 1st average SWE (between 2001-2021 as derived from the regression model), February 1st mean SWE, February 1st percent of snow-covered area, February 1st water volume (acre-feet), the area (mi²) inside each basin that contains data pixels (not including cloud-covered pixels, lakes or other satellite no data pixels), February 1st surveys, and February 1st snow pillow data for those areas collected, summarized for each basin. The last column shows February 1st mean SWE from SNODAS*.*

Basin	2/1/23 % 2/1 Avg.	2/1/23 SWE (in)	2/1/23 % SCA	2/1/23†† Vol (af)	Area (mi2) > 5000'	2/1/23 Surveys	2/1/23 Pillows	2/1/23 SNODAS* (in)
Upper Sacramento	185	34.3	96.1	231,015	126.4	37.3 (2)	36.9 (2)	32.3
McCloud	186	32.2	95.2	299,382	174.5	28.5 (2)	44.6 (1)	40.0
Pit	220	19.3	91.4	2,345,634	2280.1	15.4 (4)	20.9 (4)	10.1
Sac at Bend Bridge	174	27.5	84.4	367,623	250.9	NA	NA	18.7
Feather	229	26.3	95.4	3,181,388	2,264.2	28.2 (23)	34.1 (6)	19.2
Yuba	198	31.9	89.7	939,202	552.3	40.3 (13)	44.1 (3)	31.4
American	218	32.2	92.9	1,455,663	848.2	30.9 (18)	30.5 (9)	28.4
Cosumnes	206	28.2	87.0	141,111	93.7	NA	NA	20.2
Mokelumne	222	34.4	94.7	614,754	335.4	35.9 (9)	43.8 (1)	32.2
Stanislaus	236	35.0	98.2	1,102,333	589.7	41.8 (16)	42.4 (6)	30.9
Tuolumne	244	35.3	97.0	1,800,520	955.4	38.6 (16)	39.2 (6)	33.4
Merced	238	34.9	94.1	1,051,345	564.1	43.5 (4)	40.4 (3)	31.6
San Joaquin	248	34.7	95.4	2,351,736	1,270.9	36.4 (20)	38.0 (8)	30.8
Kings	>250†	35.9	93.8	2,402,236	1,255.7	41.4 (22)	42.5 (6)	33.2
Kaweah	237	29.2	82.6	498,054	319.5	36.8 (2)	32.2 (2)	30.4
Tule	239	21.2	73.0	161,665	143.0	24.0 (1)	NA	14.7
Kern	>250†	25.1	83.2	2,334,591	1,745.1	28.0 (16)	29.0 (9)	17.5
Truckee	>250†	30.3	98.7	724,832	448.5	39.3 (2)	24.1 (5)	21.9
Tahoe	243	30.6	95.1	546,330	334.8	22.4 (6)	31.5 (7)	27.1
W Carson	250	36.0	99.3	134,672	70.1	46.5 (1)	38.4 (2)	34.1
E Carson	>250†	31.1	98.9	633,756	381.8	NA	32.0 (5)	25.2
W Walker	>250†	34.6	98.5	352,591	190.9	23.8 (2)	39.4 (3)	35.0
E Walker	>250†	27.1	97.1	541,201	374.9	NA	28.4 (1)	18.3
Mono	>250†	19.0	95.6	960,622	947.2	44.9 (5)	45.3 (1)	10.8
Upper Owens	>250†	25.8	97.1	546,461	396.7	46.8 (3)	58.7 (1)	19.9
Owens	>250†	13.3	66.6	1,313,750	1,848.4	24.8 (8)	27.1 (5)	8.5

† 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 February 1st percent of February 1st average SWE (between 2001-2021 as derived from the regression model), February 1st mean SWE, February 1st percent of snow-covered area, February 1st water volume (acre-feet), the area (mi²) inside each basin that contains data pixels (not including cloud-covered pixels, lakes or other satellite no data pixels), February 1st surveys, and February 1st snow pillow data for those areas collected, summarized for each 1000' elevation band inside each basin. The last column shows February 1st mean SWE from SNODAS*.*

Basin	Elevation Band	2/1/23 % 2/1 Avg.	2/1/23 SWE (in)	2/1/23 % SCA	2/1/23†† Vol (af)	2/1/23 Area (mi2)	2/1/23 Surveys	2/1/23 Pillows	2/1/23 SNODAS* (in)
Upper Sacramento	5000-6000'	193	32.7	94.0	126,540	72.5	37.0 (1)	38.5 (1)	28.9
	6000-7000'	189	37.2	98.9	76,461	38.5	37.5 (1)	35.3 (1)	37.3
	7000-8000'	169	34.5	100.0	16,662	9.1	NA	NA	35.9
	8000-9000'	140	33.1	99.7	4,674	2.7	NA	NA	37.0
	9000-10,000'	120	32.7	98.6	3,043	1.7	NA	NA	36.7
	10,000-11,000'	119	37.4	95.7	1,949	1.0	NA	NA	32.9
	> 11,000'	107	32.4	91.1	1,686	1.0	NA	NA	28.4
McCloud	5000-6000'	197	30.0	94.5	168,604	105.5	32.0 (1)	44.6 (1)	38.0
	6000-7000'	187	33.0	95.5	75,974	43.2	25.0 (1)	NA	43.6
	7000-8000'	177	34.6	98.0	25,860	14.0	NA	NA	42.6
	8000-9000'	178	38.8	99.3	12,716	6.1	NA	NA	44.2
	>10,000'	177	44.0	97.2	5,731	2.4	NA	NA	42.7
Pit	5000-6000'	231	16.8	89.8	1,404,096	1,565.2	NA	30.0 (1)	7.2
	6000-7000'	206	23.3	94.0	687,202	553.3	15.5 (3)	18.8 (2)	14.6
	7000-8000'	209	28.8	97.4	213,573	138.9	15.0 (1)	16.1 (1)	22.8
	>8,000'	214	33.2	99.3	37,292	21.1	NA	NA	21.2
Sac at Bend Bridge	5000-6000'	171	24.0	80.6	210,214	164.4	NA	NA	14.8
	6000-7000'	173	31.2	89.1	107,896	64.9	NA	NA	23.9
	>7,000'	191	41.6	99.6	36,542	16.5	NA	NA	32.4
Feather	5000-6000'	234	24.0	93.7	1,730,121	1,351.3	24.0 (11)	43.7 (1)	17.8
	6000-7000'	225	29.2	97.7	1,219,551	783.9	33.2 (9)	33.2 (4)	20.5
	7000-8000'	216	33.6	98.3	222,956	124.6	28.8 (3)	28.3 (1)	25.5
	8000-9000'	206	36.8	96.1	8,760	4.5	NA	NA	27.0
Yuba	5000-6000'	167	22.7	75.9	243,918	201.6	29.5 (3)	NA	22.7
	6000-7000'	214	35.7	96.8	435,561	229.0	39.7 (6)	37.6 (2)	33.4
	7000-8000'	211	39.9	99.0	249,580	117.2	49.5 (4)	57.0 (1)	41.8
	8000-9000'	204	43.3	99.1	10,143	4.4	NA	NA	53.8
American	5000-6000'	213	24.8	86.3	410,761	311.2	18.5 (3)	17.6 (3)	16.0
	6000-7000'	224	33.8	96.6	506,080	280.4	30.5 (8)	31.3 (2)	28.5
	7000-8000'	218	38.2	97.4	360,575	176.9	35.0 (6)	38.8 (2)	41.3
	8000-9000'	214	41.8	96.5	157,426	70.6	47.5 (1)	40.6 (2)	47.5
	9000-10,000'	198	42.7	91.0	20,820	9.1	NA	NA	50.5
Cosumnes	5000-6000'	196	24.4	81.7	80,610	61.9	NA	NA	14.4
	6000-7000'	222	34.5	96.9	45,827	24.9	NA	NA	29.5
	7000-8000'	216	39.5	98.7	14,673	7.0	NA	NA	38.7
Mokelumne	5000-6000'	207	22.9	83.4	107,509	88.1	4.0 (1)	NA	10.6
	6000-7000'	233	33.2	98.6	120,997	68.3	23.5 (1)	NA	27.9
	7000-8000'	225	39.0	98.6	188,860	90.8	40.0 (5)	NA	42.2
	8000-9000'	223	41.8	99.3	177,850	79.9	48.0 (2)	43.8 (1)	47.0
	9000-10,000'	215	43.8	96.8	19,538	8.4	NA	NA	47.4
Stanislaus	5000-6000'	248	25.5	95.4	151,931	111.9	NA	NA	10.4
	6000-7000'	239	31.6	97.5	237,920	141.1	32.0 (4)	31.7 (1)	25.2
	7000-8000'	236	37.1	99.7	299,744	151.4	38.7 (7)	33.8 (1)	35.6
	8000-9000'	233	41.0	99.8	258,133	118.1	58.8 (3)	49.7 (3)	42.3
	9000-10,000'	226	43.2	98.3	123,438	53.6	47.0 (2)	39.9 (1)	46.7
	10,000-11,000'	219	43.1	95.1	30,449	13.3	NA	NA	46.1
	> 11,000'	202	38.6	86.6	717	0.3	NA	NA	44.3

Basin	Elevation Band	2/1/23 % 2/1 Avg.	2/1/23 SWE (in)	2/1/23 % SCA	2/1/23†† Vol (af)	2/1/23 Area (mi2)	2/1/23 Surveys	2/1/23 Pillows	2/1/23 SNODAS* (in)
Tuolumne	5000-6000'	>250†	23.7	91.8	224,864	178.1	NA	NA	8.8
	6000-7000'	>250†	30.7	97.2	240,145	146.6	27.3 (6)	24.6 (1)	24.0
	7000-8000'	243	36.7	99.1	305,431	156.1	43.5 (2)	41.5 (1)	36.1
	8000-9000'	237	38.8	99.3	357,663	172.7	46.5 (4)	44.7 (2)	43.8
	9000-10,000'	235	40.9	98.9	399,836	183.4	45.0 (4)	39.7 (2)	46.4
	10,000-11,000'	235	42.9	97.0	206,908	90.4	NA	NA	44.4
	11,000-12,000'	238	43.9	91.8	58,828	25.1	NA	NA	39.2
	> 12,000'	227	43.8	87.1	6,845	2.9	NA	NA	33.5
Merced	5000-6000'	209	17.3	71.7	68,688	74.6	NA	NA	6.0
	6000-7000'	233	27.3	90.3	119,934	82.4	37.0 (1)	NA	20.7
	7000-8000'	245	36.0	98.8	272,377	141.9	NA	31.6 (1)	33.8
	8000-9000'	241	40.1	99.8	266,446	124.6	45.7 (3)	44.8 (2)	39.3
	9000-10,000'	244	41.8	99.7	195,659	87.7	NA	NA	40.4
	10,000-11,000'	237	45.2	97.5	95,650	39.7	NA	NA	45.6
	11,000-12,000'	223	46.4	92.2	28,840	11.6	NA	NA	48.5
	> 12,000'	199	45.8	86.8	3,752	1.5	NA	NA	45.9
San Joaquin	5000-6000'	224	17.1	76.5	131,869	144.3	NA	NA	6.9
	6000-7000'	>250†	27.2	96.5	271,390	186.9	26.3 (2)	37.3 (2)	21.0
	7000-8000'	247	31.7	98.7	375,140	222.1	33.1 (8)	38.8 (4)	31.4
	8000-9000'	245	37.0	99.4	399,417	202.2	40.0 (1)	NA	35.8
	9000-10,000'	250	40.7	99.3	448,344	206.7	44.2 (3)	40.7 (1)	37.9
	10,000-11,000'	>250†	43.2	98.1	372,512	161.9	39.2 (3)	33.7 (1)	42.3
	11,000-12,000'	>250†	45.0	94.4	284,782	118.6	40.0 (3)	NA	38.1
	12,000-13,000	244	45.6	89.2	65,183	26.8	NA	NA	28.9
	> 13,000	230	39.7	83.5	3,099	1.5	NA	NA	20.1
Kings	5000-6000'	182	11.6	58.1	62,303	100.6	NA	NA	6.9
	6000-7000'	>250†	25.7	93.6	186,208	136.1	33.0 (1)	NA	17.0
	7000-8000'	>250†	32.2	98.6	303,009	176.4	31.4 (4)	NA	30.6
	8000-9000'	>250†	37.1	98.6	436,023	220.1	42.7 (7)	41.2 (1)	39.3
	9000-10,000'	>250†	40.5	99.1	478,066	221.4	47.0 (5)	43.8 (2)	41.7
	10,000-11,000'	>250†	42.9	98.1	441,635	193.0	43.0 (4)	42.0 (3)	41.9
	11,000-12,000'	>250†	44.6	93.7	369,403	155.3	46.0 (1)	NA	37.2
	12,000-13,000	>250†	44.8	89.3	116,578	48.8	NA	NA	29.7
	>13,000'	248	41.1	84.1	9,011	4.1	NA	NA	22.7
Kaweah	5000-6000'	119	6.8	35.2	21,637	59.7	NA	NA	6.8
	6000-7000'	236	22.9	83.4	72,172	59.1	20.5 (1)	18.0 (1)	17.5
	7000-8000'	250	31.9	94.3	102,020	60.0	NA	NA	31.2
	8000-9000'	>250†	37.5	98.2	114,934	57.4	53.0 (1)	NA	40.6
	9000-10,000'	>250†	40.7	97.9	94,809	43.7	NA	46.4 (1)	49.2
	10,000-11,000'	>250†	43.5	95.7	71,725	30.9	NA	NA	51.3
	>11,000'	>250†	44.3	93.6	20,758	8.8	NA	NA	44.4
Tule	5000-6000'	173	7.7	40.5	22,535	55.0	NA	NA	4.2
	6000-7000'	>250†	23.6	88.8	52,530	41.8	24.0 (1)	NA	11.6
	7000-8000'	>250†	32.4	96.2	46,428	26.8	NA	NA	24.7
	8000-9000'	>250†	38.7	99.2	30,531	14.8	NA	NA	34.6
	9000-10,000'	>250†	39.9	99.7	9,640	4.5	NA	NA	46.9
Kern	5000-6000'	198	5.3	26.8	72,461	257.3	NA	NA	2.7
	6000-7000'	>250†	16.7	76.7	319,007	357.8	NA	NA	8.1
	7000-8000'	>250†	25.7	97.1	465,138	339.4	17.5 (1)	22.7 (2)	15.1
	8000-9000'	>250†	32.1	99.7	558,276	325.8	28.0 (5)	30.8 (3)	24.3
	9000-10,000'	>250†	33.8	99.9	348,250	193.2	25.7 (3)	36.6 (1)	30.8
	10,000-11,000'	>250†	37.1	99.3	262,633	132.9	31.1 (5)	25.8 (2)	31.0
	11,000-12,000'	>250†	41.9	95.8	211,005	94.5	29.0 (2)	34.6 (1)	29.9
	12,000-13,000	>250†	42.1	88.8	85,276	38.0	NA	NA	23.8
	>13,000'	246	37.5	81.1	12,544	6.3	NA	NA	16.6

Basin	Elevation Band	2/1/23 % 2/1 Avg.	2/1/23 SWE (in)	2/1/23 % SCA	2/1/23†† Vol (af)	2/1/23 Area (mi2)	2/1/23 Surveys	2/1/23 Pillows	2/1/23 SNODAS* (in)
Truckee	5000-6000'	>250†	21.2	96.5	79,005	69.9	NA	NA	8.6
	6000-7000'	>250†	28.1	98.8	329,508	219.8	36.0 (1)	24.1 (5)	17.3
	7000-8000'	238	36.6	99.4	233,780	119.7	42.5 (1)	NA	32.0
	8000-9000'	228	39.7	99.6	65,052	30.7	NA	NA	40.5
	9000-10,000'	232	39.1	100.0	16,584	8.0	NA	NA	43.6
	10,000-11,000'	233	40.5	100.0	903	0.4	NA	NA	41.8
Tahoe	6000-7000'	>250†	22.7	91.3	158,234	130.9	21.8 (3)	24.8 (2)	16.4
	7000-8000'	242	32.9	97.5	198,877	113.2	23.0 (3)	34.4 (4)	30.4
	8000-9000'	233	38.8	98.0	151,208	73.0	NA	33.0 (1)	37.8
	9000-10,000'	225	40.1	96.9	36,400	17.0	NA	NA	40.5
	10,000-11,000'	237	43.3	96.4	1,611	0.7	NA	NA	35.3
W. Carson	5000-6000'	>250†	20.7	100.0	231	0.2	NA	NA	11.7
	6000-7000'	>250†	25.1	96.2	2,984	2.2	NA	NA	23.5
	7000-8000'	>250†	33.2	99.7	56,993	32.2	NA	NA	32.3
	8000-9000'	245	38.8	99.7	57,759	27.9	46.5 (1)	38.4 (2)	36.1
	9000-10,000'	235	41.4	97.1	15,557	7.0	NA	NA	38.6
	10,000-11,000'	240	38.6	100.0	1,148	0.6	NA	NA	35.8
E. Carson	5000-6000'	>250†	19.5	98.0	52,235	50.3	NA	NA	8.1
	6000-7000'	>250†	24.0	97.9	99,833	78.0	NA	15.9 (1)	13.6
	7000-8000'	>250†	30.8	99.2	171,450	104.4	NA	NA	22.9
	8000-9000'	>250†	37.4	99.7	202,530	101.5	NA	36.0 (4)	37.4
	9000-10,000'	245	42.0	99.8	81,702	36.5	NA	NA	41.9
	>10,000'	243	44.3	98.5	26,006	11.0	NA	NA	39.3
W. Walker	6000-7000'	>250†	22.8	97.5	9,477	7.8	NA	NA	11.8
	7000-8000'	>250†	25.3	98.6	54,856	40.7	NA	21.9 (1)	16.7
	8000-9000'	>250†	32.4	99.1	82,870	48.0	23.8 (2)	33.8 (1)	35.0
	9000-10,000'	>250†	39.6	99.1	137,014	64.9	NA	62.5 (1)	45.3
	10,000-11,000'	238	43.5	96.3	63,243	27.3	NA	NA	44.1
	> 11,000'	246	43.1	94.2	5,130	2.2	NA	NA	38.8
E. Walker	6000-7000'	>250†	17.9	95.8	57,752	60.5	NA	NA	11.2
	7000-8000'	>250†	21.8	98.2	139,880	120.2	NA	NA	8.5
	8000-9000'	>250†	27.9	97.7	141,851	95.5	NA	NA	18.5
	9000-10,000'	>250†	36.2	98.2	108,298	56.1	NA	28.4 (1)	32.5
	10,000-11,000'	>250†	41.1	94.2	74,364	33.9	NA	NA	37.2
	>11,000'	247	40.7	88.9	19,055	8.8	NA	NA	33.3
Mono	6000-7000'	>250†	11.9	90.8	131,293	206.0	NA	NA	7.3
	7000-8000'	>250†	15.0	97.1	330,068	413.0	NA	NA	7.0
	8000-9000'	>250†	22.1	97.3	218,371	185.2	NA	NA	9.7
	9000-10,000'	>250†	32.3	98.2	111,170	64.5	43.9 (4)	NA	23.7
	10,000-11,000'	>250†	39.5	96.0	101,272	48.1	49.0 (1)	45.3 (1)	38.7
	11,000-12,000'	>250†	42.2	91.9	58,860	26.2	NA	NA	37.0
	> 12,000'	243	41.6	89.8	9,587	4.3	NA	NA	33.7
Upper Owens	6000-7000'	>250†	16.3	94.2	57,299	66.0	NA	NA	14.6
	7000-8000'	>250†	21.0	98.0	170,608	152.5	NA	NA	14.8
	8000-9000'	>250†	28.0	98.3	119,710	80.1	40.0 (2)	NA	20.2
	9000-10,000'	>250†	34.7	98.3	81,409	43.9	60.5 (1)	58.7 (1)	27.2
	10,000-11,000'	>250†	39.3	97.0	72,186	34.5	NA	NA	35.4
	11,000-12,000'	>250†	43.7	93.3	36,926	15.8	NA	NA	34.1
	> 12,000'	>250†	40.7	88.6	8,323	3.8	NA	NA	25.4
Owens	5000-6000'	>250†	0.6	18.5	13,849	442.5	NA	NA	1.0
	6000-7000'	>250†	4.7	56.4	89,680	356.4	NA	NA	3.6
	7000-8000'	>250†	9.9	82.0	175,533	333.9	NA	NA	6.2
	8000-9000'	>250†	14.5	93.7	145,551	188.2	17.0 (1)	NA	9.5
	9000-10,000'	>250†	23.6	96.2	192,128	152.4	24.3 (4)	28.3 (3)	15.4
	10,000-11,000'	>250†	30.9	96.5	274,267	166.2	24.3 (2)	25.3 (2)	20.9
	11,000-12,000'	>250†	37.6	92.9	265,451	132.4	36.0 (1)	NA	22.4
	12,000-13,000	>250†	39.1	87.0	137,459	66.0	NA	NA	18.0
	>13,000'	>250†	35.5	82.2	19,833	10.5	NA	NA	12.9

†† 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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