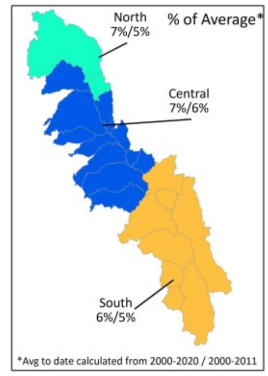
Real-Time Spatial Estimates of Snow-Water Equivalent (SWE)

Sierra Nevada Mountains, California

May 11, 2021



Team: Noah Molotch[1,2], Leanne Lestak[1], Keith Musselman[1], and Kehan Yang[1]
Institute of Arctic and Alpine Research, University of Colorado Boulder
[2] Jet Propulsion Laboratory, California Institute of Technology
Contact: Leanne.Lestak@colorado.edu

Summary of current conditions

The regional summary map above shows the mean SWE above 5000' elevation for three major regions of the Sierra Nevada, the first value is calculated from a long-term average of 2000-2020 and the second value is calculated from an average between 2000-2011. As of May 11, melt has greatly increased, with percent of average SWE highest in the central (7%/6%), then north (7%/5%) and lowest in the south (6%/5%), based on the two respective historical averaging periods (i.e. 2000-2011 / 2000-2020). 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.

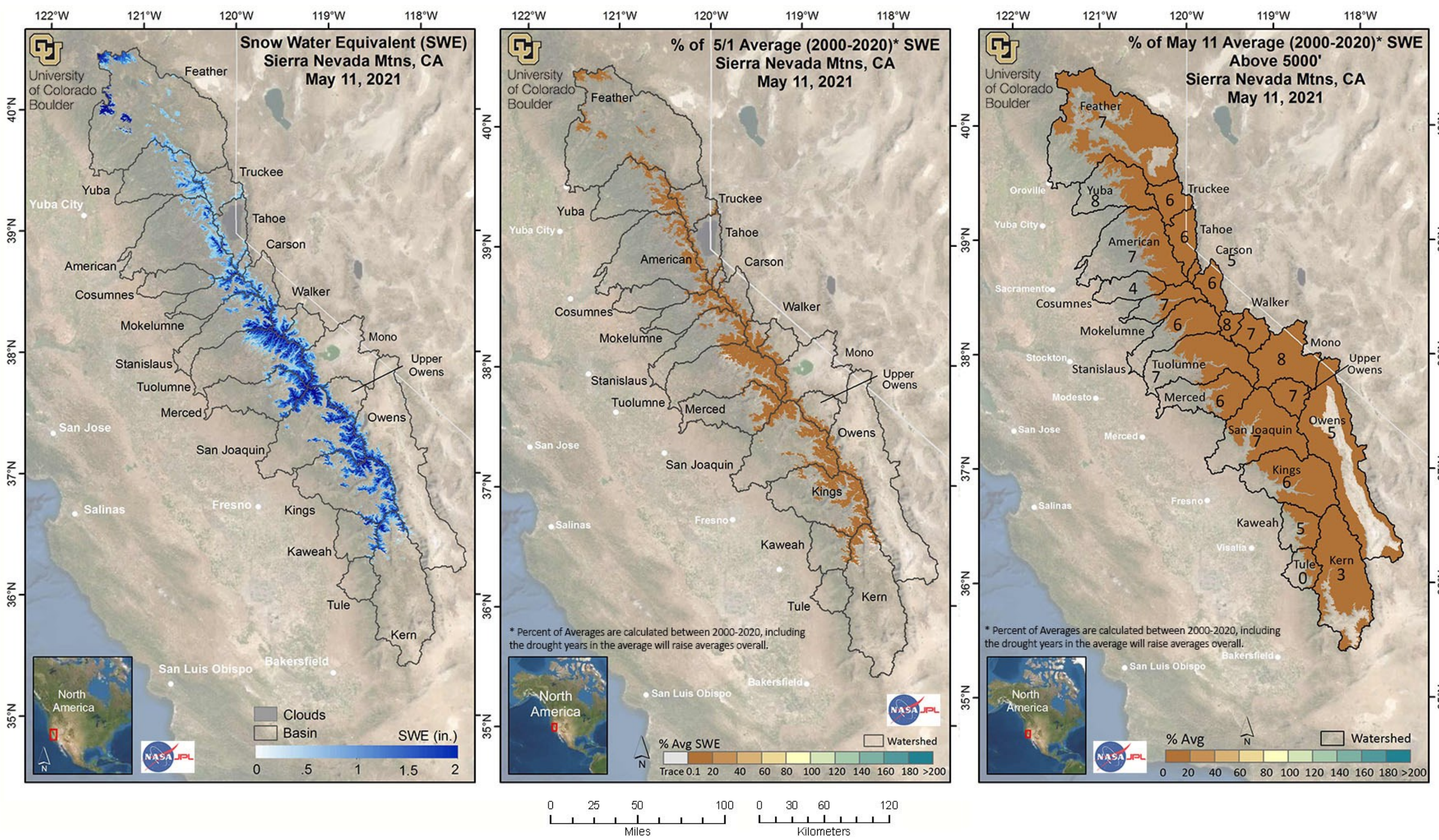


Figure 1. Estimated SWE and % of Average SWE across the Sierra Nevada. SWE amounts for May 11, 2021 (left), percent of average (2000-2020) SWE for May 11, 2021 for the Sierra Nevada, calculated for each pixel (middle) and basin-wide (right). Basin-wide percent of average is calculated across all model pixels >5000' elevation, and includes the drought which brings the percent of average higher.

Location of Reports and Excel Format Tables
ftp://snowserver.colorado.edu/pub/Sierras (some browsers may not open this FTP site)
http://instaar.colorado.edu/research/labs-groups/mountain-hydrology-group/page/37199/

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 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 snow gage 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 (2000-2014) 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
96 snow gage sites in the Sierra Nevada network were recording SWE values out of a total of 114 sites, 18 were offline, and 71 were recording 0 (shown in black, red, and yellow, respectively, in Figure 6, 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 just over a hundred snow gage 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 sensor 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 SNOTEL
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.

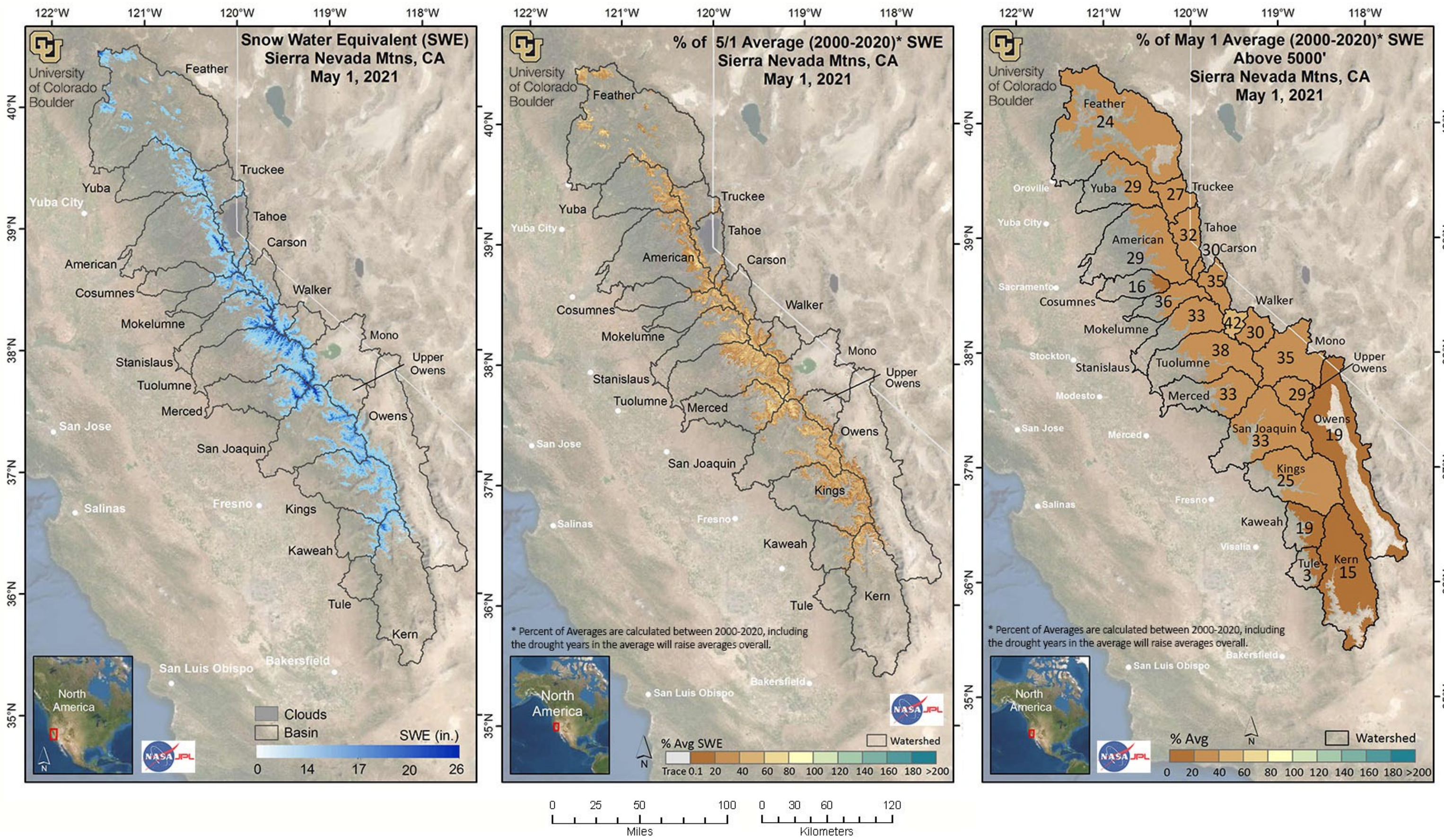


***Figure 2**. Estimated SWE and % of Average SWE across the Sierra Nevada.* SWE amounts for May 1, 2021 (left), percent of average (2000-2020) SWE for May 1, 2021 for the Sierra Nevada, calculated for each pixel (middle) and basin-wide (right). Basin-wide percent of average is calculated across all model pixels >5000' elevation, and includes the drought which brings the percent of average higher.

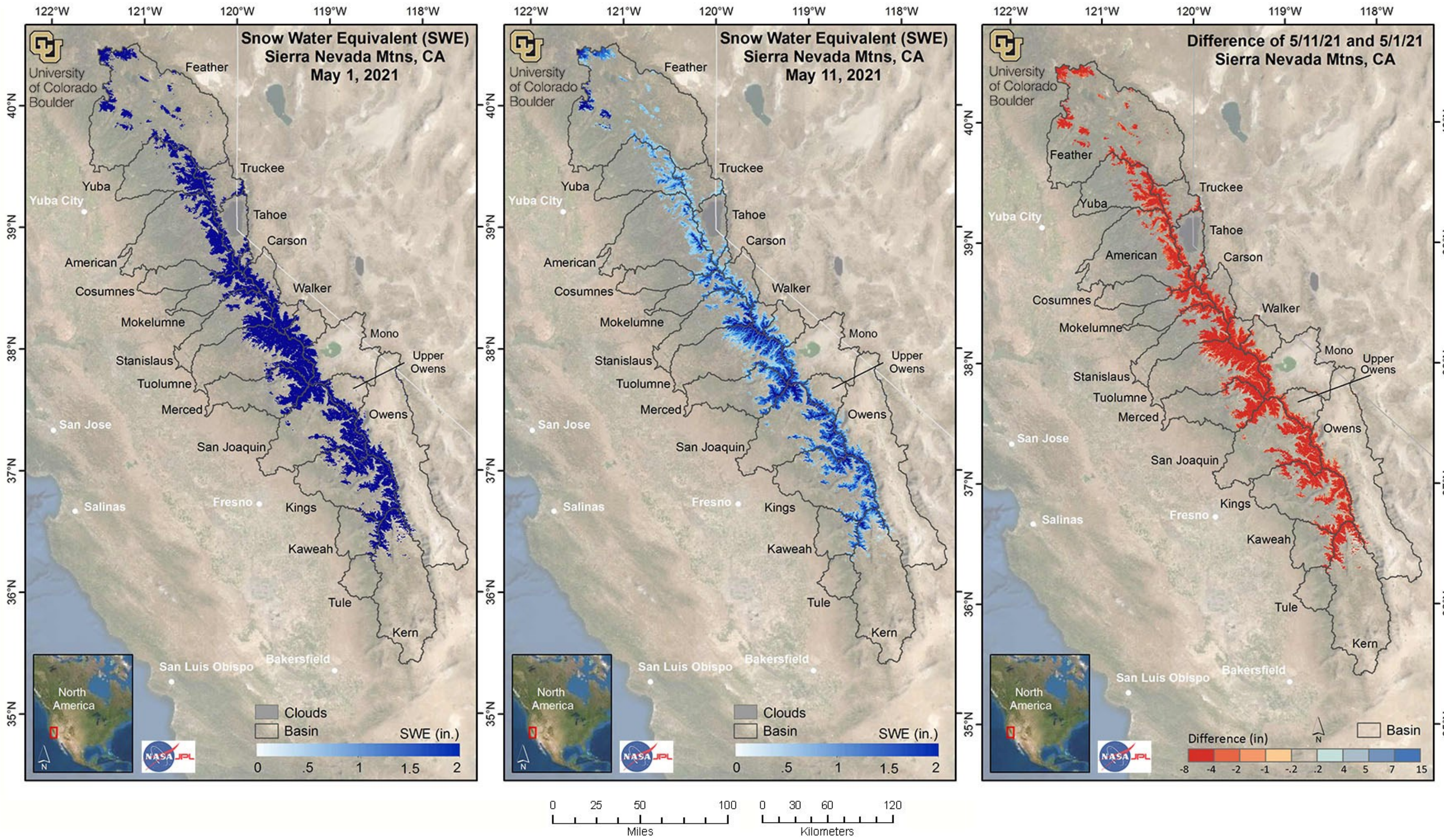


Figure 3. Estimated SWE across the Sierra Nevada, May 11, 2021. SWE amounts for May 1st (left), May 11th (middle) and the difference between May 1st and May 11th (right).

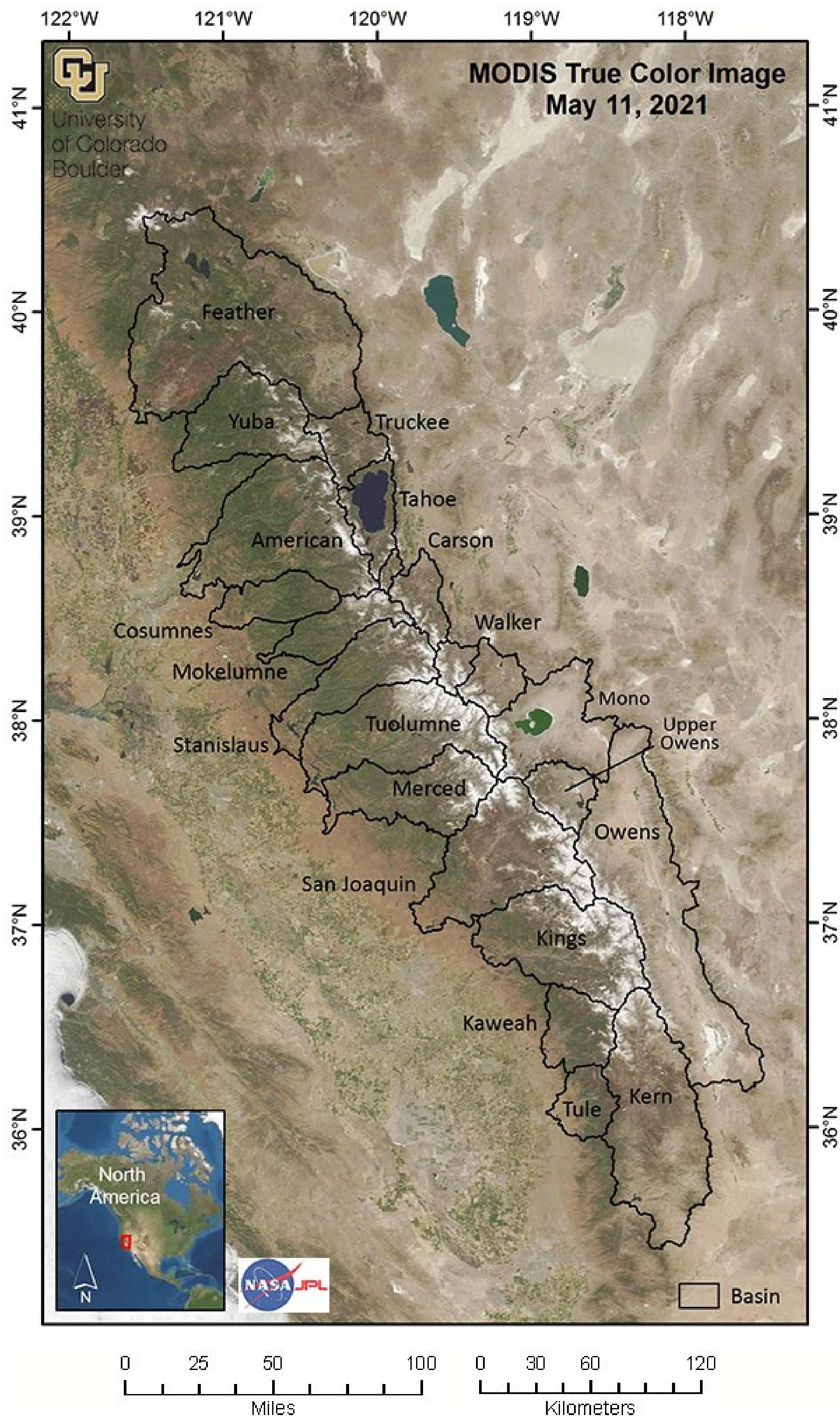


Figure 4. MODIS image, Sierra Nevada. A cloud-free true color MODIS image, showing the MODSCAG fractional snow-covered image that was used for the May 11, 2021 regression model run.

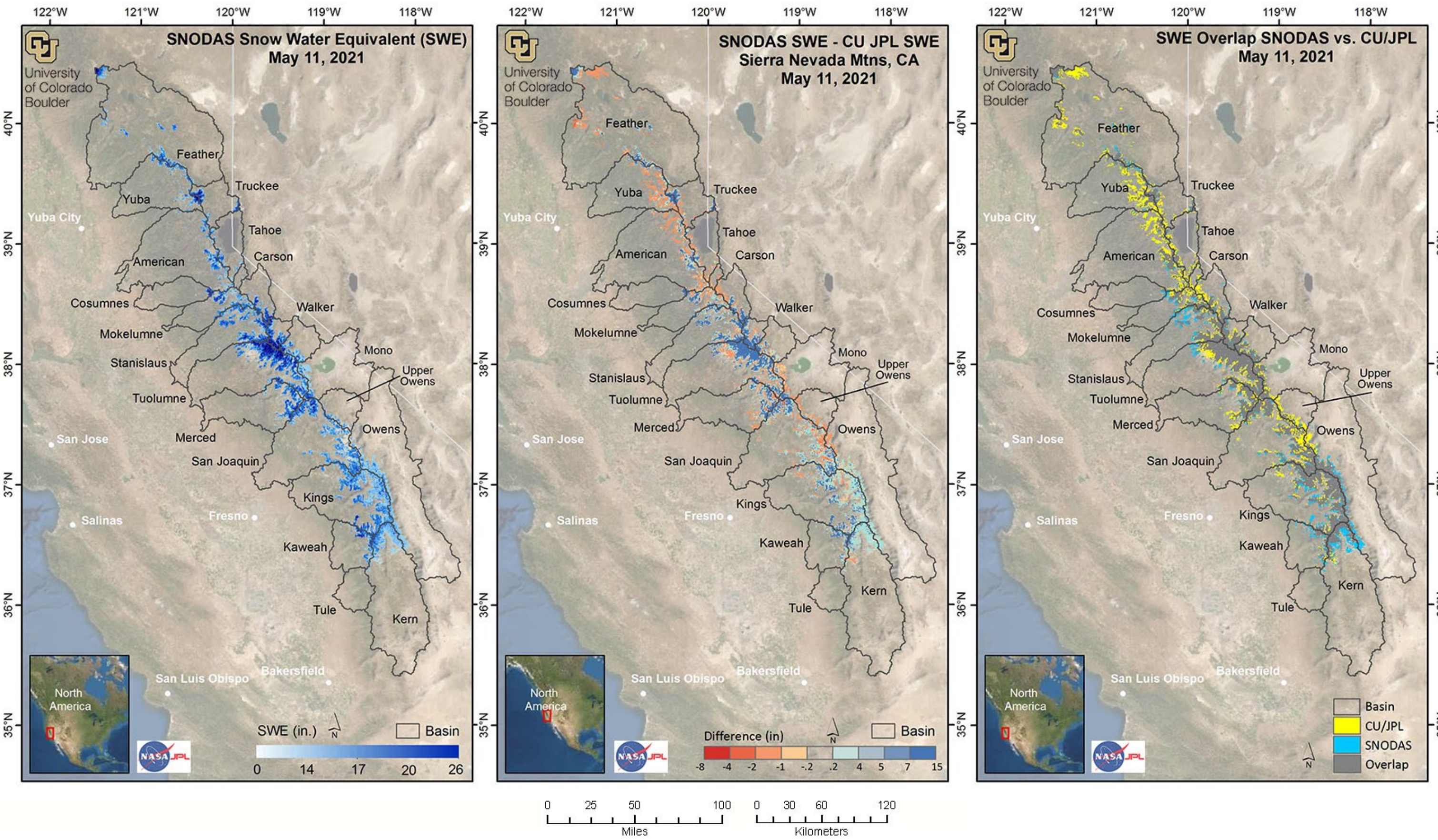


Figure 5. Comparison of CU/JPL regression SWE product and SNODAS SWE for the Sierra Nevada. The map on the left shows estimated SWE for May 11th from the NOAA National Weather Service's National Operational Hydrologic Remote Sensing Center (NOHRSC) SNOw Data Assimilation System (SNODAS). The middle map shows the difference between the May 11th SNODAS SWE estimate and CU/JPL regression SWE estimate. Red pixels denote areas where SNODAS SWE is less than CU/JPL SWE and blue pixels show areas where SNODAS SWE is higher than CU/JPL SWE. The map on the right shows the snow-cover extent of SNODAS and CU/JPL SWE estimates. Yellow pixels show where the location of CU/JPL snow extends beyond the location of the SNODAS snow extent. Blue pixels show where the SNODAS snow extends beyond the CU/JPL snow extent. Gray areas indicate regions where both products agree on the snow-cover extent.

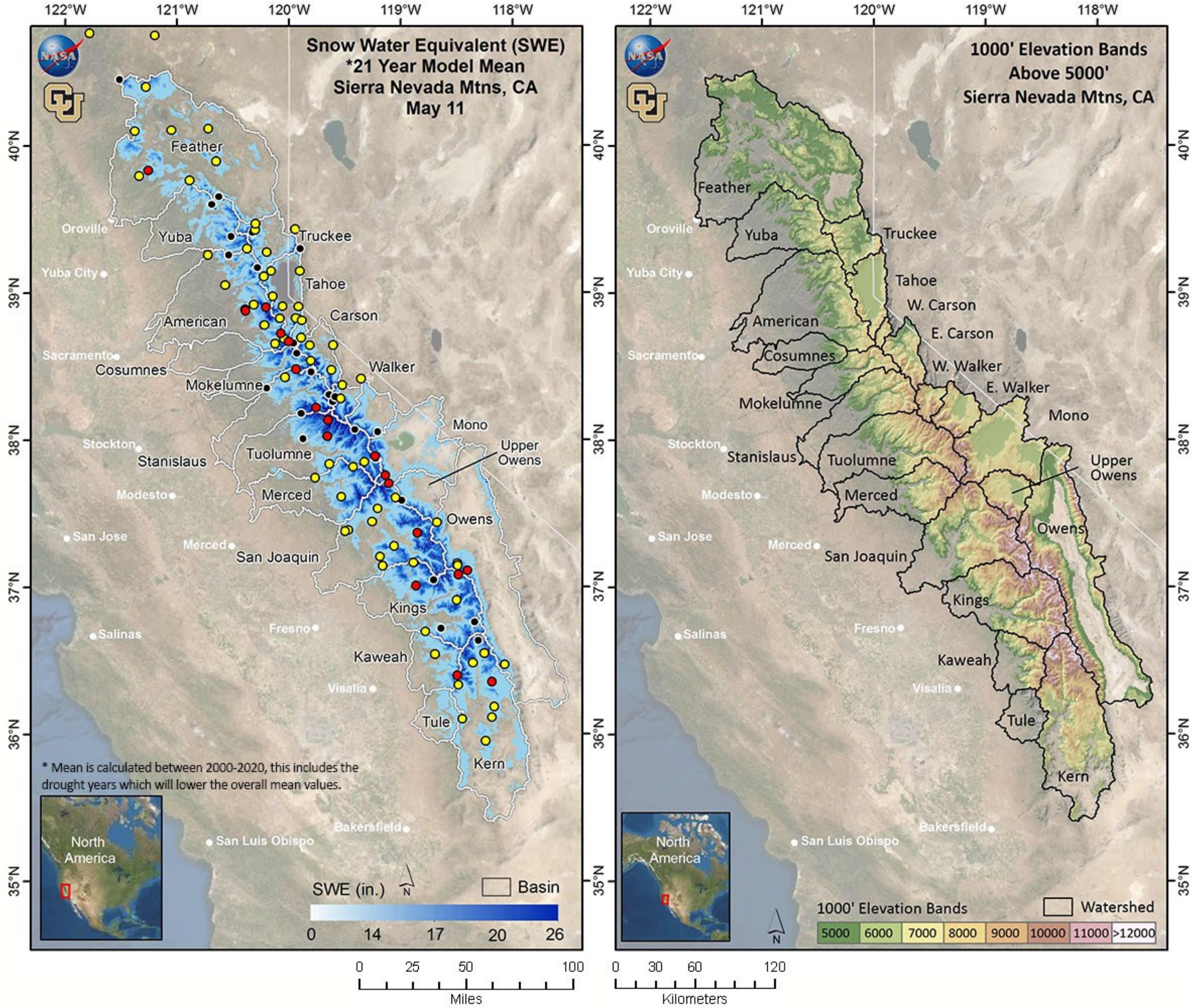


Figure 6. Historical average May 11th and Elevation Bands for the Sierra Nevada. Average SWE (2000-2020) for May 11th (left), and the Banded Elevation map (right) identifies basins used in this report (black boundaries) and 1000' elevation bands (colored shading) that match those used in Table 1 and Table 2. The mean map is calculated using the drought years, which will lower the overall mean values. Map on left shows snow gage sensor sites recording SWE on May 11th (black), sites that were offline are shown in red, and sensors recording zero are shown in yellow.

Methods

The spatial SWE estimation method is described in 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 sensor sites in the domain. The snow sensor SWE observations are scaled by the fractional snow-covered area (fSCA) across the 500 m pixel containing that snow 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, snow.jpl.nasa.gov) 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 Figure 2 in Schneider and Molotch (2016) 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 SNOTEL-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 SNOTEL data are randomly removed and the model prediction is compared to the measured value at the removed SNOTEL stations. This is repeated 30 times to obtain an average R-squared value, which denotes how closely the model fits the SNOTEL 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* May 11, 2021 *– IMPORTANT – READ THIS!

- 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.
- NEW AVERAGE CALCULATIONS – Average calculations are based on 2000-2020 model values, this includes the drought years (2012-2016) which brings our overall average SWE down considerably, thereby increasing percent of averages.
- 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.
- MODEL PERFORMANCE - SWE estimates are based on a statistical model, therefore some areas of the domain (e.g. the northern Sierra) will be underestimated and some areas (e.g. the southern Sierra) will be overestimated. These effects may be larger in 2021 given the large SWE gradient between the North and South.

List of All Known Data Issues/Caveats

- NEW AVERAGE CALCULATIONS – Average calculations are based on 2000-2020 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.
- MODEL PERFORMANCE - SWE estimates are based on a statistical model, therefore some areas of the domain (e.g. the northern Sierra) will be underestimated and some areas (e.g. the southern Sierra) will be overestimated. These effects may be larger in 2021 given the large SWE gradient between the North and South.

Table 1. Estimated SWE by basin. *The basin-wide SWE values and averages, are across all pixels at elevations >5000',* and includes the drought which brings the percent of average higher*. Shown are May 1 percent of May 1 average SWE, May 11 percent of May 11 average SWE (between 2000-2020 as derived from the regression model), May 1 mean SWE, May 11 mean SWE, May 11 percent of snow-covered area, May 11 water volume (acre-feet), the change in SWE between May 1 and May 11, the area (mi^2) inside each basin that contains data pixels (not including cloud-covered pixels, lakes or other satellite no data pixels), May 1 snow pillow data, and May 11 snow pillow data for those areas collected, summarized for each basin. The last column shows May 11 mean SWE from SNODAS*.*

Basin	5/1/21†† % 5/1 Avg.	5/11/21†† % 5/11 Avg.	5/1/21 SWE (in)	5/11/21 SWE (in)	5/11/21 % SCA	5/11/21 Vol (af)	5/1 thru 5/11/21 Chg. in SWE (in)	Area (mi2) > 5000'	5/1/21 Pillows	5/11/21 Pillows	5/11/21 SNODAS* (in)
Feather	24	7	1.2	0.2	9.2	21,249	-1.0	2,033.2	2.5 (6)	0.0 (6)	0.4
Yuba	29	8	3.3	0.6	24.0	14,615	-2.7	433.2	14.2 (4)	6.5 (4)	1.1
American	29	7	2.9	0.5	20.4	19,141	-2.5	780.9	5.3 (10)	0.5 (9)	0.8
Cosumnes	16	4	0.6	0.1	5.2	446	-0.5	83.8	NA	NA	1.2
Mokelumne	36	7	4.3	0.6	31.6	10,413	-3.7	315.6	11.2 (1)	2.1 (1)	2.0
Stanislaus	33	6	4.0	0.5	26.1	15,738	-3.5	555.5	15.0 (6)	5.7 (5)	2.6
Tuolumne	38	7	5.2	0.7	40.9	36,510	-4.5	940.4	5.0 (6)	1.2 (6)	3.8
Merced	33	6	3.9	0.5	27.0	15,846	-3.4	543.5	6.6 (2)	0.0 (2)	1.7
San Joaquin	33	7	4.0	0.6	33.1	39,288	-3.4	1,223.0	0.5 (8)	0.0 (8)	1.5
Kings	25	6	3.0	0.6	33.7	35,516	-2.5	1,195.5	5.1 (6)	0.3 (6)	1.8
Kaweah	19	5	1.5	0.3	15.7	4,312	-1.2	309.0	0.0 (1)	0.0 (1)	1.7
Tule	3	0	0.1	0.0	0.7	32	-0.1	142.0	0.0 (1)	0.0 (1)	0.0
Kern	15	3	0.8	0.1	5.3	9,025	-0.7	1,712.5	0.6 (7)	0.4 (7)	0.3
Truckee	27	6	2.1	0.3	13.5	6,424	-1.8	424.6	5.5 (4)	4.4 (4)	1.1
Tahoe	32	6	3.0	0.4	13.0	7,002	-2.6	308.1	2.5 (7)	0.0 (8)	0.7
W Carson	30	5	4.0	0.4	21.9	1,583	-3.6	69.1	7.5 (2)	2.6 (2)	0.2
E Carson	35	6	3.0	0.4	20.3	7,626	-2.6	375.8	3.5 (5)	0.0 (5)	1.5
W Walker	42	8	6.0	0.8	45.7	8,166	-5.2	188.1	14.7 (3)	9.1 (3)	5.4
E Walker	30	7	2.1	0.3	17.4	6,050	-1.7	370.7	8.2 (1)	1.9 (1)	1.1
Mono	35	8	1.0	0.2	8.2	8,371	-0.9	972.3	NA	NA	0.2
Upper Owens	29	7	1.6	0.3	15.0	5,805	-1.3	388.9	21.3 (1)	12.6 (1)	0.2
Owens	19	5	0.7	0.1	7.7	12,353	-0.5	1,837.0	0.3 (4)	0.0 (4)	0.2

†† Percent of Averages are calculated between 2000-2020, including the drought years in the average will raise averages overall.

* 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',* and includes the drought which brings the percent of average higher. *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 May 1 percent of May 1 average SWE, May 11 percent of May 11 average SWE (between 2000-2020 as derived from the regression model), May 1 mean SWE, May 11 mean SWE, May 11 percent of snow-covered area, May 11 water volume (acre-feet), the change in SWE between May 1 and May 11, the area (mi^2) inside each basin that contains data pixels (not including cloud-covered pixels, lakes or other satellite no data pixels), May 1 snow pillow data, and May 11 snow pillow data for those areas collected, summarized for each 1000' elevation band inside each basin. The last column shows May 11 mean SWE from SNODAS*.*

Basin	Elevation Band	5/1/21†† % 5/1 Avg.	5/11/21†† % 5/11 Avg.	5/1/21 SWE (in)	5/11/21 SWE (in)	5/11/21 % SCA	5/11/21 Vol (af)	5/1 thru 5/11/21 Chg. in SWE (in)	Area (mi2) > 5000'	5/1/21 Pillows	5/11/21 Pillows	5/11/21 SNODAS* (in)
Feather	5000-6000'	11	3	0.3	0.0	2.9	2,748	-0.2	1,210.5	NA	NA	0.0
	6000-7000'	30	9	2.0	0.4	15.9	13,896	-1.7	698.7	3.0 (5)	0.0 (5)	0.6
	7000-8000'	35	7	5.0	0.7	34.6	4,393	-4.3	119.3	0.1 (1)	0.0 (1)	2.5
	8000-9000'	48	6	10.4	0.9	39.4	212	-9.5	4.6	NA	NA	7.2
Yuba	5000-6000'	3	2	0.2	0.0	0.3	345	-0.1	130.8	NA	NA	0.1
	6000-7000'	26	7	3.3	0.7	20.4	6,587	-2.7	185.3	11.6 (3)	4.9 (3)	0.8
	7000-8000'	43	8	8.3	1.2	69.9	7,329	-7.1	112.6	22.1 (1)	11.4 (1)	2.9
	8000-9000'	51	7	13.1	1.5	93.8	354	-11.6	4.5	NA	NA	13.3
American	5000-6000'	1	1	0.0	0.0	0.1	107	0.0	288.8	0.4 (2)	0.0 (2)	0.0
	6000-7000'	16	4	1.7	0.3	8.0	4,153	-1.4	243.0	11.5 (2)	2.4 (2)	0.1
	7000-8000'	35	8	5.8	1.0	46.8	8,792	-4.8	169.6	3.9 (4)	0.0 (4)	2.0
	8000-9000'	50	8	11.5	1.4	83.4	5,252	-10.1	70.4	7.1 (2)	0.1 (1)	3.2
	9000-10,000'	62	8	17.6	1.7	99.2	837	-15.9	9.1	NA	NA	2.0
Cosumnes	5000-6000'	0	0	0.0	0.0	2.1	0	0.0	59.7	NA	NA	0.0
	6000-7000'	9	2	0.7	0.1	7.6	127	-0.6	17.4	NA	NA	1.0
	7000-8000'	37	8	5.9	0.9	24.0	319	-5.0	6.7	NA	NA	12.7
Mokelumne	5000-6000'	0	0	0.0	0.0	0.8	0	0.0	87.2	NA	NA	0.0
	6000-7000'	4	1	0.3	0.0	6.5	102	-0.3	56.3	NA	NA	0.9
	7000-8000'	33	7	5.2	0.8	31.8	3,761	-4.4	85.1	NA	NA	3.7
	8000-9000'	49	8	10.5	1.4	79.8	5,822	-9.1	78.3	11.2 (1)	2.1 (1)	3.3
	9000-10,000'	54	8	14.1	1.6	97.6	728	-12.5	8.6	NA	NA	2.8
Stanislaus	5000-6000'	0	0	0.0	0.0	0.7	0	0.0	111.4	NA	NA	0.0
	6000-7000'	3	0	0.2	0.0	2.5	87	-0.2	125.6	11.3 (1)	0.6 (1)	0.8
	7000-8000'	22	4	3.0	0.4	10.0	2,725	-2.6	139.3	9.6 (2)	0.0 (1)	2.4
	8000-9000'	42	8	8.1	1.2	60.7	6,978	-7.0	112.5	19.4 (2)	8.1 (2)	4.7
	9000-10,000'	53	9	13.1	1.6	93.4	4,587	-11.5	53.1	20.8 (1)	11.4 (1)	8.1
	10,000-11,000'	58	9	16.4	1.9	100.0	1,323	-14.5	13.3	NA	NA	7.0
	> 11,000'	59	9	17.1	2.0	100.0	37	-15.1	0.3	NA	NA	2.8
Tuolumne	5000-6000'	0	0	0.0	0.0	0.0	0	0.0	179.0	NA	NA	0.0
	6000-7000'	1	0	0.1	0.0	0.3	30	-0.1	143.2	1.2 (1)	0.9 (1)	0.1
	7000-8000'	16	3	2.0	0.3	14.8	2,435	-1.7	149.6	3.4 (1)	0.0 (1)	1.0
	8000-9000'	37	8	6.5	1.0	55.4	9,108	-5.4	167.0	0.3 (2)	0.0 (2)	4.2
	9000-10,000'	47	9	10.5	1.5	84.2	14,225	-9.0	181.5	12.4 (2)	3.1 (2)	10.8
	10,000-11,000'	53	9	13.3	1.6	97.4	7,939	-11.7	91.2	NA	NA	8.4
	11,000-12,000'	56	9	14.5	1.8	100.0	2,457	-12.7	26.0	NA	NA	1.3
	> 12,000'	59	10	16.3	2.0	95.2	316	-14.3	2.9	NA	NA	0.3
Merced	5000-6000'	0	0	0.0	0.0	0.0	0	0.0	74.9	NA	NA	0.0
	6000-7000'	0	0	0.0	0.0	0.6	0	0.0	78.2	NA	NA	0.0
	7000-8000'	6	1	0.6	0.1	1.6	487	-0.5	135.3	NA	NA	0.0
	8000-9000'	27	6	4.2	0.6	22.9	4,025	-3.6	116.2	6.6 (2)	0.0 (2)	0.7
	9000-10,000'	45	9	9.1	1.4	78.4	6,333	-7.7	86.1	NA	NA	6.8
	10,000-11,000'	56	9	13.9	1.7	97.6	3,571	-12.3	39.7	NA	NA	6.1
	11,000-12,000'	63	10	17.6	2.0	93.5	1,225	-15.6	11.6	NA	NA	1.2
	> 12,000'	66	10	20.6	2.4	100.0	204	-18.3	1.6	NA	NA	0.1

Basin	Elevation Band	5/1/21†† % 5/1 Avg.	5/11/21†† % 5/11 Avg.	5/1/21 SWE (in)	5/11/21 SWE (in)	5/11/21 % SCA	5/11/21 Vol (af)	5/1 thru 5/11/21 Chg. in SWE (in)	Area (mi2) > 5000'	5/1/21 Pillows	5/11/21 Pillows	5/11/21 SNODAS* (in)
San Joaquin	5000-6000'	0	0	0.0	0.0	0.0	0	0.0	139.4	NA	NA	0.0
	6000-7000'	0	0	0.0	0.0	0.2	0	0.0	181.7	0.0 (3)	0.0 (3)	0.0
	7000-8000'	1	0	0.1	0.0	1.7	150	-0.1	214.4	1.0 (4)	0.0 (4)	0.0
	8000-9000'	15	4	1.8	0.3	13.7	3,083	-1.5	188.8	NA	NA	0.4
	9000-10,000'	33	8	5.9	1.0	51.8	10,401	-4.9	195.1	0.0 (1)	0.0 (1)	3.3
	10,000-11,000'	46	9	10.0	1.5	86.6	12,517	-8.5	156.0	NA	NA	4.4
	11,000-12,000'	48	9	11.7	1.6	94.6	10,447	-10.1	119.2	NA	NA	3.0
	> 12,000'	46	9	12.2	1.8	98.8	2,690	-10.4	28.4	NA	NA	1.3
Kings	5000-6000'	0	0	0.0	0.0	0.1	0	0.0	101.3	NA	NA	0.0
	6000-7000'	0	0	0.0	0.0	0.3	0	0.0	136.8	NA	NA	0.0
	7000-8000'	0	0	0.0	0.0	1.4	4	0.0	173.7	0.0 (1)	0.0 (1)	0.0
	8000-9000'	5	1	0.5	0.1	4.8	691	-0.4	203.0	NA	NA	0.1
	9000-10,000'	18	5	2.8	0.6	29.9	5,819	-2.2	194.2	10.4 (2)	0.4 (2)	2.5
	10,000-11,000'	31	9	5.9	1.3	76.6	12,189	-4.7	181.3	3.3 (3)	0.4 (3)	4.4
	11,000-12,000'	41	9	8.9	1.5	92.0	12,307	-7.4	152.2	NA	NA	4.0
	> 12,000'	41	9	9.9	1.6	95.8	4,506	-8.3	52.9	NA	NA	3.7
Kaweah	5000-6000'	0	0	0.0	0.0	0.0	0	0.0	61.4	NA	NA	0.0
	6000-7000'	0	0	0.0	0.0	0.0	0	0.0	60.7	0.0 (1)	0.0 (1)	0.0
	7000-8000'	0	0	0.0	0.0	1.0	4	0.0	61.2	NA	NA	0.2
	8000-9000'	4	1	0.5	0.1	8.0	239	-0.4	52.2	NA	NA	0.8
	9000-10,000'	18	6	2.8	0.6	34.2	1,239	-2.1	36.4	NA	NA	4.9
	10,000-11,000'	37	9	7.5	1.4	75.7	2,102	-6.1	28.5	NA	NA	7.6
	11,000-12,000'	48	9	10.8	1.6	84.7	716	-9.2	8.4	NA	NA	5.4
	> 12,000'	50	9	11.0	1.6	100.0	12	-9.4	0.1	NA	NA	8.6
Tule	5000-6000'	0	0	0.0	0.0	0.0	0	0.0	55.2	NA	NA	0.0
	6000-7000'	0	0	0.0	0.0	0.2	0	0.0	41.6	NA	NA	0.0
	7000-8000'	0	0	0.0	0.0	0.5	0	0.0	26.6	0.0 (1)	0.0 (1)	0.0
	8000-9000'	1	0	0.1	0.0	0.5	0	-0.1	14.4	NA	NA	0.0
	9000-10,000'	13	1	1.8	0.1	15.9	32	-1.7	4.1	NA	NA	0.7
	10,000-11,000'	26	0	4.0	0.0	0.0	0	-4.0	0.1	NA	NA	1.8
Kern	5000-6000'	0	0	0.0	0.0	0.0	0	0.0	258.0	NA	NA	0.0
	6000-7000'	0	0	0.0	0.0	0.0	0	0.0	347.6	NA	NA	0.0
	7000-8000'	0	0	0.0	0.0	0.0	0	0.0	326.5	0.0 (1)	0.0 (1)	0.0
	8000-9000'	0	0	0.0	0.0	0.1	0	0.0	325.0	0.0 (2)	0.0 (2)	0.0
	9000-10,000'	3	0	0.3	0.0	1.3	231	-0.3	191.0	0.0 (1)	0.0 (1)	0.2
	10,000-11,000'	15	3	2.4	0.3	16.1	2,110	-2.1	131.0	0.0 (2)	0.0 (2)	1.2
	11,000-12,000'	29	5	6.2	0.8	43.7	4,010	-5.4	92.3	4.0 (1)	3.1 (1)	2.7
	> 12,000'	33	7	8.1	1.2	59.8	2,674	-6.9	41.0	NA	NA	3.4
Truckee	5000-6000'	0	0	0.0	0.0	0.0	0	0.0	69.0	NA	NA	0.0
	6000-7000'	10	3	0.4	0.1	1.4	784	-0.4	207.6	5.5 (4)	4.4 (4)	0.1
	7000-8000'	30	6	4.2	0.6	28.7	3,548	-3.6	109.6	NA	NA	1.8
	8000-9000'	42	6	8.6	1.0	58.6	1,561	-7.6	30.1	NA	NA	6.4
	9000-10,000'	39	7	9.3	1.2	81.6	503	-8.1	7.9	NA	NA	9.6
	10,000-11,000'	45	6	12.4	1.3	100.0	29	-11.1	0.4	NA	NA	9.2

Basin	Elevation Band	5/1/21†† % 5/1 Avg.	5/11/21†† % 5/11 Avg.	5/1/21 SWE (in)	5/11/21 SWE (in)	5/11/21 % SCA	5/11/21 Vol (af)	5/1 thru 5/11/21 Chg. in SWE (in)	Area (mi2) > 5000'	5/1/21 Pillows	5/11/21 Pillows	5/11/21 SNODAS* (in)
Tahoe	6000-7000'	9	3	0.2	0.0	0.3	259	-0.1	122.8	2.6 (3)	0.0 (3)	0.0
	7000-8000'	24	6	2.4	0.4	16.4	2,138	-2.0	99.5	2.5 (4)	0.0 (4)	0.5
	8000-9000'	39	7	7.1	0.9	48.9	3,367	-6.1	67.6	NA	0.0 (1)	1.6
	9000-10,000'	47	7	11.2	1.3	85.5	1,179	-9.9	17.3	NA	NA	4.0
	10,000-11,000'	54	7	14.1	1.3	91.7	59	-12.8	0.8	NA	NA	3.3
W. Carson	5000-6000'	0	0	0.0	0.0	0.0	0	0.0	0.2	NA	NA	0.0
	6000-7000'	0	0	0.0	0.0	0.0	0	0.0	2.2	NA	NA	0.0
	7000-8000'	14	2	1.3	0.1	3.4	159	-1.2	31.9	NA	NA	0.0
	8000-9000'	34	5	5.6	0.6	32.6	917	-5.0	26.8	7.5 (2)	2.6 (2)	0.1
	9000-10,000'	45	7	10.5	1.2	63.5	458	-9.3	7.2	NA	NA	1.0
	10,000-11,000'	51	7	12.2	1.2	81.8	49	-11.0	0.8	NA	NA	3.0
E. Carson	5000-6000'	0	0	0.0	0.0	0.0	0	0.0	50.5	NA	NA	0.0
	6000-7000'	4	0	0.0	0.0	0.0	0	0.0	77.9	0.0 (1)	0.0 (1)	0.0
	7000-8000'	17	4	0.9	0.1	2.5	628	-0.8	101.9	4.8 (1)	0.0 (1)	0.0
	8000-9000'	33	6	5.0	0.7	35.0	3,535	-4.3	98.6	4.2 (3)	0.0 (3)	1.2
	9000-10,000'	46	8	10.2	1.3	80.0	2,515	-8.9	36.1	NA	NA	8.7
	10,000-11,000'	54	8	14.2	1.6	96.1	925	-12.5	10.6	NA	NA	10.8
	> 11,000'	57	7	16.0	1.6	100.0	24	-14.4	0.3	NA	NA	6.7
W. Walker	6000-7000'	0	0	0.0	0.0	0.0	0	0.0	7.8	NA	NA	0.0
	7000-8000'	2	1	0.1	0.0	0.0	8	-0.1	40.2	0.0 (1)	0.0 (1)	0.0
	8000-9000'	23	6	2.6	0.4	16.7	1,038	-2.2	46.1	11.0 (1)	1.9 (1)	2.1
	9000-10,000'	44	8	9.2	1.3	78.3	4,488	-7.9	64.4	33.1 (1)	25.3 (1)	10.4
	10,000-11,000'	54	8	14.0	1.7	96.2	2,435	-12.3	27.3	NA	NA	8.7
	> 11,000'	52	8	13.7	1.7	100.0	197	-12.0	2.2	NA	NA	4.9
E. Walker	6000-7000'	0	0	0.0	0.0	0.0	0	0.0	60.6	NA	NA	0.0
	7000-8000'	2	2	0.0	0.0	0.0	25	0.0	118.9	NA	NA	0.0
	8000-9000'	8	2	0.5	0.1	3.5	386	-0.4	92.8	NA	NA	0.2
	9000-10,000'	30	7	4.7	0.8	43.8	2,292	-3.9	55.1	8.2 (1)	1.9 (1)	3.7
	10,000-11,000'	45	9	10.1	1.4	86.3	2,626	-8.7	34.4	NA	NA	4.7
	11,000-12,000'	45	8	11.2	1.5	90.4	702	-9.7	8.7	NA	NA	2.1
	> 12,000'	52	9	12.8	1.6	66.7	18	-11.2	0.2	NA	NA	0.7
Mono	6000-7000'	6	0	0.0	0.0	0.3	0	0.0	307.8	NA	NA	0.0
	7000-8000'	0	0	0.0	0.0	0.0	4	0.0	356.2	NA	NA	0.0
	8000-9000'	2	1	0.1	0.0	1.0	155	0.0	167.4	NA	NA	0.0
	9000-10,000'	22	7	2.6	0.6	32.1	1,888	-2.1	62.7	NA	NA	1.3
	10,000-11,000'	44	9	9.3	1.4	84.3	3,637	-7.9	47.8	NA	NA	3.1
	11,000-12,000'	50	9	12.5	1.6	92.1	2,270	-10.8	26.1	NA	NA	0.8
	> 12,000'	51	9	13.4	1.8	84.1	417	-11.6	4.3	NA	NA	0.2
Upper Owens	6000-7000'	>200†	0	0.0	0.0	0.0	0	0.0	65.8	NA	NA	0.0
	7000-8000'	0	0	0.0	0.0	0.0	0	0.0	152.7	NA	NA	0.0
	8000-9000'	14	4	0.9	0.2	4.2	679	-0.7	78.2	NA	NA	0.0
	9000-10,000'	27	8	3.3	0.7	36.2	1,508	-2.6	40.7	21.3 (1)	12.6 (1)	0.8
	10,000-11,000'	39	9	6.9	1.2	69.0	2,088	-5.7	32.6	NA	NA	1.6
	11,000-12,000'	43	9	9.7	1.5	85.5	1,244	-8.1	15.3	NA	NA	0.4
	> 12,000'	34	8	8.3	1.5	89.1	285	-6.8	3.6	NA	NA	0.0
Owens	5000-6000'	0	0	0	0	0	0	0.0	447.1	NA	NA	0.0
	6000-7000'	0	0	0	0	0	0	0.0	358.7	NA	NA	0.0
	7000-8000'	0	0	0.0	0.0	0.0	0	0.0	334.2	NA	NA	0.0
	8000-9000'	0	0	0.0	0.0	0.3	0	0.0	190.0	NA	NA	0.0
	9000-10,000'	1	0	0.0	0.0	2.1	73	0.0	149.8	0.2 (2)	0.0 (2)	0.0
	10,000-11,000'	9	4	0.9	0.2	16.5	1,992	-0.7	156.1	0.5 (2)	0.0 (2)	0.5
	11,000-12,000'	24	7	4.1	0.9	48.7	5,801	-3.3	125.7	NA	NA	1.4
	> 12,000'	31	7	6.6	1.1	55.9	4,486	-5.5	75.3	NA	NA	1.5

†† Percent of Averages are calculated between 2000-2020, including the drought years in the average will raise averages overall.

† Deep, low-elevation snow in areas that typically are snow-free can report exceptionally high percent of average for this date because the mean 2000-2020 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

ftp://snowserver.colorado.edu/pub/Sierras

http://instaar.colorado.edu/research/labs-groups/mountain-hydrology-group/page/37199/

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