http://cwest.colorado.edu

Integrating satellite data, distributed models, and SNOTEL observations to improve real-time SWE estimation in the Colorado River Basin

Noah Molotch, Leanne Lestak, Kehan Yang & Keith Musselman

Noah.Molotch@Colorado.edu

CWEST University of Colorado Boulder INSTAAR University of Colorado Boulder

Photo: Jim Steenburgh

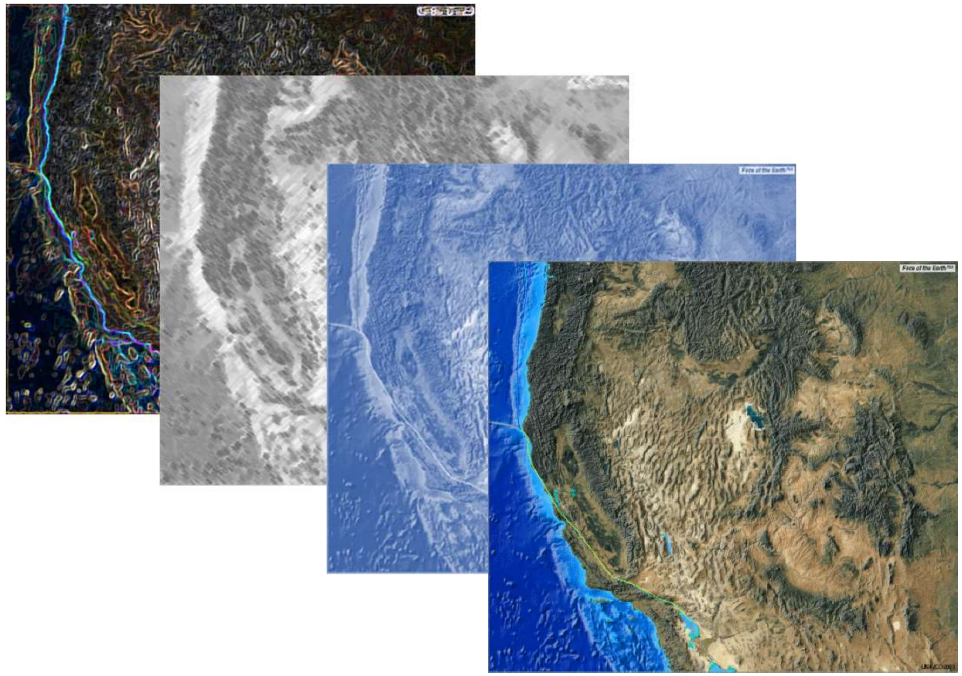
Objective

- Develop more accurate spatial snow estimates using satellite data.
  - Reconstruct SWE distribution using MODIS snow cover data and an energy balance model.
  - Use multi-variate regression to interpolate SNOTEL & CoCoRaHS SWE based on topography & historical satellite data.
  - Reanalysis and real time daily SWE products at 500-m resolution from 2000 – present.

SNOTEL SWE Interpolation

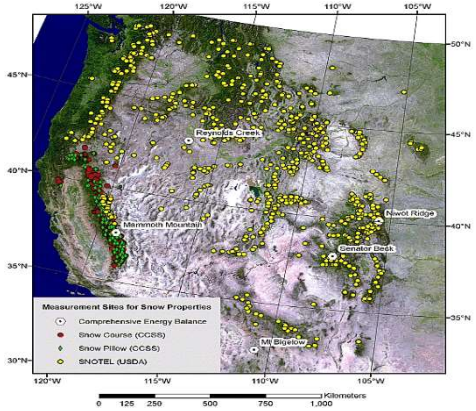
Independent Variables

DEM: slope, aspect, elevation, NW barrier difference, distance to ocean, others.
Historical Satellite-model derived SWE.

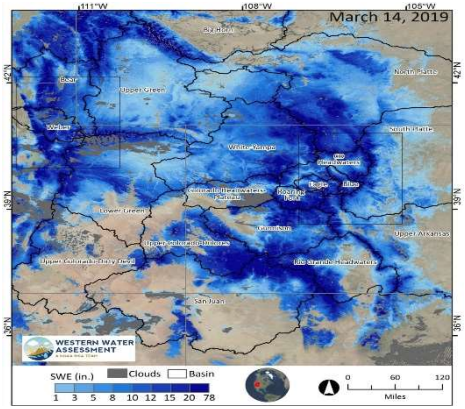


Dependent Variable

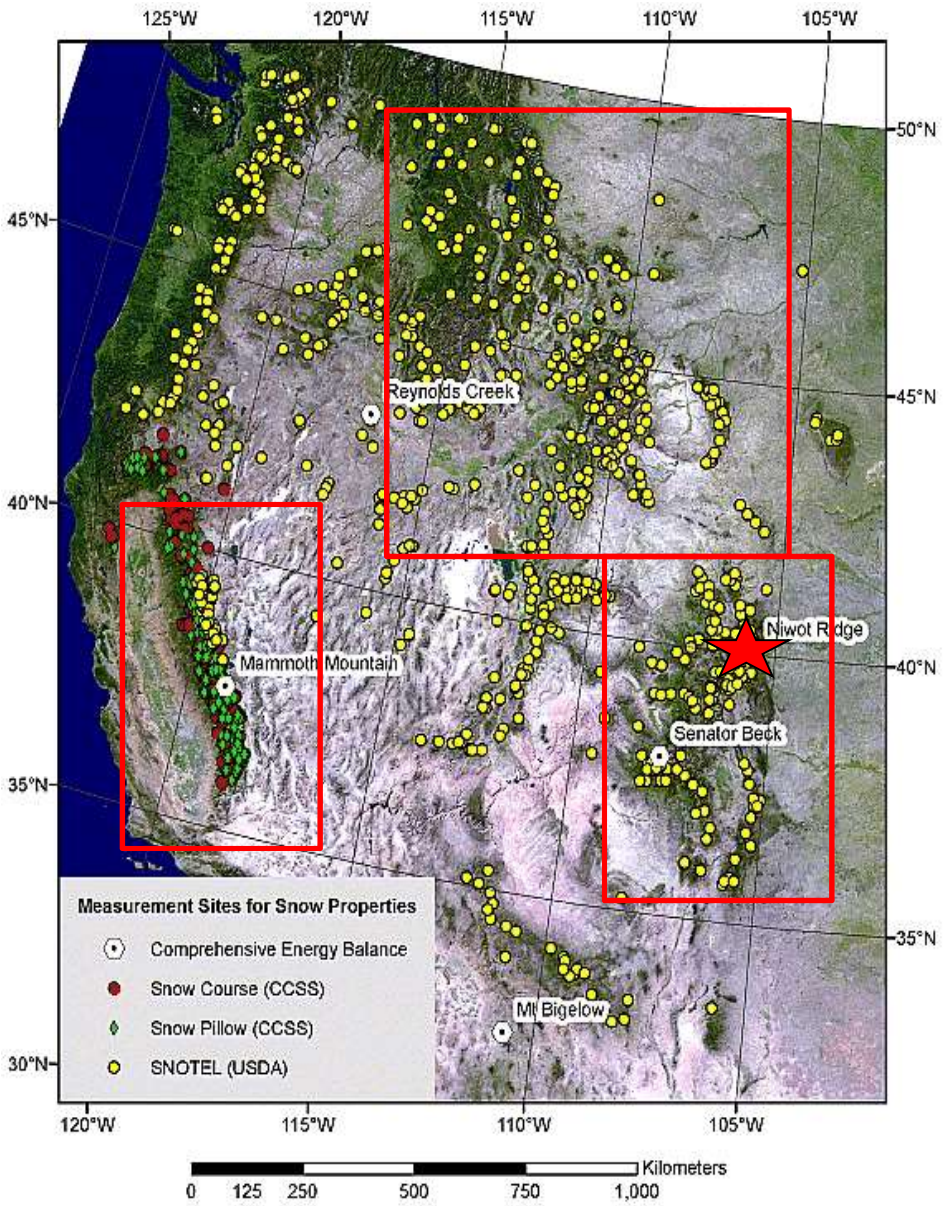
SNOTEL SWE
CoCoRaHS
Measurements



Gridded SWE Prediction



Study Areas & Data



Snowpack Metrics

- 450+ SNOTEL SWE sites
- 300+ CoCoRaHS sites

- MODIS-based SWE Reconstruction (*Guan et al., 2013; Molotch et al., 2009*)

Independent Variables

- Elevation, slope, aspect, distance to ocean, barrier height, others.

- MODIS-based SWE Reconstruction

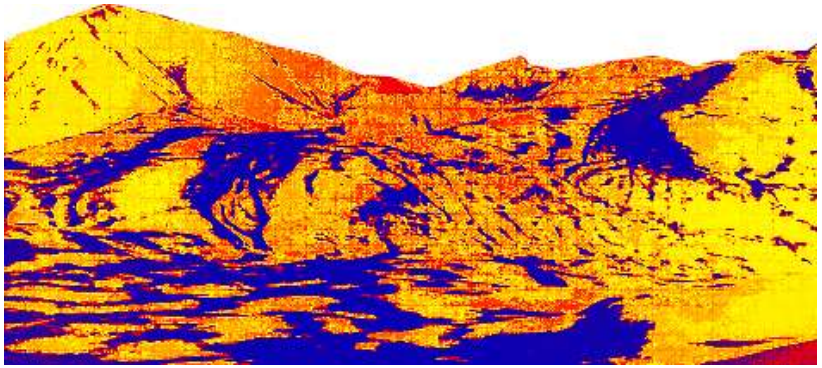
SWE Reconstruction model

- Model uses energy balance to recover amount of snow prior to melt.

- Requires adequate estimate of snowpack energy balance and satellite observed snow covered area.

snow covered area

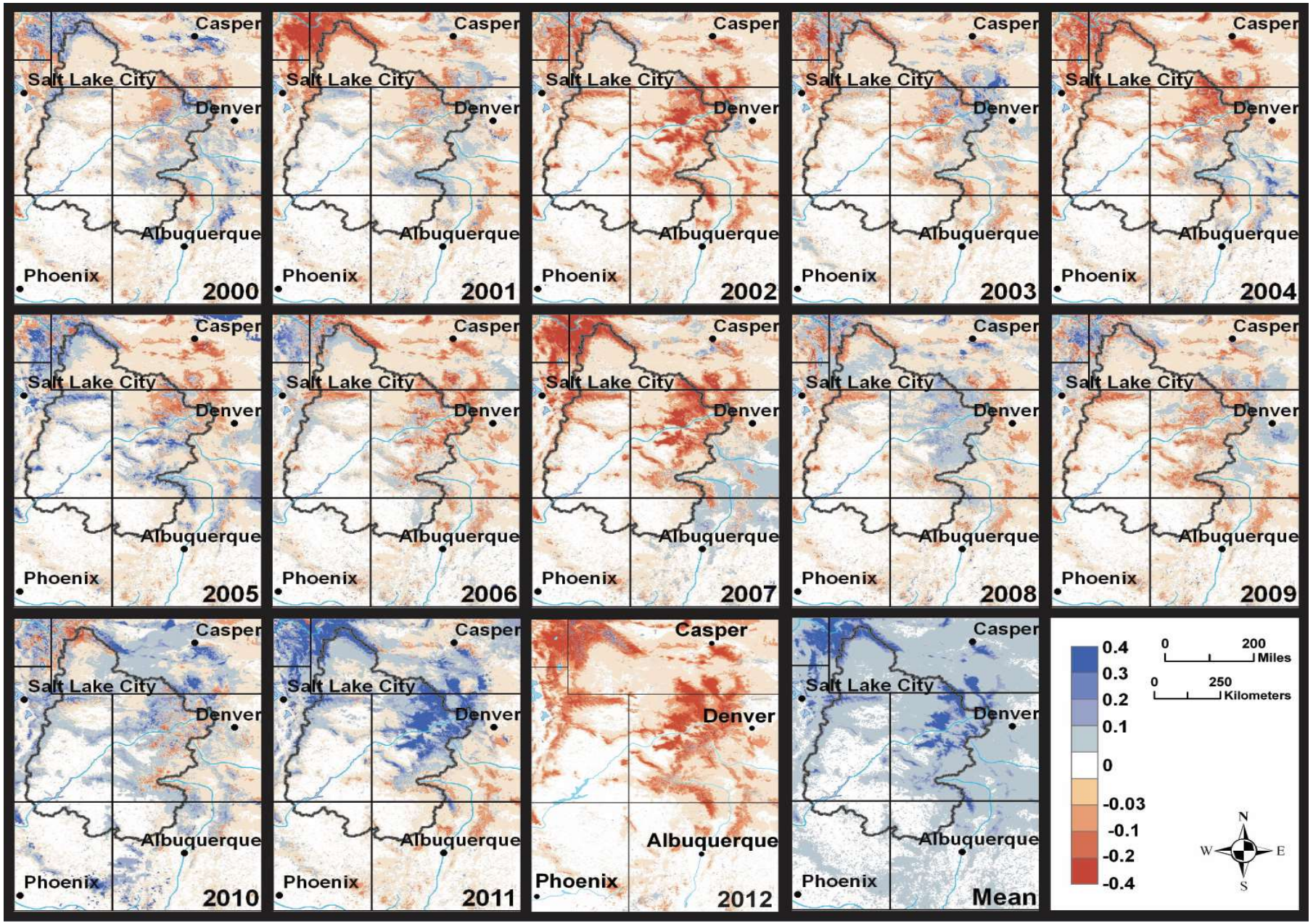
daily snowmelt, cm



0 1.6 3.2

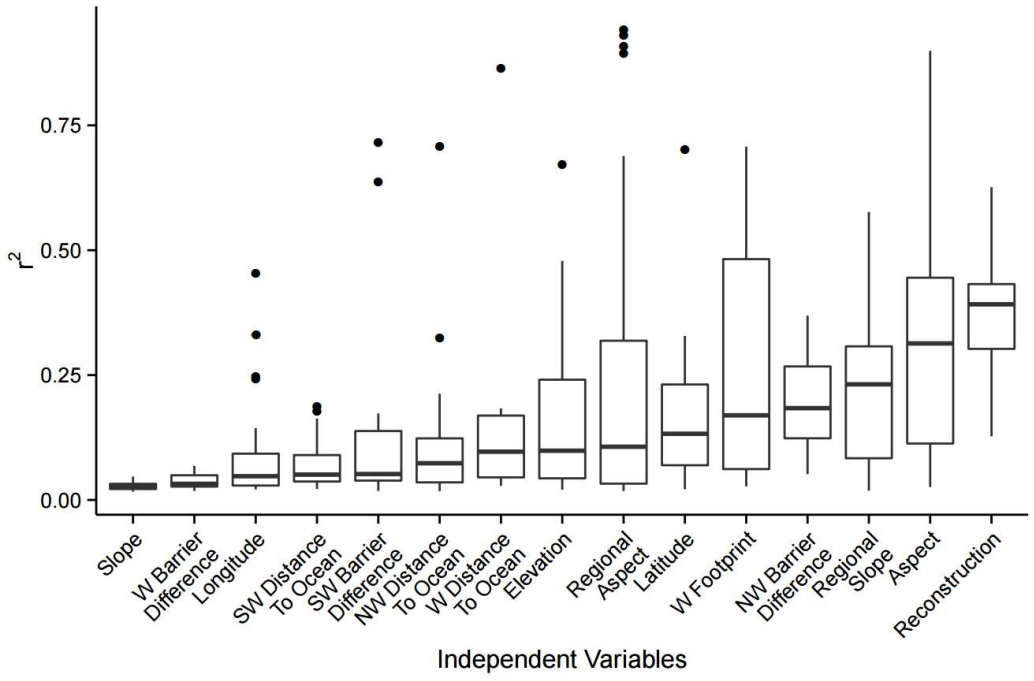
Cline et al., 1998a,b; Liston, 1999; Molotch et al., 2004b; Molotch & Bales, 2005;2006; Durand et al., 2007; Molotch, 2008.

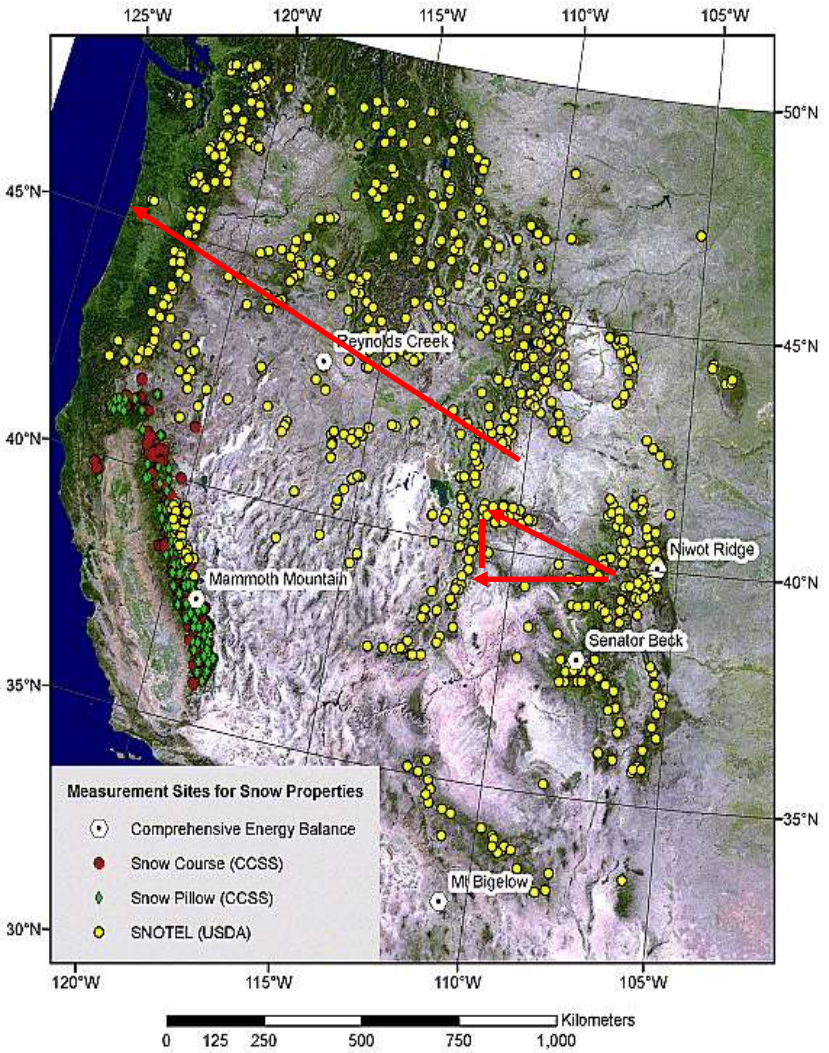
Historical Colorado River Basin Snowpack



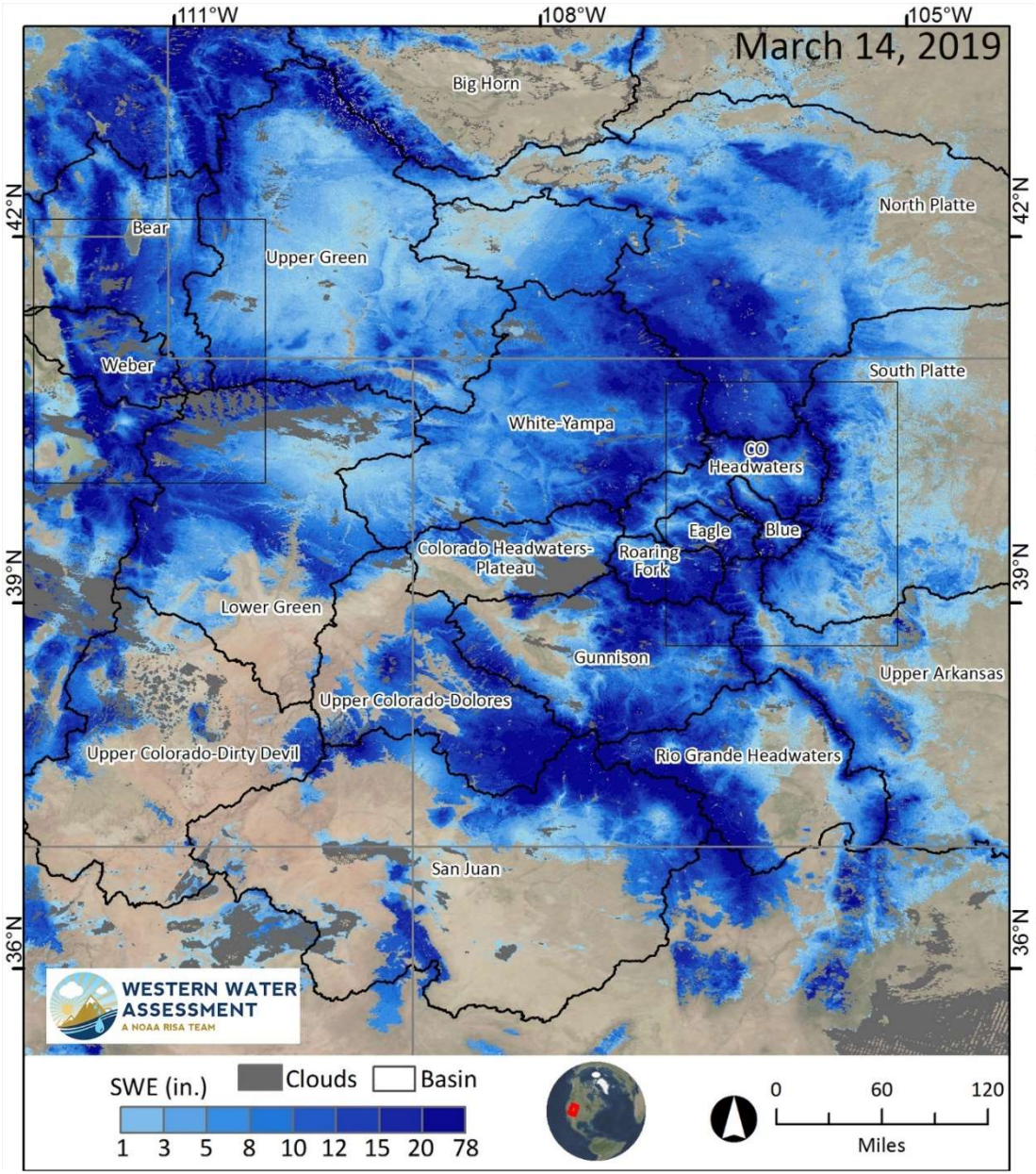
Correlation between SNOTEL SWE & Single Variables

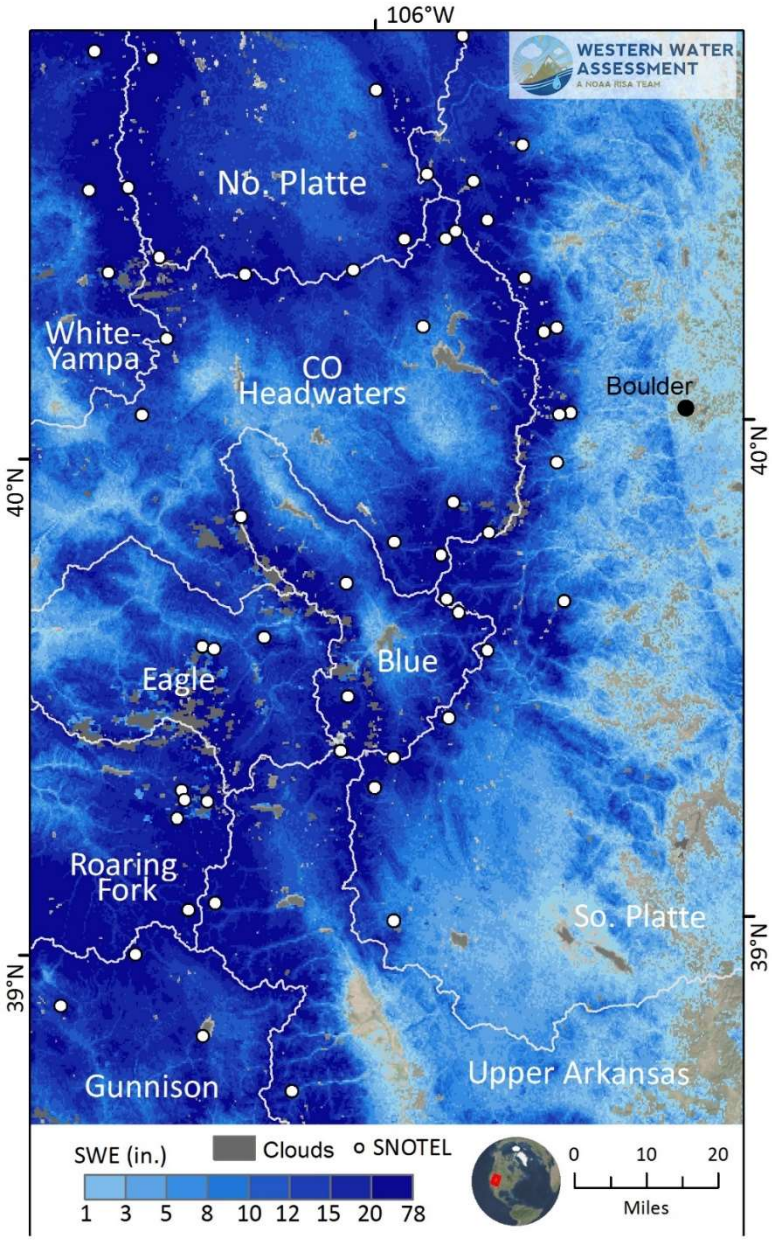
April 1, 2010 - 2015



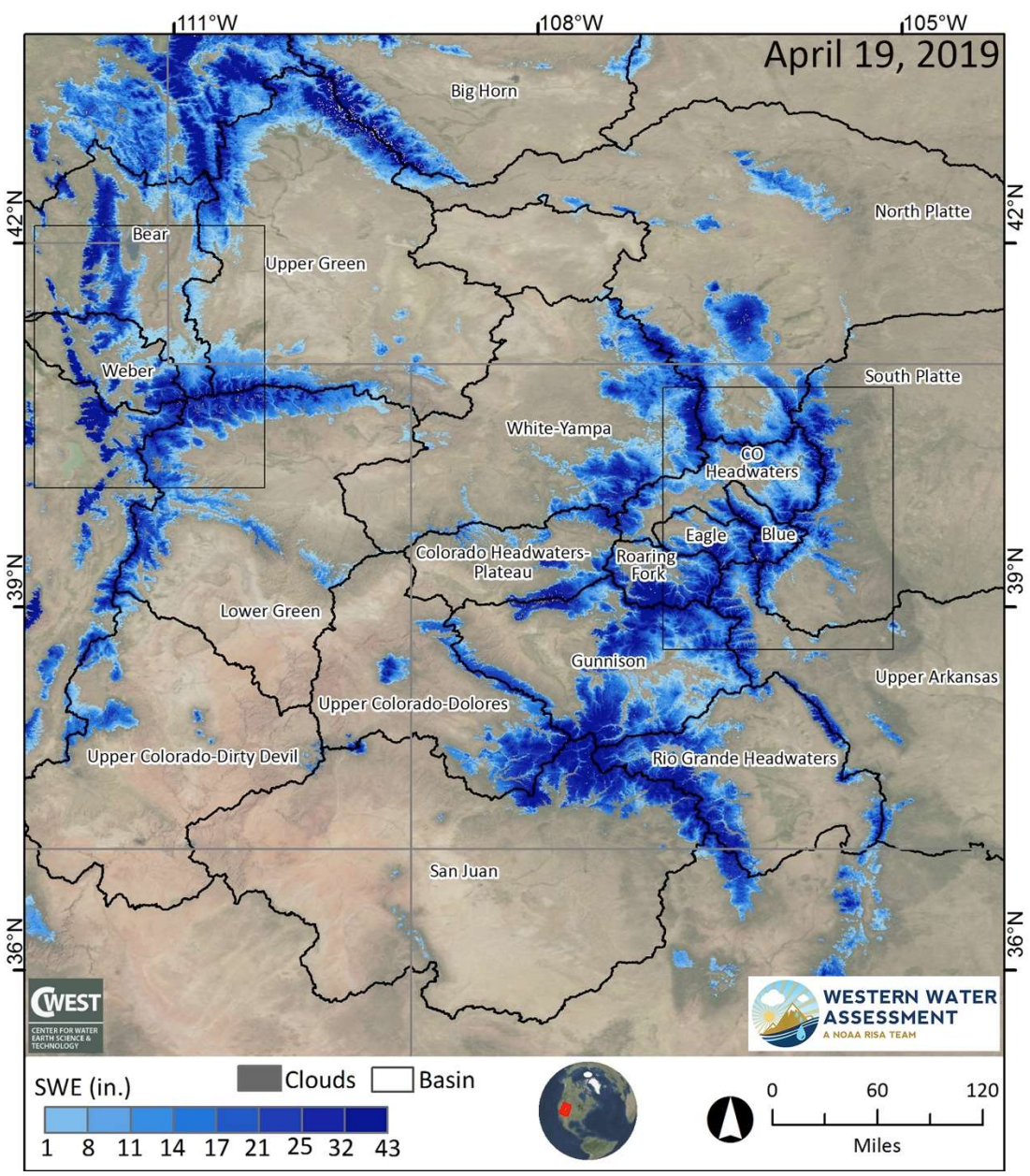


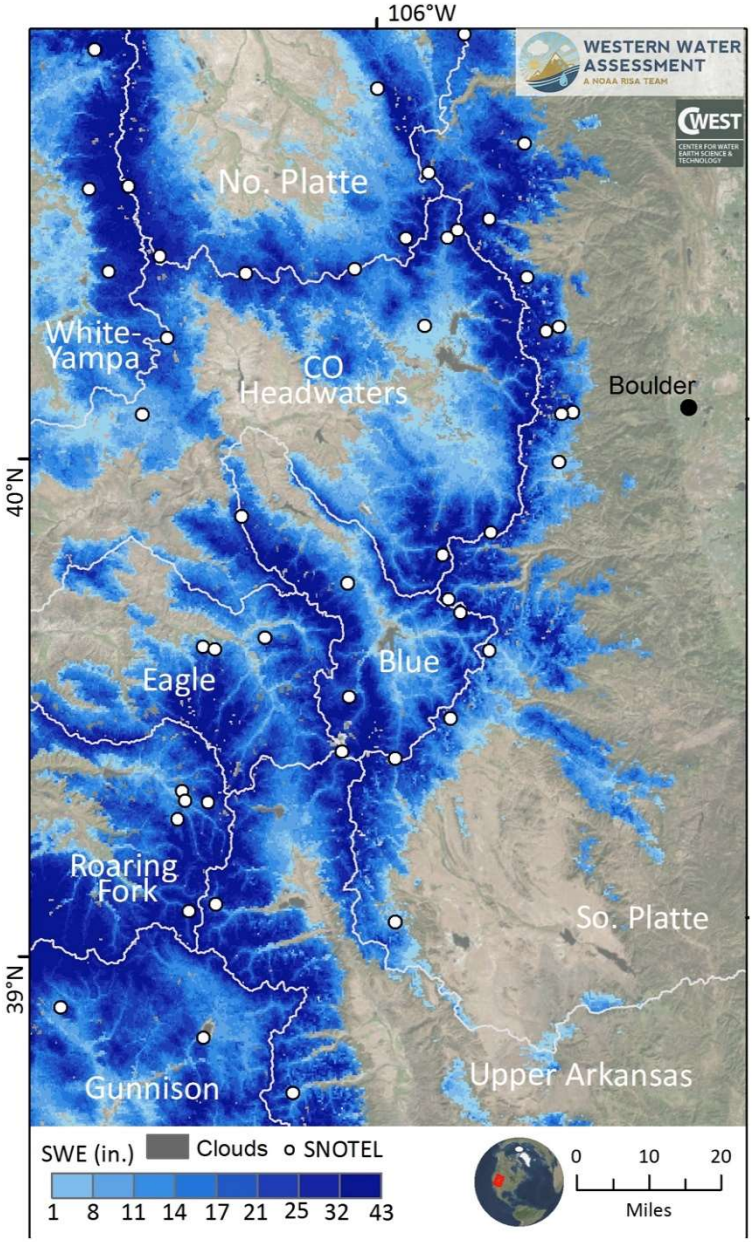
Real-time SWE for the Southern Rockies



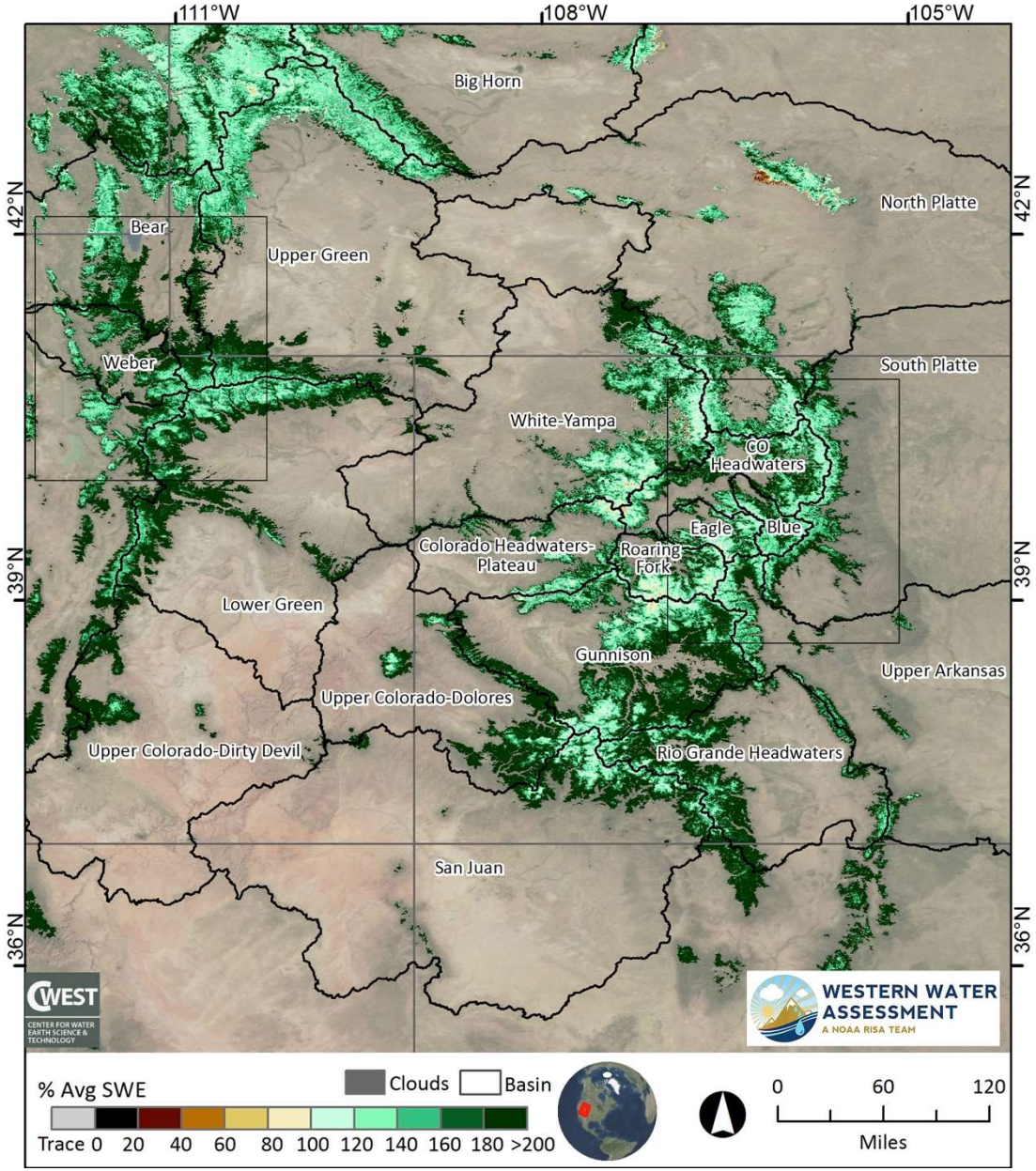


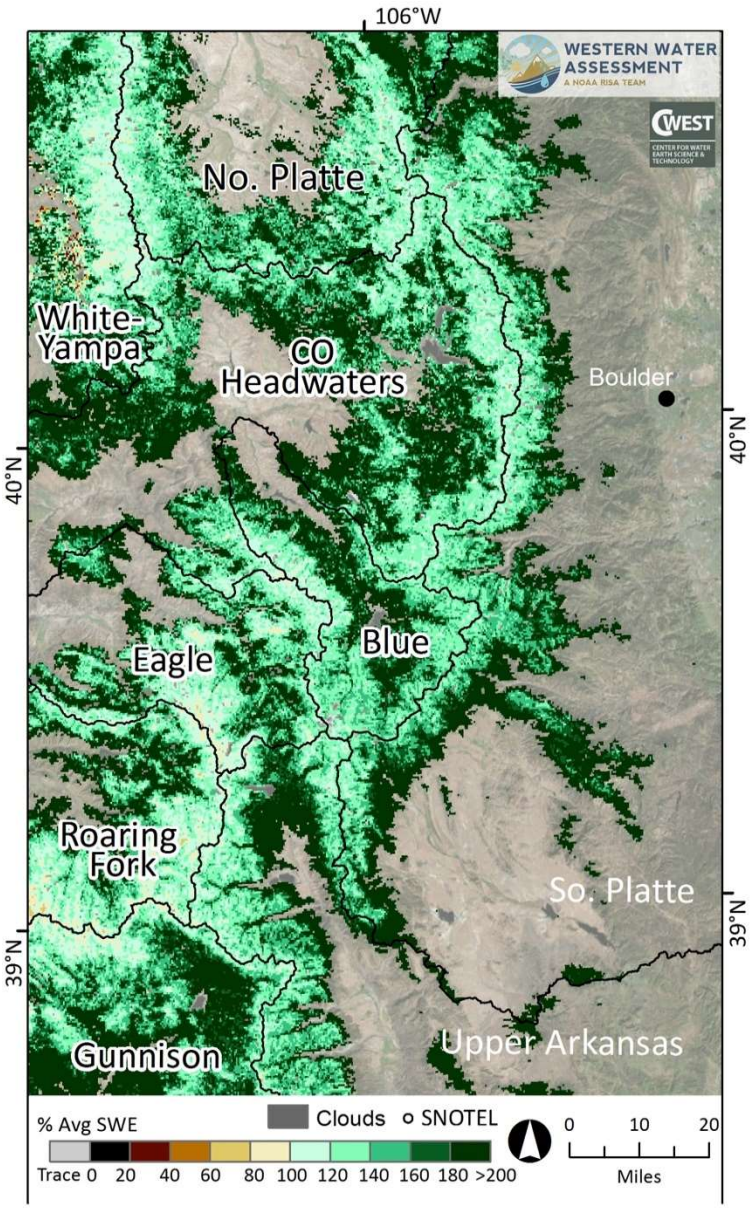
Real-time SWE for the Southern Rockies



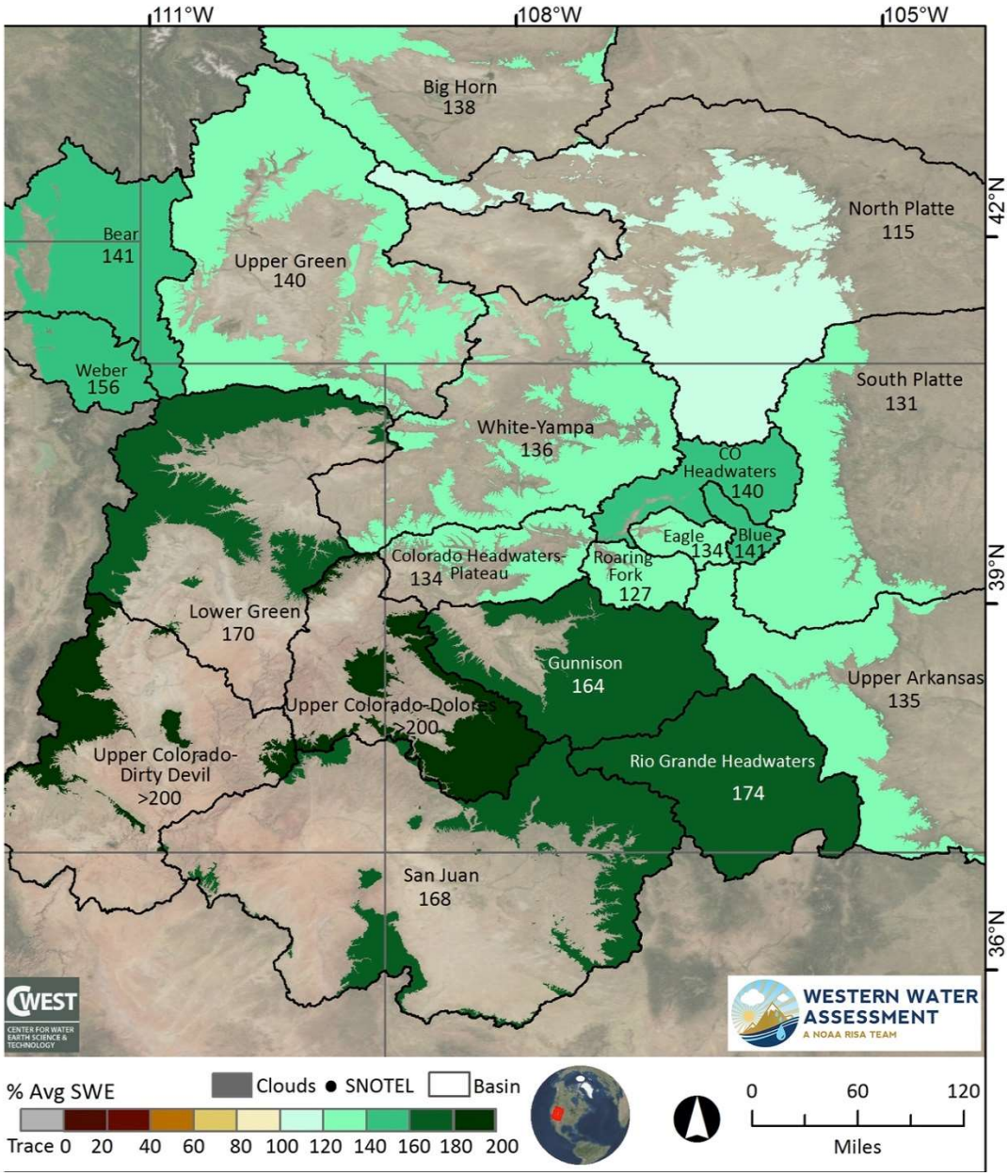


% of Average for the Southern Rockies





% of Average for the Southern Rockies



SWE by Watershed

Basin	4/1/19 % 4/1 Avg	4/19/19 % 4/19 Avg	4/1/19 SWE (in)	4/19/19 SWE (in)	4/19/19 % SCA	4/19/19 Vol (af)	4/1 thru 4/19/19 Chg. In SWE (in)	Area (mi^2)	4/19/19 SNOTEL	4/19/19 SNODAS* (in)
Bear	159.4	141.5	13.9	7.7	49.6	2,654,463	-6.2	6,498	19.8 (18)	8.2
Big Horn	125.8	138.4	11.2	11.9	63.7	1,913,861	0.7	3,019	12.1 (11)	8.7
Blue	135.8	141.0	19.2	18.4	88.1	707,678	-0.9	722	20.5 (5)	12.9
Colorado Headwaters	140.9	140.4	13.2	12.0	75.0	1,928,472	-1.2	3,020	18.1 (10)	9.5
Colorado Headwaters-Plateau	157.5	134.4	12.6	9.3	55.3	960,958	-3.3	1,930	24.5 (1)	7.6
Eagle	141.7	134.4	15.8	14.8	75.0	782,408	-1.1	993	16.2 (3)	12.9
Gunnison	164.9	163.8	14.3	13.6	74.8	4,933,276	-0.7	6,815	20.4 (9)	11.4
Lower Green	172.3	170.4	13.2	9.8	60.5	3,224,582	-3.3	6,150	17.7 (20)	9.4
North Platte	143.9	115.2	10.0	5.1	36.8	3,124,075	-4.8	11,413	20.2 (18)	4.7
Rio Grande Headwaters	182.0	173.6	8.5	6.8	34.0	2,864,813	-1.7	7,884	14.6 (13)	5.6
Roaring Fork	139.1	126.9	22.1	20.1	78.6	1,558,534	-2.0	1,454	21.2 (7)	15.3
San Juan	179.5	168.5	9.4	7.8	31.0	2,789,070	-1.6	6,695	26.4 (16)	6.4
South Platte	162.6	131.5	6.3	4.8	28.0	1,572,157	-1.4	6,084	15.4 (17)	3.5
Upper Arkansas	160.8	134.9	5.4	4.2	22.7	1,411,600	-1.1	6,240	13.3 (6)	2.8
Upper Colorado-Dirty Devil	>200†	>200†	7.3	4.4	35.1	651,869	-2.9	2,775	11.2 (4)	5.3
Upper Colorado-Dolores	>200†	>200†	14.7	9.2	50.4	1,780,548	-5.5	3,616	20.2 (7)	7.2
Upper Green	159.3	139.7	10.0	7.0	43.4	3,967,962	-3.0	10,665	15.2 (20)	6.2
Weber	165.1	156.5	17.2	10.5	57.9	1,254,472	-6.7	2,248	26.0 (14)	11.2
White-Yampa	151.4	136.2	13.5	8.8	58.5	3,048,607	-4.7	6,492	21.1 (13)	8.6

SWE by Elevation & Watershed

Basin	Elevation Band	4/1/19 % 4/1 Avg	4/19/19 % 4/19 Avg	4/1/19 SWE (in)	4/19/19 SWE (in)	4/1/19 % SCA	4/19/19 Vol (af)	4/1 thru 4/19/19 Chg. In SWE (in)	4/19/19 Area (mi^2)	4/19/19 SNOTEL	4/19/19 SNODAS* (in)
Bear	5000-6000'	153.4	9.9	5.4	0.1	1.2	3,602	-5.3	840.1	N/A	0.2
	6000-7000'	198.2	96.7	12.8	2.3	24.9	343,946	-10.5	2786.1	5.1 (2)	2.0
	7000-8000'	154.5	169.0	15.6	10.4	83.1	1,105,037	-5.2	1984.1	16.5 (8)	12.8
	8000-9000'	125.0	149.7	21.2	24.2	99.4	830,640	3.0	644.3	30.6 (6)	25.9
	9000-10,000'	120.6	143.6	21.4	25.7	99.8	199,266	4.3	145.5	15.7 (2)	23.9
	10,000-11,000'	118.7	138.7	25.1	30.2	100.0	133,868	5.2	83.1	N/A	25.3
	11,000-12,000'	122.1	138.6	37.8	46.7‡	100.0	34421‡	8.9	13.8	N/A	26.6
	12,000-13,000'	127.3	145.9	42.1	52.1‡	100.0	3682‡	10.0	1.3	N/A	22.9
Big Horn	7000-8000'	148.0	118.4	4.0	1.4	24.1	76,685	-2.6	1050.5	8.3 (1)	0.8
	8000-9000'	134.8	137.8	7.3	5.6	66.3	214,606	-1.7	717.1	7.4 (4)	5.3
	9000-10,000'	124.7	140.4	11.0	12.1	90.0	339,417	1.2	524.3	15.7 (5)	13.2
	10,000-11,000'	114.9	141.1	19.0	25.0	99.4	638,186	6.1	477.7	17.2 (1)	18.8
	11,000-12,000'	115.5	143.1	35.0	44.8‡	100.0	479036‡	9.8	200.3	N/A	20.0
	12,000-13,000'	115.1	133.5	51.0	62.3‡	100.0	158041‡	11.3	47.6	N/A	20.4
	13,000+	113.9	128.8	59.2‡	75.8‡	100.0	7889‡	16.6	2.0	N/A	19.2
Blue	7000-8000'	177.5	1.5	6.6	0.0	0.2	6	-6.6	35.8	N/A	0.0
	8000-9000'	172.6	147.8	11.7	4.3	58.9	24,368	-7.4	107.1	N/A	1.9
	9000-10,000'	159.3	183.0	13.9	10.6	95.9	72,877	-3.3	129.2	11.7 (1)	7.9
	10,000-11,000'	138.5	157.0	17.5	17.7	99.5	186,679	0.2	197.4	21.8 (2)	16.7
	11,000-12,000'	123.1	129.2	25.8	28.6	100.0	269,768	2.8	176.9	23.6 (2)	20.6
	12,000-13,000'	123.5	130.6	33.7	38.1	100.0	139,237	4.4	68.5	N/A	16.8
	13,000+	131.5	145.4	35.5	40.0	100.0	14,744	4.5	6.9	N/A	7.9
Colorado Headwaters-Plateau	7000-8000'	177.4	79.8	6.4	0.7	11.1	28,618	-5.7	731.8	N/A	0.5
	8000-9000'	167.8	156.5	12.7	8.3	71.2	313,460	-4.5	710.2	N/A	5.3
	9000-10,000'	147.9	139.5	19.3	20.0	99.1	273,509	0.7	255.9	N/A	18.6
	10,000-11,000'	133.0	122.6	24.0	27.7	98.9	333,086	3.7	225.4	24.5 (1)	24.1
	11,000-12,000'	124.0	91.3	32.2	34.8‡	100.0	12286‡	2.6	6.6	N/A	32.2
Colorado Headwaters	7000-8000'	196.0	32.3	5.8	0.2	3.4	4,512	-5.7	465.8	N/A	0.0
	8000-9000'	164.1	153.6	10.4	5.1	68.3	242,845	-5.3	898.8	6.7 (2)	2.3
	9000-10,000'	151.0	165.3	13.7	12.9	98.2	536,579	-0.8	779.8	13.9 (3)	11.2
	10,000-11,000'	130.4	136.7	17.2	20.3	99.7	662,431	3.1	612.2	26.0 (4)	21.2
	11,000-12,000'	116.2	121.3	27.6	33.2	100.0	407,018	5.6	230.0	21.9 (1)	21.4
	12,000-13,000'	119.5	127.3	35.7	42.4	100.0	74,611	6.7	33.0	N/A	13.7
	13,000+	117.2	125.9	37.2	42.6	100.0	475	5.4	0.2	N/A	12.6
Eagle	7000-8000'	>200†	62.4	5.0	0.2	5.9	2,052	-4.8	171.5	N/A	0.0
	8000-9000'	166.7	156.5	10.8	5.6	66.0	57,457	-5.3	193.8	12.4 (1)	2.9
	9000-10,000'	153.1	159.8	14.0	12.6	93.2	123,516	-1.4	184.0	15.7 (1)	12.5
	10,000-11,000'	135.6	143.4	17.4	19.4	97.1	277,480	2.0	268.4	20.4 (1)	20.8
	11,000-12,000'	123.1	118.9	28.4	31.6	99.7	235,047	3.2	139.3	N/A	25.2
	12,000-13,000'	123.5	113.9	43.4 ‡	44.6‡	100.0	81386‡	1.2	34.2	N/A	22.1
	13,000+	130.3	128.0	44.7‡	47.4‡	100.0	5469‡	2.7	2.2	N/A	16.4

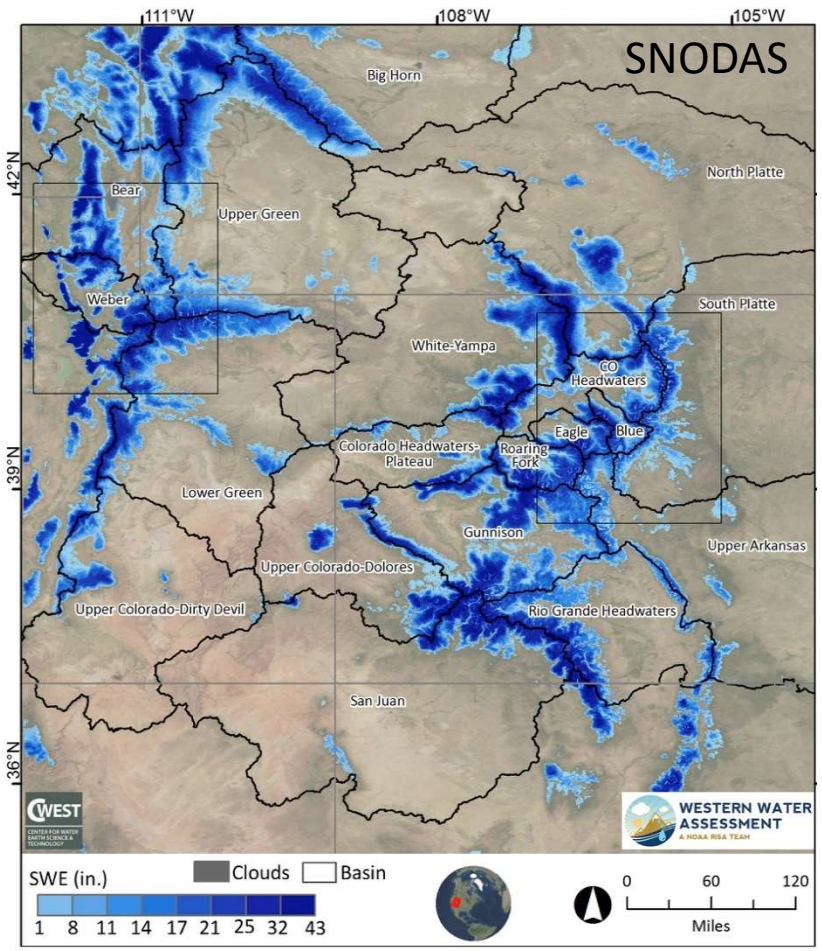
SWE by Elevation & Watershed

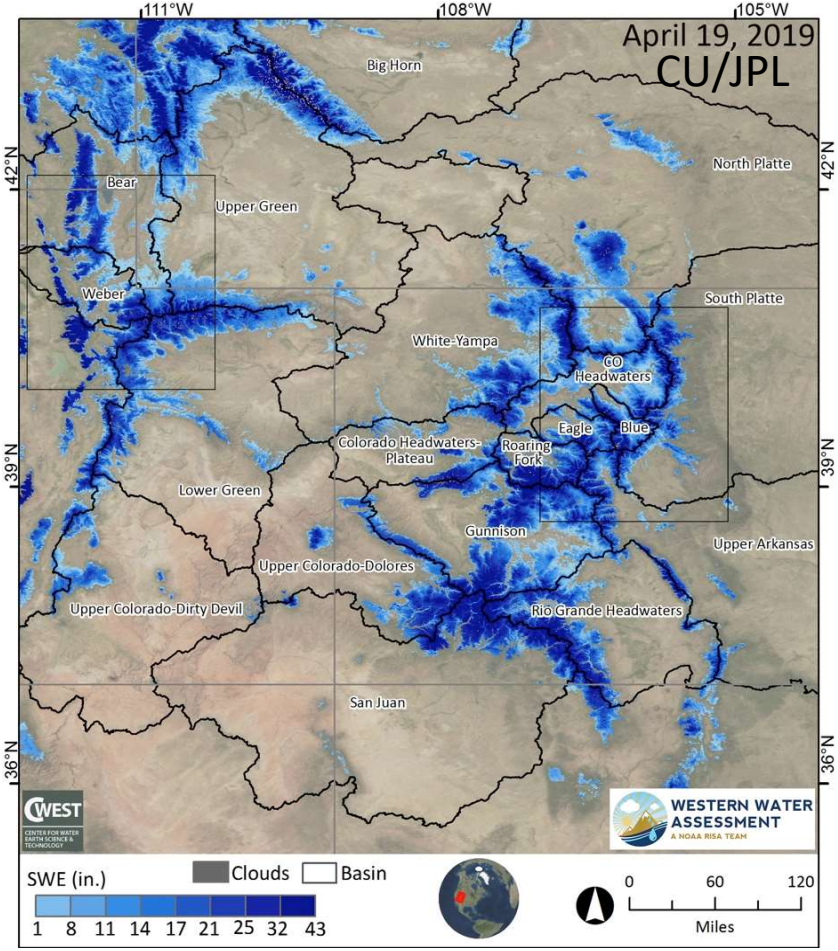
Basin	Elevation Band	4/1/19 % 4/1 Avg	4/19/19 % 4/19 Avg	4/1/19 SWE (in)	4/19/19 SWE (in)	4/1/19 % SCA	4/19/19 Vol (af)	4/1 thru 4/19/19 Chg. In SWE (in)	4/19/19 Area (mi^2)	4/19/19 SNOTEL	4/19/19 SNODAS* (in)
Gunnison	7000-8000'	>200†	116.8	4.7	0.6	9.2	34,493	-4.1	1078.2	N/A	0.5
	8000-9000'	>200†	>200†	10.6	7.1	66.5	686,551	-3.5	1809.7	17.6 (1)	5.1
	9000-10,000'	173.7	>200†	13.9	13.7	93.4	1,035,544	-0.2	1413.6	18.4 (2)	12.4
	10,000-11,000'	154.0	169.8	17.4	19.6	98.0	1,599,738	2.2	1532.9	21.8 (5)	19.3
	11,000-12,000'	137.0	135.6	24.0	27.3	99.8	992,254	3.3	680.9	19.8 (1)	22.1
	12,000-13,000'	132.6	121.9	33.0	36.3	100.0	530,891	3.3	274.4	N/A	20.5
	13,000+	135.1	126.8	36.0	39.2	100.0	53,804	3.2	25.7	N/A	15.9
Lower Green	7000-8000'	>200†	190.5	7.3	1.4	20.0	188,245	-5.9	2449.9	9.3 (1)	1.6
	8000-9000'	184.2	>200†	13.8	8.8	76.6	888,821	-5.0	1903.9	14.4 (9)	10.0
	9000-10,000'	144.5	176.0	17.9	18.1	97.7	849,209	0.2	880.6	21.0 (5)	18.1
	10,000-11,000'	130.5	148.4	20.5	23.4	99.4	831,305	2.8	667.1	20.7 (4)	21.2
	11,000-12,000'	126.5	133.3	29.5	33.8	100.0	374,775	4.3	208.0	27.1 (1)	20.2
	12,000-13,000'	130.5	147.3	32.6	42.6‡	100.0	88650‡	10.0	39.0	N/A	14.8
	13,000+	132.8	159.0	32.8	48.1‡	100.0	3577‡	15.3	1.4	N/A	7.1
North Platte	7000-8000'	148.2	50.5	6.1	0.7	11.2	263,596	-5.4	7087.6	13.7 (3)	0.4
	8000-9000'	156.0	142.3	13.3	6.7	66.6	976,524	-6.6	2715.6	13.9 (5)	6.0
	9000-10,000'	133.2	151.0	17.4	17.2	98.8	891,958	-0.2	969.7	23.5 (6)	17.4
	10,000-11,000'	118.7	131.1	24.6	27.3	99.9	830,195	2.7	570.4	27.8 (4)	28.0
	11,000-12,000'	116.2	121.7	38.5	43.5	100.0	152,391	5.0	65.7	N/A	24.2
	12,000-13,000'	119.5	127.3	38.1	46.0	100.0	9,412	7.9	3.8	N/A	11.6
Rio Grande Headwaters	7000-8000'	9.8	0.4	0.0	0.0	0.0	3	0.0	2690.2	N/A	0.0
	8000-9000'	>200†	60.6	2.8	0.3	2.7	22,208	-2.5	1494.7	N/A	0.1
	9000-10,000'	>200†	175.5	10.6	4.0	31.6	235,325	-6.6	1111.3	N/A	2.8
	10,000-11,000'	193.8	>200†	16.9	13.6	82.7	1,039,612	-3.3	1428.1	11.0 (7)	13.6
	11,000-12,000'	154.2	161.1	22.4	23.4	98.7	1,092,622	1.1	873.9	18.8 (6)	19.4
	12,000-13,000'	142.4	138.6	28.8	31.0	100.0	441,243	2.2	267.1	N/A	17.1
	13,000+	141.7	154.4	28.4	34.6‡	100.0	33799‡	6.2	18.3	N/A	9.7
Roaring Fork	7000-8000'	>200†	81.6	7.4	0.5	7.9	5,421	-6.9	212.0	N/A	0.5
	8000-9000'	169.8	172.5	13.4	7.7	67.5	112,607	-5.7	274.8	7.0 (1)	4.9
	9000-10,000'	152.7	162.8	18.1	16.8	92.8	221,093	-1.3	247.1	16.8 (2)	15.8
	10,000-11,000'	136.0	140.7	23.0	23.7	98.0	420,307	0.7	332.4	27.7 (3)	23.0
	11,000-12,000'	124.5	111.0	35.2	35.6	100.0	507,701	0.3	267.7	24.6 (1)	25.4
	12,000-13,000'	125.2	109.1	44.7	44.9	100.0	267,755	0.1	111.9	N/A	21.4
	13,000+	128.7	120.0	48.0	52.1	100.0	23,649	4.1	8.5	N/A	16.3
San Juan	7000-8000'	>200†	>200†	1.5	0.1	1.1	22,295	-1.4	3877.9	N/A	0.0
	8000-9000'	>200†	>200†	11.4	4.9	36.6	290,798	-6.5	1103.4	18.2 (3)	2.9
	9000-10,000'	>200†	>200†	18.9	16.8	85.6	484,516	-2.1	540.8	12.9 (3)	13.5
	10,000-11,000'	163.2	181.7	25.6	27.0	99.1	774,254	1.3	538.6	31.3 (5)	25.3
	11,000-12,000'	140.7	135.0	32.1	33.9	99.9	779,195	1.8	431.1	34.6 (5)	30.3
	12,000-13,000'	135.8	119.4	38.7	40.2	100.0	403,917	1.4	188.5	N/A	28.5
	13,000+	134.8	123.8	41.5	44.7	100.0	34,095	3.2	14.3	N/A	24.3
South Platte	7000-8000'	101.9	0.1	0.7	0.0	0.0	49	-0.7	1551.5	N/A	0.0
	8000-9000'	>200†	39.7	2.9	0.4	5.3	34,911	-2.5	1584.8	5.4 (3)	0.5
	9000-10,000'	>200†	114.1	5.4	2.1	18.0	152,978	-3.3	1384.1	15.7 (4)	2.1
	10,000-11,000'	158.0	169.2	12.1	11.6	78.6	549,447	-0.6	890.8	17.2 (7)	9.9
	11,000-12,000'	131.2	142.7	19.8	21.5	98.8	540,869	1.7	471.9	20.6 (3)	13.7
	12,000-13,000'	131.3	142.5	26.6	27.0	99.5	250,585	0.4	173.9	N/A	12.5
	13,000+	140.8	158.7	28.7	30.0	98.2	43,319	1.4	27.1	N/A	7.5

SWE by Elevation & Watershed

Basin	Elevation Band	4/1/19 % 4/1 Avg	4/19/19 % 4/19 Avg	4/1/19 SWE (in)	4/19/19 SWE (in)	4/1/19 % SCA	4/19/19 Vol (af)	4/1 thru 4/19/19 Chg. In SWE (in)	4/19/19 Area (mi^2)	4/19/19 SNOTEL	4/19/19 SNODAS* (in)
Upper Arkansas	7000-8000'	66.9	0.0	0.4	0.0	0.0	0	-0.4	1857.2	N/A	0.0
	8000-9000'	154.9	3.2	1.6	0.0	0.2	1,222	-1.6	1591.5	N/A	0.0
	9000-10,000'	>200†	84.3	4.7	1.0	12.0	65,727	-3.7	1240.4	6.4 (1)	0.9
	10,000-11,000'	189.5	171.9	10.3	8.7	65.3	365,397	-1.6	787.6	14.7 (3)	8.0
	11,000-12,000'	142.6	144.2	18.6	20.5	96.8	493,806	1.9	452.5	14.6 (2)	14.3
	12,000-13,000'	135.1	137.5	26.2	28.9	99.8	403,688	2.7	261.9	N/A	11.2
	13,000+	139.9	149.4	28.5	31.4	99.7	81,760	2.9	48.9	N/A	5.9
Upper Colorado-Dirty Devil	7000-8000'	>200†	>200†	1.5	0.1	0.9	4,734	-1.5	1188.6	N/A	0.1
	8000-9000'	>200†	>200†	8.3	2.1	32.5	93,513	-6.2	834.6	13.0 (1)	3.2
	9000-10,000'	197.9	>200†	13.2	10.0	86.5	211,589	-3.2	397.5	12.4 (2)	11.8
	10,000-11,000'	161.7	198.4	17.3	17.5	98.0	267,548	0.2	287.4	7.2 (1)	20.1
	11,000-12,000'	141.6	161.3	19.8	21.1	100.0	74,485	1.2	66.3	N/A	22.1
Upper Colorado-Dolores	7000-8000'	>200†	>200†	6.2	0.3	4.2	24,493	-5.9	1484.8	N/A	0.2
	8000-9000'	>200†	>200†	16.3	8.4	69.8	506,865	-7.9	1133.0	12.6 (1)	4.8
	9000-10,000'	185.1	>200†	21.7	18.1	95.0	467,221	-3.6	484.5	18.5 (3)	14.2
	10,000-11,000'	163.7	184.9	26.2	24.9	98.6	460,352	-1.3	347.1	24.3 (3)	25.0
	11,000-12,000'	136.8	136.2	32.6	33.3	99.9	219,889	0.7	123.9	N/A	31.3
	12,000-13,000'	132.0	121.6	42.1 ‡	44.0‡	100.0	87132‡	1.9	37.1	N/A	27.1
	13,000+	132.9	122.9	46.6 ‡	49.7‡	100.0	14596‡	3.1	5.5	N/A	23.1
Upper Green	7000-8000'	>200†	114.1	6.4	1.0	18.8	397,168	-5.4	7164.8	9.8 (1)	1.6
	8000-9000'	137.3	157.4	12.5	9.9	88.2	939,860	-2.5	1775.4	16.1 (10)	10.6
	9000-10,000'	116.9	145.9	15.2	18.4	99.5	850,239	3.2	865.7	14.2 (7)	18.1
	10,000-11,000'	115.0	139.5	25.2	32.8	99.8	1,083,241	7.6	619.5	16.5 (2)	22.3
	11,000-12,000'	117.4	136.5	40.9	53.3‡	100.0	574,952	12.4	202.1	N/A	22.2
	12,000-13,000'	118.5	138.0	46.4 ‡	61.0‡	100.0	117685‡	14.6	36.2	N/A	18.4
	13,000+	115.9	127.5	57.6 ‡	72.0‡	100.0	4817‡	14.4	1.3	N/A	19.8
Weber	5000-6000'	173.3	28.4	6.3	0.2	2.1	2,558	-6.2	294.2	N/A	0.9
	6000-7000'	>200†	116.5	14.6	2.6	29.4	112,952	-12.0	807.6	8.1 (2)	3.3
	7000-8000'	166.7	182.4	19.7	13.0	89.5	518,713	-6.7	746.9	30.7 (7)	14.8
	8000-9000'	140.4	158.9	25.2	26.9	99.0	374,046	1.7	260.8	23.9 (3)	27.6
	9000-10,000'	125.5	143.5	25.0	30.6	99.7	145,059	5.7	88.8	30.9 (2)	30.3
	10,000-11,000'	117.0	136.5	30.4	38.4‡	100.0	99495‡	8.0	48.6	N/A	30.9
	11,000-12,000'	118.4	129.2	42.0 ‡	49.3‡	100.0	1649‡	7.3	0.6	N/A	30.6
White-Yampa	7000-8000'	177.1	134.7	9.2	2.2	31.4	428,376	-7.0	3701.0	7.6 (1)	1.6
	8000-9000'	155.7	160.5	15.8	11.7	90.5	973,113	-4.1	1560.4	15.7 (4)	10.9
	9000-10,000'	130.4	134.1	20.8	21.3	99.5	749,054	0.5	660.7	19.5 (6)	21.3
	10,000-11,000'	121.3	121.2	25.3	28.6	99.6	740,428	3.2	485.9	43.1 (2)	32.2
	11,000-12,000'	119.1	105.6	35.2	35.4	100.0	157,386	0.2	83.3	N/A	31.1
	12,000-13,000'	122.9	112.1	32.3	33.7	100.0	250	1.4	0.1	N/A	26.2

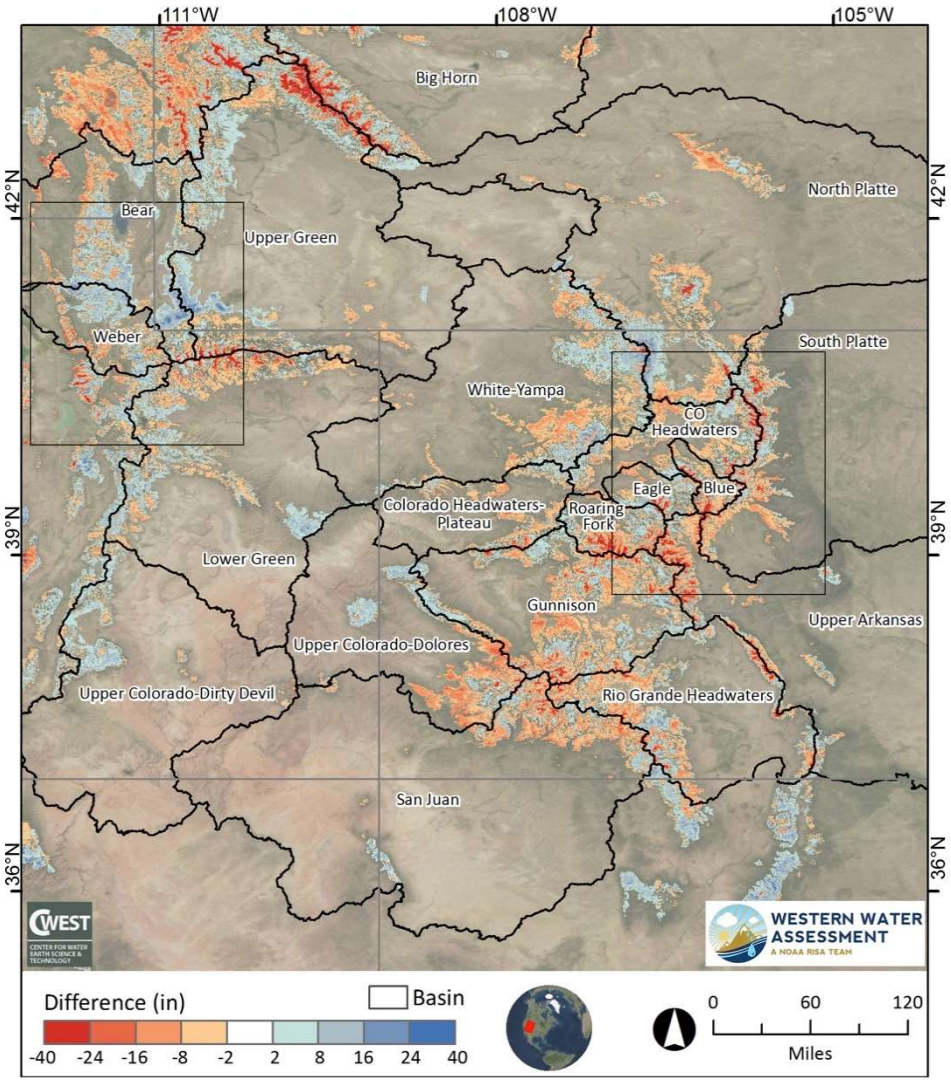
SNODAS VS REGRESSION PRODUCT 4/19/19





SWE Difference w/ SNODAS

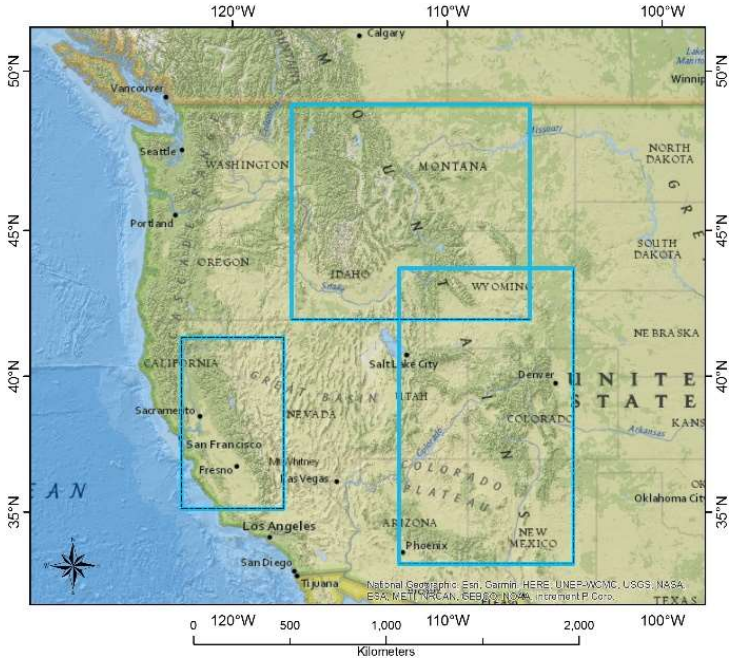
(SNODAS Minus Regression)



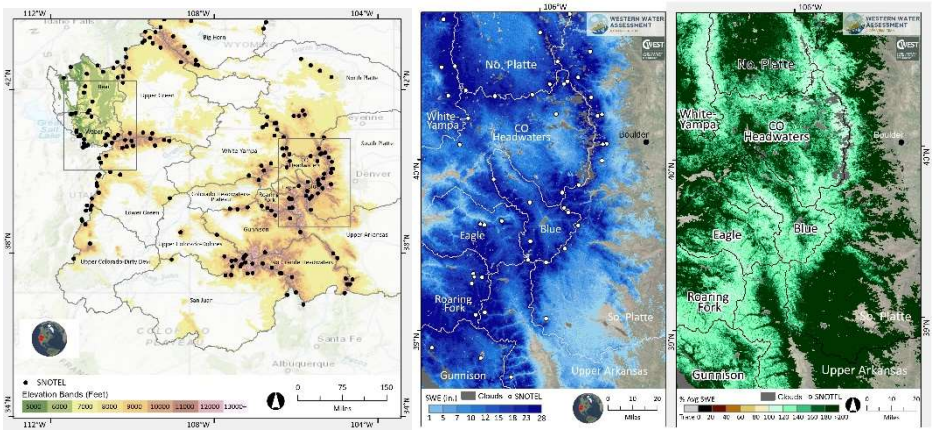
- Regression SWE is slightly greater in lower elevations
- Regression SWE was significantly lower in high elevation areas above treeline.

Expanding the Reach of Real Time SWE Products

- Conducted monthly reports in Water Year 2018 - present.
- Reports delivered to 543 distinct email addresses
- 170 unique organizations
- Presented to stakeholders monthly during the snowmelt season at Colorado WATF (Water Availability Task Force) meetings



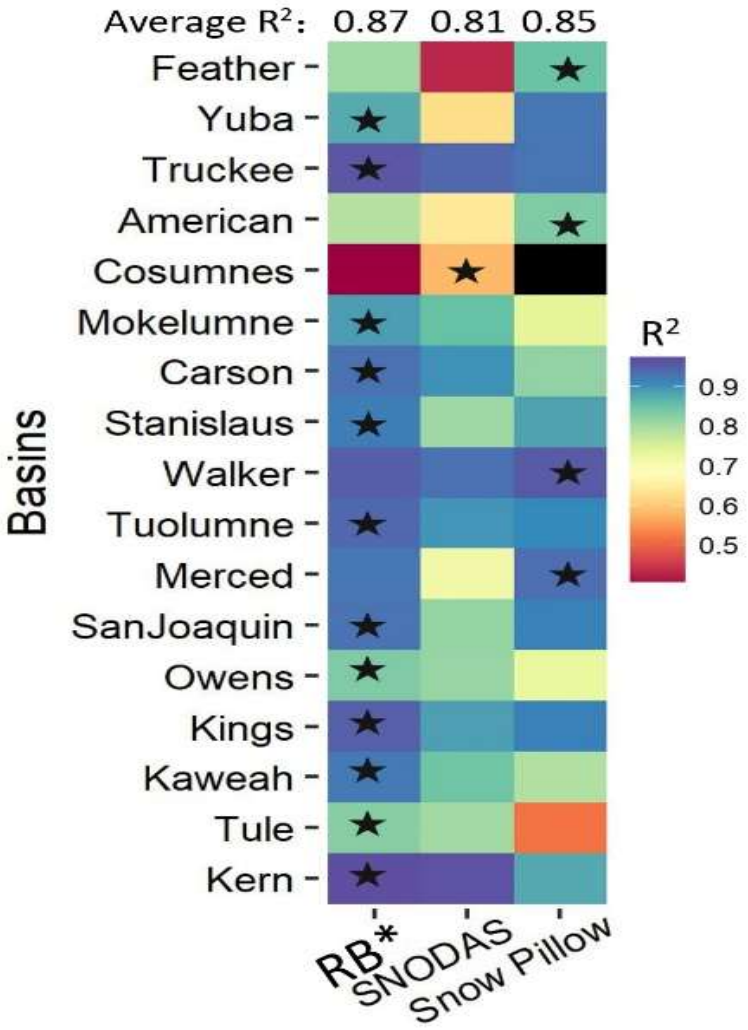
3 domains: Sierra Nevada, Southern and Northern Rockies



Location map (left) and Colorado Front Range April 1, 2019 real time SWE (middle) and Ap;ril 1, 2019 percent of average (right) from the Southern Rockies real time SWE reporting.

Correlation w/ Full Natural Flow

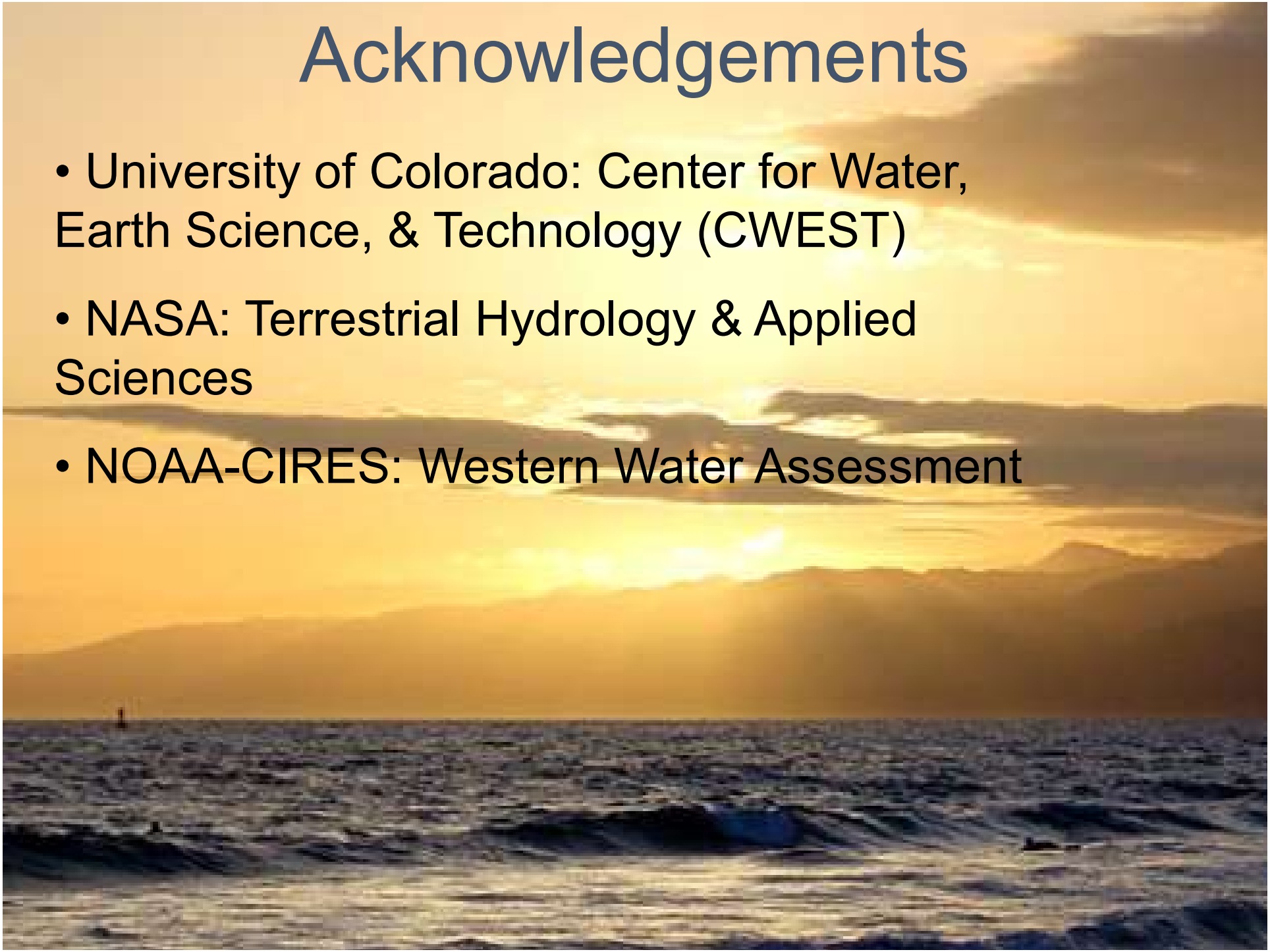
- Regression-based estimates show greater correlation than SNODAS in 17 of 18 watersheds.
- Regression-based estimates show greater correlation than Snow Pillows in 14 of 18 watersheds.



Conclusions & Future Work

- Regression Spatial SWE estimates provide valuable information for augmenting point data and SNODAS.
- Products are presented monthly to the Colorado Water Availability Task Force.
- Approach can be applied in conjunction with airborne snow measurements in context of validation and / or temporal change analysis.

Acknowledgements



- University of Colorado: Center for Water, Earth Science, & Technology (CWEST)
- NASA: Terrestrial Hydrology & Applied Sciences
- NOAA-CIRES: Western Water Assessment

Bias correction of SWE estimates with the NASA Airborne Snow Observatory SWE data

Yang, K., K. Musselman, K. Rittger & N. Molotch, University of CO

Highlight:

- Generate accurate SWE maps across the Sierra Nevada Mountains in near real time to support water supply decision-making in California.
- How to use Airborne Snow Observatory (ASO) SWE data in selected basins to bias correct SWE estimation over larger areas?
- Start by validating the LRM SWE by ASO SWE in the Upper Tuolumne River Basin (TRB).
- Data is from the drought period, 2013 - 2015 and 2 post-drought years (Figure 1).
- The LRM has estimated relatively accurate SWE both in the Upper Tuolumne River Basin and across the entire Sierra.
- The bias-correction model largely improves the LRM SWE estimates in the Upper Tuolumne River Basin.
- The same bias-correlation model can be considered as a proof of concept for other SWE products, like SNODAS.

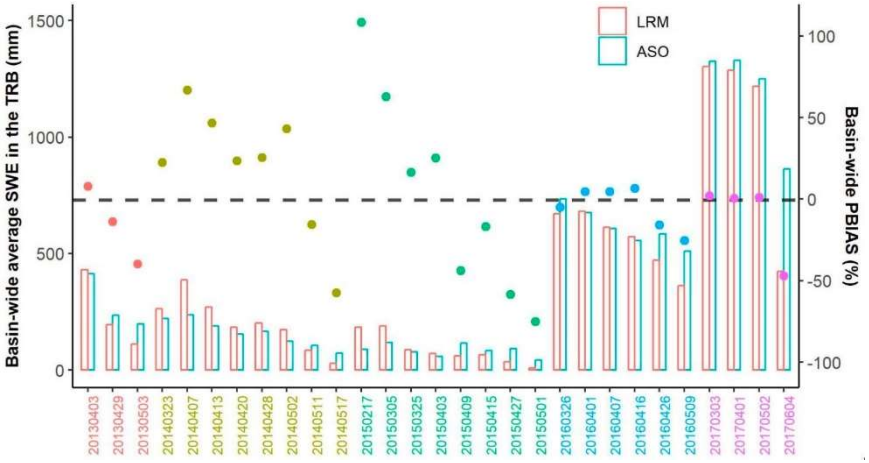


Figure 1: Validation of the LRM SWE product against the ASO SWE product. During low SWE period (2013-2015), LRM SWE shows higher PBIAS. Early snow melt season = positive PBIAS. Late snow melt season = negative PBIAS.

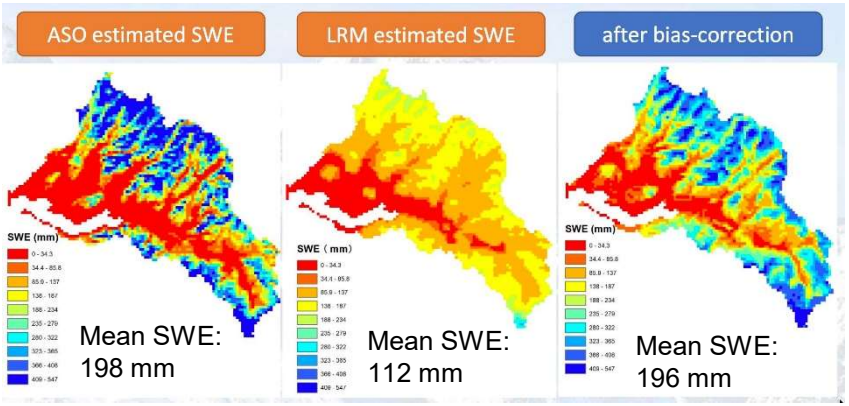


Figure 2: After bias-correction the LRM SWE is much closer to the ASO SWE. ASO SWE (left) on 5/3/2013, LRM SWE for the same date (middle) and ASO bias-corrected LRM SWE (right) for 5/3/2013.

Relevance:

- The next step is to extend the bias-correction model in time and space using the LRM SWE estimates as proxy.

Contact Us

We are looking for new partners to tailor SWE reports for local needs.

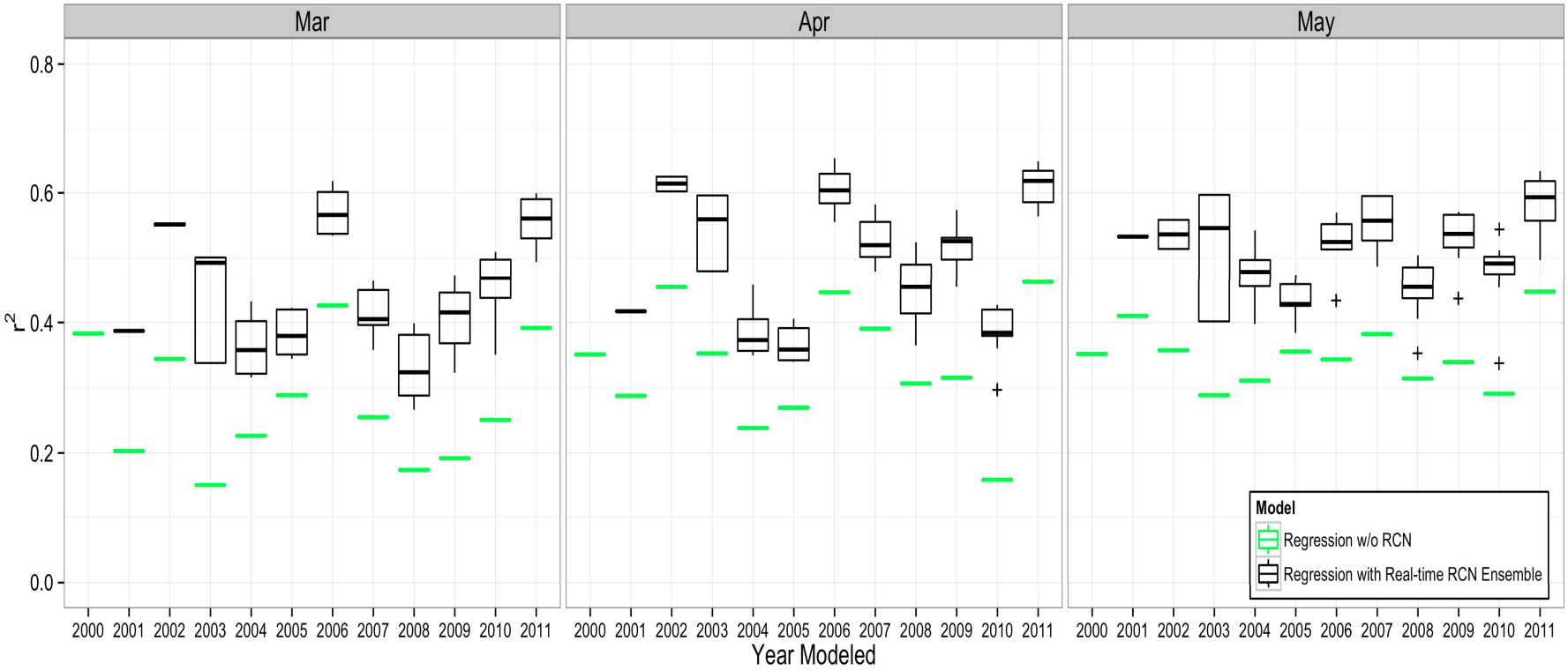
Noah Molotch: noah.molotch@colorado.edu

University of Colorado at Boulder

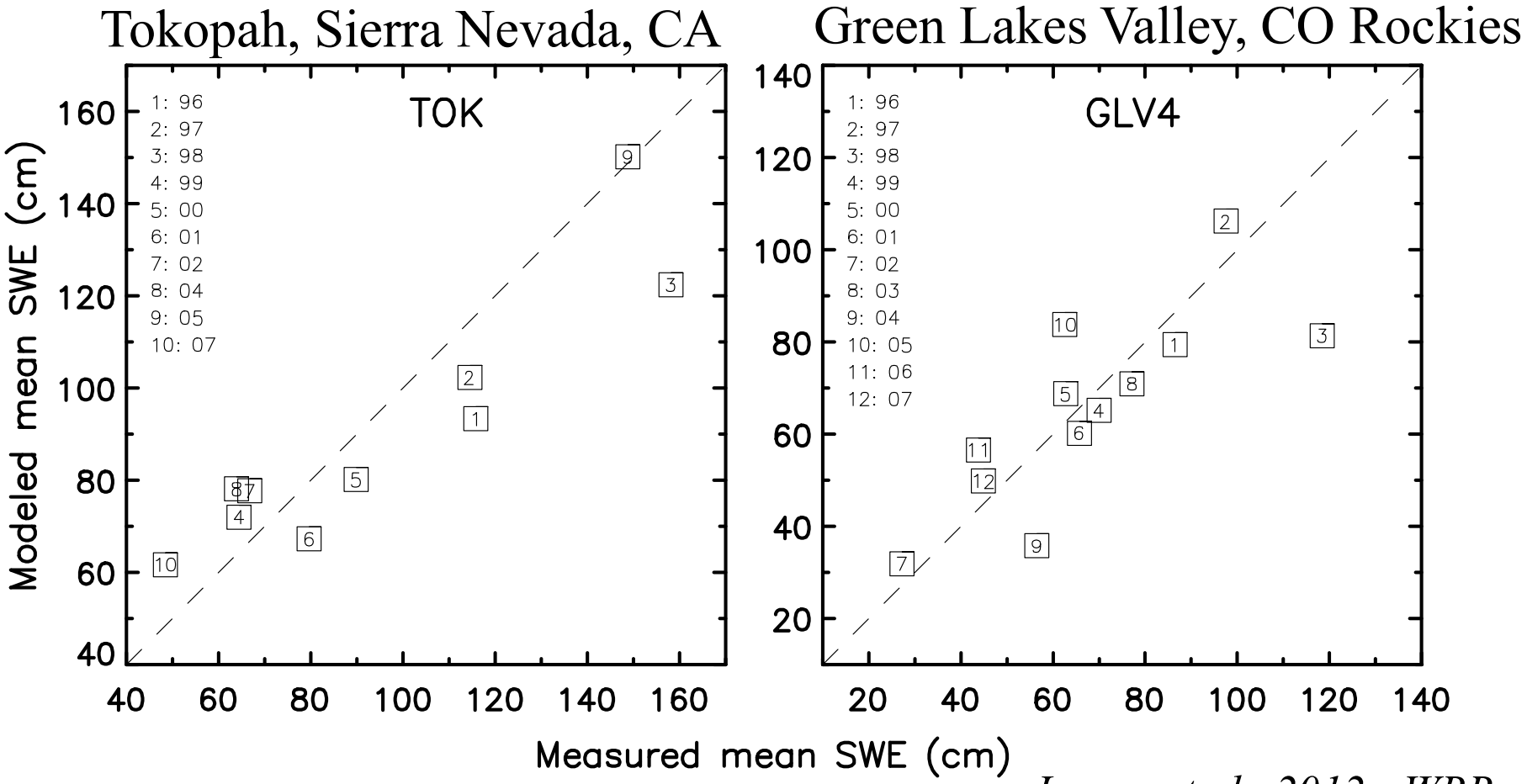
Center for Water, Earth Science and Technology

Correlation of SWE & Independent Variables: With and Without Reconstruction

Upper Colorado River Basin Domain, 2000 – 2011.



Model Evaluation: Sierra and Rockies



Jepsen et al., 2012 - WRR