Improved Snow Observations From Remote Sensing

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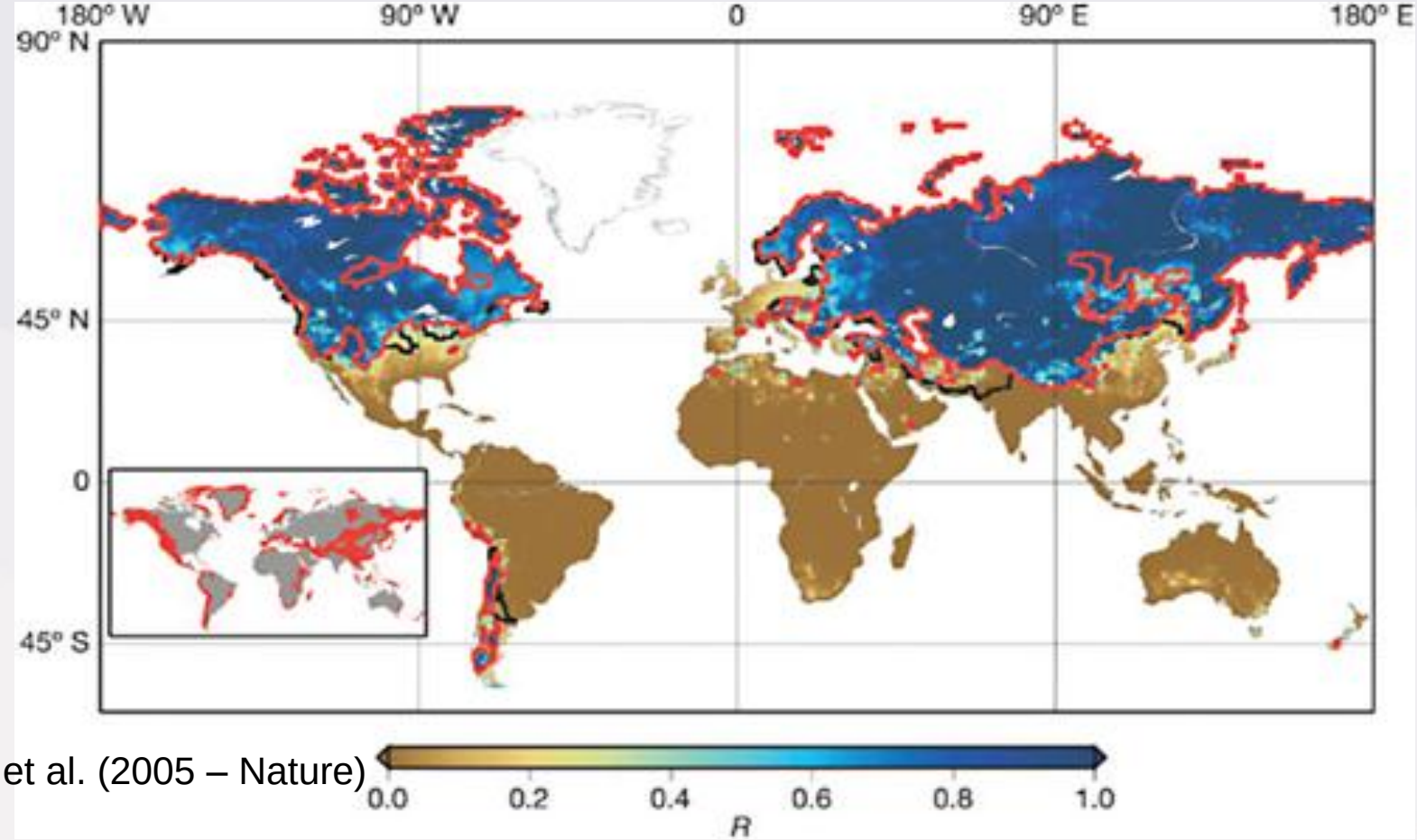
Snow and Water Availability



Barnett et al. (2005 – Nature)

- 60 Million People in US & 1 Billion People Globally
- 1/4th Global GDP

Remotely sensed snowpack reconstruction improves Sierra Nevada water storage estimates

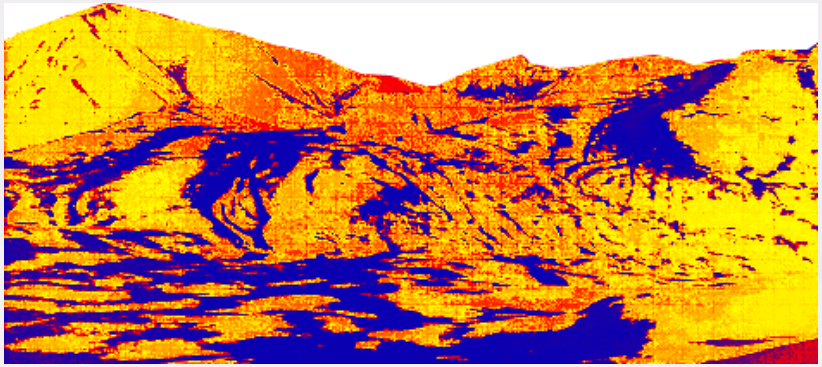
$$SWE_n = SWE_0 - \sum_{j=1}^{n} M_j$$

when $SWE_n = 0$,

snow covered area

$$SWE_0 = \sum_{j=1}^{n} M_j$$

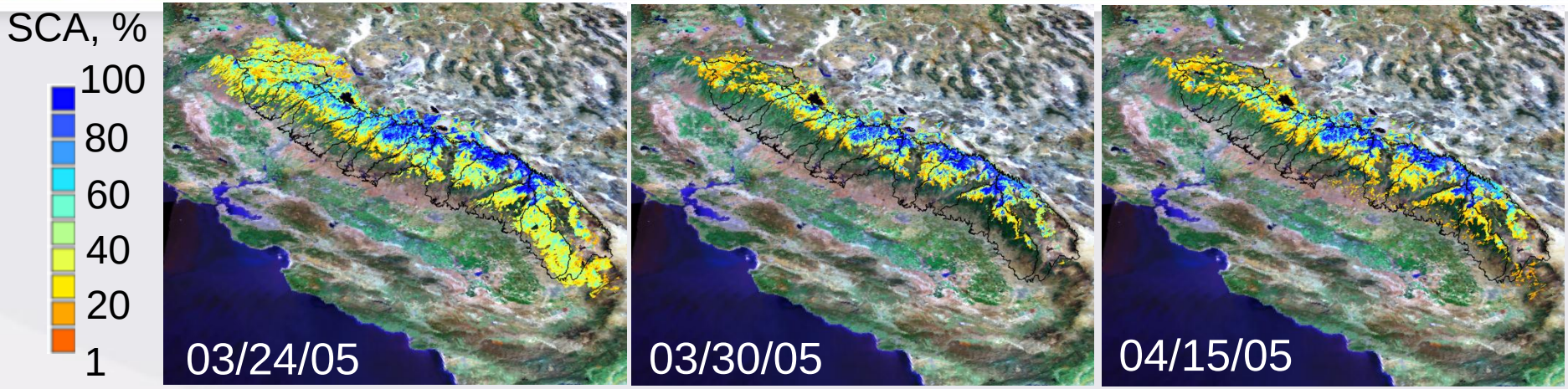
daily snowmelt, cm



0 1.6 3.2 3

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

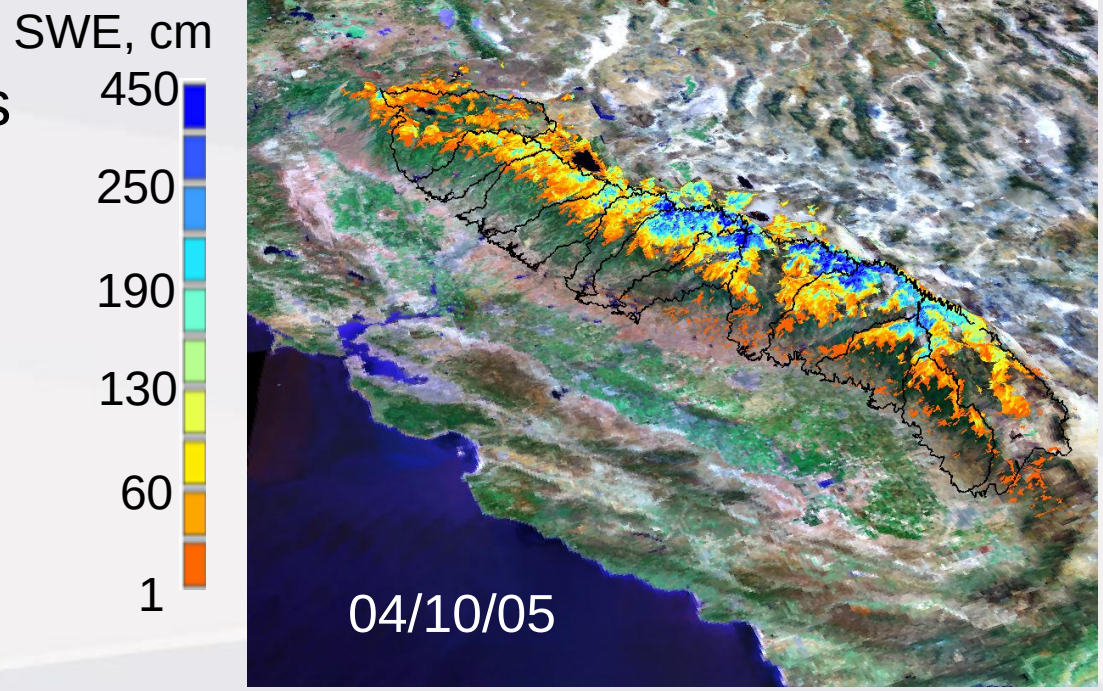
Range-Scale Snow Cover: MODIS



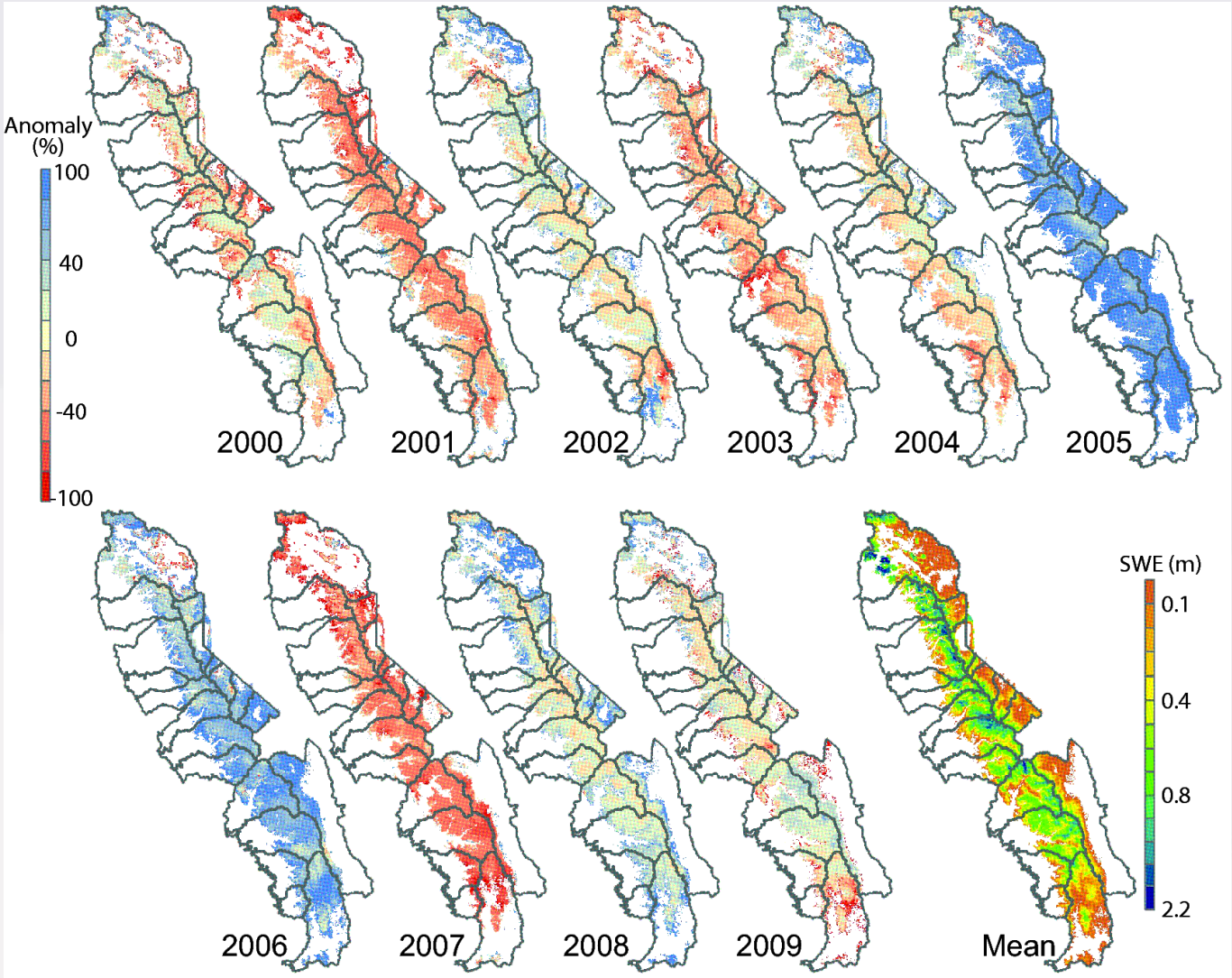
MODSCAG – Painter et al., 2009

Due to lower initial mass snow disappeared rapidly in N. Sierra.

Areas with persistent snow cover had greatest mass.

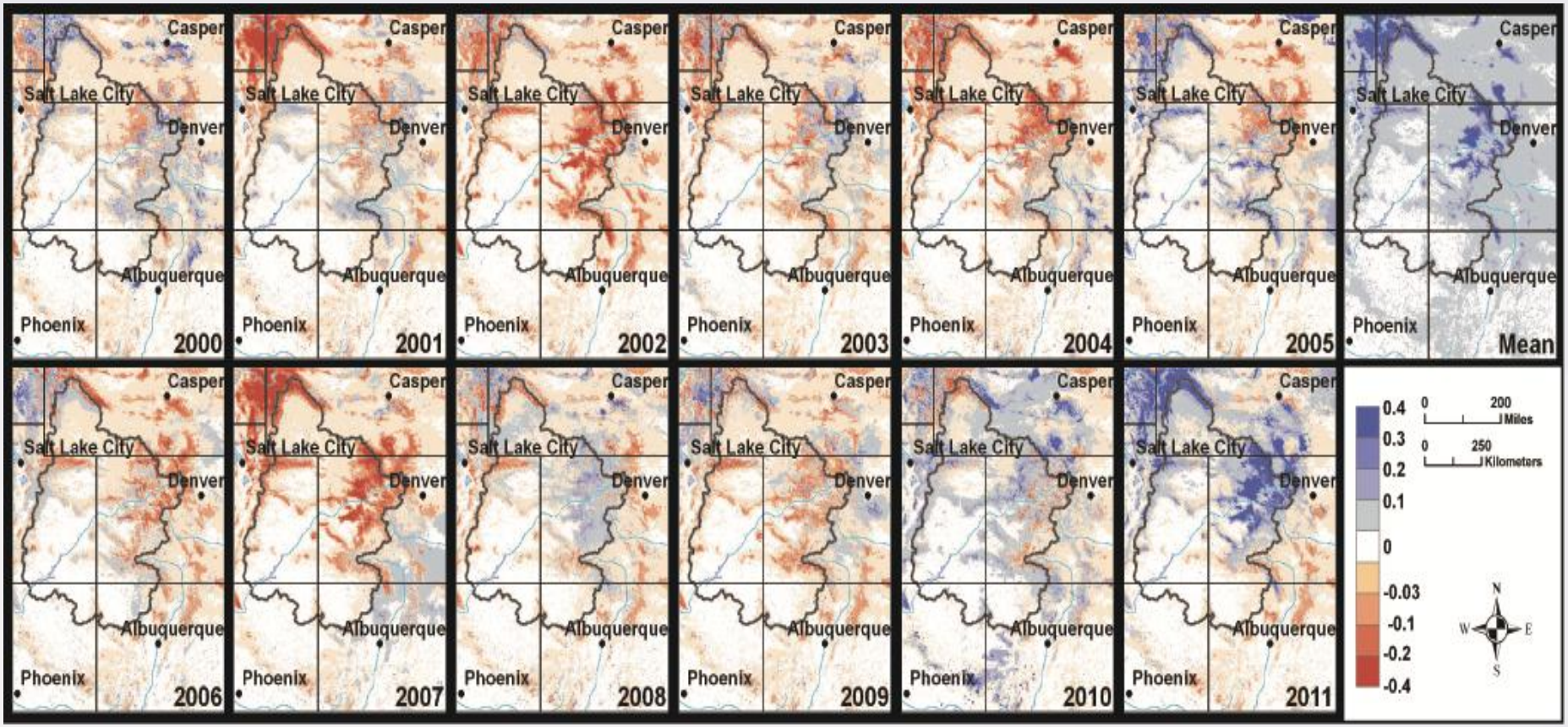


Snow Water Equivalent Anomalies



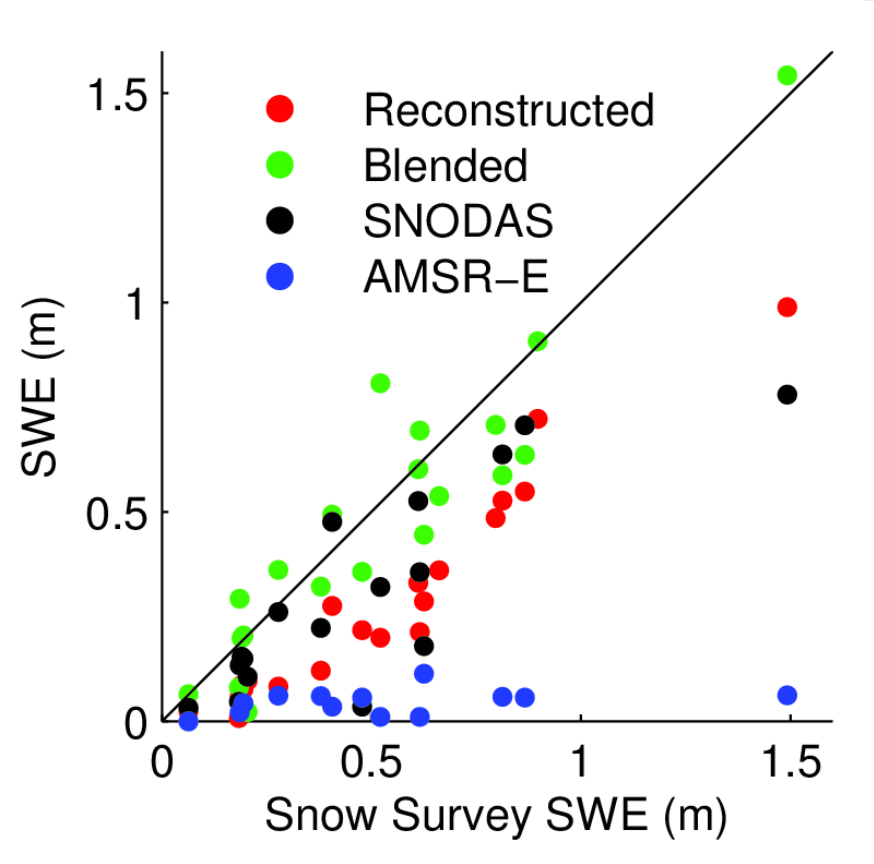
Guan et al., in review

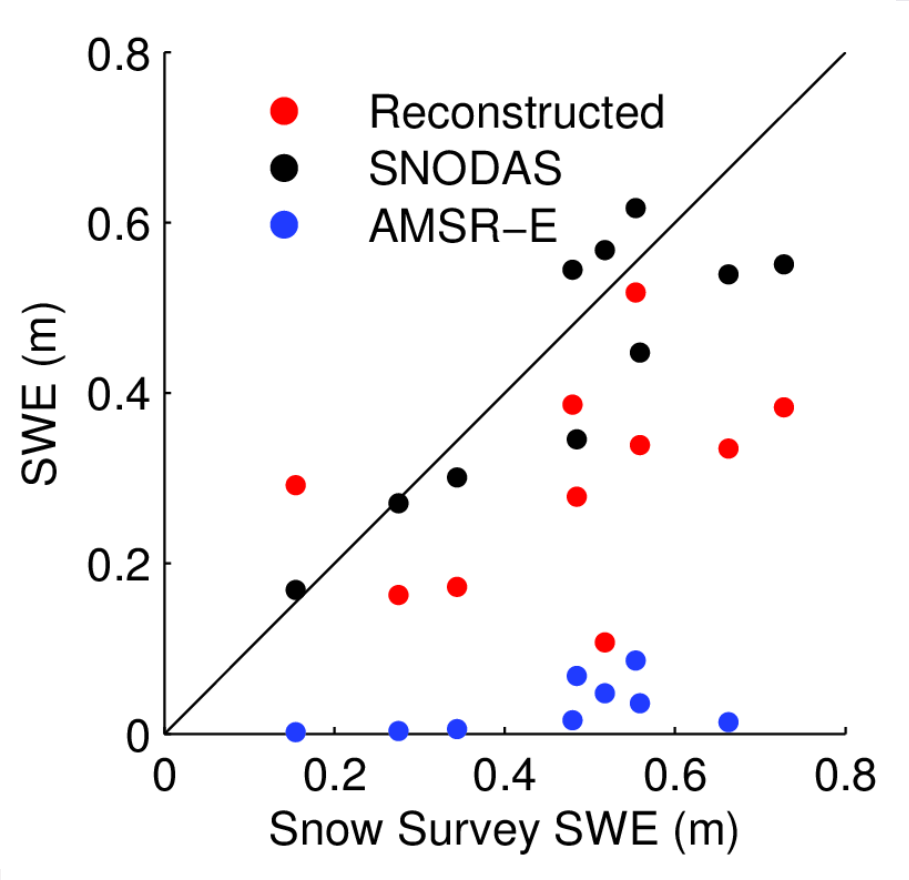
Snow Water Equivalent Anomalies



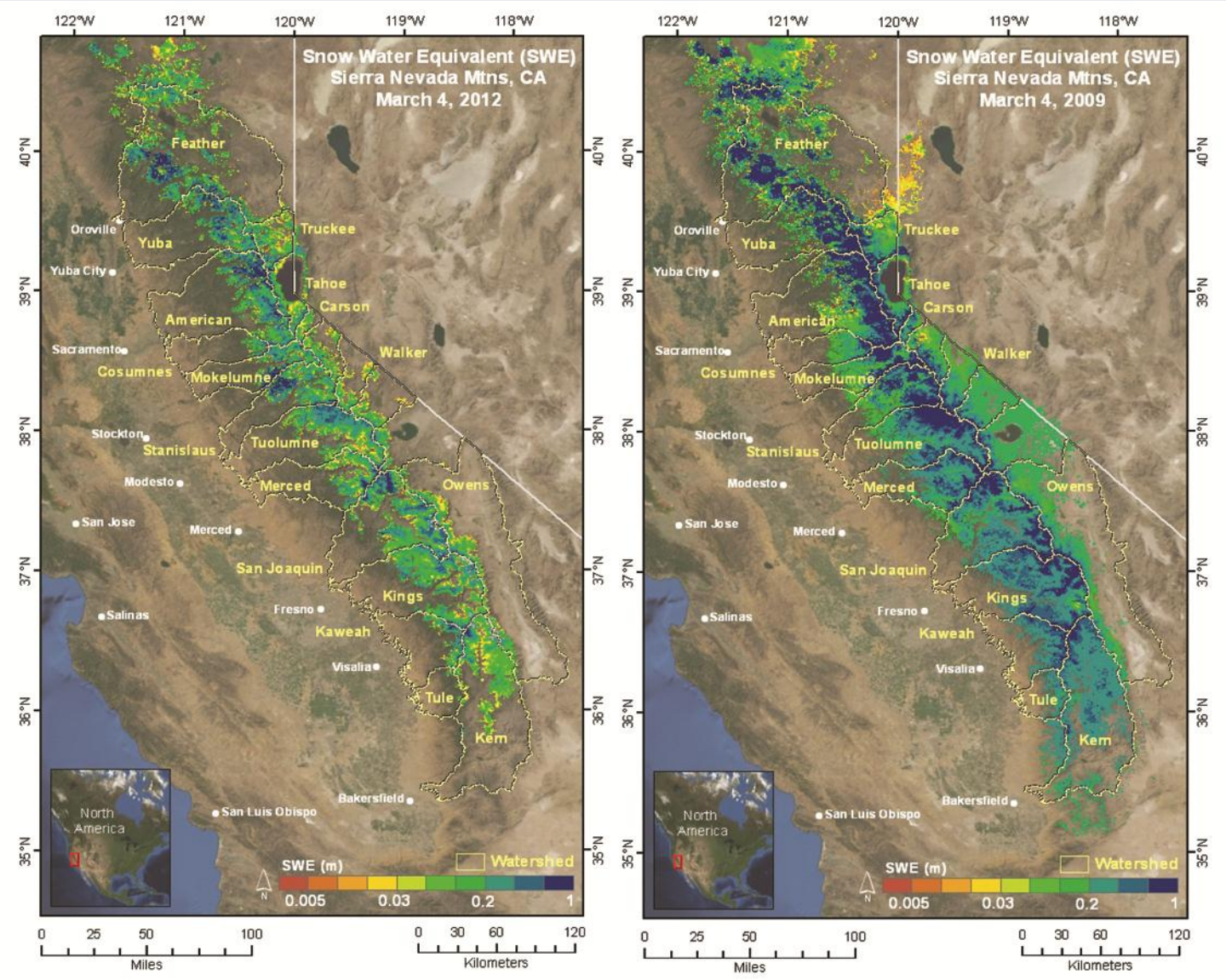
Schneider et al., in preparation

Model Performance



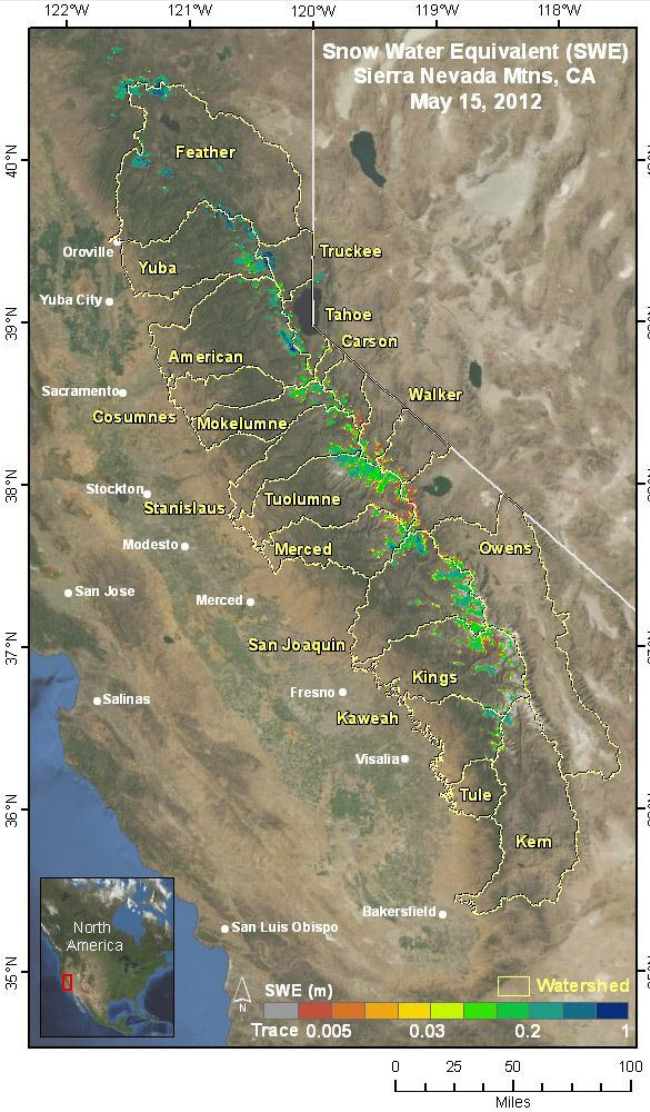


Real Time SWE Product

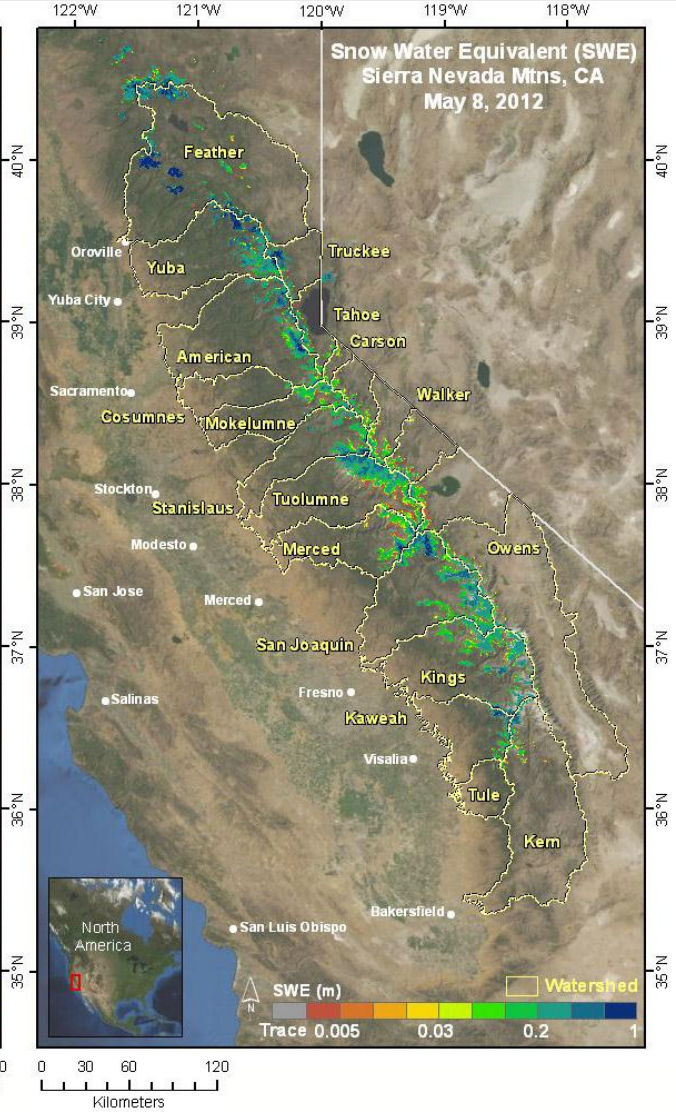


Real-Time SWE Product Beta Version

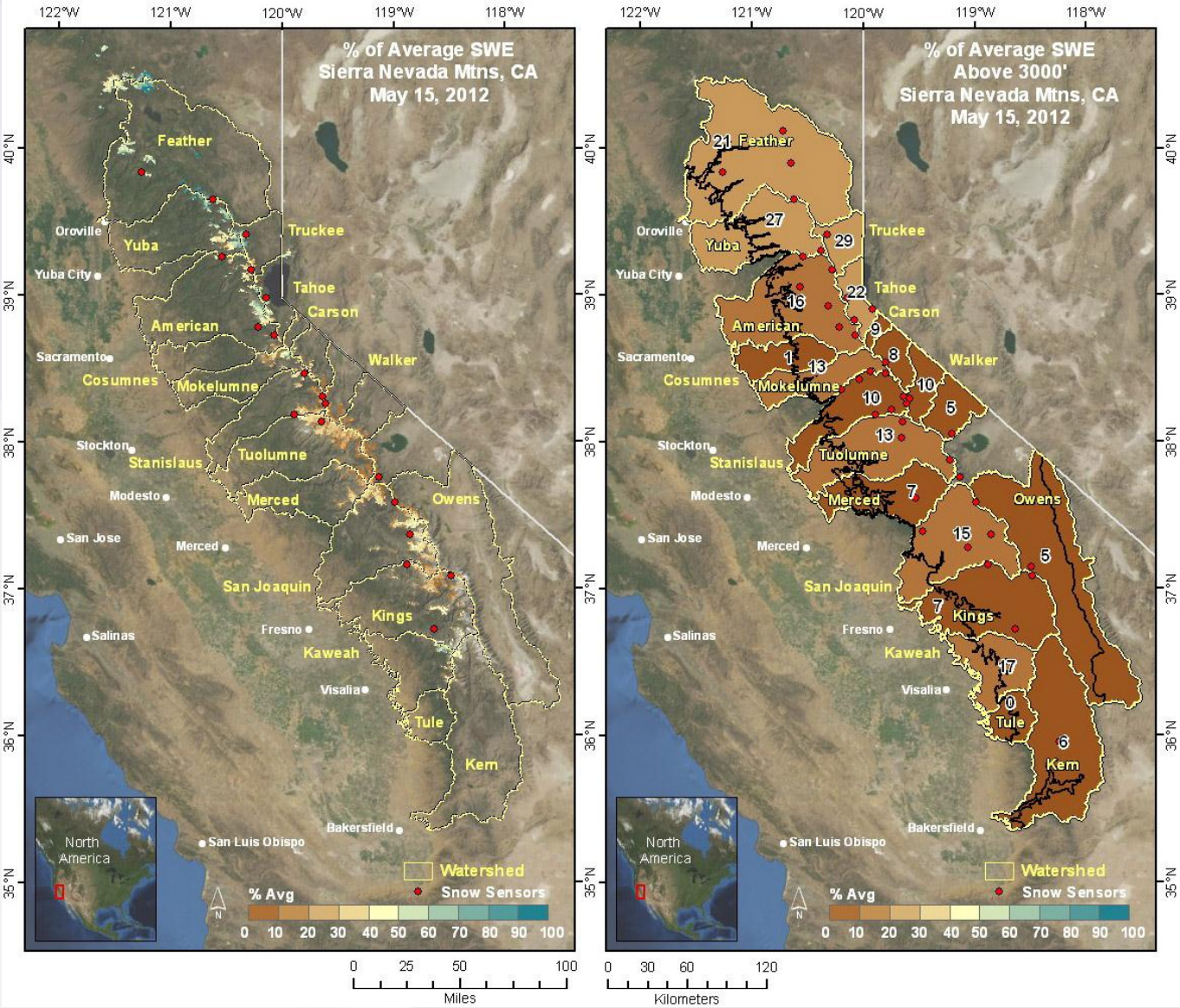
May 15, 2012



May 8, 2012



Real-Time SWE Product Beta Version



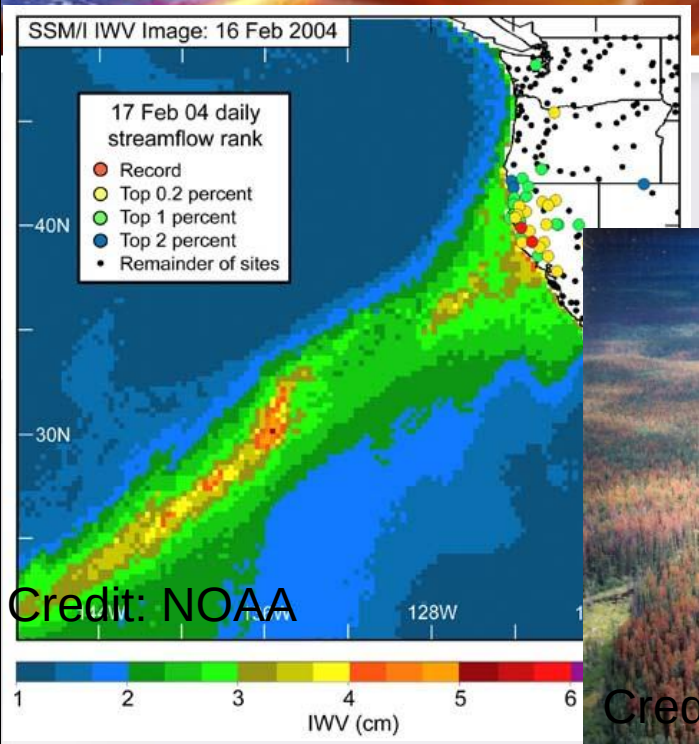
Real Time SWE Reports by Watershed

Watershed	5/15/12 SWE (in)	5/15/12 % Avg to Date	5/8/12 SWE (in)	5/8 thru 5/15 Change in SWE (in)
AMERICAN	1.17	16.28	2.75	-1.58
FEATHER	0.86	21.05	2.02	-1.17
KAWEAH	0.82	16.87	2.20	-1.38
KERN	0.13	5.63	0.44	-0.30
KINGS	0.75	7.46	2.64	-1.89
TAHOE	2.09	21.78	4.15	-2.06
MERCED	0.57	7.29	1.67	-1.10
OWENS	0.15	5.42	0.46	-0.31
SAN JOAQUIN	1.66	14.85	4.02	-2.36
STANISLAUS	1.01	9.58	2.42	-1.41
TRUCKEE	1.84	28.80	3.28	-1.44
TUOLUMNE	1.46	13.36	3.29	-1.83
YUBA	2.30	27.39	4.80	-2.50
COSUMNES	0.01	0.50	0.17	-0.16
MOKELUMNE	1.11	12.73	2.29	-1.18
TULE	0.00	0.29	0.07	-0.07
WEST WALKER RIVER	0.75	9.73	1.65	-0.90
EAST WALKER RIVER	0.30	5.46	0.73	-0.43
WEST FORK CARSON RIVER	0.57	8.68	1.26	-0.69
EAST FORK CARSON RIVER	0.48	7.59	1.23	-0.75

Real Time SWE Report by Elevation Band

Watershed	Elevation	5/15/12 SWE (in)	5/15/12 % Avg to Date	5/8/12 SWE (in)	5/8 thru 5/15 Change SWE (in)	Area Sq Mi
AMERICAN	3000-4000'	0.00	0.00	0.00	0.00	191.9
	4000-5000'	0.00	0.00	0.01	-0.01	249.3
	5000-6000'	0.00	0.19	0.09	-0.09	294.8
	6000-7000'	0.49	5.26	2.45	-1.96	296.4
	7000-8000'	3.58	18.63	8.97	-5.39	175.7
	8000-9000'	8.65	31.35	14.84	-6.19	74.2
	9000-10,000'	13.15	37.87	19.80	-6.65	8.9
COSUMNES	3000-4000'	0.00	0.00	0.00	0.00	77.8
	4000-5000'	0.00	0.00	0.00	0.00	84.7
	5000-6000'	0.00	0.00	0.00	0.00	63.6
	6000-7000'	0.00	0.00	0.20	-0.20	28.1
	7000-8000'	0.32	1.93	4.71	-4.39	8.6
E CARSON	5000-6000'	0.00	0.00	0.00	0.00	32.7
	6000-7000'	0.00	0.01	0.00	0.00	77.7
	7000-8000'	0.02	0.67	0.16	-0.14	102.6
	8000-9000'	1.01	9.58	2.54	-1.53	96.5
	9000-10,000'	1.87	10.66	4.17	-2.30	29.7
	10,000-11,000'	1.02	5.12	3.56	-2.53	13.5
	> 11,000'	1.60	5.86	9.16	-7.56	0.3
E WALKER	6000-7000'	0.00	0.00	0.00	0.00	73.6
	7000-8000'	0.00	0.00	0.00	0.00	157.4
	8000-9000'	0.00	0.10	0.05	-0.04	154.9
	9000-10,000'	0.55	4.78	1.55	-0.99	63.1
	10,000-11,000'	2.11	10.75	4.71	-2.59	48.8
	> 11,000'	1.74	8.54	4.63	-2.88	7.8
FEATHER	3000-4000'	0.00	0.00	0.02	-0.02	286.2
	4000-5000'	0.00	0.08	0.03	-0.03	735.8
	5000-6000'	0.12	3.93	0.82	-0.70	1305.1
	6000-7000'	2.19	33.32	5.09	-2.90	871.3

Other Hydrologic Applications



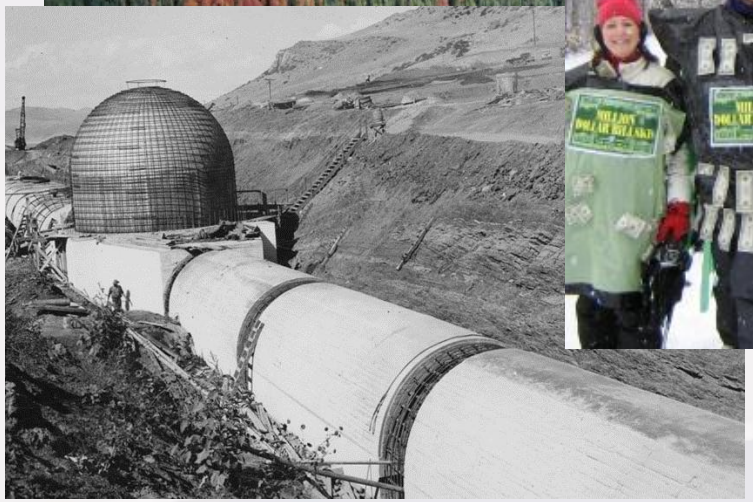
Credit: NOAA

Atmospheric Rivers (NASA / NOAA)

Credit: Gardener

Vegetation Change (NOAA WWA & CBRFC)

Rain on Snow



Sustainability of Trans-basin Diversions USDA - NSF

More Information

- Identify other users / interested parties:

- Water Resources
- Forest Management
- Weather Research
- Regional Climate Modelers

- http://instaar.colorado.edu/mtnhydro/

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NOAA: Western Water Assessment

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