Jan Curtis
NRCS - National Water & Climate Center
1201 NE Lloyd Blvd., Suite 802
Portland, OR 97232

jan.curtis@por.usda.gov
(503) 414-3017

National Water and Climate Center

PRISM Probabilistic-Spatial QC (PSQC) System for SNOTEL Data

MTNCLIM 2006 CONFERENCE
September 19-22, 2006 at Timberline Lodge, Mt. Hood, Oregon

Background

NRCS Snow Survey & Water Supply Forecasting Program

Web site: www.wcc.nrcs.usda.gov — July 24, 2006

Snow Survey Centennial Celebration 1906-2006

Hole-In-Mountain Avalanche

The number of things that can cause one of our automated SNOw TELemetry (SNOTEL) sites to go bad vary from simple equipment failure to wind damage, bear problems, mice chewing on wires, vandalism, snags falling on the equipment and in one case, a jeep trying to push the panel fence used to protect the snow pillow over with its front bumper. Often times you know something is wrong, because the data drifts or bounces all over the place, the battery slowly but surely begins its trip to the next life or more dramatically, the entire site seemingly drops off the face of the world. In most cases this is a metaphor for a site that just quits reporting for a variety of reasons, but in the case of the Hole-In-Mountain SNOTEL site, that's exactly what happened. An avalanche broke loose above the site and in a torrent of snow and a blast of wind, the site disappeared!

As you can see from the photo, this site lies on a bench just east of the East Humboldt Range at an elevation of 8,100 feet. Hole in the Mountain Peak rises to 11,306 feet just to the west of it. Vegetation is primarily young aspen along the bench and low growing shrubs on the steeper mountain side. A prime recipe for an avalanche.

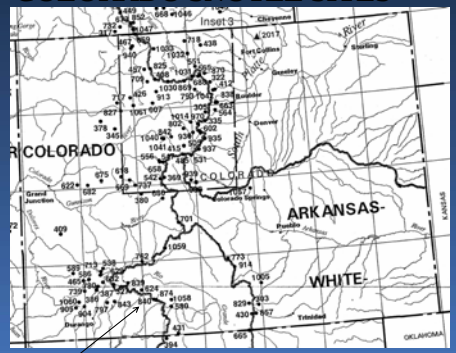
PRISM to help with Quality Control (QC)

When installation first began in the middle 1970s, the SNOTEL (**SNO**w**TEL**emetry) network was never envisioned as a data source for climate change studies; however the network has become a de facto source for middle and higher elevation snowpack, precipitation and temperature data in the West.

While sensor technology and communication capability continue to improve the quality of observations at these remote sites, PRISM methodology is now being employed to correct or back-fill all archived SNOTEL data that is suspect or missing. The results of this effort may indeed provide the basis for identifying a "benchmark" SNOTEL network for climate change studies.

Original Data Quality

COLORADO SNOTEL SITES



BA	BC	BD	BE	BF	BG	BH	BI	BJ	BK	BL
		RANKED BY NNULL								
site id			NTOTAL TMAX	NNULL	N00	PCT20	NTOTAL TMIN	NNULL	N20	PCT20
380	COLUMBINE	06J03S	7761	1058	838	0.108	7761	1210	306	0.040
701	DUTTE	04L11S	6665	1150	361	0.054	6665	1082	45	0.007
408	DURRO MOUNTAIN	07H02S	6665	714	149	0.022	6665	767	51	0.008
378	PARK RESERVOIR	07H06S	6665	711	100	0.015	6665	715	274	0.033
682	TOWER	06J29S	6665	487	173	0.013	6665	631	73	0.011
335	GRIZZLEY PEAK	05K09S	7761	574	45	0.005	7761	605	36	0.005
505	BERTHHOUD SUMMIT	05K14S	7030	608	337	0.048	7030	577	195	0.028
690	ARROW	05K06S	7030	579	409	0.058	7030	564	155	0.022
306	LAKE IRENE	05J10S	7030	477	90	0.013	7030	470	10	0.002
825	ELK RIVER	06J15S	6665	463	295	0.044	6665	470	80	0.006
565	PHANTOM VALLEY	05J04S	7030	468	165	0.023	7030	409	51	0.007
467	MESA LAKES	08K04S	6300	361	110	0.017	6300	357	82	0.013
668	PORPHYRY CREEK	06J03S	6665	1109	558	0.084	6665	387	56	0.008
457	DRY LAKE	06J01S	6665	382	209	0.031	6665	385	126	0.019
551	ROACH	06J12S	5569	343	4	0.001	5569	377	13	0.002
438	WILLOW CREEK PASS	06J05S	6665	339	75	0.011	6665	376	63	0.009
869	PARK CONE	04L02S	6665	339	311	0.047	6665	375	79	0.011
531	COPPER MOUNTAIN	04K24S	6665	366	146	0.021	6665	367	67	0.010
415	HOOSIER PASS	06K01S	6665	339	83	0.012	6665	366	56	0.008
622	RABBIT EARS PASS	06J05S	6756	382	184	0.027	6756	361	60	0.009
802	JOE WRIGHT	05J17S	5569	275	178	0.032	5569	359	56	0.010
718	SUMMIT RANCH	04K14S	6665	353	60	0.009	6665	354	766	0.115
607	DEADMAN HILL	05J06S	5569	374	0	0.000	5569	342	6	0.001
495	LYNX PASS	06J04S	6665	305	83	0.012	6665	308	111	0.017
369	FREMONT PASS	06K08S	6665	304	103	0.015	6665	306	7	0.001
542	BRUMLEY	04K40S	6665	302	59	0.009	6665	302	27	0.004
409	TRAPPER LAKE	07K12S	6634	327	104	0.016	6634	272	81	0.012
412	INDEPENDENCE PASS	06K04S	6665	289	66	0.010	6665	270	23	0.003
709	COLUMBINE PASS	04L07S	6300	354	515	0.082	6300	155	144	0.023
426	COPELAND LAKE	05J18S	5569	194	23	0.004	5569	192	155	0.027
870	CROSMO	07J04S	6300	174	97	0.015	6300	177	20	0.003
618	MC CLURE PASS	07K09S	6665	138	66	0.009	6665	144	7	0.001
827	LAKE ELDORA	05J41S	5569	106	20	0.003	5569	142	58	0.010
717	RIPPLE CREEK	07K03S	6769	127	97	0.015	6769	124	3	0.000
737	SCHOFIELD PASS	07K11S	6665	174	156	0.027	6665	122	2	0.000
793	STILLWATER CREEK	05J12S	6634	119	82	0.012	6634	120	27	0.004
842	VAIL MOUNTAIN	04K39S	6665	111	88	0.013	6665	113	258	0.038
564	NORTH LOST TRAIL	07H01S	6665	103	32	0.010	6665	103	8	0.001
669	BEAR LAKE	05J19S	5704	98	56	0.010	5704	99	98	0.017
322	WILLOW PARK	05J30S	5569	187	191	0.034	5569	98	197	0.035
838	UNIVERSITY CAMP	05J08S	5704	70	8	0.001	5704	71	15	0.003
345	BISON LAKE	07K12S	6665	56	45	0.006	6665	57	41	0.006
556	NAST LAKE	06K06S	6665	22	98	0.014	6665	46	87	0.013
668	KLN	06K39S	6665	26	181	0.015	6665	27	32	0.005
663	NIMOT	05J42S	5700	15	7	0.001	5700	17	29	0.005
675	OVERLAND RES.	07K14S	5704	11	22	0.004	5704	10	17	0.003
		Totals	296356	15361	6912	0.022	296356	15210	3450	0.011
		Percentages		5.18%	2.33%			5.13%	1.17%	

46 Colorado SNOTEL sites with more than 5,000 daily (Tmax & Tmin) observations. Missing days account for ~5.15% of POR.
PRISM determined suspect observations account for ~1.75% of POR.

PRISM Methodology

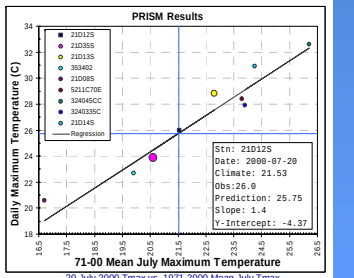
"Advances in climate mapping technology now make it possible to estimate a reasonably accurate 'expected value' for an observation based on surrounding stations.

Assumption: Spatial consistency is related to observation validity." – Dr. Chris Daly

Electronic Sensors and Modern Applications Create Challenges for Traditional QC Systems

Situation	*Need*
Errors tend to be continuous drift, rather than categorical mistakes	Continuous estimates, rather than categorical tests, of observation validity
Increasing usage of computer applications that rely on climate observations	Quantitative estimates of observational uncertainty, not just flags
Range of applications is increasingly rapidly, and each has a difference tolerance for outliers	Probabilistic information from which a decision to use an obs can be made, not up-front decision
Data are often more voluminous and disseminated in a more timely manner	Automated QC methods

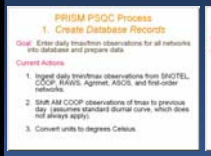
PRISM Regression of "Weather vs. Climate"

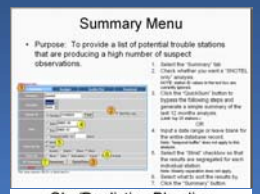


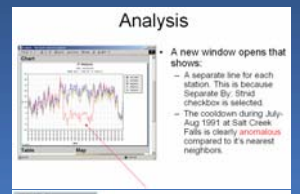
This is a scatter-plot showing how this method can be used for daily interpolation. On the x-axis is the mean July temperature, and it is being regressed with the daily maximum temperature for July 20, 2000. This plot, for a location new Mount Hood in Oregon, shows that even though the temperature is nearly 5C above the mean, the spatial patterns are remarkably similar.

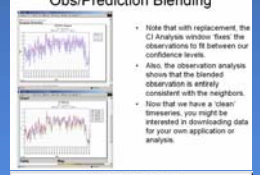
SNOTEL QC Website

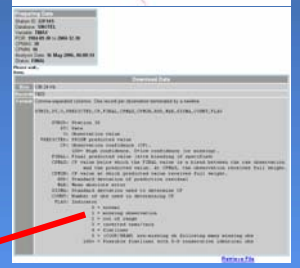
http://mistral.oce.orst.edu/www/snotelqc/

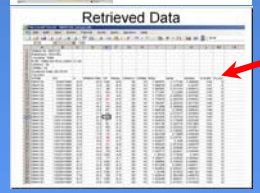












Issues to Consider

- How far can the assumption be taken that spatial consistency equates with validity?
- Are continuous and probabilistic QC systems useful for manual observing systems?
- Can a high-quality QC system ever be completely automated?
- If a QC system works effectively, can it be used for SNOTEL site selection? If so, then
- What criteria should be employed for SNOTEL site selection?

United States Department of Agriculture
NRCS Natural Resources Conservation Service