National Park Service
U.S. Department of the Interior

Natural Resource Stewardship and Science

Snowpack Monitoring, 2008-2009 Annual Summary

Central Alaska Network

Natural Resource Data Series NPS/CAKN/NRDS—2012/253

ON THE COVER
Chad Hults (NPS staff) taking snow course measurements at Kantishna in Denali National Park and Preserve.
Photograph by: Courtesy of NPS

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Abstract

The snowpack for the 2008-2009 varied across the state, from record high snowfalls on the Seward Peninsula and in Southeast Region, to below normal snowpacks for the central interior locations. The northeastern area of Wrangell-St. Elias, including the Chisana area and the western area of Denali had snowpacks well above normal, while the eastern portions of Denali, the Chugach Range in Wrangell-St. Elias, and Eagle had snowpacks 20% below normal. For the central Alaska region the snowpack accumulation started around the last week of September with most sites receiving 1-3 inches of snow, after this date snow generally remains on the ground for the rest of the season. Snow off dates for the region were between May 1 – May 9. Two notable events for the 2008-2009 season were the volcanic eruption of Mt. Redoubt in March 2009 and the devastating ice jam that occurred on the Yukon River near Eagle in early May 2009.

Acknowledgements

The data and results in this report would not be possible without the help of a number of people. Thanks to Paul Atkinson for doing the snow surveys for Yukon-Charley National Preserve and to Jared Withers for helping with the Denali snow surveys. Many thanks to the park pilots, Colin Milone, Tom Betts, and Rich Richotte, and the contract pilots, Sandy Hamilton, Robert Wing, and Jay Hudson, for flying safely and getting field data during the coldest and darkest time of the year. I also would like to thank Rick McClure, Dan Kenny, and James Montessi from NRCS, who make the surveys and data dissemination seamless.

Introduction

A predominate feature of climate in high latitude regions is the presence of a seasonal snowpack. The snowpack is a major influence on hydrology, vegetation, and faunal communities. A main objective of the Central Alaska Network's (CAKN) snowpack monitoring program is to record long-term trends in snow by engaging in an interagency agreement with the Natural Resources Conservation Service (NRCS) to survey snow courses, aerial snow markers, and install and maintain recording precipitation gauges (as part of the snow telemetry [SNOTEL] network) in all three CAKN parks, including Denali National Park and Preserve (DENA), Wrangell – St. Elias National Park and Preserve (WRST), and Yukon-Charley Rivers National Preserve. (YUCH). The SNOTEL sites have proven to be the most accurate instrumented sites to document all forms of precipitation in Alaska, including snowfall which is difficult to measure in remote locations. The agreement between the NPS and NRCS includes data dissemination and archiving. These summary reports compile snowpack data for the central Alaska region and are produced annually. The data provided in this report comes almost exclusively from the NRCS Alaska Snow, Water and Climate Services web based server (NRCS 2009).

Two significant events occurred during the 2008-2009 water year. The first was the eruption of Mt. Redoubt that occurred in late March that sent powerful ash explosions with plumes of ash between 30,000 to 60,000 feet above sea level across the south central and western interior of the state. The central interior received one of the largest snowfalls of the season just a few days after the first eruptions, blanketing the newly deposited ash with a layer of fresh snow. The second major event was the ice jam flooding on the Yukon River that destroyed much of the low lying areas of Eagle including the Mission Creek SNOTEL site that had been in operation for 19 years. There are plans to replace and upgrade the site in the summer of 2010.

The snowpack for the interior was slow to develop in 2008, but neared normal conditions in mid January. A few significant snowfalls occurred later in the season which resulted in above normal snow depth and water equivalent for many of the sites in the CAKN region. However, much of interior Alaska experienced an accelerated snowmelt the last few days of April 2009 due to the ash fall from Mt. Redoubt and record breaking high temperatures.

Methods

Snow pack is measured in several different ways in the Central Alaska Network. The objective of a snow survey or snow measurement is to determine the snow water equivalent or SWE, which is the amount of water in the snowpack. Snowpack monitoring for the CAKN is done through an interagency agreement with NRCS in Anchorage. For detailed methods refer to the Snowpack Monitoring Protocols for the CAKN (Sousanes 2004). The snow monitoring sites for the CAKN are shown in Figure 1.

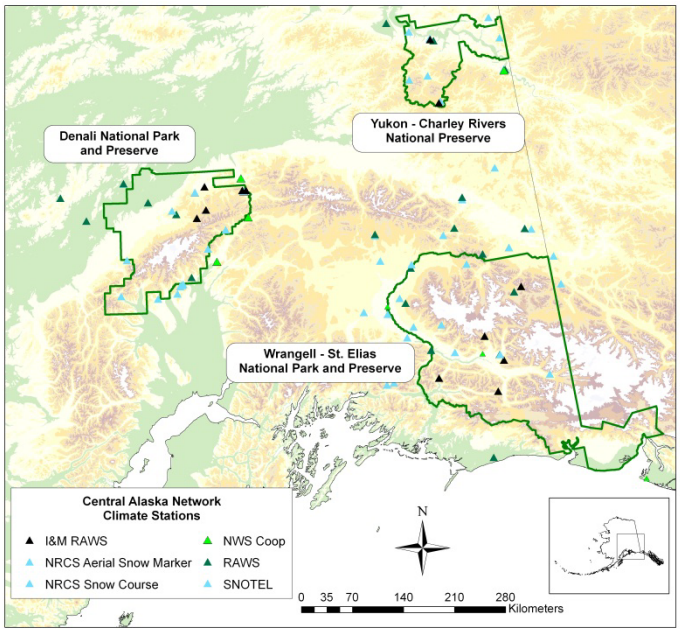

Figure 1. Locations of snow monitoring sites in the Central Alaska Network.

SNOTEL

The most useful information we have on snow pack is from the new CAKN SNOTEL sites at Kantishna and Tokositna Valley in Denali National Park and Preserve and at May Creek and Chisana in Wrangell – St. Elias National Park and Preserve. SNOTEL sites adjacent to CAKN parks are useful as well, including Mission Creek at Eagle near Yukon-Charley Rivers National Preserve, and the Upper Tsaina SNOTEL south of Copper Center near Wrangell – St. Elias National Park and Preserve.

Snow Courses and Aerial Markers

There are 20 snow courses and aerial snow markers in the three CAKN parks (Figure 2). Park staff, including park pilots and contracted pilots, fly these surveys the last 3 days of each month from November through April. A certain amount of logistic flexibility and cold weather hardiness is necessary to undertake these surveys. Weather and daylight are critical factors in making sure they are done safely.

Snow Depth Sensors

Acoustic snow depth sensors were added to most of the CAKN and Remote Automated Weather Station (RAWS) climate stations that were installed in the past few years. This measurement offers a cumulative look at snowpack development through the season.

Other Networks

The McKinley Park, Eagle, Cantwell, McCarthy, and Yakutat National Weather Service Cooperative Observer sites, or COOP sites, manually record snow depth and precipitation on a daily basis. These sites have records dating back many decades and are valuable for long term trend analysis.

Figure 2. Example of a snow course in Denali National Park and Preserve

Results

Snow surveys in all three CAKN parks were done on Dec 1, Feb 1, March 1, April 1 and May 1. Data from these surveys are available on the NRCS website at http://www.ak.nrcs.usda.gov/snow/; the sites specific to the Central Alaska region are compiled in this report. For the central Alaska region the snowpack accumulation started around the last week of September with most sites receiving 1-3 inches of snow, after this date snow generally remains on the ground for the rest of the season. Snow off dates for the region were between May 1 – May 9.

Air temperatures around the region were well below normal in October, but warmed to just above normal in November. There was a sustained cold high pressure system that started the last week of December through the first 10 days of January, which was followed by an abrupt warming as winds from the south brought record warm temperatures to the interior in the middle of January. The Denali Park headquarters station reported measurable rain on January 16 and 17, 2008 which decreased the snowpack by 2 – 3 inches at the site. As the season progressed air temperatures in February were slightly above normal at most sites and March temperatures 1-5 degrees colder than normal, and rising to a few degrees above normal for April.

The following sections provides a summary of the snowpack season for each of the major hydrologic units in the central Alaska region including the Tanana Basin, Central Yukon Basin, Western Interior Basin, Copper River basin, and the Matanuska-Susitna Basin (Figure 3).

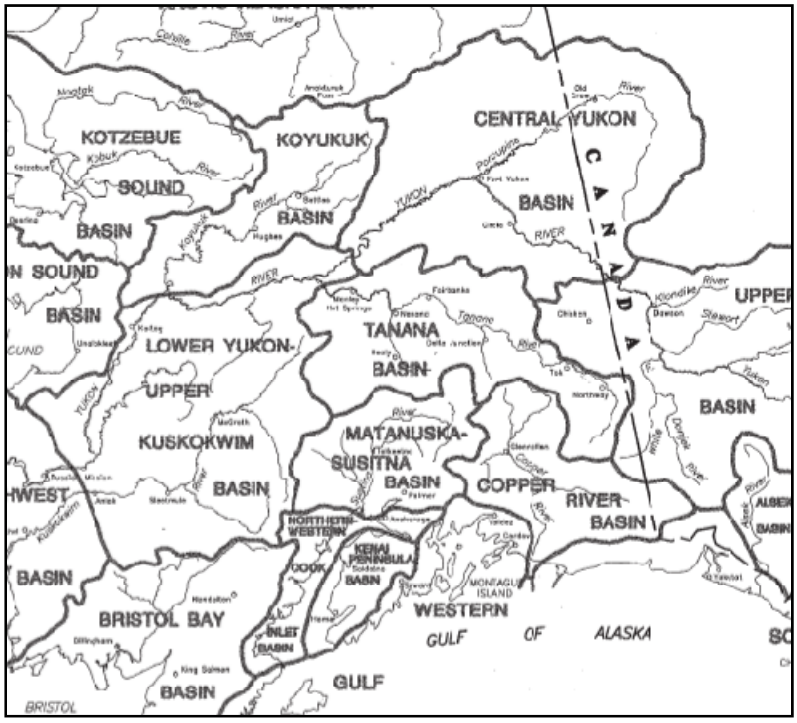

Figure 3. Map showing hydrologic basins of Alaska. Map courtesy of the Natural Resources Conservation Service Snow Survey Report (NRCS, 2009) and available at http://ambcs.org/pub/BasinRpt/2009/may.pdf

Tanana Basin 2008-2009 Surveys

The Tanana Basin includes the north side of Denali from Park headquarters to Kantishna and the northern areas of Wrangell - St. Elias from the Canadian border to the northeastern areas of Wrangell – St. Elias, including Chisana. North of the Alaska Range across the interior of Alaska the first measurable snow was recorded in the western part of the basin during the last week of September or the first week of October. At Denali park headquarters, the day of the first persistent snow was September 28. The new SNOTEL sites at Kantishna in Denali and Chisana in Wrangell–St. Elias now record daily snow depth and precipitation data, which provides the "snow on" date for the seasonal snowpack, after this date snow generally remains on the ground for the rest of the winter. On October 2, Kantishna recorded 2 inches and Chisana recorded 0.5 inches of snow, which marked the beginning of the season.

The start of the water year was cold, with October and November monthly average temperatures well below normal. The October average was 10 degrees colder than normal for most of the interior. Very few sites were visited during the first survey due to weather; the Kantishna site had 14 inches of snow on the ground with a snow water equivalent of 1.8 inches, which is 140% of normal and Chisana had 15 inches with 2.3 inches of snow water equivalent (swe), which is right at normal. The Denali Park headquarters site had 11 inches of snow on November 30$^{th;}$ the long-term average is 10 inches for this date. Jatamund Lake, north of Chisana in WRST, reported 12 inches of snow on November 30 which is 75% of normal, and Lost Creek, on the Nabesna Road, reported 11 inches.

By February the snowpack in the western portion of the Tanana Basin was slipping below normal, Kantishna had 19 inches of snow with a swe of 3.9 inches, normal is 26 inches of snow with a swe of 4.5 inches. Chisana's snowpack increased to 134% of normal with 23 inches of snow and a swe of 3.9 inches. The Jatahmund Lake snow course had 18 inches, 112% of normal. The middle Tanana Basin was still below normal, with the Denali park headquarters site at about 75% of normal with 8 inches of snow on the ground.

March air temperatures were below normal for most of the state including the interior, warming in April to just above normal. Through March and April the eastern region including Chisana and Jatahmund Lake continued to have above normal snowpack, the western region also received more snow, while the middle area remained below normal. At the end of April, the upper Tanana Basin sites were about 170% of normal, the middle basin remained at 70-75% of normal, and the western sites were 144% of normal. The snowpack generally decreases throughout April, this year however there was still a significant snowpack in the upper Tanana Basin with Chisana reporting 14 inches of snow on May 1 with 4.7 inches of water content which is 360% of average. Lake Minchumina also reported 12 inches of snow with a water content of 2.5 inches which is 192% of normal, the snowpack at Kantishna, the Rock Creek sites, and Denali headquarters however decreased more rapidly and by the May 1 survey were about 70-75% of normal. See Appendix A for individual site data.

The Kantishna SNOTEL site recorded 7.8 inches of total winter precipitation (snow water equivalent) from October 1, 2008 through May 1, 2009, 42% of the total annual precipitation of

18.5 inches. See Appendix B for snowfall and precipitation accumulation graphs. The McKinley Park long-term NWS site was 88% of normal for the year with an annual total of 70.1 inches of snow, the average snowfall is 79.9 inches. The Cantwell NWS COOP, located south of the crest of the Alaska Range, had record low snowfall amounts in November, February and April. The annual snowfall amount was 103.5 inches, 84 % of normal. See Appendix C for tables and graphs with long-term data. Figure 4 shows the NRCS snow survey report graphs for the area.

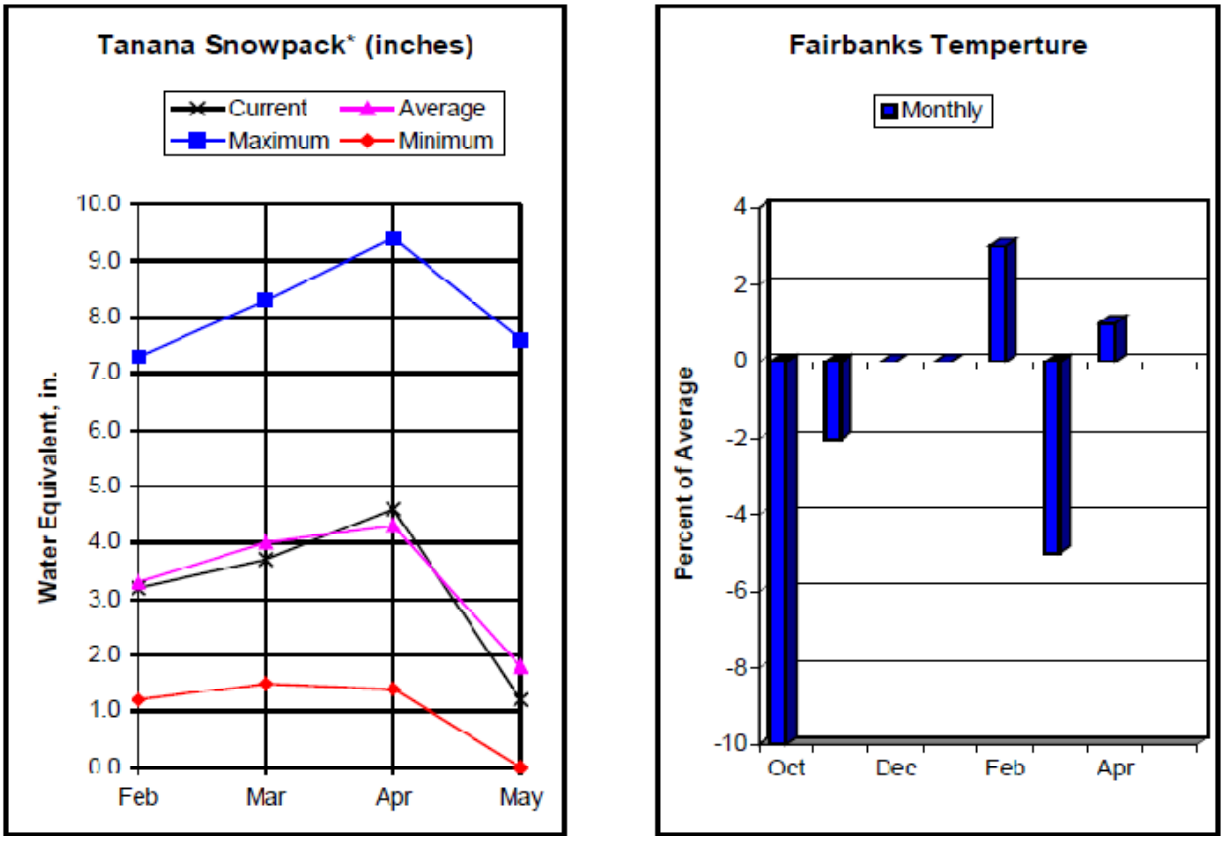

Figure 4. Tanana Basin 2008-2009 snow season. Graphs courtesy of the NRCS, Anchorage, AK (NRCS, 2009).

Central Yukon Basin 2008 – 2009 Surveys

The Central Yukon Basin encompasses all of Yukon-Charley Rivers National Preserve (YUCH). This part of the state had a snowpack that was just at normal or slightly above for the entire season, according to long-term records at Eagle. The sites at YUCH had consistently more snow throughout the season than Eagle. The Coal Creek climate station reported the first measurable snow on September 30, 2008. The first measurable snow at Mission Creek in Eagle occurred on October 2, 2008. December measurements of the Yukon-Charley snow markers and Coal Creek snow courses ranged from 12 inches to 17 inches.

By February 1, the snowpack on the north side of the Yukon River at Cathedral Mountain and Step Mountain aerial markers was between 19 and 22 inches, Coal Creek had 18 inches and as you progressed south the snowpack tapered off to 11 and 14 inches at Crescent Creek and

Copper Creek respectively. The Three Fingers site was not measured in February due weather. The peak snowpack was measured on April 1 and ranged between 16 and 26 inches in the lower valley sites with 30 inches in the upper Charley River drainage at the Three Fingers site. Although there are no long term records from YUCH, this year's April 1 measurements averaged about 9 inches more than last year's survey. The Mission Creek site in Eagle had 13 inches of snow on April 1 which is 70% of normal. There was still close to two feet of snow on the ground at the Upper Charley river site and at Step Mountain on May 1. Coal Creek had 9 inches and the other sites ranged between 0 inches at Copper Creek to 14 inches at Cathedral Creek. The Copper Creek site was the only site with no snow. The graphs taken from the NRCS Alaska Snow Survey Report for May 1 shows the average of all of the snow courses within the watershed; with temperatures from a nearby long-running climate station (Figure 5).

The May 5, 2009 ice jam on the Yukon River near Eagle destroyed the Mission Creek SNOTEL site; water year measurements are not available from the site. There are plans to replace the site in 2010. On May 5 the total precipitation accumulation for the year was 5.4 inches, or 93% of normal. See Appendix B for water year charts for the Mission Creek SNOTEL. The Eagle NWS COOP site recorded an annual snowfall amount of 49.5 inches or 83% of the normal 60 inches. See Appendix C for tables and graphs with long-term data.

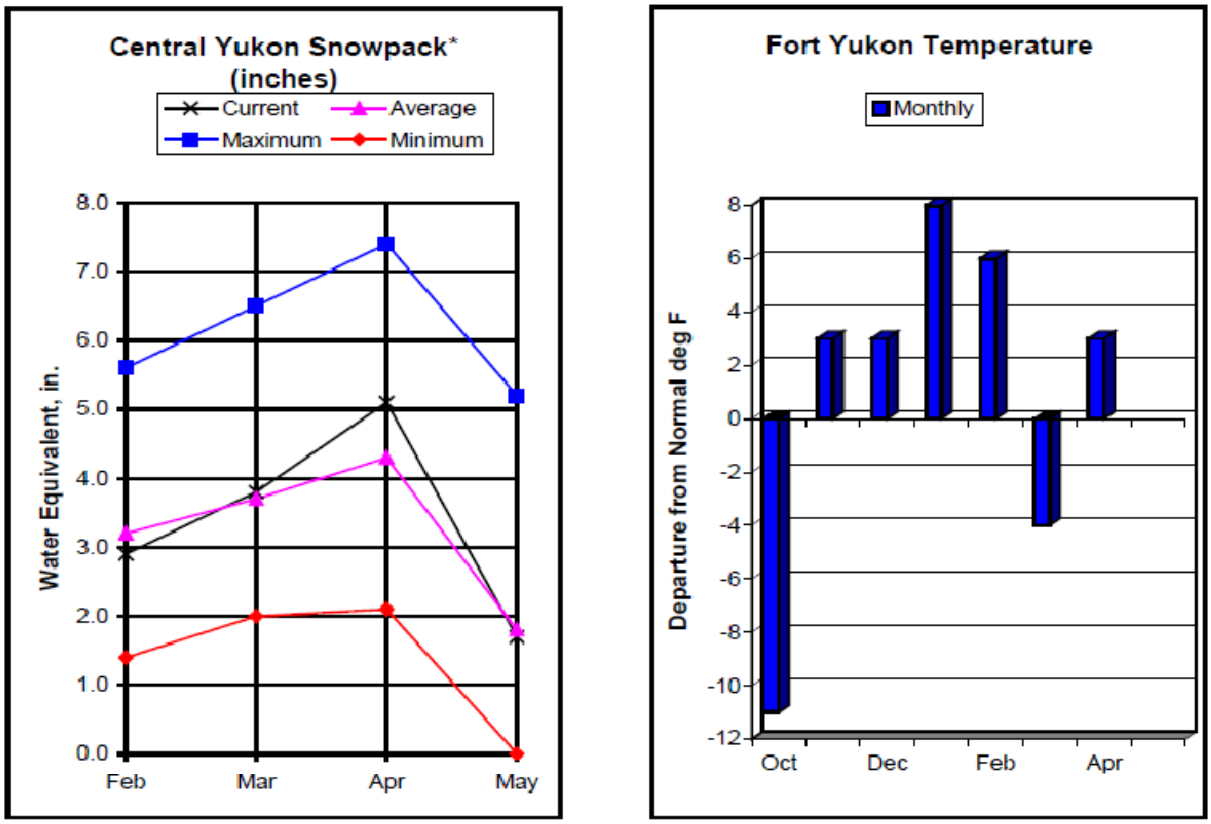

Figure 5. Central Yukon Basin 2008-2009 snow season. Courtesy of NRCS, Anchorage, AK (NRCS, 2009).

Western Interior Basin (Formerly called Lower Yukon –Upper Kuskokwim) 2008-2009 Surveys

Lake Minchumina and Purkeypile in Denali, are the two sites within the CAKN that are included in this hydrological division. This region had snowpacks that were above normal for the year with snow depths at Lake Minchumina at 27 inches for April, which is 128% of normal. Purkeypile was about 110% of normal with 23 inches of snow and 5.2 inches of water content. Minchumina still had 12 inches on the ground for the May 1 survey which is 240% of normal. Figure 6 shows the NRCS snow survey report graphs for the area.

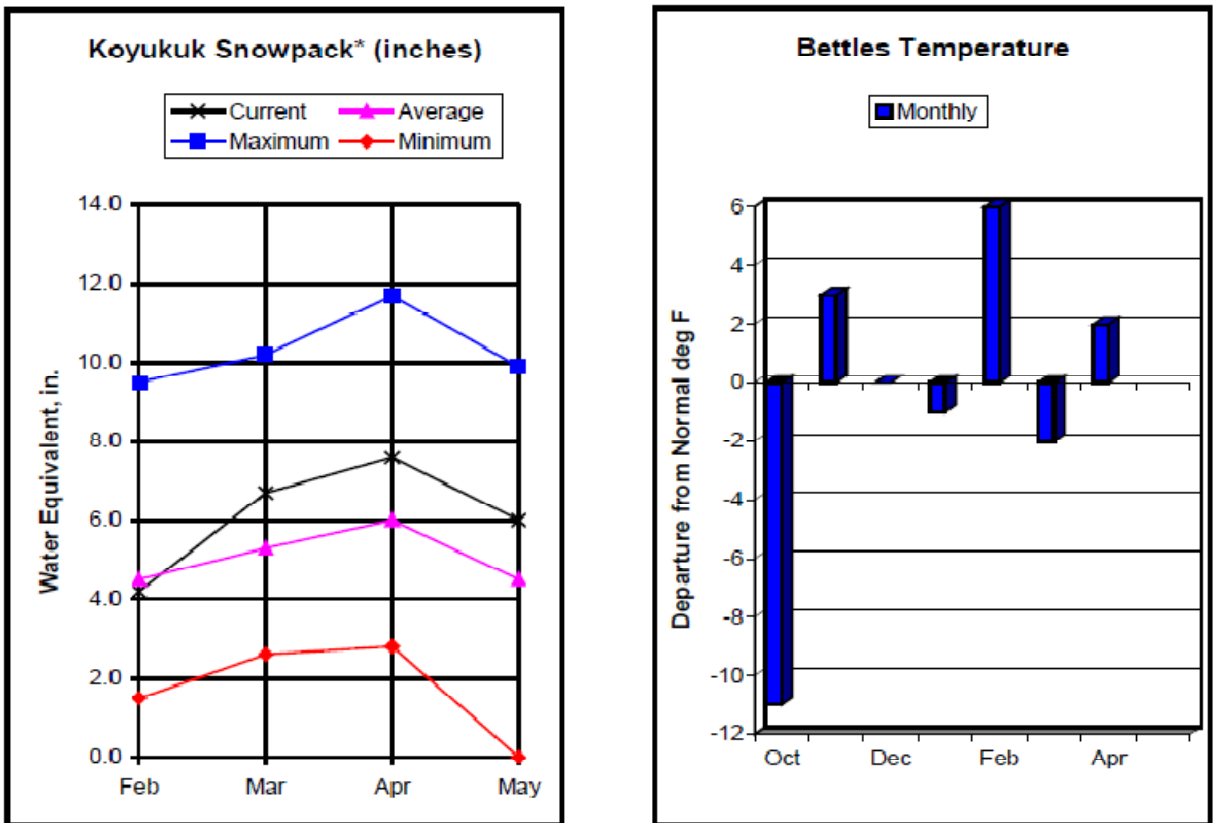

Figure 6. Koyukuk Basin 2008-2009 snow season. Courtesy of NRCS, Anchorage, AK

Copper Basin 2008 - 2009 Surveys

The Copper Basin is divided into 3 regions that encompass Wrangell – St. Elias: the Chugach Range, the Basin Floor and the Wrangell Mountains. The data from the early season surveys showed the Basin Floor at 104% of normal, the Chugach Range at 83% of normal, and the Wrangell Mountains at 100% of normal. The new May Creek SNOTEL showed snow on the ground starting on October 3 with 1 inch of snow. By the March 1 surveys the snow courses in the Chugach Range remained at about 80% of normal, the Wrangell Range courses were at 110% of normal, while the Basin Floor snowpack lost a bit of its snowpack and was at 93% of normal (NRCS, 2009).

There was considerable variability in the snowpack for April throughout the Copper River Basin. The Wrangell Mountains and the basin floor were above average, while the north side of the Chugach remained below average. The Wrangell Mountains area was 160% of normal for the April 1 survey. The snow remained through April and sites that normally report 0 inches of snow on May 1st still had a snowpack. May Creek SNOTEL had 12 inches of snow and the average is zero. Figure 7 shows the NRCS snow survey report graphs for the area.

The new SNOTEL site at May Creek reported precipitation, snow water equivalent, and cumulative precipitation. There was 8.4 inches of snow water equivalent on May 1st; the annual total precipitation was 14.2 inches, so the winter snowfall accounted for 60% of the total precipitation for the year. The snow off date was May 5, 2009. The McCarthy NWS COOP site has daily snowfall going back 13 years. There was 61.3 inches of total snowfall for the 2008-09 season; the mean after 13 years is 64.6 inches. October and March had snowfall totals higher than normal. See Appendix C for McCarthy snowfall data.

I will include the data from Yakutat in this section. It does not fall within the Copper Basin, but it does describe the coastal southeast area of WRST. There are no snow courses in this area, but the NWS Yakutat COOP station records snowfall. The site reported a total of 224.7 inches of snow for the year, or 120% of the 187 inches the site normally receives. Monthly snow totals for December, January and March were over 50 inches, all well above normal. See Appendix C for graphs related to the Yakutat site.

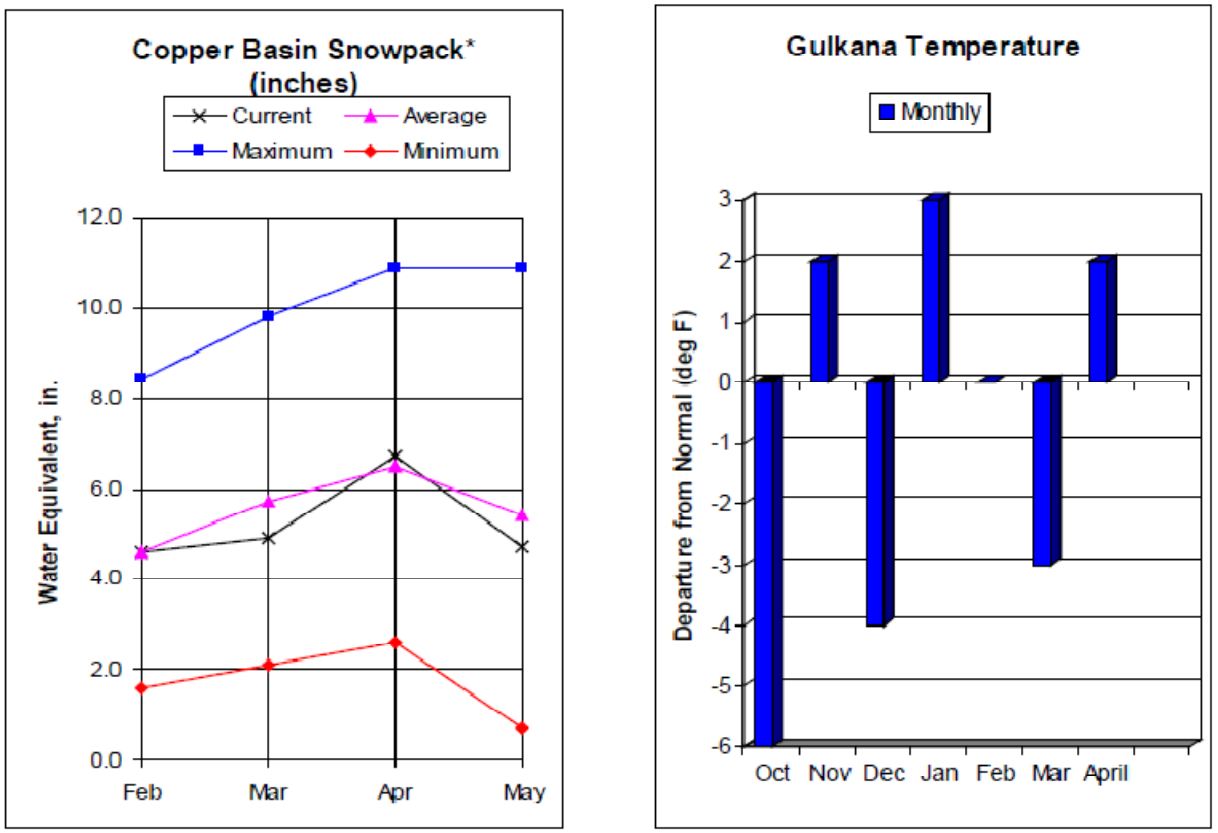

Figure 7. Copper Basin 2008-2009 snow season. Courtesy of NRCS, Anchorage, AK

Matanuska – Susitna Basin 2007-2008 Surveys

The new CAKN Tokositna Valley SNOTEL site now provides daily measurements of precipitation and snow. The first measurable snow that persisted was on October 7, 2008. The early season measurements for the markers in the western part of the Susitna Valley were at or below normal with the Tokositna SNOTEL reporting 35 inches of snow with 5.3 inches of water content for December 1, which is 63% of average. There was some additional accumulation for January and February, and the March 1 surveys indicated a snowpack near normal for most of the snow markers in the Peters and Dutch Hills area of Denali. This pattern persisted into late spring with most of the sites having near normal snowpacks for the May 1 survey.

Mount Redoubt erupted multiple times in March and there was widespread ash cover in the region, however additional snow accumulation quickly covered up the dark colored ash and did not cause an accelerated melt. The snowpack for the area was at 105% of normal for the May 1 survey. Figure 8 shows the NRCS snow survey report graphs for the area.

The precipitation gage at Tokositna Valley recorded 24.3 inches of precipitation from October 1, 2008 through May 1, 2009, which is about 2 inches more than the 1971-2000 normal. This is 55% of the total annual precipitation of 44.4 inches for the 2009 water year. See Appendix B for more information on the Tokositna SNOTEL data.

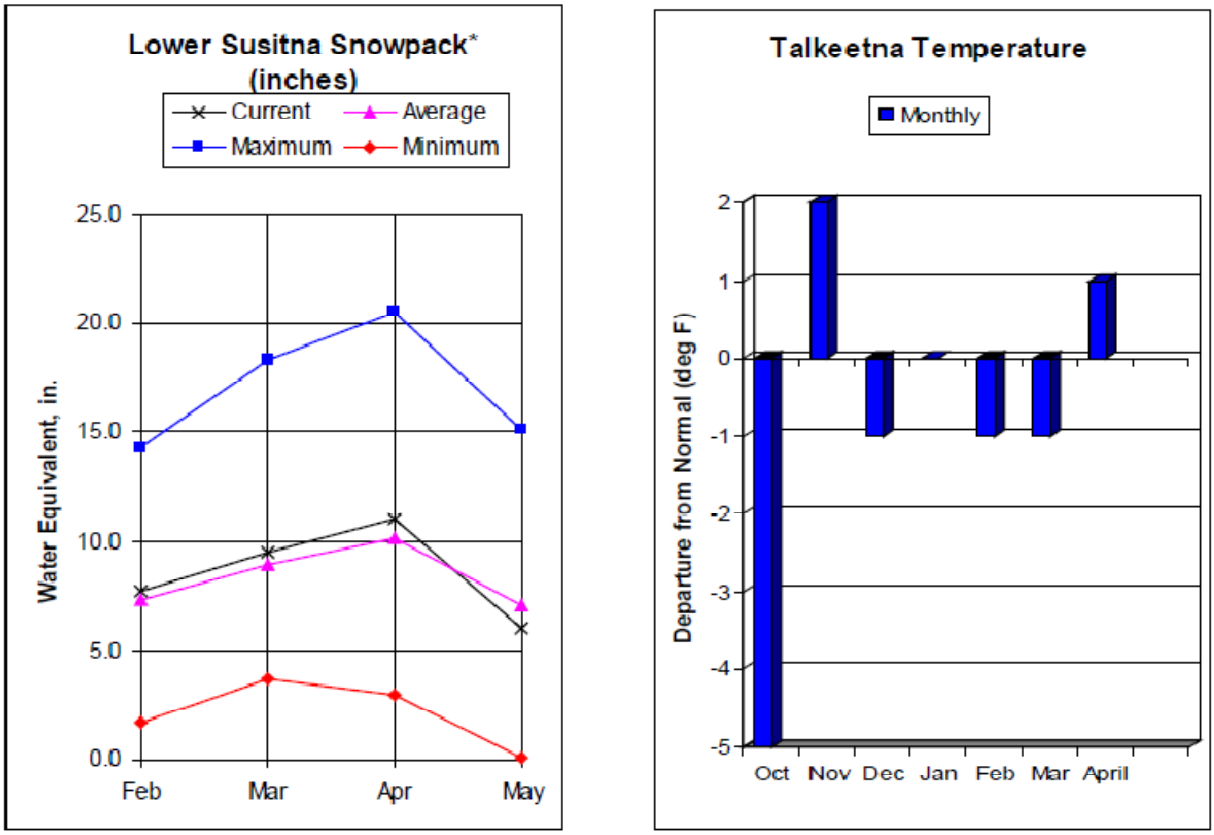

Figure 8. Lower Susitna Basin 2008-2009 snow season. Courtesy of NRCS, Anchorage, AK

Discussion

The snowpack across the Central Alaska Network varied quite a bit, mainly because the network encompasses over 21 million acres and includes north and south aspects of four major mountain ranges. Within the major ecoregions there were consistent patterns, with snow accumulation and departures from normal that were similar to the previous two years. The storms that brought the most snow originated from the southwest and decreased in strength as they approached the middle of the state. There were some storm tracks that originated from the Gulf of Alaska and these storms tended to track up along the eastern boundary of the state dumping snow in the Wrangell Mountains and the northeast corner of Wrangell-St. Elias, leaving the central interior with lower than normal snowpacks; the same patterns occurred the past few years. Yakutat total snowfall was 120% of normal, while Valdez was at 90% of normal. The Chugach Range and the western Gulf of Alaska remained slightly below normal, while the southeast panhandle was above normal, indicating that the storm tracks were circulating farther east.

The sites in Yukon-Charley Rivers again had consistently more snow than Eagle over the entire season, but we don't have long term records to compare how this year measured up to normal. There was more snow on the ground in 2008-2009 then the previous few years; Coal Creek peak snowpack at the end of March was 7.5 inches more than the past 2 years. The Upper Susitna Basin was near normal and received most of the snow from storms moving southwest to southeast. The NRCS publishes Alaska snowpack maps for each month the snow surveys are done starting on Feb 1. These maps give a nice overall picture of snowpack variability around the state (See Appendix E).

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Appendix A. Snow Course Data from 2009

Snow Course Data	**2008**								
SNOW COURSE	**ELEV.**	**FEB**		**MAR**		**APR**		**May**	
Name	ft.	depth	swe	depth	swe	depth	swe	depth	swe
		in.	in.	in.	in.	in.	in.	in.	in.
Talkeetna	350	18	3.0	38	8.5	38	10.2	20	6.2
Tokositna Valley	850	35	5.3	53	11.5	58	13.8	44	14.0
Chelatna Lake	1450	***	***	45	10.0	***	***	34	11.5
Nugget Bench	2010	***	***	64	14.7	66	16.7	44	14.5
Ramsdyke Creek	22200	***	***	84	20.6	89	23.5	63	23.0
Dutch Hills	3100	***	***	96	25.0	102	28.5	83	30.5
Fairbanks Field Off.	450	***	***	25	3.6	26	4.6	0	0
Lake Minchumina	730	***	***	23	3.5	27	5.0	12	2.5
Kantishna	1550	19	3.9	25	4.4	31	5.8	9	2.5
Jatahmund Lake	2180	18	2.7	24	4.1	24	5.1	12	2.6
Rock Creek Bottom	2250	***	***	16	3.2	17	3.5	0	0
Rock Creek Ridge	2600	***	***	18	3.8	20	3.9	4	1.7
Lost Creek	3030	13	3.1	17	2.9	20	4.9	***	***
Chisana	3320	23	3.9	26	4.9	27	5.6	14	4.7
Purkeypile Mine	2025	***	***	***	***	23	5.2	***	***
Valdez	50	58	17.4	51	13.2	52	15.5	24	8.0
Tazlina	1225	6	1.2	10	2.0	13	2.9	0	0
Kenny Lake School	1300	12	2.7	13	2.0	15	3.4	0	0
Chokosna	1550	***	***	16	3.1	17	4.9	***	***
May Creek	1610	23	4.0	27	5.6	28	8.0	12	3.2
Tsaina River	1750	40	10.8	40	11.9	42	12.4	12	4.0
Chistochina	1950	20	3.0	25	3.6	25	4.6	9	2.8
Tolsona Creek	2000	20	3.5	21	3.5	22	4.4	***	***
Dadina Lake	2160	19	4.0	33	6.0	31	6.5	***	***
Sanford River	2280	22	4.4	28	4.8	34	7.5	***	***
Mission Creek	900	10	2.1	13	2.3	13	3.0	2	0.7
Coal Creek	1000	18	2.7	21	3.7	24	4.5	9	1.7

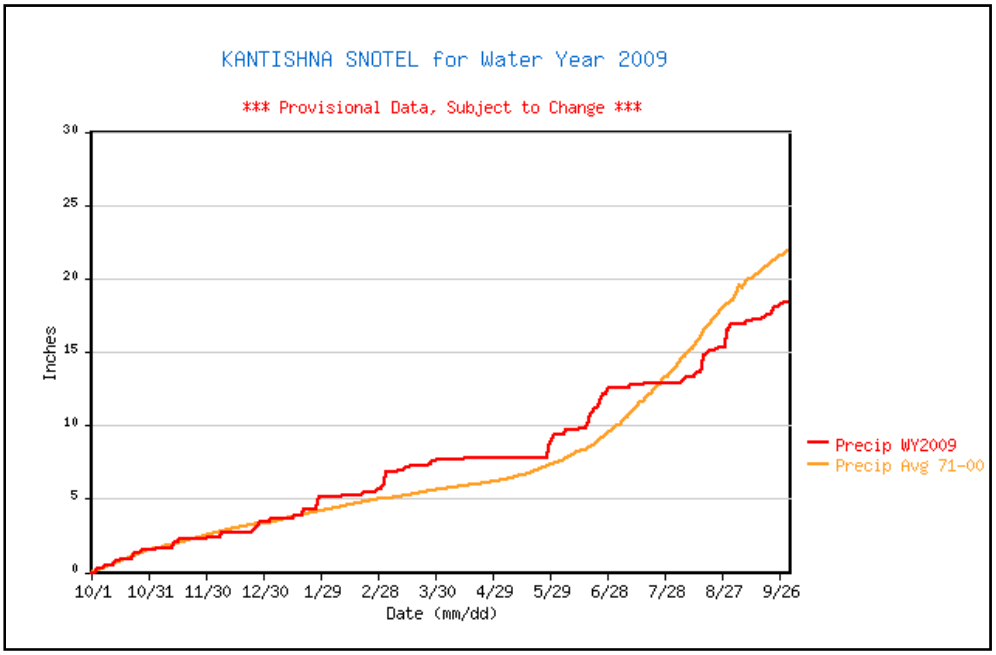
Snow Course Averages 1971-2001

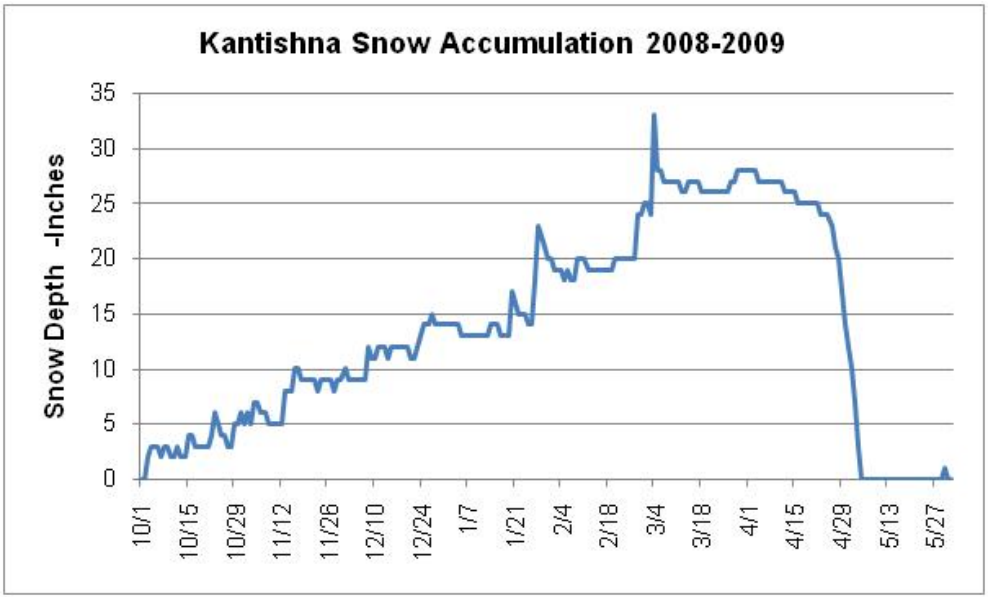
Snow Course Averages	**1971-2000**								
SNOW COURSE	**ELEV.**	**FEB**		**MAR**		**APR**		**May**	
Name	ft.	depth	swe	depth	swe	depth	swe	depth	swe
		in.	in.	in.	in.	in.	in.	in.	in.
Matanuska Susitna basin									
Talkeetna	350	28	6.2	32	7.6	34	8.7	16	5.4
Tokositna Valley	850	55	13.6	67	15.7	62	18.7	43	17
Chelatna Lake	1450	36	8.3	42	10	44	11.6	33	10.9
Nugget Bench	2010	45	10.9	51	12.9	55	15.5	46	15.3
Ramsdyke Creek	2220	61	16.3	66	18.9	69	22	57	21.9
Dutch Hills	3100	69	19.6	76	23	80	27.5	74	28.7
Fairbanks Field Off.	450	21	3.5	23	4.1	23	4.5	3	0.8
Lake Minchumina	730	19	3.2	21	4	21	4.4	5	1.3
Kantishna	1550	26	4.5	28	5.3	30	5.7	15	3.1
Jatahmund Lake	2180	16	2.3	18	2.9	18	3.2	***	***
Rock Creek Bottom	2250	20	3.7	22	4.2	22	4.3	8	2.2
Rock Creek Ridge	2600	24	4.3	26	4.9	26	5.3	14	4.9
Lost Creek	3030	25	4.8	26	4.8	21	4.2	***	***
Chisana	3320			22	3.4	22	3.6	***	***
Purkeypile Mine	2025	20	3.9	21	4.2	21	4.1	10	2.5
Valdez	50	45	11.9	51	15.5	54	17.8	33	12.6
Tazlina	1225	17	3	20	3.7	19	4.2	***	***
Kenny Lake School	1300	14	2.6	18	3.4	17	3.7	3	0.9
Chokosna	1550	***	***	21	3.2	22	3.9	***	***
May Creek	1610	***	***	21	3.8	21	4.5	***	***
Tsaina River	1650	50	12.5	56	15.7	57	17.6	41	14.6
Chistochina	1950	18	3	22	3.5	22	4.1	4	1.2
Tolsona Creek	2000	19	3.2	22	3.8	22	4.1	5	2.1
Dadina Lake	2160	24	4.1	29	5.1	27	5.9	***	***
Sanford River	2280	24	4.2	28	5.4	28	6.2	15	4
Mission Creek	900	15	3.1	18	3.6	18	4.1	2	0.5
Upper Chena	3000	28	6.2	30	6.9	33	7.8	25	7.5

Appendix B. SNOTEL Site Data

These data are available courtesy of the NRCS and are can be accessed at http://www.ambcs.org/dbArchive.html and http://www.wcc.nrcs.usda.gov/

Kantishna: North Side Denali National Park and Preserve

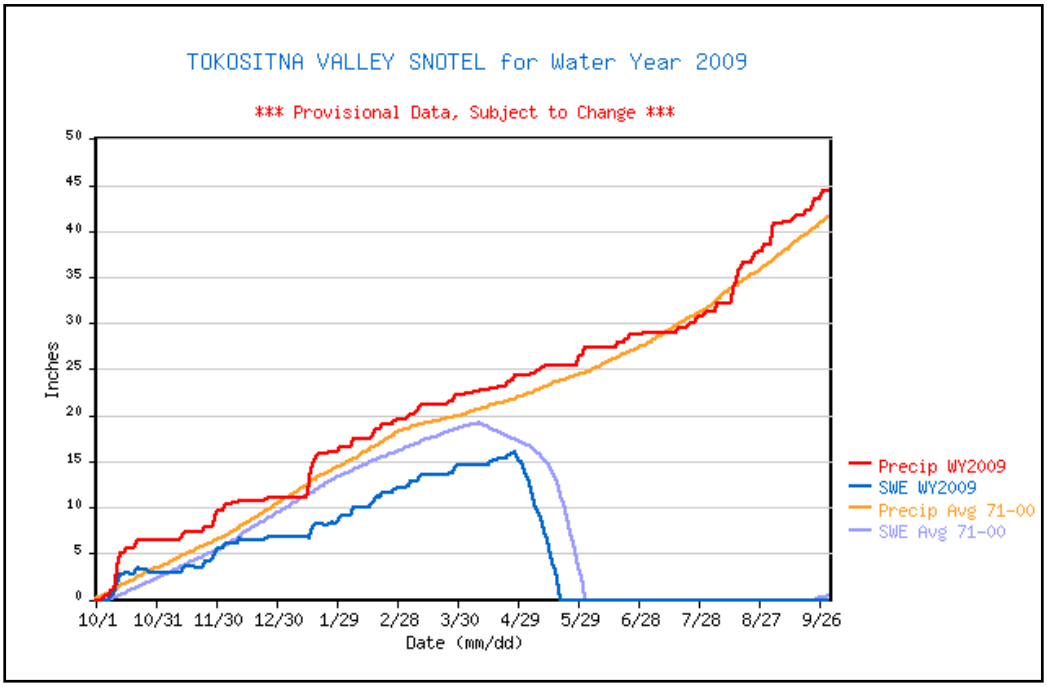


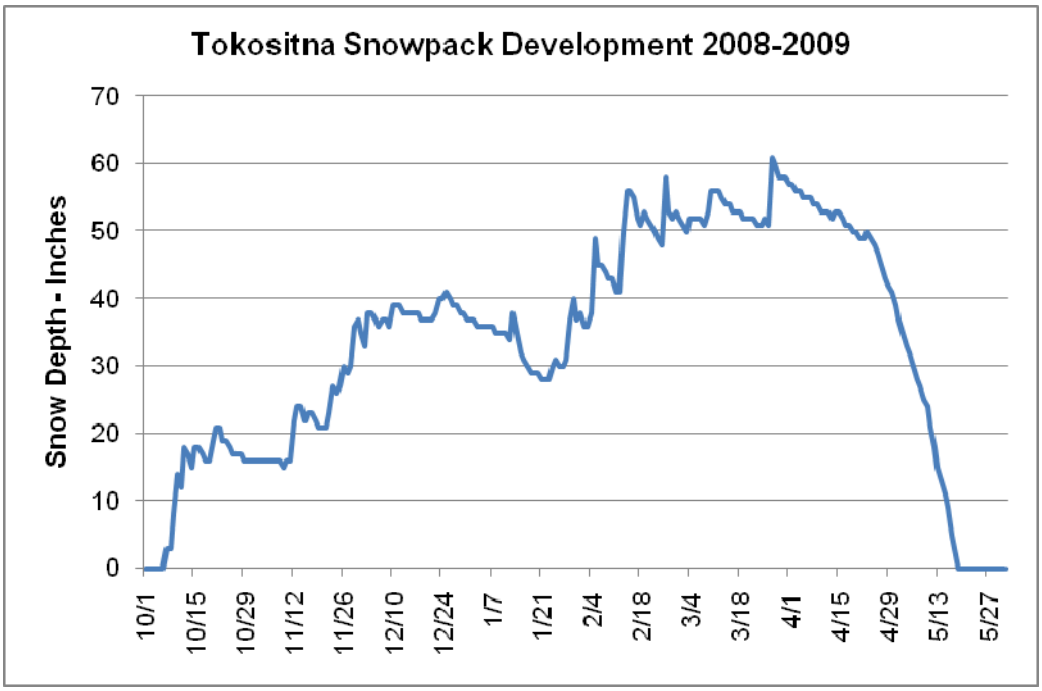


Daily precipitation totals for Kantishna for 2008-2009 season Oct 1 – Sep 30.
Unit = inches

day	oct	nov	dec	jan	feb	mar	apr	may	jun	jul	aug	sep
1	0.0	1.5	2.4	3.5	5.2	5.7	7.7	7.8	9.4	12.6	12.9	17.0
2	0.0	1.5	2.4	3.5	5.2	5.9	7.7	7.8	9.4	12.6	12.9	17.0
3	0.1	1.5	2.4	3.7	5.2	6.0	7.7	7.8	9.4	12.6	12.9	17.0
4	0.3	1.6	2.4	3.7	5.2	6.9	7.7	7.8	9.4	12.6	12.9	17.0
5	0.3	1.6	2.4	3.7	5.2	6.9	7.7	7.8	9.4	12.6	12.9	17.0
6	0.3	1.7	2.4	3.7	5.2	6.9	7.7	7.8	9.7	12.6	13.0	17.0
7	0.4	1.7	2.4	3.7	5.2	6.9	7.7	7.8	9.7	12.6	13.2	17.0
8	0.5	1.7	2.7	3.7	5.2	6.9	7.7	7.8	9.7	12.6	13.3	17.0
9	0.5	1.7	2.7	3.7	5.3	6.9	7.7	7.8	9.7	12.6	13.3	17.2
10	0.5	1.7	2.7	3.7	5.3	7.0	7.7	7.8	9.7	12.8	13.4	17.2
11	0.5	1.7	2.7	3.7	5.3	7.0	7.7	7.8	9.7	12.8	13.4	17.2
12	0.5	1.7	2.7	3.7	5.3	7.0	7.7	7.8	9.7	12.8	13.4	17.3
13	0.7	2.1	2.7	3.7	5.3	7.0	7.7	7.8	9.8	12.8	13.6	17.3
14	0.8	2.1	2.7	3.7	5.3	7.2	7.8	7.8	9.8	12.8	13.7	17.3
15	0.8	2.1	2.7	3.9	5.3	7.2	7.8	7.8	9.8	12.8	13.7	17.3
16	0.9	2.3	2.7	3.9	5.3	7.2	7.8	7.8	9.8	12.8	14.0	17.3
17	0.9	2.3	2.7	3.9	5.3	7.3	7.8	7.8	10.1	12.9	14.8	17.4
18	0.9	2.3	2.7	3.9	5.3	7.3	7.8	7.8	10.4	12.9	14.8	17.4
19	0.9	2.3	2.7	3.9	5.3	7.3	7.8	7.8	10.8	12.9	14.9	17.6
20	0.9	2.3	2.7	4.3	5.5	7.3	7.8	7.8	11.0	12.9	15.2	17.6
21	0.9	2.3	2.7	4.3	5.5	7.3	7.8	7.8	11.2	12.9	15.2	17.6
22	0.9	2.3	2.7	4.3	5.5	7.3	7.8	7.8	11.2	12.9	15.2	17.7
23	1.3	2.3	2.7	4.3	5.5	7.3	7.8	7.8	11.3	12.9	15.2	18.1
24	1.3	2.3	2.8	4.3	5.5	7.3	7.8	7.8	11.7	12.9	15.3	18.1
25	1.3	2.3	2.9	4.3	5.5	7.3	7.8	7.8	12.2	12.9	15.4	18.1
26	1.3	2.3	3.1	4.3	5.5	7.3	7.8	7.8	12.2	12.9	15.4	18.2
27	1.5	2.3	3.2	4.7	5.6	7.4	7.8	7.8	12.2	12.9	15.4	18.4
28	1.5	2.3	3.5	5.2	5.7	7.6	7.8	8.6	12.5	12.9	15.4	18.5
29	1.5	2.3	3.5	5.2	---	7.6	7.8	8.8	12.6	12.9	16.5	18.5
30	1.5	2.3	3.5	5.2	---	7.6	7.8	9.3	12.6	12.9	16.5	18.5
31	1.5	---	3.5	5.2	---	7.7	---	9.4	---	12.9	16.9	---
mean	0.8	2.0	2.8	4.1	5.3	7.1	7.8	8.0	10.5	12.8	14.3	17.5
max	1.5	2.3	3.5	5.2	5.7	7.7	7.8	9.4	12.6	12.9	16.9	18.5
min	0.0	1.5	2.4	3.5	5.2	5.7	7.7	7.8	9.4	12.6	12.9	17.0

Tokositna Valley: South side of Denali National Park and Preserve

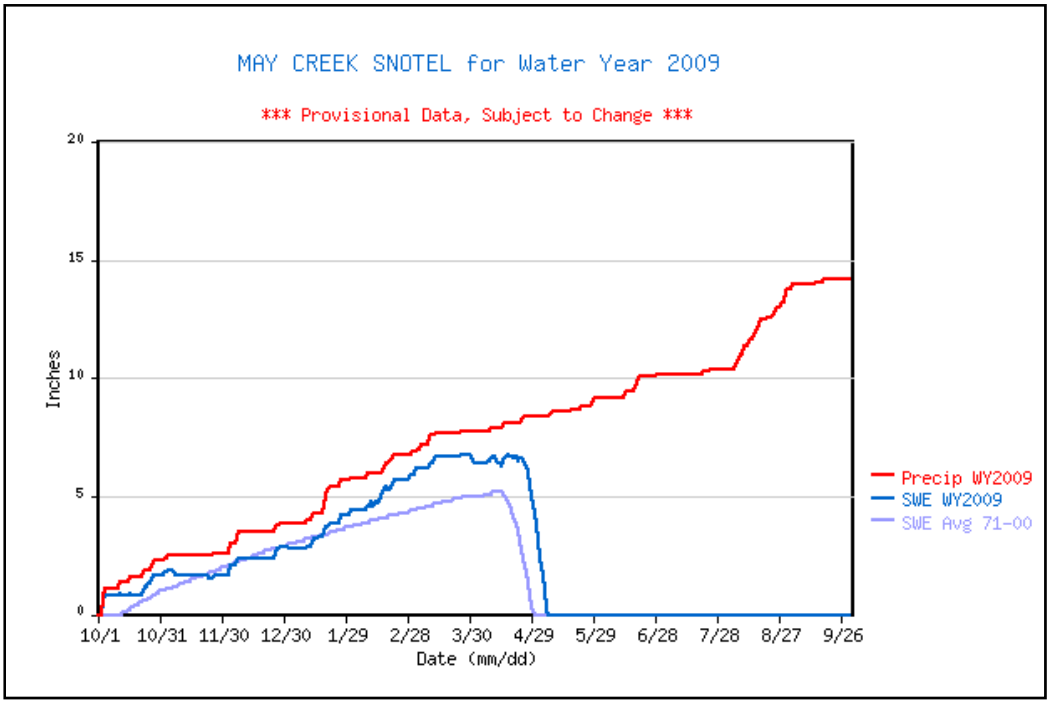


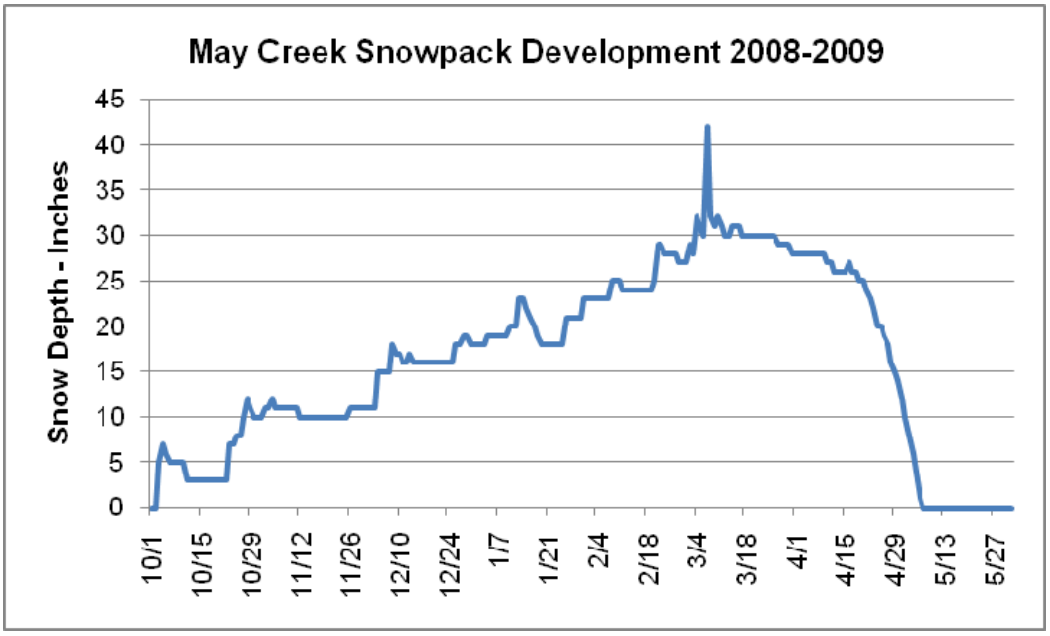


Daily precipitation totals for Tokositna Valley for 2008-2009 season Oct 1 – Sep 30.
Unit = inches

day	oct	nov	dec	jan	feb	mar	apr	may	jun	jul	aug	sep
1	0.0	6.4	9.7	11.0	16.6	19.6	22.3	24.3	27.4	29.0	31.3	38.6
2	0.0	6.4	9.7	11.0	16.6	19.6	22.3	24.3	27.4	29.0	31.3	40.1
3	0.0	6.4	9.7	11.0	16.6	19.6	22.4	24.4	27.4	29.0	31.3	40.9
4	0.1	6.4	10.2	11.0	16.6	19.6	22.4	24.4	27.4	29.0	31.3	40.9
5	0.3	6.4	10.4	11.0	16.8	20.0	22.4	24.5	27.4	29.0	31.3	40.9
6	0.5	6.4	10.4	11.0	17.4	20.2	22.4	24.6	27.4	29.0	32.1	40.9
7	0.5	6.4	10.4	11.0	17.4	20.2	22.6	24.6	27.4	29.0	32.2	40.9
8	1.0	6.4	10.5	11.0	17.4	20.2	22.6	24.8	27.4	29.0	32.2	41.0
9	1.0	6.4	10.5	11.0	17.4	20.4	22.6	24.9	27.4	29.0	32.2	41.0
10	1.5	6.4	10.5	11.0	17.4	20.6	22.7	25.1	27.4	29.0	32.2	41.0
11	3.7	6.4	10.7	11.0	17.4	21.0	22.7	25.2	27.4	29.0	32.2	41.0
12	4.0	6.6	10.7	11.0	17.4	21.2	22.7	25.3	27.4	29.0	32.2	41.3
13	5.0	7.2	10.7	11.0	17.4	21.2	22.7	25.4	27.4	29.0	32.3	41.4
14	5.1	7.4	10.7	11.4	17.4	21.2	22.7	25.5	27.4	29.0	33.9	41.8
15	5.3	7.4	10.7	13.1	17.6	21.2	22.9	25.5	27.4	29.0	34.5	41.8
16	5.6	7.4	10.7	14.1	18.2	21.2	22.9	25.5	27.4	29.0	35.6	41.8
17	5.6	7.4	10.7	15.1	18.5	21.2	22.9	25.5	28.0	29.4	35.9	41.8
18	5.6	7.4	10.7	15.4	18.6	21.2	23.0	25.5	28.0	29.5	36.0	41.8
19	5.6	7.4	10.7	15.7	18.6	21.2	23.2	25.5	28.0	29.5	36.7	42.2
20	5.7	7.4	10.7	15.9	19.1	21.2	23.2	25.5	28.0	29.5	36.7	42.2
21	6.1	7.4	10.7	15.9	19.1	21.2	23.2	25.5	28.2	29.5	36.7	42.2
22	6.4	7.4	10.7	15.9	19.1	21.2	23.2	25.5	28.3	29.7	36.7	42.5
23	6.4	7.6	10.8	15.9	19.1	21.2	23.3	25.5	28.4	29.8	36.7	43.5
24	6.4	7.9	10.9	15.9	19.1	21.2	23.7	25.5	28.9	30.0	37.5	43.5
25	6.4	7.9	10.9	16.1	19.1	21.3	23.7	25.5	28.9	30.0	37.7	43.6
26	6.4	7.9	11.0	16.1	19.5	21.5	23.8	25.5	28.9	30.3	37.7	43.6
27	6.4	7.9	11.0	16.1	19.5	21.6	24.3	25.5	28.9	30.5	37.8	44.4
28	6.4	8.0	11.0	16.1	19.6	22.0	24.3	25.5	28.9	30.7	37.8	44.4
29	6.4	8.8	11.0	16.1	---	22.2	24.3	26.4	28.9	30.8	38.5	44.4
30	6.4	9.5	11.0	16.6	---	22.3	24.3	26.5	29.0	30.9	38.6	44.4
31	6.4	---	11.0	16.6	---	22.3	---	26.7	---	31.1	38.6	---
mean	4.1	7.2	10.6	13.6	18.0	21.0	23.1	25.3	27.9	29.5	34.8	42.0
max	6.4	9.5	11.0	16.6	19.6	22.3	24.3	26.7	29.0	31.1	38.6	44.4
min	0.0	6.4	9.7	11.0	16.6	19.6	22.3	24.3	27.4	29.0	31.3	38.6

May Creek SNOTEL: Wrangell –St. Elias National Park and Preserve

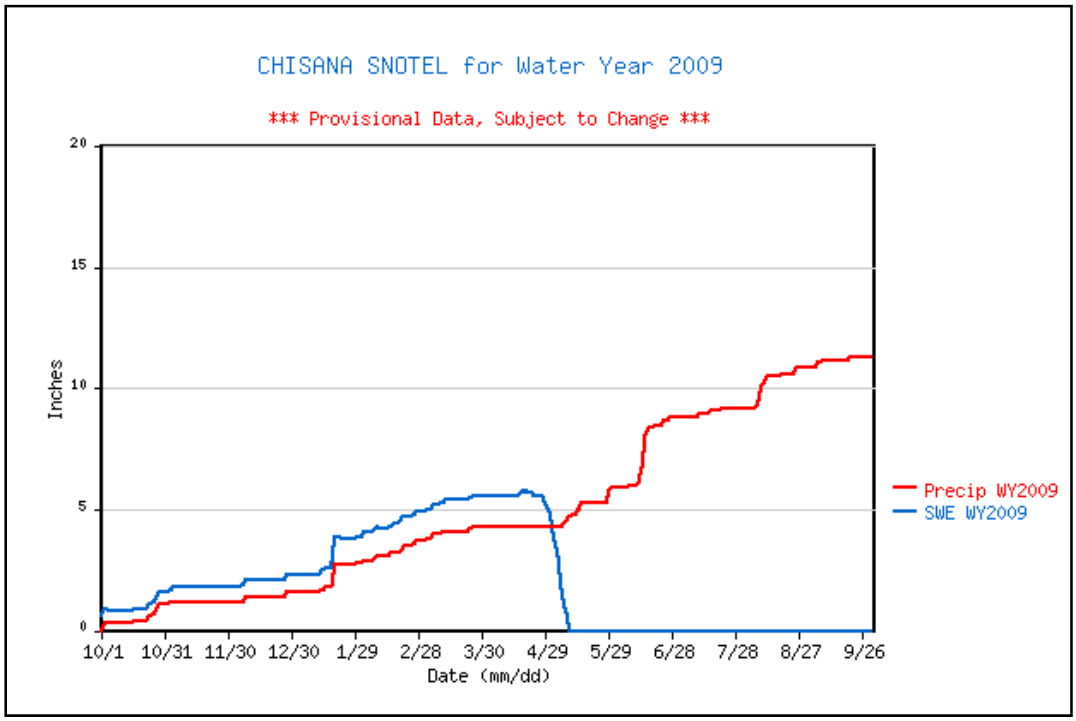


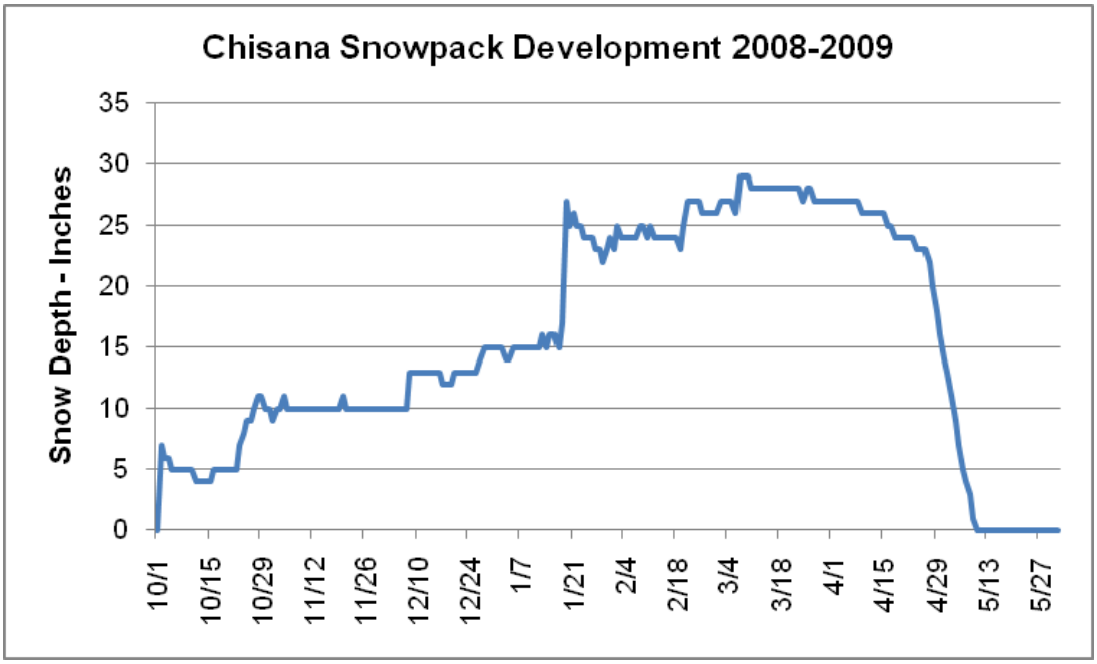


Daily precipitation totals for May Creek for 2008-2009 season Oct 1 – Sep 30.
Unit = inches

day	oct	nov	dec	jan	feb	mar	apr	may	jun	jul	aug	sep
1	0.0	2.3	2.6	3.9	5.8	6.8	7.8	8.4	9.2	10.2	10.4	13.8
2	0.0	2.4	2.6	3.9	5.8	6.9	7.8	8.4	9.2	10.2	10.4	14.0
3	0.7	2.4	2.6	3.9	5.8	6.9	7.8	8.4	9.2	10.2	10.4	14.0
4	1.1	2.5	3.0	3.9	5.8	6.9	7.8	8.4	9.2	10.2	10.4	14.0
5	1.1	2.5	3.0	3.9	5.8	7.0	7.8	8.4	9.2	10.2	10.4	14.0
6	1.1	2.5	3.0	3.9	5.8	7.2	7.8	8.4	9.2	10.2	10.5	14.0
7	1.1	2.5	3.2	3.9	5.8	7.2	7.8	8.4	9.2	10.2	10.8	14.0
8	1.1	2.5	3.5	3.9	6.0	7.2	7.8	8.5	9.2	10.2	11.0	14.0
9	1.1	2.5	3.5	3.9	6.0	7.2	7.9	8.6	9.2	10.2	11.0	14.0
10	1.1	2.5	3.5	4.0	6.0	7.5	7.9	8.6	9.2	10.2	11.4	14.0
11	1.4	2.5	3.5	4.0	6.0	7.6	7.9	8.6	9.2	10.2	11.4	14.0
12	1.4	2.5	3.5	4.0	6.0	7.6	7.9	8.6	9.2	10.2	11.6	14.0
13	1.4	2.5	3.5	4.3	6.0	7.6	7.9	8.6	9.3	10.2	11.7	14.0
14	1.4	2.5	3.5	4.3	6.0	7.7	7.9	8.6	9.5	10.2	11.7	14.1
15	1.4	2.5	3.5	4.3	6.0	7.7	8.0	8.6	9.5	10.2	12.0	14.1
16	1.6	2.5	3.5	4.3	6.2	7.7	8.1	8.6	9.5	10.2	12.1	14.1
17	1.6	2.5	3.5	4.3	6.4	7.7	8.1	8.6	9.5	10.2	12.2	14.1
18	1.6	2.5	3.5	4.6	6.4	7.7	8.1	8.7	9.6	10.2	12.5	14.2
19	1.6	2.5	3.5	5.0	6.5	7.7	8.1	8.7	9.8	10.2	12.5	14.2
20	1.6	2.5	3.5	5.3	6.6	7.7	8.1	8.7	10.1	10.2	12.5	14.2
21	1.6	2.5	3.5	5.4	6.8	7.7	8.1	8.7	10.1	10.3	12.6	14.2
22	1.6	2.5	3.5	5.4	6.8	7.7	8.1	8.7	10.1	10.3	12.6	14.2
23	1.9	2.5	3.5	5.4	6.8	7.7	8.1	8.8	10.1	10.3	12.6	14.2
24	1.9	2.5	3.5	5.4	6.8	7.7	8.2	8.8	10.1	10.3	12.7	14.2
25	1.9	2.5	3.5	5.4	6.8	7.7	8.3	8.8	10.1	10.4	12.9	14.2
26	1.9	2.6	3.8	5.7	6.8	7.8	8.4	8.8	10.1	10.4	13.0	14.2
27	2.2	2.6	3.8	5.7	6.8	7.8	8.4	8.8	10.1	10.4	13.0	14.2
28	2.3	2.6	3.9	5.7	6.8	7.8	8.4	8.9	10.1	10.4	13.2	14.2
29	2.3	2.6	3.9	5.7	---	7.8	8.4	9.1	10.2	10.4	13.2	14.2
30	2.3	2.6	3.9	5.7	---	7.8	8.4	9.2	10.2	10.4	13.7	14.2
31	2.3	---	3.9	5.8	---	7.8	---	9.2	---	10.4	13.8	---
mean	1.5	2.5	3.4	4.7	6.3	7.5	8.0	8.7	9.6	10.3	11.9	14.1
max	2.3	2.6	3.9	5.8	6.8	7.8	8.4	9.2	10.2	10.4	13.8	14.2
min	0.0	2.3	2.6	3.9	5.8	6.8	7.8	8.4	9.2	10.2	10.4	13.8

Chisana SNOTEL: Wrangell –St. Elias National Park and Preserve



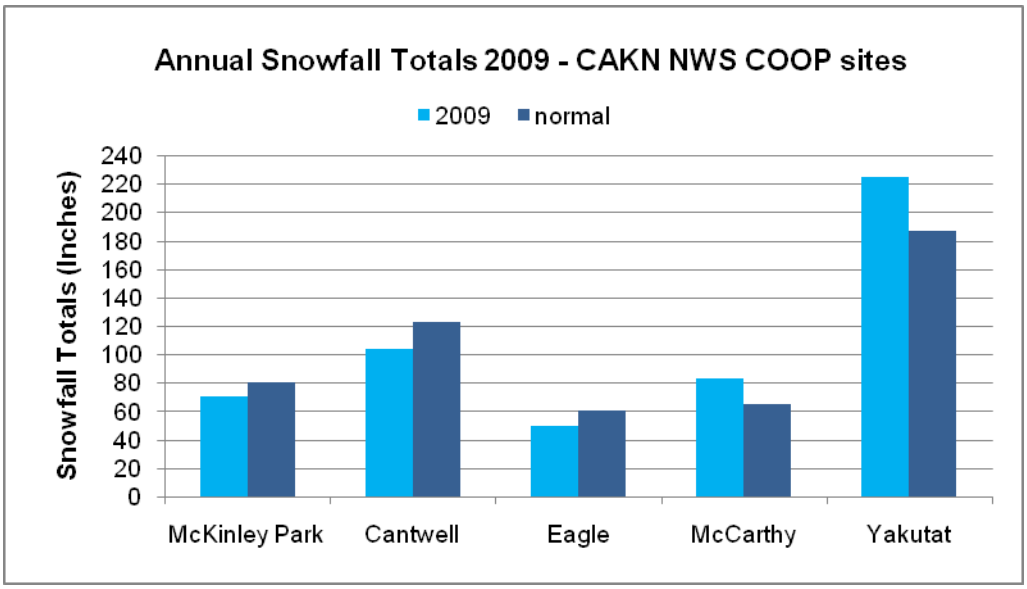


Daily precipitation totals for Chisana for 2008-2009 season Oct 1 – Sep 30.
Unit = inches

day	oct	nov	dec	jan	feb	mar	apr	may	jun	jul	aug	sep
1	0.0	1.1	1.2	1.6	2.8	3.7	4.3	4.3	5.9	8.8	9.2	10.9
2	0.3	1.2	1.2	1.6	2.9	3.7	4.3	4.3	5.9	8.8	9.2	10.9
3	0.3	1.2	1.2	1.6	2.9	3.7	4.3	4.3	5.9	8.8	9.2	10.9
4	0.3	1.2	1.2	1.6	2.9	3.8	4.3	4.3	5.9	8.8	9.2	10.9
5	0.3	1.2	1.2	1.6	2.9	3.8	4.3	4.3	5.9	8.8	9.2	11.1
6	0.3	1.2	1.2	1.6	2.9	3.9	4.3	4.3	5.9	8.8	9.2	11.1
7	0.3	1.2	1.2	1.6	3.0	4.0	4.3	4.3	5.9	8.8	9.3	11.2
8	0.3	1.2	1.4	1.6	3.1	4.0	4.3	4.4	6.0	8.8	9.6	11.2
9	0.3	1.2	1.4	1.6	3.1	4.0	4.3	4.6	6.0	8.8	10.0	11.2
10	0.3	1.2	1.4	1.6	3.1	4.0	4.3	4.7	6.0	8.8	10.2	11.2
11	0.3	1.2	1.4	1.6	3.1	4.1	4.3	4.7	6.0	9.0	10.4	11.2
12	0.3	1.2	1.4	1.6	3.1	4.1	4.3	4.8	6.1	9.0	10.5	11.2
13	0.3	1.2	1.4	1.7	3.1	4.1	4.3	4.8	6.7	9.0	10.5	11.2
14	0.3	1.2	1.4	1.7	3.1	4.1	4.3	5.0	6.8	9.0	10.5	11.2
15	0.3	1.2	1.4	1.8	3.2	4.1	4.3	5.0	8.0	9.0	10.5	11.2
16	0.4	1.2	1.4	1.8	3.2	4.1	4.3	5.3	8.3	9.1	10.5	11.2
17	0.4	1.2	1.4	1.8	3.2	4.1	4.3	5.3	8.4	9.1	10.5	11.2
18	0.4	1.2	1.4	1.9	3.2	4.1	4.3	5.3	8.4	9.1	10.5	11.2
19	0.4	1.2	1.4	2.7	3.2	4.1	4.3	5.3	8.4	9.1	10.6	11.2
20	0.4	1.2	1.4	2.7	3.4	4.1	4.3	5.3	8.5	9.1	10.6	11.3
21	0.4	1.2	1.4	2.7	3.5	4.1	4.3	5.3	8.5	9.2	10.6	11.3
22	0.4	1.2	1.4	2.7	3.5	4.1	4.3	5.3	8.5	9.2	10.6	11.3
23	0.6	1.2	1.4	2.7	3.5	4.1	4.3	5.3	8.5	9.2	10.6	11.3
24	0.6	1.2	1.4	2.7	3.5	4.2	4.3	5.3	8.7	9.2	10.6	11.3
25	0.7	1.2	1.4	2.7	3.6	4.2	4.3	5.3	8.7	9.2	10.8	11.3
26	0.7	1.2	1.4	2.7	3.6	4.3	4.3	5.3	8.7	9.2	10.9	11.3
27	1.0	1.2	1.6	2.7	3.7	4.3	4.3	5.3	8.8	9.2	10.9	11.3
28	1.1	1.2	1.6	2.7	3.7	4.3	4.3	5.3	8.8	9.2	10.9	11.3
29	1.1	1.2	1.6	2.7	---	4.3	4.3	5.8	8.8	9.2	10.9	11.3
30	1.1	1.2	1.6	2.8	---	4.3	4.3	5.9	8.8	9.2	10.9	11.3
31	1.1	---	1.6	2.8	---	4.3	---	5.9	---	9.2	10.9	---
mean	0.5	1.2	1.4	2.1	3.2	4.1	4.3	5.0	7.4	9.0	10.3	11.2
max	1.1	1.2	1.6	2.8	3.7	4.3	4.3	5.9	8.8	9.2	10.9	11.3
min	0.0	1.1	1.2	1.6	2.8	3.7	4.3	4.3	5.9	8.8	9.2	10.9

Appendix C. Long-term Snowfall Data – NWS COOP

These data are available courtesy of the Western Regional Climate Center web site at http://www.wrcc.dri.edu

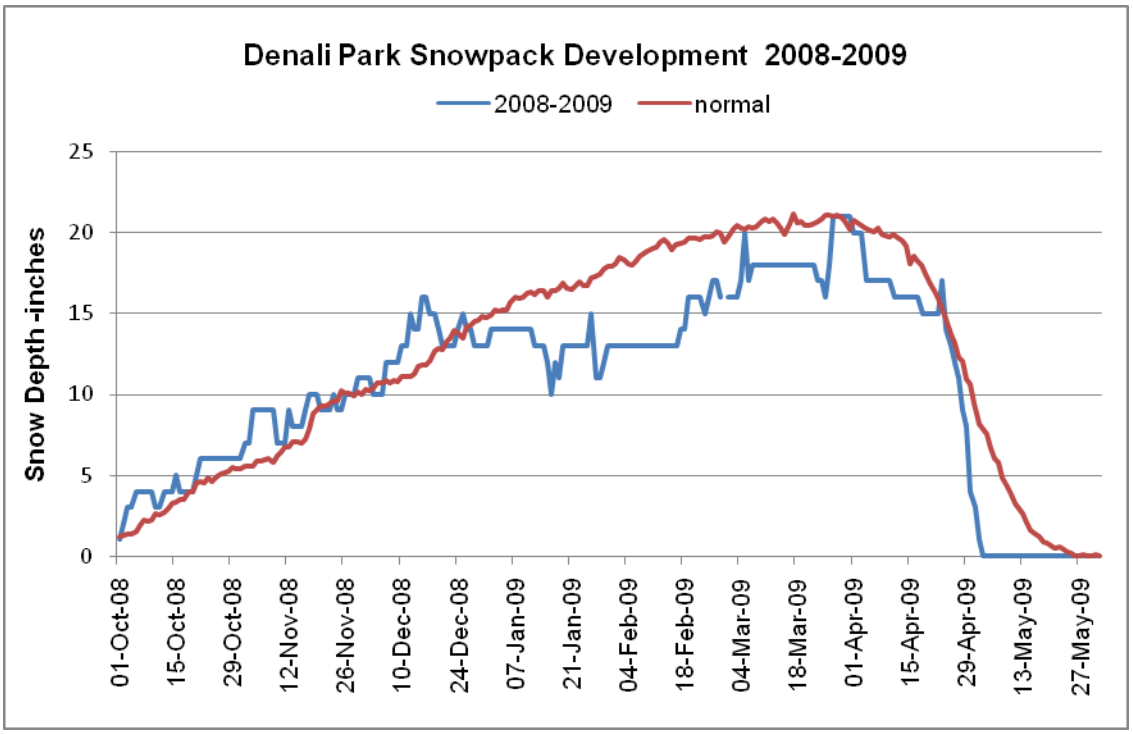


NWS COOP sites with monthly snowfall measurements

McKinley Park (78)	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	**Annual**
2008-09	0.0	0.0	3.0	13.4	11.3	12.8	8.6	7.8	10.1	3.1	0	0	**70.1**
MEAN	0.0	0.0	3.4	12.8	12.7	12.6	11.7	9.9	7.8	5.9	2.7	0.2	**79.9**
Cantwell (24)													
2008-09	0	0	0.2	19.5	16.3	5.2	23.3	15.8*	16.8	7.2	0	0	**103.5**
MEAN	0.3	0.0	4.0	16.2	17.9	20.5	22.3	15.8	12.7	10.8	5.2	0.2	**122.5**
Eagle (29)													
2008-09	0	0	0.5	15.5	11.3	8.4	1.5	6.0	5.8	0.5	0	0	**49.5**
MEAN	0.0	0.0	0.9	9.7	10.6	11.3	7.7	6.9	5.3	3.1	0.8	0.0	**60.0**
McCarthy (12)													
2008-09	0	0	1	24.6	6.7	11**	10.7	7**	15.4	7	0	0	**83.4**
MEAN	0.0	0.0	2.6	10.4	13.5	12.4	12.6	8.9	5.7	2.6	0.2	0.0	**64.6**
Yakutat (49)													
2008-09	0	0	0	5.6	10.7	51.7	57.9	37.6	56.0	5.2	0	0	**224.7**
MEAN	0.0	0.0	0.0	4.9	20.9	36.1	35.4	35.4	36.9	15.3	1.0	0.0	**186.6**

* Missing Cantwell data file din with long-term mean
**Missing McCarthy data filled in with nearby May Creek data from December and February

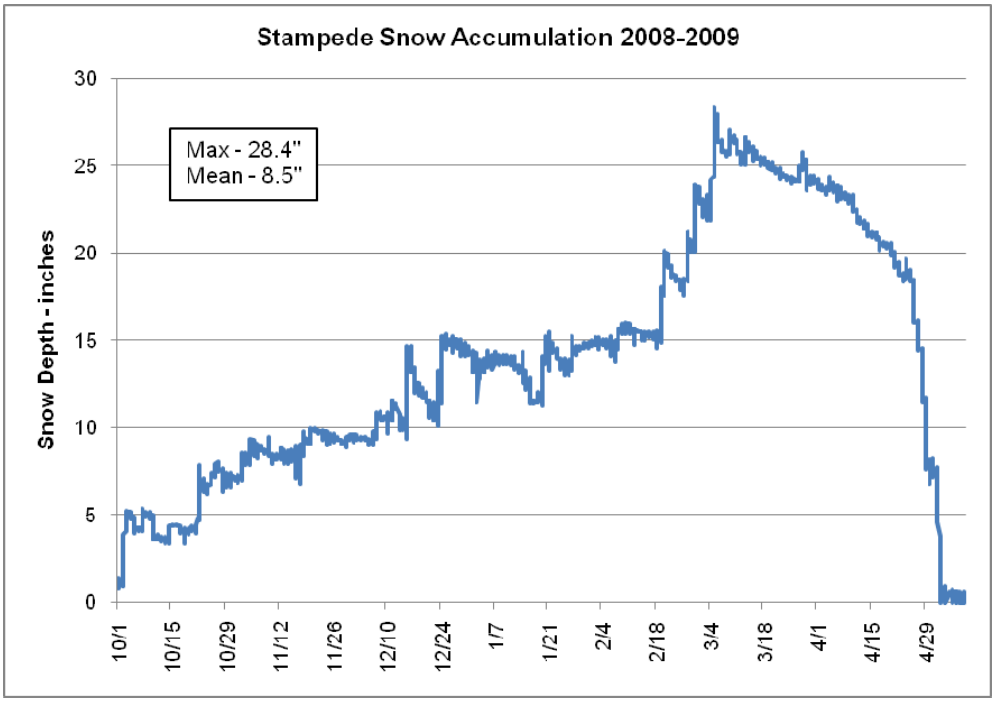
Snowpack development for Denali Park headquarters site – this is the only long-term site with accessible daily data.

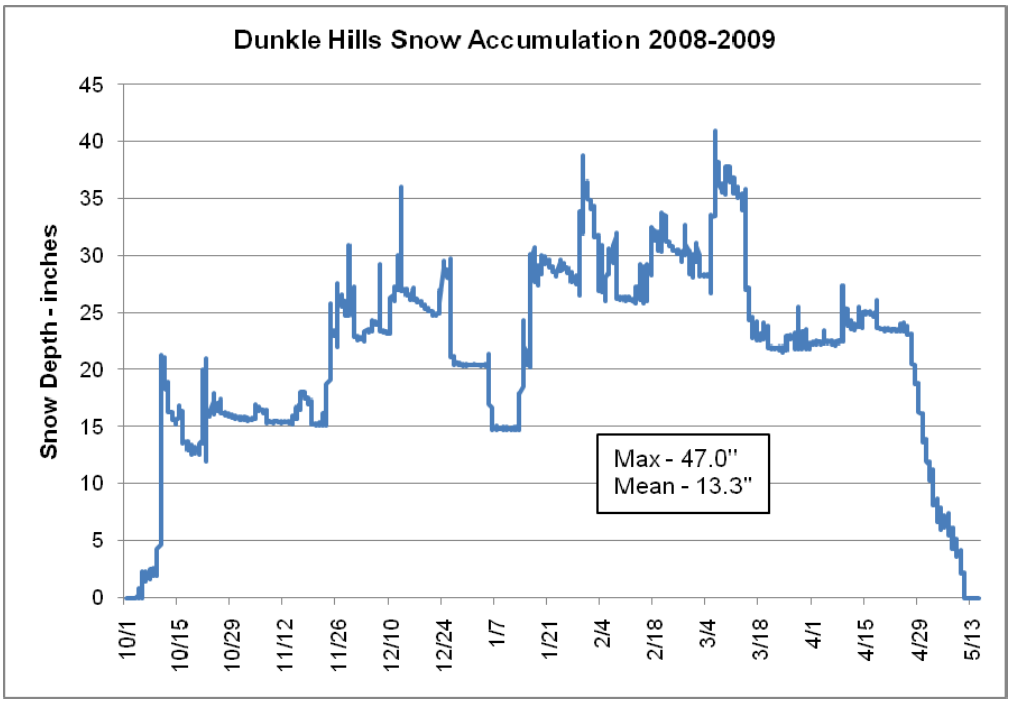


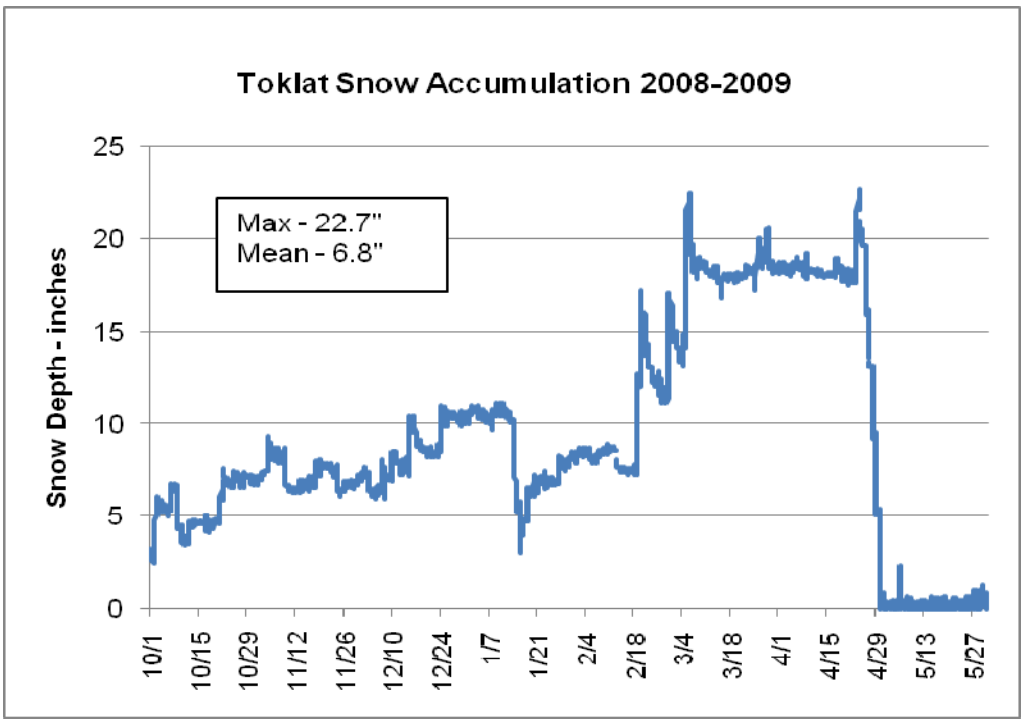
Appendix D. Cumulative Snow Depths at CAKN Climate Stations

These data and additional graphs are available at http://www.wrcc.dri.edu/NPS.html.

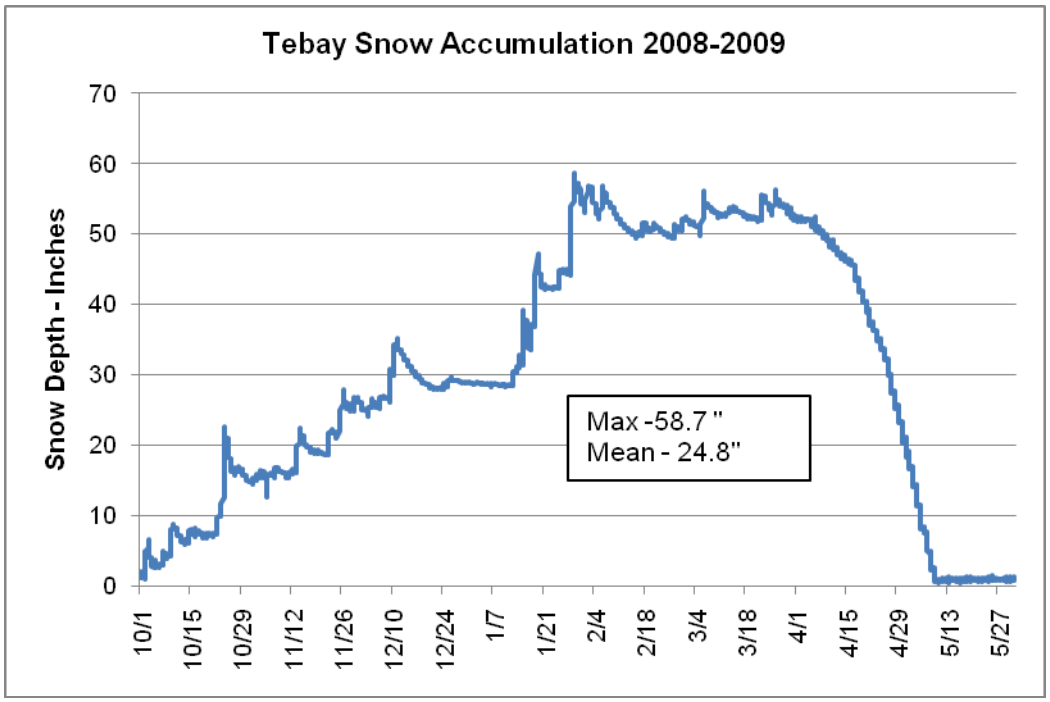
Denali

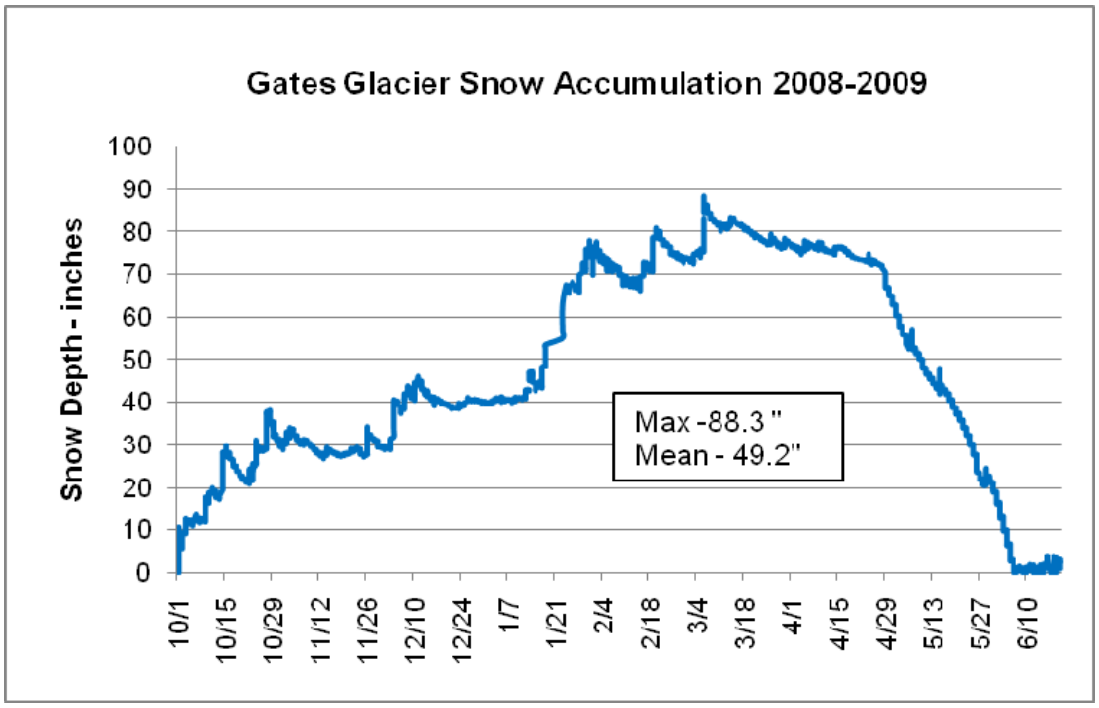


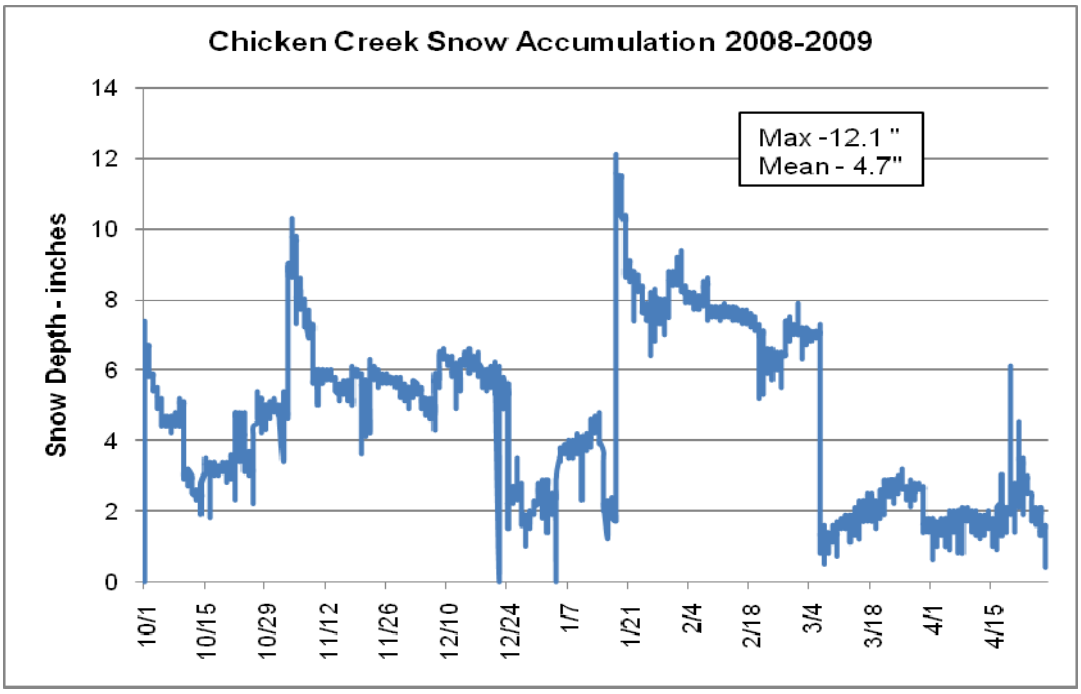




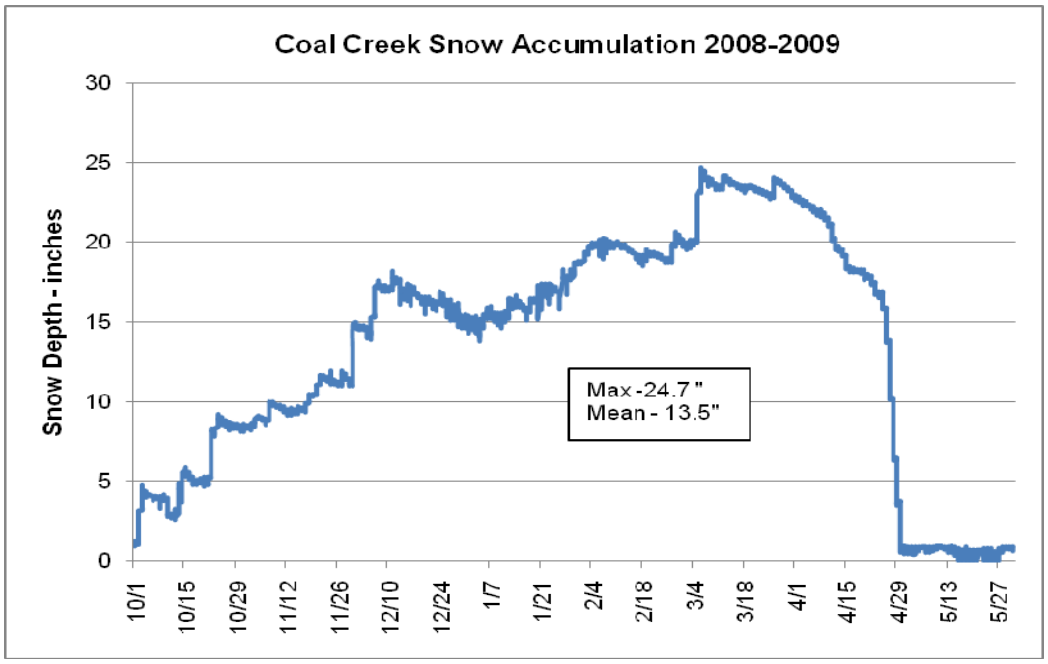
Wrangell – St. Elias

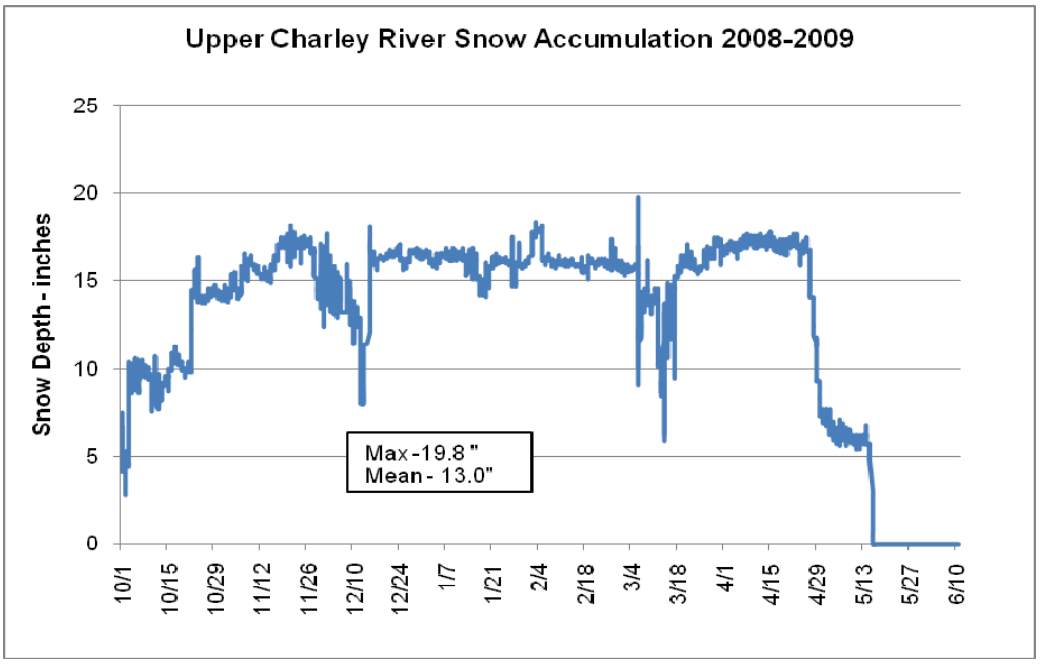



Gates Glacier Snow Accumulation 2008-2009
Snow Depth - inches
100
90
80
70
60
50
40
30
20
10
0
Max -88.3 "
Mean - 49.2"
10/1
10/15
10/29
11/12
11/26
12/10
12/24
1/7
1/21
2/4
2/18
3/4
3/18
4/1
4/15
4/29
5/13
5/27
6/10


Chicken Creek Snow Accumulation 2008-2009
Snow Depth - inches
14
12
10
8
6
4
2
0
Max -12.1 "
Mean - 4.7"
10/1
10/15
10/29
11/12
11/26
12/10
12/24
1/7
1/21
2/4
2/18
3/4
3/18
4/1
4/15

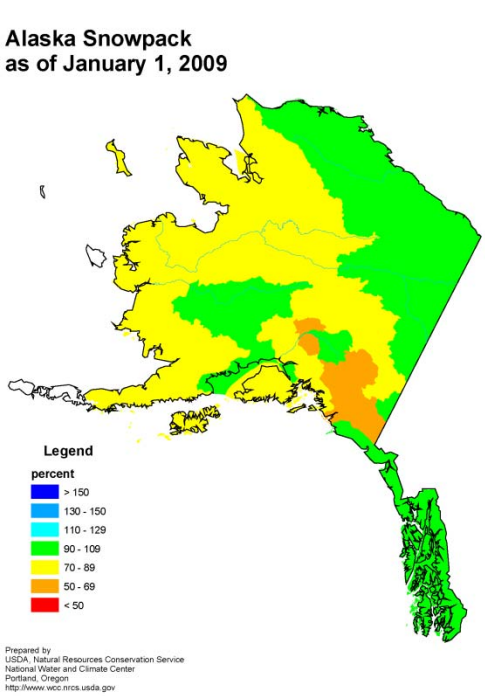
Yukon-Charley Rivers

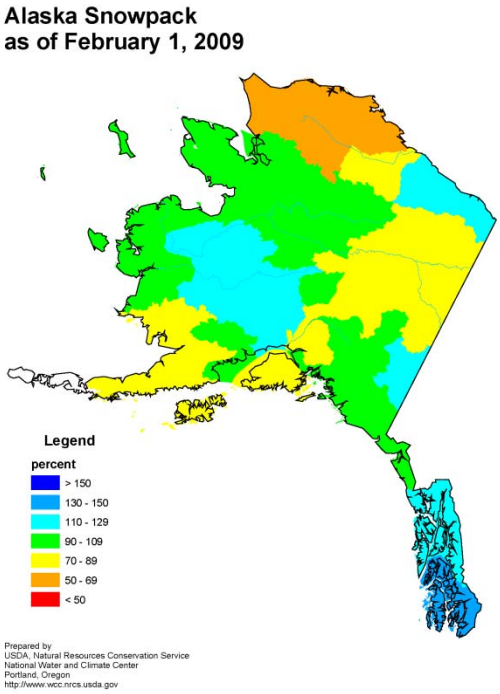


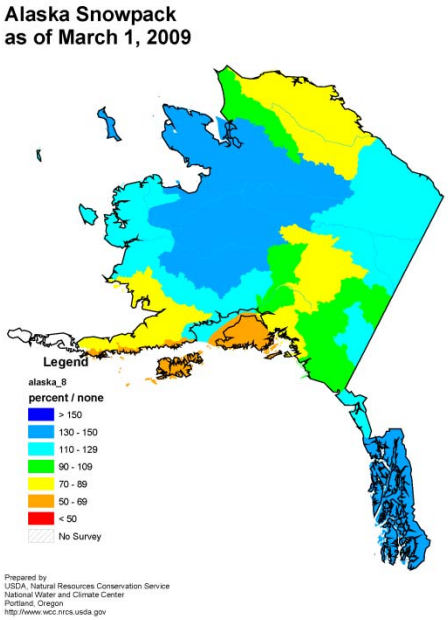


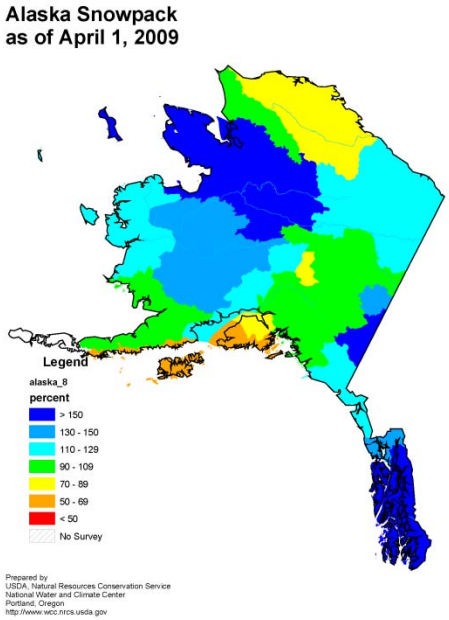
Appendix E. Statewide Snowpack Maps for 2008 -2009

Published by the Natural Resources Conservation Service each month during the season and available online at http://www.wcc.nrcs.usda.gov/cgibin/ak_snow.pl?state=alaska

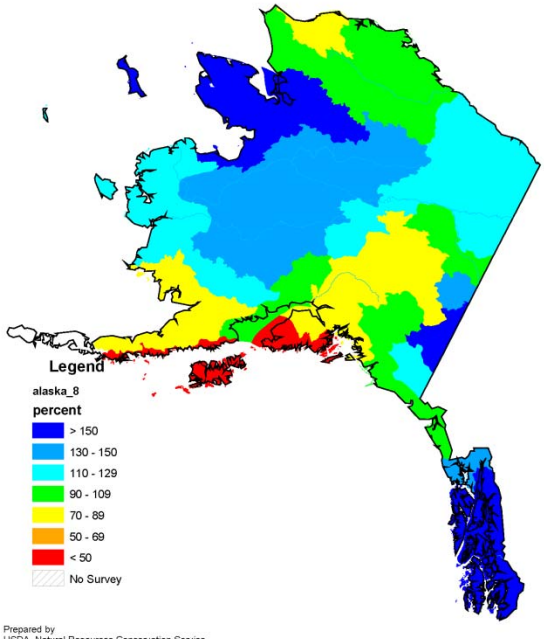








Alaska Snowpack
as of May 1, 2009



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