REQUIREMENTS STATEMENT

DEVELOPMENT OF DAILY PRECIPITATION AVERAGES FOR SNOTEL SITES

ACTIVITY DESCRIPTION

Every time that a new SNOTEL site is installed, there is an immediate need to produce daily precipitation averages. When these data are analyzed to provide information for water resource management decisions, the data are often compared to average conditions. This need is especially critical now, because each Data Collection Office (DCO) must, within the next year and a half, produce 1971 to 2000 averages to comply with interagency policy to adopt the World Meteorological Organization (WMO) guidelines. In the past, this has been a very labor intensive activity required by each DCO to produce hand calculated charts and graphs that defined the average on the first and fifteenth of each month. Application programs then use these averages to estimate a specific daily average. The following process describes how a program can be used with existing information in our current operational database to calculate these daily averages. This would result in significant savings in manpower and produce a more accurate product.

TIMING

Producing average daily precipitation at a new site is performed by the responsible DCO after sufficient data have been collected to compare the daily precipitation with another, close proximity site, either a NWS Coop station or another SNOTEL site. Every ten years, daily averages at all SNOTEL sites within the system must be calculated, using data from the most recent thirty-year period. This complete reevaluation is due to be completed prior to October 1, 2001.

RESPONSIBILITY

Developing new daily precipitation averages for each SNOTEL site is the responsibility of each DCO. The DCO may ask that the individual state water supply specialists participate in this effort, however the responsibility for completion ultimately rests with the DCO. Without the ability to produce these averages quickly and accurately, using computer facilities, this becomes a difficult task for the under-staffed DCO's to complete within the mandated time frame.

TIME REQUIRED

As stated above, the daily precipitation averages are produced for a new site as soon as the site characteristics can be determined statistically. Additionally, the averages within the entire system must be reevaluated every ten years. It is estimated that it takes at least a day to develop daily precipitation averages for a SNOTEL site that has a relatively long period of record (i.e., more than 15 years). For sites that have a short record, the process could take considerably longer. When you consider that each DCO has in excess of one hundred SNOTEL sites that must be reevaluated, this becomes a considerable workload. Also, precipitation is only one of the parameters that must be analyzed.

INPUT DATA REQUIREMENTS

The required input data would be the entire historical daily record for each SNOTEL site (table 1) and the daily precipitation data for a co-located or adjacent precipitation site (table

2) that has the required period of record. This would be thirty years for an unconditional average, or twenty-five to twenty-nine years for a conditional average.

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/cdbs/ut/snot49  99  prec

Station : UT10J52S, TRIAL LAKE
-------   Unit = inches
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day	oct	nov	dec	jan	feb	mar	apr	may	jun	jul	aug	sep
1	0.0	2.2	5.3	6.4	11.9	18.6	21.9	27.9	32.4	34.1	36.4	38.5
2	0.0	2.3	5.3	6.6	12.1	18.8	22.1	28.0	32.4	34.1	36.4	38.6
3	-0.1	2.4	5.3	6.6	12.1	18.8	22.2	28.6	33.0	34.1	36.4	39.2
4	0.3	2.5	5.3	6.6	12.1	18.8	22.3	29.5	33.2	34.1	36.5	39.3
5	1.0	2.5	5.9	6.6	12.1	19.0	22.5	30.2	33.7	34.1	36.7	39.3
6	1.0	2.8	5.9	6.6	12.3	19.1	22.5	30.2	33.8	34.1	36.8	39.3
7	1.0	3.3	5.9	6.6	12.6	19.1	22.5	30.2	34.1	34.1	36.8	39.3
8	1.0	3.3	5.9	6.6	13.8	19.5	22.7	30.2	34.1	34.1	36.8	39.3
9	1.0	4.1	5.9	6.6	14.9	19.5	22.9	30.2	34.1	34.1	36.8	39.3
10	1.0	4.2	5.9	6.6	15.6	20.1	23.3	30.5	34.1	34.1	36.8	39.3
11	1.0	4.2	5.9	6.6	16.2	20.2	23.3	30.5	34.1	34.1	36.9	39.3
12	1.0	4.2	5.9	6.6	16.2	20.6	23.3	30.5	34.1	34.1	37.0	39.4
13	1.0	4.2	5.9	6.6	16.2	20.6	23.3	30.6	34.1	34.1	37.1	39.4
14	1.0	4.2	5.9	6.6	16.2	20.6	23.3	31.3	34.1	34.1	36.9	39.4
15	1.0	4.2	5.9	6.6	16.2	20.6	23.3	31.5	34.1	34.6	36.9	39.4
16	1.0	4.2	5.9	6.6	16.3	20.7	23.3	31.6	34.1	34.6	36.9	39.4
17	1.2	4.2	5.9	7.0	16.3	20.7	23.3	31.6	34.1	35.0	36.9	39.4
18	1.2	4.6	5.9	7.2	16.9	20.7	23.3	31.6	34.1	35.0	36.9	39.4
19	1.2	4.8	5.9	8.4	17.2	20.7	23.3	31.6	34.1	35.0	36.9	39.4
20	1.2	4.8	5.9	8.9	17.5	20.8	23.3	31.6	34.1	35.1	36.9	39.7
21	1.2	4.8	6.1	9.8	17.6	20.8	23.7	31.6	34.1	35.1	37.6	39.7
22	1.2	4.8	6.1	10.6	18.2	21.0	23.9	31.6	34.1	35.1	37.7	39.7
23	1.2	4.9	6.1	10.7	18.2	21.0	24.2	31.6	34.1	35.2	37.7	39.7
24	1.3	4.9	6.1	10.9	18.3	21.0	24.5	31.6	34.1	35.1	37.7	39.7
25	1.3	4.9	6.1	11.4	18.3	21.0	24.9	31.7	34.1	35.1	37.7	39.7
26	1.4	4.9	6.1	11.4	18.6	21.0	25.3	31.9	34.1	35.1	37.7	39.7
27	1.5	4.9	6.1	11.8	18.6	21.1	25.4	31.9	34.1	35.1	37.7	39.7
28	1.7	4.9	6.1	11.9	18.6	21.4	25.9	31.9	34.1	35.2	38.1	40.1
29	1.7	5.0	6.1	11.9	---	21.5	26.7	32.0	34.1	35.3	38.1	40.1
30	2.0	5.2	6.1	11.9	---	21.5	27.6	32.3	34.1	35.6	38.1	39.9
31	2.2	---	6.2	11.9	---	21.5	---	32.2	---	36.4	38.5	---
mean	1.1	4.1	5.9	8.4	15.8	20.3	23.7	30.9	33.9	34.7	37.2	39.5
max	2.2	5.2	6.2	11.9	18.6	21.5	27.6	32.3	34.1	36.4	38.5	40.1
min	-0.1	2.2	5.3	6.4	11.9	18.6	21.9	27.9	32.4	34.1	36.4	38.5

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Table 1 – SNOTEL Daily Data

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/cdbs/ut/clim49  98  prcp

Station : UT1588, COALVILLE
-------   Unit = inches
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day	oct	nov	dec	jan	feb	mar	apr	may	jun	jul	aug	sep
1	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.12	0.00	0.00	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.15	0.00	0.00	0.03	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.13	0.09	0.30	0.98	0.00	0.00	0.04
5	0.00	0.00	0.00	0.09	0.05	0.00	0.02	0.12	0.23	0.00	0.00	0.03
6	0.00	0.00	0.00	0.00	0.00	0.50	0.00	0.10	0.05	0.00	0.00	0.00
7	0.14	0.00	0.02	0.00	0.01	0.00	0.02	0.05	0.01	0.00	0.00	0.00

8	0.00	0.00	0.12	0.00	0.14	0.00	0.00	0.06	0.10	0.00	0.00	0.00
9	0.00	0.00	0.18	0.00	0.04	0.00	0.05	0.02	0.19	0.00	0.02	0.00
10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.09	0.22	0.00	0.12
11	0.31	0.29	0.00	0.05	0.03	0.00	0.00	0.01	0.03	0.00	0.07	0.02
12	0.01	0.02	0.00	0.57	0.00	0.00	0.18	0.00	0.00	0.00	0.00	0.27
13	0.00	0.00	0.00	0.45	0.00	0.00	0.00	0.17	0.56	0.00	0.00	0.00
14	0.00	0.00	0.00	0.00	0.00	0.00	0.12	0.00	0.05	0.00	0.00	0.00
15	0.00	0.00	0.00	0.21	0.00	0.00	0.13	0.45	0.00	0.00	0.00	0.00
16	0.00	0.00	0.00	0.00	0.19	0.00	0.02	0.00	0.51	0.00	0.00	0.00
17	0.00	0.00	0.00	0.19	0.00	0.17	0.00	0.00	1.15	0.00	0.07	0.00
18	0.00	0.00	0.00	0.00	0.04	0.00	0.00	0.00	0.01	0.00	0.09	0.00
19	0.00	0.00	0.00	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
20	0.00	0.32	0.00	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
21	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.51	0.00	0.05	0.02	0.13
22	0.00	0.00	0.00	0.00	0.39	0.00	0.00	0.09	0.00	0.00	0.00	0.09
23	0.03	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.04
24	0.36	0.00	0.08	0.00	0.43	0.06	0.24	0.00	0.00	0.53	0.00	0.00
25	0.00	0.00	0.00	0.00	0.02	0.05	0.00	0.00	0.00	0.52	0.20	0.02
26	0.00	0.01	0.00	0.00	0.21	0.00	0.00	0.07	0.03	0.27	0.02	0.00
27	0.00	0.13	0.00	0.00	0.00	0.40	0.00	0.00	0.00	0.00	0.03	0.00
28	0.00	0.00	0.00	0.00	0.00	0.67	0.00	0.00	0.00	0.13	0.00	0.00
29	0.00	0.00	0.00	0.00	---	0.25	0.00	0.00	0.00	0.00	0.00	0.00
30	0.00	0.00	0.00	0.05	---	0.14	0.00	0.00	0.00	0.04	0.00	0.03
31	0.10	---	0.00	0.00	---	0.00	---	0.00	---	0.00	0.00	---
total	1.22	0.77	0.43	1.94	1.57	2.42	0.87	2.02	3.99	1.76	0.52	0.79
max	0.36	0.32	0.18	0.57	0.43	0.67	0.24	0.51	1.15	0.53	0.20	0.27
min	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 2 – CLIM Daily Precipitation Data

OUTPUT DATA REQUIREMENTS

The output required is shown is Table 3. This table would contain the average daily precipitation for the specified period. For WMO compliance, the period would be thirty years. This table could then be used to plot against the current year, a specified year, the site historical average, etc.

Average 19712000

Station : UT10J52S, TRIAL LAKE

day	oct	nov	dec	jan	feb	mar	apr	may	jun	jul	aug	sep
1	0.0	2.9	6.9	10.6	15.4	20.2	24.7	28.7	32.7	34.8	36.8	39.0
2	0.0	3.0	7.0	10.7	15.6	20.4	25.0	28.9	32.8	34.8	36.9	39.0
3	0.1	3.1	7.1	10.8	15.7	20.6	25.2	29.0	32.9	34.9	36.9	39.1
4	0.2	3.2	7.2	10.9	15.8	20.8	25.3	29.2	33.0	34.9	37.0	39.2
5	0.4	3.3	7.5	11.1	15.8	20.9	25.4	29.3	33.2	34.9	37.1	39.3
6	0.4	3.4	7.6	11.3	15.9	21.1	25.5	29.4	33.3	34.9	37.1	39.4
7	0.5	3.5	7.7	11.4	16.0	21.2	25.6	29.6	33.4	34.9	37.1	39.4
8	0.6	3.6	7.8	11.6	16.2	21.4	25.6	29.7	33.5	34.9	37.2	39.5
9	0.7	3.8	7.9	11.7	16.4	21.5	25.7	29.9	33.6	35.0	37.3	39.6
10	0.7	4.0	8.0	11.9	16.5	21.5	25.9	30.0	33.7	35.0	37.3	39.7
11	0.8	4.1	8.2	12.1	16.6	21.6	26.0	30.3	33.8	35.1	37.4	39.7
12	0.9	4.2	8.3	12.4	16.7	21.8	26.2	30.5	33.9	35.2	37.5	39.9
13	1.0	4.4	8.5	12.6	16.9	21.9	26.3	30.6	34.0	35.3	37.5	40.0
14	1.1	4.6	8.6	12.7	17.3	22.2	26.4	30.7	34.1	35.3	37.7	40.1
15	1.2	4.7	8.7	13.0	17.6	22.3	26.5	30.8	34.1	35.4	37.7	40.1
16	1.3	4.7	8.8	13.2	17.7	22.5	26.5	30.9	34.2	35.4	37.8	40.2
17	1.4	4.8	8.9	13.4	17.9	22.7	26.6	31.0	34.3	35.4	37.9	40.2

18	1.5	5.0	9.0	13.6	18.3	22.9	26.7	31.1	34.4	35.5	38.0	40.4
19	1.6	5.2	9.1	13.7	18.6	23.0	26.9	31.2	34.4	35.5	38.1	40.5
20	1.8	5.3	9.2	13.9	18.9	23.2	27.0	31.3	34.4	35.6	38.2	40.6
21	1.8	5.4	9.3	14.0	19.1	23.3	27.1	31.5	34.5	35.6	38.4	40.7
22	1.9	5.5	9.4	14.2	19.3	23.4	27.2	31.6	34.5	35.7	38.5	40.8
23	2.0	5.7	9.5	14.3	19.5	23.5	27.3	31.7	34.5	35.9	38.5	40.8
24	2.1	5.8	9.6	14.4	19.6	23.6	27.5	31.8	34.5	36.1	38.6	40.9
25	2.1	6.0	9.7	14.5	19.7	23.8	27.6	31.9	34.6	36.2	38.7	41.0
26	2.2	6.2	9.8	14.6	20.0	23.8	27.8	32.1	34.6	36.3	38.7	41.1
27	2.3	6.4	10.0	14.7	20.1	24.0	28.0	32.2	34.7	36.5	38.8	41.3
28	2.4	6.4	10.2	14.9	20.1	24.2	28.2	32.3	34.7	36.6	38.9	41.4
29	2.5	6.6	10.3	15.1	---	24.4	28.4	32.4	34.8	36.7	38.9	41.4
30	2.6	6.7	10.4	15.2	---	24.6	28.6	32.5	34.8	36.7	38.9	41.5
31	2.8	---	10.5	15.3	---	24.7	---	32.6	---	36.8	38.9	---
avg	1.3	4.7	8.7	13.0	17.6	22.5	26.6	30.8	34.0	35.5	37.9	40.2
max	2.8	6.7	10.5	15.3	20.1	24.7	28.6	32.6	34.8	36.8	38.9	41.5
min	0.0	2.9	6.9	10.6	15.4	20.2	24.7	28.7	32.7	34.8	36.8	39.0

Table 3 – Daily Average SNOTEL Precipitation

CURRENT METHODOLOGY

Nearly all SNOTEL sites will not have a full period of record for the period 1971-2000. However, many will have 20 plus years of record. The “compute” function or the “plotdaily” program can be used to generate an arithmetic average annual precipitation value for the available period.

If the SNOTEL site period of record is less than 20 years, the mean annual arithmetic average is computed, using correlations with nearby NWS sites for the same period. The NWS values for the short period are compared to the 1971-2000 period for the same station. The ratio of the difference is applied to the SNOTEL short period to derive a long-term (1971-2000) mean annual precipitation value. In other words, if a group of nearby NWS stations show that the 1986-2000 average annual value was 90% of the 1971-2000 period, then the SNOTEL average for the 1986-2000 period would be adjusted by dividing by 90 percent to estimate the 1971-2000 average.

Previous analysis indicates that the monthly and daily average distribution of precipitation at NWS stations may be significantly different from the distribution at SNOTEL sites. Therefore, when possible, monthly and daily distributions at long-term SNOTEL sites (located in the same or an adjacent basin) are used to derive the distribution of the SNOTEL mean annual precipitation value over the individual months or days. Comparison of average SNOTEL monthly precipitation increases with snow pillow or snow course average increases during the winter months can aid in verification of the estimated precipitation averages. Another method that can be used to derive monthly mean averages is outlined by Phil Farnes in his paper entitled “Estimating Monthly Distribution of Average Annual Precipitation in Mountainous Areas of Montana”, presented at Western Snow Conference, 1995, Sparks, Nevada.

REQUIRED IMPROVEMENTS

All of the input data needed are stored within the current operational database (see input data requirements). Two data tables are needed: an average SNOTEL table that depicts the daily

climatology from the beginning of the historical record through September 30, 2000, and the daily precipitation climatology for a co-located or adjacent precipitation site.

The developed daily averages are integrated values that are derived from the known 30-year climatology and the SNOTEL site characteristics. The process would be to step through the year one day at a time and compare the short-term climatologies for a 31-day window, centered on the day being examined. For the co-located or adjacent station, obtain the difference between the short-term and the long-term 31-day climatology. This difference is used to modify the short-term climatology at the SNOTEL station and obtain a long-term approximation for the current day. This procedure is repeated each day. This procedure is described by Kelly Redmond, Western Regional Climate Center, in his paper, "Development of Climatologies for Remote Automated Weather Stations (RAWS)", published in the Eighth Conference on Applied Climatology, January, 1993.

STORAGE OF CALCULATED DAILY SNOTEL AVERAGES

The calculated daily SNOTEL precipitation averages will be stored in a location that is easily accessible to database queries from data users and operational software applications.

TIMING

This software must be completed on or before January 1, 2001. In all probability, the edited water year 2000 SNOTEL data will not be available prior to this date. However, once the edited data is available, the DCO offices will have just nine months to complete SNOTEL average calculations.