Computer

COMPUTER GENERATED SEA-LEVEL PRESSURE

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1. INTRODUCTION

Unmanned weather stations are an important and economical source of weather data. Information is available from remote areas where staffing is difficult. Staffs at small stations can be reduced. Finally, personnel are free to perform other services. There are important differences between automatic reports and those recorded by people. Likewise, there are different types of automatic stations. These differences are discussed in (1). However, the basic elements of an observation are the same; i.e. sky cover, visibility, temperature, dewpoint, wind speed and direction, and altimeter setting. One element not provided by the automatic station is sea-level pressure. This paper demonstrates a method to automate computation for all weather stations manned and unmanned.

2. METHODOLOGY

A pressure-reduction ratio table is calculated for every ten degrees Fahrenheit. The range covers the absolute minimum to the absolute maximum temperatures of a station. A complete description of the process is discussed in (2). An estimation of the reduction constants is accomplished by multiple linear regression. The equations take the form

$$r = B_0 - B_1 T + B_2 T^2 \qquad (1)$$

where

r is the reduction constant

$$T = \frac{T_{12} + T_c}{2}$$

and T_{12} is the temperature 12 hours ago

T_c is the current temperature

B_0, B_1, and B_2 are computed for each station Each station has a unique equation that can indeed provide a value that when multiplied by station pressure will yield sea-level pressure.

Equations were developed and a computer program written to compute sea-level pressure for the following automatic stations:

1) Mount Shasta, California
2) Junction, Texas
3) Blue Canyon, California
4) Sexton Summit, Oregon
5) Big Piney, Wyoming
6) Meacham, Oregon
7) Marfa, Texas
8) Truth or Consequences, New Mexico
9) Sidney, Nebraska
10) Wendover, Utah
11) Cody, Wyoming
12) Clayton, New Mexico
13) Fort Yukon, Alaska
14) Big Delta, Alaska
15) Gulkana, Alaska
16) Devils Lake, North Dakota
17) Sandburg, California
18) Aniak, Alaska
19) St. Johnsbury, Vermont
20) Greenville, Maine
21) Rome, Georgia
22) Nenana, Alaska
23) Iliama, Alaska
24) Worecster, Massachusetts
25) Port Heiden, Alaska
26) Chamberlain, South Dakota
27) Middelton Island, Alaska
28) Roseglen, North Dakota
29) Redig, South Dakota
30) Poplar Bluff, Missouri
31) Pequot Lake, Minnesota
32) Marseilles, Illinois
33) Page, Arizona
34) Caliente, Nevada
35) Valentine, Nebraska
36) Warroad, Minnesota
37) Elkhart, Kansas
38) Medicine Lodge, Kansas
39) Cross City, Florida
40) San Simeon, California

Reduction constant equations and elevation for some manned weather stations are listed below. Using these equations, sea-level pressure is computed and compared with recorded values.

a) Amarillo, Texas 3604 feet
$r = 1.14867582 - .00022341T + .00000057T^2$ (2)

b) Albuquerque, New Mexico 5314 feet
$r = 1.22634346 - .00034434T + .00000086T^2$ (3)

c) Salt Lake City, Utah 4227 feet
$r = 1.17698786 - .00027952T + .00000095T^2$ (4)

d) Denver, Colorado 5332 feet
$r = 1.22826559 - .00034784T + .00000089T^2$ (5)

e) Pittsburgh, Pennsylvania 1225 feet
$r = 1.04871034 - .00006944T + .00000017T^2$ (6)

f) Winnemucca, Nevada 4314 feet
$r = 1.18101765 - .00028653T + .00000105T^2$ (7)

g) Huntington, West Virginia 838 feet
$r = 1.03291019 - .00004776T + .00000013T^2$ (8)

h) Dulles, Virginia 323 feet
$r = 1.01261229 - .00001810T + .00000004T^2$ (9)

3. COMPUTATIONS

The following equations are used to compute sea-level pressure:

H = 145442.16*(1. - ((PA/29.921)**.1902632))

HA = (H + HF)*.00356616

PS = 29.921*((518.67 - HA)/518.67)**5.25588

$$r = B_0 - B_1T + B_2T^2 \quad (1)$$

SLP = (PS*r)*33.86389

where:

PA = altimeter setting at the station in inches;
HA = pressure altitude corresponding to altimeter setting;
HF = station elevation in feet;
PS = station pressure in inches (computer-generated);
SLP = sea-level pressure in millibars;
H = correction applied to station elevation.

The standard form equation (1) is replaced by equations 2-9 inclusive.

4. EXAMPLES

A few examples were computed, and the results tabulated below. Examples for Dulles and Pittsburgh were not made. If there is an interest, the computations are easily obtained.

Note the asterisked values of modeled SLP for Albuquerque and Denver. On April 22, 1980, at 16Z, Albuquerque recorded a sea-level pressure of 1013.9 mbs. The program generated a pressure of 1012.9 mbs. Likewise, Denver recorded a pressure of 1016.5 mbs on April 25, 1980, at 13Z. The program computed 1015.6 mbs. Verification shows the recorded values are indeed in error. The verification was done with the Department of Commerce Pressure Reduction Computer (WBAN 54-7-8). Errors of this nature can be avoided by using a computer program.

5. CONCLUSIONS

A computer program currently generates sea-level pressure every hour for 40 automatic stations. Also, up to 29 continuous hours of data are stored and displayed on the KCRT System (KCRT is a Keyboard Cathode Ray tube - a television-type display with a typewriter-like keyboard).

If a station records a pressure that appears to be doubtful, a verification procedure is available. A surrounding station can compute the pressure if all the parameters are available.

It should be obvious that automation can play a major role in performing routine tasks at a weather station.

Amarillo, Texas

DATE/TIME	T	PA	PS	SLP observed	SLP modeled
04/21/80/18Z	71	009	26.376	1014.4	1014.4
04/21/80/19Z	69	006	26.349	1013.6	1013.6
04/21/80/20Z	69	004	26.331	1012.9	1012.9
04/22/80/12Z	66	999	26.286	1011.5	1011.5
04/22/80/13Z	64	001	26.304	1012.5	1012.5
04/22/80/14Z	63	002	26.313	1013.0	1013.0
04/22/80/15Z	61	002	26.313	1013.4	1013.3
04/22/80/16Z	62	002	26.313	1013.2	1013.1
04/22/80/17Z	65	001	26.304	1012.5	1012.4
04/22/80/18Z	66	999	26.286	1011.6	1011.5
04/22/80/19Z	66	997	26.268	1011.1	1010.8
04/22/80/20Z	70	994	26.241	1009.4	1009.3

Albuquerque, New Mexico

DATE/TIME	T	PA	PS	SLP observed	SLP modeled
04/22/80/12Z	54	005	24.715	1013.0	1012.9
04/22/80/13Z	56	006	24.723	1012.8	1012.8
04/22/80/14Z	56	007	24.731	1013.1	1013.2
04/22/80/15Z	59	007	24.731	1012.5	1012.5
04/22/80/16Z	58	007	24.731	1013.9	1012.7 *
04/22/80/17Z	60	005	24.715	1011.5	1011.6
04/22/80/18Z	60	003	24.697	1010.8	1010.9
04/22/80/19Z	62	000	24.672	1009.5	1009.5
04/22/80/20Z	62	997	24.646	1008.4	1008.4

Winnemucca, Nevada

DATE/TIME	T	PA	PS	SLP observed	SLP modeled
04/25/80/12Z	48	005	25.655	1016.4	1016.1
04/25/80/13Z	46	005	25.655	1016.7	1016.5
04/25/80/14Z	48	006	25.663	1016.8	1016.5
04/25/80/16Z	49	006	25.663	1016.7	1016.3
04/25/80/17Z	50	005	25.655	1016.2	1015.9

Salt Lake City, Utah

DATE/TIME	T	PA	PS	SLP observed	SLP modeled
04/25/80/13Z	56	996	25.658	1011.8	1011.7
04/25/80/14Z	55	997	25.668	1012.4	1012.2
04/25/80/15Z	57	998	25.676	1012.5	1012.1
04/25/80/16Z	56	999	25.685	1013.0	1012.7
04/25/80/17Z	56	998	25.676	1012.5	1012.3

Denver, Colorado

DATE/TIME	T	PA	PS	SLP observed	SLP modeled
04/25/80/13Z	41	002	24.672	1016.5	1015.6 *
04/25/80/14Z	41	004	24.689	1016.3	1016.3
04/25/80/15Z	41	005	24.698	1016.6	1016.6
04/25/80/16Z	40	007	24.715	1017.0	1017.5
04/25/80/17Z	43	008	24.724	1017.3	1017.2

Huntington, West Virginia

DATE/TIME	T	PA	PS	SLP observed	SLP modeled
04/25/80/12Z	54	994	29.044	1013.7	1013.7
04/25/80/13Z	54	995	29.054	1014.0	1014.1
04/25/80/14Z	54	995	29.054	1014.7	1014.5
04/25/80/15Z	52	996	29.063	1014.7	1014.5
04/25/80/16Z	51	996	29.063	1014.7	1014.5
04/25/80/17Z	50	996	29.063	1014.7	1014.5

ACKNOWLEDGEMENTS

I would like to thank Data Systems Division of the National Weather Service, NOAA for providing the data used in generating the reduction constants. I would also like to thank Dr. George Canavos of the Virginia Commonwealth University, Richmond, Virginia for his help in regression techniques.

REFERENCES

(1) U.S. Department of Commerce, 1979. User's Guide to the Automatic Observing Station.

(2) U.S. Weather Bureau, 1963. Manual of barometry, Department of Commerce, Vols. 1 and 2. See chapter 7, page 7-5, section 9.0.5.