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National Weather Digest

ANALYZING AIRWAYS OBSERVATIONS USING A TIME SHARING COMPUTER

by

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1. INTRODUCTION

The weather forecaster's chief concern is the hour to hour, and sometimes minute to minute weather changes taking place in his forecast area. For the aviation forecaster, ceilings and visibilities are the prime concern since amendments must be issued when weather limits are exceeded. Similarly, the public service forecaster must monitor temperature, dew point, and winds as well as changes in cloudiness, and the onset and type of precipitation, etc. that affect the current forecast or that may require the issuance of special statements, advisories, bulletins, etc. The weather forecaster has a large span of data to survey; nevertheless he must constantly check for significant changes and assess their impact on the forecast product. This article describes a computer program that partly answers the problem of data analysis for the forecaster.

2. DISCUSSION

Figures 1 and 2 are computer formatted lists or files of the aviation observations taken at Newark Airport and at J. F. Kennedy Airport on May 31, 1974. The program to execute this was written in Fortran language on the Univac 1108 Time Sharing System. Two separate files were written by the program and then analyzed by the program (partial listing attached (see Appendix)). The data elements used by the program are shown in the column headings of Figures 1 and 2. Low Middle and High clouds are shown as condition codes (CND) where code 3 indicates scattered clouds, 6 broken and 8 overcast conditions. Heights (HT) are in hundreds of feet. Visibility, pressure, temperature, dew point and wind follow. (Pressure is in millibars with the first 2 digits omitted.)

The program reads the first file (Newark) and prints out the changes during the last 3, 6, and 12 hours. These are shown in Figures 3 and 4 under the Title PROGRAM OUTPUT. In this program, changes in cloud cover conditions are for a period of 3 hours only, but could be extended, if desired. On the top of Figure 3, opposite visibility, the changes for 3, 6, and 12 hours are shown. These values can be checked by referring to Figure 1. At 2000 GMT, visibility was 4.0, and 3 hours later at 2300 GMT it was 7.0 for a 3.0 mile increase. Checking the 12 hour change, it can be seen that at 1100 GMT visibility was 2.5 miles and 12 hours later it was 7.0 miles for an increase of 4.5 miles. Likewise the changes in pressure, temperature, and dew point are also determined and listed. The changes in sky condition and heights were calculated in a similar way. Thus, it can be seen that

NEWARK AIRPORT OBSERVATIONS MAY 31 1974

TIME	LOW CLOUDS		MIDDLE CLOUDS		HIGH CLOUDS							
Z	CND	HT	CND	HT	CND	HT	VSBY	PRES	TMP	DP	WIND	VEL
0	0	0	0	0	0	0	7.0	129	63	52	150	5
1	0	0	0	0	0	0	6.0	135	61	53	150	7
2	0	0	0	0	0	0	6.0	142	60	53	150	8
3	0	0	0	0	0	0	6.0	149	60	53	150	4
4	0	0	0	0	0	0	6.0	152	60	53	160	5
5	0	0	0	0	0	0	5.0	152	59	53	110	3
6	8	9	0	0	0	0	4.0	159	59	53	80	6
7	8	9	0	0	0	0	5.0	159	59	53	150	6
8	8	6	0	0	0	0	4.0	173	58	53	120	6
9	8	6	0	0	0	0	4.0	173	52	52	120	6
10	8	5	0	0	0	0	2.5	180	56	52	130	8
11	8	5	0	0	0	0	2.5	190	56	52	130	7
12	8	6	0	0	0	0	3.0	193	55	51	120	9
13	8	7	0	0	0	0	3.5	186	58	52	136	8
14	8	11	0	0	0	0	2.5	190	59	52	110	8
15	8	12	0	0	0	0	3.0	190	60	52	110	8
16	8	12	0	0	0	0	3.0	190	60	52	110	8
17	8	12	0	0	0	0	4.0	180	63	54	110	8
18	8	13	0	0	0	0	4.0	176	64	54	120	9
19	8	9	0	0	0	0	4.0	176.	64	55	140	9
20	8	13	0	0	0	0	4.0	180	62	56	140	7
21	8	8	0	0	0	0	4.0	169	63	55	140	8
22	8	6	0	0	0	0	6.0	166	64	55	140	8
23	3	10	8	60	0	0	7.0	159	64	55	130	9

Figure 1.

PROGRAM OUTPUT- NEWARK AIRPORT

CHANGES DURING THE LAST

	3 HOURS	6 HOURS	12 HOURS
VISIBILITY (MILES)	+3.0	+3.0	+4.5
PRESSURE (MILLIBARS)	-2.1	-2.1	-3.1
TEMPERATURE (DEGREES)	+2	+1	+8
DEW POINT (DEGREES)	-1	+1	+3

CHANGES DURING THE LAST 3 HOURS

# SKY CONDITIONS CHANGED FROM 3 HRS AGO		TO PRESENT	CLOUD HEIGHTS (IN HUNDREDS OF FEET)
LOW CLOUDS	8	3	-3
MIDDLE CLOUDS	0	8	+60
HIGH CLOUDS	0	0	0

PREDICTED VALUES BASED ON LEAST SQUARES FIT FOR THE NEXT 3 HOURS

FORECAST FOR THE NEXT...	HOUR	2 HOURS	3 HOURS
TEMPERATURE (DEGREES)	66	67	68
DEW POINT (DEGREES)	56	57	57
VISIBILITY (MILES)	5.9	6.1	6.4
WIND VELOCITY (KNOTS)	9	9	9
SURFACE PRESSURE (MILLIBARS)	16.3	16.0	15.8

#NOTE: SKY CONDITION 3 = SCATTERED CLOUDS 1-5 TENTHS
" " 6 = BROKEN CLOUDS 6-9 TENTHS
" " 8 = OVERCAST CLOUDS 10 TENTHS

Figure 3.

J F KENNEDY AIRPORT OBSERVATIONS MAY 31 1974

TIME	LOW CLOUDS		MIDDLE CLOUDS		HIGH CLOUDS							
Z	CND	ET	CND	HT	CND	HT	VSBY	PRES	TMP	DP	WIND	VEL
0	3	9	6	15	8	40	9.0	132	58	54	130	8
1	6	15	6	25	8	39	4.0	139	57	53	120	7
2	3	3	6	26	8	44	4.0	146	57	53	120	5
3	2	2	6	28	8	50	5.0	149	57	53	190	4
4	0	0	0	0	0	0	4.0	156	55	53	100	4
5	6	8	0	0	0	0	5.0	159	56	53	110	5
6	6	8	0	0	0	0	5.0	159	55	52	100	5
7	8	3	0	0	0	0	1.0	163	54	52	90	7
8	8	4	0	0	0	0	3.0	168	54	52	85	8
9	8	4	0	0	0	0	3.0	168	54	52	86	8
10	8	5	0	0	0	0	3.0	185	53	51	90	9
11	8	6	0	0	0	0	2.5	190	54	51	120	8
12	8	6	0	0	0	0	3.0	193	55	51	120	9
13	8	8	0	0	0	0	3.0	190	56	51	120	8
14	8	8	0	0	0	0	3.0	186	57	52	120	10
15	8	11	0	0	0	0	3.0	190	60	53	100	8
16	0	0	0	0	0	0	3.0	190	60	54	100	8
17	8	15	0	0	0	0	4.0	183	63	56	120	10
18	6	15	8	35	0	0	5.0	183	67	57	100	9
19	6	15	6	25	8	35	5.0	183	63	56	130	10
20	3	9	6	15	8	35	5.0	183	63	56	130	10
21	3	15	8	35	0	0	7.0	176	62	56	120	10
22	8	40	0	0	0	0	7.0	173	61	56	100	9
23	8	35	0	0	0	0	7.0	170	60	55	100	6

Figure 2.

PROGRAM OUTPUT- JF KENNEDY AIRPORT

CHANGES DURING THE LAST

	3 HOURS	6 HOURS	12 HOURS
VISIBILITY(MILES)	+8.0	+3.0	+4.5
PRESSURE (MILLIBARS)	-1.3	-1.3	-2.0
TEMPERATURE(DEGREES)	- 3	-3	+6
DEW POINT (DEGREES)	-1	-1	+4

CHANGES DURING THE LAST 3 HOURS

# SKY CONDITIONS CHANGED FROM 3 HRS AGO		TO PRESENT	CLOUD HEIGHTS (IN HUNDREDS OF FEET)
LOW CLOUDS	3	8	+26
MIDDLE CLOUDS	6	0	-15
HIGH CLOUDS	8	0	-35

PREDICTED VALUES BASED ON LEAST SQUARES FIT FOR THE NEXT 3 HOURS

FORECAST FOR THE NEXT....	HOUR	2 HOURS	3 HOURS
TEMPERATURE (DEGREES)	65	65	66
DEWPOINT (DEGREES)	58	58	59
VISIBILITY (MILES)	7.3	7.7	8.1
WIND VELOCITY (KNOTS)	9	9	9
SURFACE PRESSURE (MILLIBARS)	17.2	17.0	16.9

#NOTE: SKY CONDITION 3 = SCATTERED CLOUDS 1-5 TENTHS
" " 6 = BROKEN CLOUDS 6-9 "
" " 8 = OVERCAST CLOUDS 10 "

Figure 4.

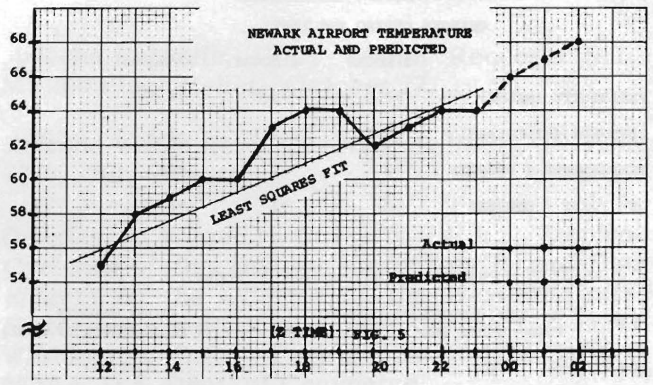

Figure 5.

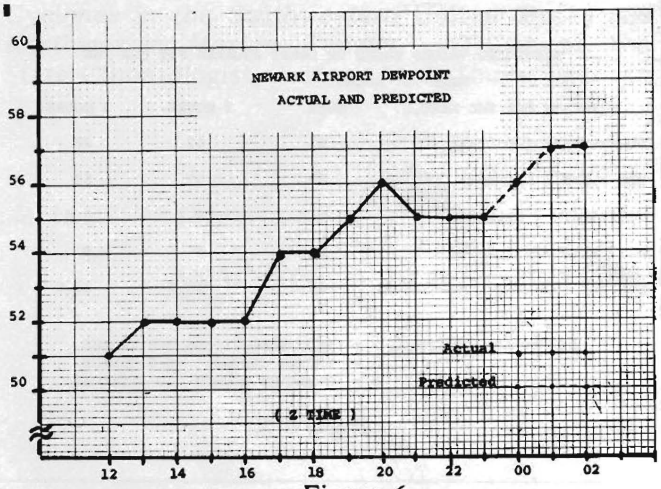

Figure 6.

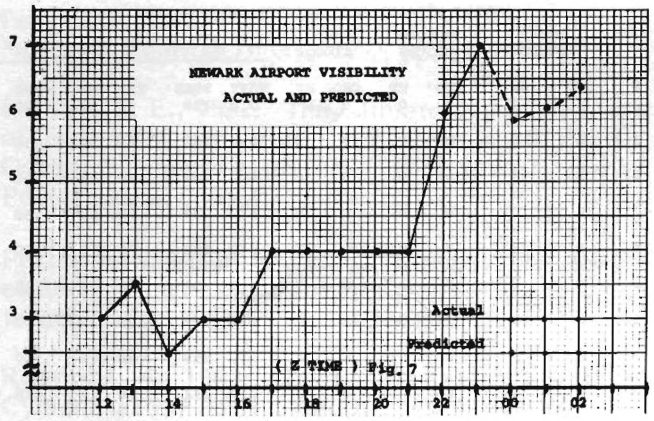

Figure 7.

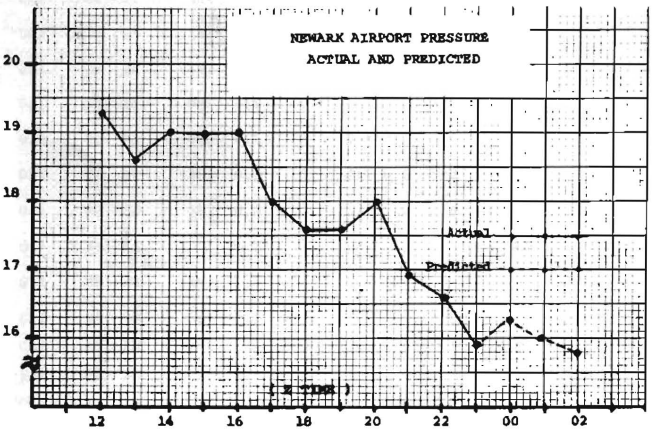

Figure 8.

the program can be designed to check for significant changes for any number of data elements over specific time periods and subsequently these can be highlighted to the forecaster.

3. THE FORECAST

If the forecaster is presented with data information like this for his forecast area, he should have an excellent understanding of the direction of trends up to the present, and be in a good position to make his forecast for the next period. To aid in this aspect, the program has a subroutine that uses the current data file, such as that shown in Figures 1 and 2, to develop a least squares fit and trend line. Based on the previous trend calculated by the subroutine a forecast for each element is made for the next 3 hours. (A longer period could have been developed but with diminished accuracy.) On the bottom of Figures 3 and 4, under the sub-heading PREDICTED VALUES BASED ON LEAST SQUARES FIT FOR THE NEXT 3 HOURS ... The predicted values for temperature, dew point, visibilitv, wind velocity and surface pressure are listed. These are shown on the graphs (Figures 5, 6, 7, 8). The solid line is the actual data and the dotted values for the 0000, 0100 and 0200 GMT times are the predicted values. Also on Figure 5 only the calculated LEAST SQUARES FIT line is shown to illustrate how closely the predicted values follow the trend line. The predicted values may be slightly off due to the fact that the program printed them as integer values and not decimal values.

After the Newark data file has been processed the program recycles and analyzes the J. F. Kennedy file and as many more files that may be available.

4. FUTURE APPLICATIONS

With the arrival of the AFOS System there will probably be available to users large amounts of data stored on disc or magnetic tapes or on punch cards. Programs similar to this one could process this data and this will afford an opportunity to those who wish to, to make a contribution to the science of meteorology.

APPENDIX

PARTIAL LISTING OF SOURCE PROGRAM

```
   JSWZM1
$$$$$$ NYU - UNMC 1108 OPERATING SYSTEM     VER. 31-244-4A18 (NSI)*
@RUN WJB4,0-6239-028,BLAKE-W,5,10
DATE: 091974       TIME: 110637
@EDQ PROGRAM.OBS
EDQ 2.2P 19 SEP 74 11:06:58(0)
EDIT
PM" 2
C     THE FOLLOWING REVISIONS WERE MADE BY TED SAM  9/17/74
PEDQ 7
@EOF
END EDQ.    LINES FILED: 174
@EDQ PROGRAM.OBS
EDQ 2.2P 19 SEP 74 11:08:42(0)
EDIT
P 180
C *** THE FOLLOWING REVISIONS WERE MADE BY TED SAM  9/17/74
C *** ALL LINES THAT WERE CHANGED ARE PRECEDED BY COMMENTS & STARS
      COMMON Z(30)
      DIMENSION J1(27),J2(27),J3(27),J4(27),J5(27),J6(27),J7(27),
C ***  THE DIMENSION FOR V(24) REMOVED, SINCE NOT USED
C ***  DIMENSIONS WERE CHANGED TO 27
     1J8(27),J9(27),J10(27),J11(27),J12(27),J13(27)
      DIMENSION STN(1)
      DIMENSION V2(27),V3(27),V4(27),V6(27),V7(27)
5     FORMAT(1X,A5,5I6,4I4,3(1X,I1,1X,I3))
7      FORMAT(2X,A3,7I5,2X,F5.2,5I5,/)
8     FORMAT(1X,72H STN    Z    CND    HT    CND    HT    CND  HT  VSBY    PR
     1TMP    DP    WIND     )
6     FORMAT(1X,1A5,8(2X,I3),1X,1F3.1,5(1X,13))
9      FORMAT(1X,43H           LOW CLOUDS  MID CLOUD HI CLOUD    )
10       FORMAT(20X,38HSIGNIFICANT CHANGES   DURING   LAST    )
16    FORMAT(2X,//)
15    FORMAT(30X,7H3 HOURS,2X,7H6 HOURS,2X,8H12 HOURS,//)
11    FORMAT(1X,20HVISIBILITY MILES     ,5X,3(5X,F5.2),/)
12    FORMAT(1X,20HPRESSURE MBS         ,5X,3(5X,I5),/)
13    FORMAT(1X,20HTEMPERATURE DEGS     ,5X,3(5X,I5),/)
14     FORMAT(1X,20HDEW POINT DEGS       ,5X,3(5X,I5))
30     FORMAT(1X,24HNO CHANGE CLEAR TO CLEAR,/)
31     FORMAT(1X,24HCLEAR TO SCATTERED      ,/)
32     FORMAT(1X,24HCLEAR TO BROKEN         ,5X,F5.2,/)
33     FORMAT(1X,24HCLEAR TO OVERCAST       ,/)
34    FORMAT(1X,49H ANALYSIS OF JFK AIRPORT OBSERVATIONS MAY 31 1974,//
C ***  THE RIGHT PARENTHESIS PUT ON A CONTINUATION
     1)
35     FORMAT(1X,4CH....WINDS AND CLOUD CHANGES LAST 3 HOURS,/)
36     FORMAT(1X,23H   AVG WIND DIR DEG    ,5X,F5.2,/)
37     FORMAT(1X,23H   AVG WIND VEL MPH    ,5X,F5.2,/)
38     FORMAT(1X,23HCHANGE IN SKY CONDITIONS,5X,10HCHANGE IN )
39     FORMAT(1X,23H  LAST 3 HOURS         ,5X,10HHEIGHT    ,/)
40    FORMAT(1X,24HLOW CLOUDS              ,1X,3(5X,I5),/)
41    FORMAT(1X,24HMIDDLE CLOUDS            ,1X,3(5X,I5),/)
42    FORMAT(1X,24HHIGH CLOUDS             ,1X,3(5X,I5),/)
43    FORMAT(55X,4HFROM,5X,2HTO,5X,6HHEIGHT,//)
44     FORMAT(2X,/)
46      FORMAT('          ESTIMATES BASED ON  LEAST SQUARES FIT')
45      FORMAT(8X,6HHOUR  ,5X,6HTEMP  ,5X,6HDEW PT,5X,6HVSBY  ,5X,
     1 6HAND FF,5X,6HPRESS  ,//)
47      FORMAT(1X,20HTEMPERATURE          ,5X,3(5X,F5.0),/)
48      FORMAT(1X,20HDEW POINT            ,5X,3(5X,F5.0),/)
49      FORMAT(1X,20HVISIBILITY           ,5X,3(5X,F5.1),/)
50      FORMAT(1X,20HWIND VELOCITY        ,5X,3(5X,F5.0),/)
51      FORMAT(1X,20HSURFACE PRESSURE     ,5X,3(5X,F5.0),/)
52      FORMAT('  FORECAST FOR NEXT...        HOUR        2 HOURS
     1 3HRS ')
53       FORMAT('      SIGNIFICANT CHANGES LAST HOUR,2HOURS,3HOURS')
      NN=24
      N3=NN-3
      N6=NN-6
      N12=NN-12
      N15=NN+3
      DO 400 K=1,2
      DO 100 J=1,NN
C ***  END =111 CLAUSE USED TO HANDLE END-OF-INPUT CONDITION
      READ(10,5,END=111)STN,J1(J),J2(J),J3(J),J4(J),J5(J),J6(J),J7(J)
     1,J8(J),J9(J),J10(J),J11(J),J12(J),J13(J)
111    V4(J)=J4(J)*.01
      V6(J)=J6(J)
      V6(J)=V6(J)+.5
      V7(J)=J7(J)
      V3(J)=J3(J)
      V2(J)=J2(J)
```