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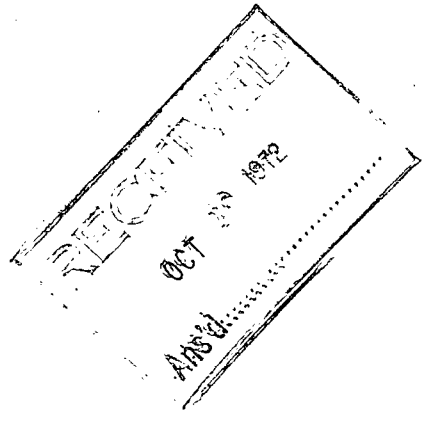
DEPARTMENT OF THE ENVIRONMENT – CANADA

Technical Memoranda

EVALUATION OF COMPUTER 18- AND 42-HOUR TEMPERATURE FORECASTS FOR MAXIMUM AND MINIMUM TEMPERATURES FOR THE ATLANTIC PROVINCES

by

D.C. DAY



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ENVIRONMENT CANADA - ATMOSPHERIC ENVIRONMENT SERVICE
4905 Dufferin Street
Downsview, Ontario

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ABSTRACT

When minimum and maximum temperatures stay near the mean maximum and minimum temperatures for the season, the temperature error is small with little bias. When maximum and minimum temperatures depart from normal by more than five degrees, the computer forecast error becomes large, with the forecast always tending toward the mean.

ÉVALUATION DES PRÉVISIONS DE LA TEMPÉRATURE MAXIMALE ET MINIMALE FAITES PAR ORDINATEUR 18 h ET 42 h À L'AVANCE POUR LES PROVINCES DE L'ATLANTIQUE

par

D. C. Day

RÉSUMÉ

Lorsque les températures maximales et minimales se rapprochent de la température moyenne pour la saison, la marge d'erreur est petite. Cependant, si les températures maximales et minimales s'écartent de plus de 5 degrés de la température normale, la marge d'erreur des prévisions par ordinateur devient assez importante, les chiffres obtenus tendant toujours vers la température moyenne.

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(Manuscript received November 3, 1971)

1. Introduction

The Extended Forecast Section of the Central Analysis Office issues temperature forecasts twice daily for key terminals in Canada.

The forecast issued at 0400Z forecasts the maximum temperature for today and tomorrow, and the minimum temperature for tonight and the following night. The forecast maximum temperatures for today (18-hour) and tomorrow (42-hour) have been evaluated in this study.

At 1600Z, minimum temperatures are forecast for tonight and tomorrow, and maximum temperatures for tomorrow and the next day. The forecast minimum temperatures for tonight (18-hour) and tomorrow night (42-hour) have been evaluated in this study.

The evaluation was carried out for Fredericton and Moncton in New Brunswick, Shearwater and Sydney in Nova Scotia, Charlottetown in Prince Edward Island, and Gander and Torbay in Newfoundland. For each of these stations, graphs were prepared comparing the forecast maximum temperature, the mean maximum temperature, and the actual maximum temperature for each day from 1 February to 25 April 1971. Similar graphs were prepared comparing the forecast minimum temperatures, the mean minimum temperatures and the actual minimum temperatures for each day in the same period.

2. Evaluation of Errors Based on Departure from Mean Temperatures

Examination of the graphs for both the maximum and minimum temperatures indicate that errors were greater for all stations when the actual temperatures departed from the climatological mean by more than 5°F. and that, with very few exceptions, the forecast errors were in the direction of the mean. Even when there had been a large departure from the mean when the forecast was prepared, a considerable forecast error would still occur in the direction of the mean.

Figure 1, a comparison of reported minimum temperature and computer 18-hour minimum temperature forecast, and relationship to the climatological mean minimum temperature for Moncton, N. B.,

is a typical graph. On 3 February the minimum temperature is 25°F. below normal, but the forecast for 4 February forecasts the temperature to be 14°F. below normal. The actual observed temperature for 4 February is 27°F. below normal. Similarly, on 4 February a forecast is made for 5 February for 6°F, below normal. The observed forecast temperature for 5 February is 26°F. below normal. Similar errors are evident from the graph in above-normal temperatures on 12, 13 and 14 February.

The results are presented in four categories:

(a) The average error using all cases,

(b) The average error when temperatures remained between five degrees above and five degrees below normal,

(c) The average error when temperatures were more than five degrees above normal, and

(d) The average error when temperatures were more than five degrees below normal.

Tables 1 and 2 evaluate the minimum temperature error, Tables 3 and 4 those of the maximum temperatures. In Tables 1-4 the bias values are the averaged signed errors, and the average errors are the average absolute errors. Table 5 lists the maximum errors, and compares them with the departure of the climatological mean from the observed temperature. Table 6 compares the number of occurrences of temperatures six degrees or more from the mean with the number of times the computer forecasts these temperatures further from the mean than occurred.

3. Conclusion

Based on the graphs prepared for each terminal, it was found that the reported minimum temperatures at all terminals were more frequently above than below normal for the period 1 February to 25 April 1971. This is the reason for the larger number of cases of temperatures more than five degrees above normal than more than five degrees below normal in Tables 1 and 2. This is also evident on the graph in Figure 1. The reported maximum temperatures were more frequently above normal at Gander and Torbay but there was little difference in frequency at the other terminals. This is evident in a comparison of the number of cases more than 5°F. above normal and the number of cases more than 5°F. below normal in Tables 3 and 4.

When the temperature remained within five degrees of the mean, the forecast temperature errors were small, ranging from 3-6°F. for 18-hour forecasts, and 3-7°F. for 42-hour forecasts. The small negative bias shown for minimum temperatures in Tables 1 and 2 was probably due to the fact that temperatures were generally above normal, and the forecast temperatures were tending toward the mean. In Tables 3 and 4 there was a small negative bias for all terminals but this cannot be explained as a departure of forecast temperatures toward the mean except for Gander and Torbay.

When the observed temperatures were more than 5°F. above the mean, the 18-hour forecasts ranged from 5-8°F. too low, and the 42-hour forecasts ranged from 6-10°F. too low. An exception was Shearwater minimum temperature which averaged 1.9°F. too low for 18-hour forecasts and 4.4°F. low for 42-hour forecasts.

When the observed temperatures were more than 5°F. below normal, the 18-hour forecasts ranged from 5-10°F. too high and the 42-hour forecasts ranged from 7-14°F, too high.

Fitzgerald (1), in a similar study for the period 16 June-15 August 1970, found smaller errors for the forecast temperatures when the observed temperatures varied from the mean by more than 5°F. (Table 3 of his paper). He stated that computer temperature forecasts were consistently closer to the climatological mean than the observed temperature. Tyner (2), in a similar paper, 14 November 1969 to 31 January 1970, found similar forecast errors when the temperature departed from the mean by 2°F. or more.

The small number of times that the computer overestimated the departure from the mean when the departure of observed temperatures from the mean was 6°F. or more is indicated in Table 6. Fitzgerald (1), in Table 4 of his paper, indicated similar results.

When maximum and minimum temperatures depart from the climatological mean by more than 5°F., the computer forecast error becomes large, with the forecast always tending toward the mean.

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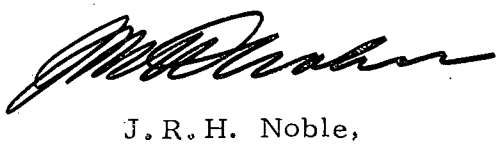

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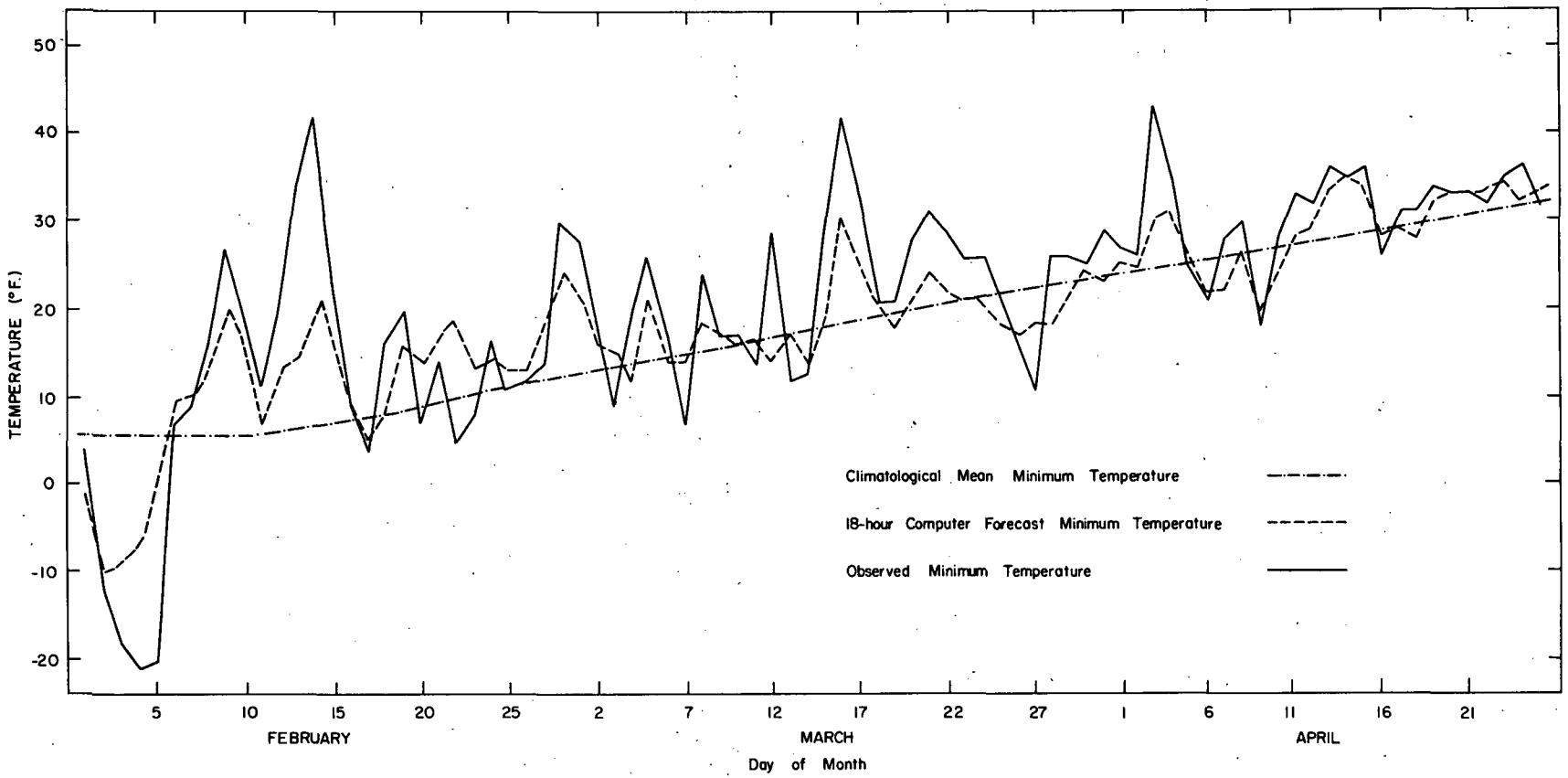

Figure 1.
Comparison of Reported Minimum Temperature and Computer 18-Hour Minimum Temperature Forecast, and Relationship to the Climatological Mean Minimum Temperature, for Moncton, N.B.

TABLE 1

Comparison Between Actual Minimum Temperatures and 18-hour Computer Forecasts

Station	Total No. of Cases	Avg Error in °F.	Avg Bias in °F.	Min Temps +5°F. to -5°F. of Normal			Min Temps More Than 5°F. Above Normal		Min Temps More Than 5°F. Below Normal		
				No. of Cases	Avg Error in °F.	Avg Bias in °F.	No. of Cases	Avg Bias in °F.	No. of Cases	Avg Bias in °F.	Total No. of Cases
Fredericton	84	6.4	-1.5	34	5.7	-1.9	36	-5.8	14	+10.0	84
Moncton	84	4.9	-1.9	50	3.1	-0.6	27	-7.1	7	+8.7	84
Shearwater	84	5.1	-3.8	51	3.6	-3.1	27	-7.6	6	+6.5	84
Sydney	83	4.8	-2.7	47	2.8	-1.1	29	-7.6	7	+6.9	83
Charlottetown	84	4.7	-2.3	48	2.9	-1.3	27	-7.4	9	+7.8	84
Gander	84	5.3	-1.3	31	3.2	+0.5	43	-5.5	10	+10.7	84
Torbay	81	4.2	-1.8	35	3.7	-0.4	39	-4.9	7	+5.7	81

TABLE 2

Comparison Between Actual Minimum Temperatures and 42-hour Computer Forecasts

Station	No. of Cases	Avg Error in °F.	Avg Bias in °F.	Min Temps + 5°F. to -5°F of Normal: No. of Cases	Avg Error in °F.	Avg Bias in °F.	Min Temps More Than 5°F. Above Normal: No. of Cases	Avg Bias in °F.	Min Temps More Than 5°F. Below Normal: No. of Cases	Avg Bias in °F.
Fredericton	84	8.7	-3.6	34	6.7	-3.8	36	-9.5	14	+9.9
Moncton	84	6.3	-3.2	50	3.8	-1.2	27	-10.2	7	+9.4
Shearwater	84	6.5	-4.9	51	4.6	-4.0	27	-9.6	6	+8.3
Sydney	83	5.7	-3.3	47	3.0	-1.3	29	-9.4	7	+9.1
Charlottetown	84	6.2	-3.2	48	3.6	-1.7	27	-9.7	9	+8.8
Gander	84	6.7	-2.7	31	3.4	-1.5	43	-7.1	10	+13.5
Torbay	81	5.8	-2.6	35	4.1	-0.7	39	-6.7	7	+9.7

TABLE 3

Comparison Between Actual Maximum Temperatures and 18-hour Computer Forecasts

Station	No. of Cases	Avg Error in °F.	Avg Bias in °F.	Max Temps +5°F. to -5°F. of Normal			Max Temps More than 5°F. Above Normal		Max Temps More than 5°F. Below Normal	
				No. of Cases	Avg Error in °F.	Avg Bias in °F.	No. of Cases	Avg Bias in °F.	No. of Cases	Avg Bias in °F.
Fredericton	82	5.1	+0.5	41	3.2	-0.6	17	-6.3	24	+7.3
Moncton	82	5.1	-0.3	43	2.8	-0.9	19	-6.7	20	+7.0
Shearwater	83	4.2	+0.3	56	4.0	-0.7	12	-1.9	15	+5.7
Sydney	83	4.3	0	53	2.9	-0.4	18	-6.3	13	+7.2
Charlottetown	82	4.9	-0.3	48	3.4	-0.9	18	-5.5	16	+7.2
Gander	82	5.1	-1.6	45	3.3	-0.8	28	-5.8	9	+9.5
Torbay	82	4.2	-1.7	49	3.0	-1.0	22	-6.6	11	+4.8

TABLE 4

Comparison Between Actual Maximum Temperatures and 42-hour Computer Forecasts

Station	All Cases: No. of Cases	All Cases: Avg Error in °F.	All Cases: Avg Bias in °F.	Max Temps + 5°F. to -5°F. of Normal: No. of Cases	Max Temps + 5°F. to -5°F. of Normal: Avg Error in °F.	Max Temps + 5°F. to -5°F. of Normal: Avg Bias in °F.	Max Temps More than 5°F. Above Normal: No. of Cases	Max Temps More than 5°F. Above Normal: Avg Bias in °F.	Max Temps More than 5°F. Below Normal: No. of Cases	Max Temps More than 5°F. Below Normal: Avg Bias in °F.
Fredericton	82	5.2	+0.2	41	3.5	-1.0	17	-6.8	24	+7.2
Moncton	82	5.8	-0.8	43	3.1	-1.8	19	-7.6	20	+7.6
Shearwater	83	4.9	-0.8	56	4.4	-2.2	12	-4.4	15	+7.1
Sydney	82	4.9	-0.5	52	3.1	-0.4	18	-7.8	13	+8.3
Charlottetown	82	5.4	-0.8	48	3.6	-1.8	18	-6.5	16	+8.3
Gander	82	6.1	-2.0	45	3.8	-1.4	28	-7.0	9	+12.1
Torbay	81	5.2	-2.2	49	3.6	-1.4	21	-8.3	11	+6.6

TABLE 5

Maximum Errors Found in Comparison of Actual Maximum and Minimum Temperatures and 18- and 42-hour Computer Forecasts

Station	Maximum Error in 18-hour Forecast of Minimums (°F.) and Date	Maximum Error in 42-hour Forecast of Minimums (°F.) and Date	Maximum Error in 18-hour Forecast of Maximums (°F.) and Date	Maximum Error in 42-hour Forecast of Maximums (°F.) and Date
Fredericton	+18 - Feb 4 (+30) -17 - Feb 14 (-30)	+23 - Feb 5 (+21) -21 - Feb 14 (-30)	+15 - Feb 5 (+13) -12 - Apr 14 (-11)	+17 - Feb 5 (+13) -12 - Apr 14 (-11)
Moncton	+20 - Feb 5 (+26) -21 - Feb 14 (-35)	+22 - Feb 5 (+26) -28 - Feb 14 (-35)	+14 - Feb 2 (+24) -16 - Apr 14 (-15)	+19 - Feb 3 (+24) -19 - Apr 14 (-15)
Shearwater	+15 - Feb 5 (+25) -12 - Feb 10 (-15)	+19 - Feb 5 (+25) -15 - Feb 10 (-15)	+15 - Feb 3 (+30) - 9 - Feb 7 (- 4)	+22 - Feb 3 (+30) - 9 - Mar 17 (- 9)
Sydney	+11 - Feb 6 (+16) -16 - Feb 13 (-21)	+16 - Feb 6 (+16) -20 - Feb 1 (-15)	+12 - Feb 3 (+24) -16 - Apr 12 (-19)	+18 - Feb 3 (+24) -14 - Apr 12 (-19)
Charlottetown	+14 - Feb 5 (+20) -18 - Feb 14 (-32)	+17 - Feb 5 (+20) -25 - Feb 14 (-32)	+21 - Feb 5 (+24) -16 - Apr 12 (-19)	+23 - Feb 5 (+24) -17 - Apr 14 (-17)
Gander	+19 - Feb 24 (+17) -13 - Feb 15 (-26)	+22 - Feb 24 (+17) -21 - Feb 1 (-15)	+16 - Feb 21 (+13) -16 - Apr 1 (-22)	+21 - Feb 3 (+27) -20 - Apr 1 (-22)
Torbay	+12 - Feb 24 (+11) -18 - Feb 1 (-19)	+14 - Feb 24 (+11) -24 - Feb 1 (-19)	+14 - Feb 21 (+13) -13 - Feb 1 (-20)	+14 - Feb 21 (+13) -17 - Feb 1 (-20)

Values in brackets indicate in °F. how the climatological mean temperature differs from the observed temperature.

TABLE 6

Occurrences of:

	The Number of Cases Where Observed Temperatures are 6°F. or More Above or Below the Mean	The Number of Cases Where the Forecasts Show a Greater Departure from the Mean than Occurred
Computer Minimum 18-hour	258 (186)	3 (1)
Forecast 42-hour	288	5
Computer Maximum 18-hour	242 (227)	14 (13)
Forecast 42-hour	240	10

Bracketed Values are results from Table 4 of Fitzgerald's paper (1).

References

1. Fitzgerald, J.A., 1970: Errors in Temperature Forecasts for the Atlantic Provinces 16 June to 15 August 1970. Canada, Department of Transport, Meteorological Branch. Technical Memoranda Series. TEC-744.

2. Tyner, R.V., 1970: Errors in the Temperature Forecasts for the Atlantic Provinces 14 November 1969 to 31 January 1970. Canada, Department of Transport. Meteorological Branch. Technical Memoranda Series. TEC-737.

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3 pps. 6 tables 1 fig. 2 refs.

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2. Computers
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