NOAA Technical Memorandum AR-12

MARINE FORECAST VERIFICATION PROGRAM FOR WESTERN AND NORTHERN ALASKA APRIL 1974--MARCH 1975

Benjamin C. Hablutzel
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Weather Service Forecast Office
Fairbanks, Alaska

April 1975

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION / National Weather Service

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NATIONAL OCEANIC AND
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TABLE OF CONTENTS

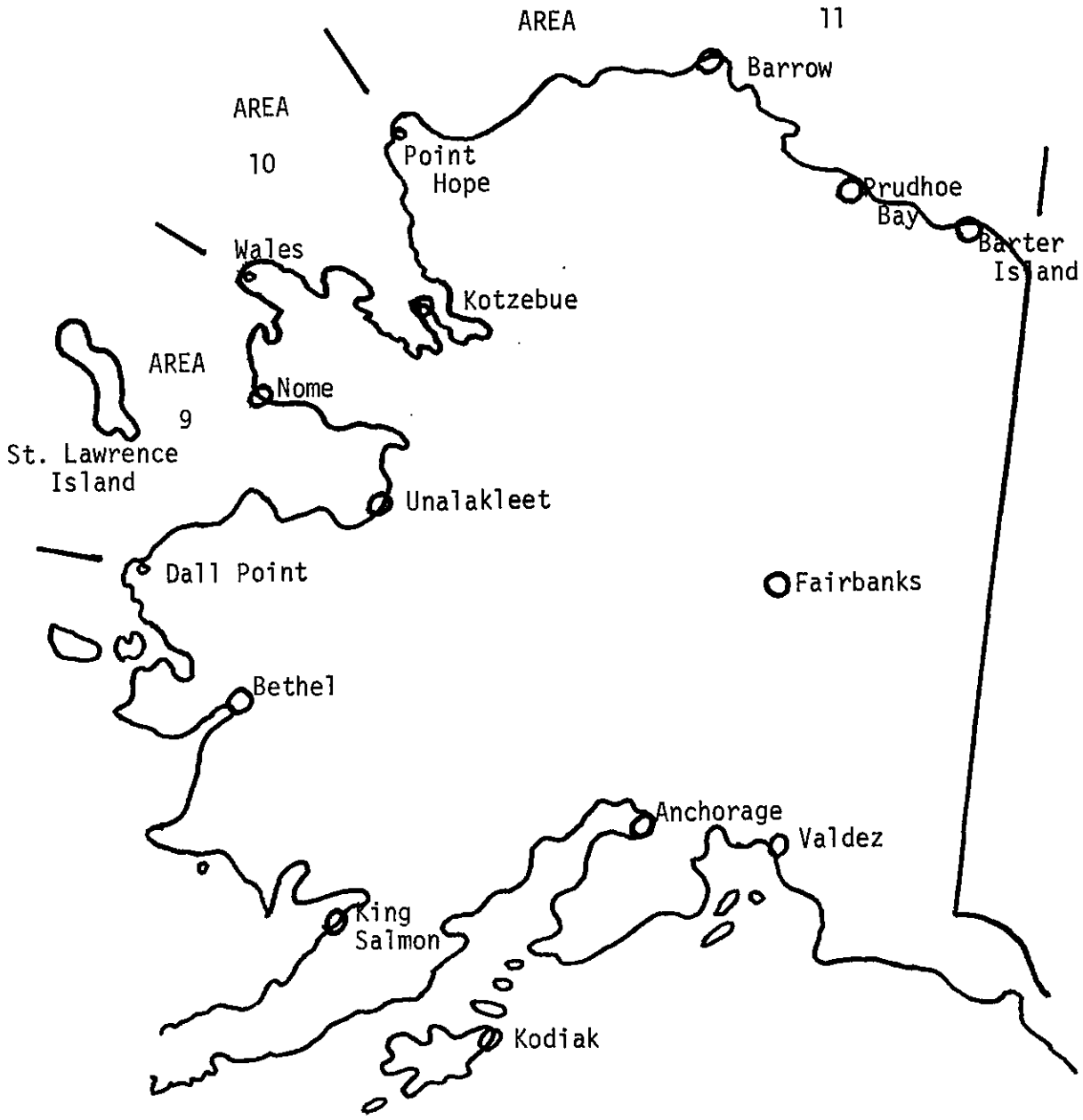
	Page
LIST OF TABLES	ii
LIST OF FIGURES	iii
MAP OF AREAS 9, 10, AND 11	iv
INTRODUCTION	1
VERIFICATION PROCEDURES	2
RESULTS	4
CONCLUSION	17
APPENDIX	18

LIST OF TABLES

Table		Page
1	Fairbanks Marine Forecast Verification Weighted Scores from April 1974 to October 1974.	6
2	Fairbanks Marine Forecast Verification Weighted Scores from November 1974 to March 1975	7
3	Percentage of Correct, Overforecasted, and Underforecasted FZAK5 and FOUS Forecasts	12
4	Average Categorical Error in the FZAK5 and FOUS Forecasts.	15

LIST OF FIGURES

Figure		Page
1	First period weighted scores for Area 9.	8
2	Second period weighted scores for Area 9	8
3	First period weighted scores for Area 10	9
4	Second period weighted scores for Area 10.	9
5	First period weighted scores for Area 11	10
6	Second period weighted scores for Area 11.	10
7	Average weighted scores for Western Alaska (Areas 9 and 10).	11
8	Average weighted scores for Northern Alaska (Area 11). . .	11
9	Percentage of correct FZAK5 and FOUS forecasts	14
10	Percentage of overforecasted FZAK5 and FOUS forecasts. . .	14
11	Percentage of underforecasted FZAK5 and FOUS forecasts . .	16
12	Average categorical error in the FZAK5 and FOUS forecasts.	16



Map of Areas 9, 10, and 11

INTRODUCTION

The verification of marine forecasts (FZAK5) and the NMC boundary wind layer (FOUS) forecasts during the first year of the Fairbanks WSFO are discussed. The objective was to determine how well the FZAK5 forecasts verified and how much, if any, the forecasters improved the FOUS.

In addition to the verification results, an analysis was made of the tendency to underforecast or overforecast. This was done by determining the percentage of correct forecasts, underforecasts, and overforecasts, as well as determining the average positive (negative) categorical error, resulting in overforecasts (underforecasts). Included are possible explanations for the missed forecasts.

VERIFICATION PROCEDURES

For each area, the forecast is divided into two 12 hour periods ("day" and "night" for the morning forecast and "night" and "day" for the afternoon forecast). The "day" period is verified by the gradient wind on the 1800Z and 0000Z Anchorage WSFO surface analyses. The "night" period is similarly verified on the 0600Z and 1200Z charts. The winds for both forecast and verification are placed into one of the following categories:

a. No warnings or advisories (0 - 20 knots)

b. Small craft (or brisk wind) advisories (21 - 35 knots)

c. Gale warnings (36 - 50 knots)

d. Storm warnings (over 50 knots)

If there is any change in a category during a 12 hour period, the higher (or highest) category prevails. If the two verifying categories for the day (or night) forecast are different, the higher category prevails. If a forecast category is in agreement with the verification, no points are scored. A miss by one category (such as a forecast of small craft and a verification of gale) scores one point. A miss by two categories scores four points and a miss by three categories scores nine points. The smaller the score, the better.

Each month, the scores are totaled. Assume one consistently missed by one category. For a 30 day month, this would be a score of 60 for both the first and second twelve hour periods, which would not be good. A score of under 20 would indicate few, if any, misses by more than one category. 21 to 35 would be about average. 36 to 50 would indicate a large number of wide misses. Over 50 means that most, if not all, forecasters

have a hard time verifying.

In addition to the FZAK5 forecasts, the FOUS wind forecasts were verified. The 1800Z forecast represents the "day" forecast and the 0000Z forecast is the "night" forecast. This verification determines how useful the FOUS is as a forecast tool and how much, if any, the forecasters improve the FOUS.

RESULTS

Tables 1-2 and Figures 1-8 generally show favorable results. It should be remembered that few storms occur during the late spring and summer months, which should result in good scores. The overall average FZAK5 score for the 12 month period (April 1974-March 1975) was 18.69 (Table 2). The average FOUS score was 23.29, both of which were good scores. The forecasters improved the FOUS by an average of 4.6 points.

For Area 9 (Dall Point to Wales including Norton Sound and the St. Lawrence Island Waters), FZAK5 scores ranged from a low of 6 (1st period, May 1974) to a high of 33 (2nd period, November 1974---the month of the Great Bering Sea Storm). FOUS values ranged from a low of 9 (1st period, May 1974) to a high of 43 (2nd period, February 1975). During November, two forecasts of "no warning" verified "gale" (8 points), one forecast of "gale" verified "no warning" (4 points), and one forecast of "storm" verified "small craft" (4 points), totaling 16 of the 33 points. February's FOUS forecasts had one "no warning" forecast verify "gale" (4 points) and two "brisk wind" forecasts verify "storm" (8 points), totaling 12 of the 43 points. There were 31 one point misses, most of them underforecasts. The only miss by three categories ("no warning" verifying "storm") occurred in the 2nd period in August 1974. The average FZAK5 score was 17.5 and the average FOUS score was 24 or an improvement of 6.5 points.

For Area 10 (Wales to Point Hope including Kotzebue Sound), FZAK5 scores ranged from a low of 6 (2nd period, May 1974) to a high of 39 (2nd period, November 1974). As with Area 9, there were a significant number of misses by two categories (5) to give such a high score. The FOUS scores ranged from a low of 9 (1st and 2nd periods, May 1974) to 41 (2nd period,

December 1974) when there were six misses by two categories (24 points). Again, most of the one point misses were underforecasts. The average FZAK5 score was 19 and the average FOUS score was 23 or an improvement of 4 points.

For Area 11 (Point Hope to Canadian Border), FZAK5 scores ranged from a low of 8 (1st period, August 1974) to 25 (2nd period, September 1974). FOUS scores ranged from a low of 7 (1st period, August 1974) to 27 (2nd period, September 1974). For the FZAK5 and the FOUS, the majority of the points were from overforecasts by one category. The average FZAK5 score was 14 and the average FOUS score was 16 or an improvement of 2 points.

Points are scored either because too high a category (overforecast) is made or too low a category is forecast (underforecast). Table 3 and Figures 9-11 show the percentage of correct forecasts, underforecasts, and overforecasts. As would be expected, the percentage of correct FZAK5 forecasts are high (above 80 percent) during late spring and summer and falls to near 65 percent during the fall. The FOUS behaved similarly during the spring and summer, but fell to a low of 50.4 percent in December, nearly 18 points behind the FZAK5. Examination of the remaining columns in Table 3 indicates that of the missed forecasts, underforecasts lead overforecasts by about 2-1 for the FZAK5 and about 3-1 for the FOUS. This means that the main problem is underforecasting. One can see the problem of underforecasting more clearly in Table 4 and Figure 12. By scoring -1, -2, and -3 (+1, +2, and +3) for an underforecast (overforecast) by one, two, and three categories respectively, combining the values, and dividing

	WESTERN ALASKA						NORTHERN ALASKA							
	AREA 9			AREA 10			AREA 11			AVERAGE				
	1ST	2ND	TOTAL	1ST	2ND	TOTAL	1ST	2ND	TOTAL	1ST	2ND	MONTH TOTAL	DIFFERENCE	
APRIL 1974														
FZAK5	18	21	19.5	20	23	21.5	--	--	----	19.00	22.00	20.50		
FOUS	23	24	23.5	15	20	17.5	--	--	----	19.00	22.00	20.50.....	+0.00	
MAY 1974														
FZAK5	6	8	7.0	7	6	6.5	--	--	----	6.50	7.00	6.75		
FOUS	9	15	12.0	9	9	9.0	--	--	----	9.00	12.00	10.50.....	+3.75	
JUNE 1974														
FZAK5	10	10	10.0	13	19	16.0	--	--	----	11.50	14.50	13.00		
FOUS	10	12	11.0	19	17	18.0	--	--	----	14.50	14.50	14.50.....	+1.50	
JULY 1974														
FZAK5	13	15	14.0	11	19	15.0	10	12	11.0	11.00	14.50	12.50		
FOUS	16	18	17.0	13	19	16.0	12	16	14.0	13.25	17.25	15.25.....	+2.75	
AUGUST 1974														
FZAK5	9	21	15.0	5	11	8.0	8	9	8.5	7.50	12.50	10.00		
FOUS	21	32	26.5	11	14	12.5	7	9	8.0	11.50	16.00	13.75.....	+3.75	
SEPTEMBER 1974														
FZAK5	12	14	13.0	9	7	8.0	21	25	23.0	15.75	17.75	16.75		
FOUS	12	14	13.0	9	11	10.0	26	27	26.5	18.25	19.75	19.00.....	+2.25	
OCTOBER 1974														
FZAK5	21	25	23.0	27	36	31.5	--	--	----	24.00	30.50	27.25		
FOUS	30	31	30.5	33	28	30.5	--	--	----	31.50	29.50	30.50.....	+3.25	

TABLE 1. FAIRBANKS MARINE FORECAST VERIFICATION WEIGHTED SCORES FROM APRIL 1974 TO OCTOBER 1974.

	WESTERN ALASKA						NORTHERN ALASKA							
	AREA 9			AREA 10			AREA 11			AVERAGE				
	1ST	2ND	TOTAL	1ST	2ND	TOTAL	1ST	2ND	TOTAL	1ST	2ND	MONTH TOTAL	DIFFERENCE	
NOVEMBER 1974														
FZAK5	25	33	29.0	19	39	29.0	--	--	----	22.00	36.00	29.00		
FOUS	25	24	24.5	27	38	32.5	--	--	----	26.00	31.00	28.50.....	-0.05	
DECEMBER 1974														
FZAK5	14	25	19.5	27	36	31.5	--	--	----	20.50	30.50	25.50		
FOUS	37	42	39.5	39	41	40.0	--	--	----	38.00	41.50	39.75.....	+14.25	
JANUARY 1975														
FZAK5	18	22	20.0	13	21	17.0	--	--	----	15.50	21.50	18.50		
FOUS	29	28	28.5	25	26	25.5	--	--	----	27.00	27.00	27.00.....	+8.50	
FEBRUARY 1975														
FZAK5	15	27	21.0	25	32	28.5	--	--	----	20.00	29.50	24.75		
FOUS	28	43	35.5	36	39	37.5	--	--	----	32.00	41.00	36.50.....	+11.75	
MARCH 1975														
FZAK5	23	23	23.0	15	18	16.5	--	--	----	19.00	20.50	19.75		
FOUS	24	23	23.5	28	20	24.0	--	--	----	26.00	21.50	23.75.....	+4.00	
12 MONTH AVERAGE														
FZAK5	15	20	17.5	16	22	19.0	13	15	14.0			18.69		
FOUS	22	26	24.0	22	24	23.0	15	17	16.0			23.29.....	+4.60	

TABLE 2. FAIRBANKS MARINE FORECAST VERIFICATION WEIGHTED SCORES FROM NOVEMBER 1974 TO MARCH 1975.

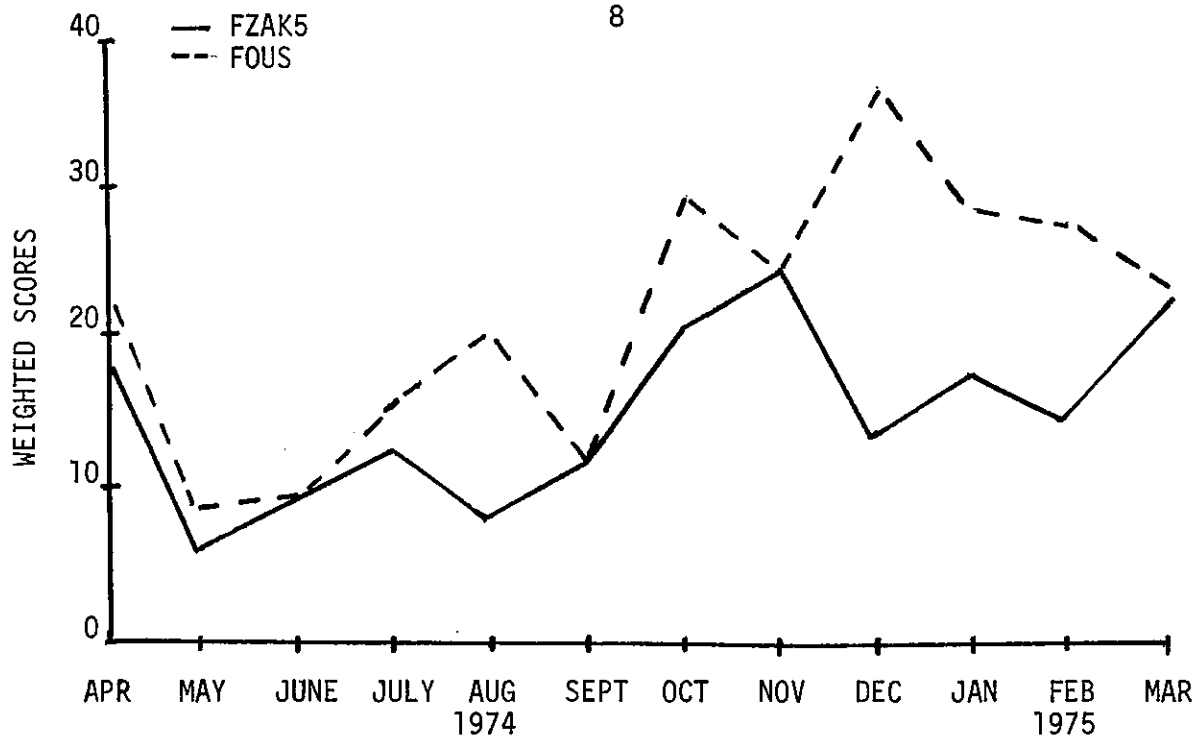


Figure 1. First period weighted scores for Area 9.

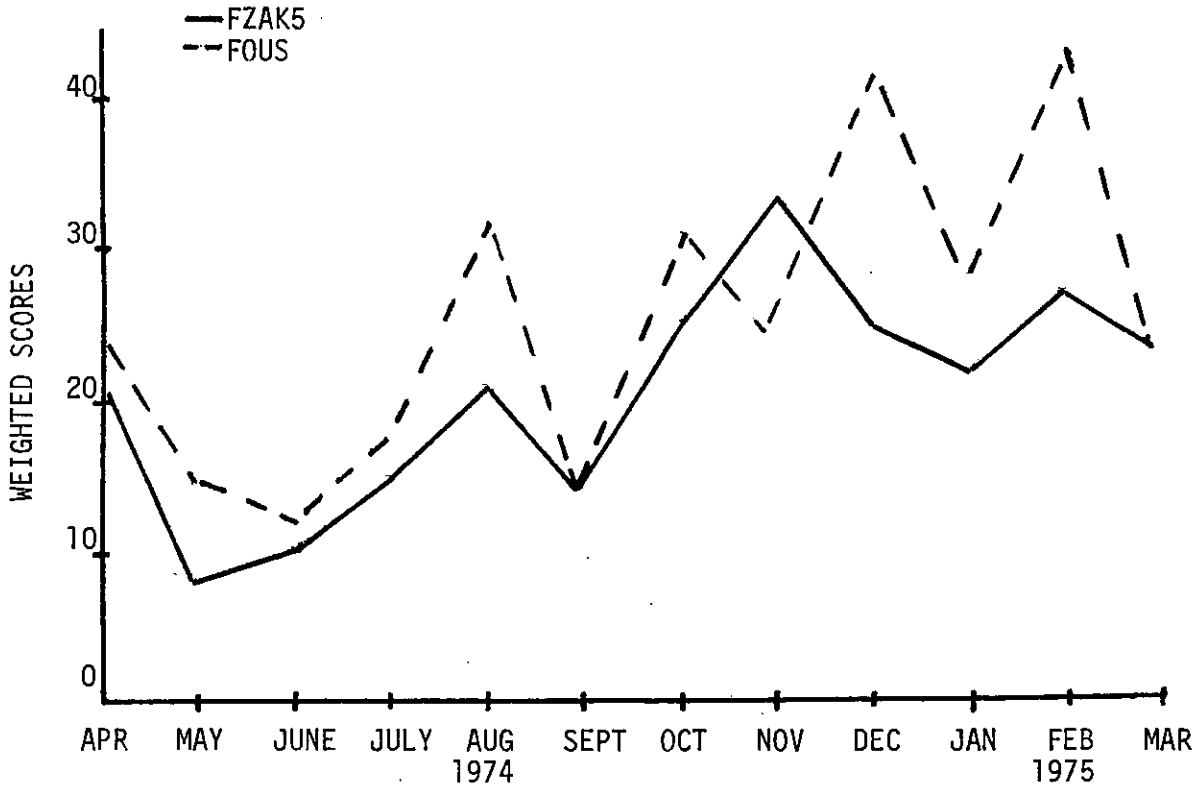


Figure 2. Second period weighted scores for Area 9.

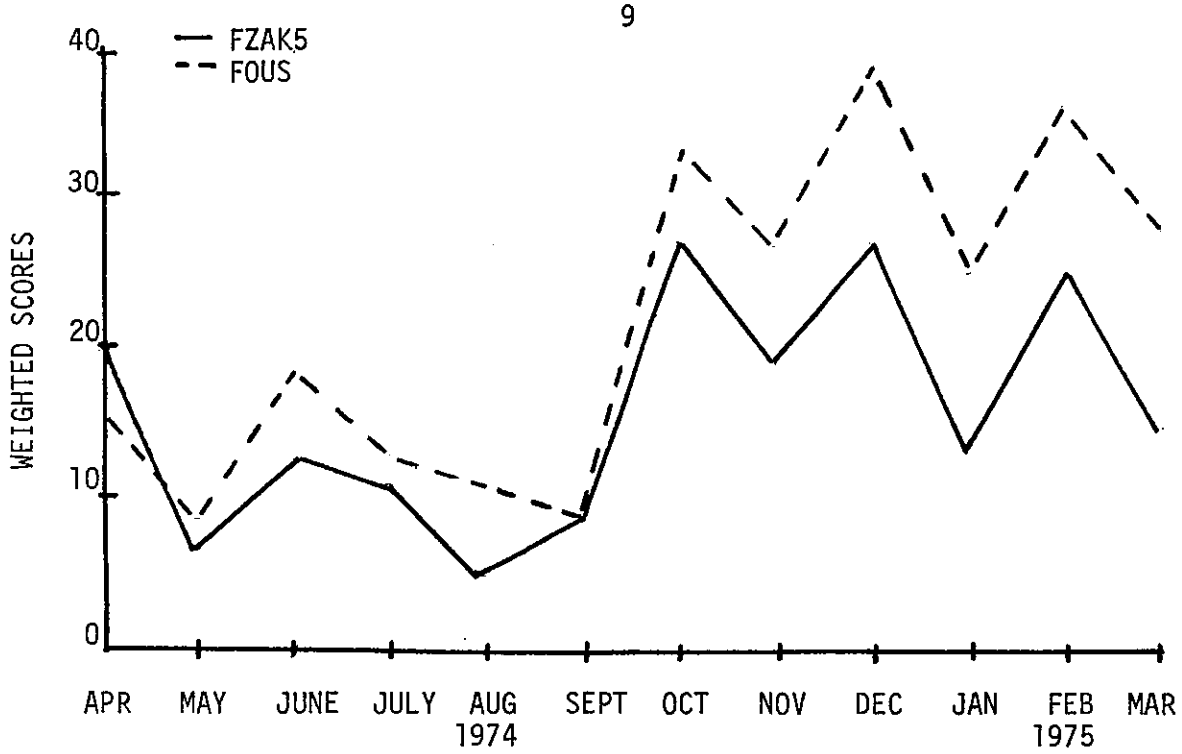


Figure 3. First period weighted scores for Area 10.

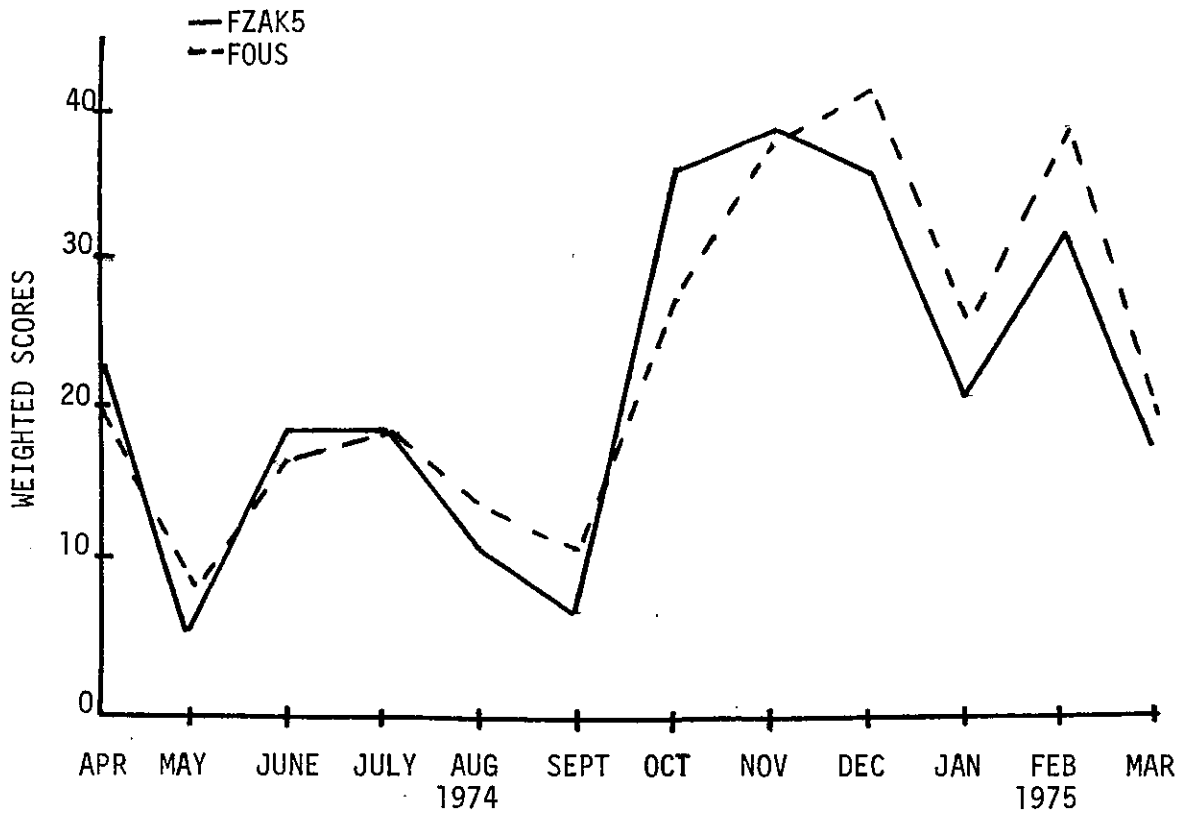


Figure 4. Second period weighted scores for Area 10.

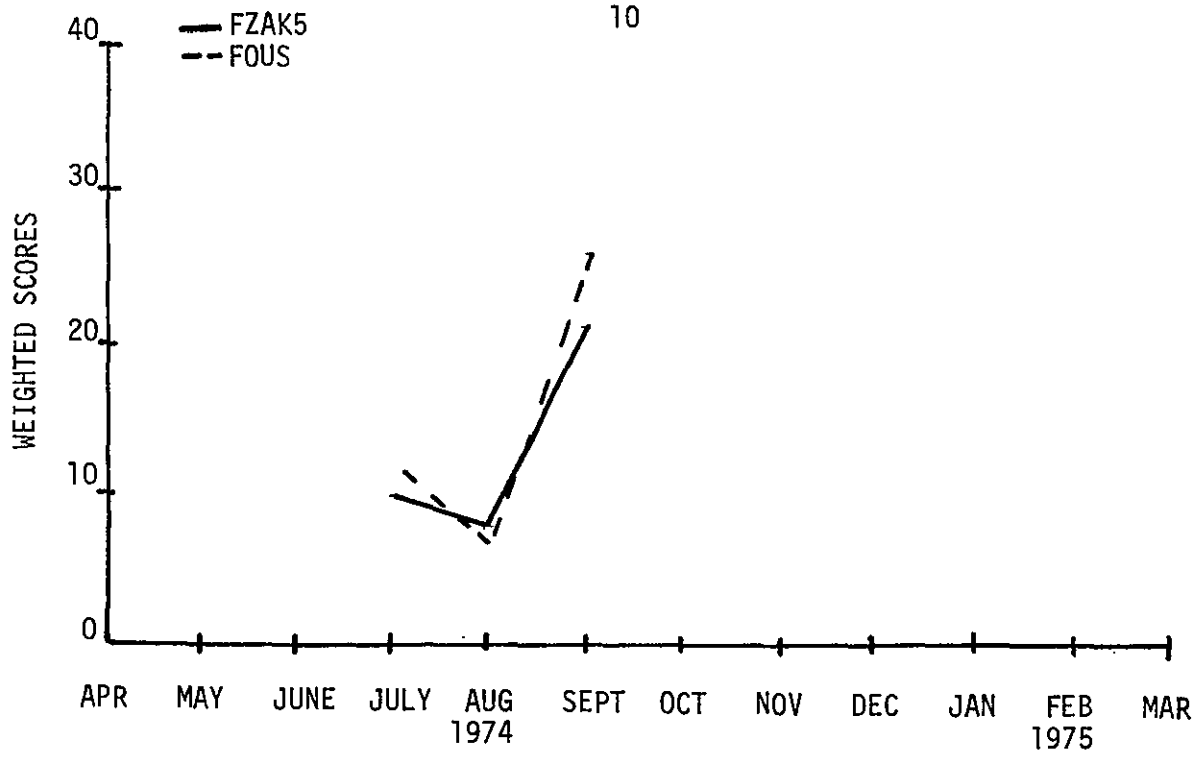


Figure 5. First period weighted scores for Area 11.

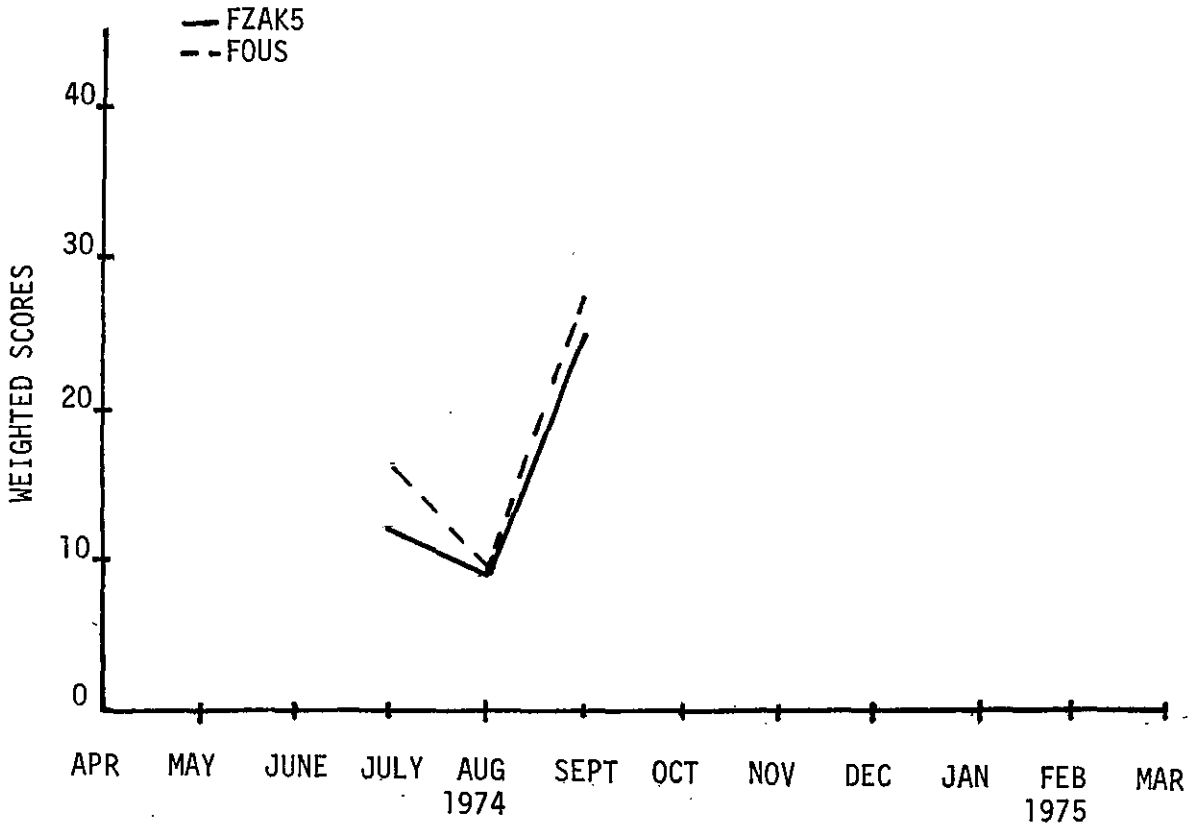


Figure 6. Second period weighted scores for Area 11.

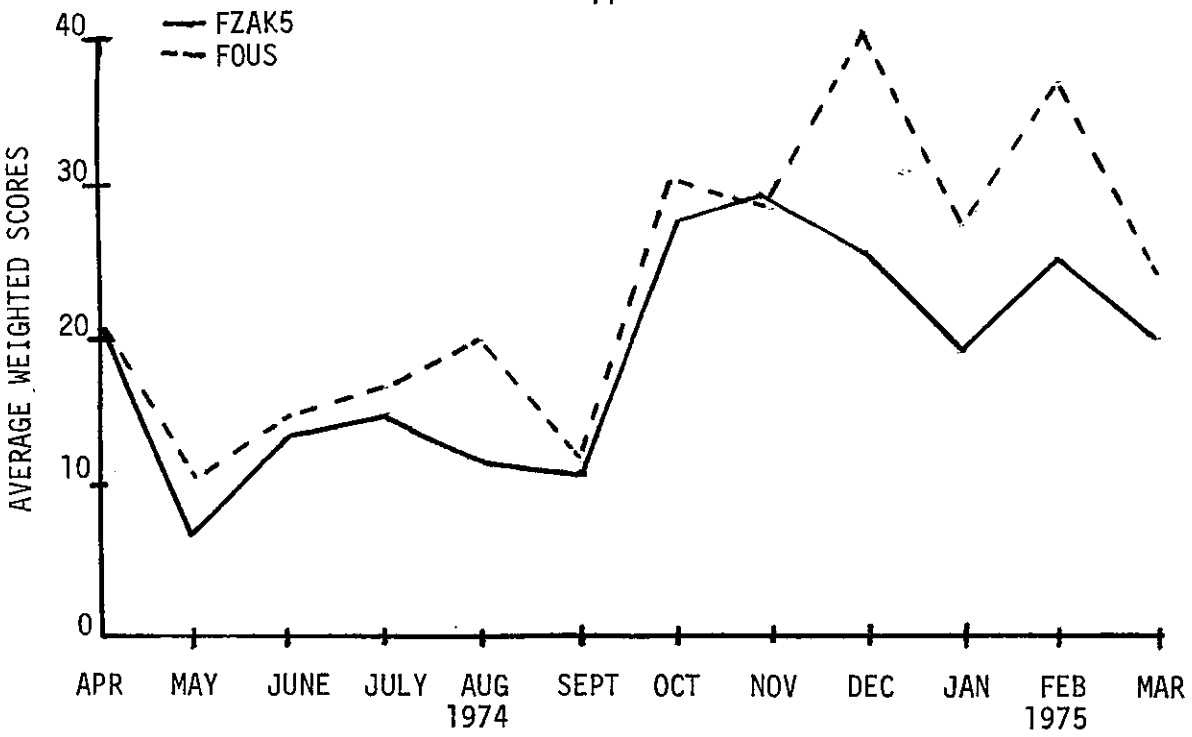


Figure 7. Average weighted scores for Western Alaska (Areas 9 and 10).

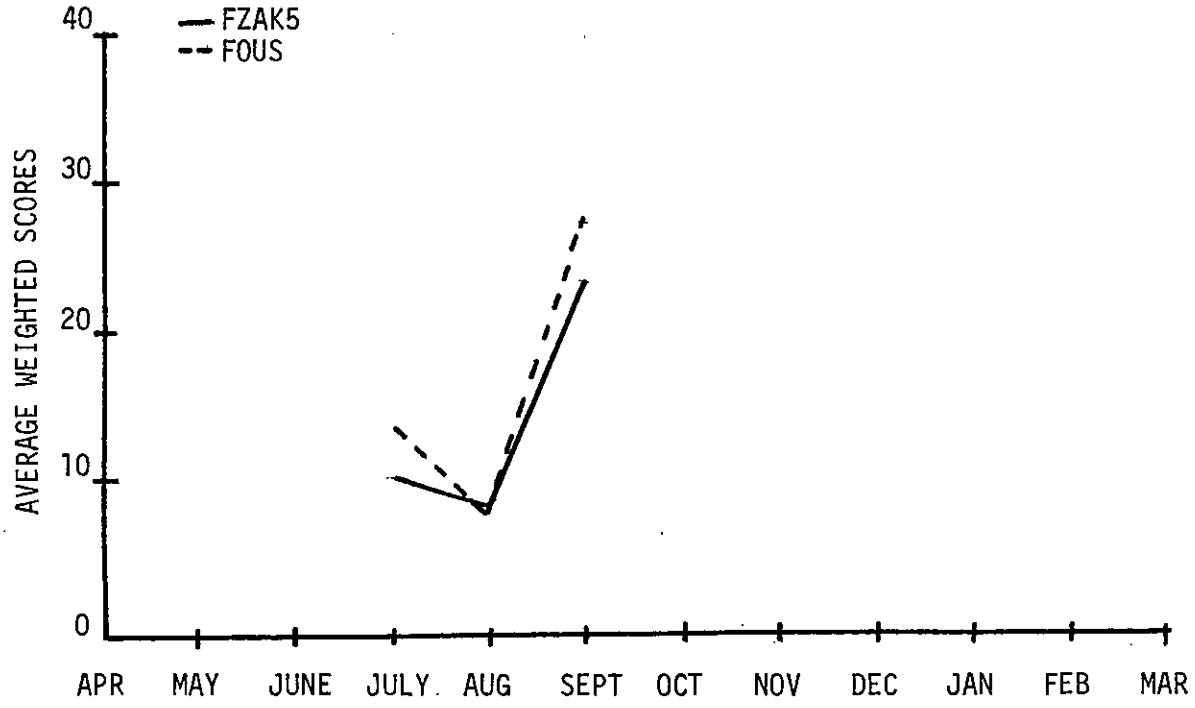


Figure 8. Average weighted scores for Northern Alaska (Area 11).

	CORRECT			UNDERFORECAST			OVERFORECAST		
	1ST	2ND	TOTAL	1ST	2ND	TOTAL	1ST	2ND	TOTAL
APRIL 1974									
FZAK5	68.3	63.3	65.8	24.2	28.3	26.7	7.5	8.3	7.9
FOUS	68.3	65.8	67.1	22.5	21.7	22.1	9.2	12.5	10.8
MAY 1974									
FZAK5	89.5	88.7	89.1	4.8	5.6	5.2	5.6	5.6	5.6
FOUS	84.8	80.4	82.6	10.9	14.1	12.5	4.3	5.4	4.9
JUNE 1974									
FZAK5	83.3	78.3	80.8	10.0	10.8	10.4	6.7	10.8	8.8
FOUS	78.3	78.3	78.3	19.2	17.5	18.3	2.5	4.2	3.3
JULY 1974									
FZAK5	85.4	82.3	83.8	7.8	9.9	8.9	6.8	7.8	7.3
FOUS	84.9	82.8	83.9	11.3	14.0	12.6	3.8	3.2	3.6
AUGUST 1974									
FZAK5	88.2	83.9	86.0	7.0	11.3	9.2	4.8	4.8	4.8
FOUS	73.9	70.9	72.4	23.6	24.2	23.9	5.6	6.1	5.8
SEPTEMBER 1974									
FZAK5	80.3	77.4	78.9	14.8	17.5	16.2	4.8	5.1	4.9
FOUS	73.9	70.9	72.4	23.6	24.2	23.9	2.4	4.8	3.6
OCTOBER 1974									
FZAK5	66.1	62.9	64.5	23.4	30.6	27.0	10.5	6.5	8.5
FOUS	61.7	62.5	62.1	29.2	28.3	28.8	9.2	9.2	9.2
NOVEMBER 1974									
FZAK5	70.8	62.5	66.7	15.8	21.7	18.8	13.3	15.8	14.6
FOUS	61.7	64.0	62.9	28.7	26.3	27.5	9.6	9.6	9.6
DECEMBER 1974									
FZAK5	71.8	65.3	68.5	21.0	20.2	20.6	7.3	14.5	10.9
FOUS	52.5	48.4	50.4	34.7	36.1	35.4	12.7	15.6	14.2
JANUARY 1975									
FZAK5	75.0	67.7	71.4	12.9	21.0	16.9	12.1	11.3	11.7
FOUS	65.2	64.5	64.9	28.6	29.1	28.8	6.3	6.4	6.3
FEBRUARY 1975									
FZAK5	69.6	58.0	63.8	21.4	30.4	25.9	8.9	11.6	10.3
FOUS	63.3	70.8	67.1	42.6	50.7	46.8	6.5	10.7	8.7
MARCH 1975									
FZAK5	71.8	71.8	71.8	15.3	17.7	16.5	12.9	10.5	11.7
FOUS	63.3	70.8	67.1	26.7	21.7	24.2	10.0	7.5	8.8
12 MONTH AVERAGE									
FZAK5	77.8	73.0	75.4	14.2	18.0	16.1	8.0	9.0	8.5
FOUS	70.6	68.7	69.7	22.8	23.7	23.2	6.6	7.6	7.1

TABLE 3. PERCENTAGE OF CORRECT, OVERFORECASTED, AND UNDERFORECASTED FZAK5 AND FOUS FORECASTS.

by the total number of forecasts, the average categorical error is obtained. Table 4 and Figure 12 show underforecasts in all but one month.

Most underforecasts occurred when no warnings or advisories were issued (both FZAK5 and FOUS), meaning verification of small craft (brisk wind) or higher. A general suggestion would be to forecast the higher category in borderline situations. In addition, some underforecasts occurred when warnings were diminished too soon. This has often occurred when strong pressure gradients persisted.

There were some overforecasts. Timing of the warning condition would definitely be a factor. The storm may have already taken place and would nearly be over when the warning was issued. The FOUS nearly always overforecasts in gale or storm situations. The only real suggestion is to try not to wait too long before issuing the warning.

Nearly all FZAK5 forecasts improved the FOUS, but usually not by more than a few points. It was interesting to note that the FOUS fared very poorly from December through February. It was discovered that some errors were introduced into the FOUS computer program at NMC when a newer and faster computer became operational. The errors have since been corrected.

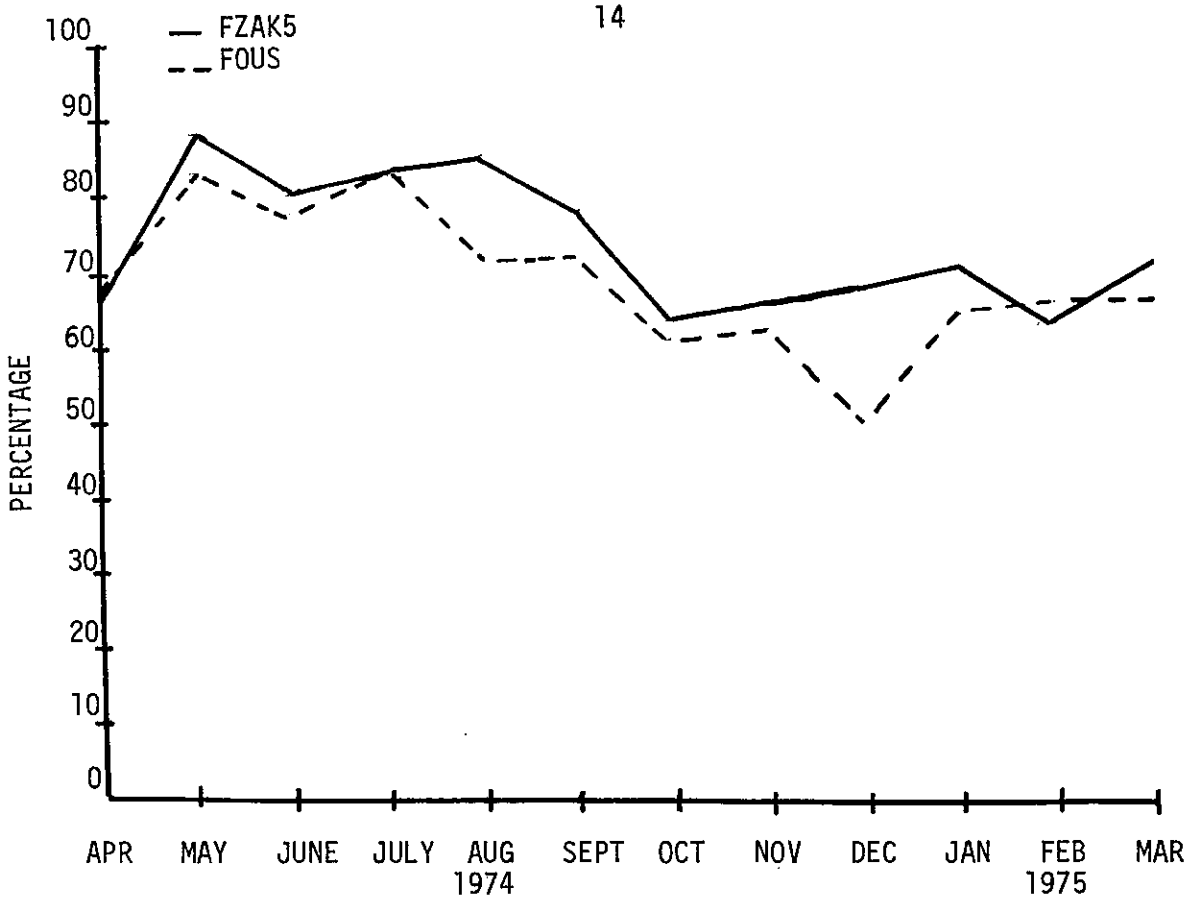


Figure 9. Percentage of correct FZAK5 and FOUS forecasts.

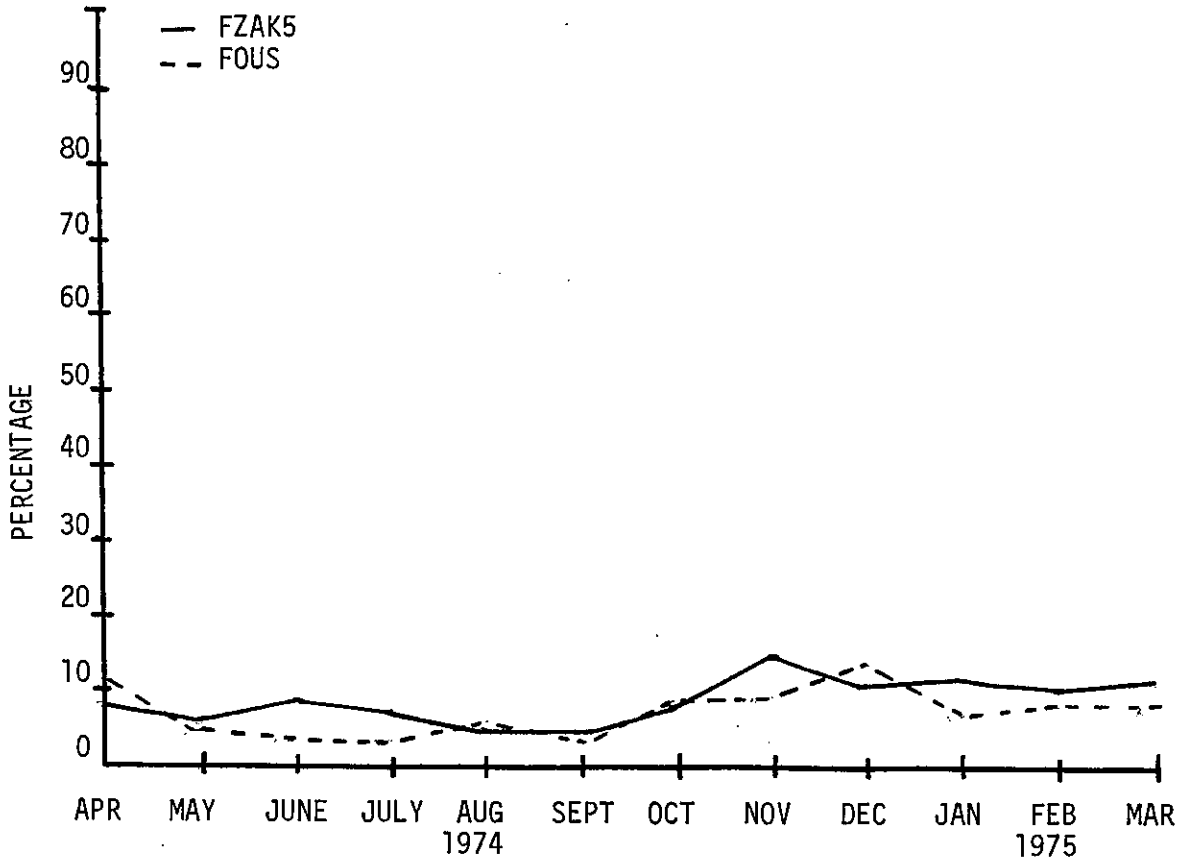


Figure 10. Percentage of overforecasted FZAK5 and FOUS forecasts.

	1ST	2ND	TOTAL	DIFFERENCE
APRIL 1974				
FZAK5	-0.15	-0.20	-0.18	
FOUS	-0.13	-0.08	-0.11	-0.07
MAY 1974				
FZAK5	+0.01	0.00	0.00	
FOUS	-0.07	-0.09	-0.08	+0.08
JUNE 1974				
FZAK5	-0.04	-0.01	-0.03	
FOUS	-0.18	-0.14	-0.16	+0.13
JULY 1974				
FZAK5	-0.01	-0.04	-0.03	
FOUS	-0.10	-0.14	-0.12	+0.09
AUGUST 1974				
FZAK5	-0.02	-0.07	-0.05	
FOUS	-0.05	-0.09	-0.07	+0.02
SEPTEMBER 1974				
FZAK5	-0.12	-0.14	-0.13	
FOUS	-0.21	-0.19	-0.20	+0.07
OCTOBER 1974				
FZAK5	-0.23	-0.28	-0.25	
FOUS	-0.24	-0.23	-0.23	-0.02
NOVEMBER 1974				
FZAK5	-0.03	-0.07	-0.05	
FOUS	-0.21	-0.19	-0.20	+0.15
DECEMBER 1974				
FZAK5	-0.14	-0.06	-0.10	
FOUS	-0.24	-0.18	-0.21	+0.11
JANUARY 1975				
FZAK5	-0.01	-0.10	-0.06	
FOUS	-0.25	-0.25	-0.25	+0.19
FEBRUARY 1975				
FZAK5	-0.13	-0.22	-0.18	
FOUS	-0.38	-0.42	-0.40	+0.22
MARCH 1975				
FZAK5	-0.03	-0.09	-0.06	
FOUS	-0.18	-0.16	-0.17	+0.11
12 MONTH AVERAGE				
FZAK5	-0.07	-0.10	-0.09	
FOUS	-0.18	-0.18	-0.18	+0.09

TABLE 4. AVERAGE CATEGORICAL ERROR IN THE FZAK5 AND FOUS FORECASTS.

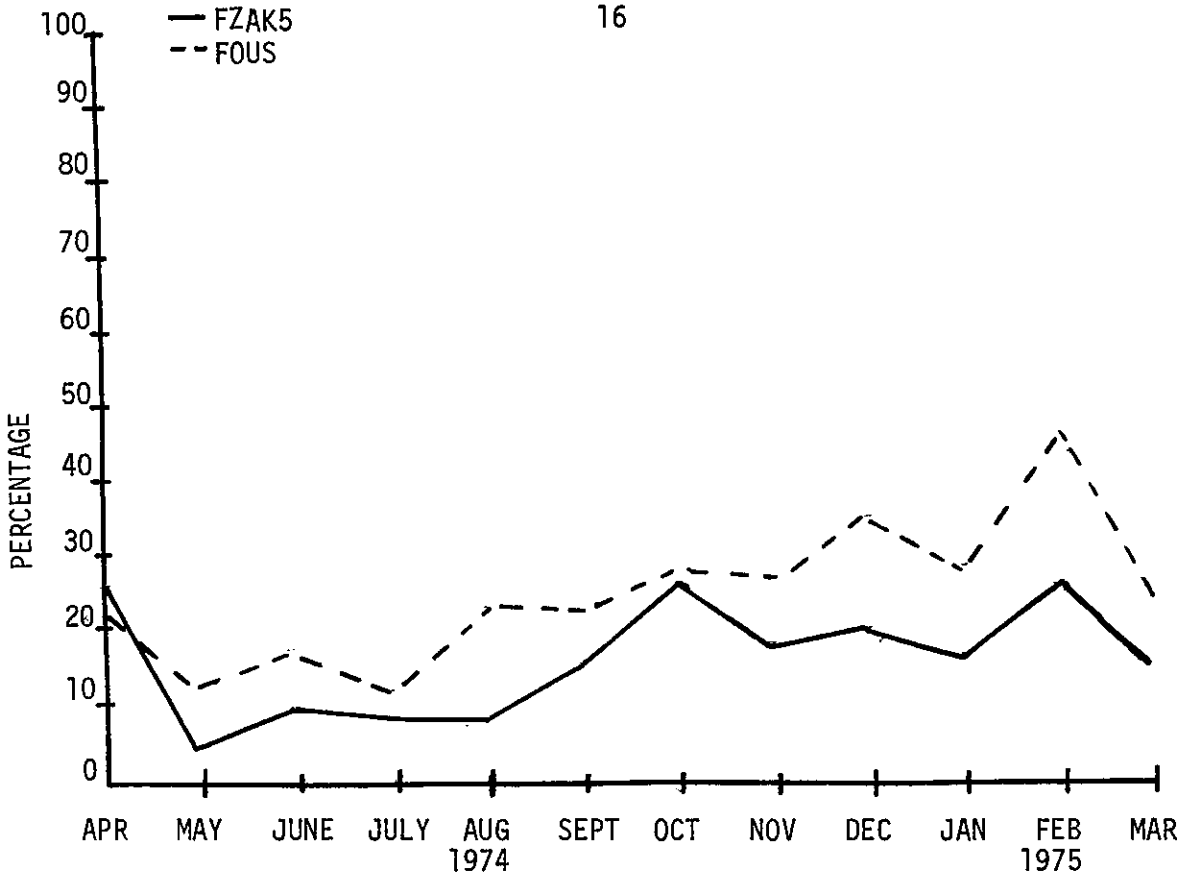


Figure 11. Percentage of underforecasted FZAK5 and FOUS forecasts.

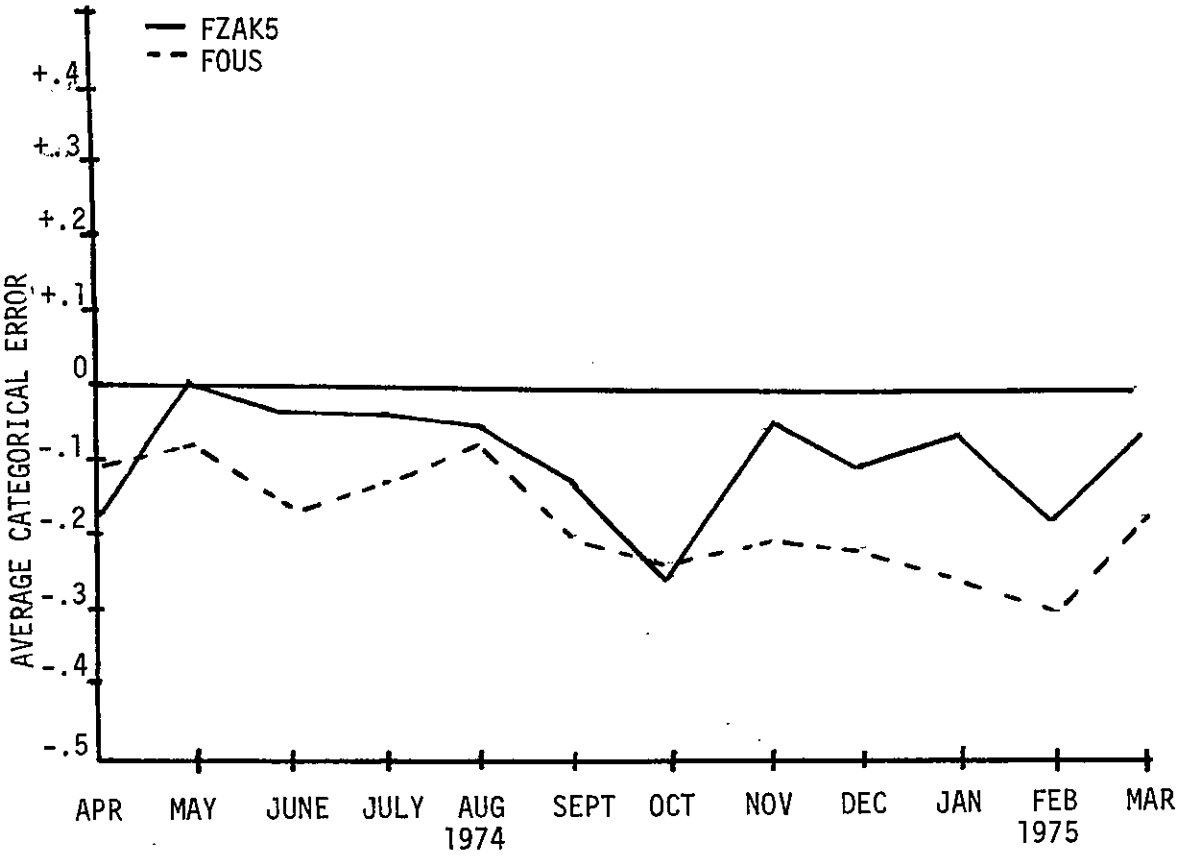


Figure 12. Average categorical error in the FZAK5 and FOUS forecasts.

CONCLUSION

Overall, the marine forecasts during the first year of the Fairbanks WSFO have been excellent. Scores were well below 20 from late spring to early fall and were below 30 the other months with a few exceptions. The FOUS forecasts also did well, except for the problem in the computer program from December through February. This means that the FOUS is an excellent forecast tool. The main problem is in underforecasting, which usually occurs in borderline situations. Overforecasts result probably because of the difficulty in timing the storm's arrival.

APPENDIX

Computer Program for Marine Verification

The program, written by the author, has been in operation for a year. Each month, the data cards are punched and fed into the computer by the Anchorage WSFO, giving results in less than one hour (including the time needed to punch the cards). Before the program became operational, the verification procedure took at least one working day each month.

COMPUTER PROGRAM FOR MARINE VERIFICATION

```
// FOR
*IOCS(CARD,1403 PRINTER,DISK,TYPEWRITER,KEYBOARD,PAPER TAPE)
*ONE WORD INTEGERS
*NAME MVERF
      DIMENSION JFOR1(12,2), JFOR2(12,2), JFUS1(12,2),JVFY(12,4,2),
     1JFUS2(12,2),KBLOK(12,4,4),JBLOK(12,4,4),JBFUS(12,4,4),KBFUS(12,4,4
     2),JDIF(4,4),JERR(12,2),JERFU(12,2),JTOT(4,4,2),KTOT(4,4,2),KTFUS(4
     3,4,2),JTFUS(4,4,2),JTTL(4,2),KTTL(4,2),JTFU(4,2),KTFU(4,2),LTTL(4
     4,2),LTFU(4,2),IL(16),PCT1(4,4,2),PCT2(4,4,2),PCT(4,4,2),ATOT(4,4,2
     5),BTOT(4,4,2),ATTL(4,2),BTTL(4,2),ATFUS(4,4,2),BTFUS(4,4,2)
      DIMENSION ATFU(4,2),BTFU(4,2),LABEL(4,20),MONTH(8),LCAT(4,6),NCAT1
     1(11),NCAT2(11),LCAT1(11),LCAT2(11),ITSN(3,2),LGRND(2),
     2LGRFU(2),ERLM(6),ERNG(2),ERSW(2),EFUG(2),EFUW(2),ERA(2),
     3ERW(2),EFW(2),EFN(2),ERN(2),ERAA(2),EFAA(2),EFA(2),EFLM(6), ERFF(2
     4),EFFF(2),PCTF(4,4,2),PCTF1(4,4,2),PCTF2(4,4,2)
      JREAD=2
      JPRNT=5
      J=12
      READ(JREAD,92) (IL(KLM),KLM=1,16),((JDIF(MO,NO),NO=1,4),MO=1,4),((
     1LCAT(L,M),M=1, 6),L=1,4)
   92 FORMAT(16A1,16I1,4(6A2))
      READ(JREAD,93)((LABEL(L,M),M=1,20),L=1,2)
      READ(JREAD,93)((LABEL(L,M),M=1,20),L=3,4)
   93 FORMAT(40A2)
      READ(JREAD,89)(MONTH(K),K=1,8),NC1,NC2,MC1,MC2,NSTA,((ISTN(L,
     1M),M=1,2),L=1,3)
   89 FORMAT(7A2,A1,2(A2,A1),6X, I1,40X,3(A2,A1))
      READ(JREAD,90)(ERLM(N),N=1,6), (EFLM(N),N=1,6)
   90 FORMAT(12F5.2)
      DO 91 N=1,11
      NCAT1(N)= NC1
      NCAT2(N)= NC2
      LCAT1(N)= MC1
      LCAT2(N)= MC2
   91 CONTINUE
      DO 1 L=1,J
      DO 1 M=1,4
      DO 1 N=1,4
      JBLOK(L,M,N)=0
      KBLOK(L,M,N)=0
      JBFUS(L,M,N)=0
      KBFUS(L,M,N)=0
      JERR(L,1)=0
      JERR(L,2)=0
      JERFU(L,1)=0
      JERFU(L,2)=0
    1 CONTINUE
```

```
      DO 2 L=1,4
      DO 2 M=1,4
      DO 2 N=1,2
      JTOT(L,M,N)=0
      KTOT(L,M,N)=0
      JTFUS(L,M,N)=0
      KTFUS(L,M,N)=0
      JTTL(M,N)=0
      KTTL(M,N)=0
      JTFU(M,N)=0
      KTFU(M,N)=0
      LGRND(N)=0
      LGRFU(N)=0
    2 CONTINUE
      READ(JREAD,3)((JVFY(I,NVFY,1),NVFY=1,4),I=1,J)
    3 FORMAT(8X,48I1)
    4 READ(JREAD,5)((JFOR1(I,NFCST),  JFOR2(I,NFCST),  NFCST=1,2),I=1,J)
      READ(JREAD,5)((JFUS1(I,NFCST),  JFUS2(I,NFCST),  NFCST=1,2),I=1,J)
      READ(JREAD,5)((JVFY(I,NVFY,2),NVFY=1,4),I=1,J)
    5 FORMAT(8X,48I1)
      IF(JFOR1(I,1)-9)122,25,25
  122 DO 10 I=1,J
      JF1=JFOR1(I,1)
      KF1=JFOR2(I,1)
      JF2=JFOR1(I,2)
      KF2=JFOR2(I,2)
      JFU1=JFUS1(I,1)
      JFU2=JFUS1(I,2)
      KFU1=JFUS2(I,1)
      KFU2=JFUS2(I,2)
      IF(JVFY(I,1,1)-JVFY(I,2,1))6,7,7
    6 JV1=JVFY(I,2,1)
      GO TO 8
    7 JV1=JVFY(I,1,1)
    8 IF(JVFY(I,3,1)-JVFY(I,4,1))60,70,70
   60 KV1=JVFY(I,4,1)
      JV2=JVFY(I,4,1)
      GO TO 80
   70 JV2=JVFY(I,3,1)
      KV1=JVFY(I,3,1)
   80 IF(JVFY(I,1,2)-JVFY(I,2,2))81,82,82
   81 KV2=JVFY(I,2,2)
      GO TO 83
   82 KV2=JVFY(I,1,2)
   83 JBLOK(I,JF1+1,JV1+1)=JBLOK(I,JF1+1,JV1+1)+1
      JBLOK(I,JF2+1,JV2+1)=JBLOK(I,JF2+1,JV2+1)+1
      KBLOK(I,KF1+1,KV1+1)=KBLOK(I,KF1+1,KV1+1)+1
      KBLOK(I,KF2+1,KV2+1)=KBLOK(I,KF2+1,KV2+1)+1
      IF(JFU1-8)84,85,85
   84 JBFUS (I,JFU1+1,JV1+1)=JBFUS (I,JFU1+1,JV1+1)+1
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 85 IF(JFU2-8)86,87,87
 86 JBFUS(I,JFU2+1,JV2+1)=JBFUS(I,JFU2+1,JV2+1)+1
 87 IF(KFU1-8)88,94,94
 88 KBFUS(I,KFU1+1,KV1+1)=KBFUS(I,KFU1+1,KV1+1)+1
 94 IF(KFU2-8)95,10,10
 95 KBFUS(I,KFU2+1,KV2+1)=KBFUS(I,KFU2+1,KV2+1)+1
 10 CONTINUE
    DO 16 I=1,J
    DO 16 K=1,4
    JVFY(I,K,1)=JVFY(I,K,2)
 16 CONTINUE
    GO TO 4
 25 DO 30 I=1,J
    DO 30 M=1,4
    DO 30 N=1,4
    JERR(I,1)=JERR(I,1)+JBLOK(I,M,N)*JDIF(M,N)
    JERR(I,2)=JERR(I,2)+KBLOK(I,M,N)*JDIF(M,N)
    JERFU(I,1)=JERFU(I,1)+JBFUS(I,M,N)*JDIF(M,N)
    JERFU(I,2)=JERFU(I,2)+KBFUS(I,M,N)*JDIF(M,N)
 30 CONTINUE
    DO 35 M=1,2
    ERNG(M)=JERR(1,M)+JERR(2,M)+JERR(3,M)
    ERNG(M)=ERNG(M)/3.
    EFUG(M)=JERFU(1,M)+JERFU(2,M)+JERFU(3,M)
    EFUG(M)=EFUG(M)/3.
    ERSW(M)=JERR(4,M)+JERR(5,M)+JERR(6,M)+JERR(7,M)
    ERSW(M)=ERSW(M)/4.
    EFUW(M)=JERFU(4,M)+JERFU(5,M)+JERFU(6,M)+JERFU(7,M)
    EFUW(M)=EFUW(M)/4.
    ERW(M)=JERR(10,M)+JERR(11,M)
    ERW(M)=ERW(M)/2.
    EFW(M)=JERFU(10,M)+JERFU(11,M)
    EFW(M)=EFW(M)/2.
    ERA(M)=JERR(8,M)+JERR(9,M)
    ERA(M)=ERA(M)/2.
    EFA(M)=JERFU(8,M)+JERFU(9,M)
    EFA(M)=EFA(M)/2.
    ERN(M)=JERR(12,M)
    EFN(M)=JERFU(12,M)
    ERAA(M)=(ERNG(M)+ERSW(M)+ERA(M))/3.
    EFAA(M)=(EFUG(M)+EFUW(M)+EFA(M))/3/
    ERFF(M)=(ERW(M)+ERN(M))/2.
    EFFF(M)=(EFW(M)+EFN(M))/2/
 35 CONTINUE
    ERNGG=(ERNG(1)+ERNG(2))/2.
    EFUGG=(EFUG(2)+EFUG(1))/2.
    ERSWW=(ERSW(1)+ERSW(2))/2.
    EFUWW=(EFUW(1)+EFUW(2))/2.
    ERWW=(ERW(1)+ERW(2))/2.
    EFWW=(EFW(1)+EFW(2))/2.
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```
      ERAL=(ERA(1)+ERA(2))/2.
      EFAL=(EFA(1)+EFA(2))/2.
      ERNN=(ERN(1)+ERN(2))/2.
      EFNN=(EFN(1)+EFN(2))/2.
      ERAAA=(ERAA(1)+ERAA(2))/2.
      EFAAA=(EFAA(1)+EFAA(2))/2.
      ERFFF=(ERFF(1)+ERFF(2))/2.
      EFFFF=(EFFF(1)+EFFF(2))/2.
      DO 45 L=1,9
      DO 45 M=1,4
      DO 45 N=1,4
      JTOT(M,N,1)=JTOT(M,N,1)+JBLOK(L,M,N)
      KTOT(M,N,1)=KTOT(M,N,1)+KBLOK(L,M,N)
      JTFUS(M,N,1)=JTFUS(M,N,1)+JBFUS(L,M,N)
      KTFUS(M,N,1)=KTFUS(M,N,1)+KBFUS(L,M,N)
   45 CONTINUE
      IF(NSTA)50,49,49
   49 DO 55 L=10,11
      DO 55 M=1,4
      DO 55 N=1,4
      JTOT(M,N,2)=JTOT(M,N,2)+JBLOK(L,M,N)
      KTOT(M,N,2)=KTOT(M,N,2)+KBLOK(L,M,N)
      JTFUS(M,N,2)=JTFUS(M,N,2)+JBFUS(L,M,N)
      KTFUS(M,N,2)=KTFUS(M,N,2)+KBFUS(L,M,N)
   55 CONTINUE
      GO TO 61
   50 DO 56 L=10,12
      DO 56 M=1,4
      DO 56 N=1,4
      JTOT(M,N,2)=JTOT(M,N,2)+JBLOK(L,M,N)
      KTOT(M,N,2)=KTOT(M,N,2)+KBLOK(L,M,N)
      JTFUS(M,N,2)=JTFUS(M,N,2)+JBFUS(L,M,N)
      KTFUS(M,N,2)=KTFUS(M,N,2)+KBFUS(L,M,N)
   56 CONTINUE
   61 DO 46 L=1,4
      DO 46 M=1,4
      DO 46 N=1,2
      JTTL(L,N)=JTTL(L,N)+JTOT(L,M,N)
      KTTL(L,N)=KTTL(L,N)+KTOT(L,M,N)
      JTFU(L,N)=JTFU(L,N)+JTFUS(L,M,N)
      KTFU(L,N)=KTFU(L,N)+KTFUS(L,M,N)
   46 CONTINUE
      DO 47 N=1,4
      DO 47 M=1,2
      LGRND(M)=LGRND(M)+JTTL(N,M)+KTTL(N,M)
      LGRFU(M)=LGRFU(M)+JTFU(N,M)+KTFU(N,M)
   47 CONTINUE
      DO 48 L=1,4
      DO 48 M=1,4
      DO 48 N=1,2
```

```
      ATOT(L,M,N)=JTOT(L,M,N)
      BTOT(L,M,N)=KTOT(L,M,N)
      ATTL(L,N)=JTTL(L,N)
      BTTL(L,N)=KTTL(L,N)
      ATFUS(L,M,N)=JTFUS(L,M,N)
      BTFUS(L,M,N)=KTFUS(L,M,N)
      ATFU(L,N)=JTFU(L,N)
      BTFU(L,N)=KTFU(L,N)
      PCT1(L,M,N)=(100.)*(ATOT(L,M,N)/ATTL(L,N))
      PCT2(L,M,N)=(100.)*(BTOT(L,M,N)/BTTL(L,N))
      PCT(L,M,N)=(100.)*((ATOT(L,M,N)+BTOT(L,M,N))/(ATTL(L,N)+BTTL(L,N))
     1)
      PCTF1(L,M,N)=(100.)*(ATFUS(L,M,N)/ATFU(L,N))
      PCTF2(L,M,N)=(100.)*(BTFUS(L,M,N)/BTFU(L,N))
      PCTF(L,M,N)=(100.)*((ATFUS(L,M,N)+BTFUS(L,M,N))/(ATFU(L,N)+BTFU(L,
     1N)))
   48 CONTINUE
      JJJ=0
      LLL=1
      GO TO 196
  195 WRITE(JPRNT,998)(ISTN(LLL+1,L),L=1,2), (MONTH(K),K=1,8),LGRFU(LLL)
  998 FORMAT('1',16X,A2,A1,' FOUS VERIFICATION FOR ',7A2,A1,'  TOTAL FOR
     1ECASTS TO BE VERIFIED=' ,I4/)
      GO TO 197
  196 WRITE(JPRNT,999)(ISTN(LLL+1,L),L=1,2), (MONTH(K),K=1,8),LGRND(LLL)
  999 FORMAT('1',11X,A2,A1,' MARINE FORECAST VERIFICATION FOR ',7A2,A1,'
     1 TOTAL FORECASTS TO BE VERIFIED= ',I4/)
  197 JJ=1
      MM=1
      IF(LLL-1)199,199,499
  199 DO 200 M=1,4
      DO 200 K=1,4
      IF(K-1)202,201,202
  201 WRITE(JPRNT,205)(LABEL(JJ,L),L=1,20)
  205 FORMAT(16X,' THE FOLLOWING WERE FORECASTS WITH ',20A2)
      WRITE(JPRNT,206)JTTL(JJ,LLL),KTTL(JJ,LLL),LTTL(JJ,LLL)
  206 FORMAT(16X,' THE TOTAL NUMBER OF FORECASTS ARE ',I4,'(1ST PERIOD)
     1PLUS ',I4,'(2ND PERIOD)= ',I4/)
      WRITE(JPRNT,1000)
 1000 FORMAT(4X,' AREA 2       3       4      5+6B     6A      7       8
     1       12     13     TOTAL    PERCENT   TOTAL')
      WRITE(JPRNT,1001)
 1001 FORMAT(80X,'FCSTS     FCSTS     ALL')
      WRITE(JPRNT,1002)(NCAT1(N),NCAT2(N),LCAT1(N),LCAT2(N),N=1,11)
 1002 FORMAT(7X,20(A2,A1,1X),1X,A2,A1,3X,A2,A1)
      JJ=JJ+1
  202 WRITE(JPRNT,1003)IL(MM),(JBLOK(I,M,K),KBLOK(I,M,K),I=1,9), JTOT(M,
     1K,LLL),KTOT(M,K,LLL),PCT1(M,K,LLL),PCT2(M,K,LLL),PCT(M,K,LLL)
 1003 FORMAT(5X,A1,1X,I3,19I4,3F6.2)
      MM=MM+1
  200 CONTINUE
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      WRITE(JPRNT,1004)((JERR(I,L),L=1,2),I=1,9)
 1004 FORMAT(6X,18I4,' AVG WEIGHTED SCORE')
      WRITE(JPRNT,1005)(ERNG(L),L=1,2),(ERSW(L),L=1,2),(ERA(L),L=1,2),
     1(ERAA(L),L=1,2)
 1005 FORMAT(7X,2(2F6.2,12X),8X,  2F6.2,4X, '1ST ',F6.2,' 2ND ',F6.2)
      WRITE(JPRNT,1006)ERNGG,ERSWW,ERAL,ERAAA
 1006 FORMAT(7X,2(F6.2,18X),8X,  F6.2,10X, 'MONTH AVG ',F6.2)
  210 WRITE(JPRNT,1007)(MONTH(K),K=1,8)
 1007 FORMAT('1',7A2,A1/)
      WRITE(JPRNT,1008)
 1008 FORMAT(/42X,'TABLE OF BASIC SCORES'/)
      WRITE(JPRNT,1009)
 1009 FORMAT(48X,'OBSERVED'/)
      WRITE(JPRNT,1010)
 1010 FORMAT(19X,'TOTAL')
      WRITE(JPRNT,1011)((LCAT(L,K),K=1,6),L=1,4)
 1011 FORMAT(20X,'ALL',12X,2(6A2,5X),2(8X,6A2))
      WRITE(JPRNT,1012)
 1012 FORMAT(' FORECAST          1ST 2ND     1ST   2ND  TOTAL     1ST   2
     1ND TOTAL     1ST   2ND  TOTAL     1ST   2ND TOTAL')
      DO 701 L=1,4
      WRITE(JPRNT,1013)(LCAT(L,K),K=1,6), JTTL(L,LLL),KTTL(L,LLL),(PCT1(
     1L,M,LLL),PCT2(L,M,LLL),PCT(L,M,LLL),M=1,4)
 1013 FORMAT(1X,6A2,4X,2I4,2(3X,3F6.2),2(2X,3F6.2))
  701 CONTINUE
      WRITE(JPRNT,1014)
 1014 FORMAT(/42X,'TABLE OF WEIGHTED SCORES'/)
      IF(LLL-1)915,915,211
  211 IF(NSTA)1915,1915,2415
  915 WRITE(JPRNT,1515)
 1515 FORMAT(30X,'N GULF COAST       SOUTHWEST ALASKA        ALEUTIANS')
      WRITE(JPRNT,1516)
 1516 FORMAT(28X,'1ST   2ND  TOTAL     1ST   2ND  TOTAL     1ST   2ND  T
     1OTAL')
      WRITE(JPRNT,1517)(ERNG(L),L=1,2),ERNGG,(ERSW(L),L=1,2),ERSWW,
     1(ERA(L),L=1,2),ERAL
 1517 FORMAT(13X,' AVERAGES ',3X,3(3F6.2,3X)/)
      WRITE(JPRNT,1518)(ERAA(L),L=1,2),ERAAA
 1518 FORMAT(13X,' AVERAGE WEIGHTED SCORES       1ST PERIOD',F6.2,'
     1 2ND PERIOD',F6.2,'      MONTH',F6.2)
      WRITE(JPRNT,1519)(ERLM(L),L=1,3)
 1519 FORMAT(13X,' COMPARE LAST MONTH',22X,F6.2,16X,F6.2,11X,F6.2)
      LLL=LLL+1
      IF(JJJ)196,196,195
  499 IF(NSTA-1)495,599,599
  495 DO 500 M=1,4
      DO 500 K=1,4
      IF(K-1)502,501,502
  501 WRITE(JPRNT,505)(LABEL(JJ,L),L=1,20)
  505 FORMAT(16X,' THE FOLLOWING WERE FORECASTS WITH ',20A2)
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      WRITE(JPRNT,506)JTTL(JJ,LLL),KTTL(JJ,LLL),LTTL(JJ,LLL)
  506 FORMAT(16X,' THE TOTAL NUMBER OF FORECASTS ARE ',I4,'(1ST PERIOD)
     1PLUS ',I4,'(2ND PERIOD)= ',I4/)
      WRITE(JPRNT,2500)
 2500 FORMAT(32X,' AREA  9      10     11     TOTAL    PERCENT   TOTAL')
      WRITE(JPRNT,2501)
 2501 FORMAT(60X,'FCSTS     FCSTS     ALL')
      WRITE(JPRNT,2502)(NCAT1(N),NCAT2(N),LCAT1(N),LCAT2(N),N=1,5)
 2502 FORMAT(35X,8(Aw,A1,1X),A2,A1,3X,A2,A1)
      JJ=JJ+1
  502 WRITE(JPRNT,2503)IL(MM),(JBLOK(I,M,K),KBLOK(I,M,K),I=10,12),JTOT(M,
     1K,LLL),KTOT(M,K,LLL),PCT1(M,K,LLL),PCT2(M,K,LLL),PCT(M,K,LLL)
 2503 FORMAT(33X,A1,1X,I3,7I4,3F6.2)
      MM=MM+1
  500 CONTINUE
      WRITE(JPRNT,2504)((JERR(I,L),L=1,2),I=10,12)
 2504 FORMAT(34X,6I4,8X,' AVG WEIGHTED SCORE')
      WRITE(JPRNT,2505)(ERW(L),L=1,2),ERN(L),L=1,2),(ERFF(L),L=1,2)
 2505 FORMAT(35X,2(2F5.1,6X),'1ST ',F6.2,' 2ND ',F6.2)
      WRITE(JPRNT,2506)ERWW,ERNN,ERFFF
 2506 FORMAT(35X,'(2F6.2,10X),'MONTH AVG ',F6.2)
      GO TO 210
 1915 WRITE(JPRNT,2515)
 2515 FORMAT(36X,'WESTERN ALASKA      NORTHERN ALASKA')
      WRITE(JPRNT,2516)
 2516 FORMAT(34X,' 1ST   2ND  TOTAL     1ST   2ND  TOTAL')
      WRITE(JPRNT,2517)(ERW(L),L=1,2),ERWW,(ERN(L),L=1,2),ERNN
 2517 FORMAT(16X,'AVERAGES ',5X,2(3X,3F6.2)/)
      WRITE(JPRNT,2518)(ERFF(L),L=1,2),ERFFF
 2518 FORMAT(22X,' AVERAGE WEIGHTED SCORES      1ST PERIOD',F6.2,'
     12ND PERIOD',F6.2,'    MONTH',F6.2)
      WRITE(JPRNT,2519)(ERLM(L),L=4,6)
 2519 FORMAT(22X,' COMPARE LAST MONTH',21X,F6.2,16X,F6.2,9X,F6.2)
      IF(JJJ)800,800,900
  599 DO 600 M=1,4
      DO 600 K=1,4
      IF(K-1)602,601,602
  601 WRITE(JPRNT,605)(LABEL(JJ,L),L=1,20)
  605 FORMAT(16X,' THE FOLLOWING WERE FORECASTS WITH ',20A2)
      WRITE(JPRNT,606)JTTL(JJ,LLL),KTTL(JJ,LLL),LTTL(JJ,LLL)
  606 FORMAT(16X,' THE TOTAL NUMBER OF FORECASTS ARE ',I4,'(1ST PERIOD)
     1PLUS ',I4,'(2ND PERIOD)= ',I4/)
      WRITE(JPRNT,3000)
 3000 FORMAT(36X,' AREA 9      10     TOTAL    PERCENT   TOTAL')
      WRITE(JPRNT,3001)
 3001 FORMAT(56X,'FCSTS     FCSTS     ALL')
      WRITE(JPRNT,3002)(NCAT1(N),NCAT2(N),LCAT1(N),LCAT2(N),N=1,4)
 3002 FORMAT(39X,6(A2,A1,1X),1X,A2,A1,3X,A2,A1)
      JJ=JJ+1
```

```
 602 WRITE(JPRNT,3003)IL(MM),(JBLOK(I,M,K),KBLOK(I,M,K),I=10,11),JTOT(M
    1,K,LLL),KTOT(M,K,LLL),PCT1(M,K,LLL),PCT2(M,K,LLL),PCT(M,K,LLL)
3003 FORMAT(37X,A1,1X,I3,5I4,3F6.2)
     MM=MM+1
 600 CONTINUE
     WRITE(JPRNT,3004)((JERR(I,L),L=1,2),I=10,11)
3004 FORMAT(38X,4I4,' AVG WEIGHTED SCORE')
     WRITE(JPRNT,3005)(ERW(L),L=1,2)
3005 FORMAT(54X,' 1ST ',F6.2,' 2ND ',F6.2)
     WRITE(JPRNT,3006)ERWW
3006 FORMAT(55X,'MONTH AVG ',F6.2)
     GO TO 210
2415 WRITE(JPRNT,3015)
3015 FORMAT(47X,'WESTERN ALASKA')
     WRITE(JPRNT,3016)
3016 FORMAT(45X,' 1ST   2ND  TOTAL')
     WRITE(JPRNT,3017)(ERW(L),L=1,2),ERWW
3017 FORMAT(26X,'AVERAGES ',9X,3F6.2)
     WRITE(JPRNT,3019)(ERLM(L),L=4,6)
3019 FORMAT(26X,'COMPARE LAST MONTH',3F6.2)
     IF(JJJ)800,800,900
 800 DO 810 L=1,J
     DO 810 M=1,4
     DO 810 N=1,4
     JBLOK(L,M,N)=JBFUS(L,M,N)
     KBLOK(L,M,N)=KBFUS(L,M,N)
     JERR(L,1)=JERFU(L,1)
     JERR(L,2)=JERFU(L,2)
 810 CONTINUE
     DO 801 L=1,4
     DO 801 M=1,4
     DO 801 N=1,2
     JTOT(L,M,N)=JTFUS(L,M,N)
     KTOT(L,M,N)=KTFUS(L,M,N)
     PCT1(L,M,N)=PCTF1(L,M,N)
     PCT2(L,M,N)=PCTF2(L,M,N)
     PCT(L,M,N)=PCTF(L,M,N)
     JTTL(L,N)=JTFU(L,N)
     KTTL(L,N)=KTFU(L,N)
     LTTL(L,N)=LTFU(L,N)
 801 CONTINUE
     DO 802 L=1,2
     ERNG(L)=EFUG(L)
     ERSW(L)=EFUW(L)
     ERW(L)=EFW(L)
     ERA(L)=EFA(L)
     ERN(L)=EFN(L)
     ERAA(L)=EFAA(L)
     ERFF(L)=EFFF(L)
```

```
802 CONTINUE
    DO 803 M=1,6
    ERLM(M)=EFLM(M)
803 CONTINUE
    ERFFF=EFFFF
    ERNGG=EFUGG
    ERWW=EFWW
    ERNN=EFNN
    ERAAA=EFAAA
    ERSWW=EFUWW
    ERAL=EFAL
    JJJ=1
    LLL=1
    GO TO 195
900 CALL EXIT
    END
```