U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL WEATHER SERVICE
NATIONAL METEOROLOGICAL CENTER

OFFICE NOTE 271

Skill of Medium Range Forecast Group

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This is an unreviewed manuscript, primarily intended for informal exchange of information among NMC staff members.

PURPOSE

This paper depicts in a graphical manner the skill of the Medium Range (3-10 day) Forecast Group (MRFG) man and machine (numerical model guidance) forecasts. It will be updated each February in order to present the latest scores for each of the several forecast categories in the MRFG. Only scores with at least a 5-year period of record will be presented. Hence, this paper contains the standardized and unstandardized mean sea level pressure and 500-mb correlation; the Gilman, Hughes, and experimental precipitation; the minimum/maximum absolute temperature error; and the mean temperature and precipitation scores. Subsequent updates to this note will also include the mean 500-mb correlation and Brier precipitation scores.

Numerical Model Guidance (Past to Present)

1. Acronyms

   a. Baro - Reed Barotropic Advection Model Hemispheric

   b. 6L PE - 6-layer Primitive Equation Model Hemispheric

   c. CM - Course Mesh 380km

   d. FM - Fine Mesh 190km

   e. SMH2C - Spectral Model Hemispheric
      24 modes 12-layers

   f. SMG3C - Spectral Model Global 30 modes 12-layers

   g. SMG26 - Spectral Model Global 24 modes 6-layers

2. 00Z Guidance

   a. To 84-hours

      (1) From 1970 through 1977: 6L PE CM

      (2) From 1978 through 1979: 7L PE FM

      (3) From January 1980 to August 15, 1980: 7L PE FM to 60-hours then 7L PE CM with Fourth Order Differencing to 84-hours.

      (4) From August 15, 1980, to April 15, 1981: SMG3C to 48-hours then SMH2C to 84-hours.

      (5) From April 15, 1981, through December 1982: SMG3C to 48-hours then SMG2C to 84-hours.

   b. Greater than 84-hours to 144-hours

      (1) From 1970 through 1979: Baro (Mesh 1977-1979)

      (2) From January 1980 to August 15, 1980: 7L PE CM with Fourth Order Differencing.

      (3) From August 15, 1980, to April 15, 1981: SMH2C

      (4) From April 15, 1981, through April 1982: SMG26

      (5) From May 1982 through December 1982: SMG2C

c. Greater than 144-hours to 252 hours

(1) From November 1977 through April 1981: Baro Mesh

(2) From December 1977 through December 1981: 3L PE CM

(3) From January 1981 through December 1982: SMG26 to 192 hours then SMH26 to 240 hours.

3. 12Z Guidance

a. To 60-hours

(1) From 1970 through 1977: 6L PE CM

b. Greater than 60-hours to 96-hours (500mb only):

(1) From 1970 through 1977: Baro (Mesh in 1977)

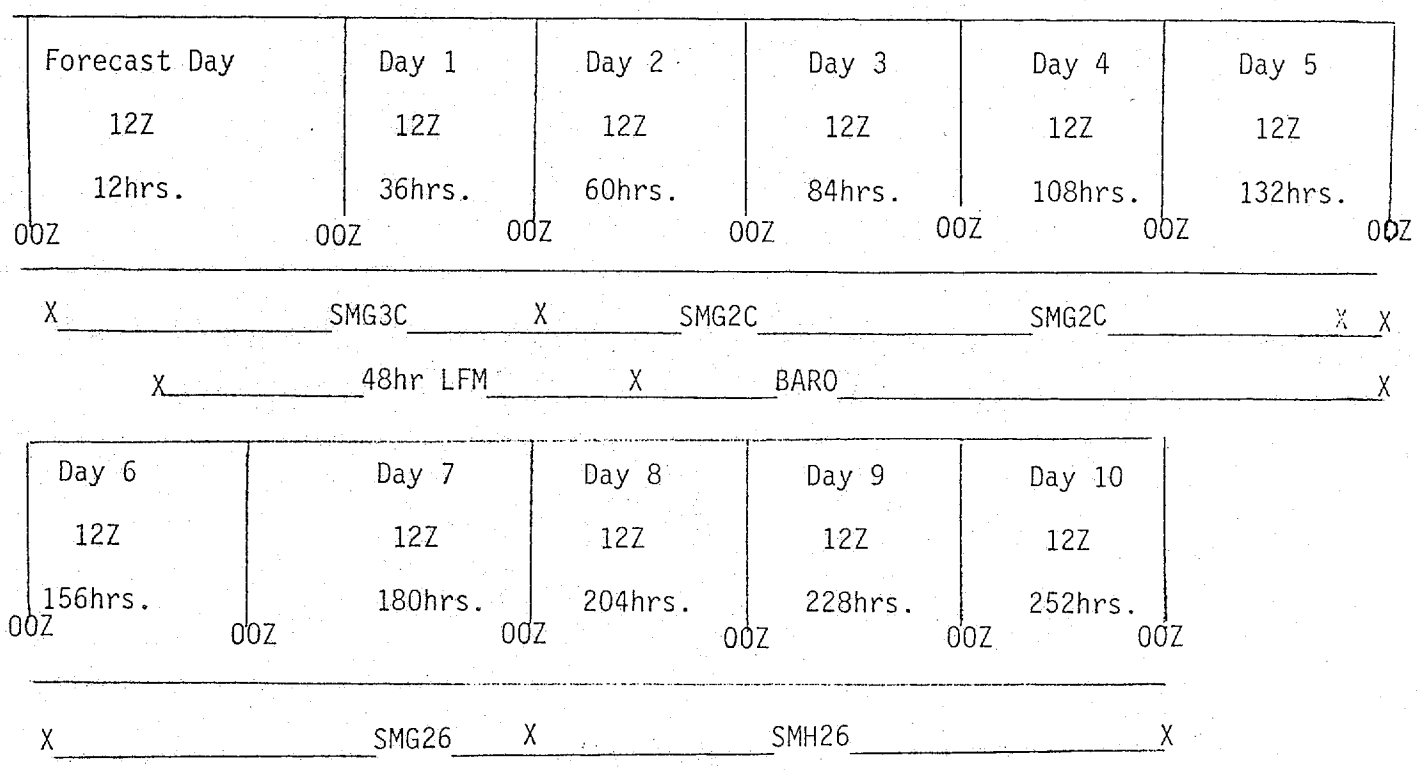
c. To 48 hours

(1) From October 1971 through August 1977: 7L PE FM (old LFM)

(2) From September 1977 through 1982: 7L PE LFM (127km)

d. Greater than 48-hours to 120 hours (500mb only)

(1) From 1978 through 1982: Baro run from the 48-hour LFM inserted into the 60-hour SMG2C from 00Z.



Figures

Figure 1 depicts the North American (130 grid points) and the United States (86 grid points) mean sea level pressure correlation verification areas.

Figures 2 through 4 are plots of the North American calendar year 1982 and 15 year average (1968 through 1982) monthly mean standardized mean sea level pressure correlation scores for the man forecasts verifying on days 3, 4, and 5 after forecast day. (See Appendix A for an explanation of this score).

Figures 5 through 7 are similar to Figures 2 through 4 except that the forecasts are machine made and are for a 13 year average (1970 through 1982).

Figures 8 through 10 are similar to Figures 2 through 4 except the average is for the 7 years (1976 through 1982) and the area is the United States.

Figures 11 through 13 are similar to Figures 8 through 10 except that the forecasts are machine made.

Figures 14 through 16 are plots of the North American calendar year 1982 and 6 year (1977 through 1982) monthly mean unstandardized mean sea level pressure correlation scores for the man forecasts verifying on days 3, 4, and 5 after forecast day. (See Appendix A for an explanation of this score).

Figures 17 through 19 are similar to Figures 14 through 16 except that the forecasts are machine made.

Figures 20 through 22 are similar to Figures 14 through 16 except that the area is the United States.

Figures 23 through 25 are similar to Figures 20 through 22 except that the forecasts are machine made.

Figures 26 through 49 are plots of the (North America + United States) ÷ 2 monthly mean (unstandardized + standardized) ÷ 2 mean sea level pressure and standardized 500 MB correlation scores verifying on days 1 through 7 after forecast day.

Figures 50 through 53 are plots of the man and machine (North America + United States) ÷ 2 seasonal mean sea level pressure correlation scores (standardized + unstandardized) ÷ 2 for the man and machine for the years 1977 through 1982.

Figure 54 is a plot of the 1968 (1970) through 1982 seasonal year average man and machine North America mean sea level pressure standardized correlation scores verifying on days 3, 4, and 5 after forecast day.

Figure 55 is a plot of the 1968 (1970) through 1982 calendar year average man and machine North America mean sea level pressure standardized correlation scores verifying on days (3+4+5) ÷ 3 after forecast day.

Figure 56 is a plot of the 1979 through 1982 calendar year average machine North America standardized correlation scores verifying on days (3+4+5) ÷ 3 after forecast day.

Figure 57 through 60 are average machine mean sea level pressure errors over North America and vicinity for January, April, July and October respectively.

Figures 61 through 64 are average machine 500 MB errors over North America and vicinity for January, April, July and October respectively.

Figures 65 and 66 are plots of the Western and Eastern North America monthly mean 500 MB S1 scores for the Barotropic and Spectral models for 1982.

Figure 67 depicts the 100 stations in the United States where the precipitation forecasts are verified.

Figure 68 is an example of a day 3, 4, or 5 precipitation forecast. The dashed lines are the 24-hour departure from normal probability of precipitation (DN POP) forecast for January 3. The solid lines are the 24-hour climatological (normal) probability of precipitation (NPOP) for the first 15 days of January. A total of (DN POP + NPOP) $\geq$ 30 is considered "yes" forecast of precipitation ($\geq$ .01 inch). All stations with an (NPOP)$\geq$ 30 are considered as a yes climatological forecast of precipitation.

Figures 69 through 71 are plots of the calendar year 1982 and 13-year average monthly mean Gilman precipitation skill scores for the man forecasts verifying on days 3, 4, and 5 after forecast day. See Appendix B for an explanation of this score.

Figures 72 through 74 are plots of the calendar year 1982 and 6-year average monthly mean Hughes precipitation skill scores for the man forecasts verifying on days 3, 4, and 5 after forecast day. See Apppendix C for an explanation of this score.

Figures 75 through 77 are plots of the 1970 (1978) through 1982 calendar year average man and climatology precipitation skill scores verifying on days (3+4+5) $\div$ after forecast day for the Gilman, Hughes, and Experimental (see Appendix D for an explanation of this score) scores.

Figure 78 depicts the 41 stations in the United States where the temperature forecasts are verified.

Figures 79 through 81 and 82 through 84 are plots of the 41 station calendar year 1982 and 11 year average (1972 through 1982) monthly mean absolute error minimum and maximum temperature scores for the man forecasts verifying on days 3, 4, and 5 after forecast day.

Figures 85 through 90 are similar to figures 79 through 84 except that the forecasts are machine (Klein Lewis (KL)) made.

Figure 91 is a plot of the 1972 through 1982 calendar year average man and KL United States (minimum + maximum) ÷ 2 temperature absolute error scores verifying on days 3, 4, and 5 after forecast day.

Figure 92 is similar to figure 91 except that the temperature forecasts verify on days (3+4+5) ÷ 3 after forecast day.

Figure 93 is an example of the 5 day mean precipitation categories for the 100 stations (figure 67) where the forecasts are verified.

Figure 94 is a plot of the calendar years 1978 through 1982 6 to 10 day mean 3 class precipitation skill scores. See appendix E for an explanation of this score.

Figure 95 is a plot of the calendar years 1978 through 1982 6 to 10 day mean 5 class temperature skill scores. See Appendix F for an explanation of this score and figure 78 for the 61 stations where the forecasts are verified.

SECTION 1

Man & Machine (NWP Guidance)

Days 3, 4, and 5 Mean Sea Level

Pressure Correlation Scores

(1982 Monthly Mean Vs. Long Term Mean)

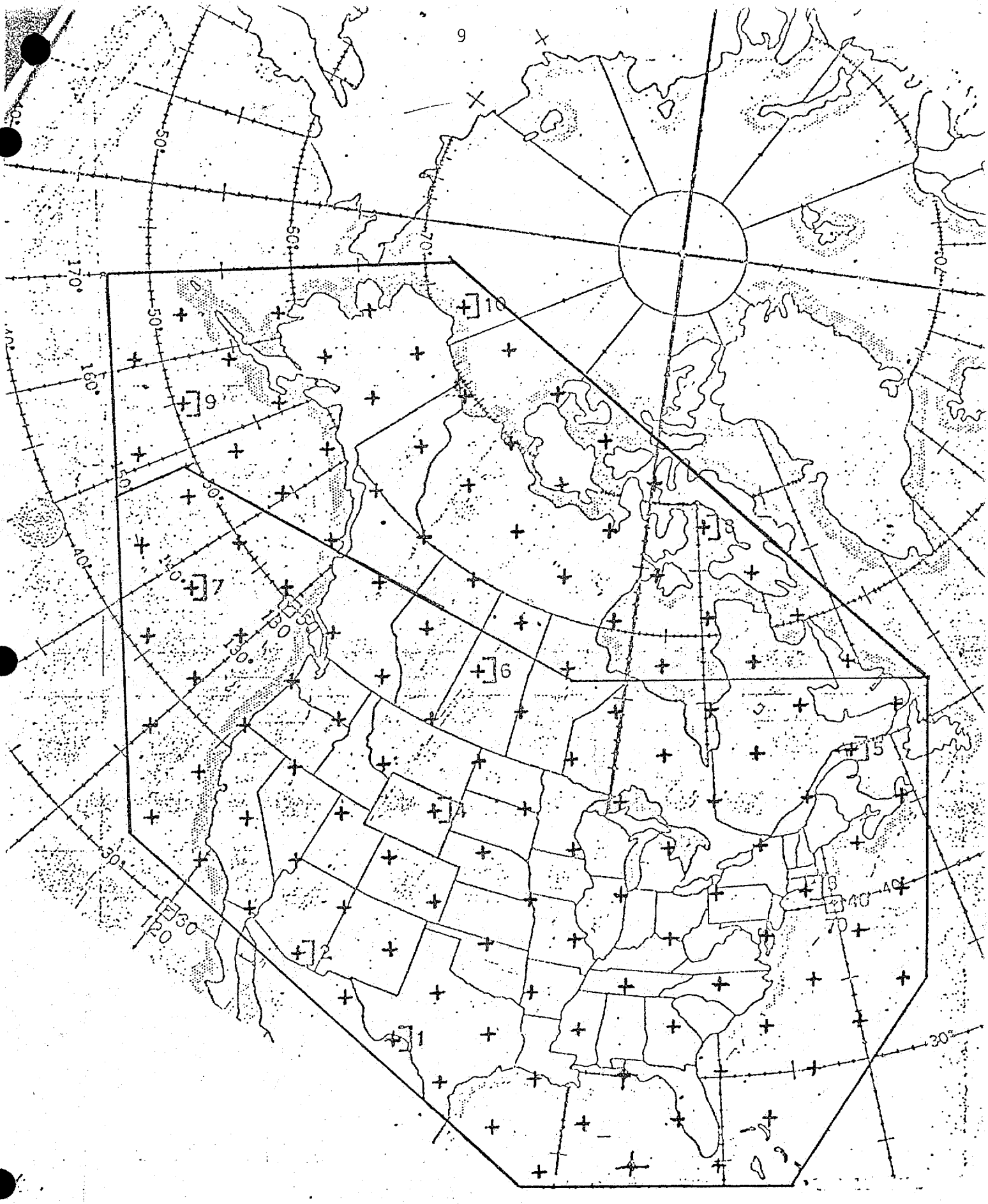
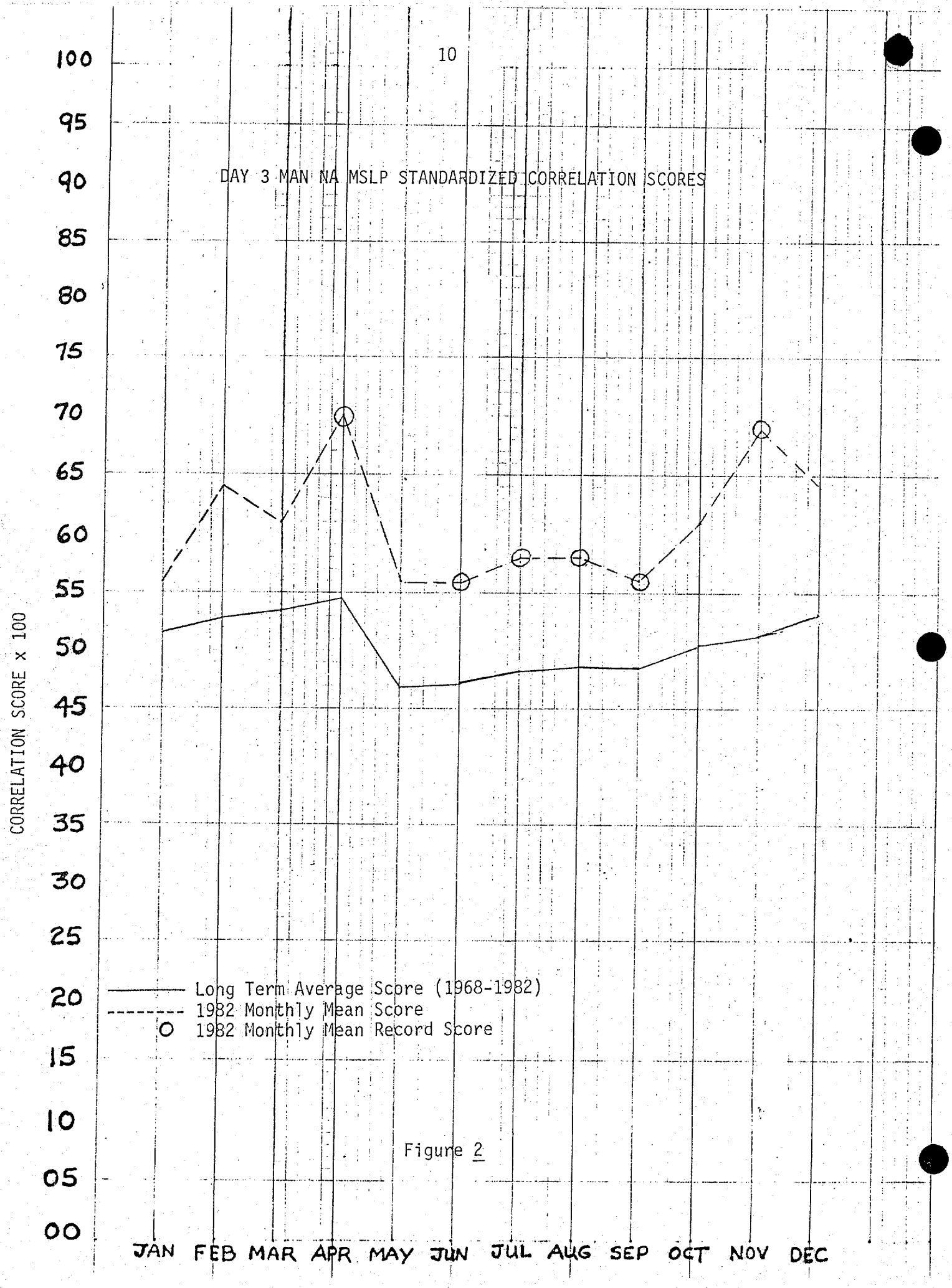


Figure 1


DAY 3 MAN NA MSLP STANDARDIZED CORRELATION SCORES
CORRELATION SCORE x 100
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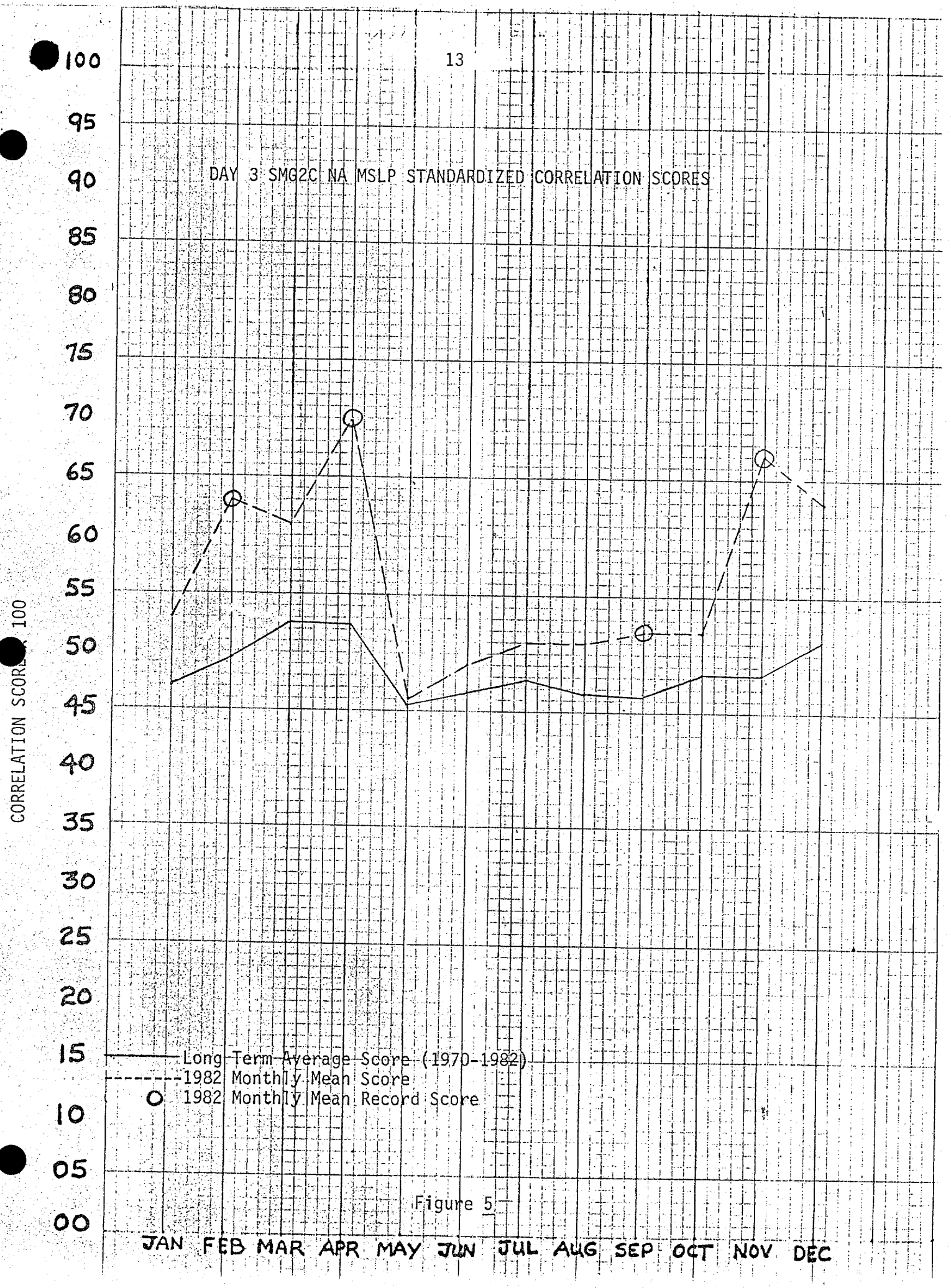
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
Long Term Average Score (1968-1982)
1982 Monthly Mean Score
1982 Monthly Mean Record Score

Figure 2


DAY 3 SMG2C NA MSLP STANDARDIZED CORRELATION SCORES
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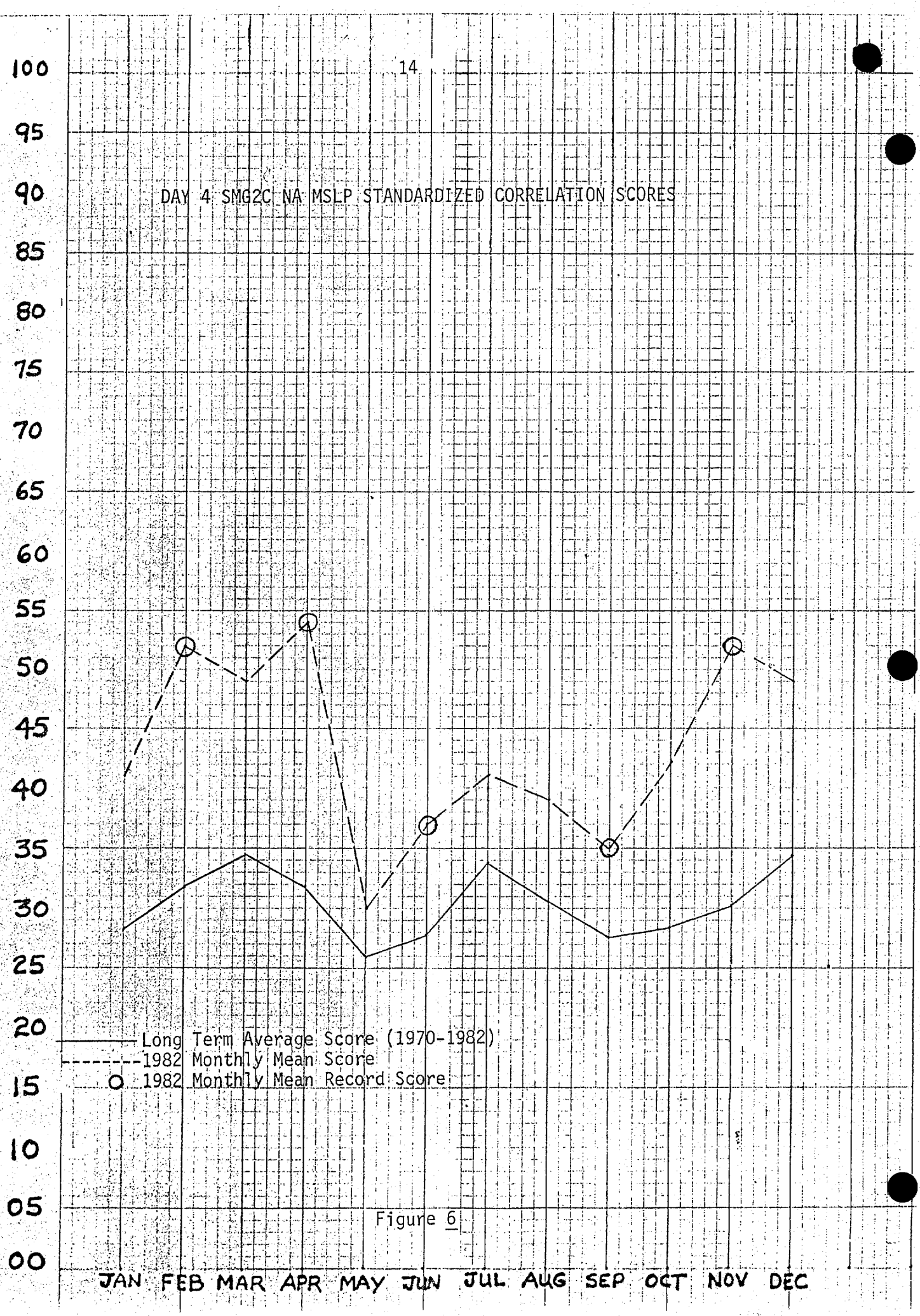
Long Term Average Score (1970-1982)
1982 Monthly Mean Score
1982 Monthly Mean Record Score
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC

Figure 5


DAY 4 SMG2C NA MSLP STANDARDIZED CORRELATION SCORES
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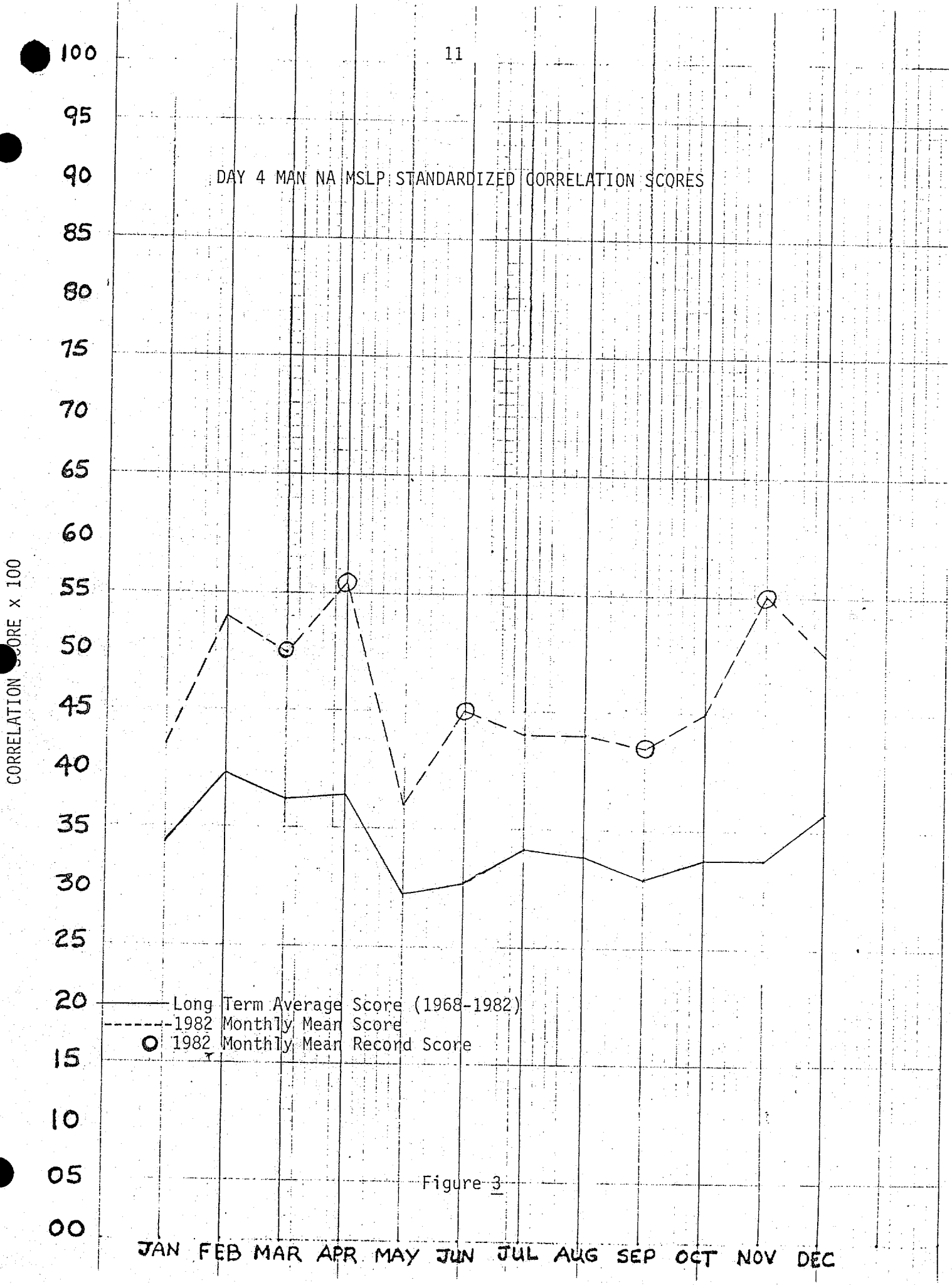
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
Long Term Average Score (1970-1982)
1982 Monthly Mean Score
1982 Monthly Mean Record Score

Figure 6


DAY 4 MAN NA MSLP STANDARDIZED CORRELATION SCORES
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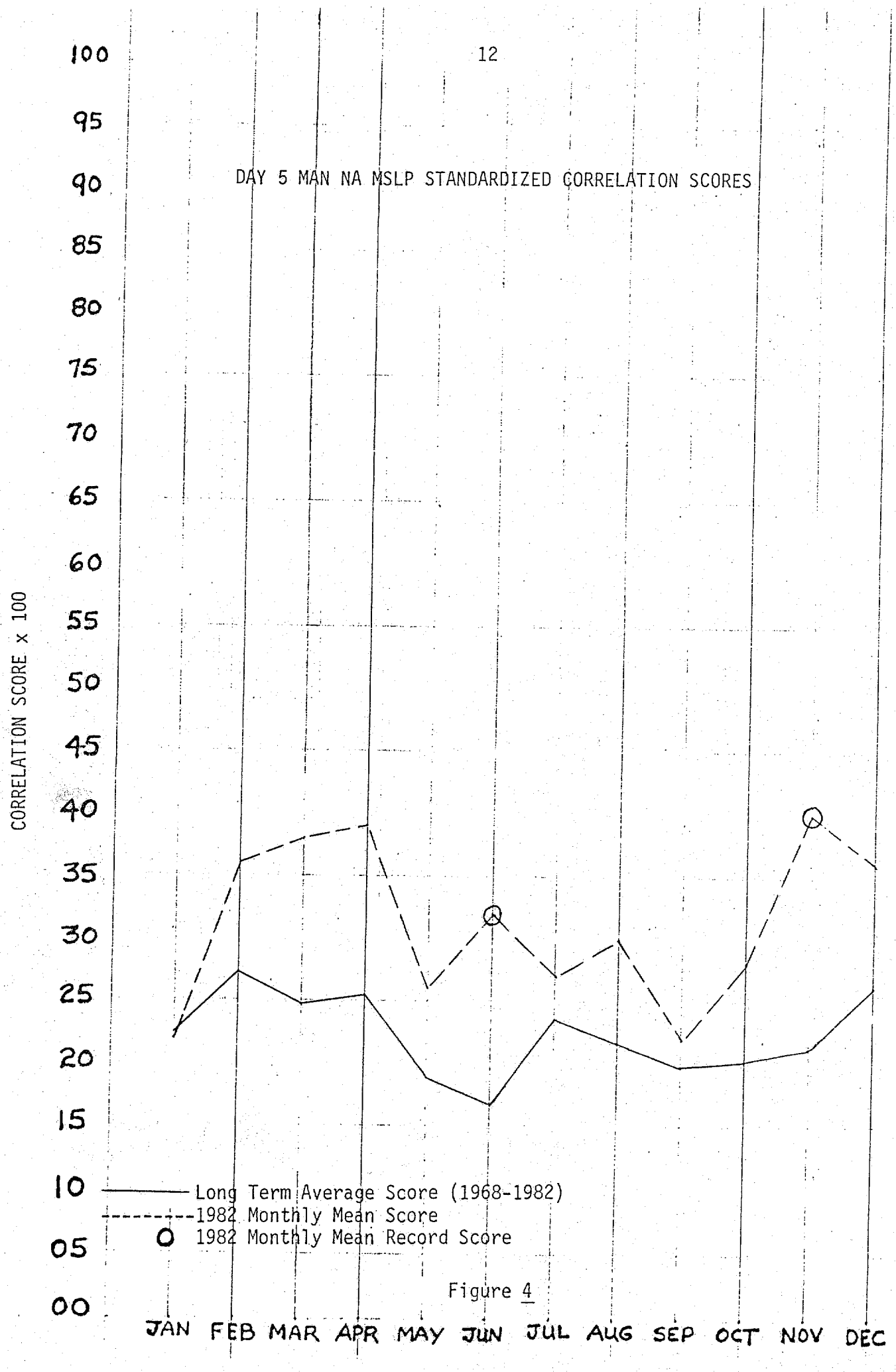
Long Term Average Score (1968-1982)
1982 Monthly Mean Score
1982 Monthly Mean Record Score

Figure 3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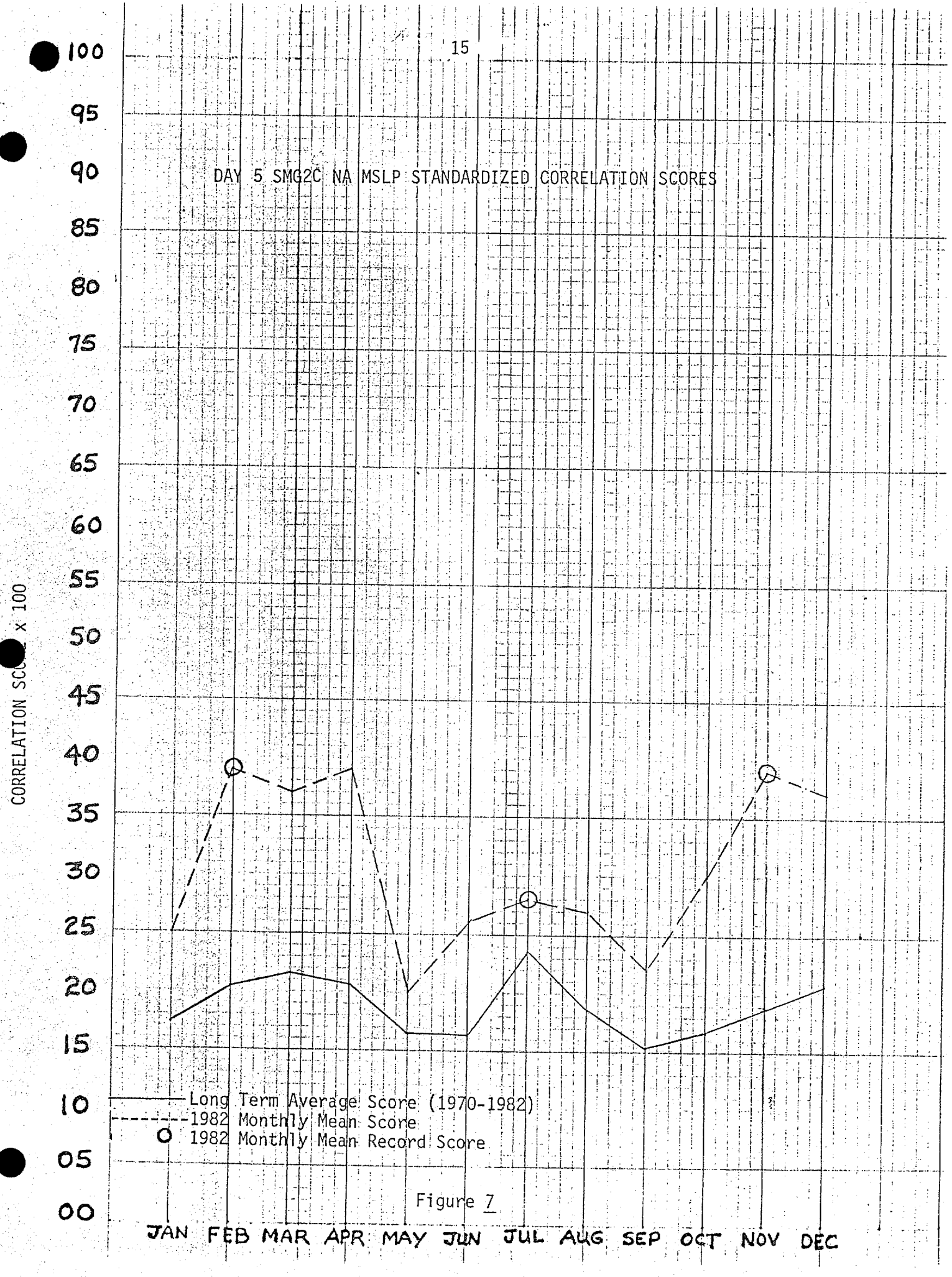
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
Long Term Average Score (1968-1982)
1982 Monthly Mean Score
1982 Monthly Mean Record Score

Figure 4


DAY 5 SMG2C NA MSLP STANDARDIZED CORRELATION SCORES
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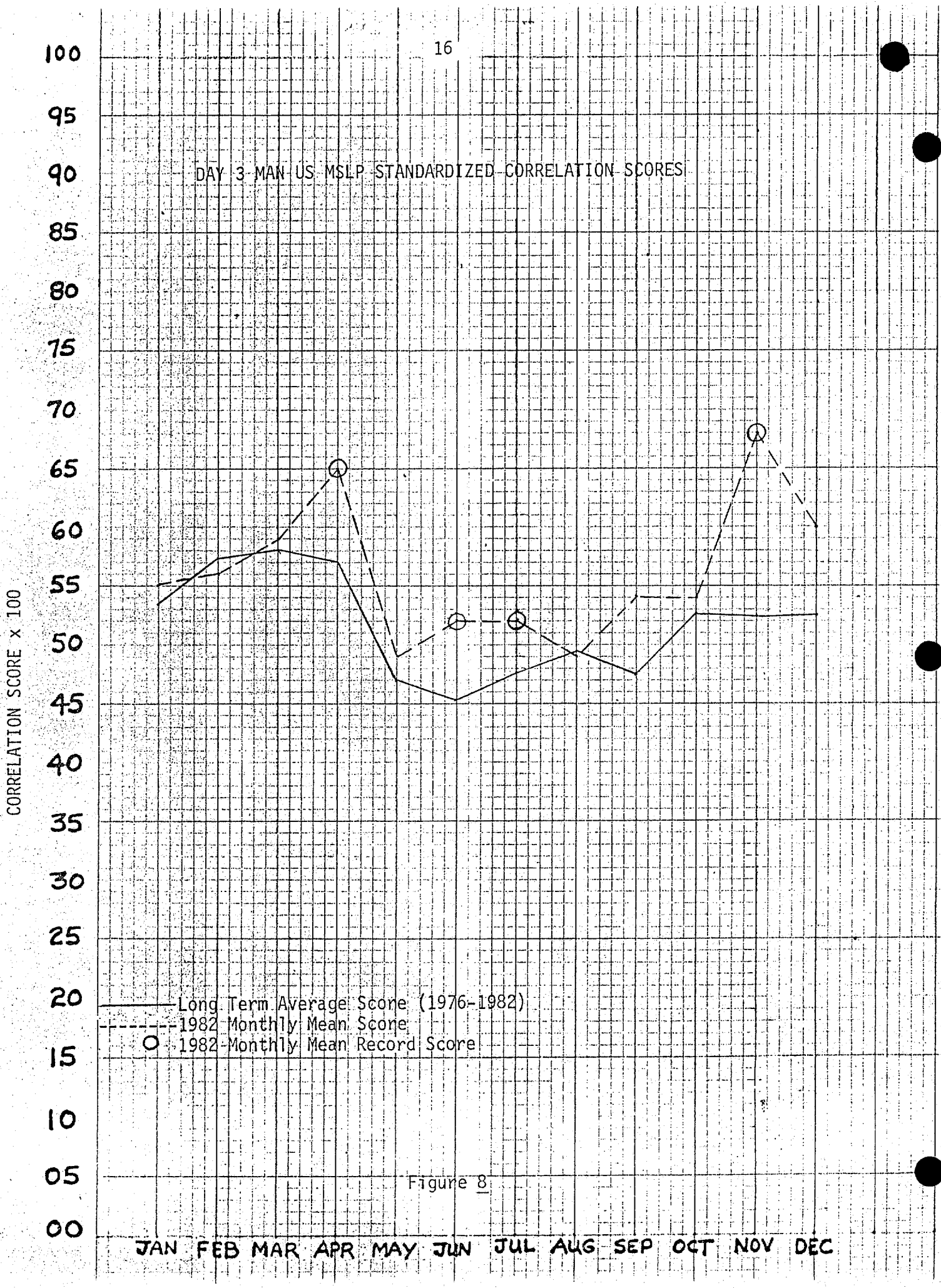
Long Term Average Score (1970-1982)
1982 Monthly Mean Score
1982 Monthly Mean Record Score

Figure 7


DAY 3 MAN US MSLP STANDARDIZED CORRELATION SCORES
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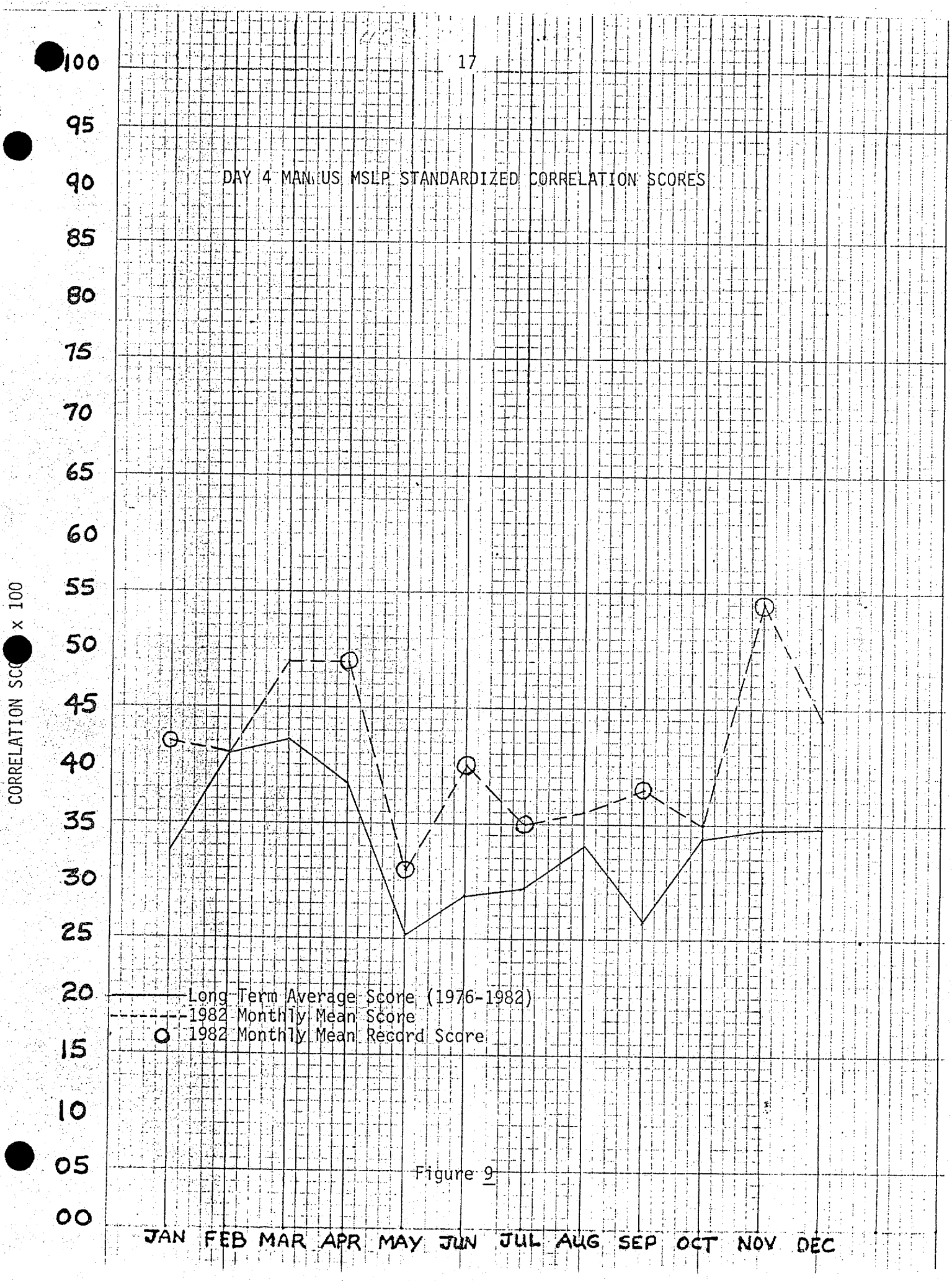
Long Term Average Score (1976-1982)
1982 Monthly Mean Score
1982 Monthly Mean Record Score

Figure 8


DAY 4 MANUS MSLP STANDARDIZED CORRELATION SCORES
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JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
Long Term Average Score (1976-1982)
1982 Monthly Mean Score
1982 Monthly Mean Record Score

Figure 9

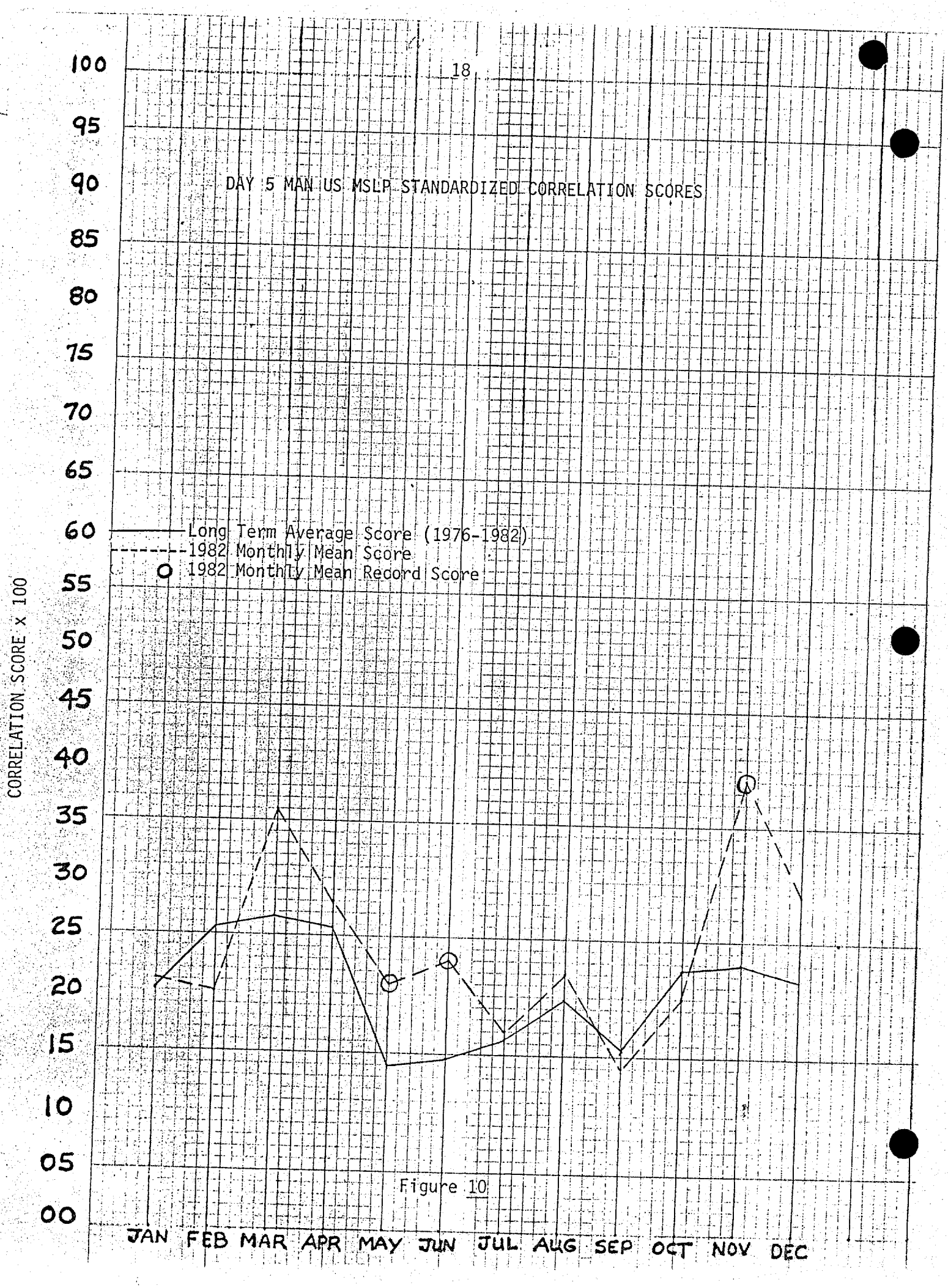
DAY 5 MAN US MSLP STANDARDIZED CORRELATION SCORES
Long Term Average Score (1976-1982)
1982 Monthly Mean Score
1982 Monthly Mean Record Score
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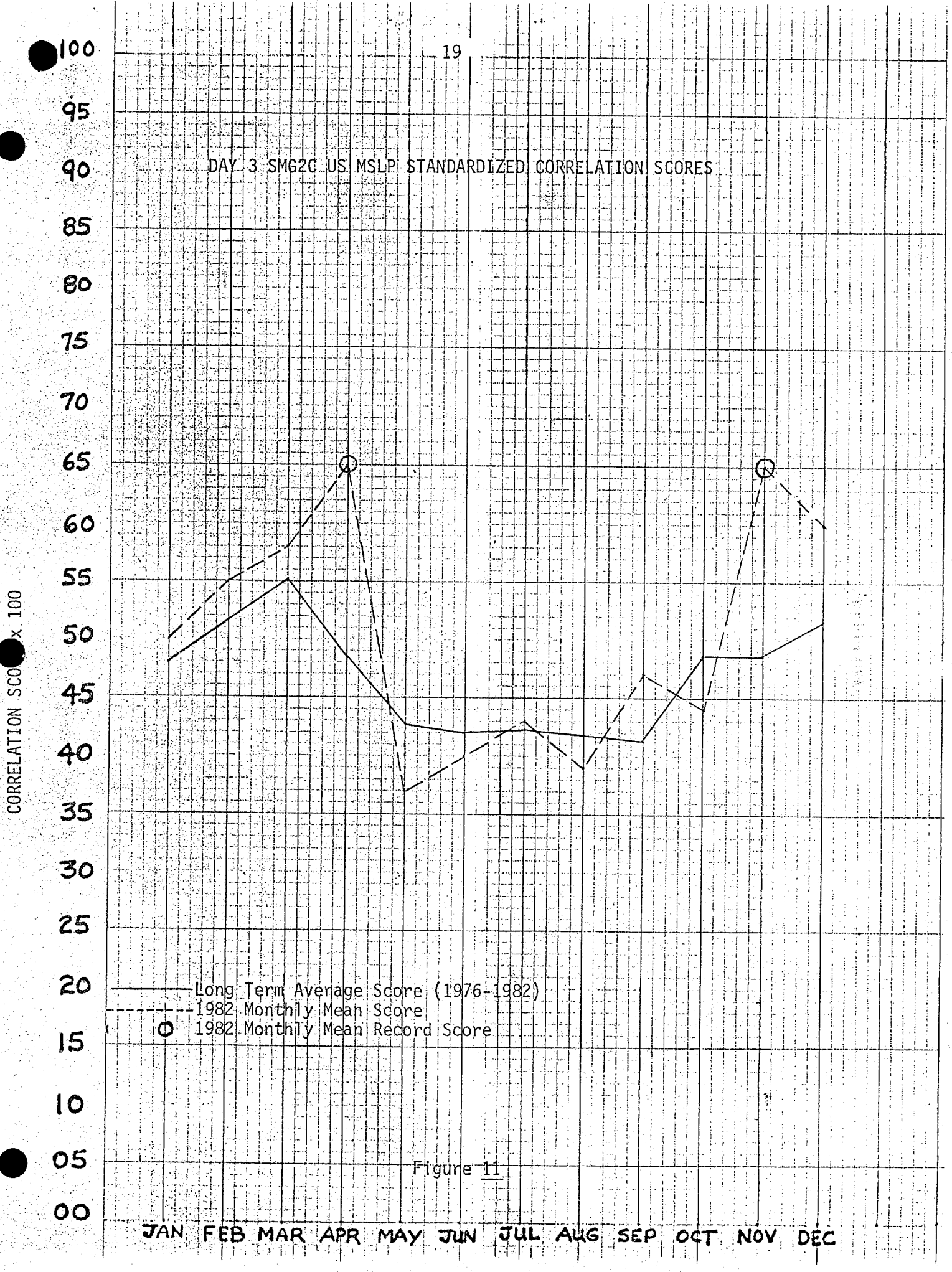
Figure 10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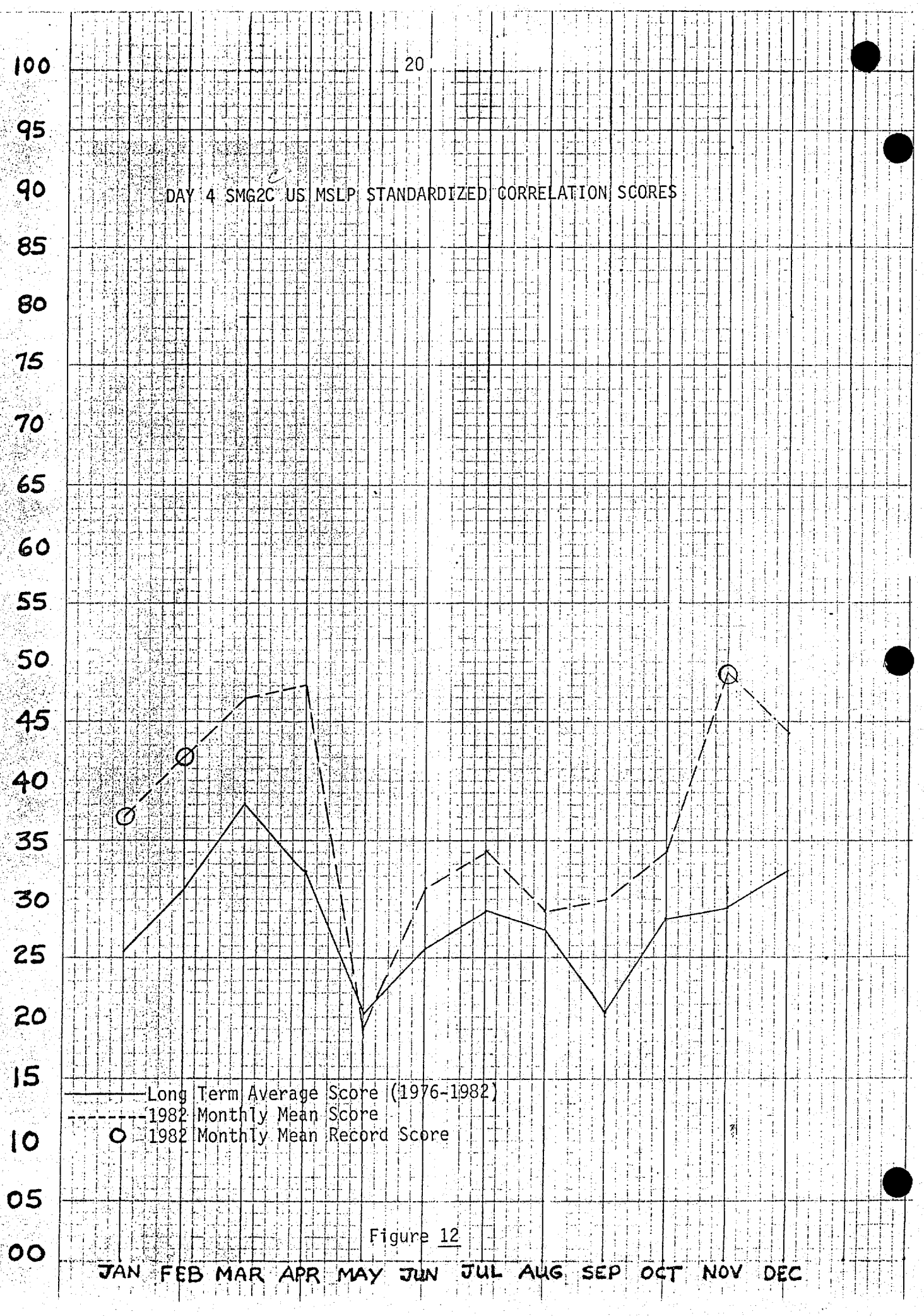
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
Long Term Average Score (1976-1982)
1982 Monthly Mean Score
1982 Monthly Mean Record Score

Figure 11


DAY 4 SMG2C US MSLP STANDARDIZED CORRELATION SCORES
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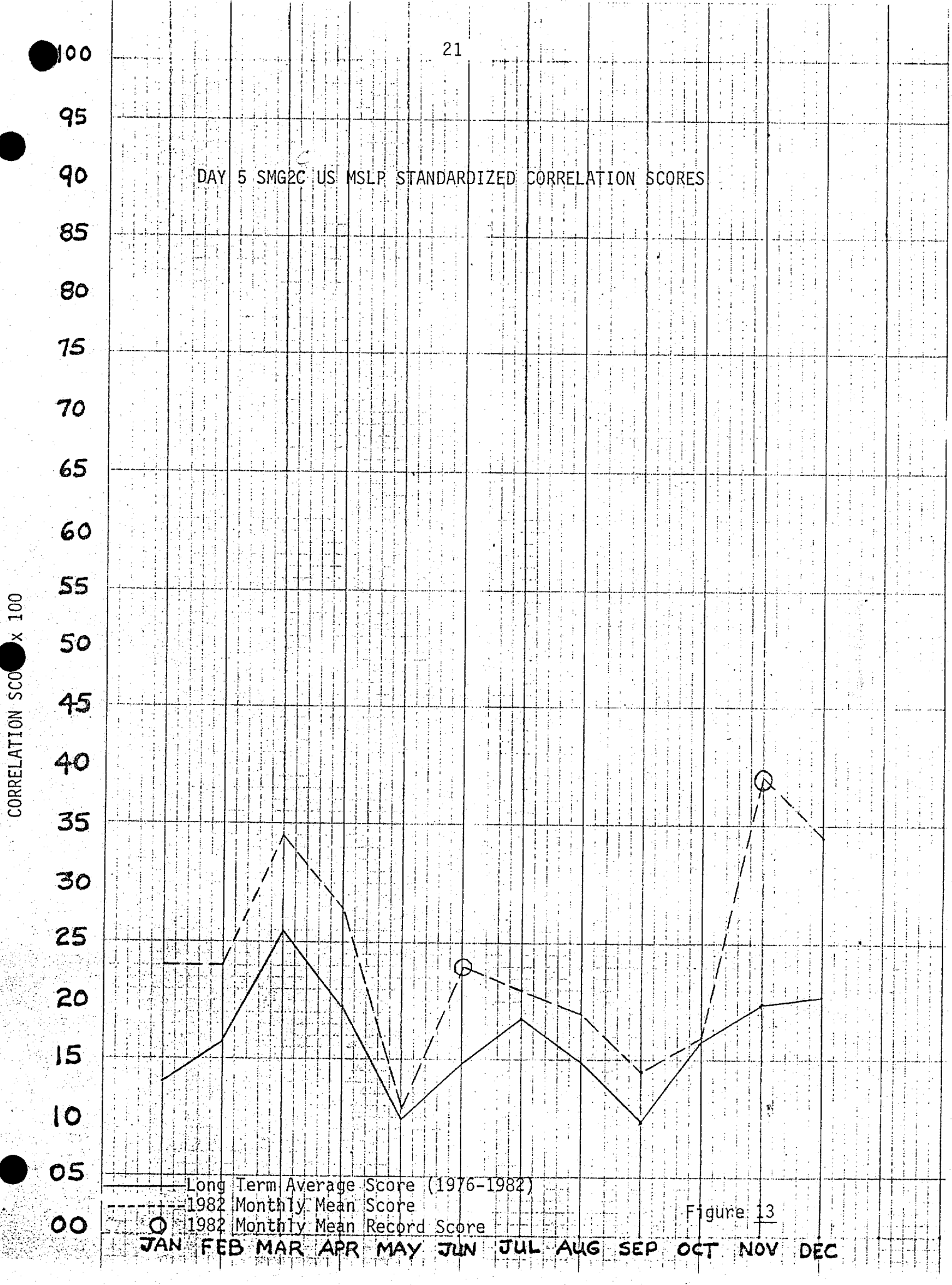
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
Long Term Average Score (1976-1982)
1982 Monthly Mean Score
1982 Monthly Mean Record Score

Figure 12


DAY 5 SMG2C US MSLP STANDARDIZED CORRELATION SCORES
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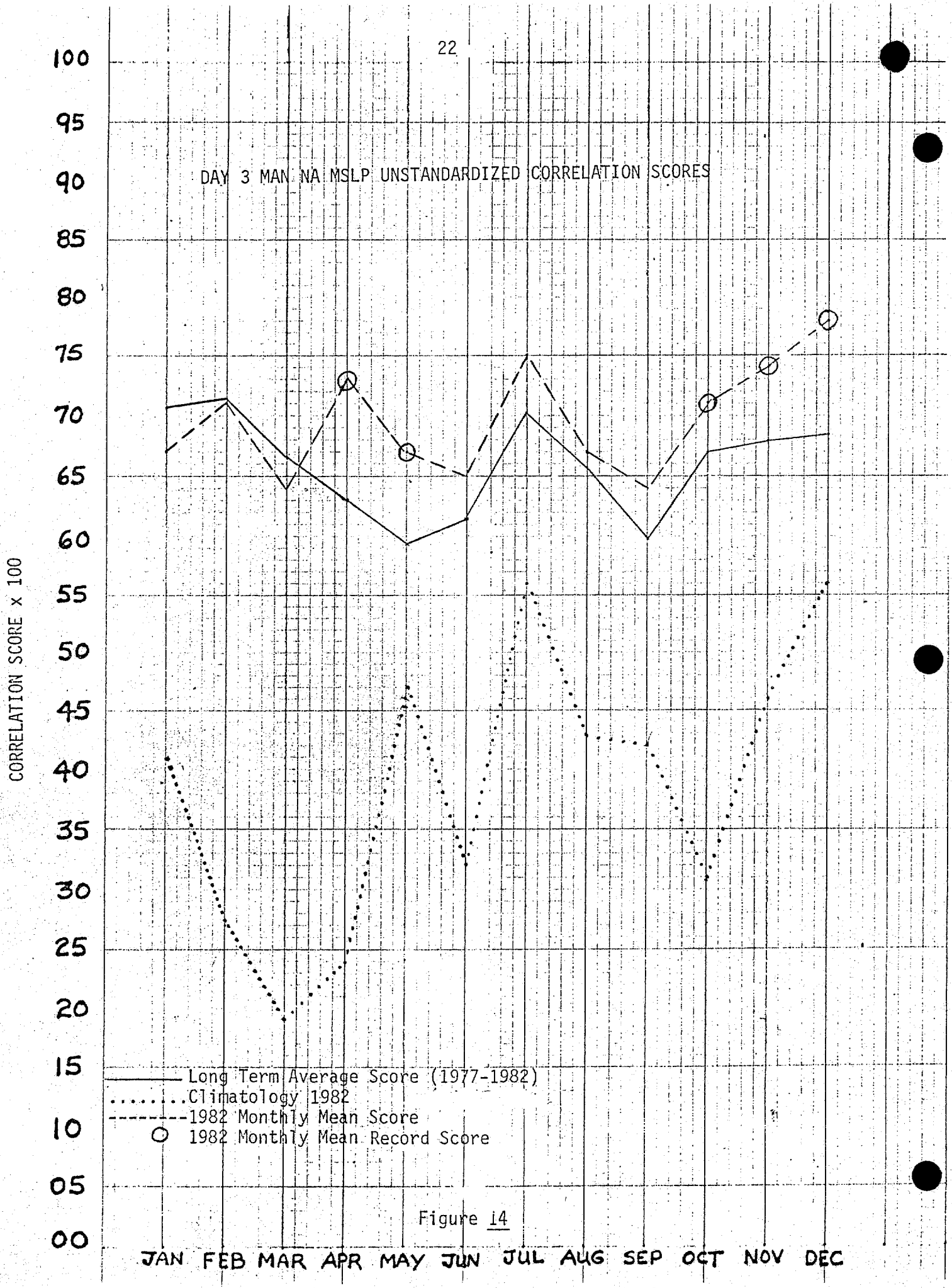
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
Long Term Average Score (1976-1982)
1982 Monthly Mean Score
1982 Monthly Mean Record Score

Figure 13


DAY 3 MAN NA MSLP UNSTANDARDIZED CORRELATION SCORES
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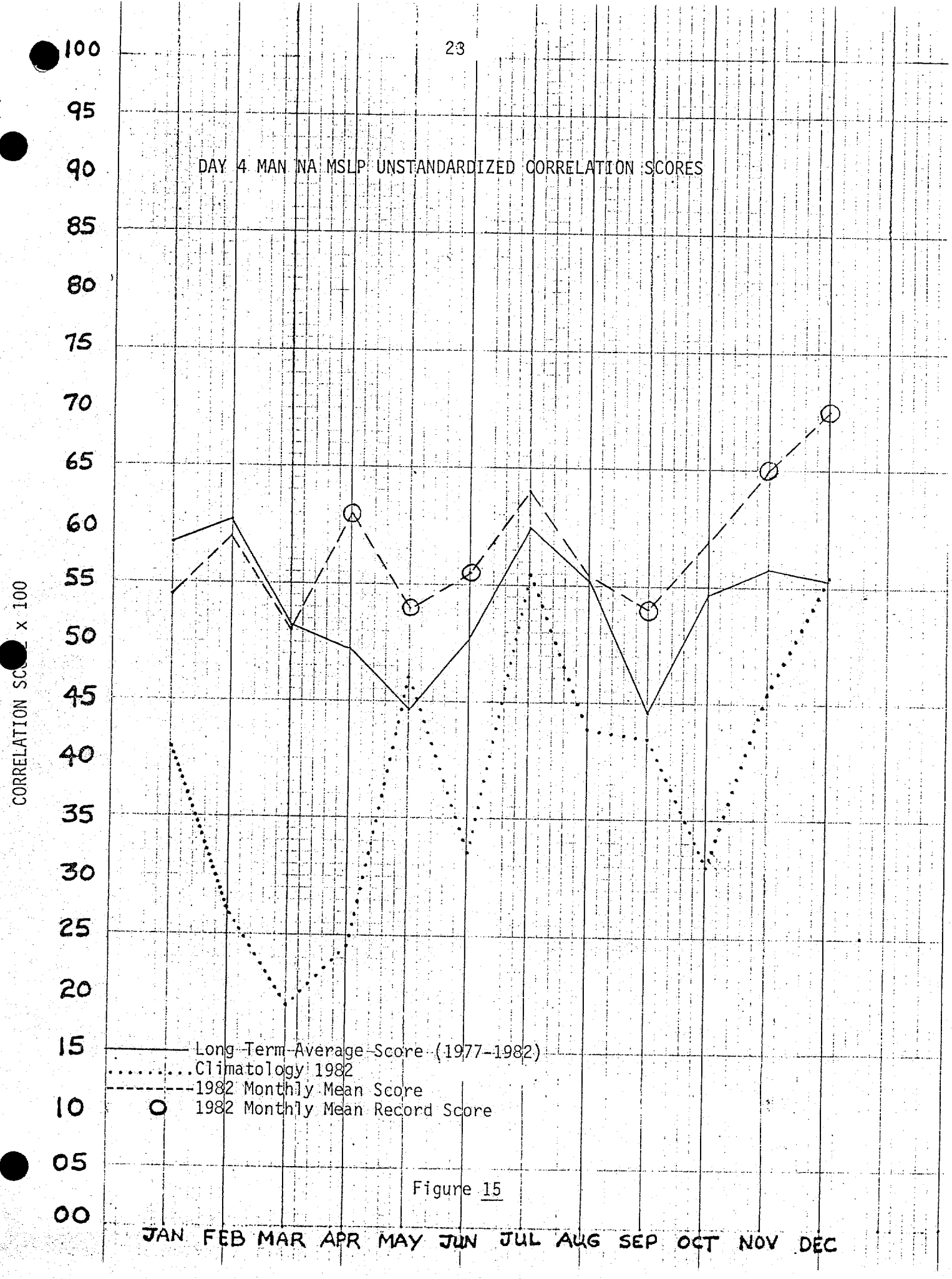
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
Long Term Average Score (1977-1982)
Climatology 1982
1982 Monthly Mean Score
1982 Monthly Mean Record Score

Figure 14


DAY 4 MAN NA MSLP UNSTANDARDIZED CORRELATION SCORES
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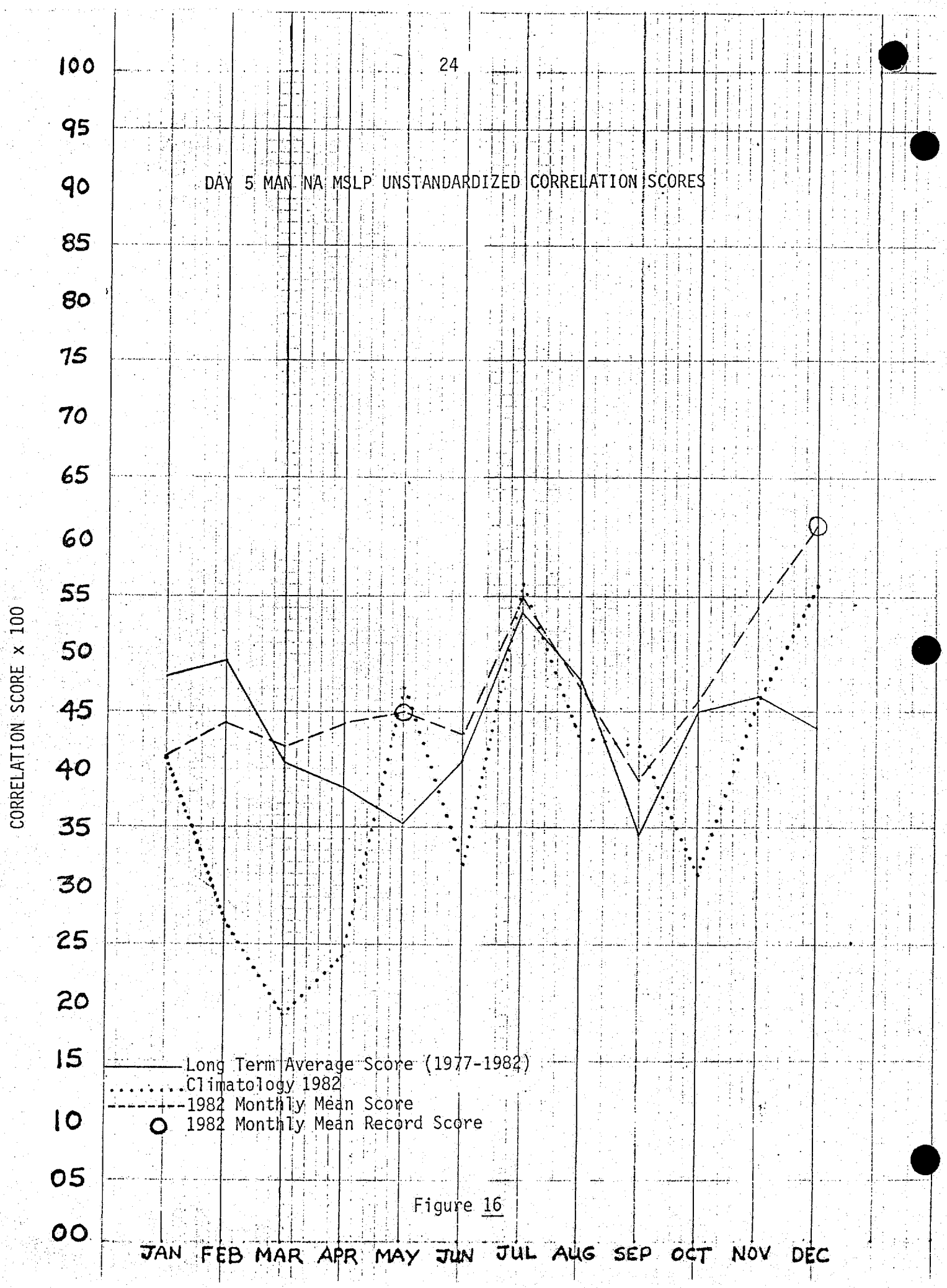
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
Long Term Average Score (1977-1982)
Climatology 1982
1982 Monthly Mean Score
1982 Monthly Mean Record Score

Figure 15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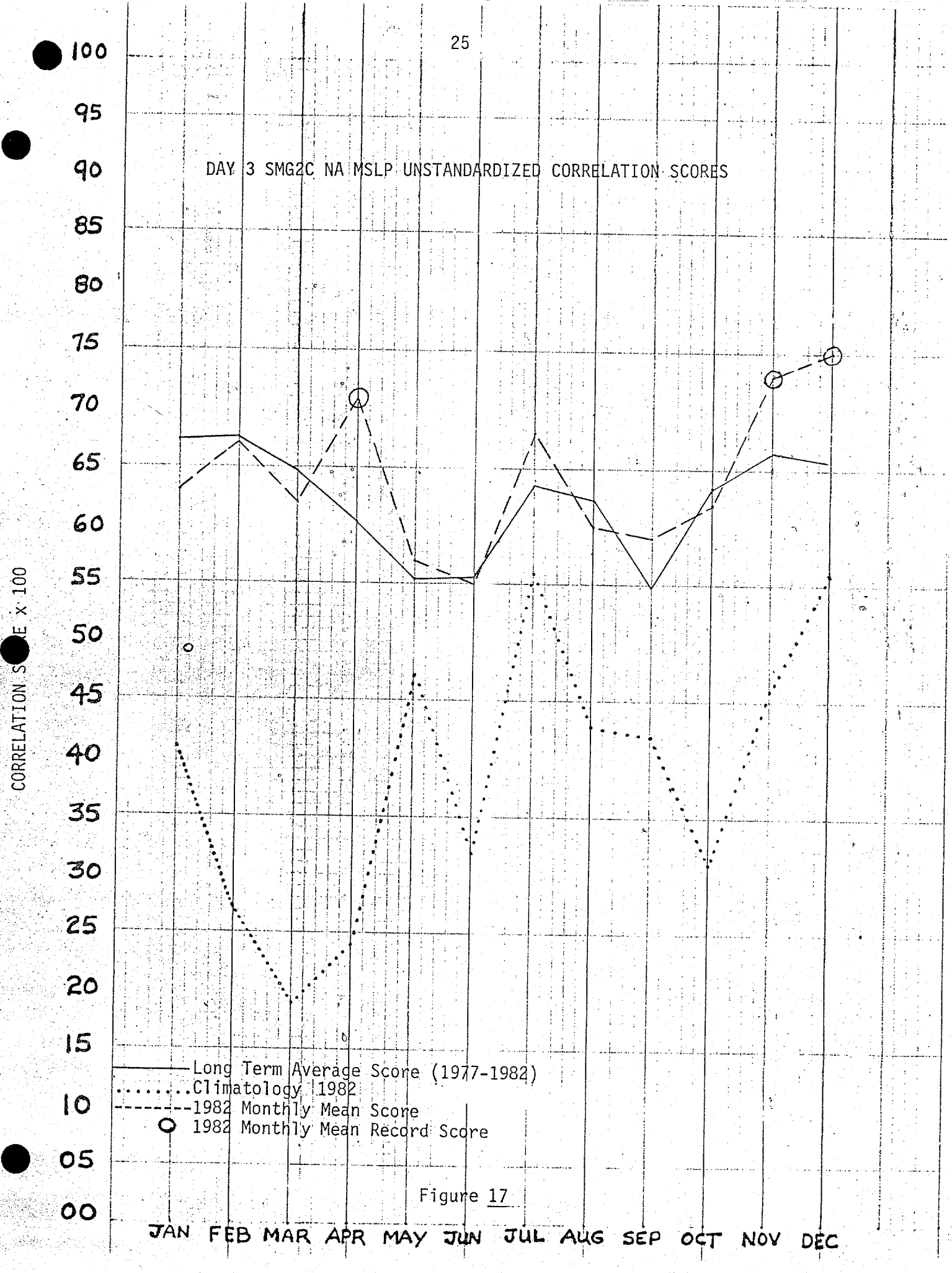
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
Long Term Average Score (1977-1982)
Climatology 1982
1982 Monthly Mean Score
1982 Monthly Mean Record Score

Figure 16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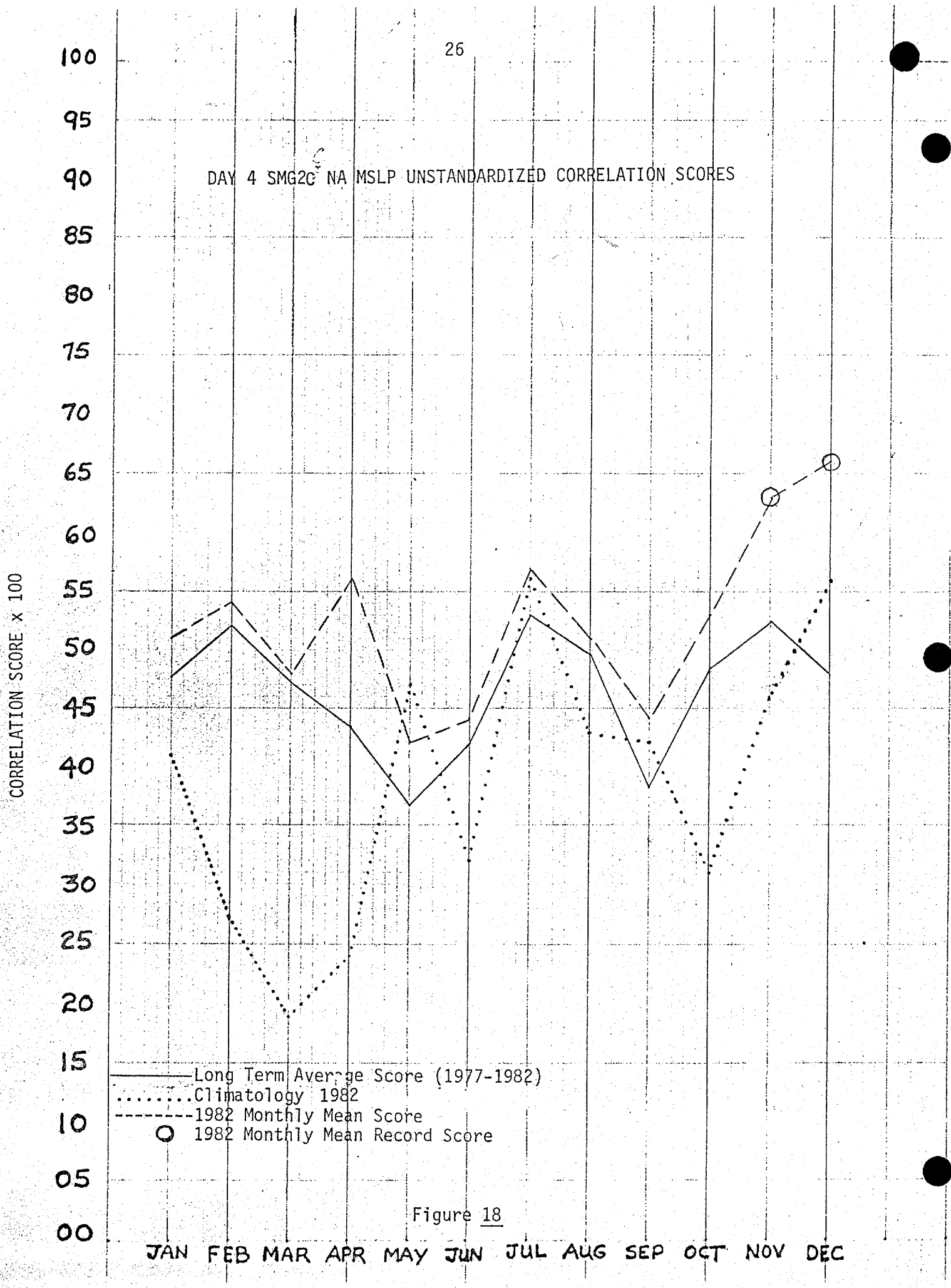
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
Long Term Average Score (1977-1982)
Climatology 1982
1982 Monthly Mean Score
1982 Monthly Mean Record Score

Figure 17


DAY 4 SMG2C NA MSLP UNSTANDARDIZED CORRELATION SCORES
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JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
Long Term Average Score (1977-1982)
Climatology 1982
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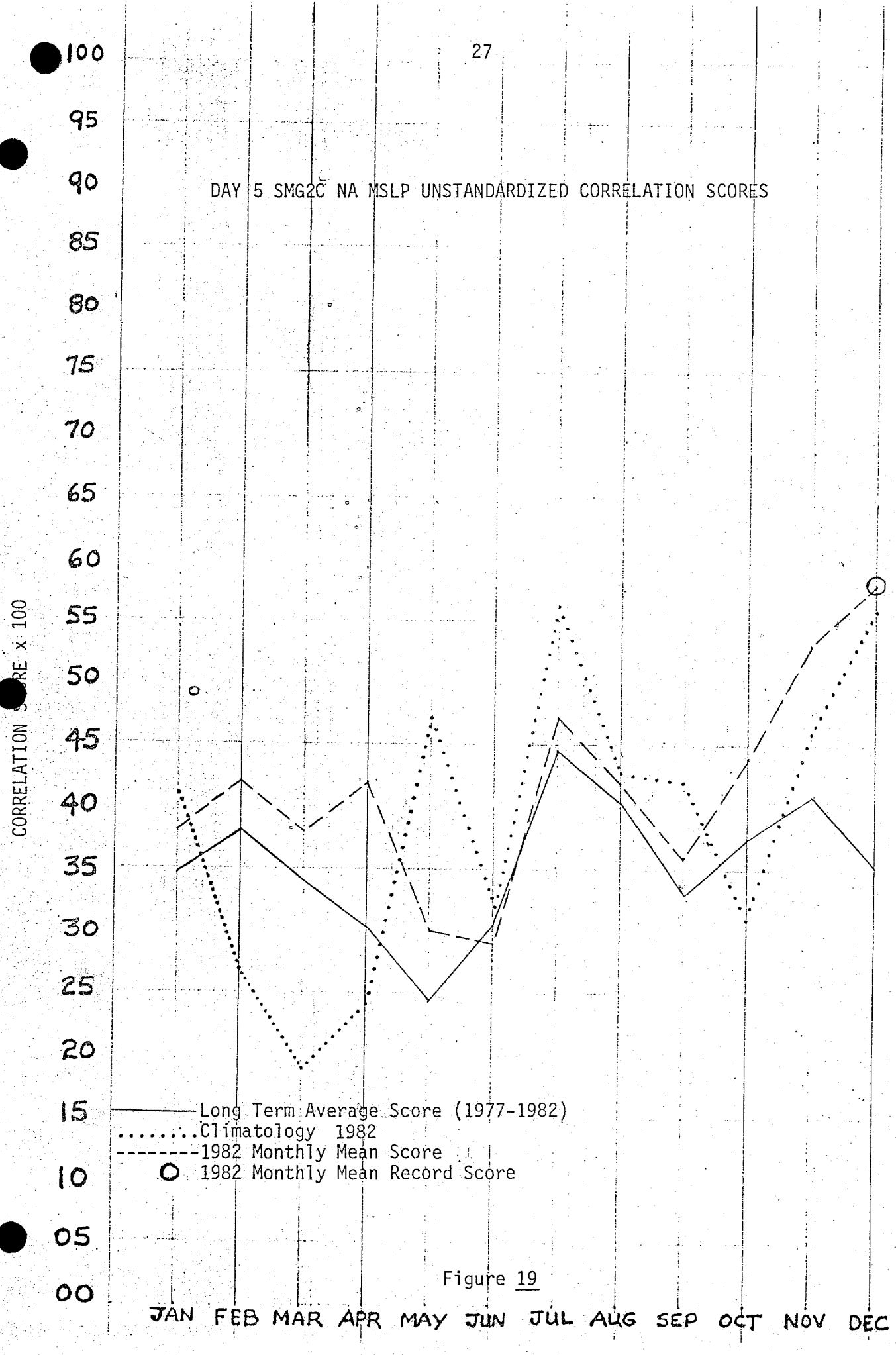
1982 Monthly Mean Record Score

Figure 18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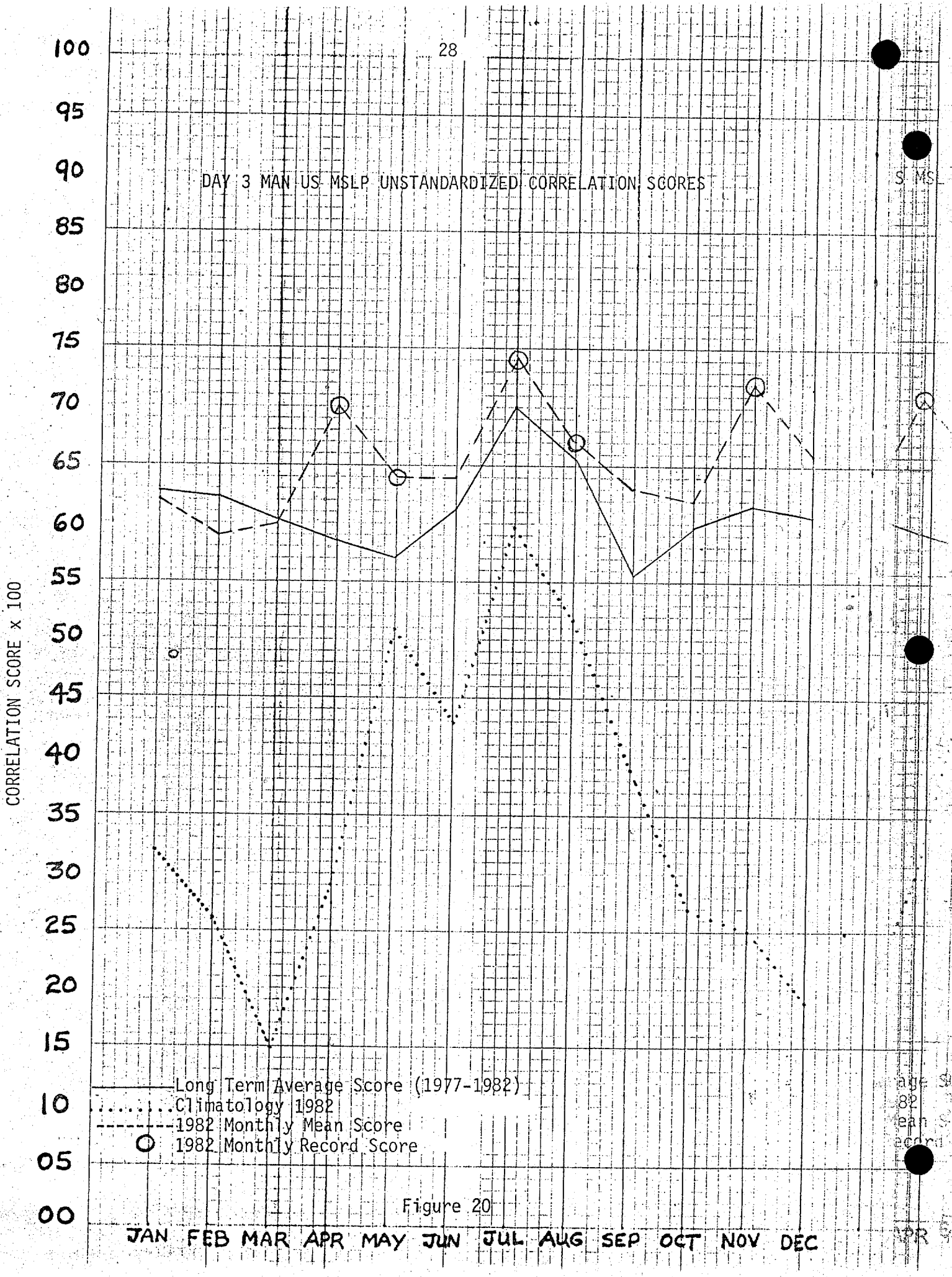
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
Long Term Average Score (1977-1982)
Climatology 1982
1982 Monthly Mean Score
1982 Monthly Mean Record Score

Figure 19


DAY 3 MAN US MSLP UNSTANDARDIZED CORRELATION SCORES
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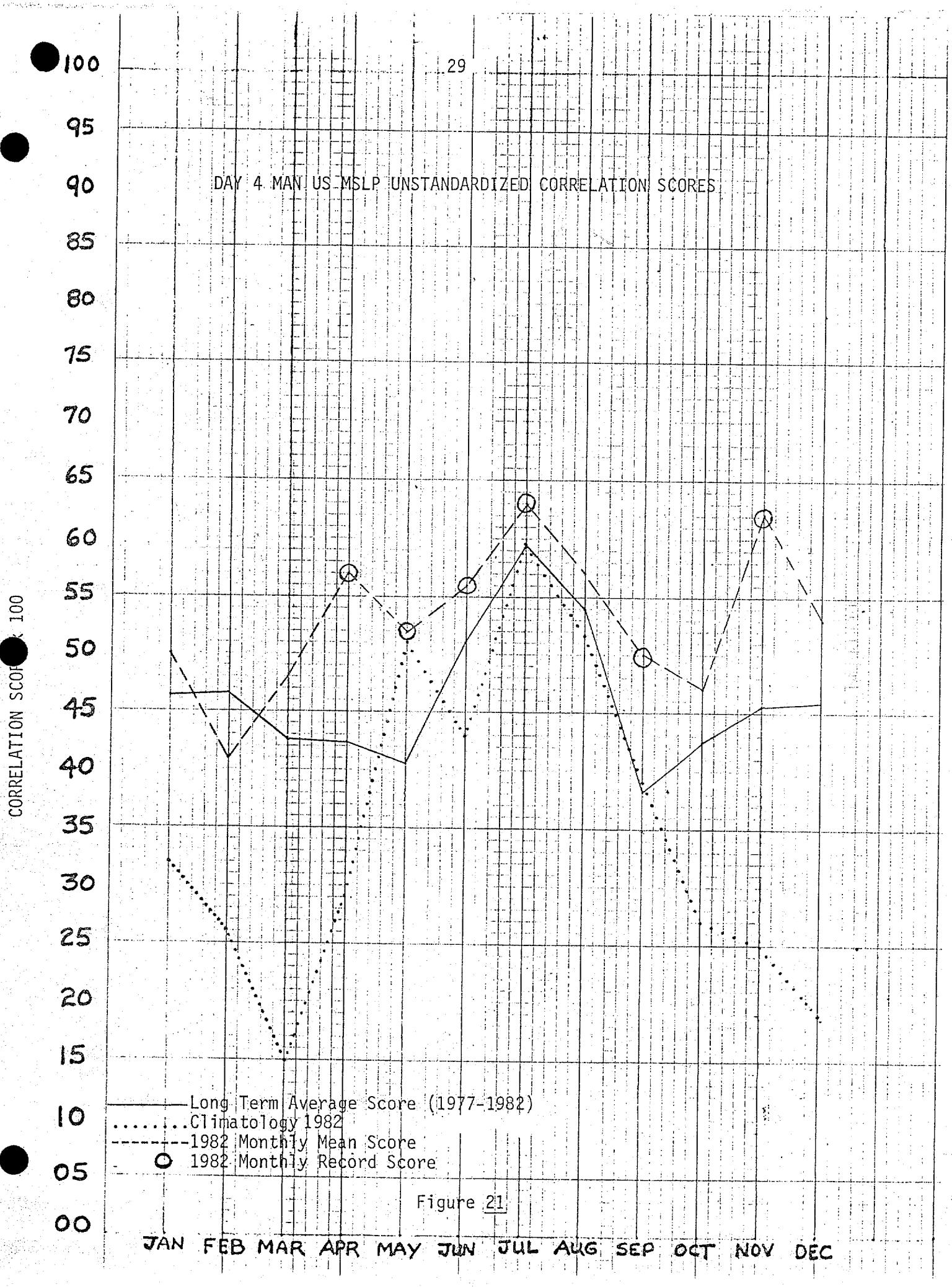
Long Term Average Score (1977-1982)
Climatology 1982
1982 Monthly Mean Score
1982 Monthly Record Score

Figure 20


DAY 4 MAN US MSLP UNSTANDARDIZED CORRELATION SCORES
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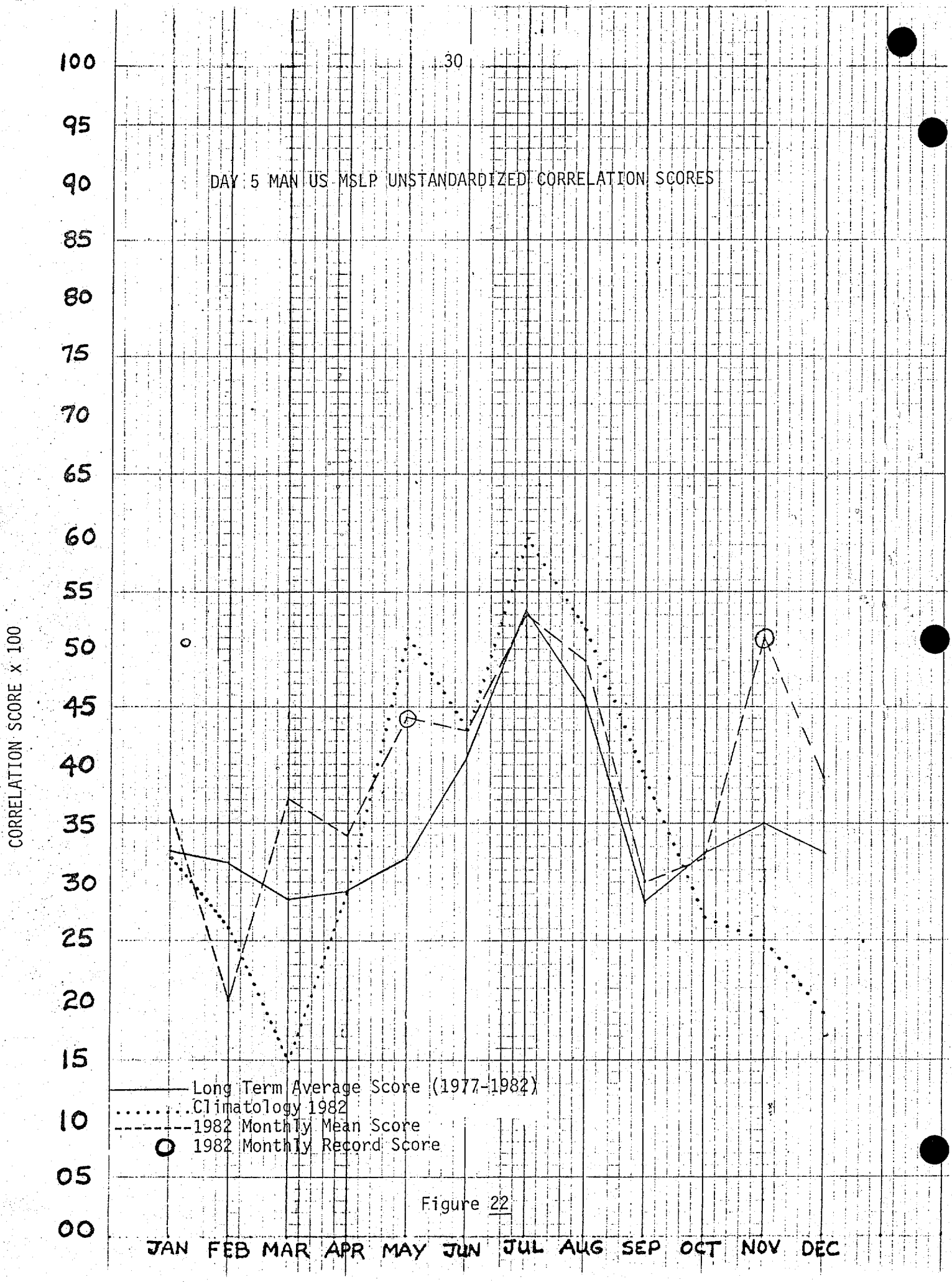
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
Long Term Average Score (1977-1982)
Climatology 1982
1982 Monthly Mean Score
1982 Monthly Record Score

Figure 21


DAY 5 MAN US MSLP UNSTANDARDIZED CORRELATION SCORES
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15
10
05
00
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
Long Term Average Score (1977-1982)
Climatology 1982
1982 Monthly Mean Score
1982 Monthly Record Score

Figure 22

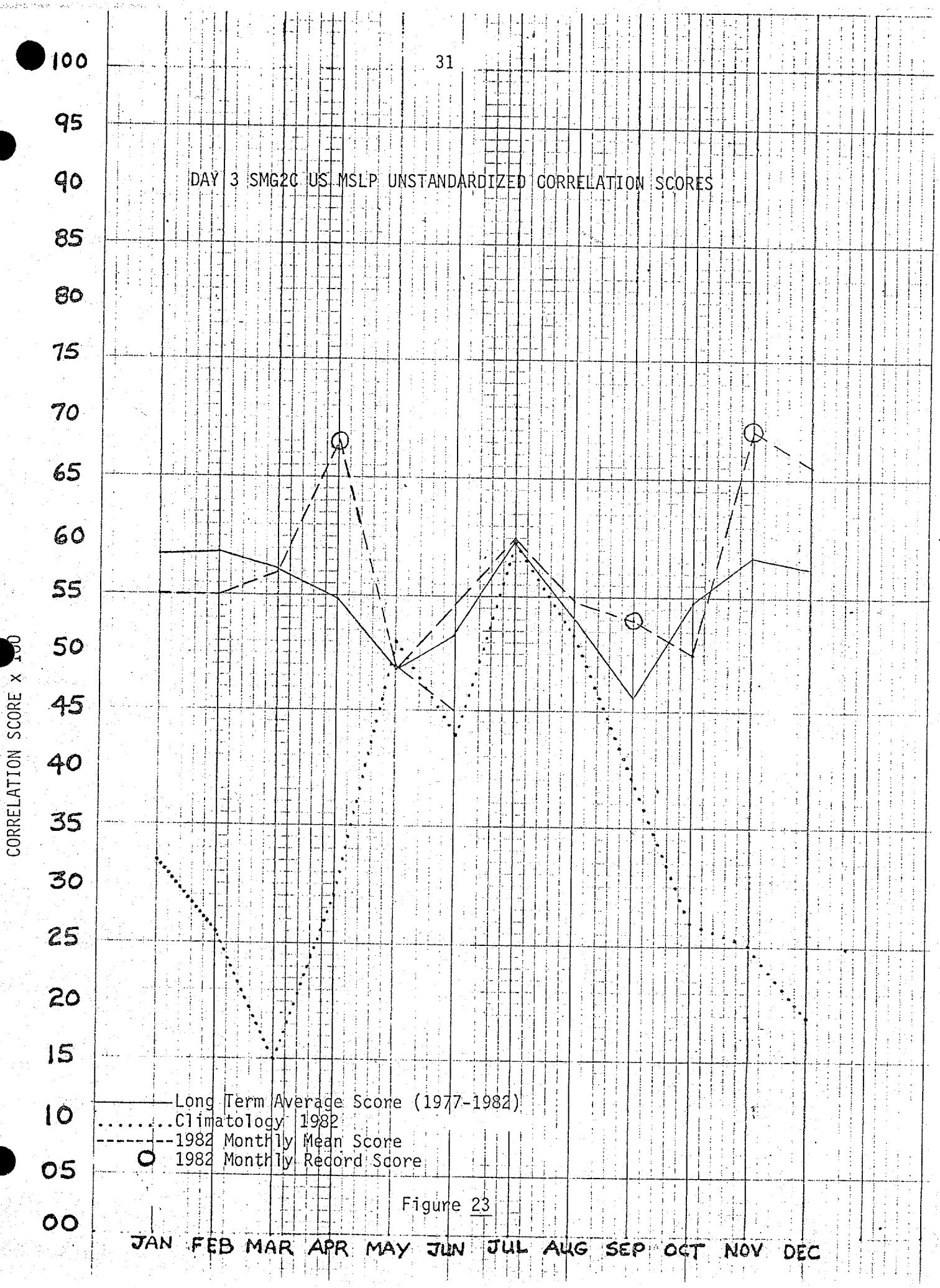

DAY 3 SMG2C US MSLP UNSTANDARDIZED CORRELATION SCORES
CORRELATION SCORE x 100
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
05
00
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
Long Term Average Score (1977-1982)
Climatology 1982
1982 Monthly Mean Score
1982 Monthly Record Score

Figure 23

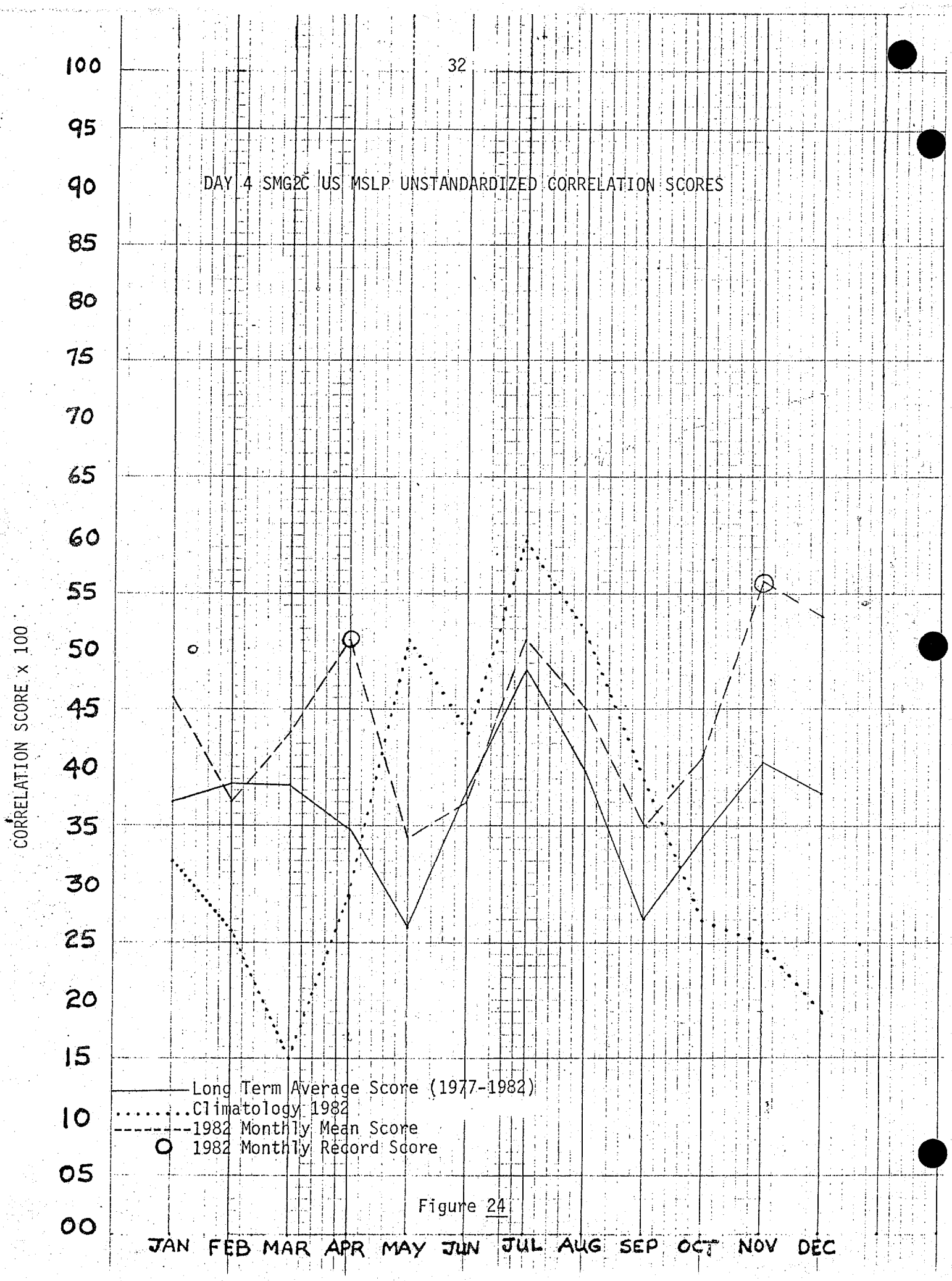

DAY 4 SMG2C US MSLP UNSTANDARDIZED CORRELATION SCORES
CORRELATION SCORE x 100
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
05
00
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
Long Term Average Score (1977-1982)
Climatology 1982
1982 Monthly Mean Score
1982 Monthly Record Score

Figure 24

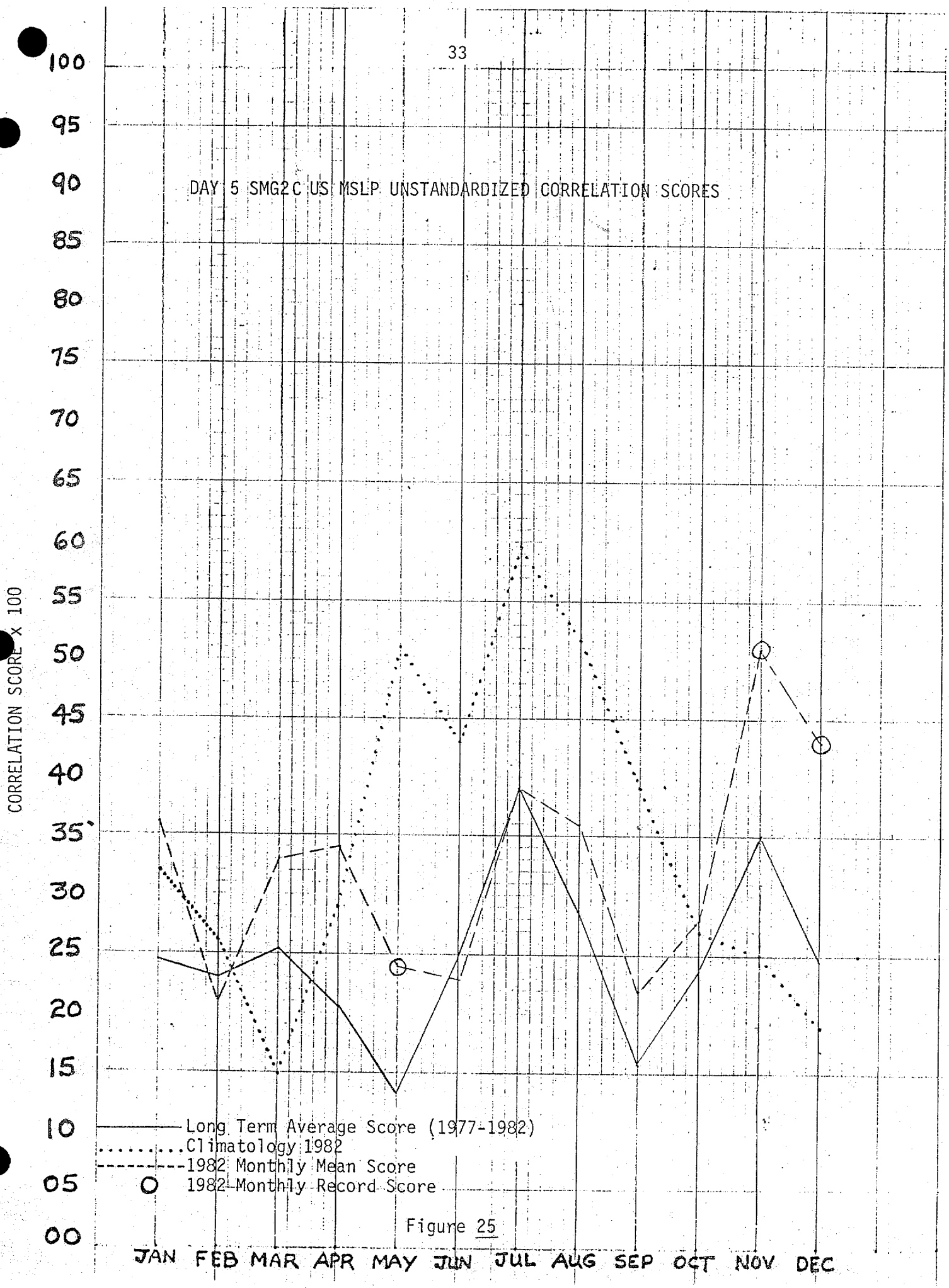

DAY 5 SMG2C US MSLP UNSTANDARDIZED CORRELATION SCORES
CORRELATION SCORE X 100
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
05
00
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
Long Term Average Score (1977-1982)
Climatology 1982
1982 Monthly Mean Score
1982 Monthly Record Score

Figure 25

SECTION 2

Man & Machine (Numerical Model Guidance)

Days 1 through 7 Monthly Mean Sea Level Pressure & 500 MB

Correlation Scores for 1982

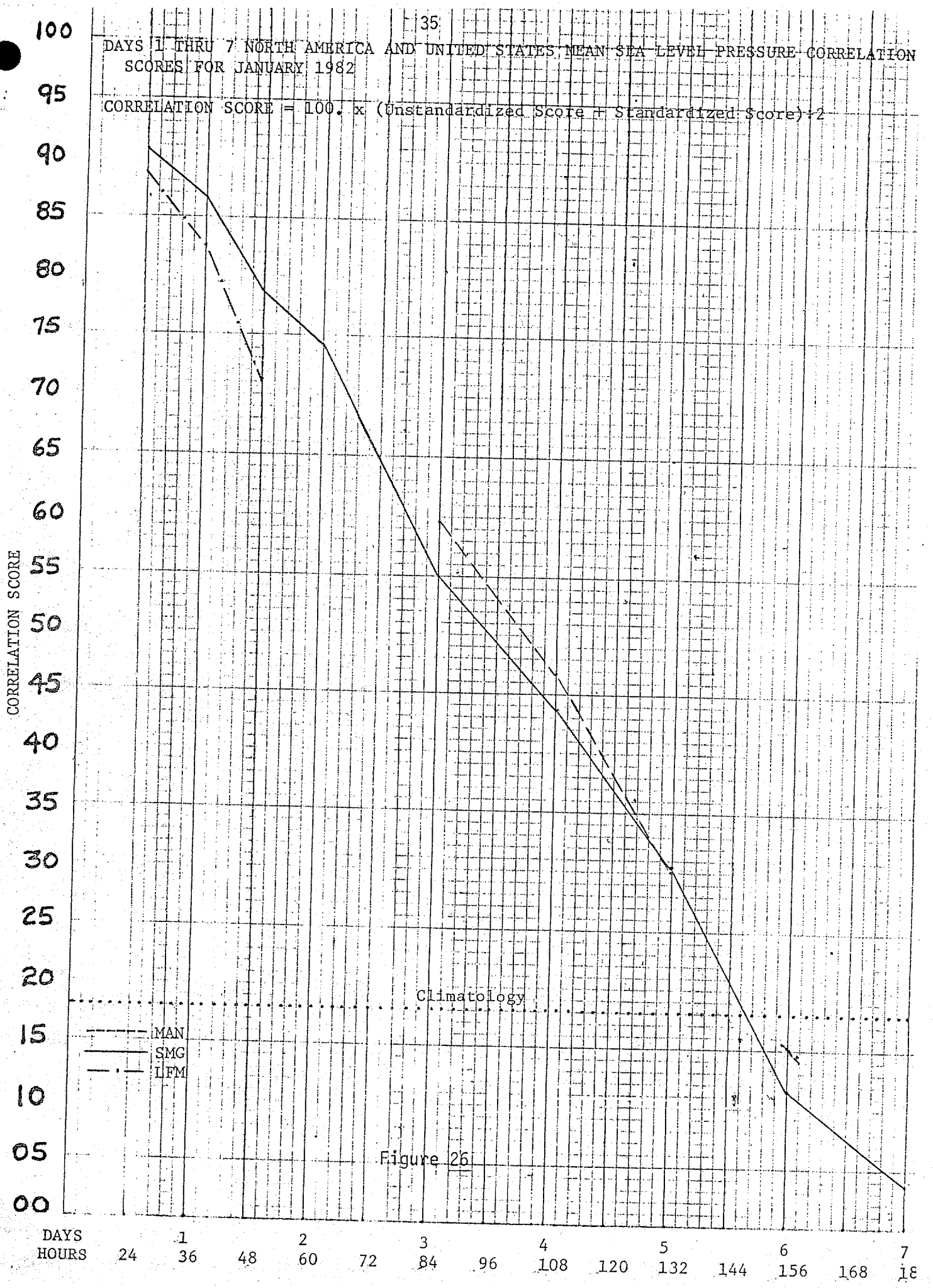

DAYS 1 THRU 7 NORTH AMERICA AND UNITED STATES MEAN SEA LEVEL PRESSURE CORRELATION SCORES FOR JANUARY 1982
CORRELATION SCORE = 100. x (Unstandardized Score + Standardized Score)÷2
CORRELATION SCORE
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
05
00
Climatology
MAN
SMG
LFM
DAYS
HOURS
24
1
36
48
2
60
72
3
84
96
4
108
120
5
132
144
6
156
168
7
18

Figure 26

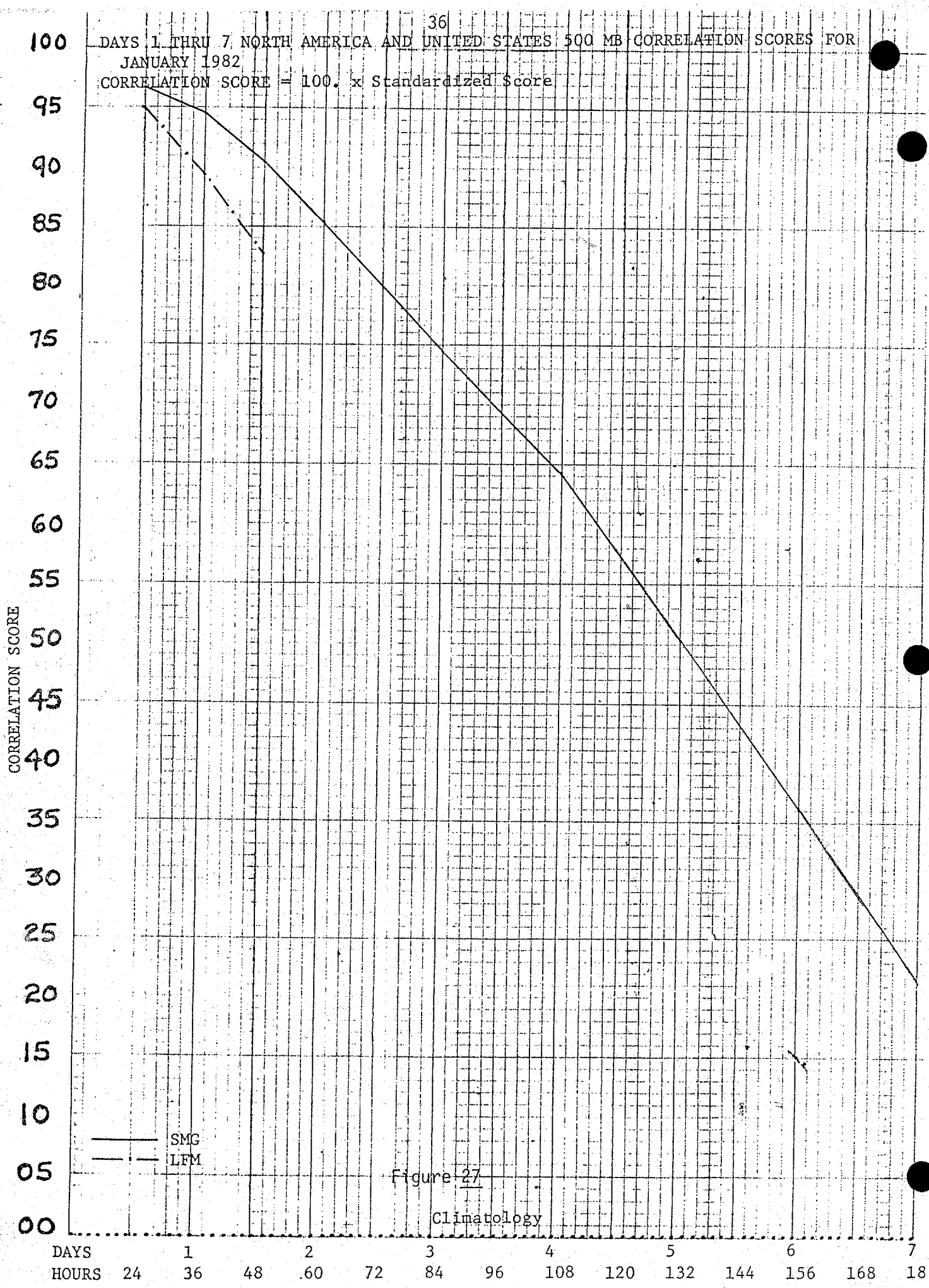

DAYS 1 THRU 7 NORTH AMERICA AND UNITED STATES 500 MB CORRELATION SCORES FOR JANUARY 1982
CORRELATION SCORE = 100. x Standardized Score
CORRELATION SCORE
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
05
00
SMG
LFM
Climatology
DAYS 1 2 3 4 5 6 7
HOURS 24 36 48 60 72 84 96 108 120 132 144 156 168 18

Figure 27

DAYS 1 THRU 7 NORTH AMERICA AND UNITED STATES MEAN SEA LEVEL PRESSURE CORRELATION SCORES FOR FEBRUARY 1982

CORRELATION SCORE = 100. x (Unstandardized Score + Standardized Score) ÷ 2

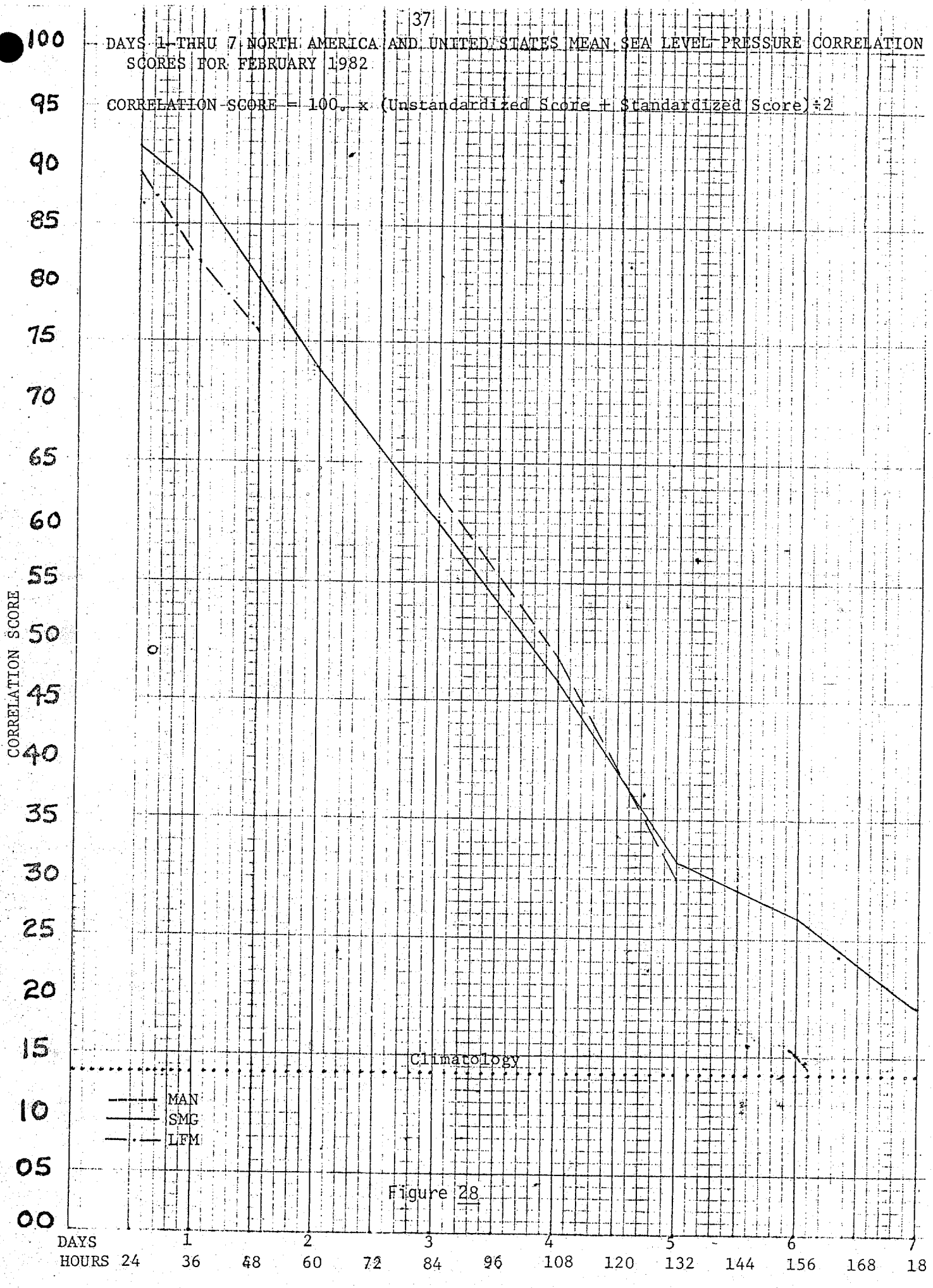


Figure 28

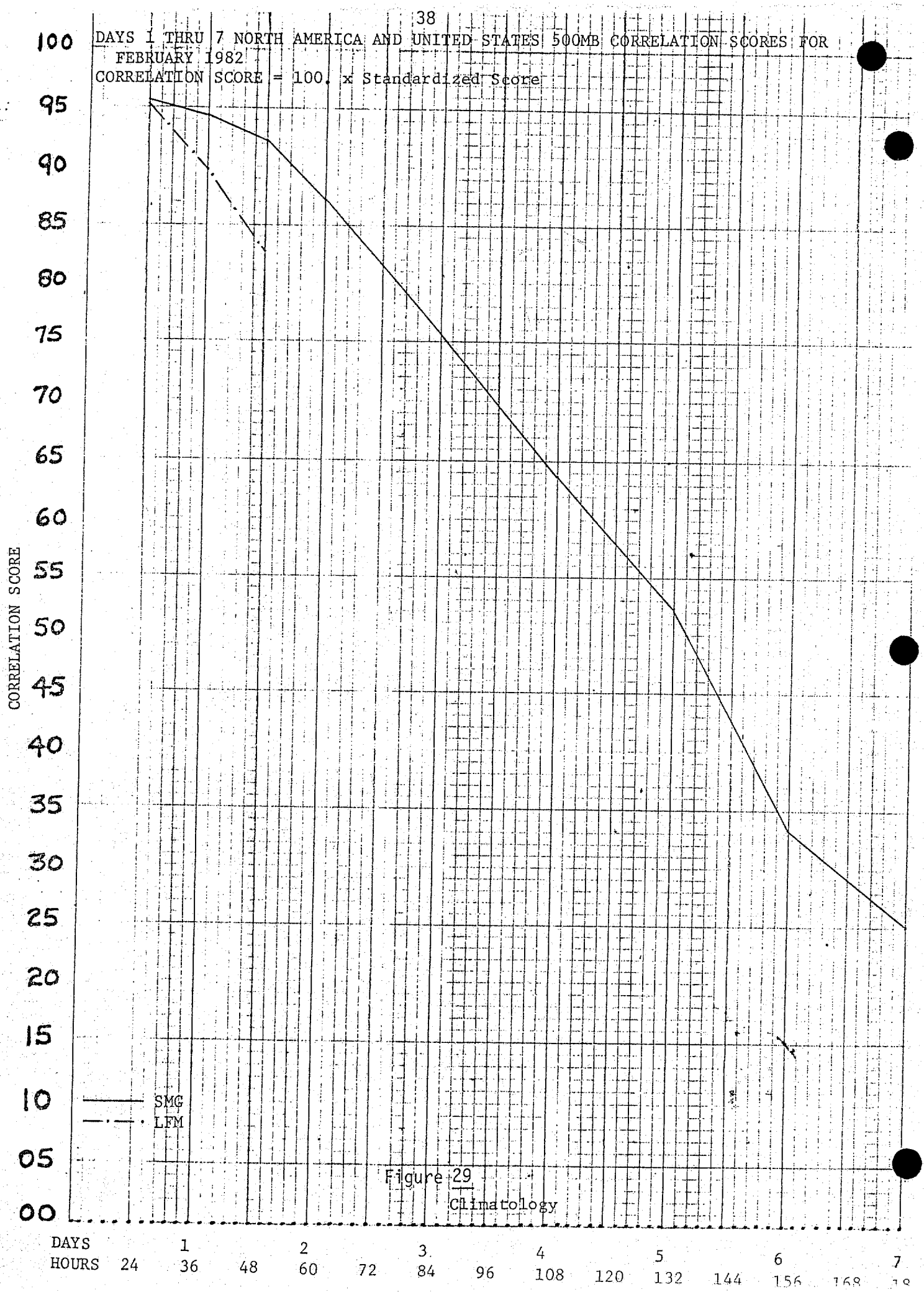


Figure 29

Climatology

DAYS 1 THRU 7 NORTH AMERICA AND UNITED STATES MEAN SEA LEVEL PRESSURE CORRELATION SCORES FOR MARCH 1982

CORRELATION SCORE = 100. x (Unstandardized Score + Standardized Score) ÷ 2

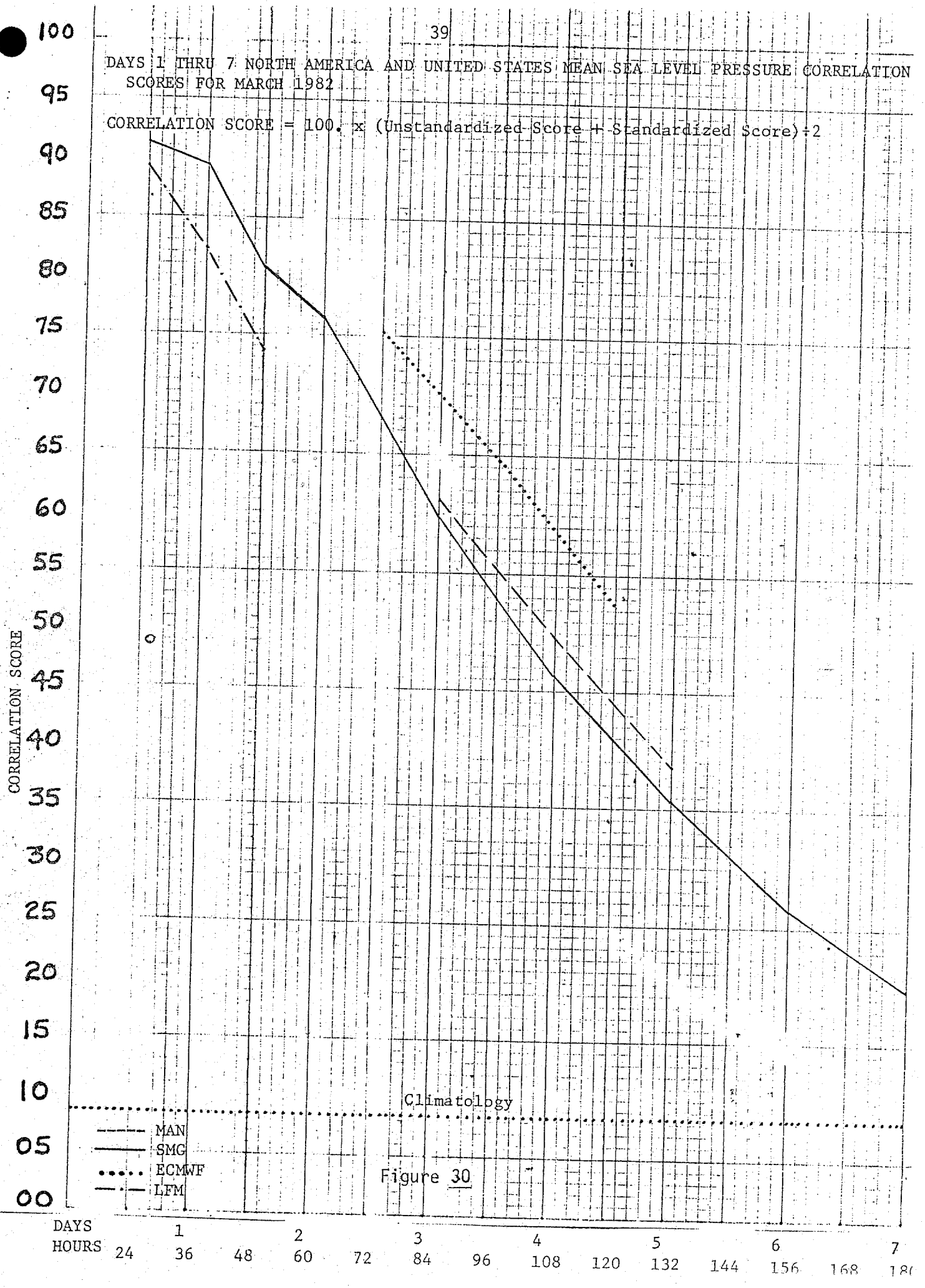


Figure 30

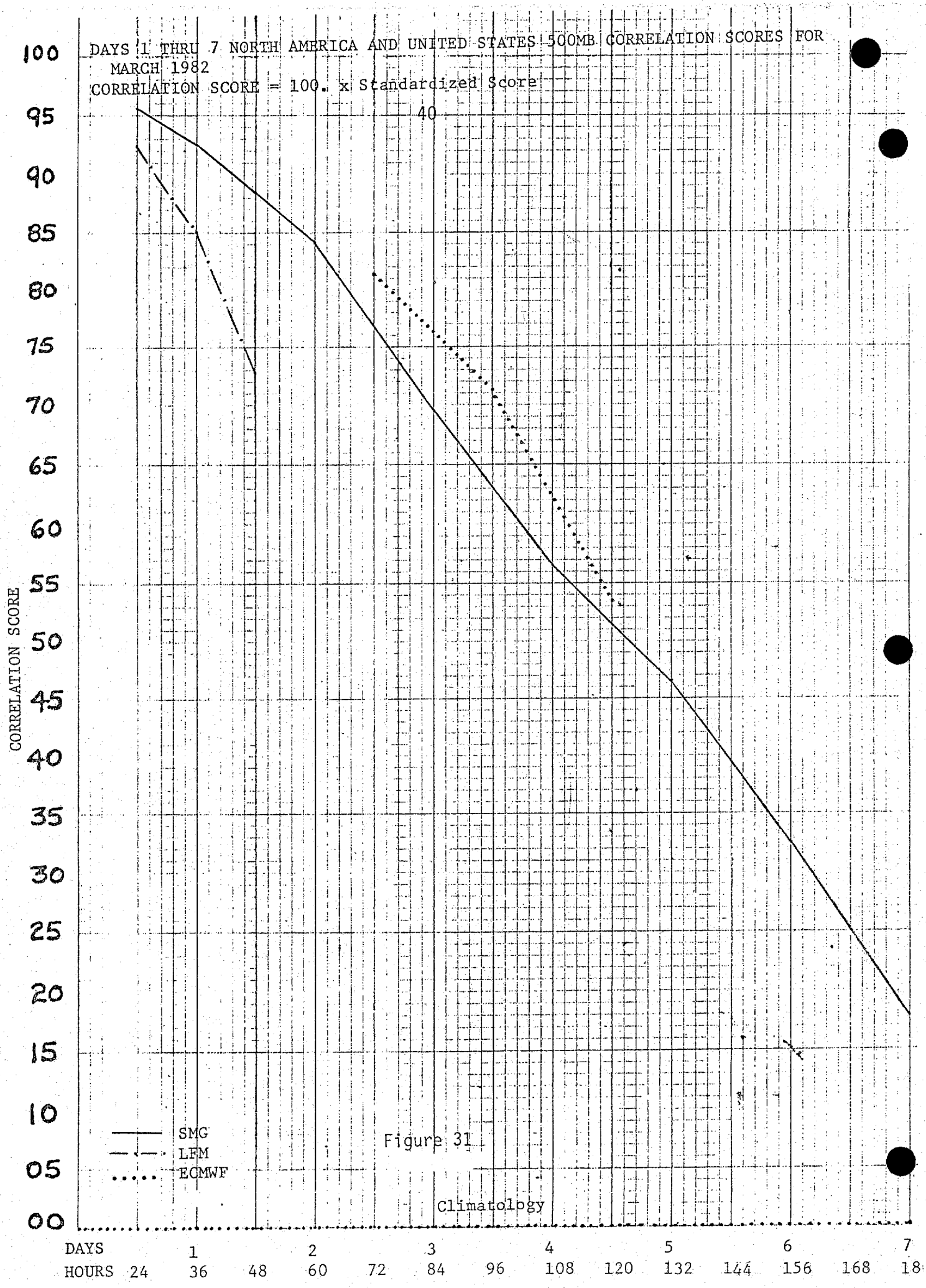

DAYS 1 THRU 7 NORTH AMERICA AND UNITED STATES 500MB CORRELATION SCORES FOR
MARCH 1982
CORRELATION SCORE = 100. x Standardized Score
40
CORRELATION SCORE
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
05
00
SMG
LFM
ECMWF
Climatology
DAYS 1 2 3 4 5 6 7
HOURS 24 36 48 60 72 84 96 108 120 132 144 156 168 18

Figure 31

DAYS 1 THRU 7 NORTH AMERICA AND UNITED STATES MEAN SEA LEVEL PRESSURE CORRELATION SCORES FOR APRIL 1982

CORRELATION SCORE = 100. x (Unstandardized Score + Standardized Score) ÷ 2

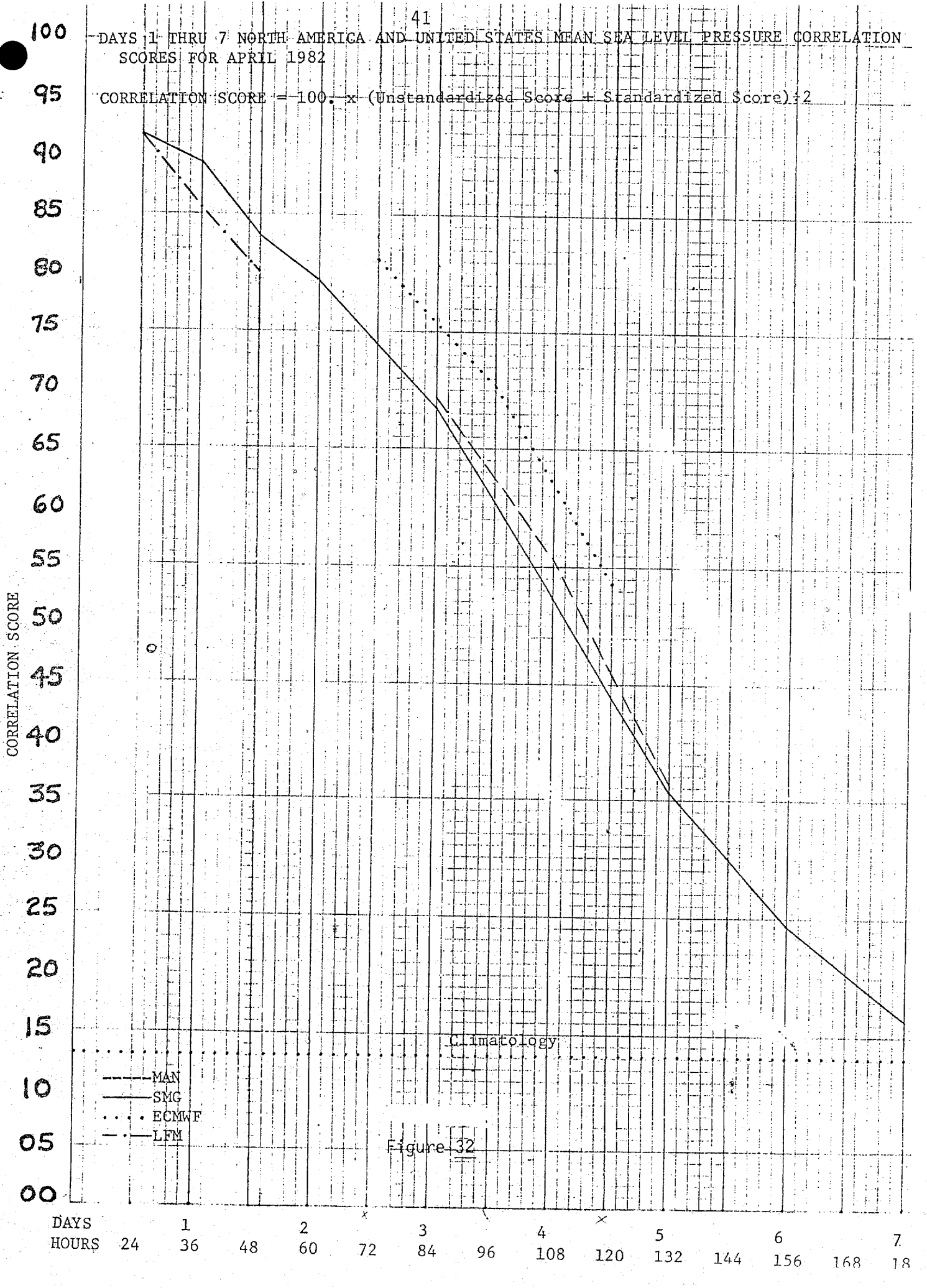


Figure 32

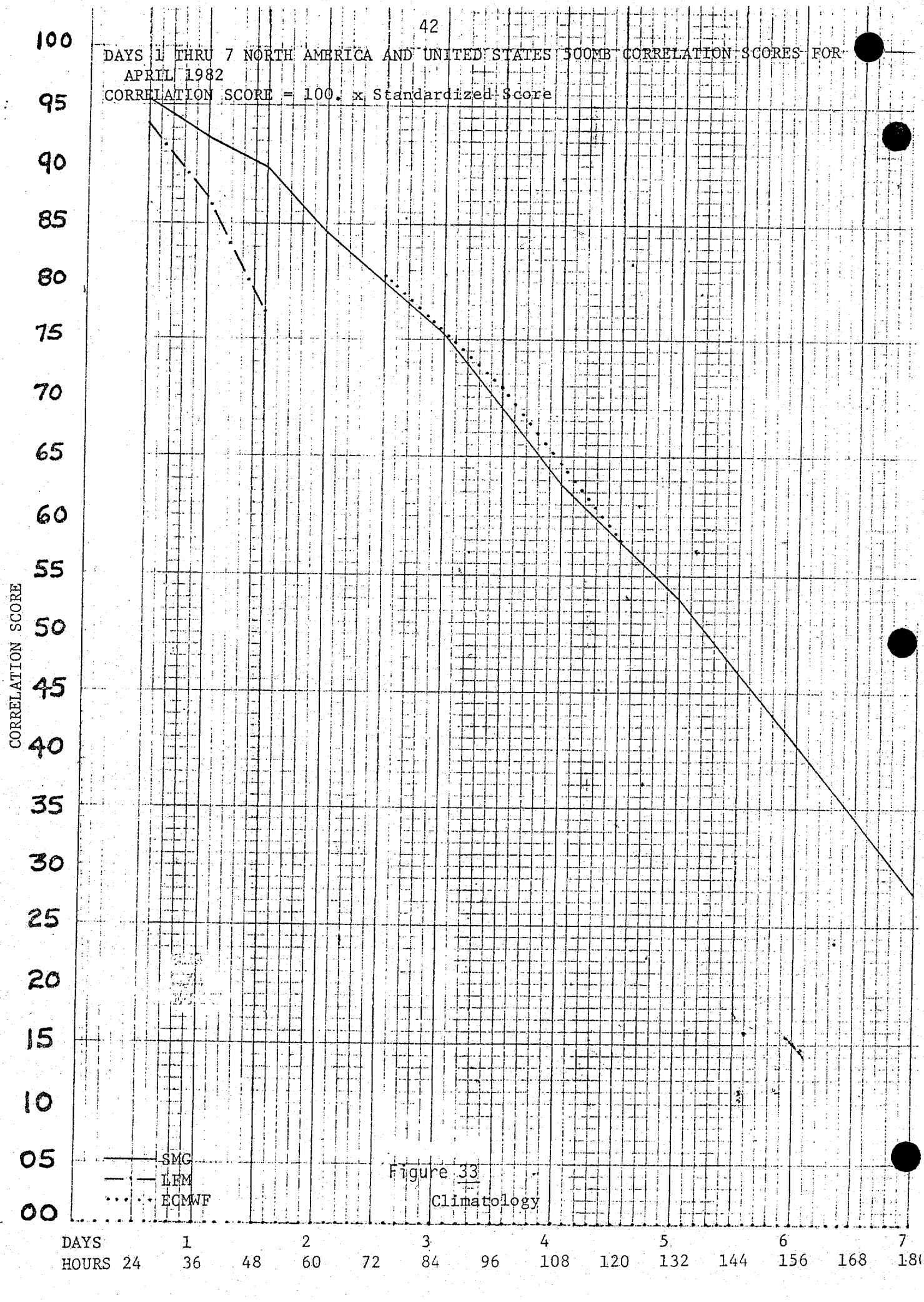


Figure 33
Climatology

DAYS 1 THRU 7 NORTH AMERICA AND UNITED STATES MEAN SEA LEVEL PRESSURE
CORRELATION SCORES FOR MAY 1982

CORRELATION SCORE = 100. x (Unstandardized Score + Standardized Score)÷2

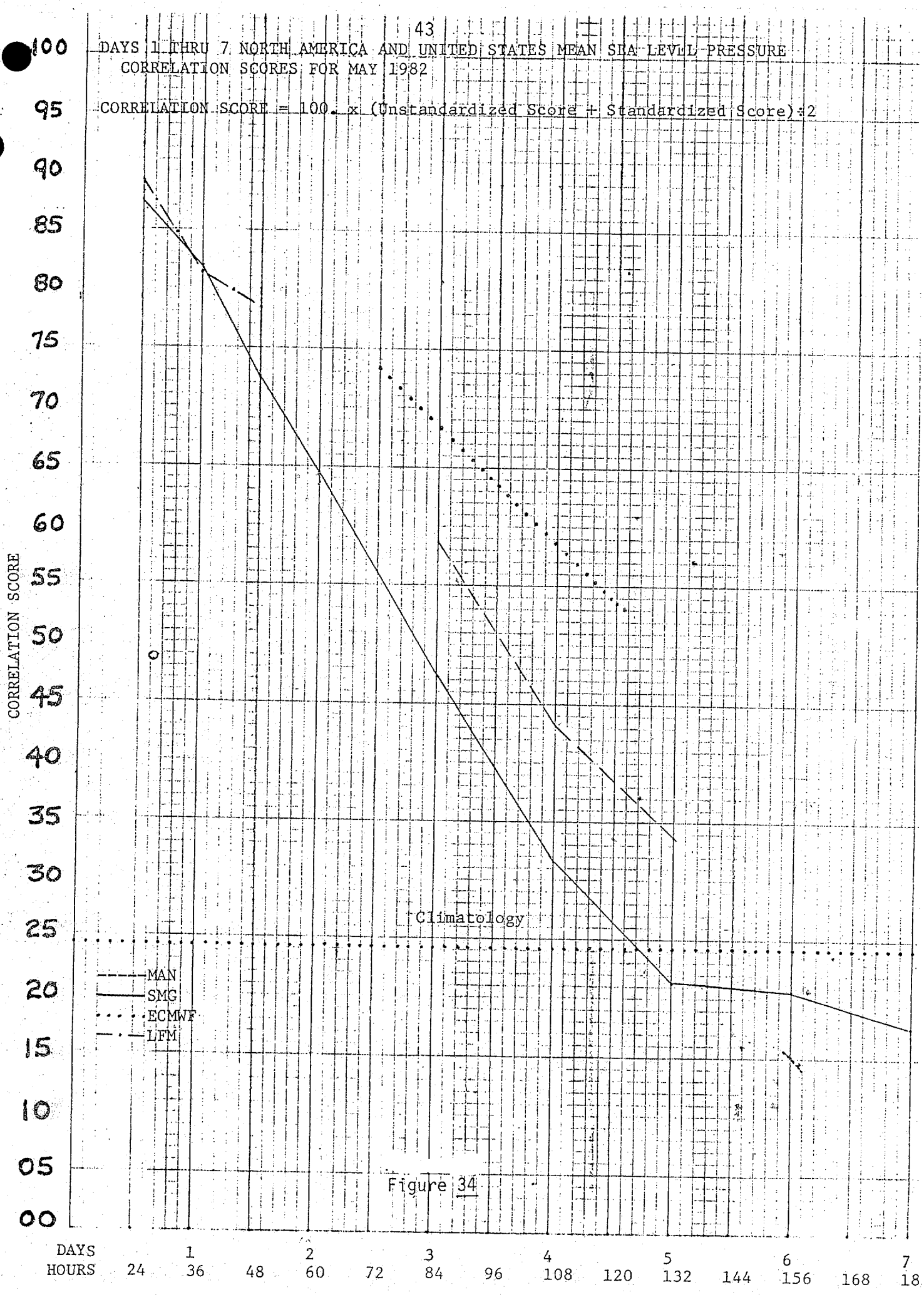


Figure 34

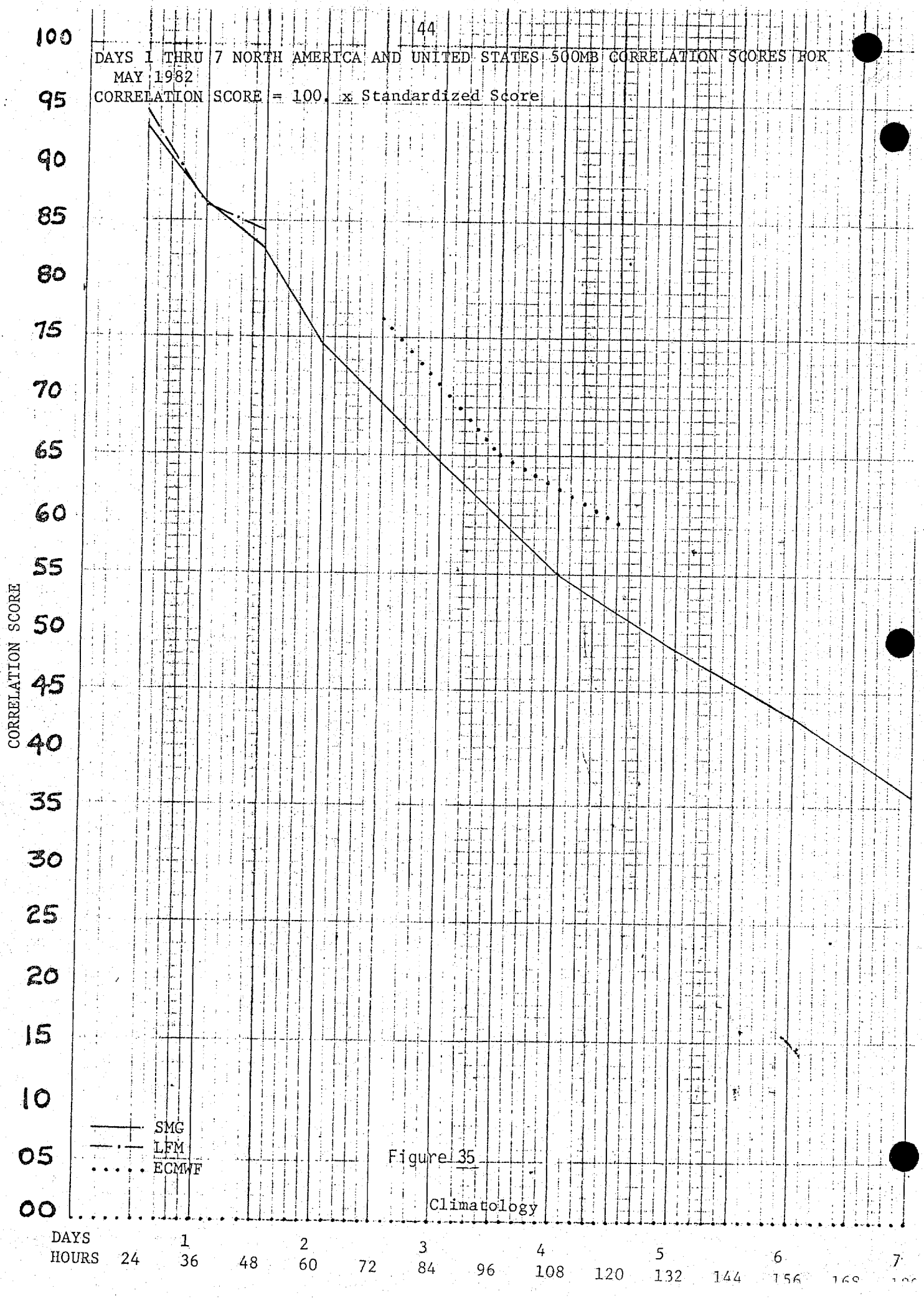

DAYS 1 THRU 7 NORTH AMERICA AND UNITED STATES 500MB CORRELATION SCORES FOR MAY 1982
CORRELATION SCORE = 100. x Standardized Score
CORRELATION SCORE
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
05
00
SMG
LFM
ECMWF
Climatology
DAYS
HOURS
24
1
36
48
2
60
72
3
84
96
4
108
120
5
132
144
6
156
7

Figure 35

DAYS 1 THRU 7 NORTH AMERICA AND UNITED STATES MEAN SEA LEVEL PRESSURE
CORRELATION SCORES FOR JUNE 1982

CORRELATION SCORE = 100. x (Unstandardized Score + Standardized Score) ÷2

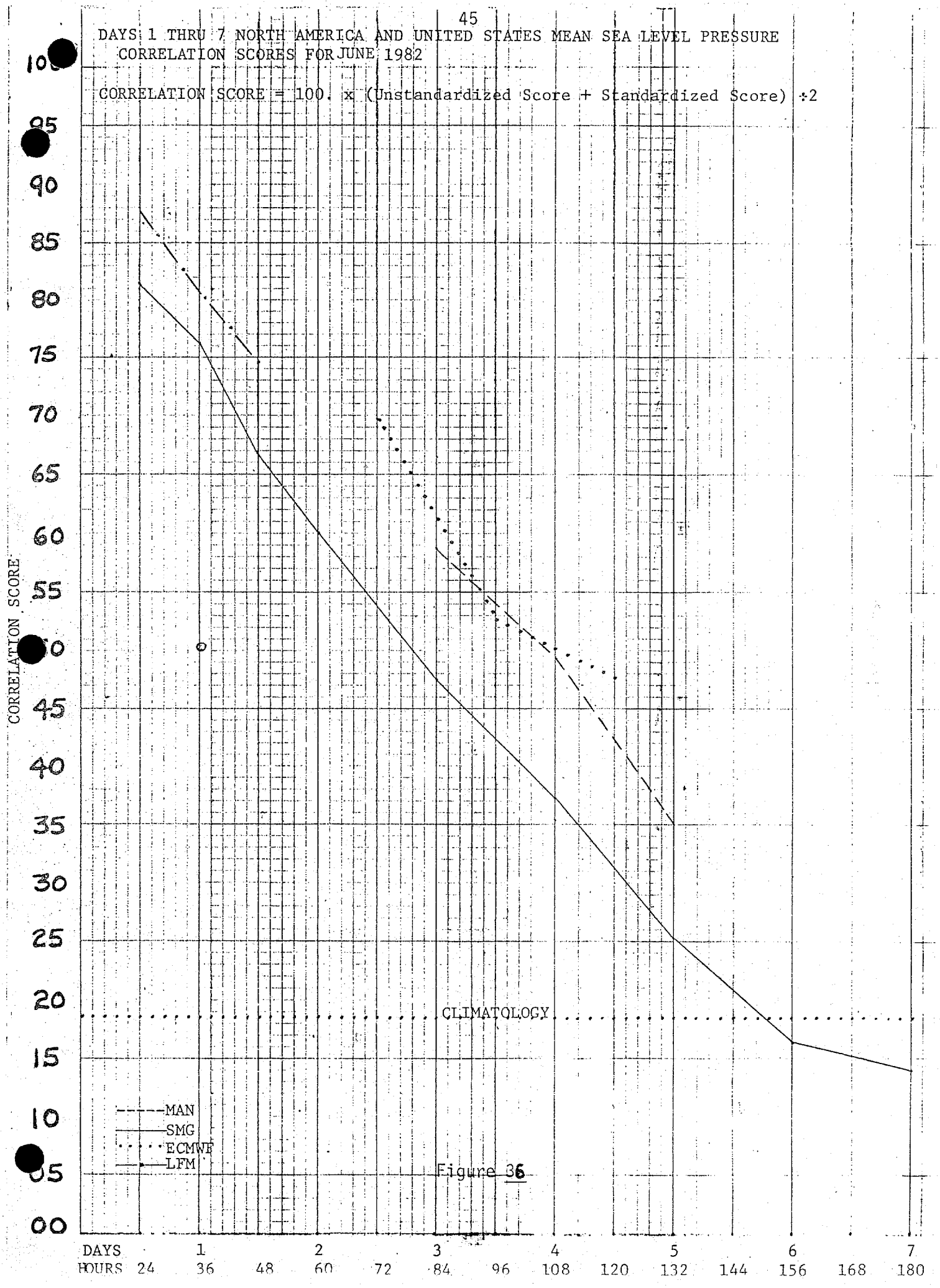


Figure 36

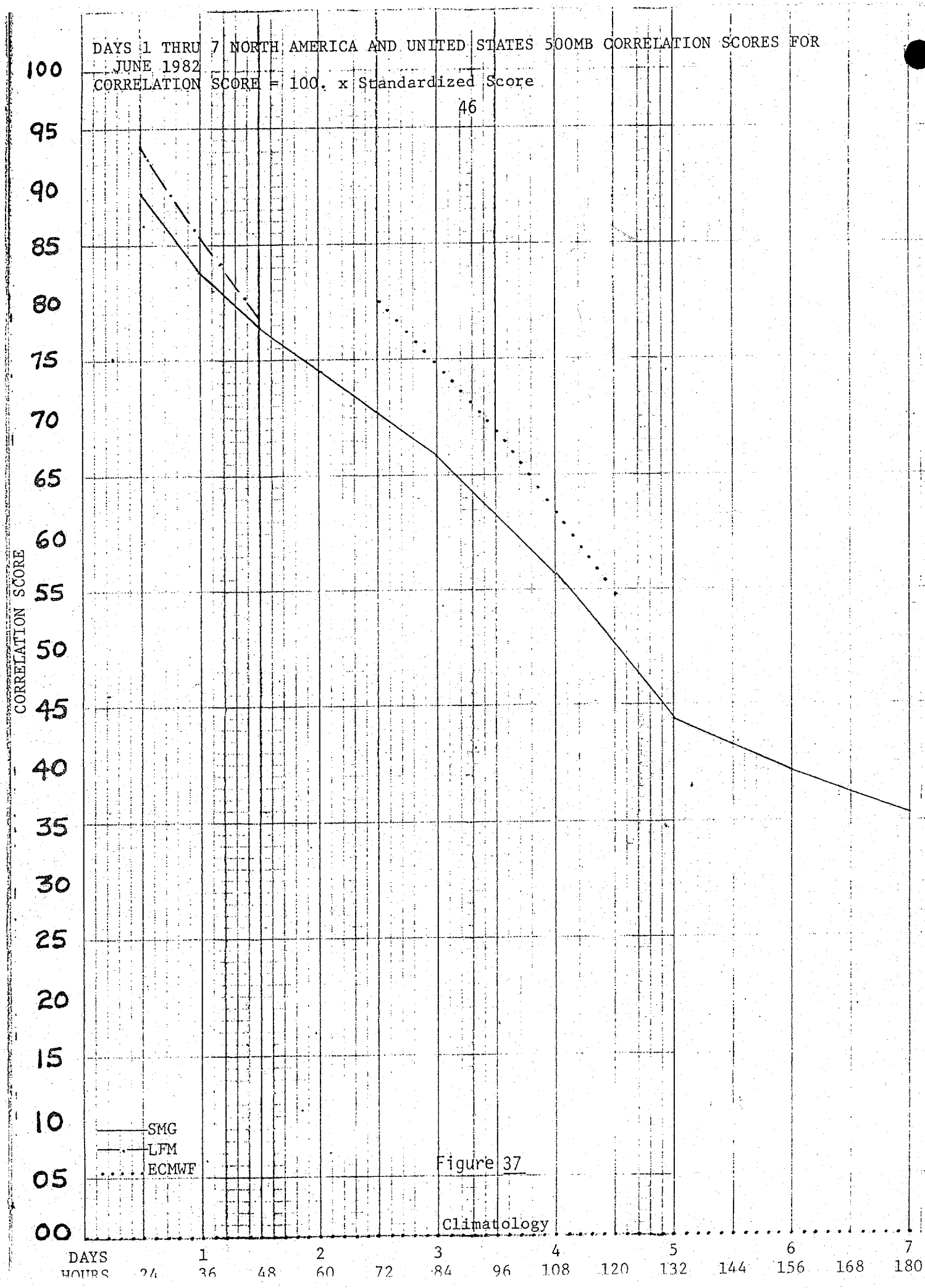

DAYS 1 THRU 7 NORTH AMERICA AND UNITED STATES 500MB CORRELATION SCORES FOR JUNE 1982
CORRELATION SCORE = 100. x Standardized Score
CORRELATION SCORE
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
05
00
SMG
LFM
ECMWF
Climatology
DAYS 1 2 3 4 5 6 7
HOURS 24 36 48 60 72 84 96 108 120 132 144 156 168 180

Figure 37

DAYS 1 THRU 7 NORTH AMERICA AND UNITED STATES MEAN SEA LEVEL PRESSURE
CORRELATION SCORES FOR JULY 1982

CORRELATION SCORE = 100. x (Unstandardized Score + Standardized Score) ÷ 2

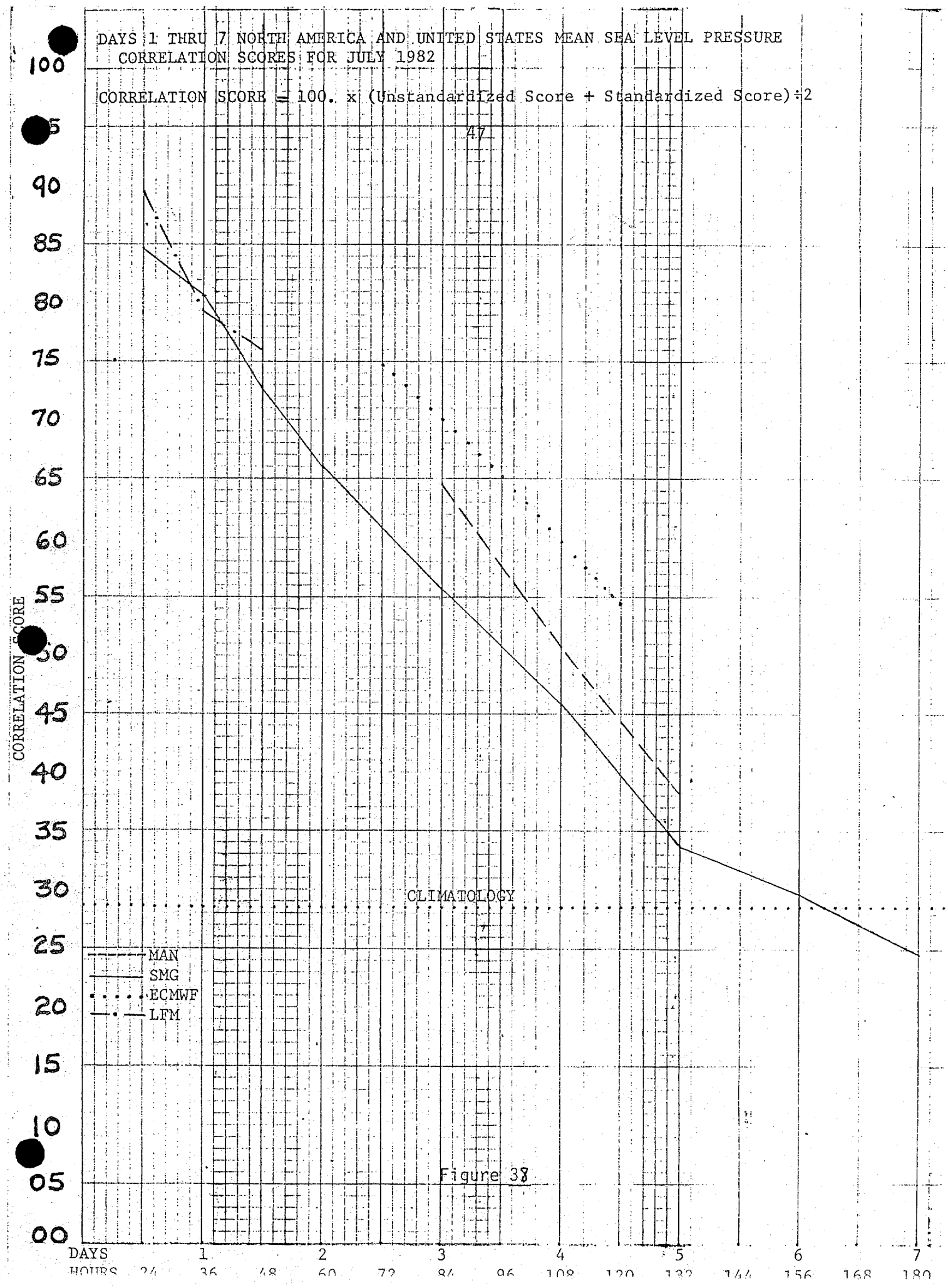


Figure 38

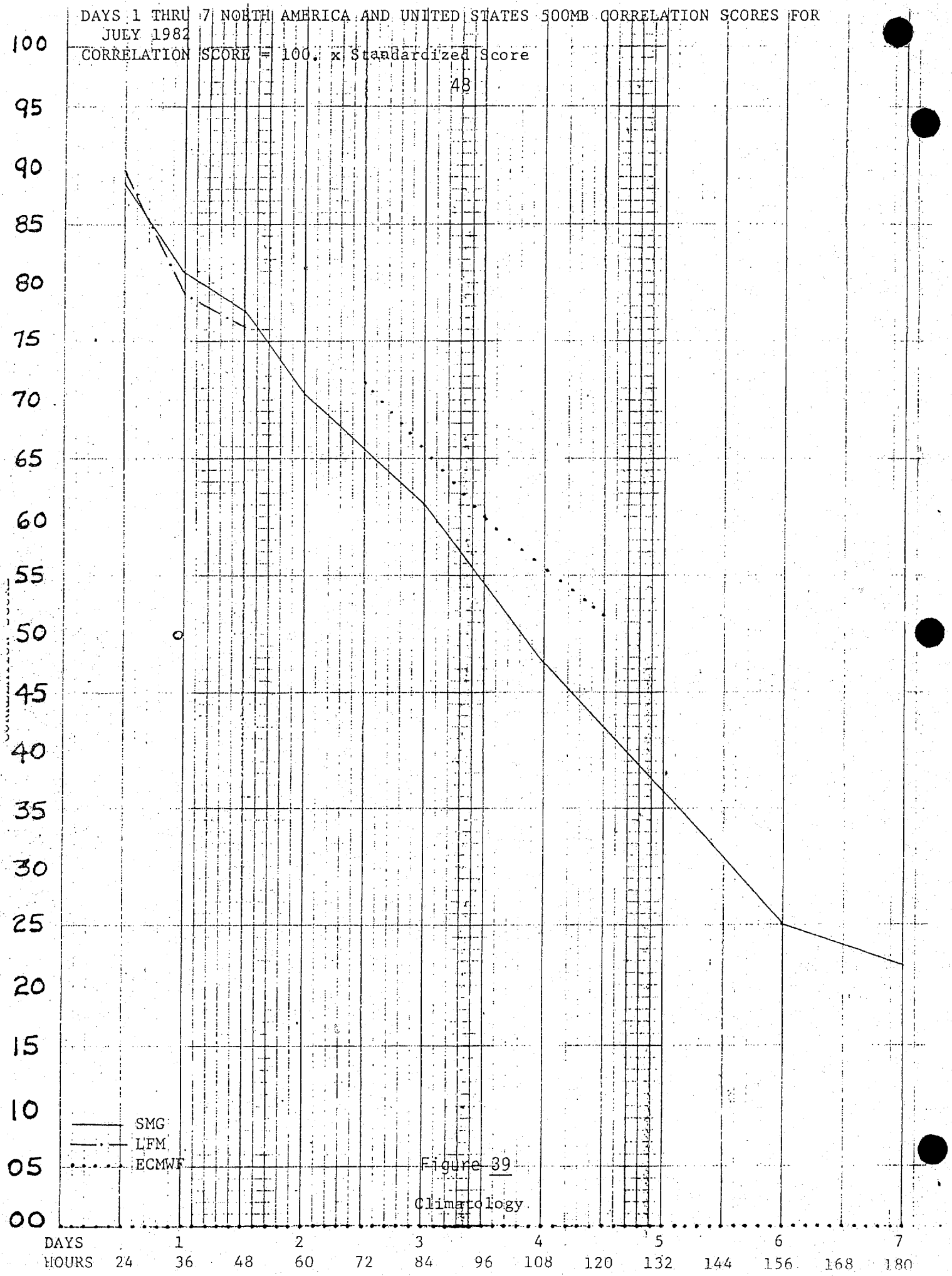

DAYS 1 THRU 7 NORTH AMERICA AND UNITED STATES 500MB CORRELATION SCORES FOR
JULY 1982
CORRELATION SCORE = 100. x Standardized Score
48
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
05
00
SMG
LFM
ECMWF
Climatology
DAYS 1 2 3 4 5 6 7
HOURS 24 36 48 60 72 84 96 108 120 132 144 156 168 180

Figure 39

DAYS 1 THRU 7 NORTH AMERICA AND UNITED STATES MEAN SEA LEVEL PRESSURE
CORRELATION SCORES FOR AUGUST 1982

CORRELATION SCORE = 100. x (Unstandardized Score + Standardized Score) ÷ 2

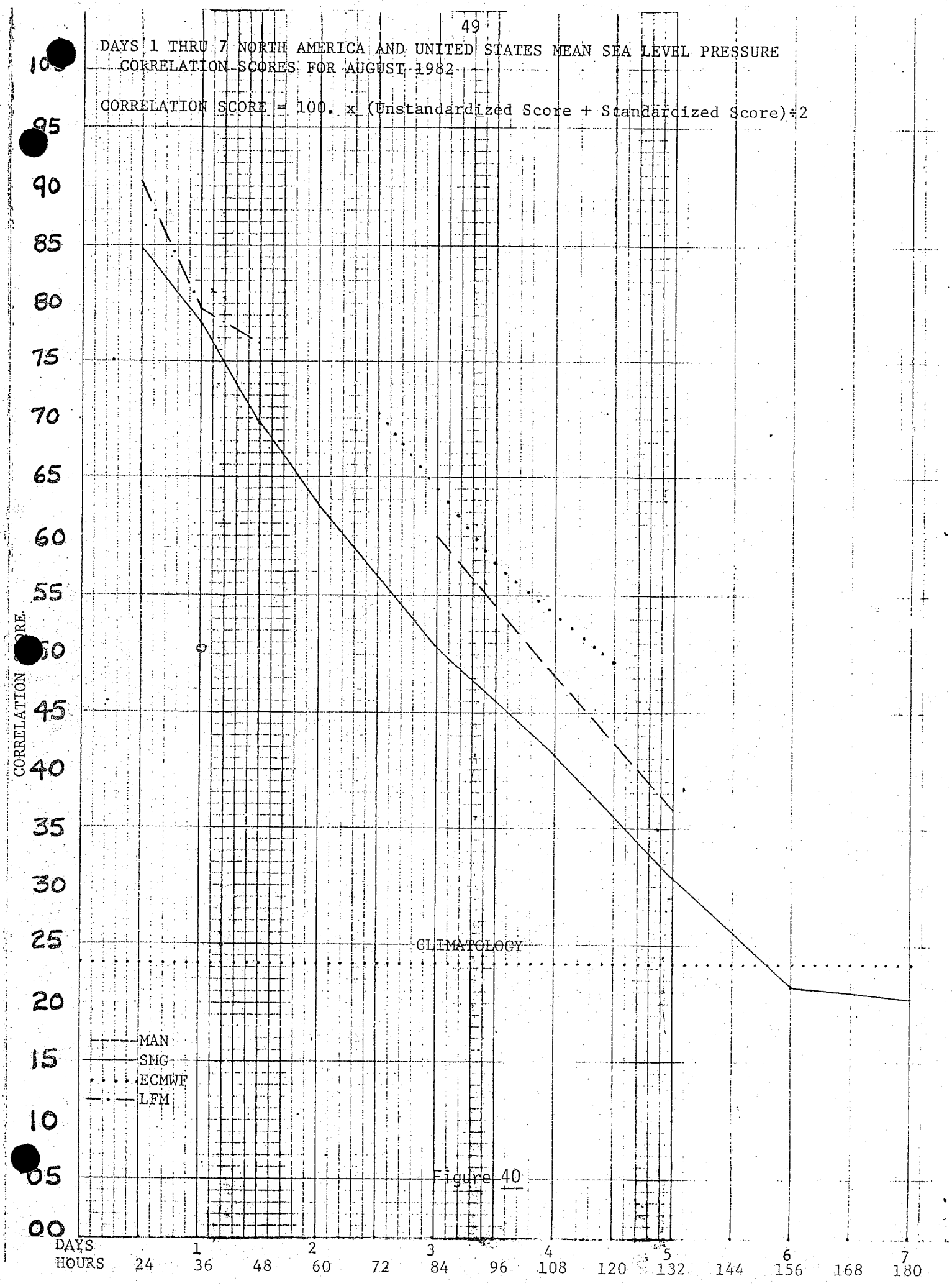


Figure 40

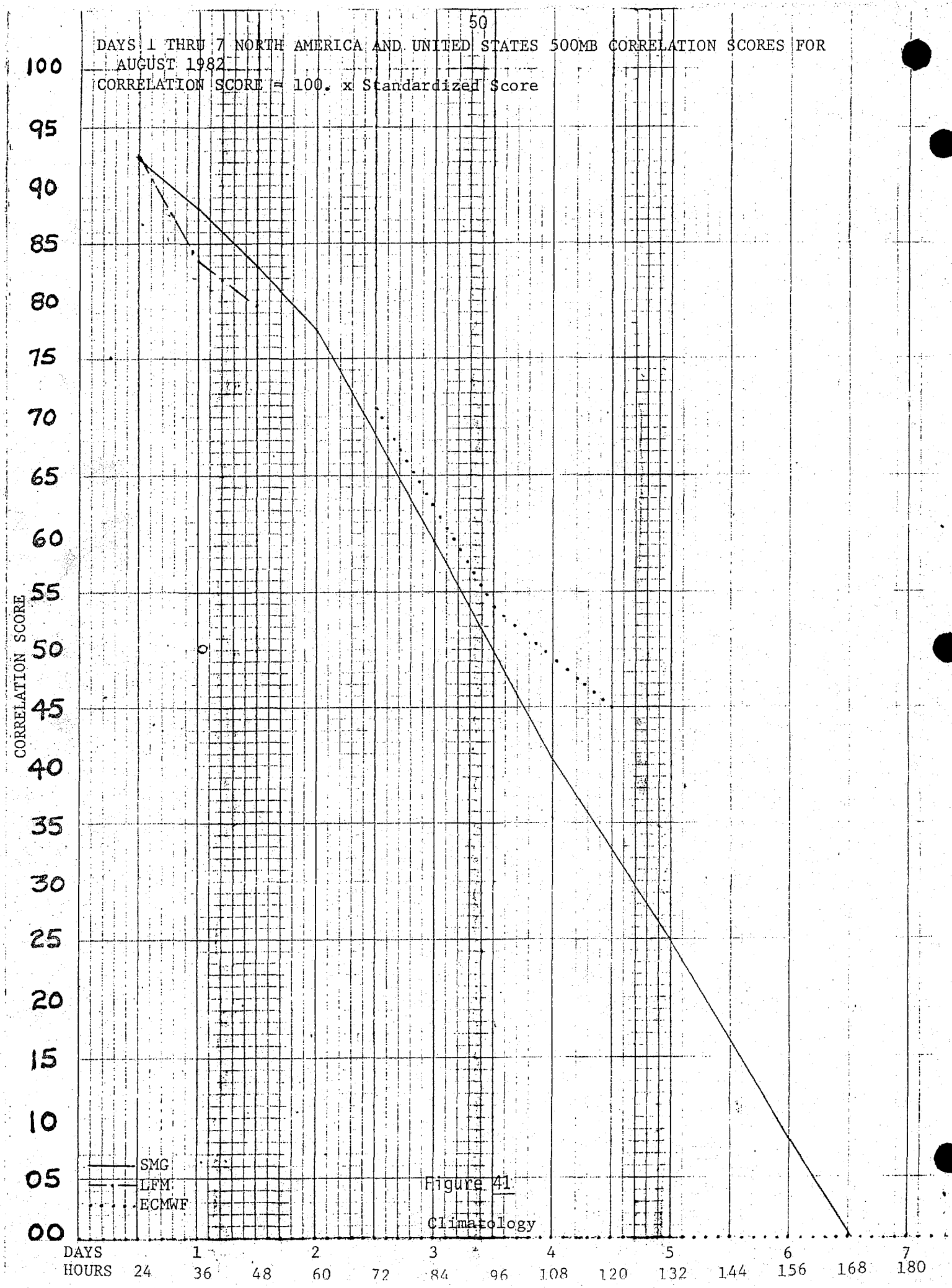

DAYS 1 THRU 7 NORTH AMERICA AND UNITED STATES 500MB CORRELATION SCORES FOR AUGUST 1982
CORRELATION SCORE = 100. x Standardized Score
CORRELATION SCORE
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
05
00
SMG
LFM
ECMWF
Climatology
DAYS 1 2 3 4 5 6 7
HOURS 24 36 48 60 72 84 96 108 120 132 144 156 168 180

Figure 41

DAYS 1 THRU 7 NORTH AMERICA AND UNITED STATES MEAN SEA LEVEL PRESSURE
CORRELATION SCORES FOR SEPTEMBER 1982

CORRELATION SCORE = 100. x (Unstandardized Score + Standardized Score)÷2

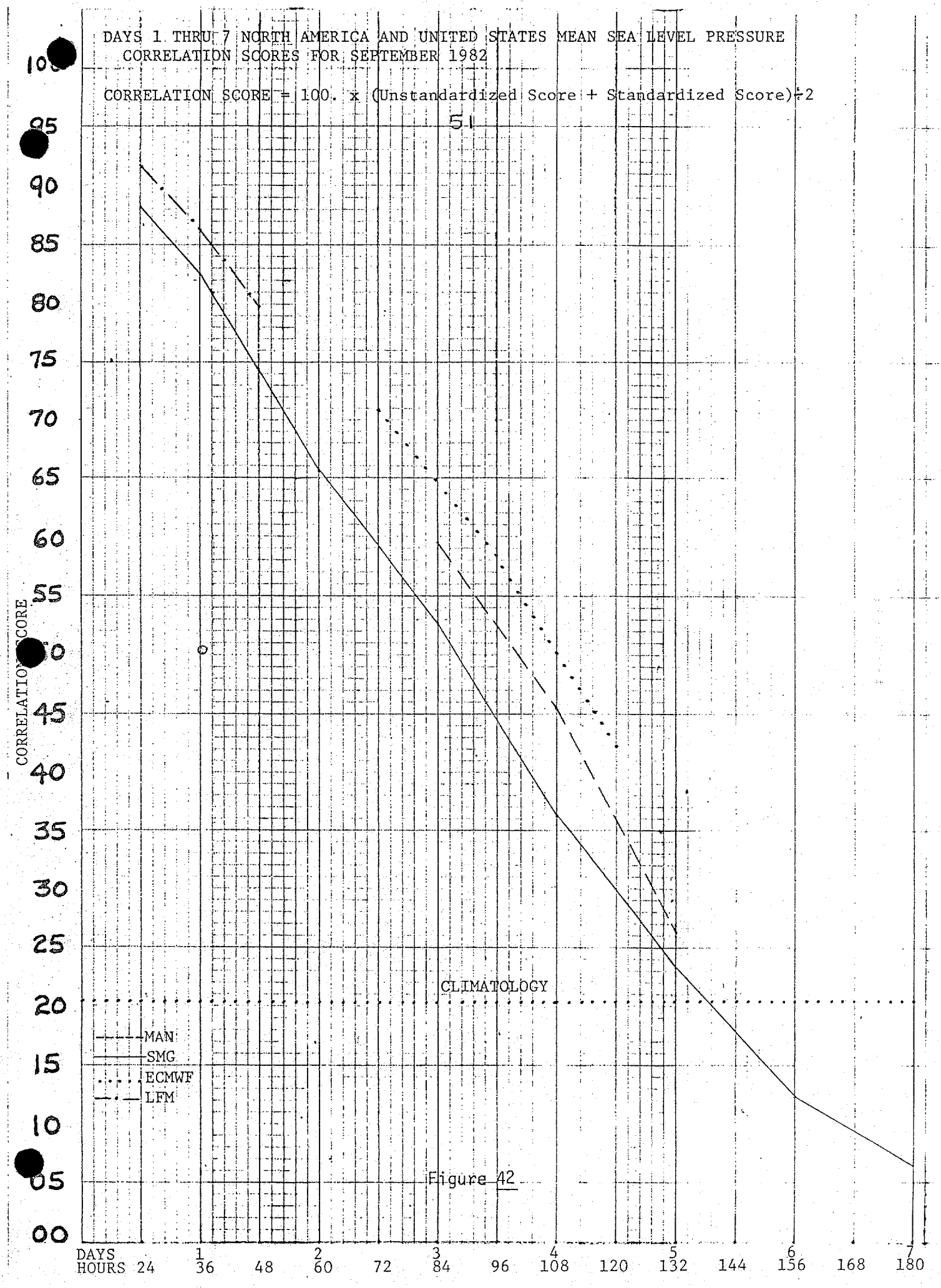


Figure 42

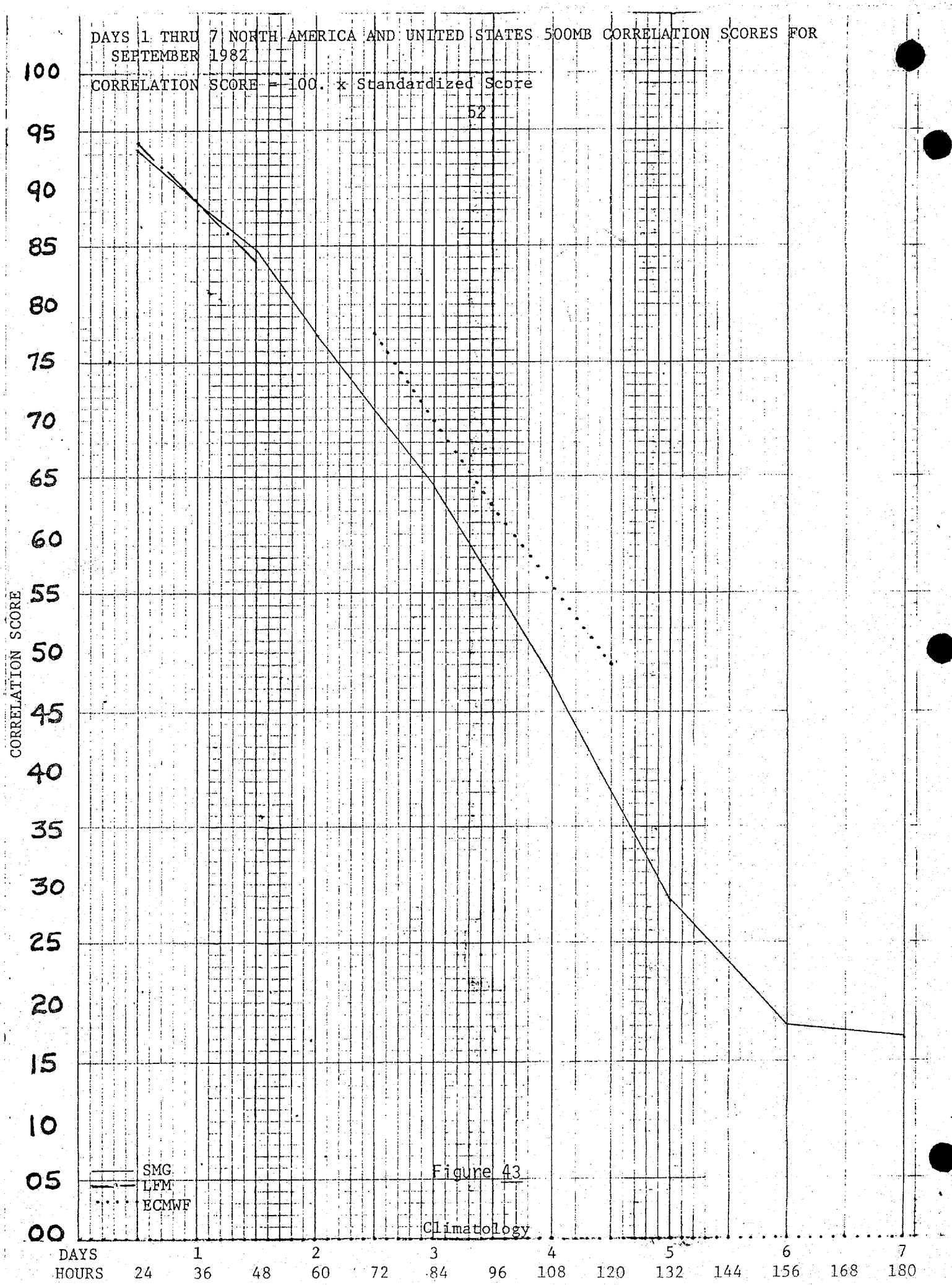

DAYS 1 THRU 7 NORTH AMERICA AND UNITED STATES 500MB CORRELATION SCORES FOR SEPTEMBER 1982
CORRELATION SCORE = 100. x Standardized Score
52
CORRELATION SCORE
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
05
00
SMG
LFM
ECMWF
Climatology
DAYS 1 2 3 4 5 6 7
HOURS 24 36 48 60 72 84 96 108 120 132 144 156 168 180

Figure 43

DAYS 1 THRU 7 NORTH AMERICA AND UNITED STATES MEAN SEA LEVEL PRESSURE
CORRELATION SCORES FOR OCTOBER 1982

CORRELATION SCORE = 100. x (Unstandardized Score + Standardized Score)÷2

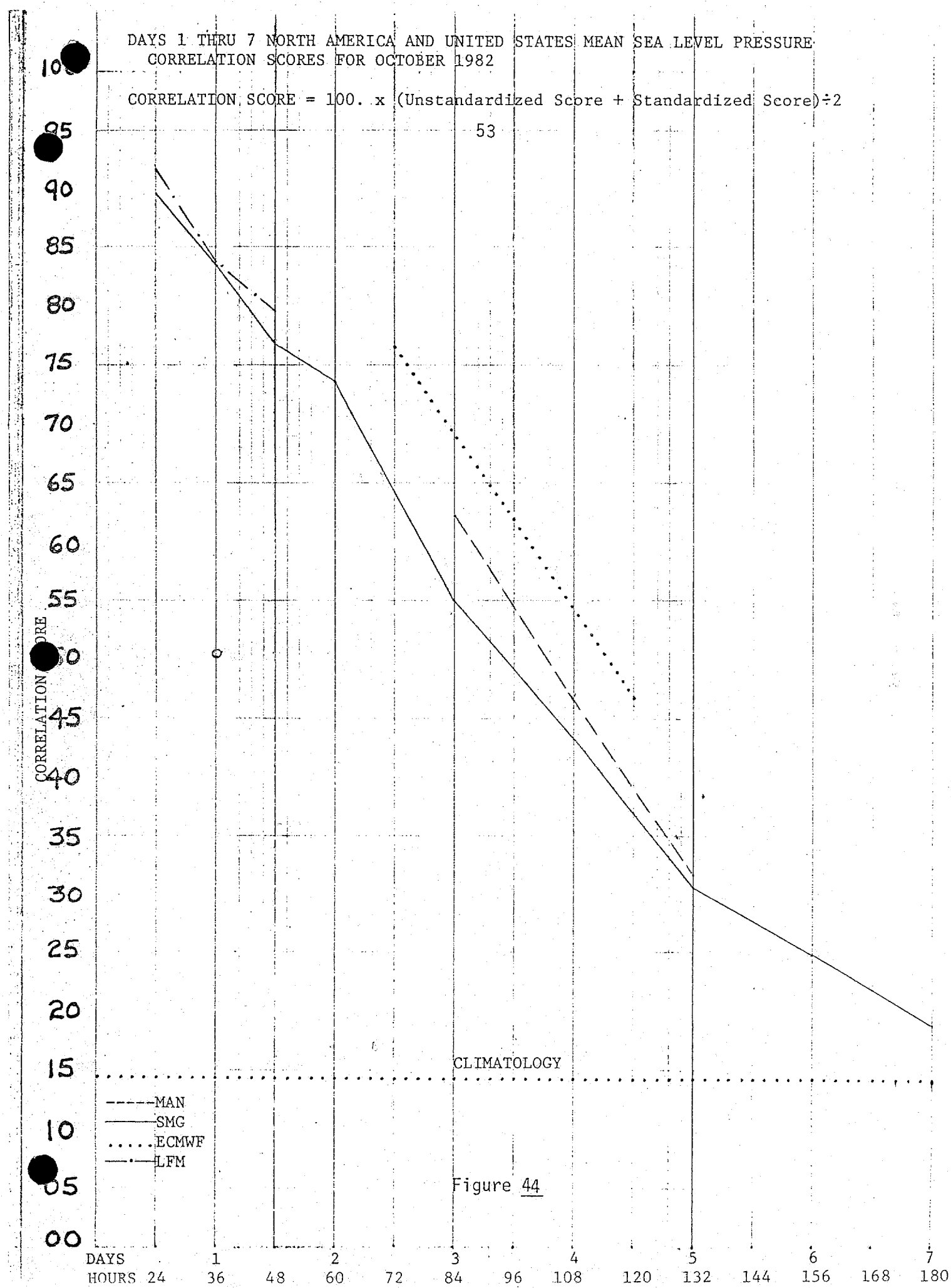


Figure 44

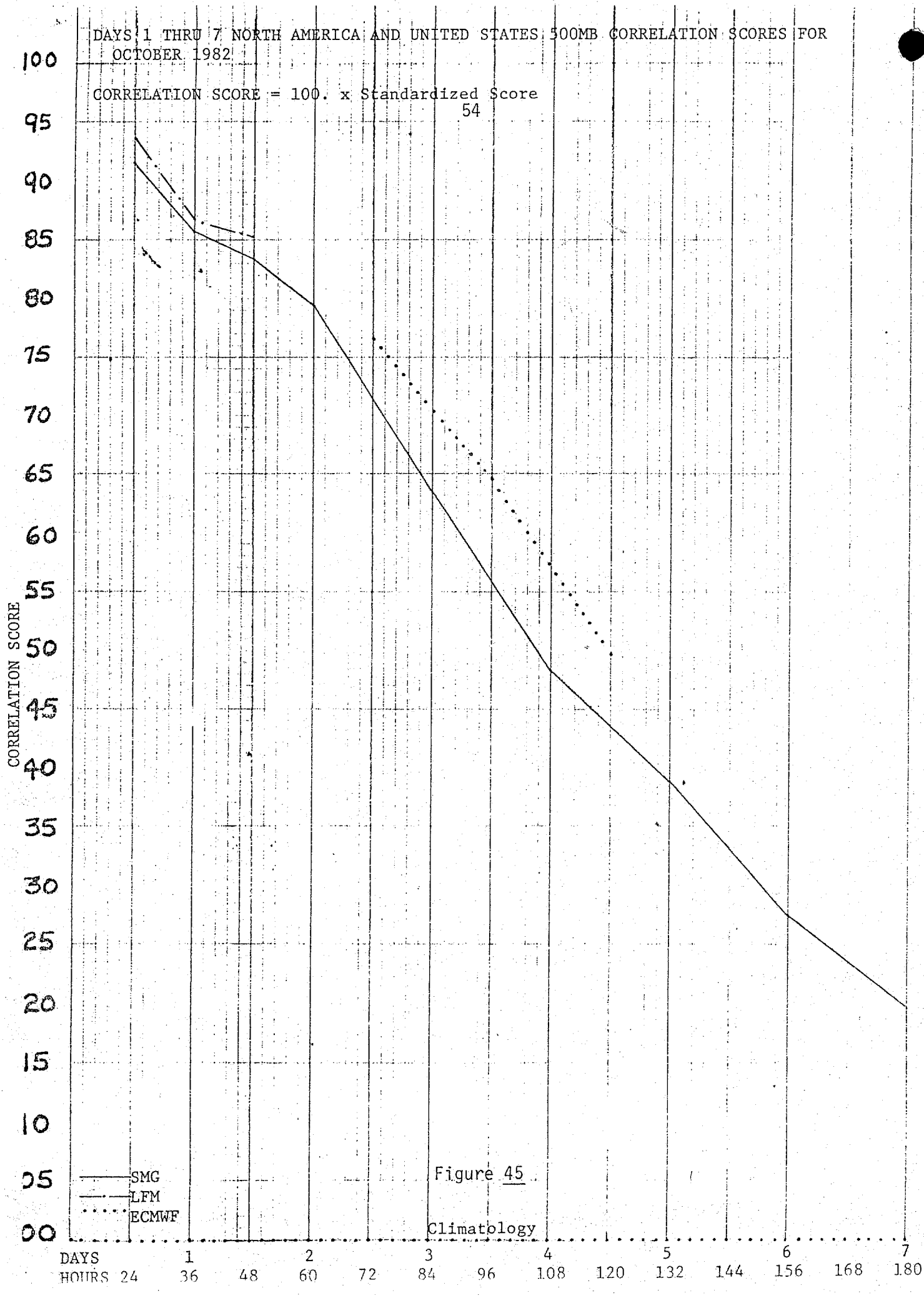

DAYS 1 THRU 7 NORTH AMERICA AND UNITED STATES 500MB CORRELATION SCORES FOR OCTOBER 1982
CORRELATION SCORE = 100. x Standardized Score
CORRELATION SCORE
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
05
00
SMG
LFM
ECMWF
Climatology
DAYS 1 2 3 4 5 6 7
HOURS 24 36 48 60 72 84 96 108 120 132 144 156 168 180

Figure 45

DAYS 1 THRU 7 NORTH AMERICAN AND UNITED STATES MEAN SEA LEVEL PRESSURE
CORRELATION SCORES FOR NOVEMBER 1982

CORRELATION SCORE = 100. x (Unstandardized Score + Standardized Score) ÷ 2

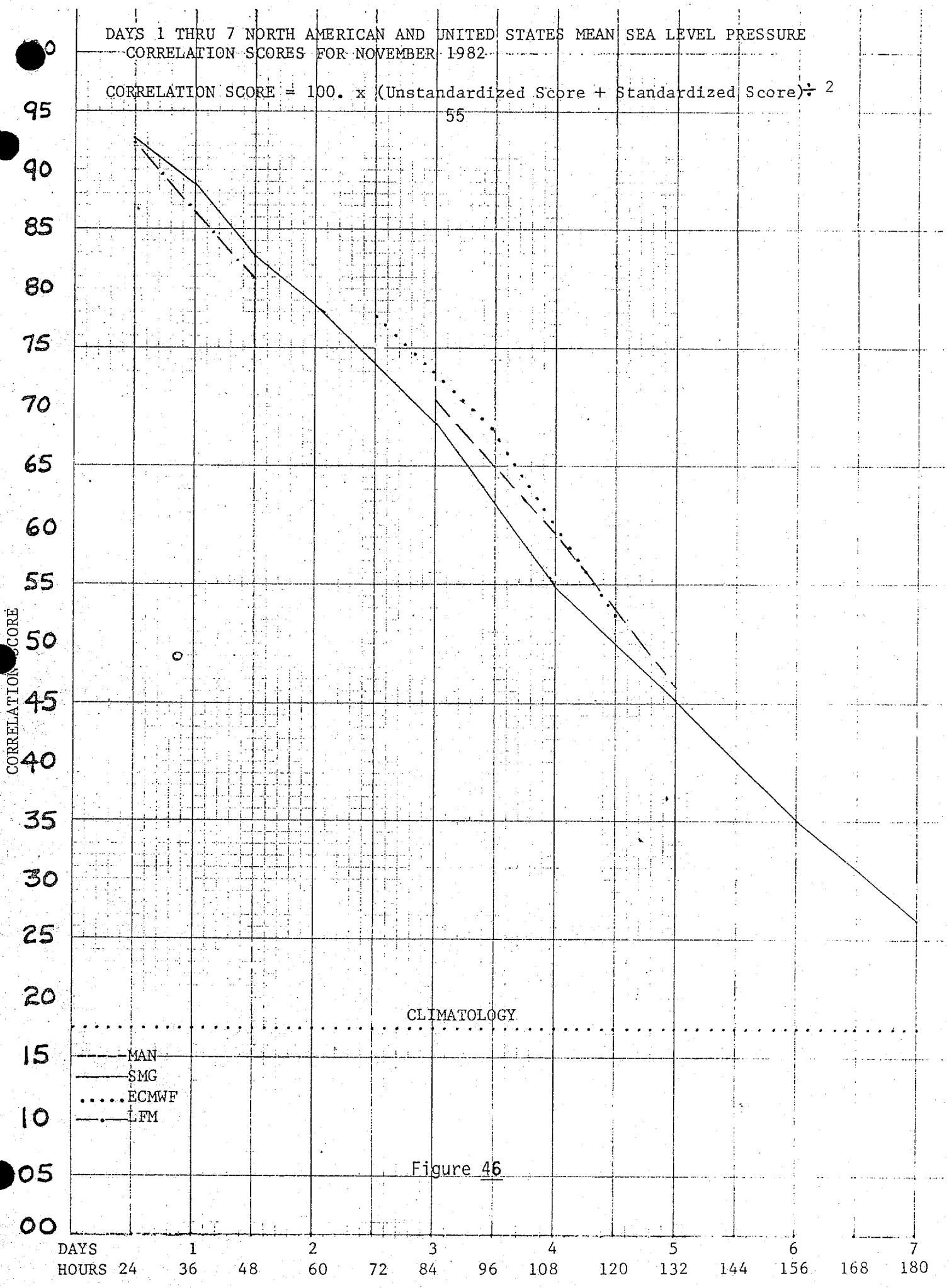


Figure 46

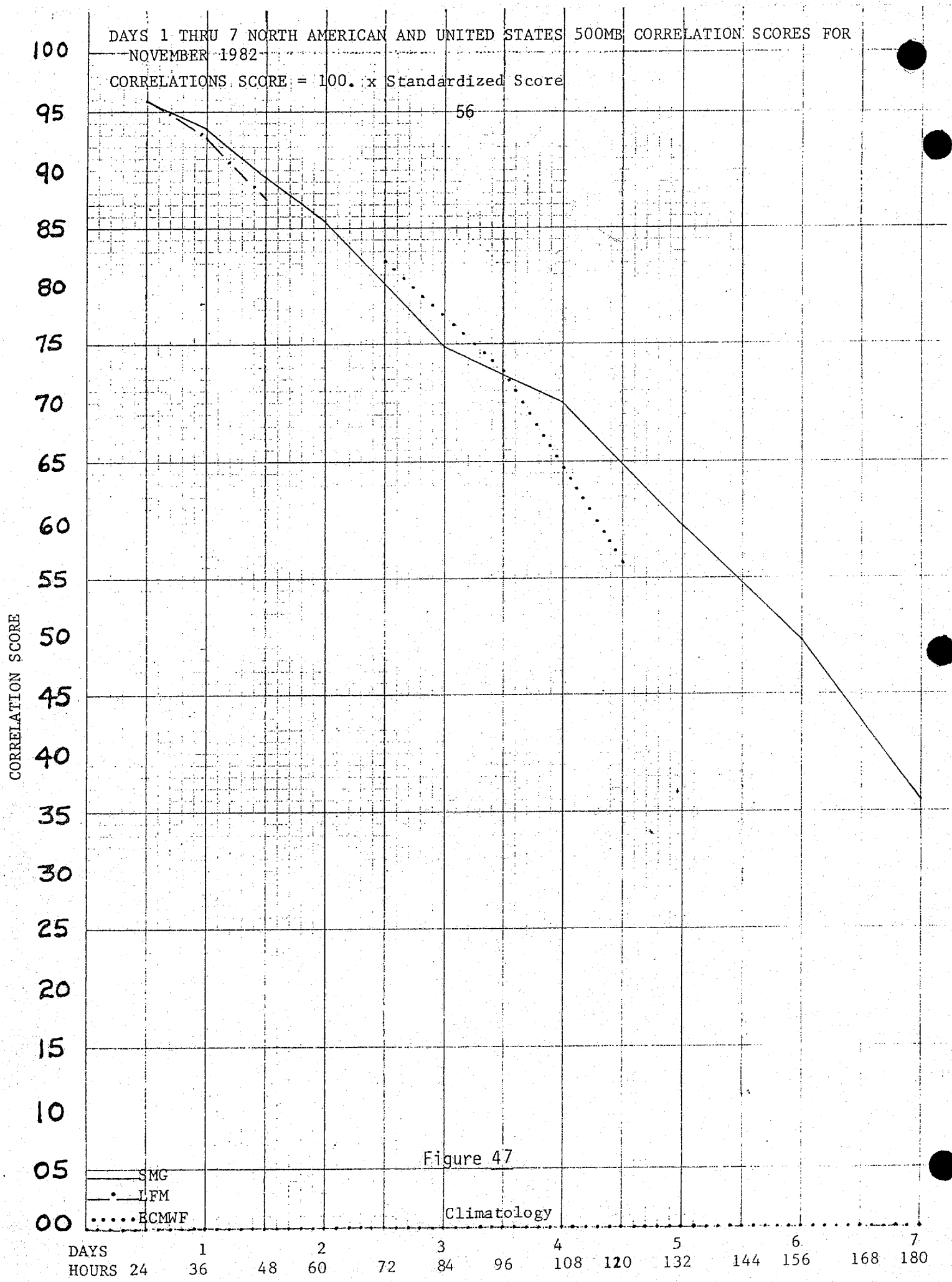

DAYS 1 THRU 7 NORTH AMERICAN AND UNITED STATES 500MB CORRELATION SCORES FOR NOVEMBER 1982
CORRELATIONS SCORE = 100. x Standardized Score
56
CORRELATION SCORE
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
05
00
SMG
LFM
ECMWF
Climatology
DAYS 1 2 3 4 5 6 7
HOURS 24 36 48 60 72 84 96 108 120 132 144 156 168 180

Figure 47

DAYS 1 THRU 7 NORTH AMERICAN AND UNITED STATES MEAN SEA LEVEL PRESSURE
CORRELATION SCORES FOR DECEMBER 1982

CORRELATION SCORE = 100. x (Unstandardized Score + Standardized Score) ÷ 2

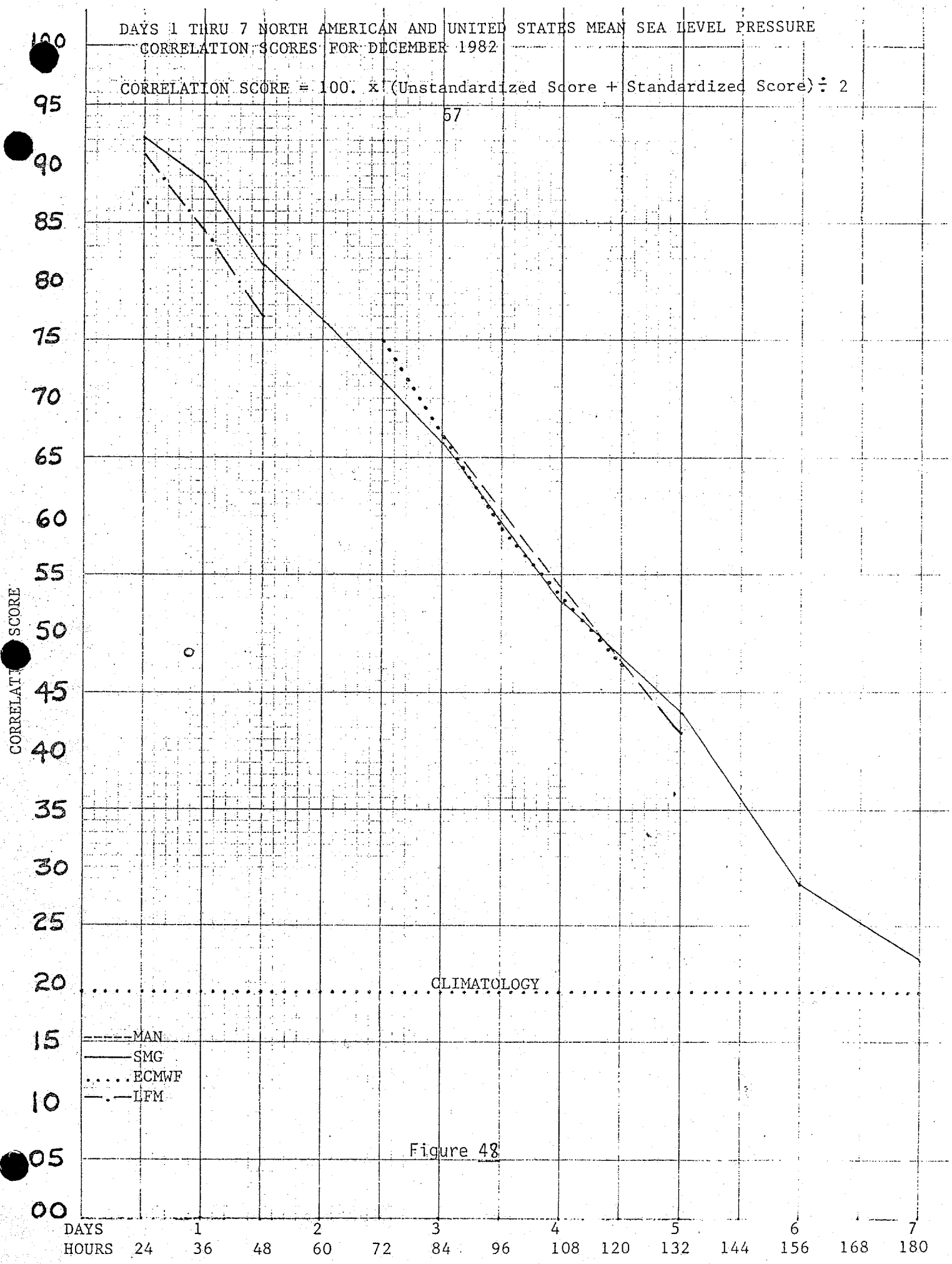


Figure 48

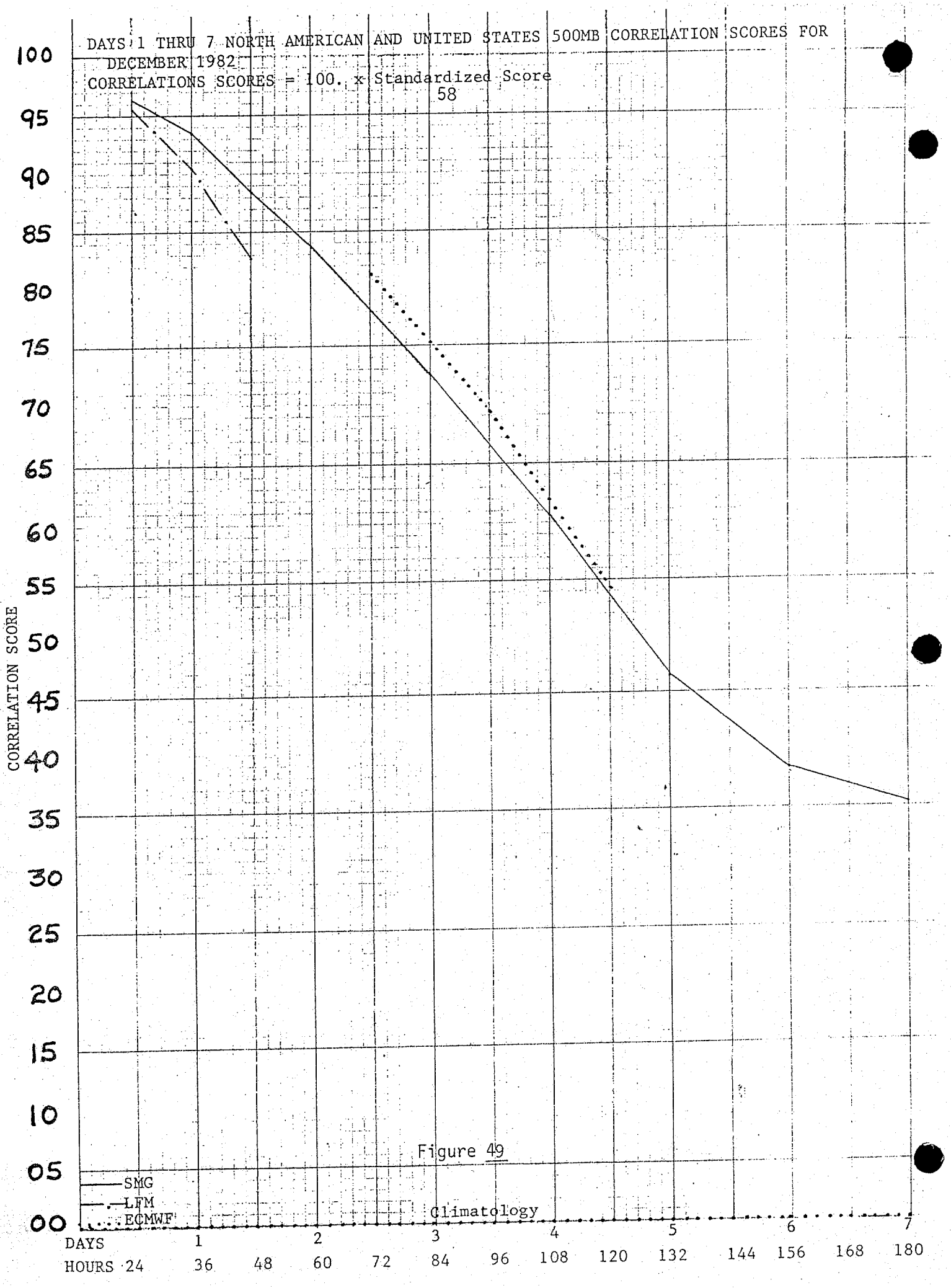

DAYS 1 THRU 7 NORTH AMERICAN AND UNITED STATES 500MB CORRELATION SCORES FOR
DECEMBER 1982
CORRELATIONS SCORES = 100. x Standardized Score
CORRELATION SCORE
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
05
00
SMG
LFM
ECMWF
Climatology
DAYS 1 2 3 4 5 6 7
HOURS 24 36 48 60 72 84 96 108 120 132 144 156 168 180

Figure 49

SECTION 3

Man & Machine (Numerical Model Guidance)

Seasonal Mean Sea Level Pressure

Correlation Scores for 1977 through 1982

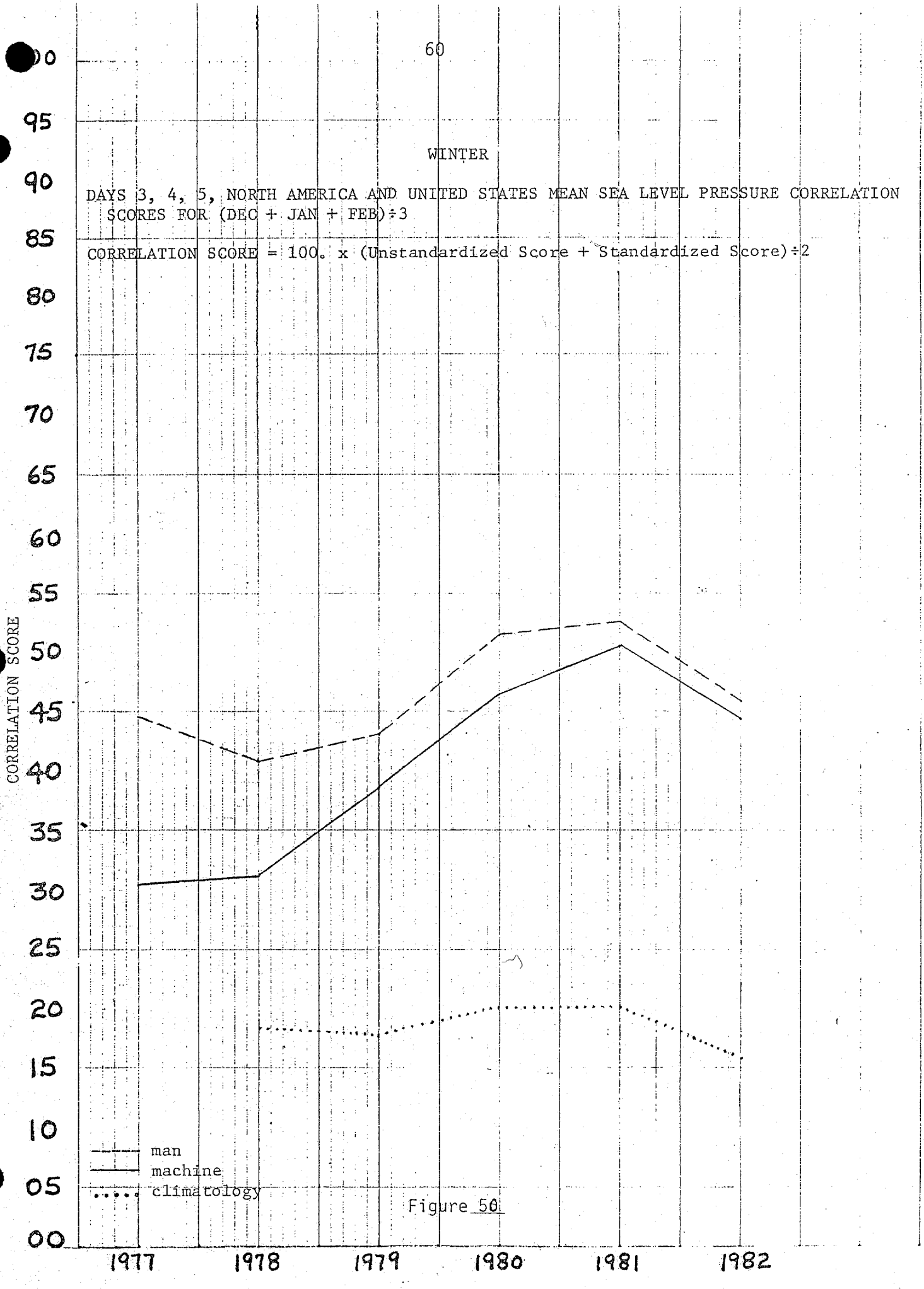

WINTER
DAYS 3, 4, 5, NORTH AMERICA AND UNITED STATES MEAN SEA LEVEL PRESSURE CORRELATION SCORES FOR (DEC + JAN + FEB)÷3
CORRELATION SCORE = 100. x (Unstandardized Score + Standardized Score)÷2
CORRELATION SCORE
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
05
00
1977
1978
1979
1980
1981
1982
man
machine
climatology

Figure 50

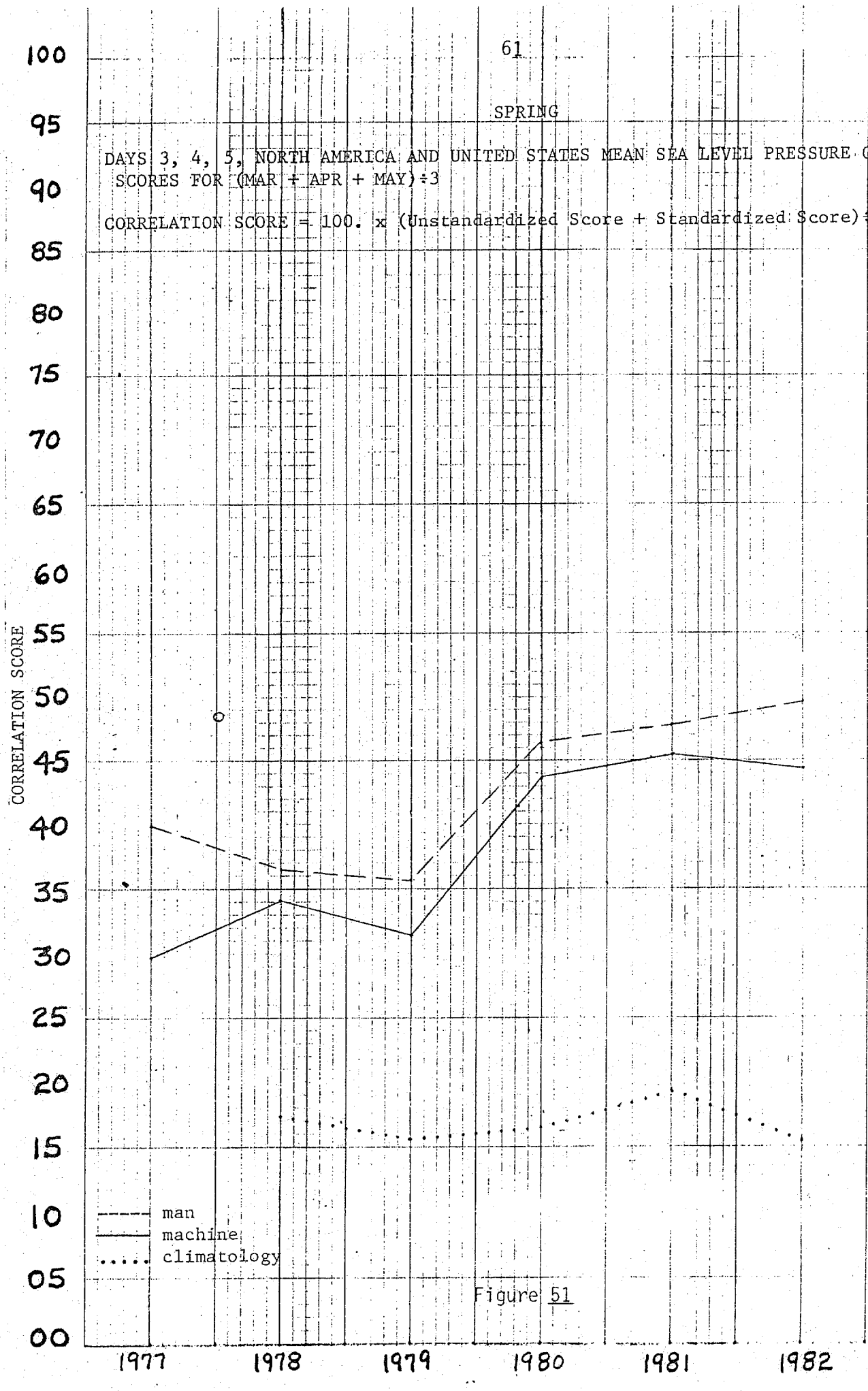

SPRING
DAYS 3, 4, 5, NORTH AMERICA AND UNITED STATES MEAN SEA LEVEL PRESSURE CORRELATION SCORES FOR (MAR + APR + MAY)÷3
CORRELATION SCORE = 100. x (Unstandardized Score + Standardized Score)÷2
CORRELATION SCORE
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
05
00
1977
1978
1979
1980
1981
1982
man
machine
climatology

Figure 51

SUMMER

DAYS 3, 4, 5, NORTH AMERICA AND UNITED STATES MEAN SEA LEVEL PRESSURE CORRELATION SCORES FOR (JUN + JUL + AUG) ÷ 3

CORRELATION SCORE = 100. x (Unstandardized Score + Standardized Score) ÷ 2

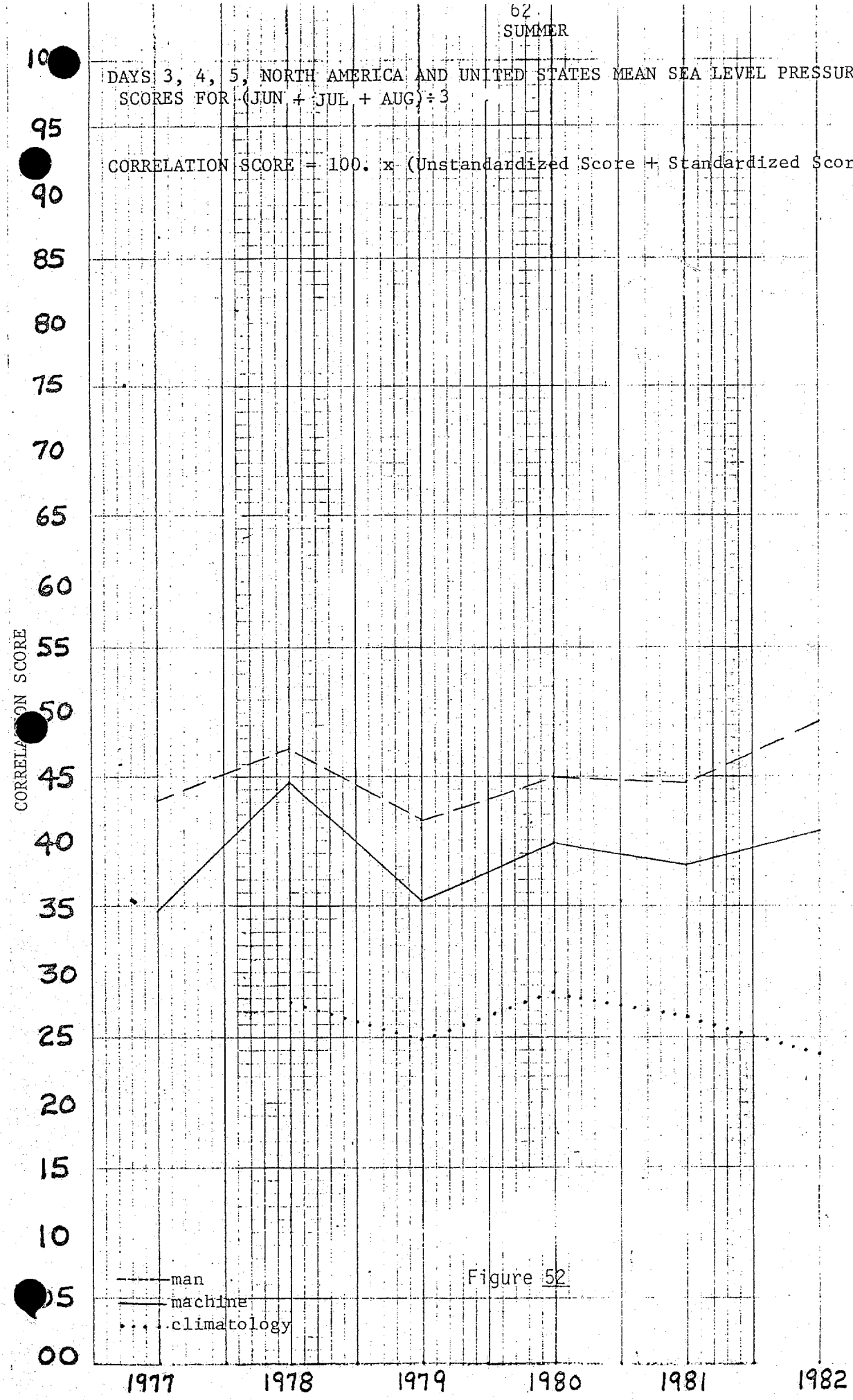


Figure 52

FALL

DAYS 3, 4, 5, NORTH AMERICA AND UNITED STATES MEAN SEA LEVEL PRESSURE CORRELATION SCORES FOR (SEP + OCT + NOV) ÷ 3

CORRELATION SCORE = 100. x (Unstandardized Score + Standardized Score) ÷ 2

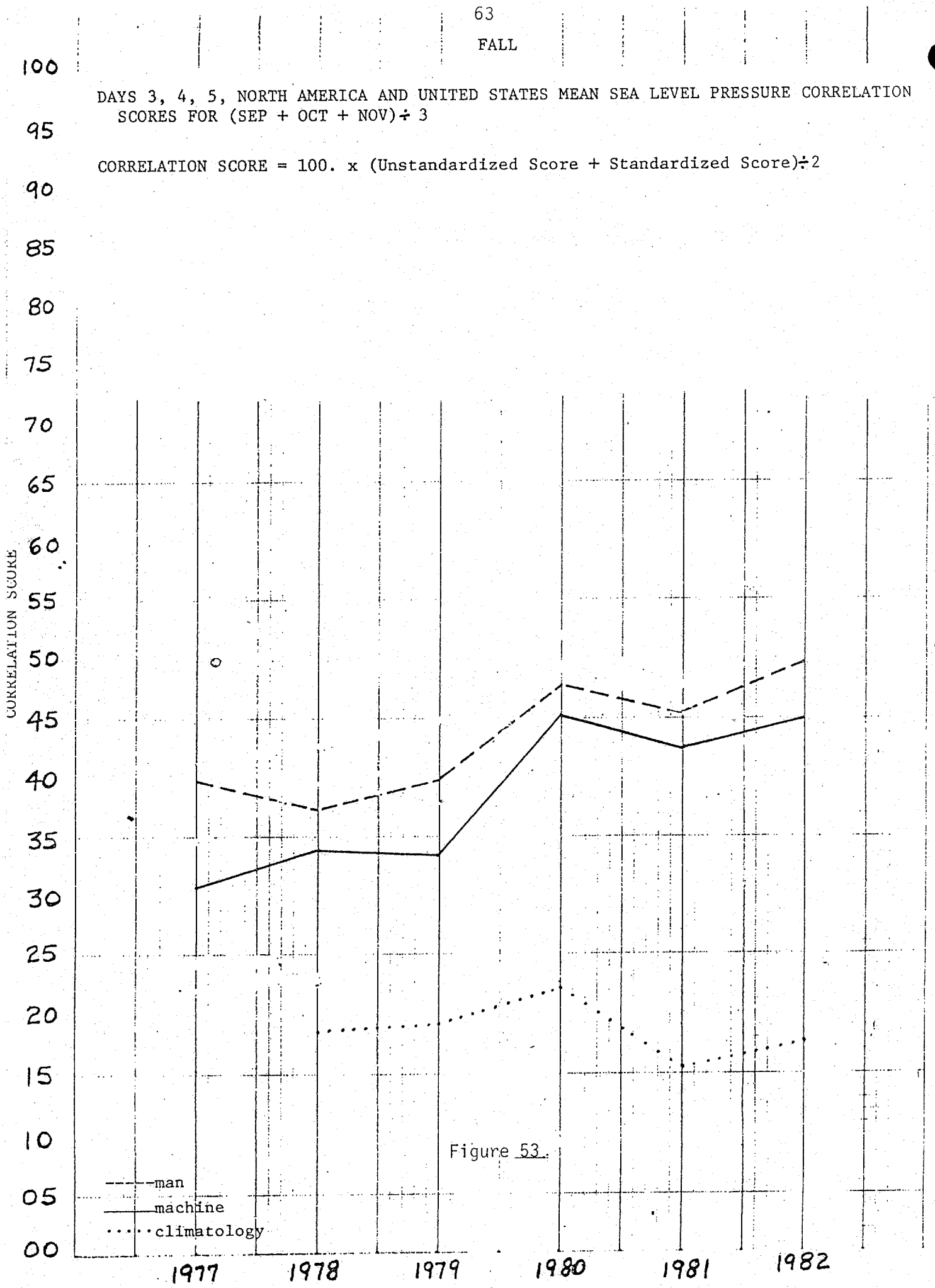


Figure 53.

SECTION 4

Man & Machine (Numerical Model Guidance)

Annual Mean Sea Level Pressure & 500 MB

Correlation Scores for 1968 (1970) through 1982

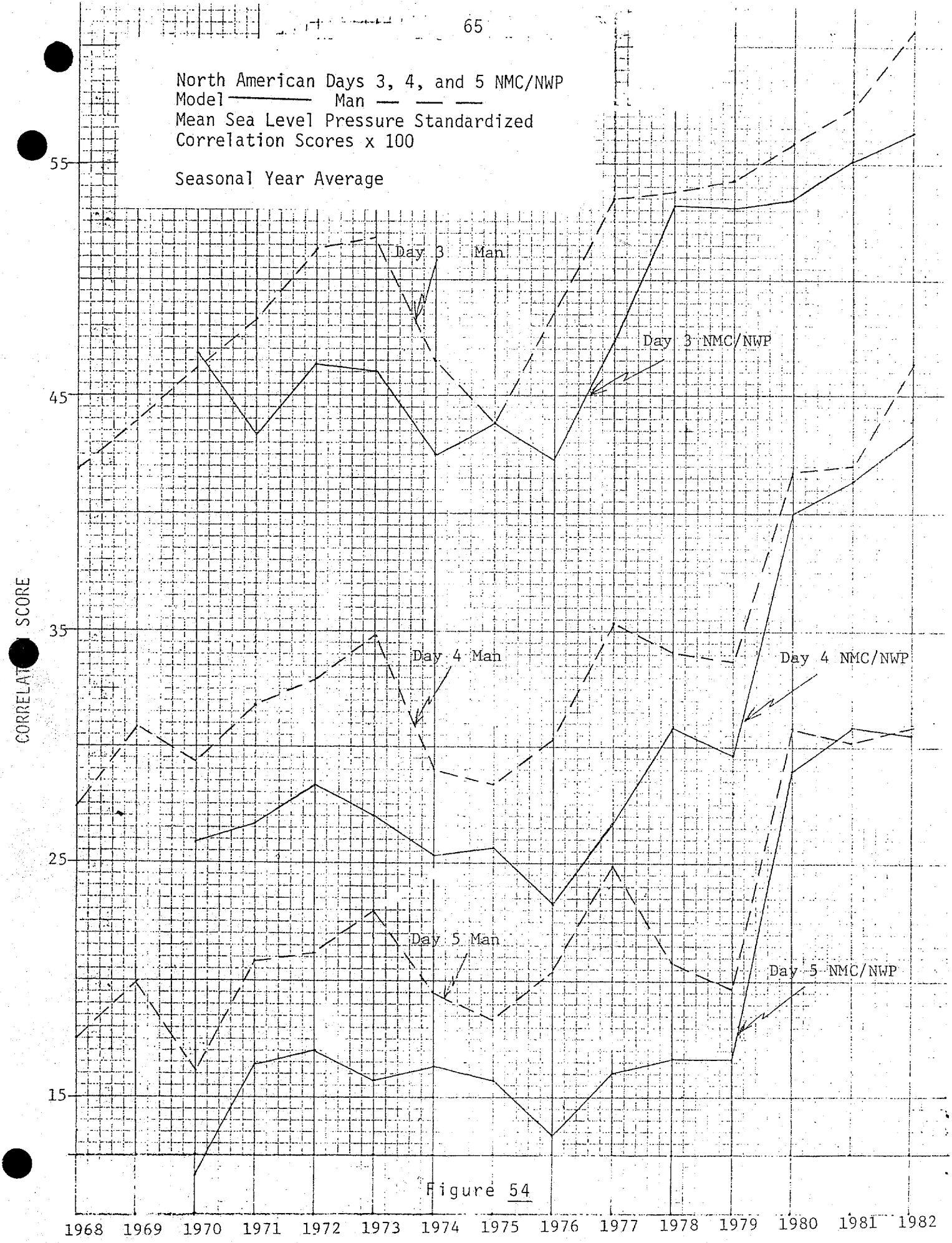

North American Days 3, 4, and 5 NMC/NWP
Model ———— Man — — —
Mean Sea Level Pressure Standardized
Correlation Scores x 100
Seasonal Year Average
Day 3 Man
Day 3 NMC/NWP
Day 4 Man
Day 4 NMC/NWP
Day 5 Man
Day 5 NMC/NWP
CORRELATION SCORE
55
45
35
25
15
1968
1969
1970
1971
1972
1973
1974
1975
1976
1977
1978
1979
1980
1981
1982

Figure 54

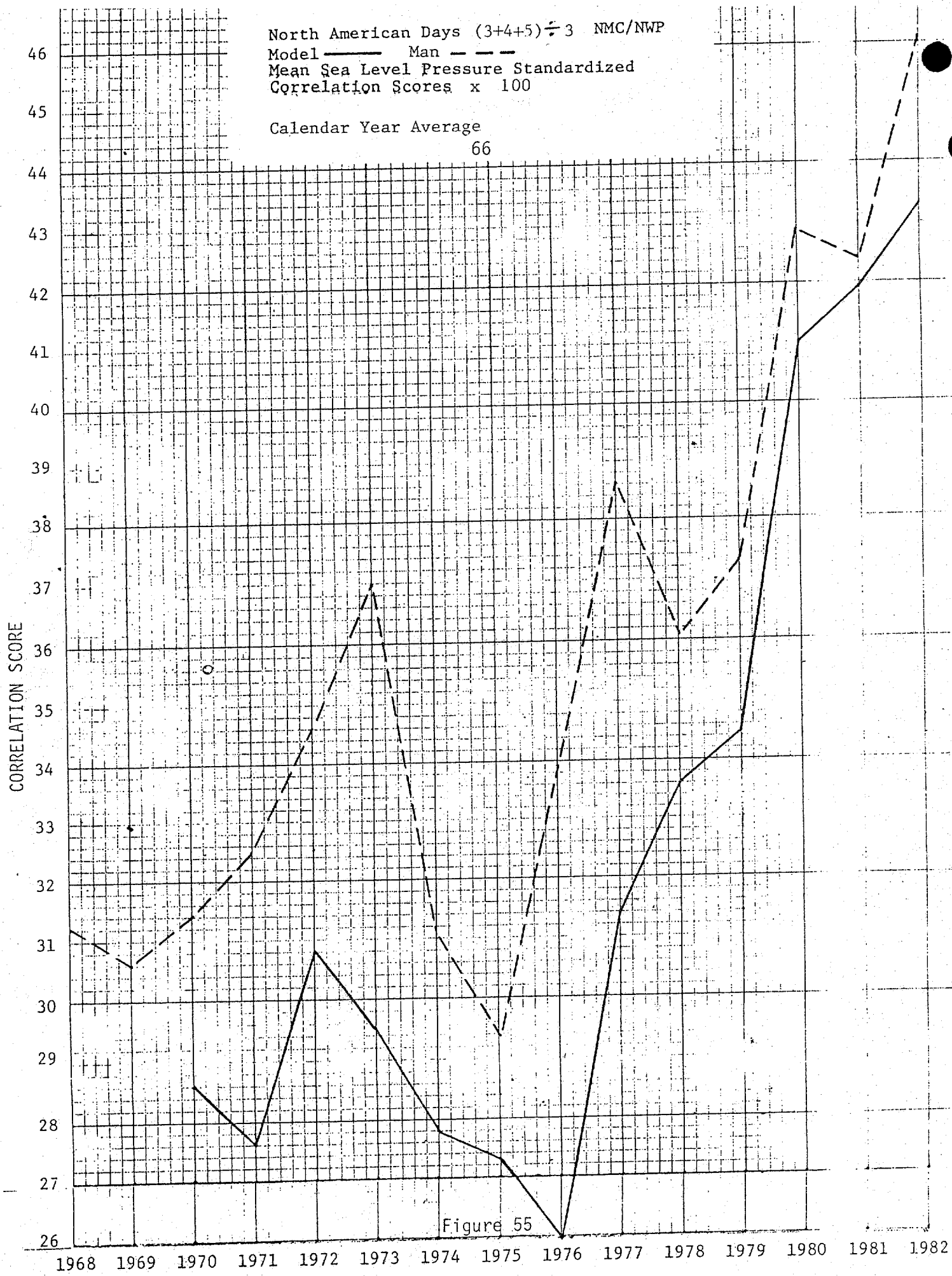

North American Days (3+4+5) ÷ 3 NMC/NWP
Model ——— Man — — —
Mean Sea Level Pressure Standardized
Correlation Scores x 100
Calendar Year Average
66
CORRELATION SCORE
46
45
44
43
42
41
40
39
38
37
36
35
34
33
32
31
30
29
28
27
26
1968
1969
1970
1971
1972
1973
1974
1975
1976
1977
1978
1979
1980
1981
1982

Figure 55

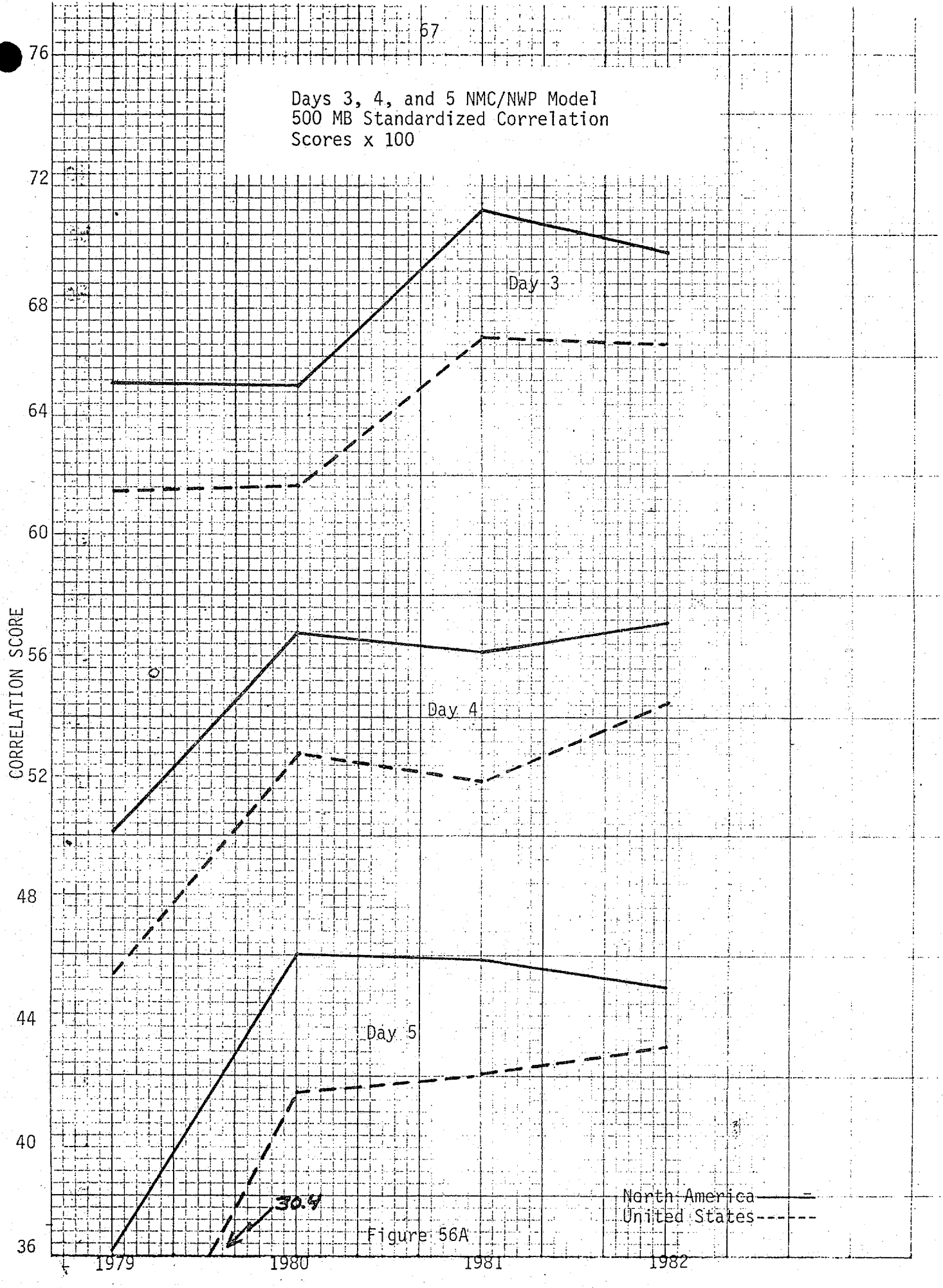

Days 3, 4, and 5 NMC/NWP Model
500 MB Standardized Correlation
Scores x 100
CORRELATION SCORE
76
72
68
64
60
56
52
48
44
40
36
Day 3
Day 4
Day 5
30.4
North America
United States
1979
1980
1981
1982

Figure 56A

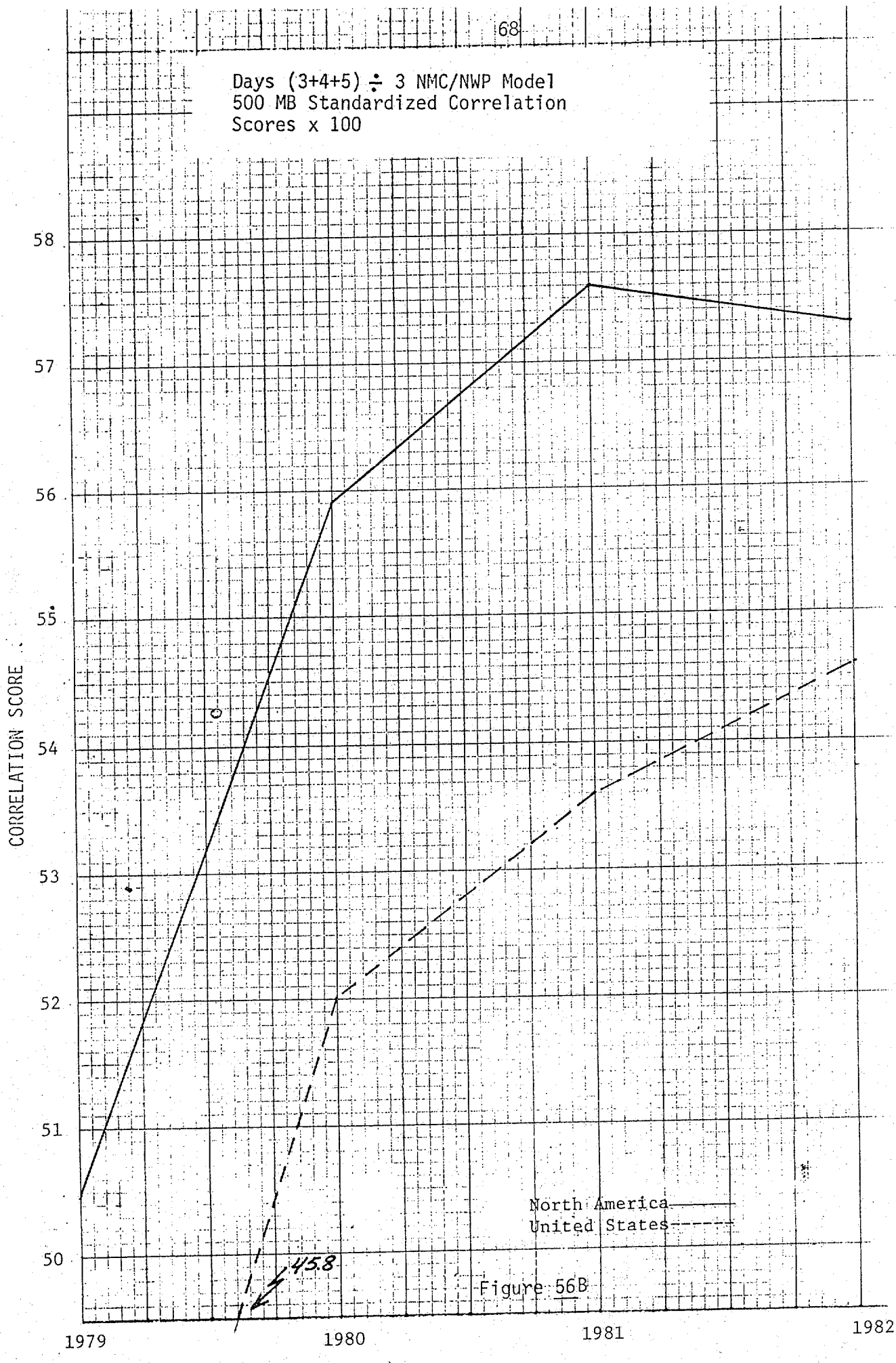

Days (3+4+5) ÷ 3 NMC/NWP Model
500 MB Standardized Correlation
Scores x 100
CORRELATION SCORE
58
57
56
55
54
53
52
51
50
1979
1980
1981
1982
North America
United States
45.8

Figure 56B

SECTION 5

Day 4 Machine (Numerical Model Guidance)

Monthly Mean Sea Level Pressure & 500 MB Average Errors

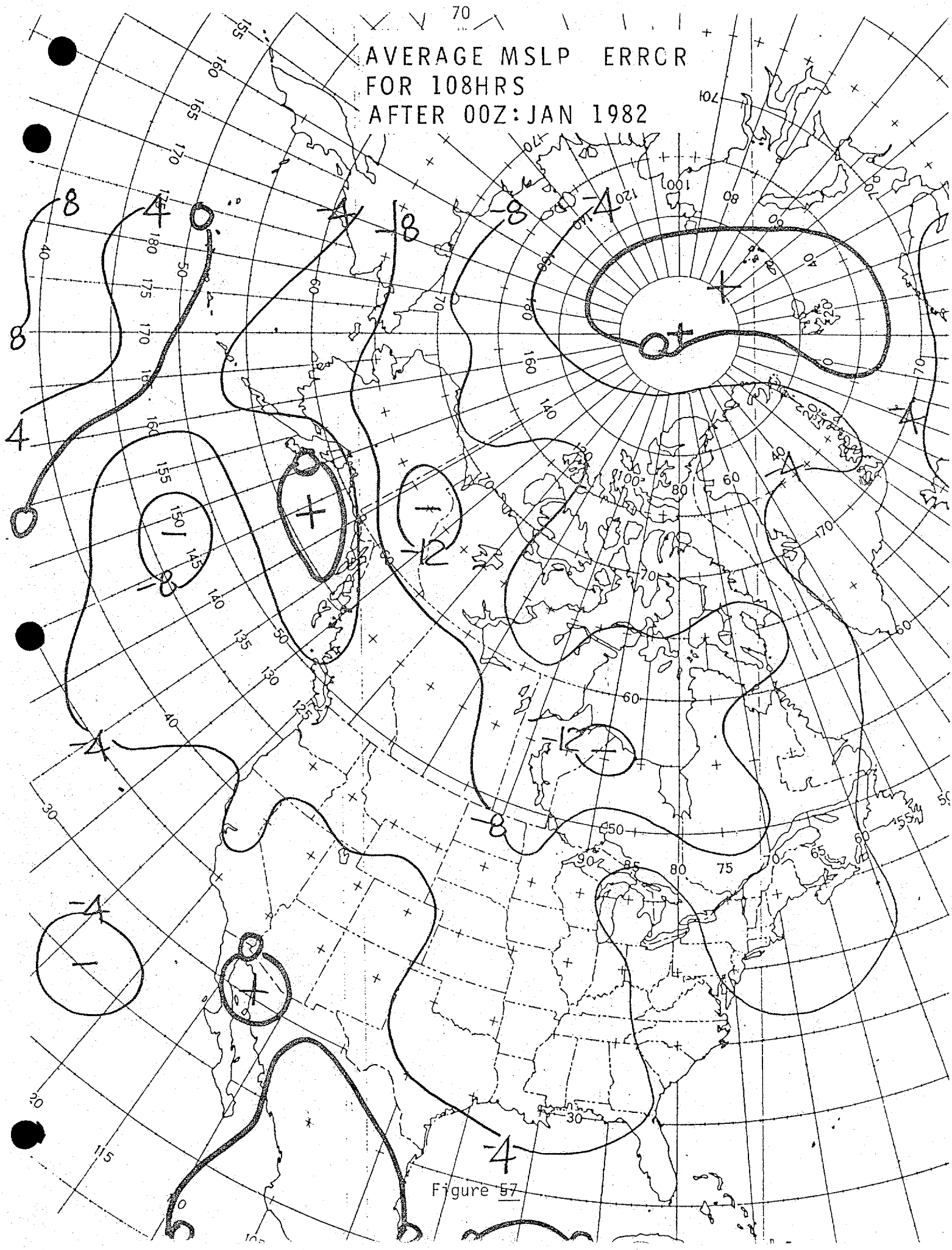


Figure 57

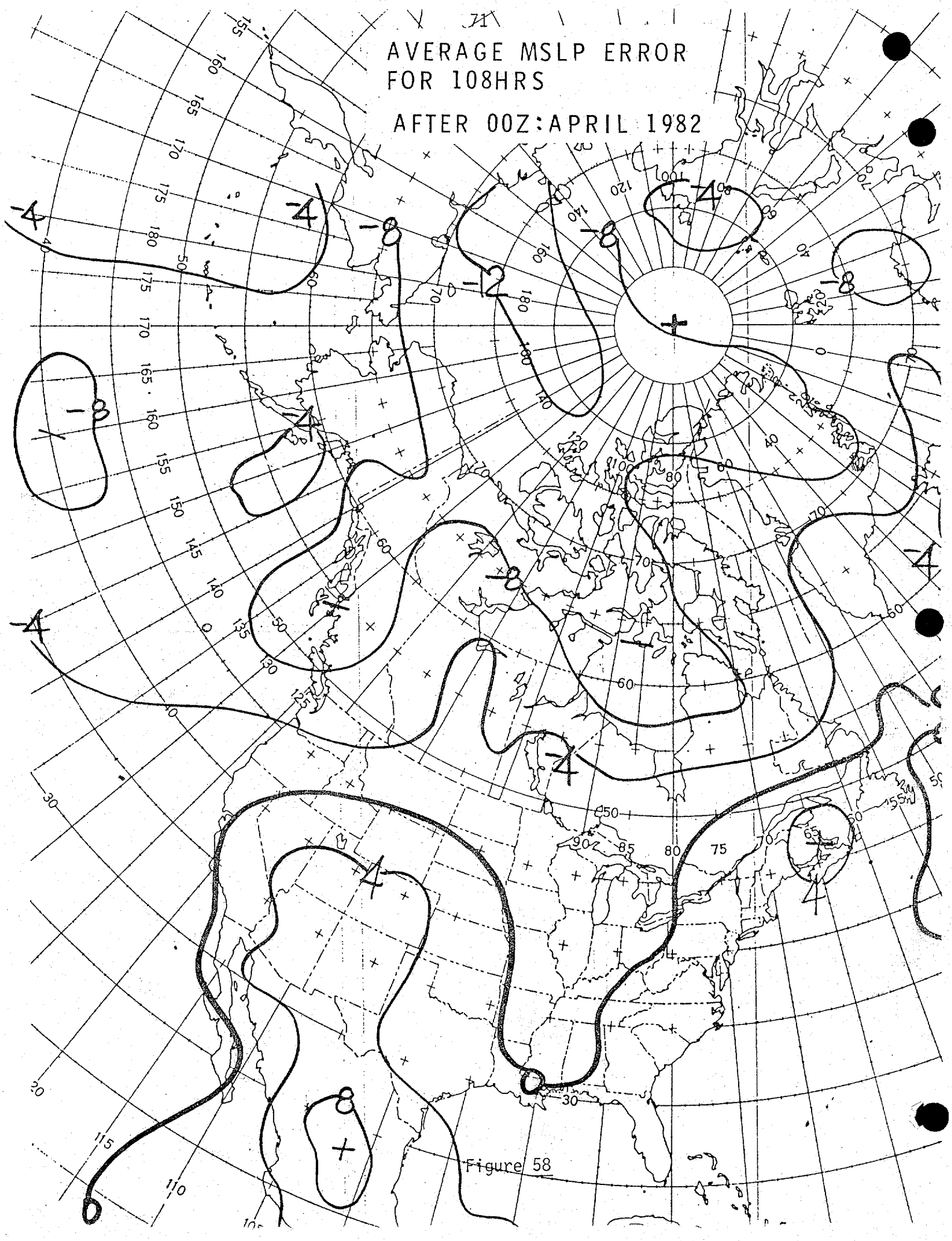


Figure 58

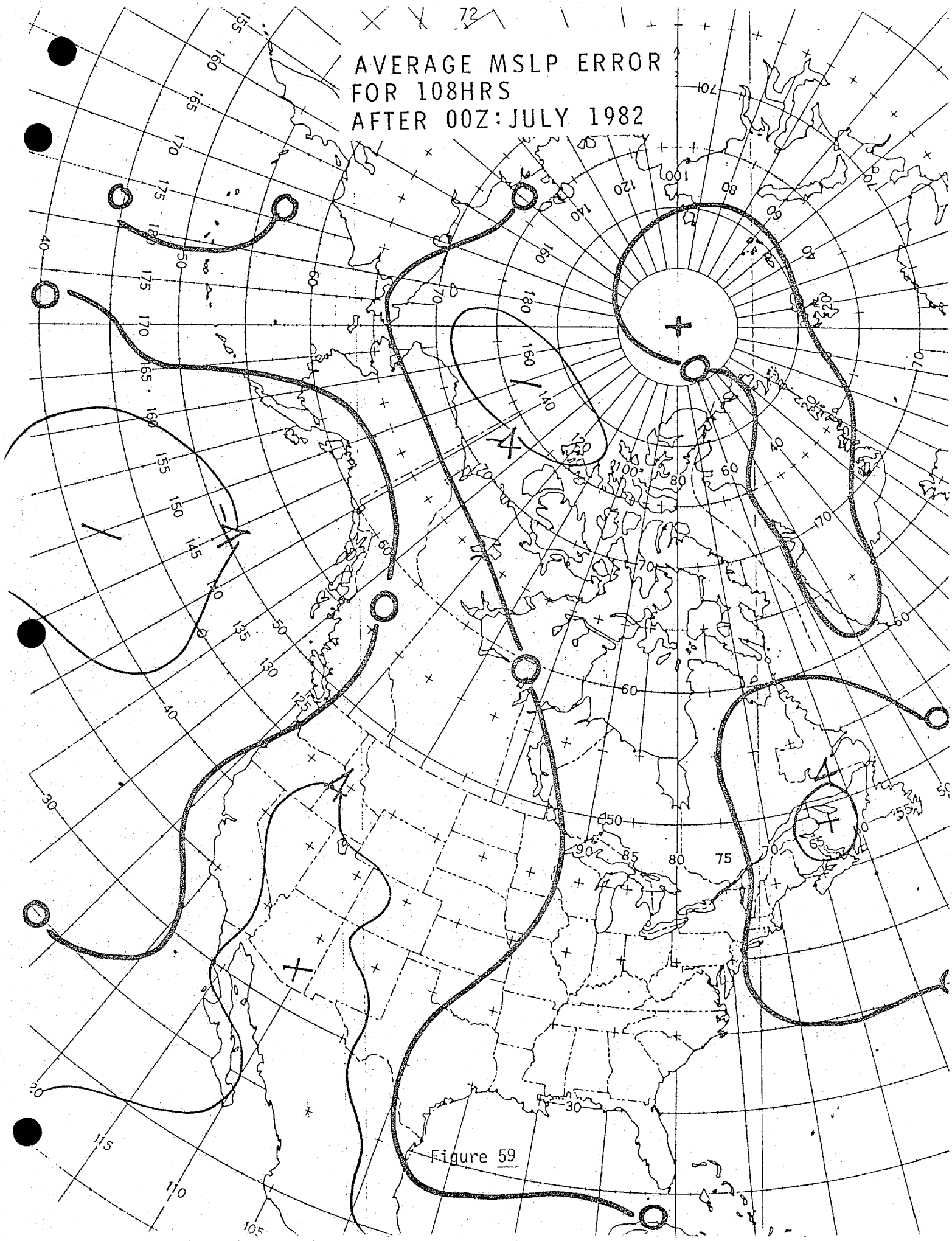


Figure 59

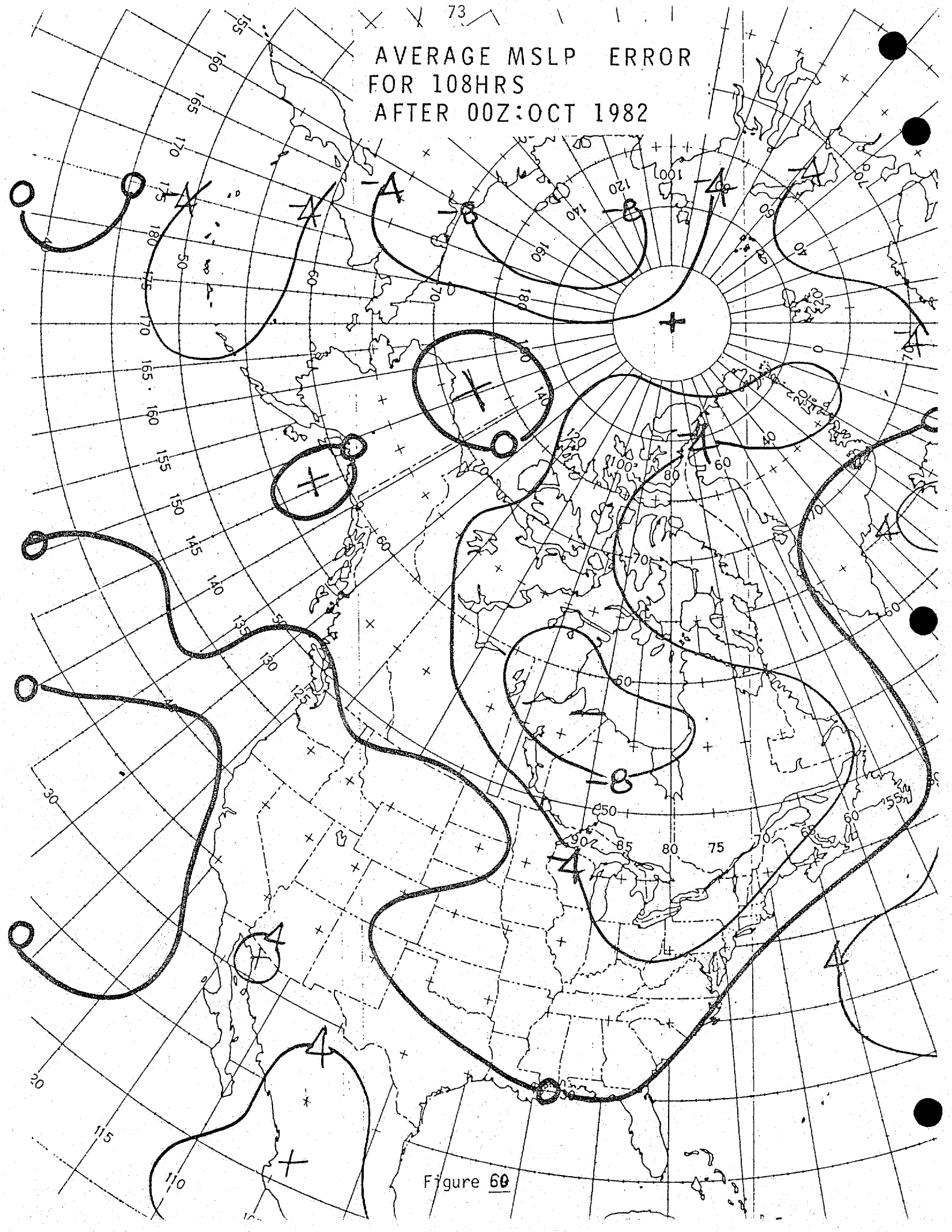


Figure 60

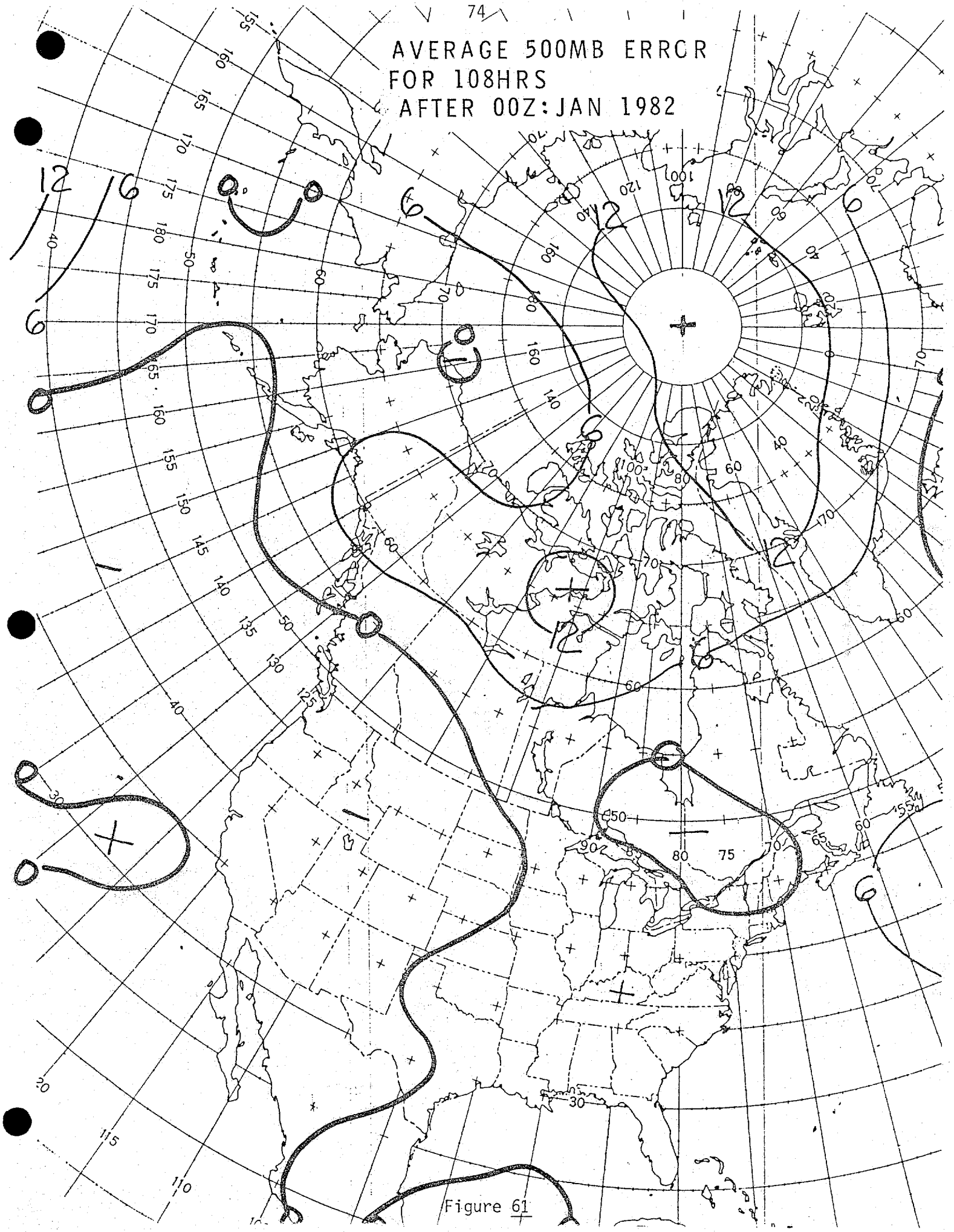


Figure 61

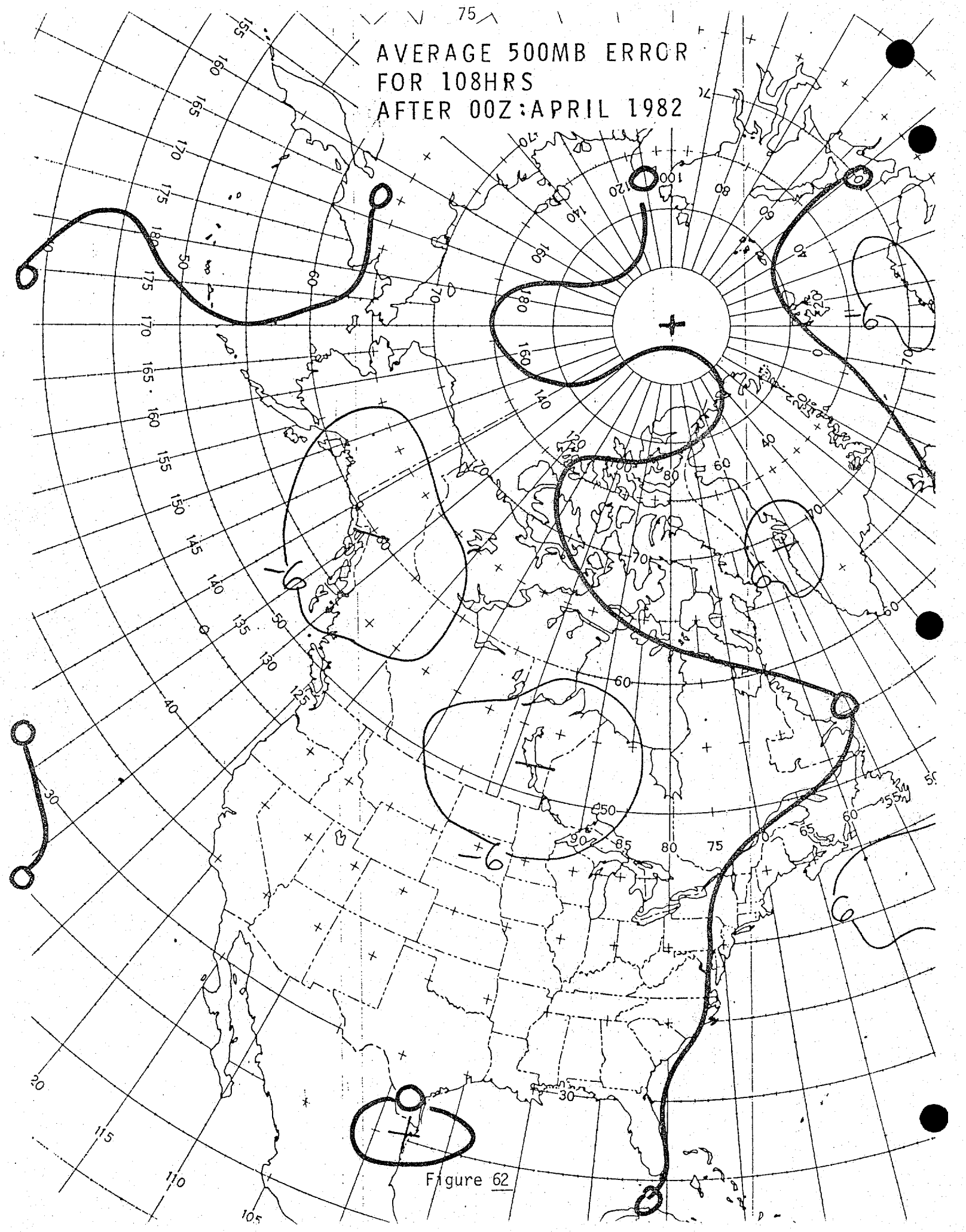


Figure 62

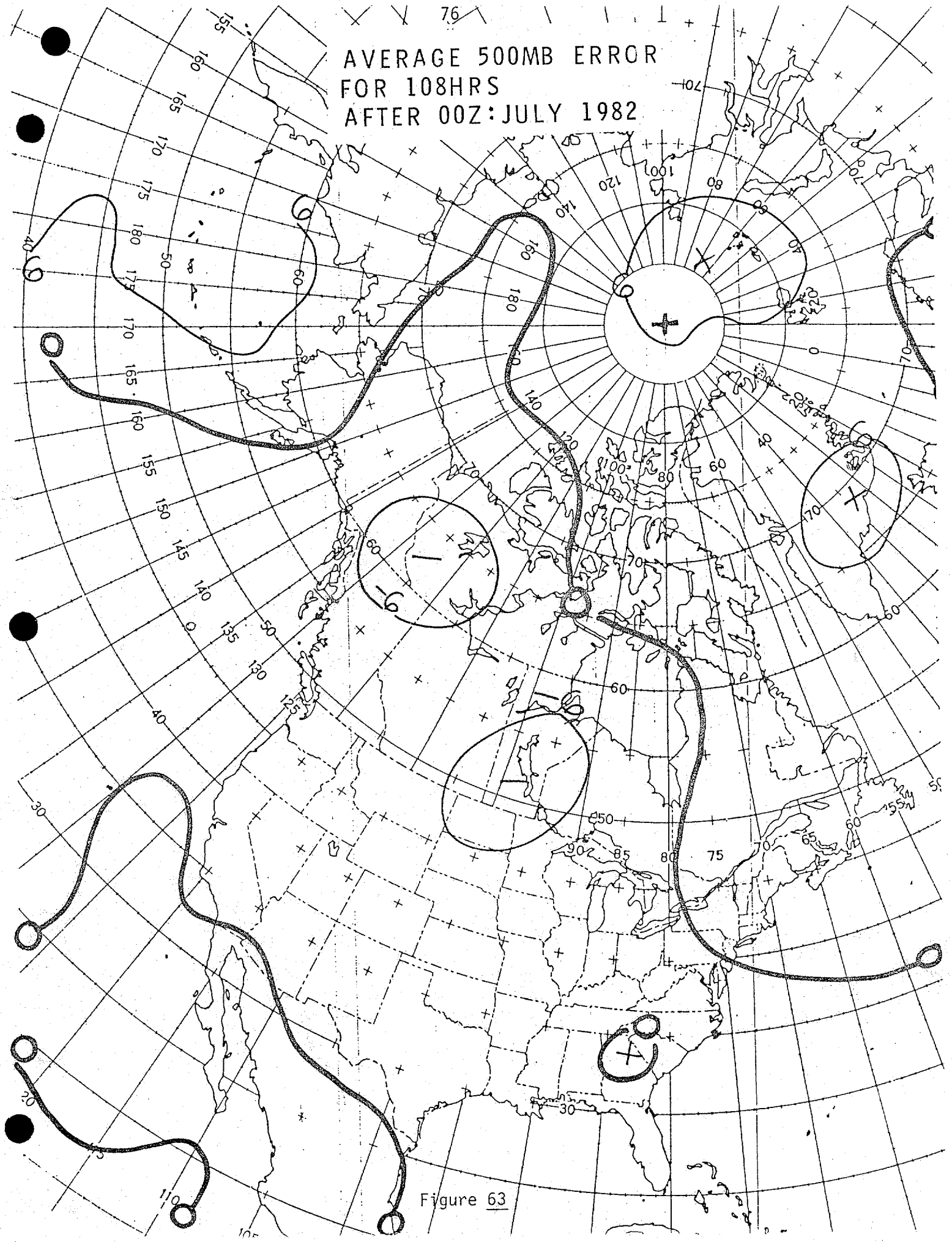


Figure 63

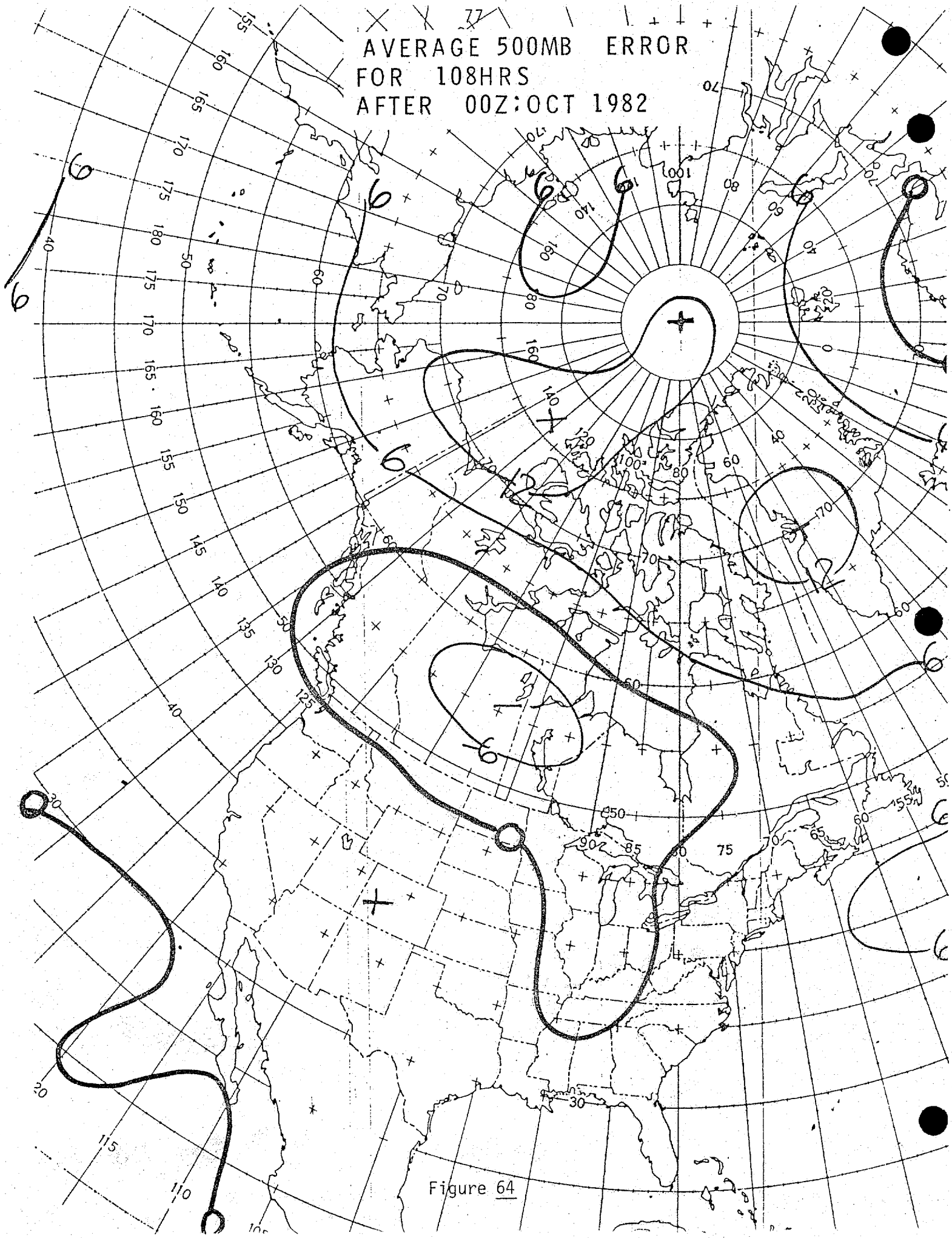


Figure 64

SECTION 6

Day 3 Western & Eastern NA

500 MB Monthly Mean

S1 Scores for 1982

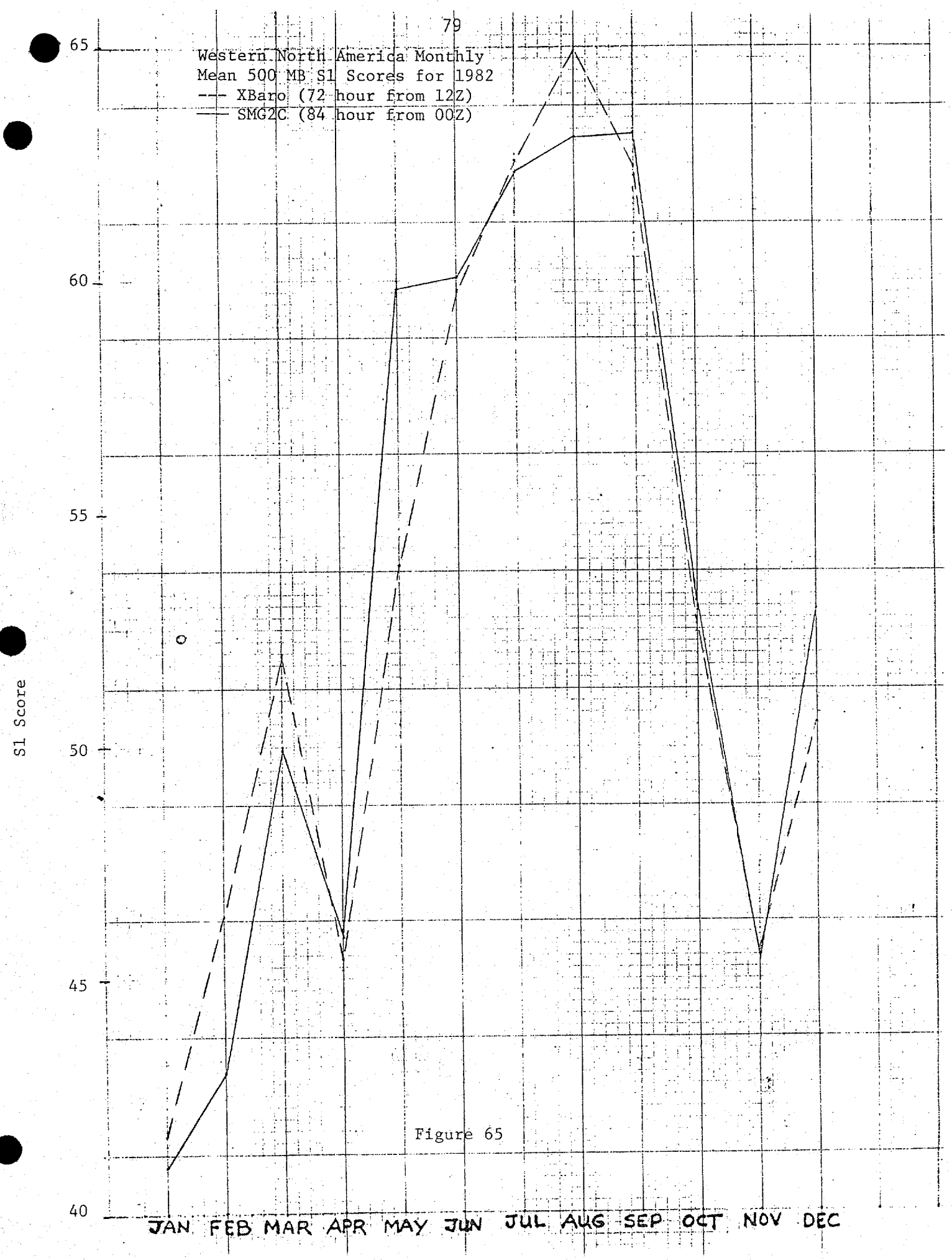

Western North America Monthly
Mean 500 MB S1 Scores for 1982
--- XBaro (72 hour from 12Z)
—— SMG2C (84 hour from 00Z)
S1 Score
65
60
55
50
45
40
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC

Figure 65

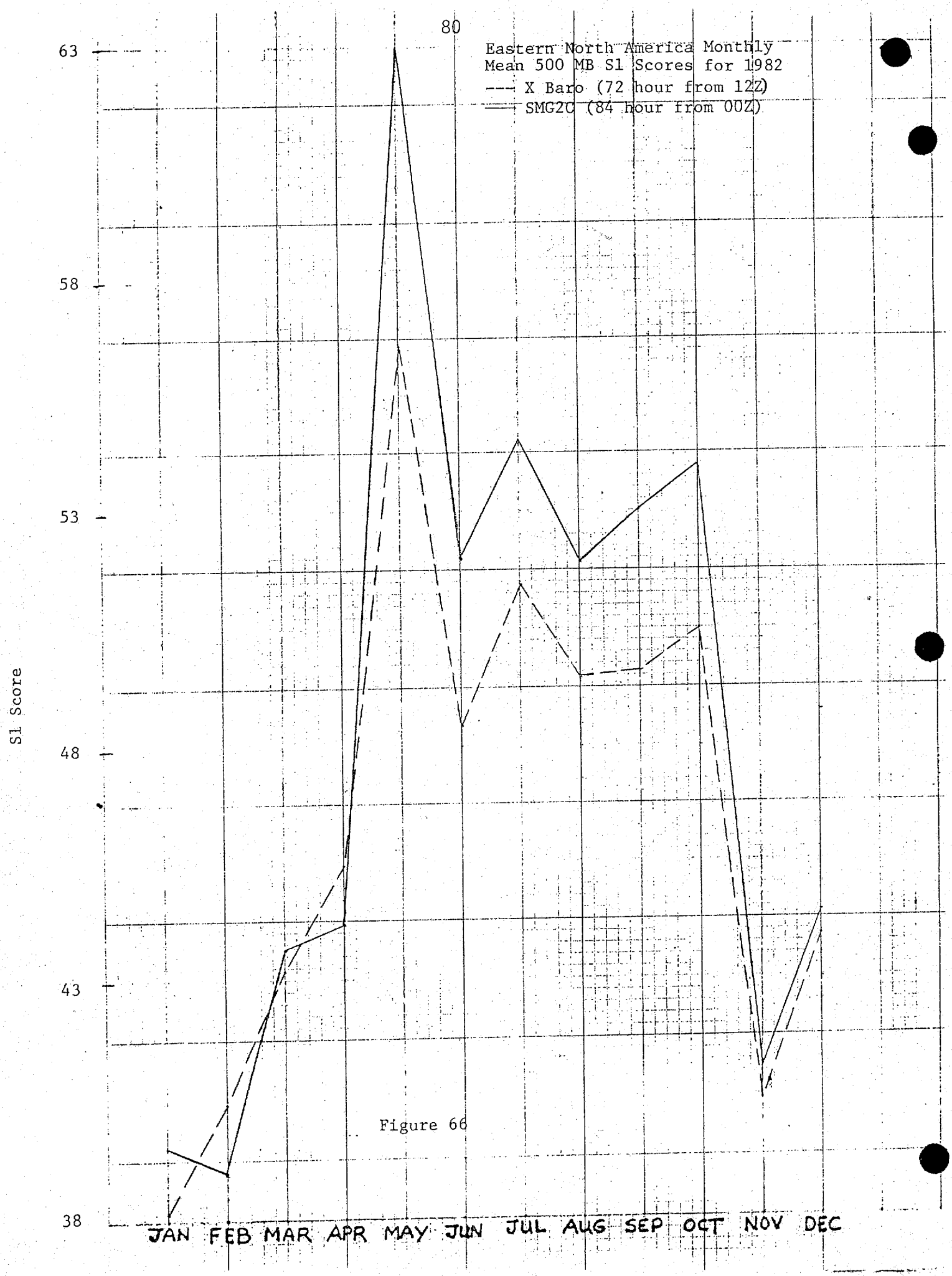

Eastern North America Monthly
Mean 500 MB S1 Scores for 1982
--- X Baro (72 hour from 12Z)
—— SMG2C (84 hour from 00Z)
S1 Score
63
58
53
48
43
38
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC

Figure 66

SECTION 7

Man & Climatology

Days 3, 4, & 5 Gilman & Hughes Precipitation Skill Scores

(1982 Monthly Mean vs. Long Term Mean)

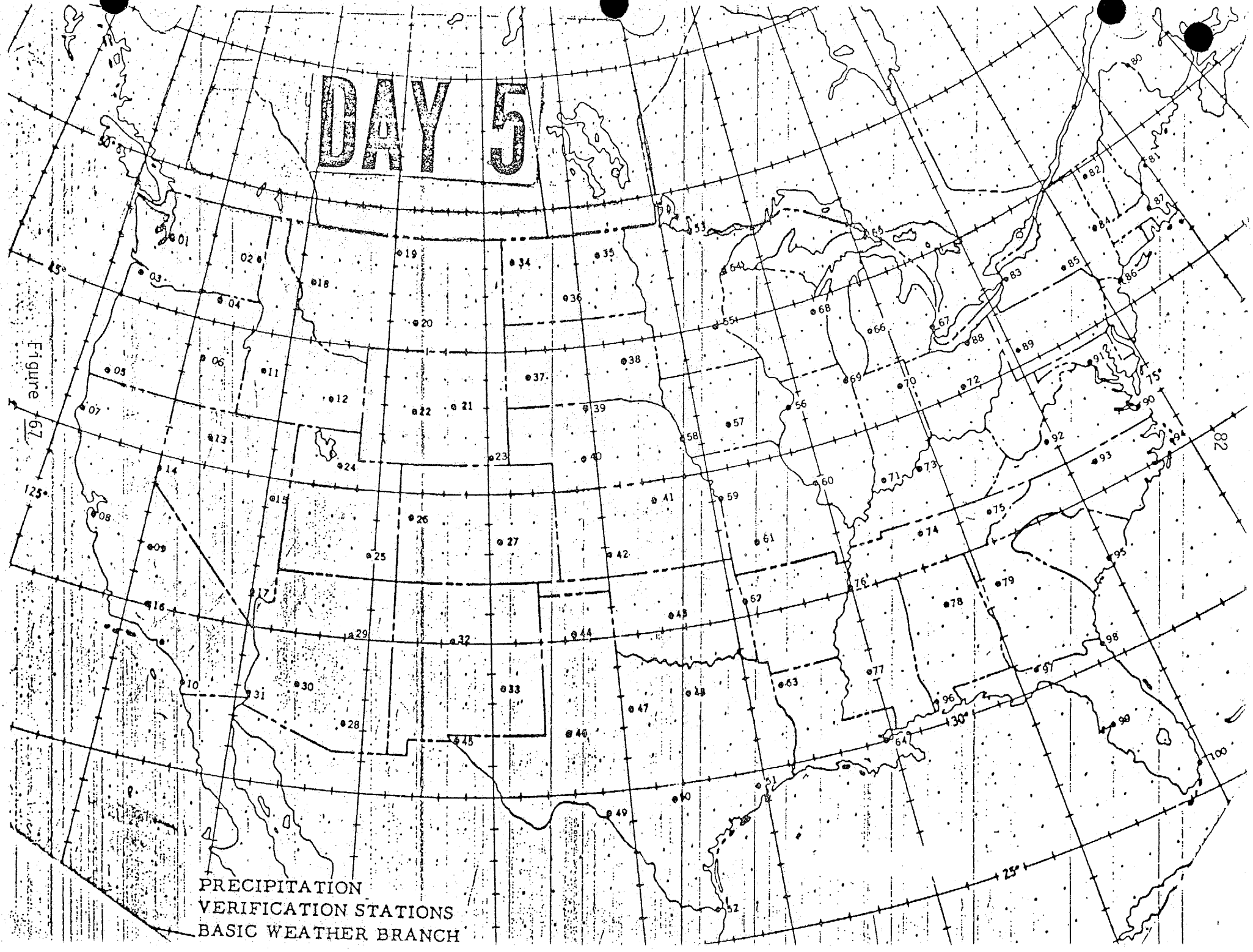

DAY 5
PRECIPITATION
VERIFICATION STATIONS
BASIC WEATHER BRANCH

Figure 67

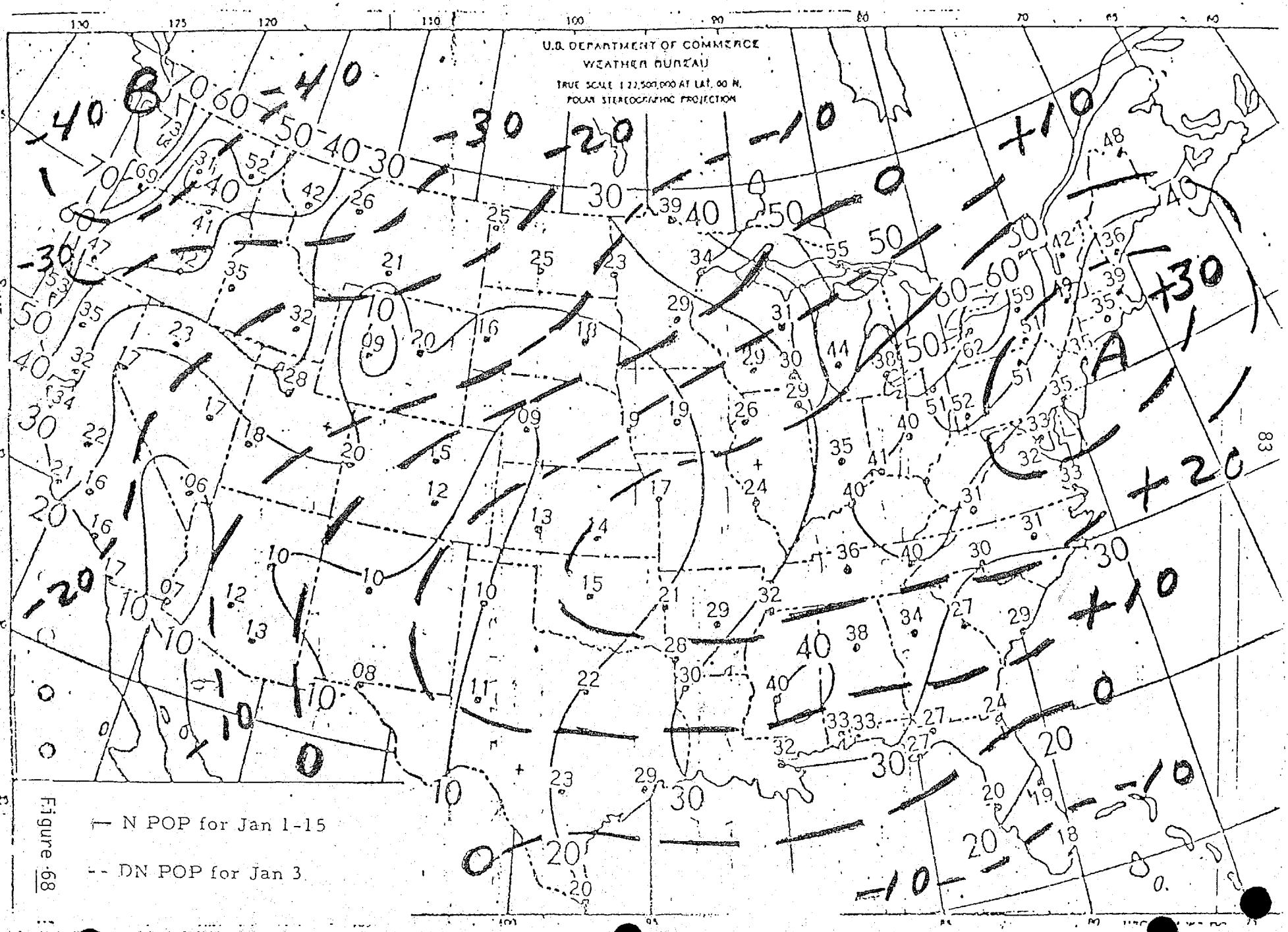

U.S. DEPARTMENT OF COMMERCE
WEATHER BUREAU
TRUE SCALE 1:22,500,000 AT LAT. 60 N.
POLAR STEREOGRAPHIC PROJECTION
— N POP for Jan 1-15
-- DN POP for Jan 3

Figure 68

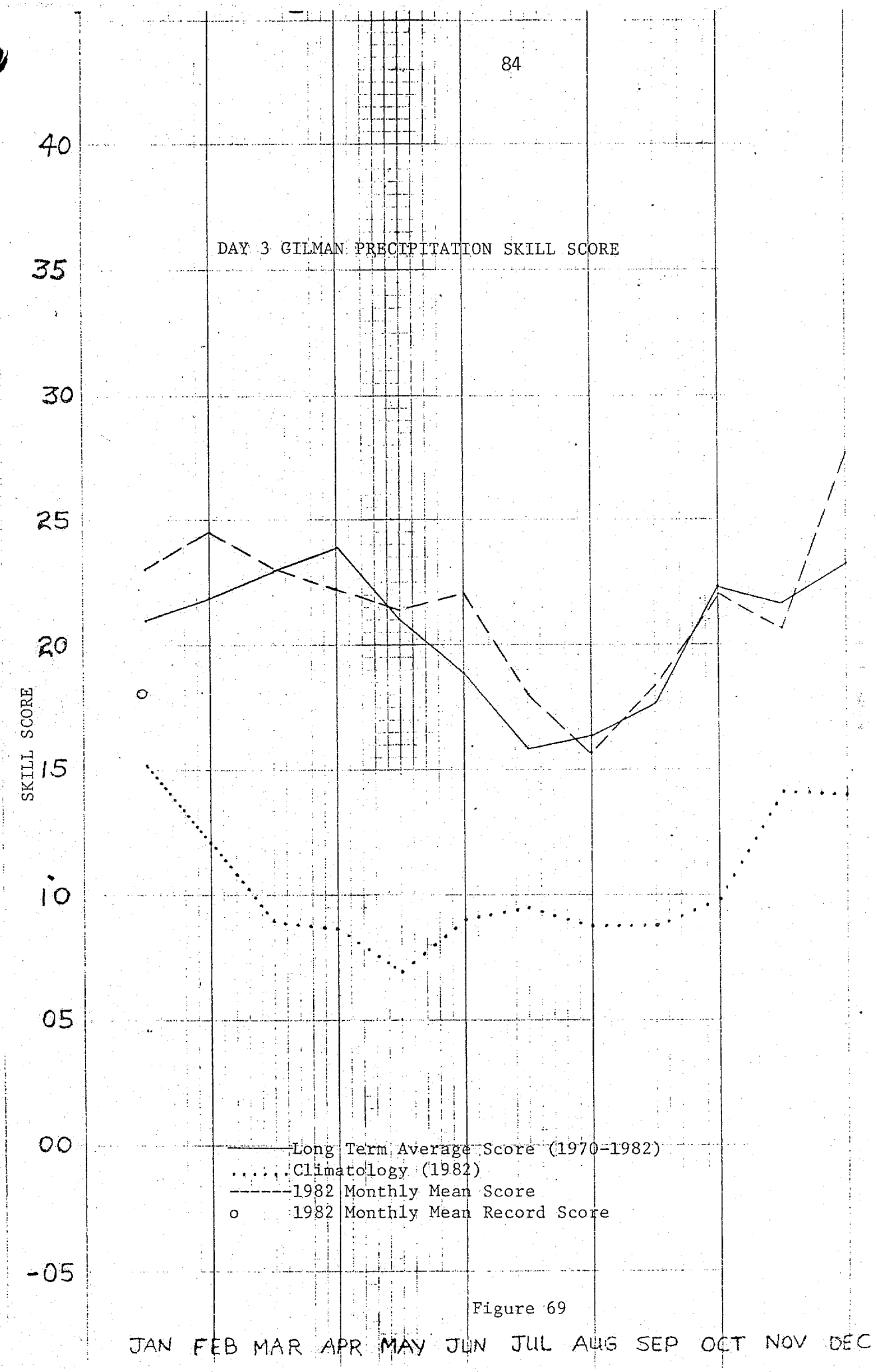

DAY 3 GILMAN PRECIPITATION SKILL SCORE
SKILL SCORE
40
35
30
25
20
15
10
05
00
-05
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
Long Term Average Score (1970-1982)
Climatology (1982)
1982 Monthly Mean Score
o 1982 Monthly Mean Record Score

Figure 69

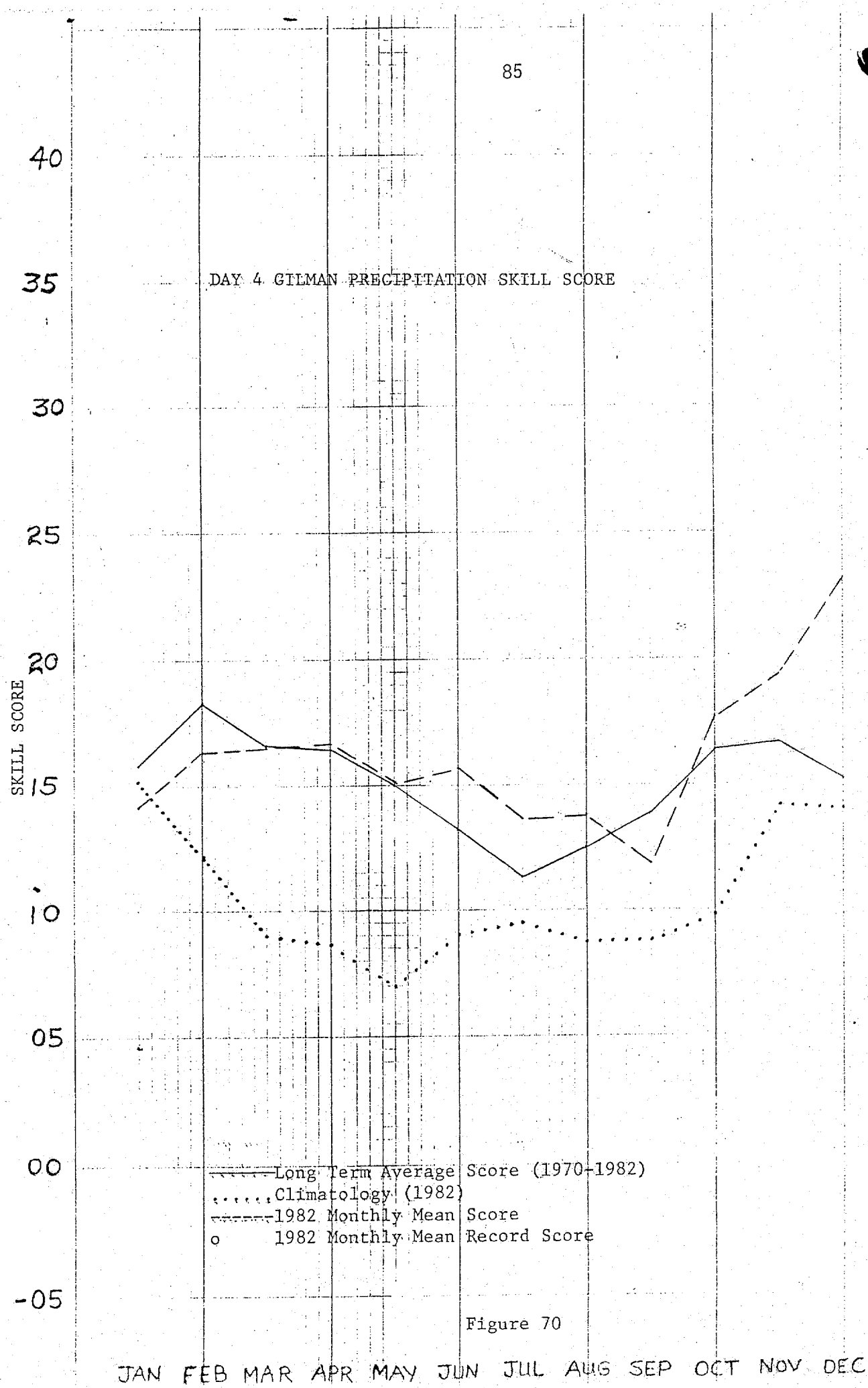

DAY 4 GILMAN PRECIPITATION SKILL SCORE
SKILL SCORE
40
35
30
25
20
15
10
05
00
-05
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
Long Term Average Score (1970-1982)
Climatology (1982)
1982 Monthly Mean Score
o 1982 Monthly Mean Record Score

Figure 70

DAY 5 GILMAN PRECIPITATION SKILL SCORE
SKILL SCORE
40
35
30
25
20
15
10
05
00
-05
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
Long Term Average Score (1970-1982)
Climatology (1982)
1982 Monthly Mean Score
o 1982 Monthly Mean Record Score

Figure 71

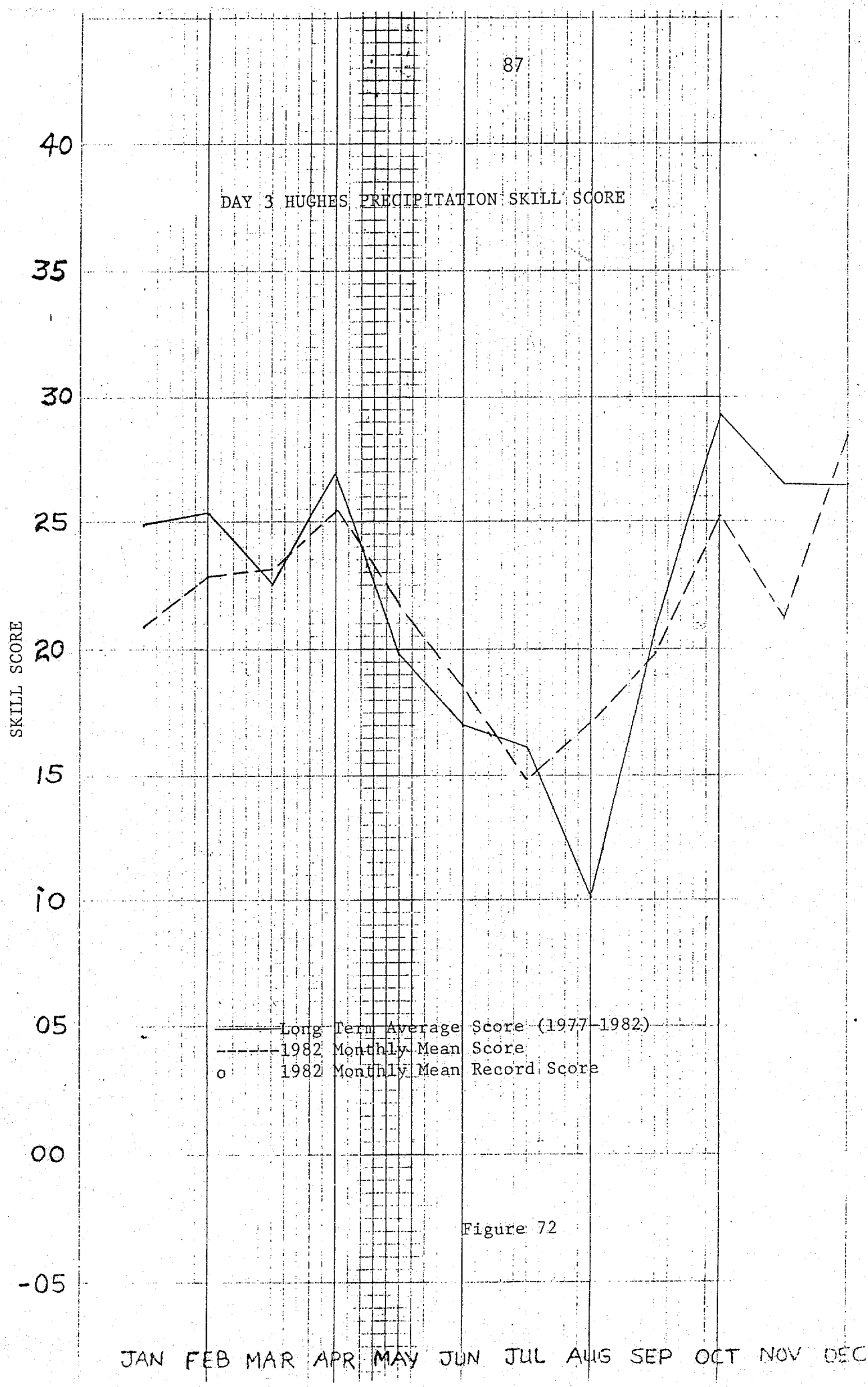

DAY 3 HUGHES PRECIPITATION SKILL SCORE
SKILL SCORE
40
35
30
25
20
15
10
05
00
-05
Long Term Average Score (1977-1982)
1982 Monthly Mean Score
o 1982 Monthly Mean Record Score
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC

Figure 72

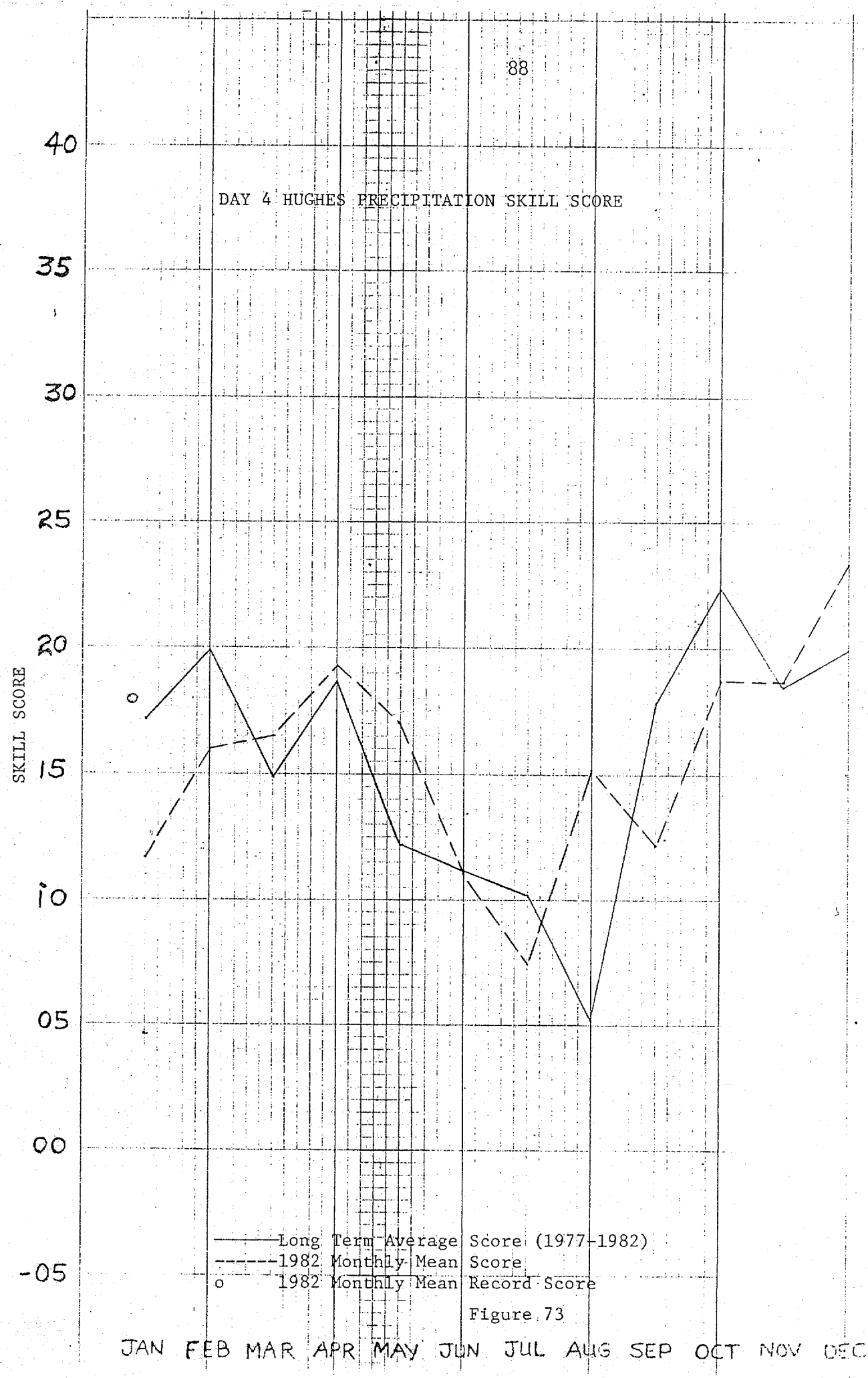

DAY 4 HUGHES PRECIPITATION SKILL SCORE
SKILL SCORE
40
35
30
25
20
15
10
05
00
-05
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
———Long Term Average Score (1977-1982)
------1982 Monthly Mean Score
o 1982 Monthly Mean Record Score

Figure 73

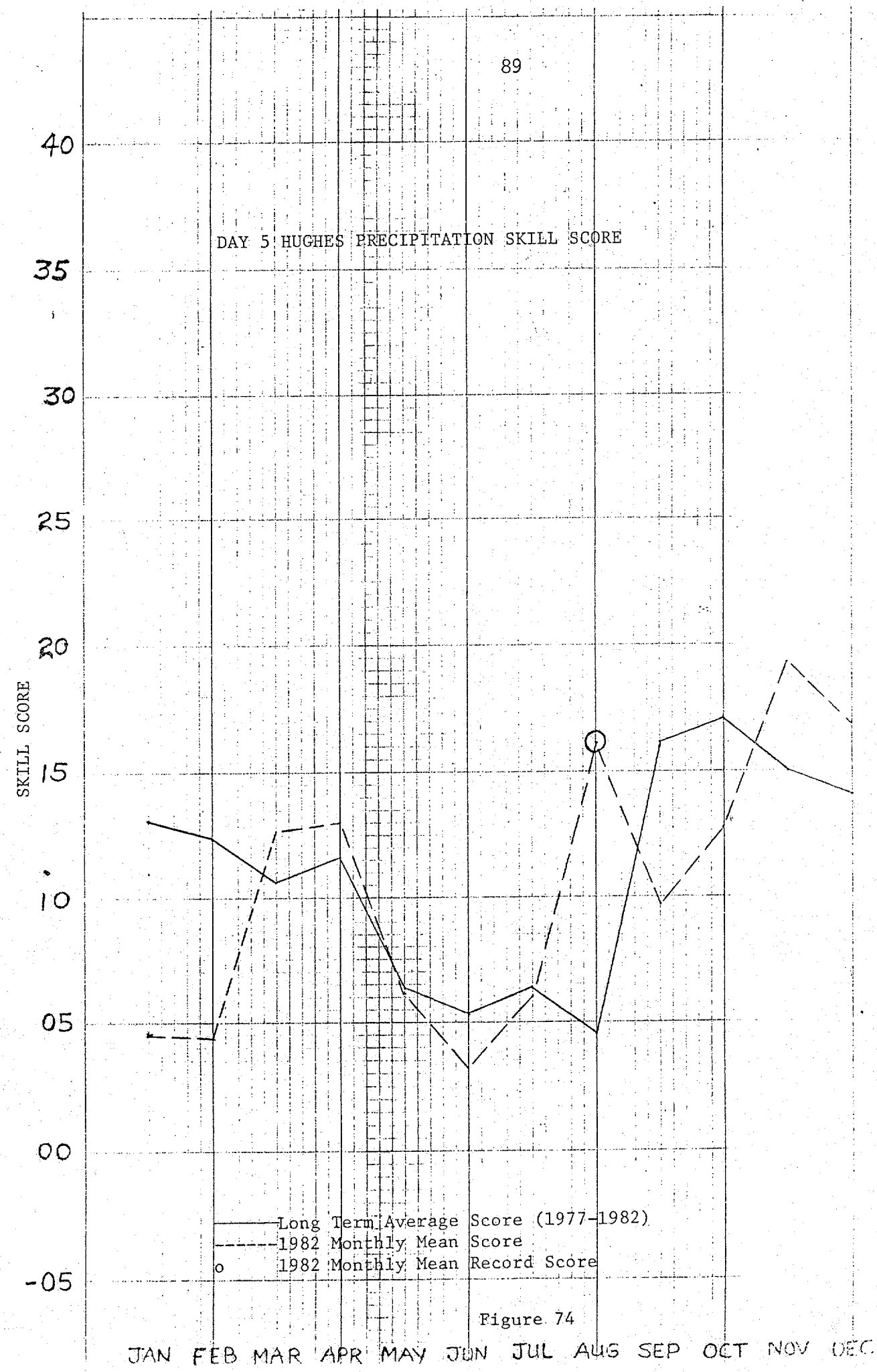

DAY 5 HUGHES PRECIPITATION SKILL SCORE
SKILL SCORE
40
35
30
25
20
15
10
05
00
-05
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
Long Term Average Score (1977-1982)
1982 Monthly Mean Score
1982 Monthly Mean Record Score

Figure 74

SECTION 8

Man & Climatology

Annual Precipitation Skill Scores

For 1970 (1978) through 1982

NOAA FORM 59-4
(2-72)

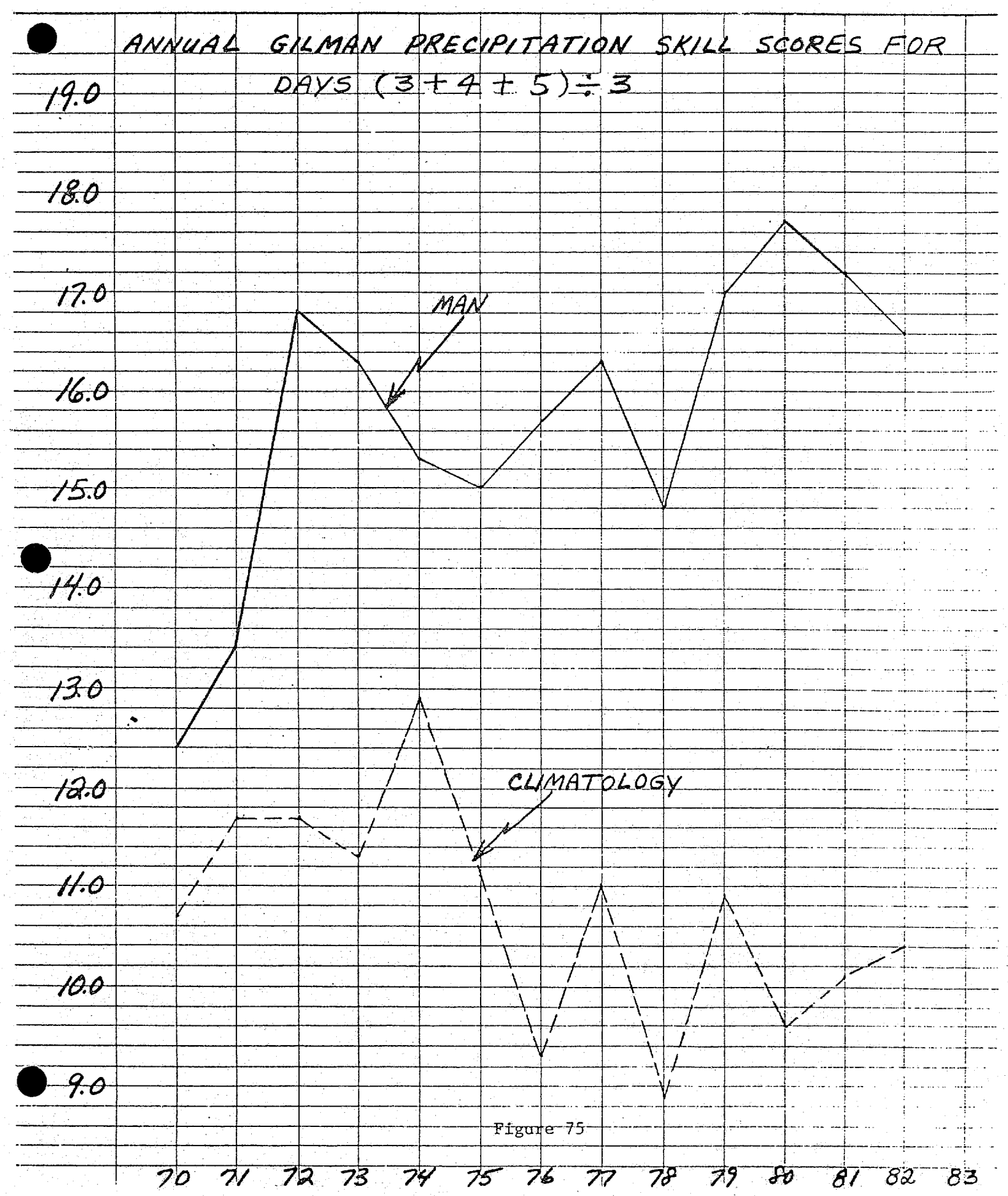


Figure 75

NOAA FORM 59-4
(2-72)

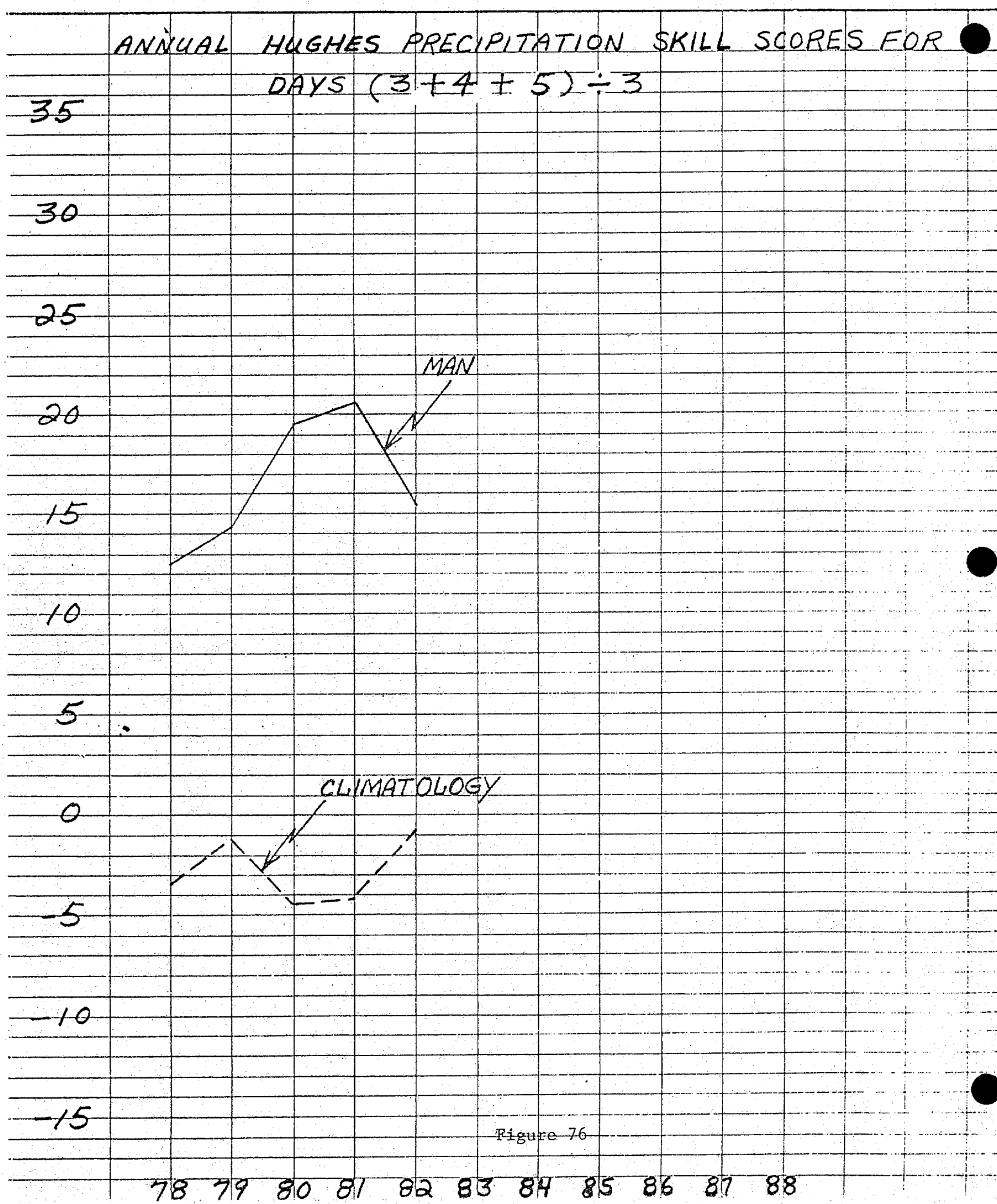


Figure 76

NOAA FORM 59-4
(2-72)

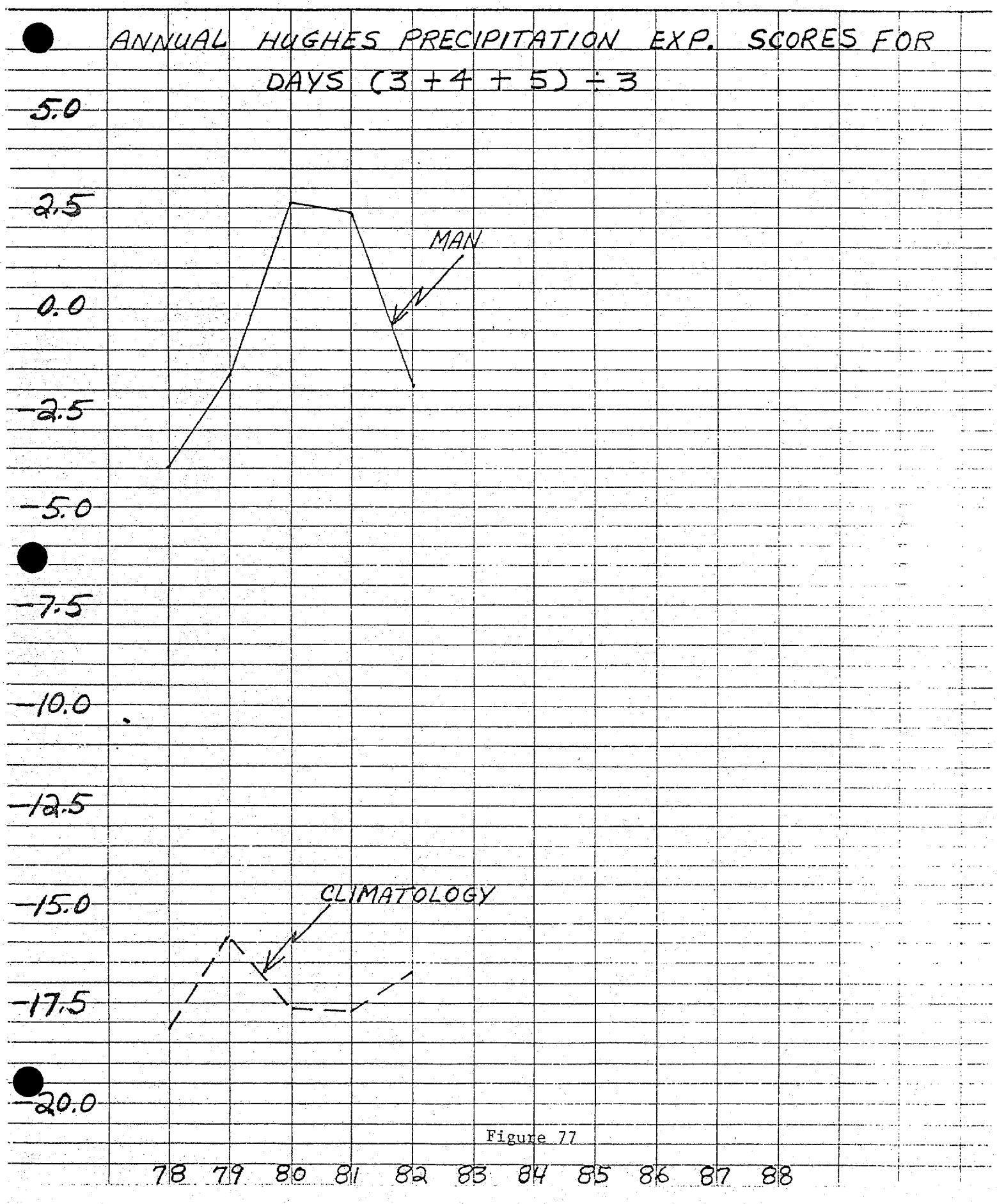


Figure 77

SECTION 9

Man & Machine (KL Guidance)

Days 3, 4, & 5 Absolute

Error Temperature Scores

(1982 Monthly Mean Vs. Long Term Mean)

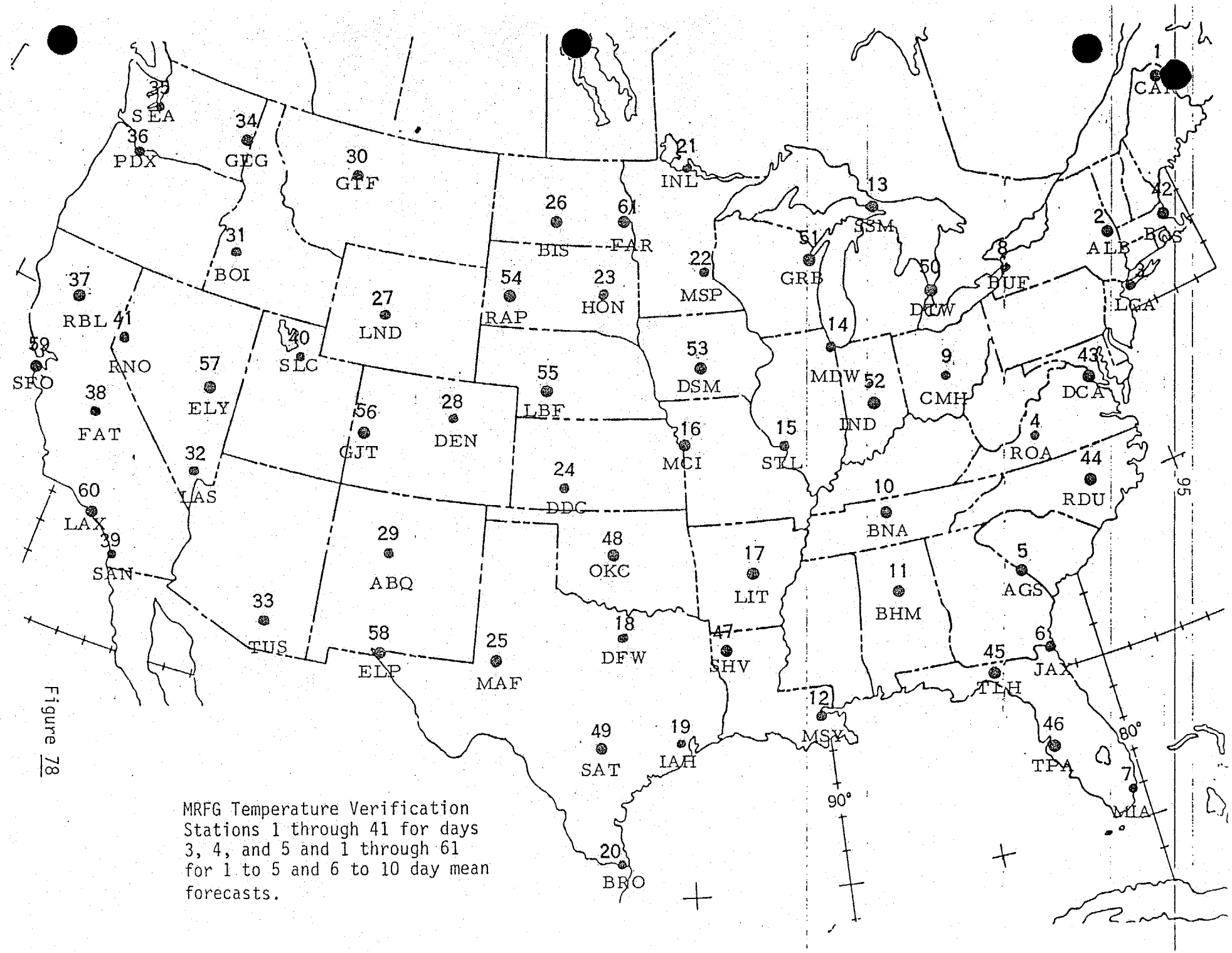


Figure 78

MRFG Temperature Verification Stations 1 through 41 for days 3, 4, and 5 and 1 through 61 for 1 to 5 and 6 to 10 day mean forecasts.

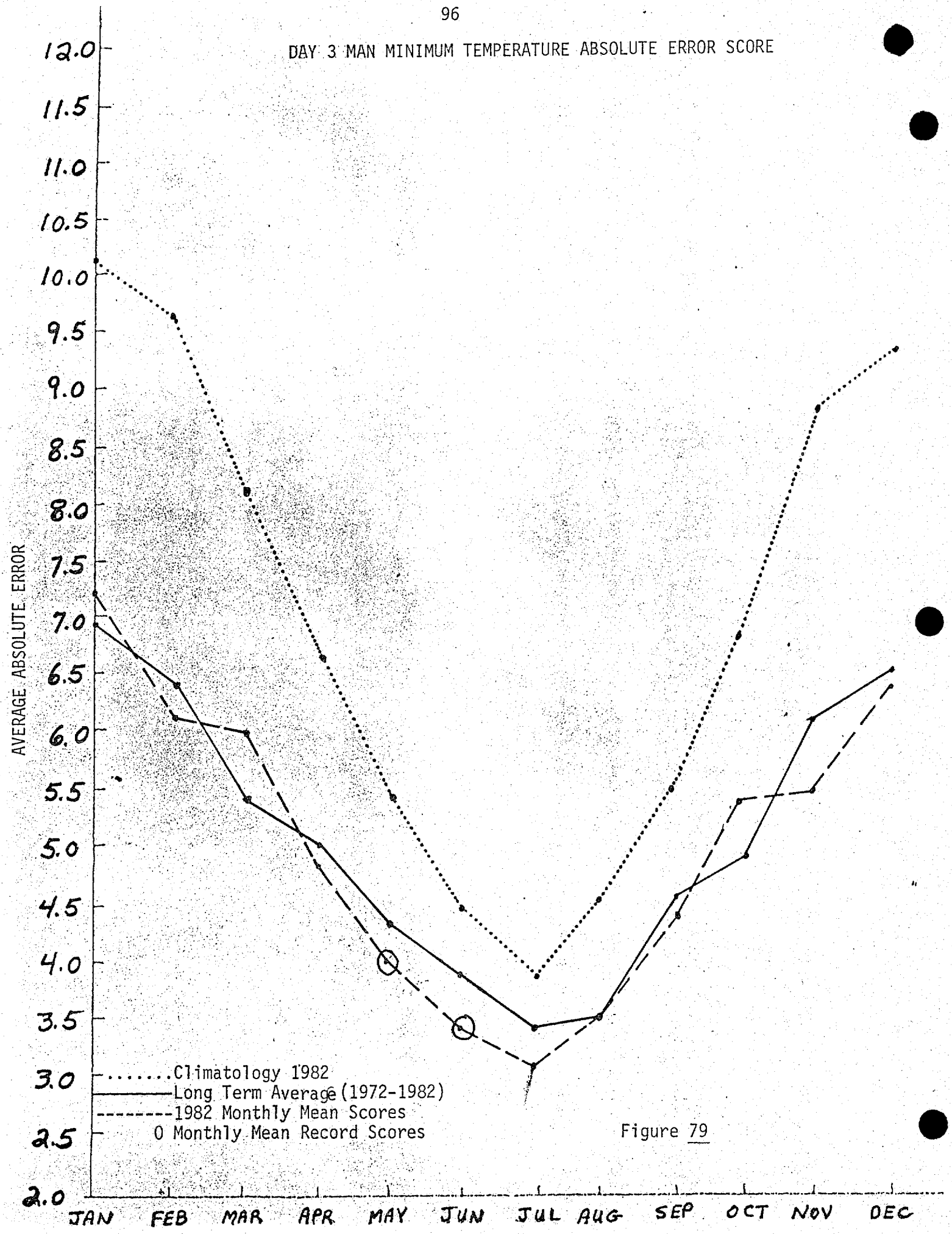

DAY 3 MAN MINIMUM TEMPERATURE ABSOLUTE ERROR SCORE
AVERAGE ABSOLUTE ERROR
12.0
11.5
11.0
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
.....Climatology 1982
———Long Term Average (1972-1982)
--------1982 Monthly Mean Scores
O Monthly Mean Record Scores

Figure 79

DAY 4 MAN MINIMUM TEMPERATURE ABSOLUTE ERROR SCORE

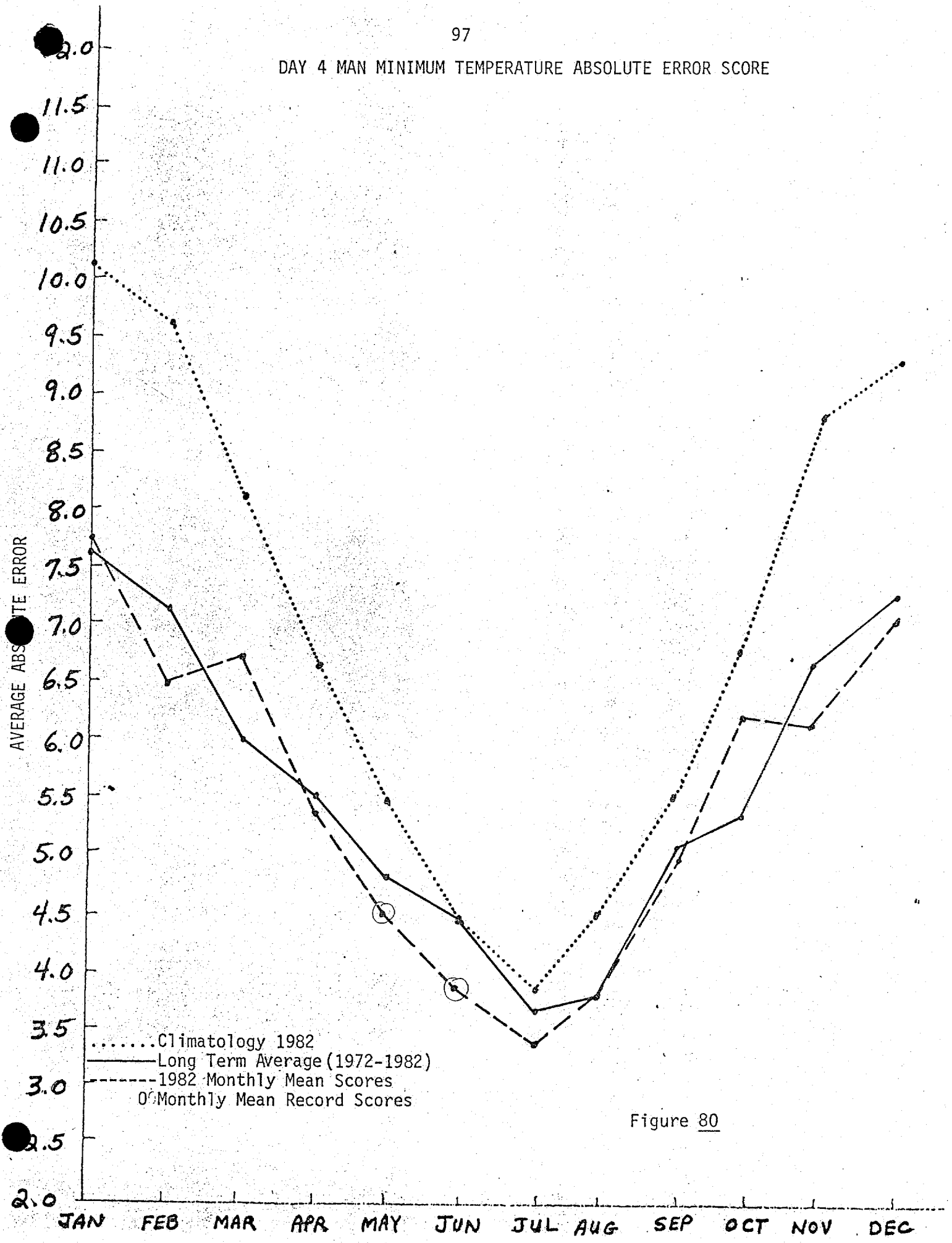


Figure 80

DAY 5 MAN MINIMUM TEMPERATURE ABSOLUTE ERROR SCORE

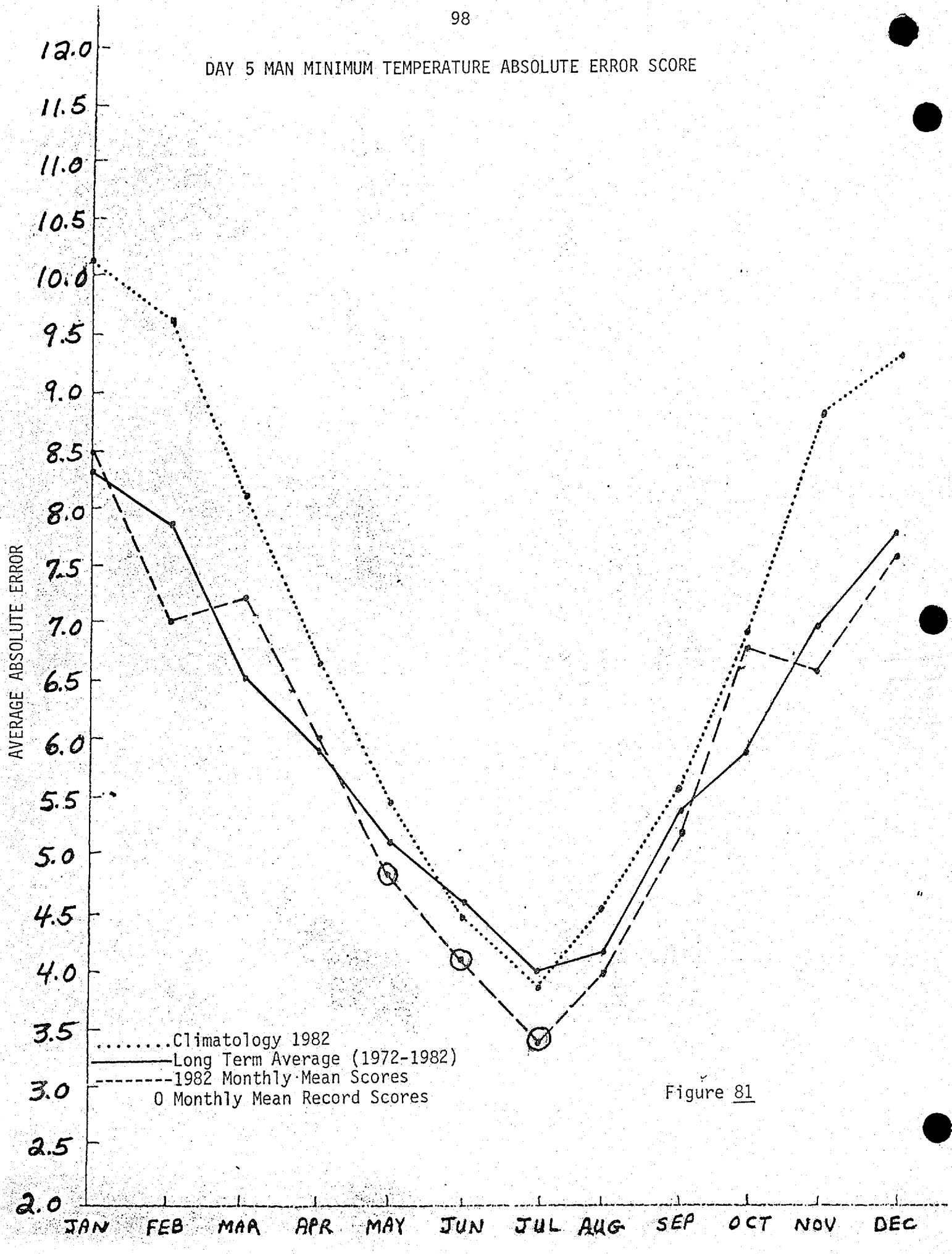


Figure 81

DAY 3 MAN MAXIMUM TEMPERATURE ABSOLUTE ERROR SCORE

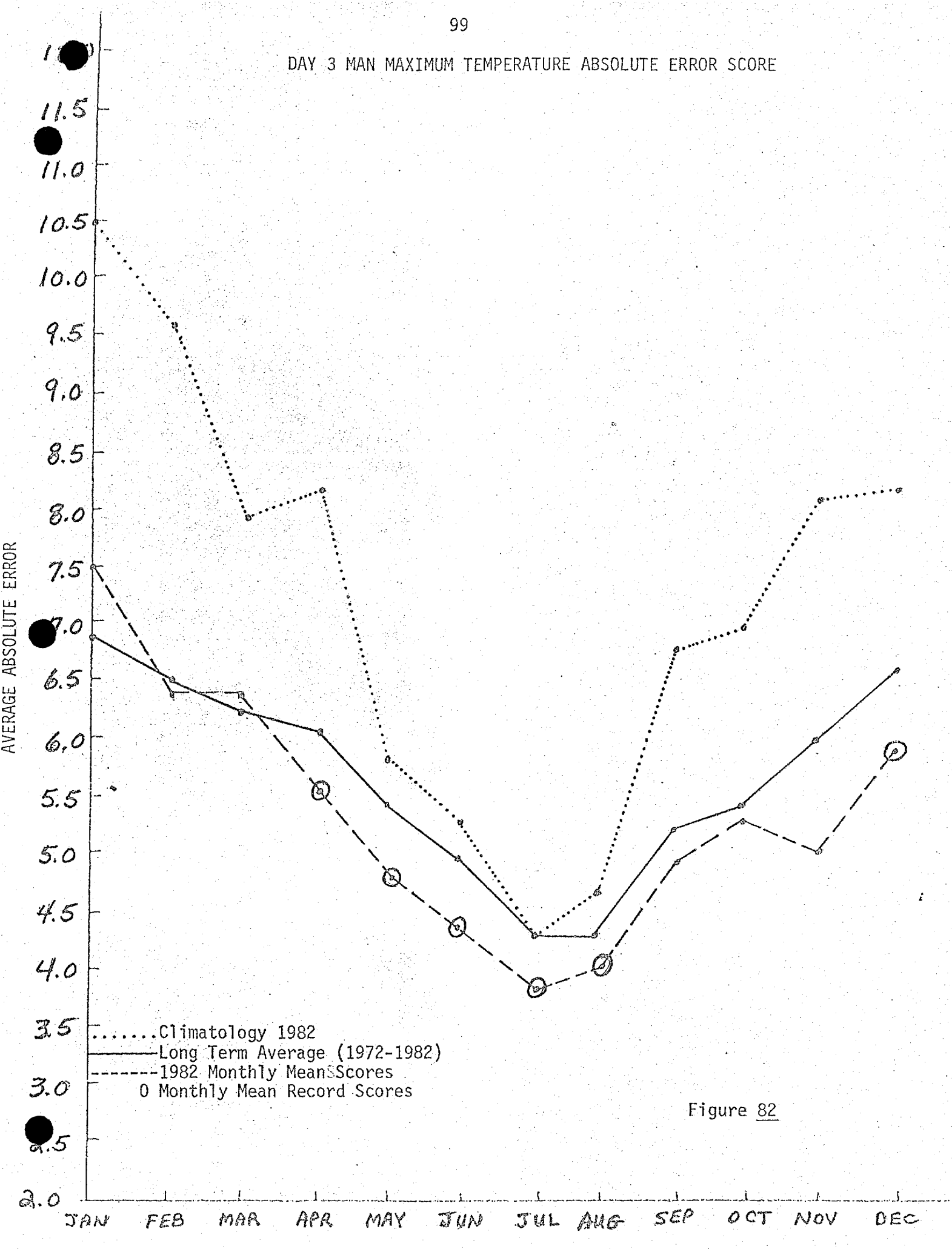


Figure 82

DAY 4 MAN MAXIMUM TEMPERATURE ABSOLUTE ERROR SCORE

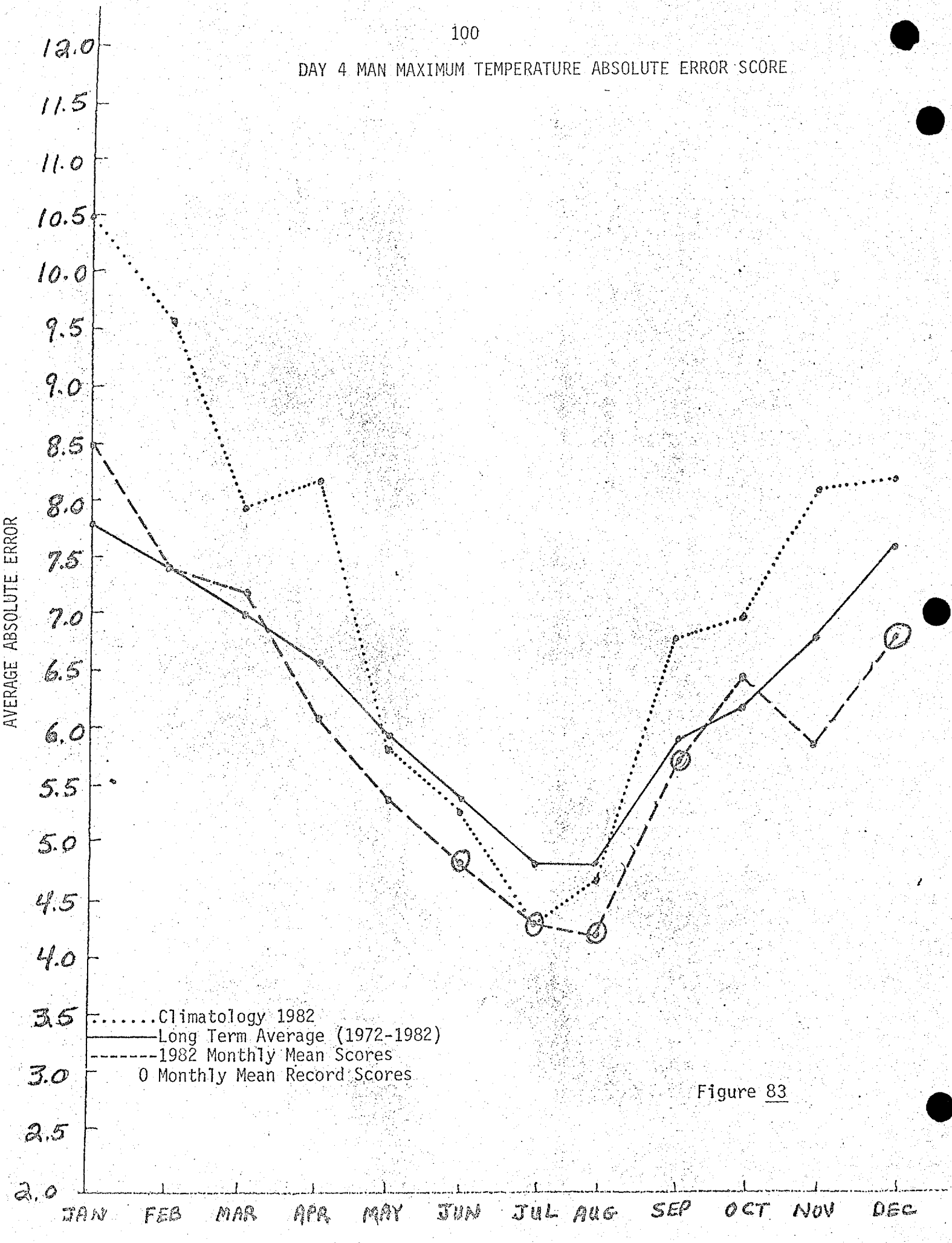


Figure 83

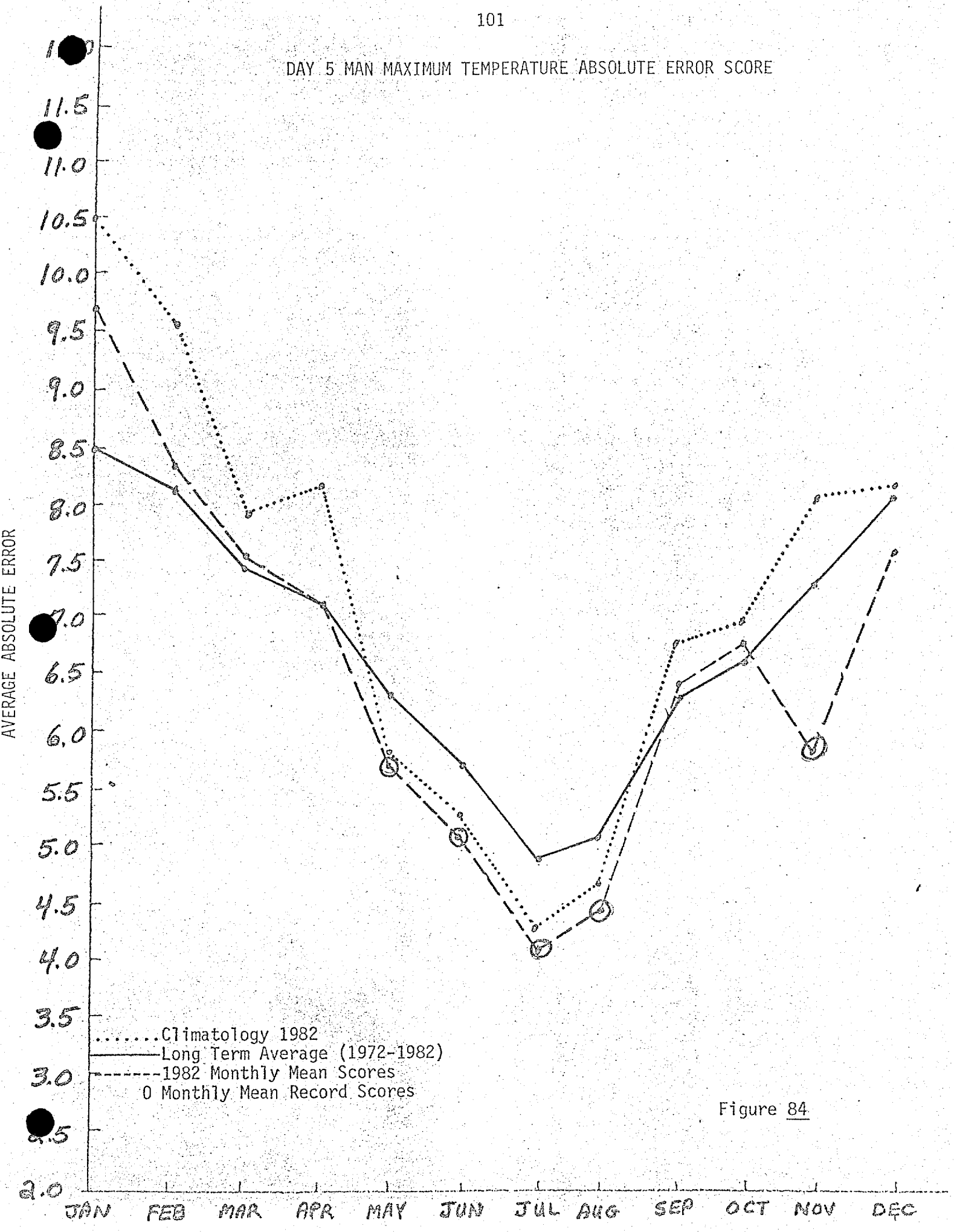

DAY 5 MAN MAXIMUM TEMPERATURE ABSOLUTE ERROR SCORE
AVERAGE ABSOLUTE ERROR
11.5
11.0
10.5
10.0
9.5
9.0
8.5
8.0
7.5
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.0
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
.....Climatology 1982
———Long Term Average (1972-1982)
-------1982 Monthly Mean Scores
O Monthly Mean Record Scores

Figure 84

DAY 3 KL MINIMUM TEMPERATURE ABSOLUTE ERROR SCORE

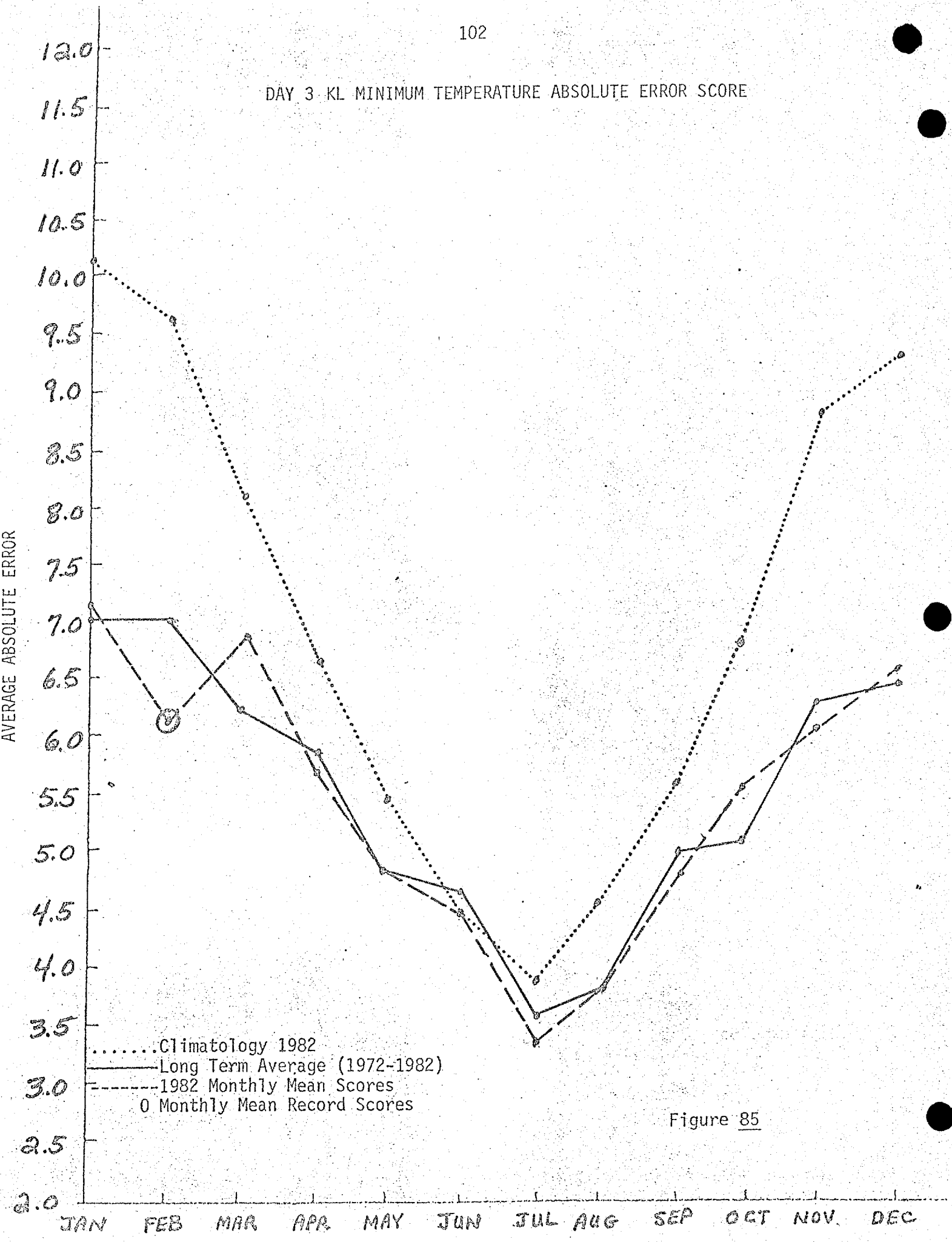


Figure 85

DAY 4 KL MINIMUM TEMPERATURE ABSOLUTE ERROR SCORE

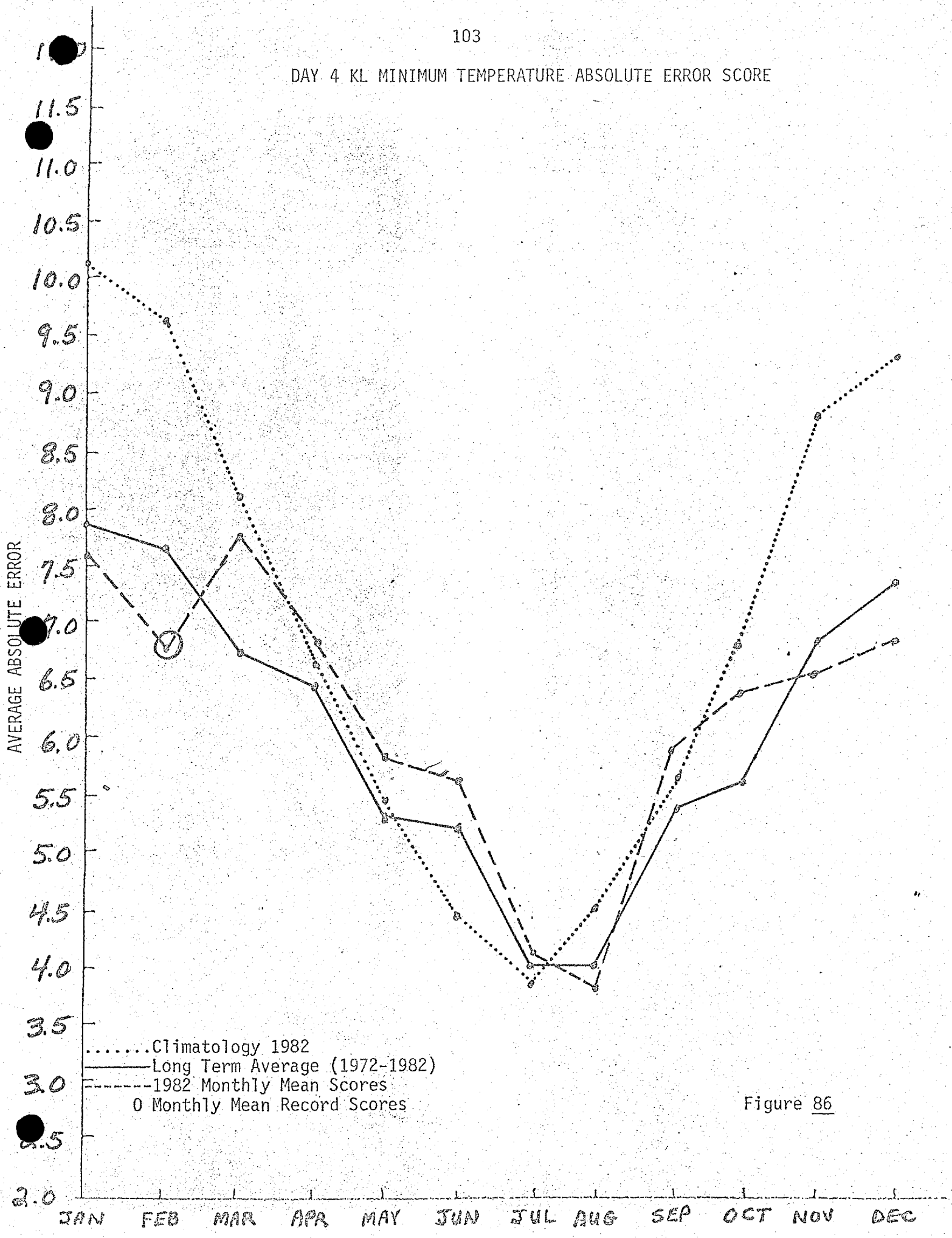


Figure 86

DAY 5 KL MINIMUM TEMPERATURE ABSOLUTE ERROR SCORE

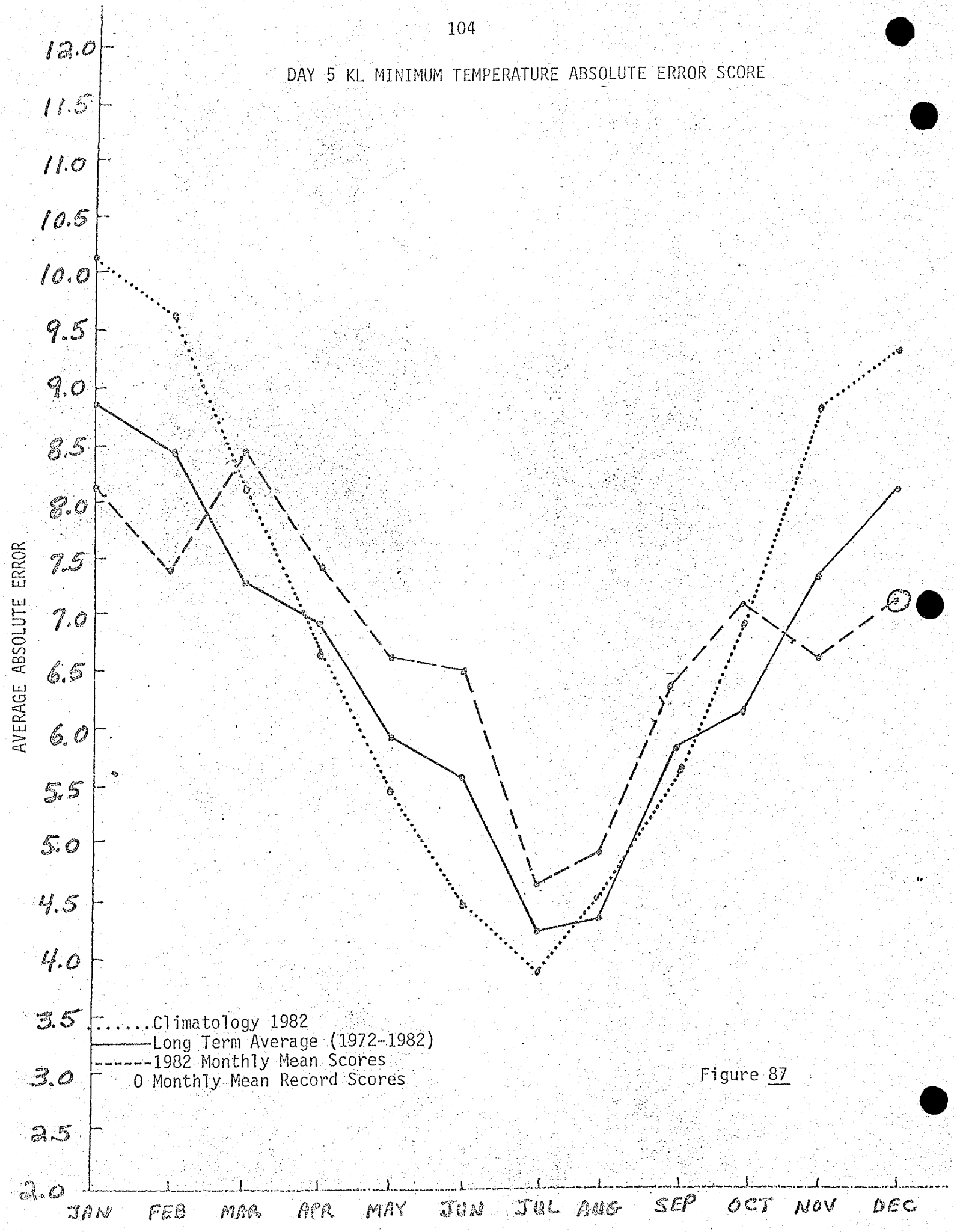


Figure 87

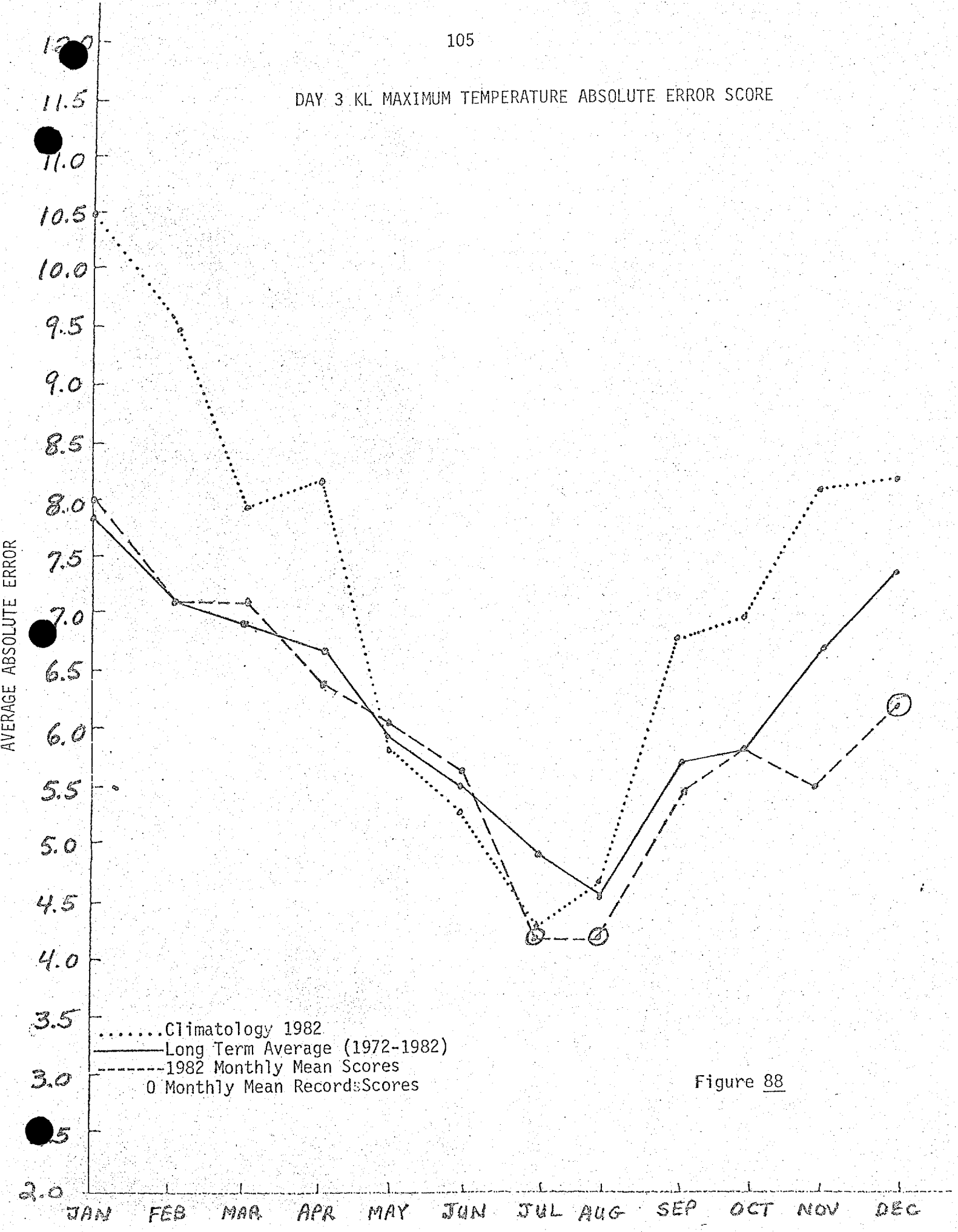

DAY 3 KL MAXIMUM TEMPERATURE ABSOLUTE ERROR SCORE
AVERAGE ABSOLUTE ERROR
11.5
11.0
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.0
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
.....Climatology 1982
———Long Term Average (1972-1982)
-------1982 Monthly Mean Scores
O Monthly Mean Record Scores

Figure 88

DAY 4 KL MAXIMUM TEMPERATURE ABSOLUTE ERROR SCORE

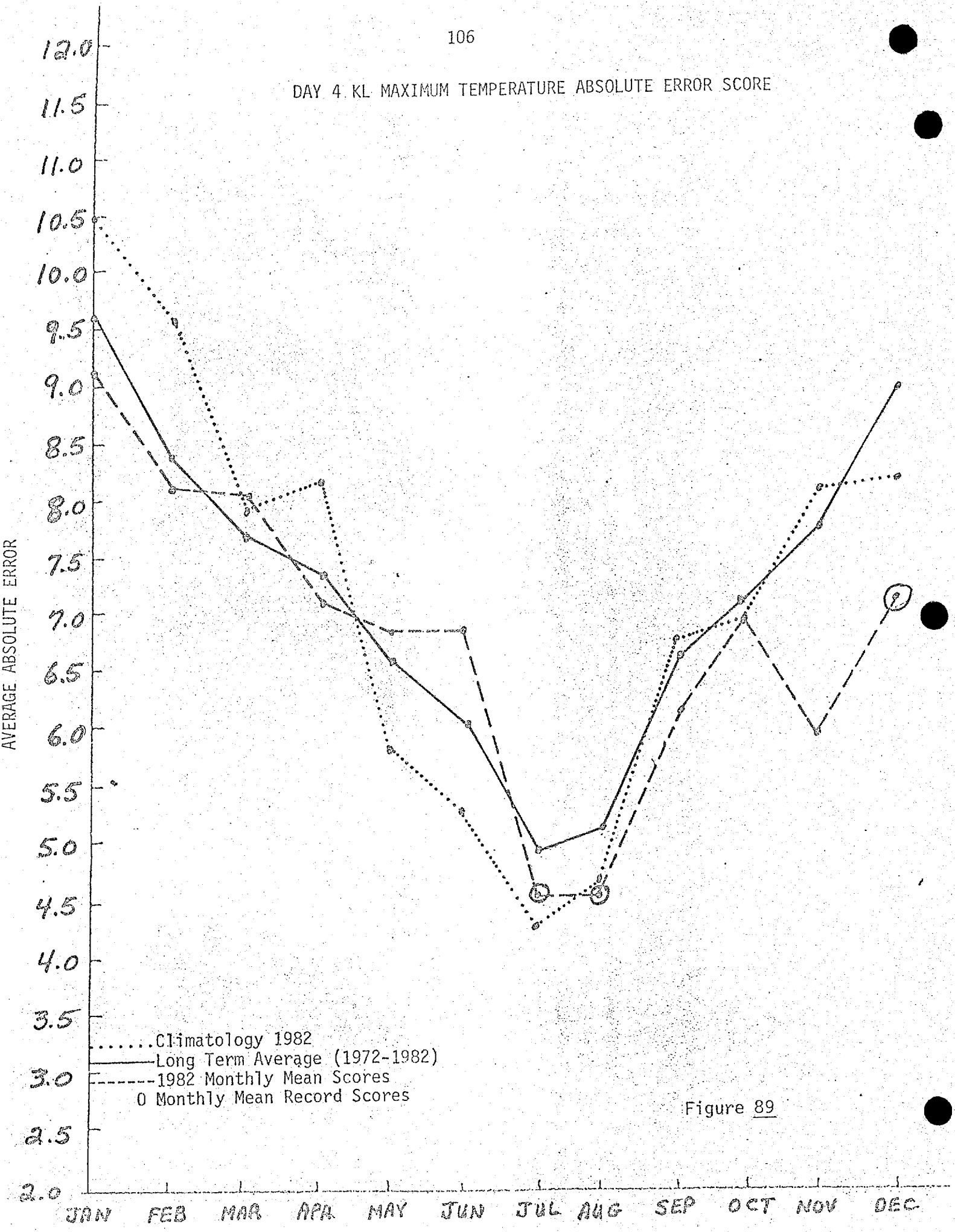


Figure 89

DAY 5 KL MAXIMUM TEMPERATURE ABSOLUTE ERROR SCORE

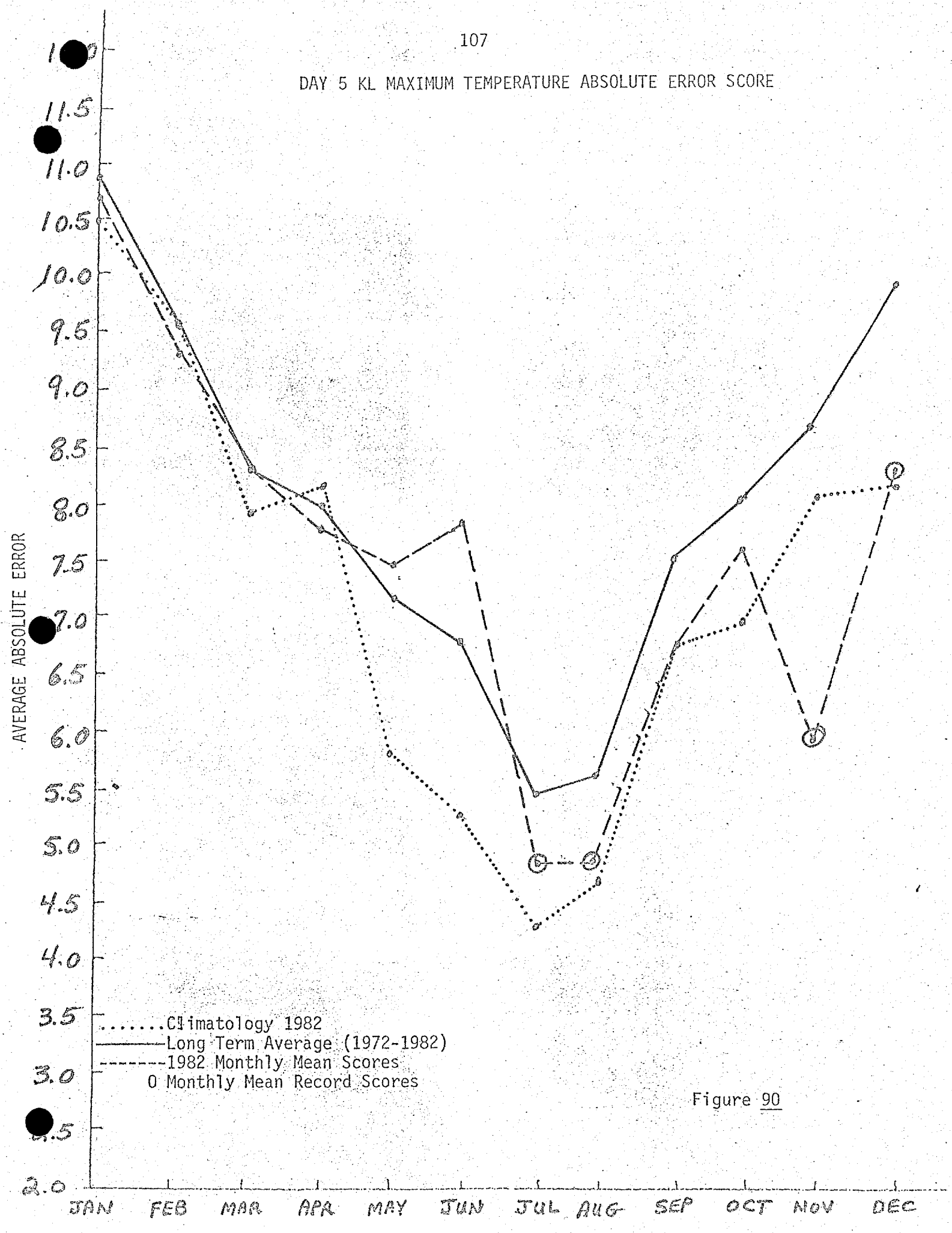


Figure 90

SECTION 10

Man & KL Annual

Temperature Absolute

Error Scores for 1972 through 1982

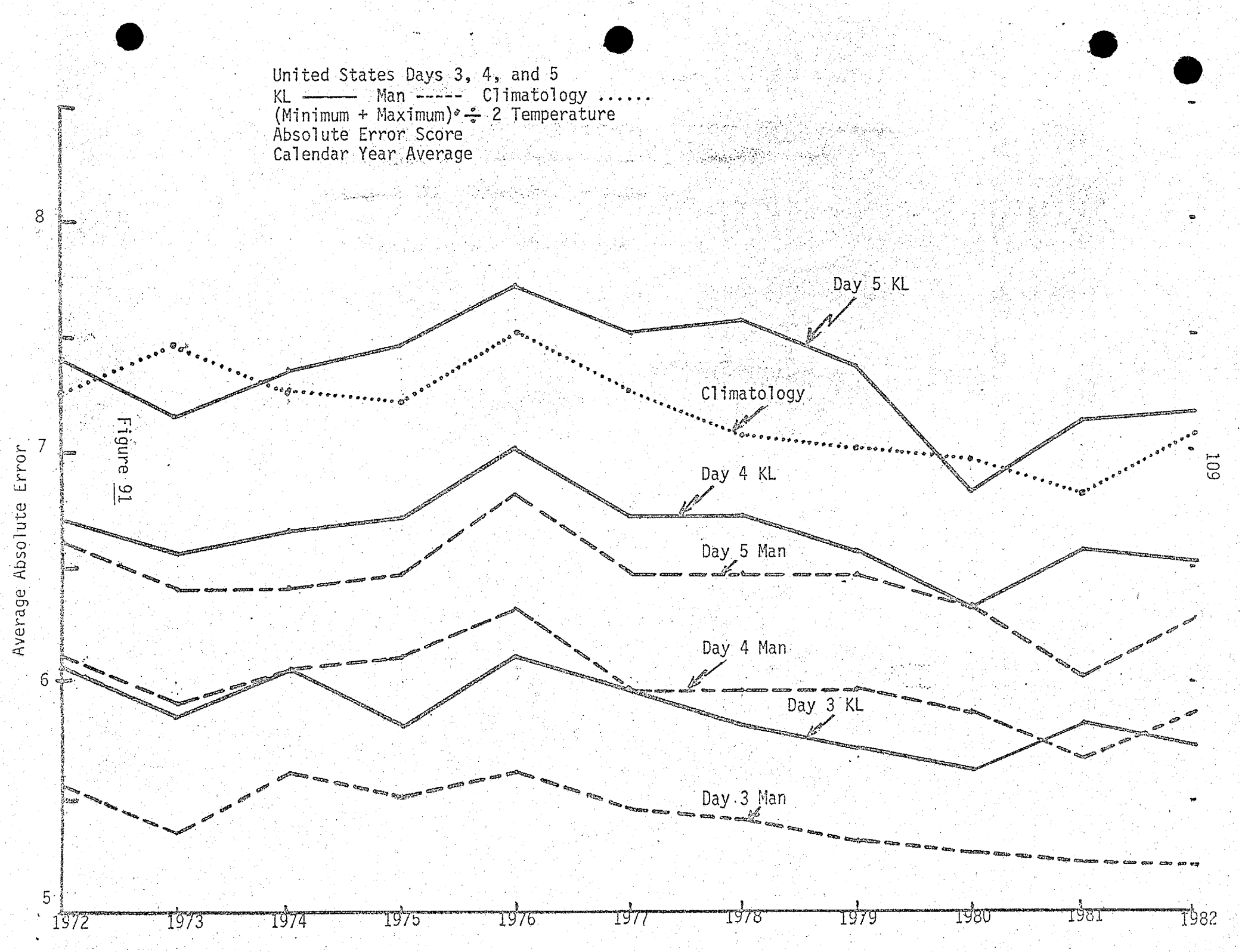

United States Days 3, 4, and 5
KL ——— Man ----- Climatology .....
(Minimum + Maximum)° ÷ 2 Temperature
Absolute Error Score
Calendar Year Average
Average Absolute Error
8
7
6
5
1972
1973
1974
1975
1976
1977
1978
1979
1980
1981
1982
Day 5 KL
Climatology
Day 4 KL
Day 5 Man
Day 4 Man
Day 3 KL
Day 3 Man

Figure 91

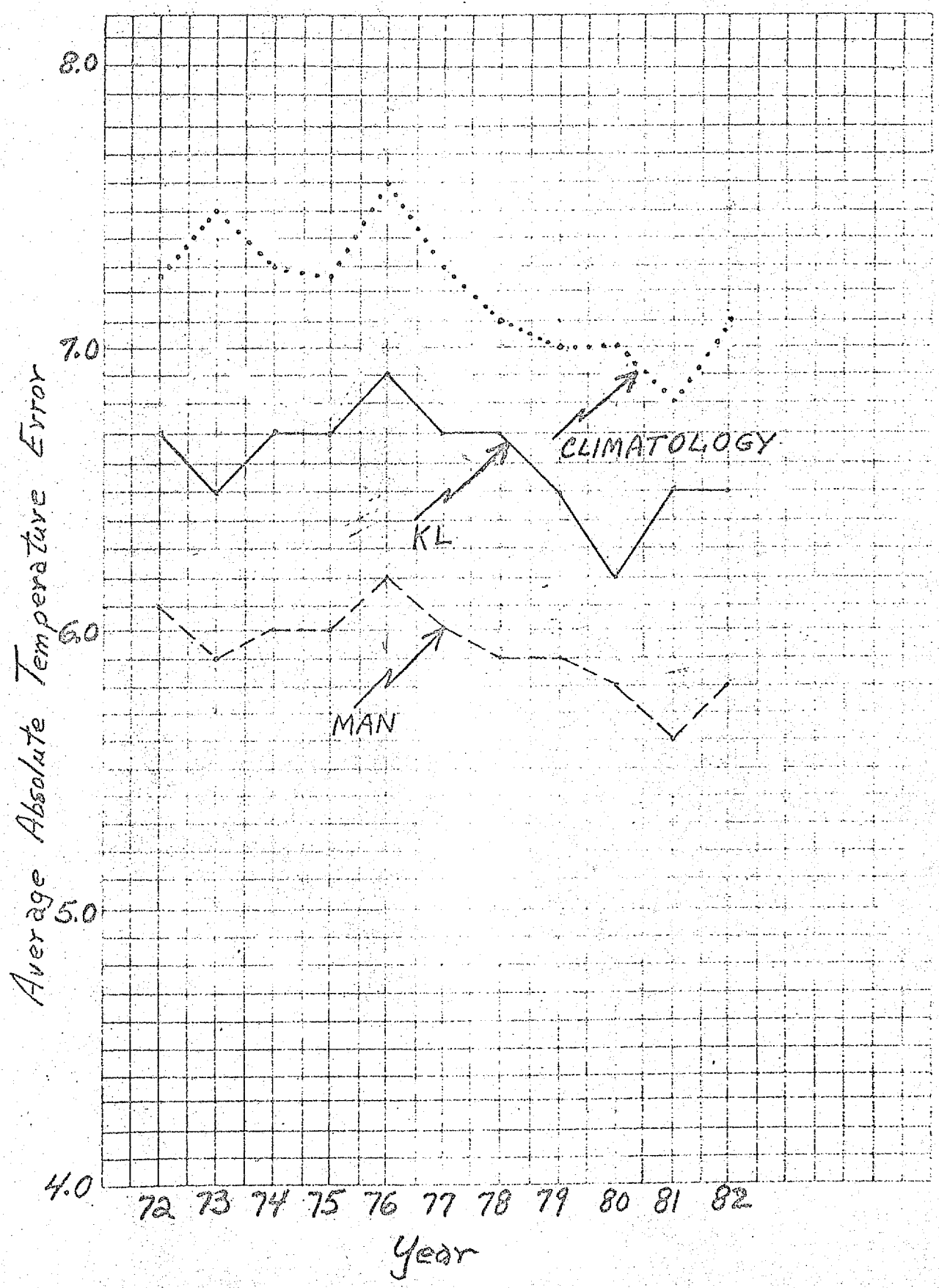
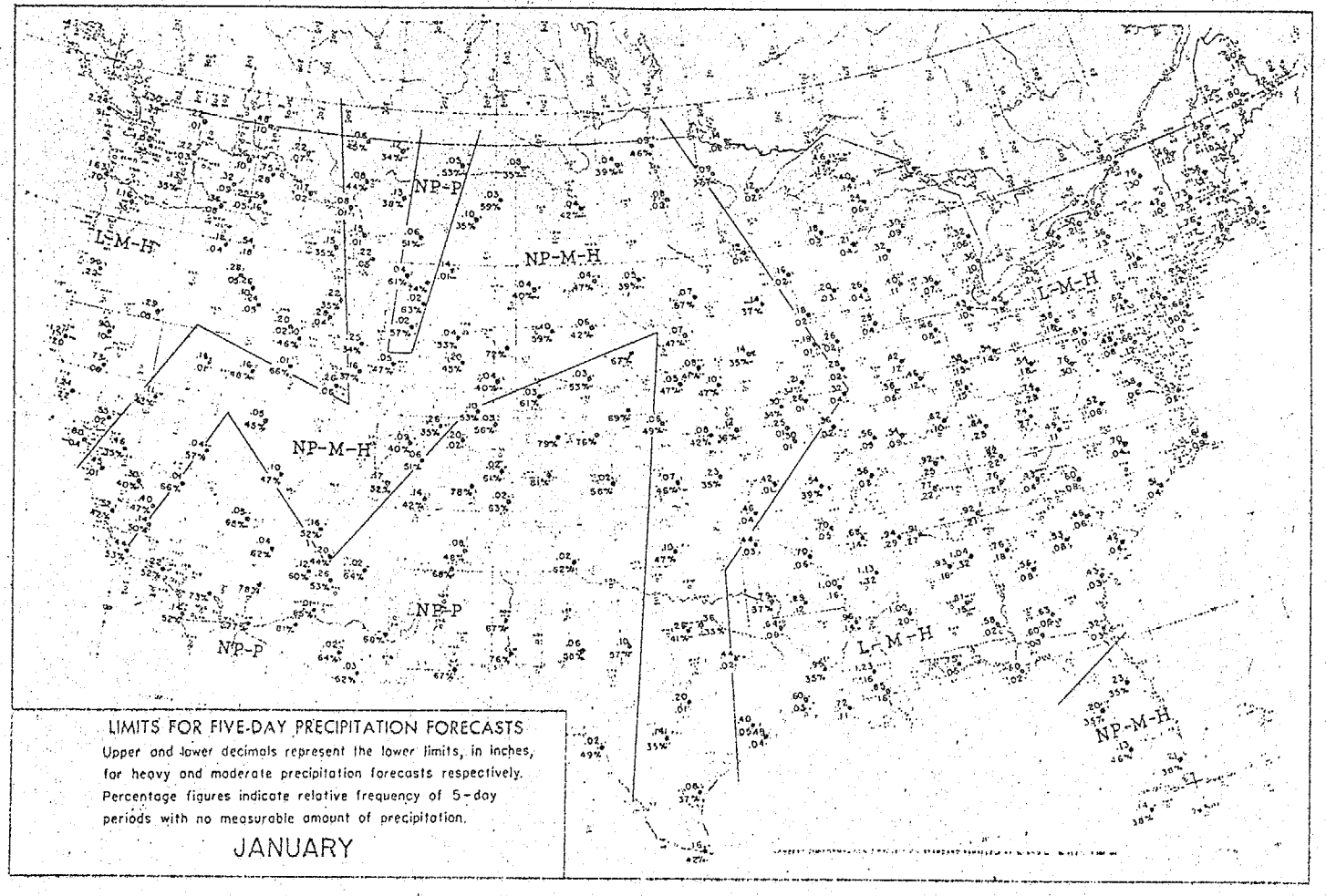

8.0
7.0
6.0
5.0
4.0
Average Absolute Temperature Error
CLIMATOLOGY
KL
MAN
72 73 74 75 76 77 78 79 80 81 82
Year

Figure 92

SECTION 11

5 Day Mean Precipitation

& Temperature Skill Scores



LIMITS FOR FIVE-DAY PRECIPITATION FORECASTS

Upper and lower decimals represent the lower limits, in inches, for heavy and moderate precipitation forecasts respectively. Percentage figures indicate relative frequency of 5-day periods with no measurable amount of precipitation.

JANUARY

Figure 93

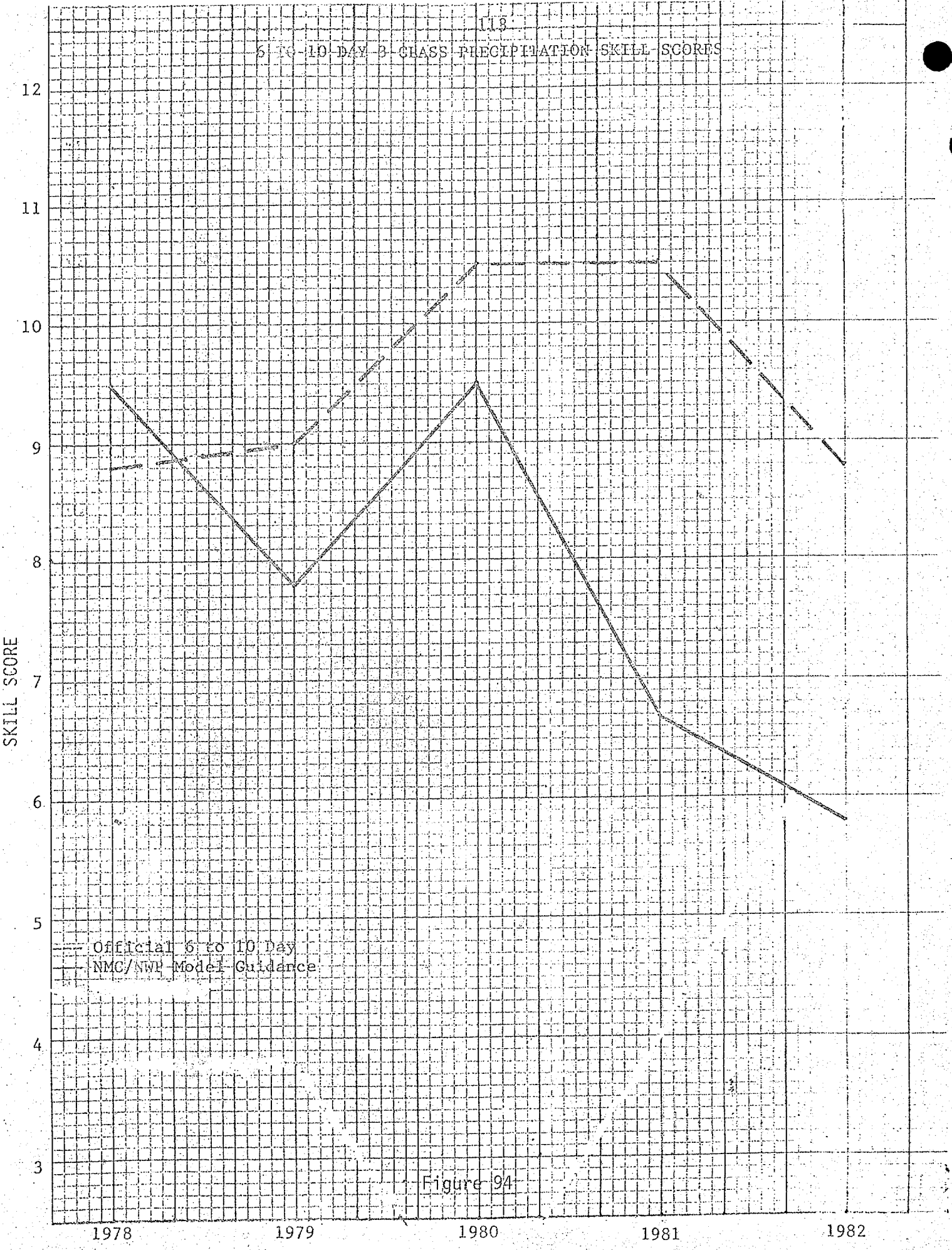

6 TO 10 DAY 3-CLASS PRECIPITATION SKILL SCORES
SKILL SCORE
12
11
10
9
8
7
6
5
4
3
Official 6 to 10 Day
NMC/NWP Model Guidance
1978
1979
1980
1981
1982

Figure 94

6 TO 10 DAY 5 CLASS TEMPERATURE SKILL SCORES

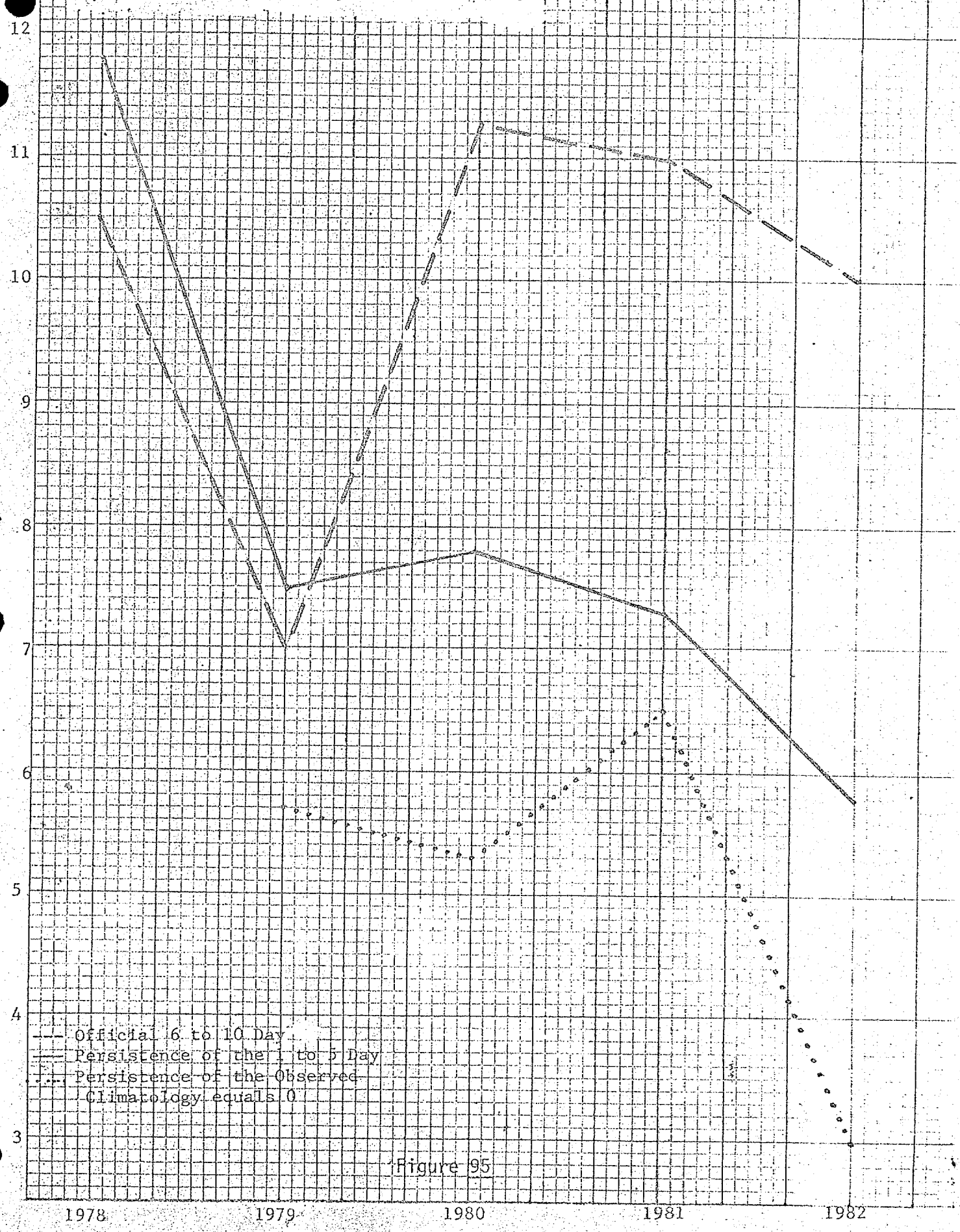
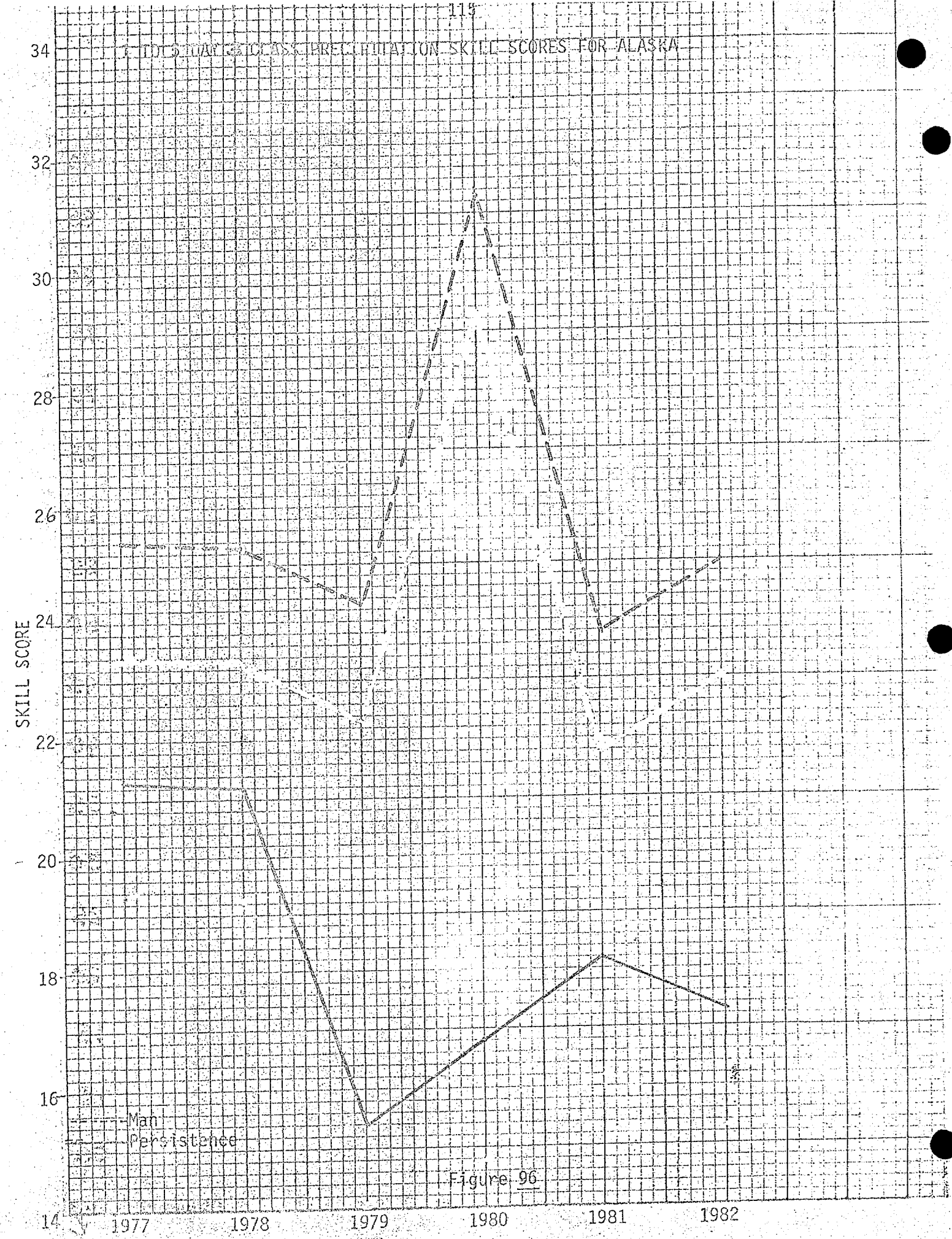


Figure 95



TOTAL DAY 3 CLASS PRECIPITATION SKILL SCORES FOR ALASKA
SKILL SCORE
34
32
30
28
26
24
22
20
18
16
14
1977
1978
1979
1980
1981
1982
Man
Persistence

Figure 96

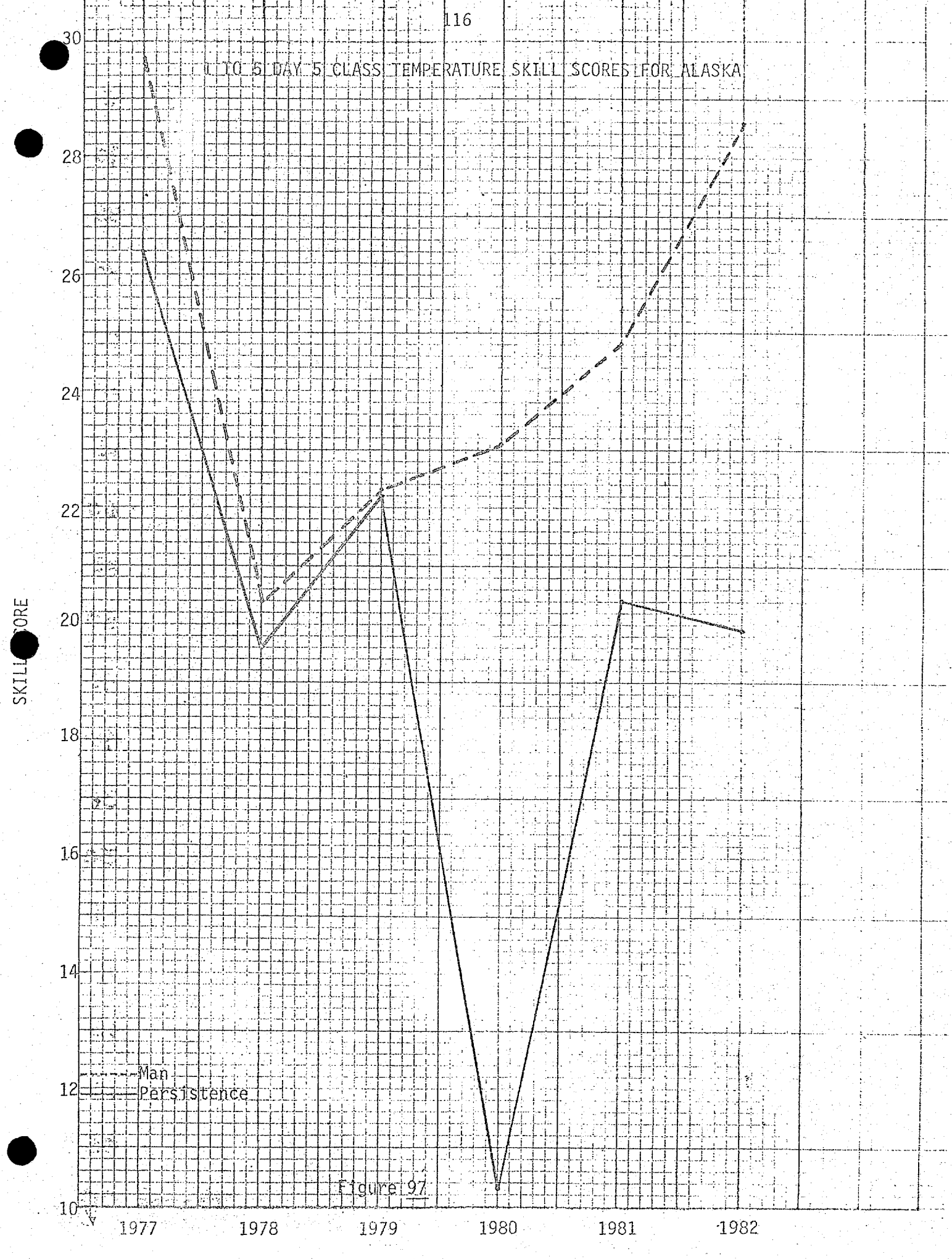

1 TO 5 DAY 5 CLASS TEMPERATURE SKILL SCORES FOR ALASKA
SKILL SCORE
30
28
26
24
22
20
18
16
14
12
10
1977
1978
1979
1980
1981
1982
Man
Persistence

Figure 97

COMMENTS

SECTION 1 PAGES 8 TO 33

The pattern correlation score (Appendix A) has been the basic score used by the MRFG to verify the MSLP and 500 MB progs since the start of the MRFG program. The correlation score was chosen because it is more sensitive to the phasing of troughs and ridges (considered to be more important) than to the depth or heighth of these systems. The MSLP and 500 MB operational analyses (HUF) were used to verify the forecast through 1976 and the LFM since 1977.

The North America (NA) standardized correlation score is the oldest score of record. The US subset unfortunately was contaminated from the beginning through 1975 by a coding (program) error affecting the observed field (verifying analysis).

It was assumed from the start that a MSLP standardized (anomalous field) score of greater than 0.0 (climatology) would result in the derived forecasts of temperature and precipitation having more skill than climatology (as a forecast). However, experience has indicated that a NA score of 0.17 or better is required to accomplish this.

Most of the forecasters complained from the beginning about verifying a forecast of the anomalous MSLP field (which they could not "see") instead of the one they produced (the actual MSLP field). In order to appease the forecaster and obtain a score for the normal (climatology) as a forecast the unstandardized (actual MSLP field) score was introduced in 1977 and has been used successfully ever since.

A glance at figures 2 through 25 shows that, for the most part, the monthly mean scores during 1982 were higher (better) than the long term mean scores (note - the long term mean includes the 1982 scores). Also a comparison of the current long term mean scores with those published

in NMC Office Note 227 of February 81 indicates an upward trend.

Though record scores may not be a good way of determining an increase in skill from one year to the next, nevertheless, they usually are interesting to see. However, before looking at the following table of the total number of monthly mean record MSLP scores (NA and US, standardized and unstandardized) for 1980, 1981, and 1982, it should be pointed out that the longer the period of scorekeeping the more difficult it is to break a record:

Number of Record Scores	1980		1981		1982	
	Man	Machine	Man	Machine	Man	Machine
NA	42	41	18	22	26	18
US	33	34	24	21	27	15
TOTAL	75	75	42	43	53	33

Note: The man set 20 more records than the machine in 1982.

November was a most interesting month for both man and machine. For example, the days 3, 4, and 5 machine NA and US standardized correlation scores beat the previous record scores for that month by +8, +11, +5 and +12, +12, +9 points respectively. Surely an impressive preformance and perhaps worth some investigation as to the probable "reasons why".

SECTION 2 PAGES 34 TO 58

Perhaps one of the surprising results in this section is the clear superiority (higher correlation score MSLP and 500MB) of the SMG3C over the LFM during the colder months of the year and the abrupt termination of the same in May. Conversely the ECMWF appears to have a distinct advantage in skill over the SMG2C for most of the year though for comparison purposes (operational utility) the ECMWF scores should be backed down approximately 12 hours.

Certainly consideration has to be given to producing (operationally) for public consumption man modified MSLP progs for days 6 and 7 since the SMG2C 500MB scores were greater than the critical correlation score of 0.17 for 10 months and the MSLP prog scores exceeded climatology for 6 months of the year at these time ranges. With the MSLP prog scores generally increasing each year and the soon arrival of the new computer (and more sophisticated model - SMG4F perhaps) at NMC it is reasonable to expect skillful MSLP progs through 1 week during the entire year in the near future.

SECTION 3 PAGES 59 TO 63

In general, each year the man and machine MSLP correlation scores are higher in Winter than in Summer. Spring and Fall scores fall in between and are roughly equivalent. Climatology (normal as a forecast) scores highest in Summer. During the other seasons of the year its scores are lower and essentially equal. Man has his greatest improvement over the machine in Summer and over climatology in Winter.

SECTION 4 PAGES 64 TO 68

A seasonal year average, figure 54, e.g. 1982 consists of (Winter (December 81 - February) + Spring (March - April) + Summer (June - August) + Fall (September - November 82)) $\div$ 4. Thus the calendar year average scores figure 55 cannot be gotten exactly from the days 3, 4, and 5 scores etc in figure 54. Certainly since the introduction of the baroclinic model (PE) in 1980 (improved day 3 in 1978 - see page 2) the increase in skill of the man and machine MSLP and machine 500 mb progs has been spectacular.

SECTION 5 PAGES 69 TO 77

These selected (mid season) day 4 error patterns are part of the monthly mean output which also include mean positive/negative errors and frequency of positive/negative errors. These patterns are compiled for days 2 through 7 and assist the man in modifying the machine MSLP guidance. Any unusual patterns are reported to the NMC Development Division.

SECTION 6 PAGES 78 TO 80

Forecasters (as part of their repertoire) like to look at Barotropic progs (see page 3 paragraph 3d), and, perhaps, not without some justification since figure 66 indicates a superiority of this model (technique) over the baroclinic in eastern NA during the warmer months of the year. This skill gradually diminshes to equal or less than the SMG2C on day 5 (days 4 and 5 not shown).

SECTION 7 & 8 PAGES 81 TO 93

The Gilman skill score, except for the problem mentioned in Appendix B, is quite sensitive to correct forecasts of precipitation. The Hughes skill score is quite sensitive to correct forecasts of no precipitation at stations with a high climatic precipitation probability. The experimental score is quite sensitive to correct forecasts of precipitation at stations with a low climatic precipitation probability. Thus these three scores complement one another.

1982 was a good year but not a banner year for the forecast of precipitation by the MRFG. There are several reasons that come immediately to mind for this but the overriding one remains that precipitation is the most difficult of the weather events that the MRFG is required to forecast.

Notably missing from these sections are the scores for the precipitation forecasts made by the machine. The machine precipitation forecasts do not have much skill in the MR, at present, and have been available only since the introduction of the PE model in 1980. For example, the 1982 average day 3 Gilman skill score for the model is no better than climatology and gets worse thereafter.

SECTION 9 PAGES 94 TO 107

A quick look at figures 79 through 90 shows that, for the most part, the man monthly mean temperature absolute error scores during 1982 were lower (better) than the long term mean scores (note - the long term mean includes the 1982 scores). In particular, the man maximum temperature scores were exceptionally good during the warmer months of the year and established many new records. Note the man and KL scores for November. (See comments on November MSLP scores). As usual the KL did not do well compared to climatology (as a forecast) during the warmer months of the year.

SECTION 10 PAGES 108 TO 110

1982 was a good year for the forecasts of temperature by the MRFG. E.g. the margin over climatology was the third largest, the average absolute error was tied for the second lowest, and the improvement (man-KL) was somewhat better than the long term difference.

SECTION 11 PAGES 111 TO 116

The average skill score of the 6 to 10 and (1 to 5) day mean forecasts for the past 5 years is 9.6 (23.0) for precipitation and 10.0 (26.4) for temperature. This equates to 41% (50%) compared to 35% by chance

and 31% (43%) compared to 21% by chance of the Nation (61 US stations) forecast in the correct 3 class precipitation and 5 class temperature categories respectively.

The 1 to 5 day mean 3 class precipitation and 5 class temperature skill scores for Alaska are calculated from forecast/observed data at the following 9 stations: Pt Barrow, Nome, King Salmon, Cold Bay, Kodiak, Anchorage, Fairbanks, Juneau, and Annette. Persistence of the 1 to 5 day mean observed temperature and precipitation has been found to be a good control against which to measure the skill of the Alaskan forecasts by the MRFG. There appears to be a definite increase in skill of the temperature forecasts since the introduction of the baroclinic model (PE) in 1980 (improved day 3 in 1978 -- see page 2).

Appendix A

The standardized mean sea level pressure correlation score is used to determine the skill of the man and machine days 3, 4 and 5 mean sea level pressure forecasts. The correlation score is employed because the phasing instead of the intensity of systems primarily determines how well the various weather parameters can be forecast. The standardizing procedure prevents the contribution of the high variability (higher latitude) grid points from overwhelming the low variability grid points (lower latitude).

f = forecast mean sea level pressure at a grid point

o = observed mean sea level pressure at a grid point

σ = standard deviation at a grid point

n = normal mean sea level pressure at a grid point

$$F = \frac{f-n}{\sigma} \qquad O = \frac{o-n}{\sigma}$$

$\overline{F}$ = average standardized forecast across n grid points

$\overline{O}$ = average standardized observed across n grid points

$$\text{RMS } F = \sqrt{\overline{F}^2} \qquad \text{RMS } O = \sqrt{\overline{O}^2}$$

$$\text{RMS Error} = \sqrt{\overline{(F-O)}^2}$$

$$\text{Average Absolute Error} = \overline{|F-O|}$$

$$\text{Correlation} = \frac{\overline{FO} - \overline{F}\,\overline{O}}{\sqrt{(\overline{F^2} - \overline{F}^2)\,(\overline{O^2} - \overline{O}^2)}} \times 100$$

Since the normal mean sea level pressure is subtracted from the forecast/observed pressure at each grid point, it is assumed that the correlation of the normal to the observed is always zero. Therefore, any positive score is considered

to have skill over the normal. Some doubts have been raised about this assumption, however, and for the past 5 years the unstandardized correlation score also has been calculated. This procedure allows a correlation score to be computed for the normal. This score then is simply the correlation of the forecast to the observed mean sea level pressure.

Appendix B

The Gilman skill score is a generalization of the Heidke skill score where the expected values are derived from a randomized version of the precipitation forecast.

$$\text{Heidke Skill} = \frac{C-E}{N-E}$$

C = total correct (hits)

N = total number of forecasts (100)

E = expected number of hits

However, for a randomized forecast allowance must be made for stations having far different precipitation climate (N POP) across the United States. Therefore, to compute and score an expected chance forecast, climatology must be considered. The procedure for this is as follows:

First, the actual number of forecasts of precipitation are distributed randomly taking into account station climatology. The expected number of chance hits is then given by:

$$E = \sum^{N} (p_i\, r_i + (1 - p_i)(1 - r_i)) \text{ or}$$

$$E = 2\sum^{N} p_i\, r_i + N - \sum^{N} p_i - \sum^{N} r_i \quad (a)$$

where $r_i = 1$ for precipitation ($\geq$.01 inch) and 0 for no precipitaiton ($<$.01 inch). Now an expression for p_i, which is the probability that after the forecast precipitation events are redistributed randomly a forecast precipitation event will fall at point "i" is given approximately by $p_i = F\frac{a_i}{\sum^{N} a_i}$ (b). Here F = total number of forecasted precipitation events and a_i = climatic precipitation probability (N POP). This approximate value for p_i is most valid for small values of F and ($a_i / \sum a_i$) and is unstable at times. Because of this instability the less sophisticated but more stable Hughes skill score was developed.

Substituting the expression (b) into (a) gives $E = \frac{2F\sum^{N} a_i r_i}{\sum^{N} a_i} + N - F - R$, where E = the approximate expected value of a randomized forecast, R = total precipitation cases, and N = total number of stations. If the climatic probabilities are uniform ($a_i = a_j = a$), then the approximate value of E reduces to the standard Heidke value given by: $E = \frac{(N-F)(N-R)+FR}{N}$.

Appendix C

The Hughes skill score is a generalization of the Heidke skill score where the expected values are derived from the observed precipitation:

$$\text{Heidke Skill} = \frac{C-E}{N-E}$$

C = total correct (hits)
N = total number of forecasts (100)
E = expected number of hits

If the average precipitation climate (NPOP) of 12 stations having precipitation is 25, then the expected (precipitation) is simply 12 x .25 or 3 stations. If the average NPOP of the (100-12) stations not having precipitation is also 25 then the expected (no precipitation) is simply 88 x (1.0-.25) or 66 stations. The total expected (E) then is 69 stations. If the forecaster hit (C) 75 stations correctly, his skill score then is (75-69)/(100-69) x 100 or 19.

APPENDIX D

The (Hughes) experimental score is not a skill score yet it is quite simple to understand. A rough score (RS) is calculated for each station (N=1 to 100) as follows:

Forecast	Observed	RS
(DN POP + NPOP) $\geq$30	P=1	+(1 - NPOP)
(DN POP + NPOP) $\geq$30	P=0 and NPOP $\geq$50	-(NPOP)
(DN POP + NPOP) $<$30	P=1 and NPOP $\geq$50	-(NPOP)
(DN POP + NPOP) $\geq$30	P=0 and NPOP $<$50	-(1 - NPOP)
(DN POP + NPOP) $<$30	P=1 and NPOP $<$50	-(1 - NPOP)
(DN POP + NPOP) $<$30	P=0	+(NPOP)

Since the total rough score (TRS) for the 100 stations does not equal 100 points, a simple iterative technique is employed which uses the RS as a f(NPOP) for each station to bring the total number of points up to 100. The FORTRAN language routine is:

```
            TTY = 0
70          DO 69   I = 1, 100
            TRS = (100.0 - TRS) * ABS(RS(I)) * .01
            IF(RS(I)) 73, 74, 74
73          RS(I) = RS(I) - TRS
            GO TO 69
74          RS(I) = RS(I) + TRS
69          TTY = TTY + ABS(RS(I))
            TRS = TTY
            TTY = 0.0
            IF (TRS - 99.8) 70, 71, 71
71          CONTINUE
```

APPENDIX E

The 5-Day mean precipitation skill score is a generalization of the Heidke skill score where the expected values are derived from the observed precipitation:

$$\text{Heidke Skill} = \frac{C-E}{N-E}$$

C = total correct (hits)
N = total number of forecasts (100)
E = expected number of hits

For example, in January the number of stations in the area covered by the (NP/P), (NP/M/H) and (L/M/H) categories is 21, 28 and 51 respectively. The average value of the probability of NP for the stations in the (NP/P) area is 59% and 40% in the (NP/M/H) area. Now if (NP/L) is coded as 1, M as 2 and (P/H) as 3, then the number of stations expected to have coded value 1 thru 3 is as follows:

33% of (L/M/H) = 51 x .33 = 17 stations coded 1, 2, 3

40% of (NP/M/H) = 28 x .40 = 11 stations coded as 1 and 8.5 coded as 2,3

59% of (NP/P) = 21 x .59 = 12 stations coded as 1 and 9 coded as 3

Thus, code 1 = 17 + 11 + 12 = 40 stations
code 2 = 17 + 8.5 = 25.5 stations
code 3 = 17 + 8.5 + 9 = 34.5 stations
100.0 stations

Therefore, the expected value = .40a + .255b + .345c

where a, b and c are the number of coded values 1, 2 and 3 observed.

APPENDIX F

The 5 day mean temperature skill score is a generalization of the Heidke skill score where the expected values are derived from the observed temperature

$$\text{Heidke Skill} = \frac{C-E}{N-E}$$

C = total correct (hits)
N = total number of forecasts (61)
E = expected number of hits

The expected value is calculated as follows from the number of stations in each of the observed temperature categories.

E = 1/8 x Much Below + 1/8 x Much Above +
1/4 x Below + 1/4 x Above + 1/4 x Normal