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

OFFICE NOTE 284

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 are presented. This paper contains the standardized and unstandardized mean sea level pressure and 500-mb correlation; the Gilman, Hughes, and experimental precipitation skill; the minimum/maximum absolute temperature error; and the mean normalized 500-mb correlation, temperature, and precipitation skill scores. Subsequent updates to this note will include the Brier precipitation score. (See COMMENTS pages 105 to 107.)

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 FM - Fine Mesh 190km
   d. SMG26 - Spectral Model Global 24 modes 6-layers
   e. SMH2C - Spectral Model Hemispheric 24 modes 12-layers
   f. SMG3C - Spectral Model Global 30 modes 12-layers
   g. SMG4C - Spectral Model Global 40 modes 12-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 October 19, 1983: SMG3C to 48-hours then SMG2C to 84-hours.
      (6) From October 19, 1983, through December 1983: SMG4C

   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 October 19, 1983: SMG2C
      (6) From October 19, 1983 through December 1983: SMG4C

   c. Greater than 144-hours to 252 hours

      (1) From November 1977 through April 1981: Baro Mesh
      (2) From December 1977 through April 15, 1981: 3L PE CM
      (3) From April 15, 1981 through October 19, 1983: SMG26 to 192 hours then SMH26 to 240 hours.
      (4) From October 19, 1983 through December 1983: SMG4C 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):

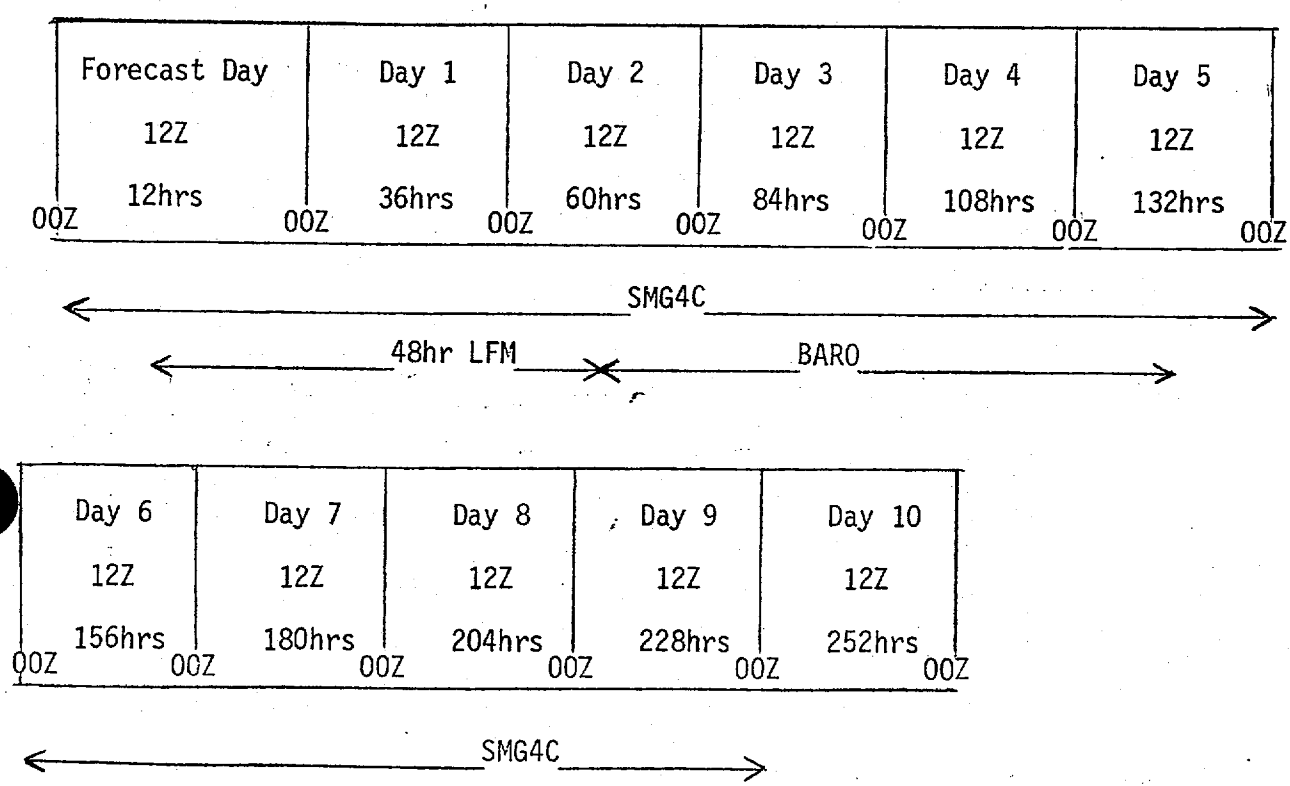
      (1) From 1970 through 1977: Baro (Mesh in 1977)

c. To 48-hours

(1) From October 1971 through August 1977: 7L PE FM (old LFM)
(2) From September 1977 through 1983: 7L PE LFM (127km)

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

(1) From 1978 through 1983: Baro run from the 48-hour LFM inserted into the 60-hour SMG4C from 00Z.



Figures

Figure 1 depicts the North American (NA 130 grid points) and the United States (US 86 grid points) subset mean sea level pressure (MSLP) and 500 mb correlation score verification areas.

Figure 2 is a plot of the calendar year 1983 monthly mean standardized correlation scores for the man and NMC/NWP model North American area mean sea level pressure progs verifying on days 3, 4, and 5 after forecast day. (See Appendix A for an explanation of this score.)

Figure 3 is a plot of the 16/14 year (1968/70-1983) average monthly mean standardized correlation scores for the man and NMC/NWP model North American area mean sea level pressure progs verifying on days 3,4, and 5 after forecast day. (See Appendix A for an explanation of this score.)

Figure 4 is a plot of the 1968/70 through 1983 calendar year standardized correlation scores for the man and NMC/NWP model North American area mean sea level pressure progs verifying on days 3, 4, and 5 after forecast day. (See Appendix A for an explanation of this score.)

Figure 5 is similar to figure 2 except the score is unstandarized.

Figure 6 is similar to figure 3 except the average is for 7 years and the score is unstandardized.

Figure 7 is similar to figure 4 except the calendar years are 1977 through 1983 and the score is unstandardized.

Figure 8 is a plot of the calendar year 1983 monthly mean standardized correlation scores for the NMC/NWP model North American area 500 mb progs verifying on days 3, 4, and 5 after forecast day. (See Appendix A for an explanation of this score.)

Figure 9 is a plot of the 14 year (1970-1983) average monthly mean standardized correlation scores for the NMC/NWP model North American area 500 mb progs verifying on days 3, 4, and 5 after forecast day. (See Appendix A for an explanation of this score.)

Figure 10 is a plot of the 1970 through 1983 calendar year standardized correlation scores for the NMC/NWP model North American area 500 mb progs verifying on days 3, 4, and 5 after forecast day. (See Appendix A for an explanation of this score.)

Figure 11 is similar to figure 2 except the area is the United States.

Figure 12 is similar to figure 3 except the average is for 8 years and the area is the United States.

Figure 13 is similar to figure 4 except the calendar years are 1976 through 1983 and the area is the United States.

Figure 14 is similar to figure 5 except the area is the United States.

Figure 15 is similar to figure 6 except the area is the United States.

Figure 16 is similar to figure 7 except the area is the United States.

Figure 17 is similar to figure 8 except the area is the United States.

Figure 18 is similar to figure 9 except the average is for 9 years and the area is the United States.

Figure 19 is similar to figure 10 except the calendar years are 1975 through 1983 and the area is the United States.

Figure 20 is a plot of the calendar year 1983 monthly mean standardized correlation scores for the man, NMC/NWP model, European Center for Medium Range Weather Forecasting (ECMWF), and Linear Regression (LR-see NMC ON 259 of June 82) North American area 500 mb mean progs verifying 6 to 10 days after forecast day.

Figure 21 is a plot of the 5 year (1979-1983) average monthly mean standardized correlation scores for the man and NMC/NWP model North American area 500 mb mean progs verifying 6 to 10 days after forecast day.

Figure 22 is a plot of the 1979 through 1983 calendar year standardized correlation scores for the man, NMC/NWP model and ECMWF (1982-1983) North American area 500 mb mean progs verifying 6 to 10 days after forecast day.

Figure 23 depicts the 41 stations in the United States where the temperature forecasts are verified.

Figure 24 is a plot of the calendar year 1983 bi-monthly mean absolute error minimum temperature scores for the man, Klein Lewis (KL) objective, and climatology temperature forecasts verifying on days 3, 4, and 5 after forecast day.

Figure 25 is a plot of the 13 year (1971-1983) average bi-monthly mean absolute error minimum temperature scores for the man, KL, and climatology temperature forecasts verifying on days 3, 4, and 5 after forecast day.

Figure 26 is a plot of the 1971 through 1983 calendar year absolute error minimum temperature scores for the man, KL, and climatology temperature forecasts verifying on days 3, 4, and 5 after forecast day.

Figure 27 is similar to figure 24 except the temperature is maximum.

Figure 28 is similar to figure 25 except the temperature is maximum.

Figure 29 is similar to figure 26 except the temperature is maximum.

Figure 30 is a plot of the 1972 through 1983 calendar year absolute error (minimum + maximum)÷2 temperature scores for the man, KL, and climatology temperature forecasts verifying on days (3+4+5)÷3 after forecast day.

Figure 31 is a plot of the calendar year 1983 monthly mean 5 class temperature skill scores for the man, forecast persistence (FP-persistence of the 1-5 day mean temperature forecast as a 6-10 day), linear regression (LR-see NMC ON 259 of June 82), and observed (T OBS-persistence of the 5 day mean observed temperatures as a 6-10 day forecast) mean temperature forecasts verifying 6 to 10 days after forecast day. (See Appendix B for an explanation of this score.)

Figure 32 is a plot of the 6 year (1978-1983) average monthly mean 5 class temperature skill scores for the man, FP, LR, and T OBS mean temperature forecasts verifying 6 to 10 days after forecast day.

Figure 33 is a plot fo the 1978 through 1983 calendar year 5 class temperature skill scores for the man, FP, LR, and T OBS mean temperature forecasts verifying 6 to 10 days after forecast day.

Figure 34 is similar to figure 31 except the temperature skill scores are 3 class.

Figure 35 is similar to figure 32 except the temperature skill scores are 3 class.

Figure 36 is similar to figure 33 except the temperature skill scores are 3 class.

Figure 37 depicts the 100 stations in the United States where the precipitation forecasts are verified.

Figure 38 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) 30 are considered as a yes climatological forecast of precipitation.

Figure 39 is a plot off the calendar year 1983 monthly mean Gilman precipitation skill scores for the man, climatology, and NMC/NWP model precipitation forecasts verifying on days 3, 4, and 5 after forecast day. (See Appendix C for an explanation of this score.)

Figure 40 is a plot of the 14 year (1970-1983) average monthly mean Gilman precipitation skill socres for the man and climatology precipitation forecasts verifying on days 3, 4, and 5 after forecast day.

Figure 41 is a plot of the 1970 through 1983 calendar year Gilman precipitation skill scores for the man and climatology precipitation forecasts verifying on days 3, 4, and 5 after forecast day.

Figure 42 is a plot of the 1970 through 1983 Gilman precipitation skill scores for the man and climatology precipitation forecasts verifying on days $(3+4+5) \div 3$ after forecast day.

Figure 43 is similar to figure 38 except the skill score is Hughes. (See Appendix D for an explanation of this score.)

Figure 44 is similar to figure 39 except the average is for 7 years, the skill score is Hughes, and climatology is not depicted.

Figure 45 is similar to figure 40 except the calendar years are 1977 through 1983 and the skill score is Hughes.

Figure 46 is similar to figure 38 except the skill score is Hughes Probability. (See Appendix E for an explanation of this score.)

Figure 47 is similar to figure 39 except the average is for 6 years and the skill score is Hughes Probability.

Figure 48 is similar to figure 40 except the calendar years are 1978 through 1983 and the skill score is Hughes Probability.

Figure 49 is a plot of the calendar year 1983 monthly mean 3 class precipitation skill scores for the man and climatology mean precipitation forecasts verifying 1 to 5 days after forecast day. (See Appendix F for an explanation of this score.)

Figure 50 is a plot of the 6 year (1978-1983) average monthly mean 3 class precipitation skill scores for the man and climatology mean precipitation forecasts verifying 1 to 5 days after forecast day.

Figure 51 is a plot of the 1978 through 1983 calendar year precipitation skill scores for the man and climatology mean precipitation forecasts verifying 1 to 5 days after forecast day.

Figure 52 is similar to figure 49 except the observed (P OBS - persistence of the 5 day mean observed precipitation as a 6-10 day forecast) is depicted and the forecast is for 6 to 10 days.

Figure 53 is similar to figure 50 except the forecast is for 6 to 10 days.

Figure 54 is similar to figure 51 except the forecast is for 6 to 10 days.

Figures 55 through 66 are plots of the calendar year 1983 monthly mean (standardized + unstandardized)÷2 correlation scores for the man, LFM, ECMWF, LR, NMC/NWP model and climatology (North American + United States)÷2 area mean sea level pressure progs verifying on days 1 through 7 after forecast day.

Figure 67 is a plot of the 1968 through 1983 calendar year standardized correlation scores for the man and NMC/NWP model North American area mean sea level pressure progs verifying on days (3+4+5)÷3 after forecast day.

Figures 68 through 79 are plots of the calendar year 1983 monthly mean standardized correlation scores for the LFM, LR, ECMWF, and NMC/NWP model North American area 500 mb progs verifying on days 1 through 7 after forecast day.

Figures 80 through 91 are plots of the calendar year 1983 absolute error minimum and maximum temperature scores for the man, KL, LR, and climatology temperature forecasts verifying on days 1 through 7 after forecast day.

SECTION 1

Man & Machine (NMC/NWP Guidance)

Mean Sea Level Pressure and 500 MB Correlation Scores

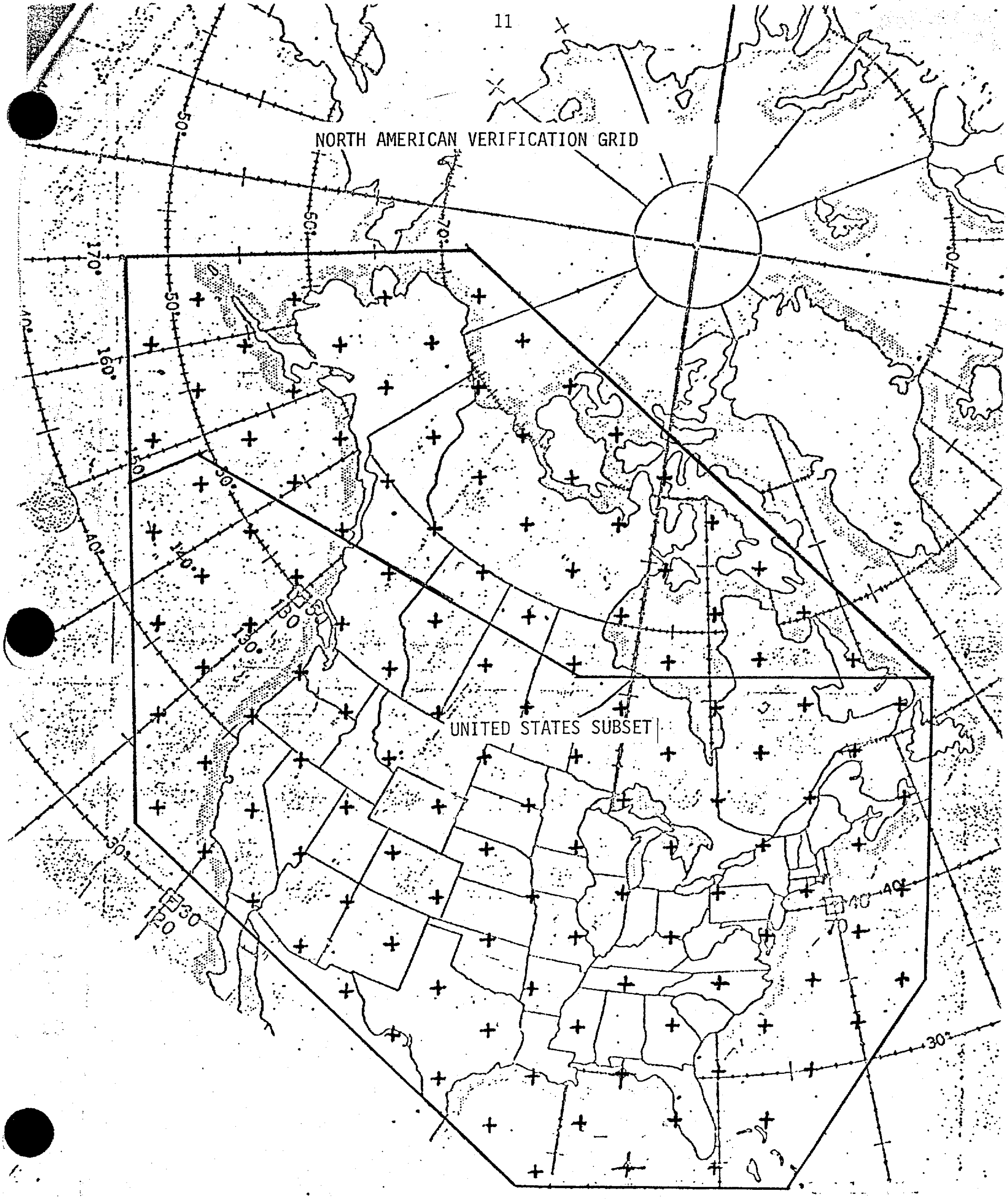
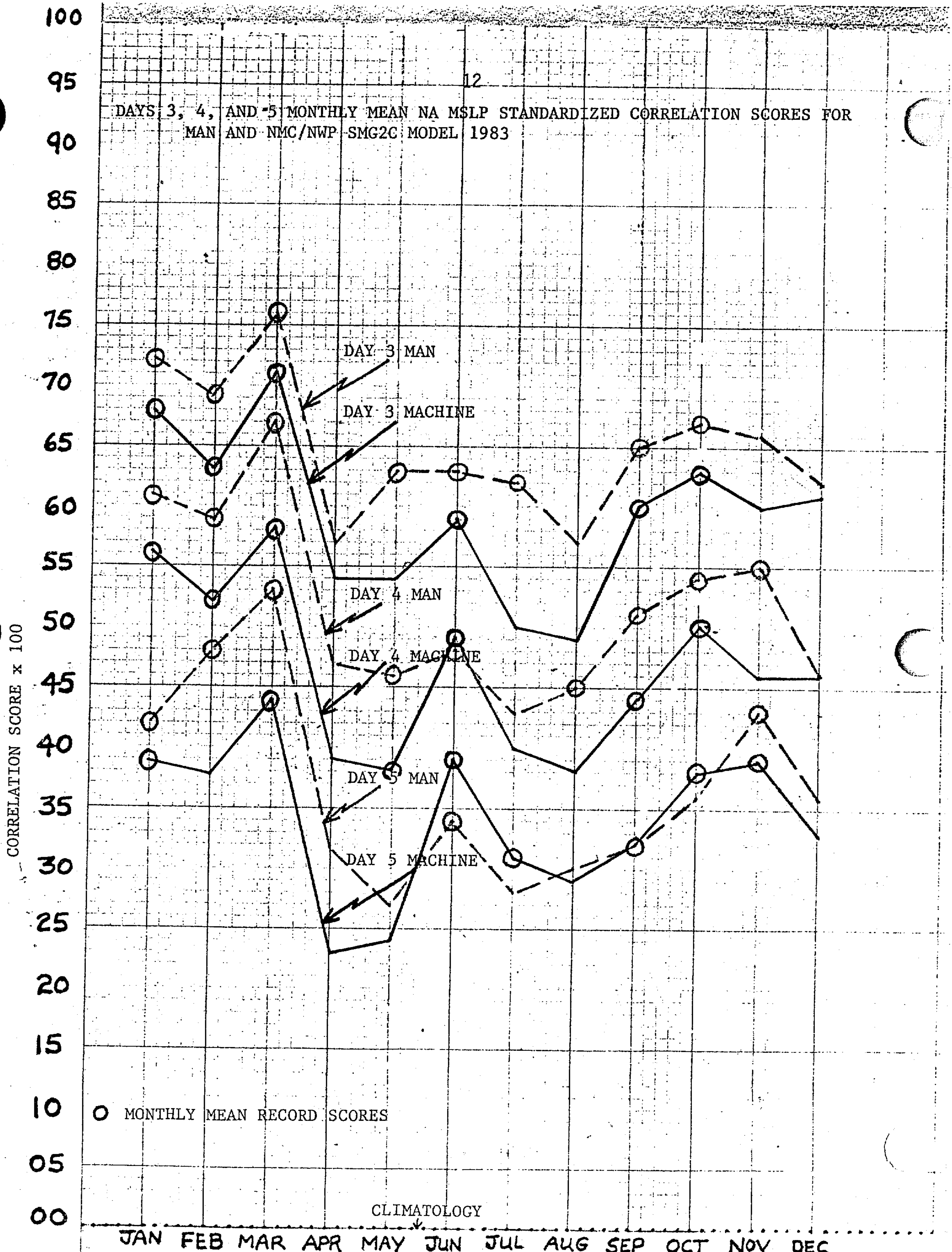


Figure 1


DAYS 3, 4, AND 5 MONTHLY MEAN NA MSLP STANDARDIZED CORRELATION SCORES FOR MAN AND NMC/NWP SMG2C MODEL 1983
100
95
90
85
80
75
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50
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15
10
05
00
CORRELATION SCORE x 100
DAY 3 MAN
DAY 3 MACHINE
DAY 4 MAN
DAY 4 MACHINE
DAY 5 MAN
DAY 5 MACHINE
MONTHLY MEAN RECORD SCORES
CLIMATOLOGY
JAN
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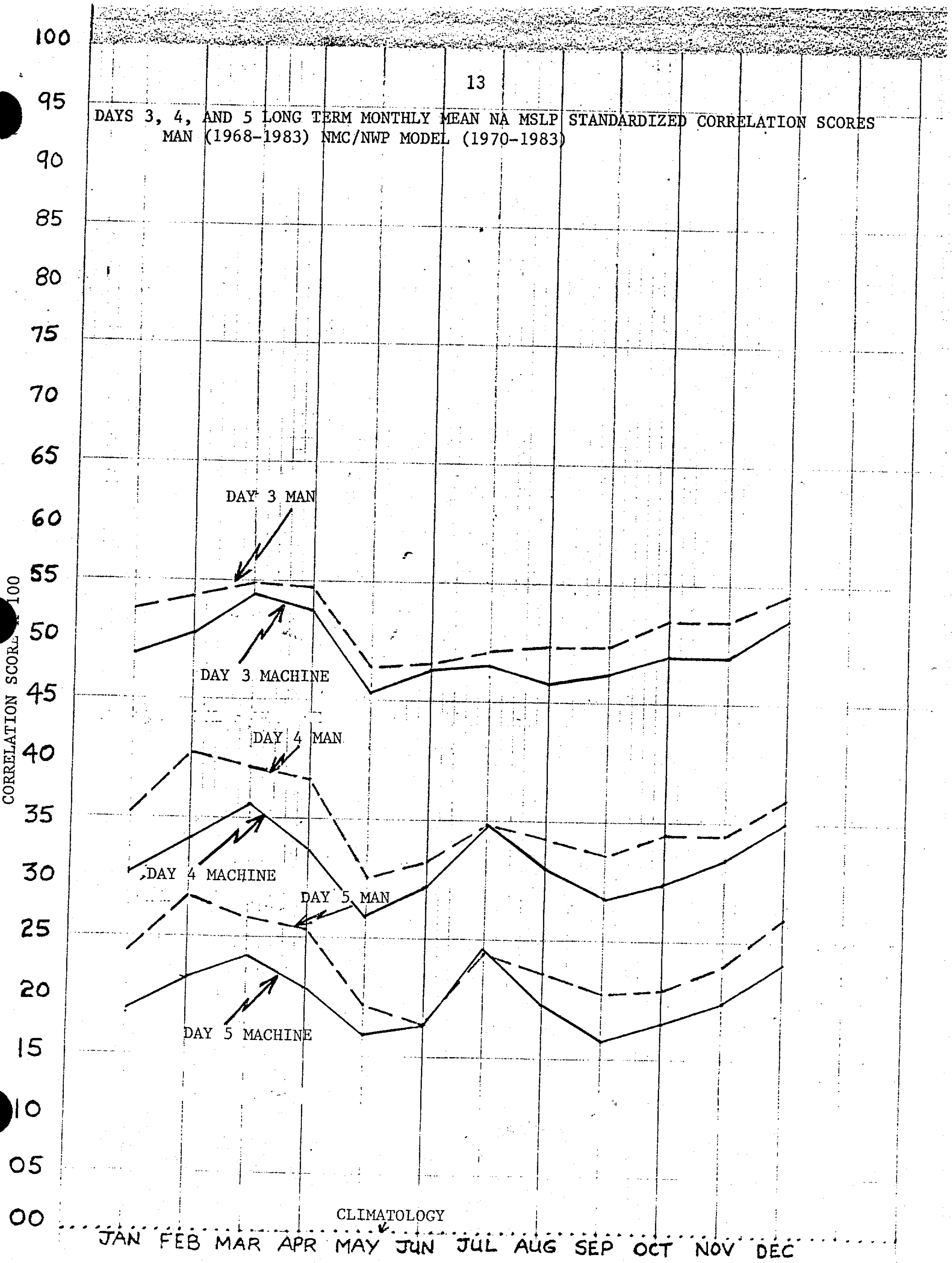
Figure 2


DAYS 3, 4, AND 5 LONG TERM MONTHLY MEAN NA MSLP STANDARDIZED CORRELATION SCORES
MAN (1968-1983) NMC/NWP MODEL (1970-1983)
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
DAY 3 MAN
DAY 3 MACHINE
DAY 4 MAN
DAY 4 MACHINE
DAY 5 MAN
DAY 5 MACHINE
CLIMATOLOGY
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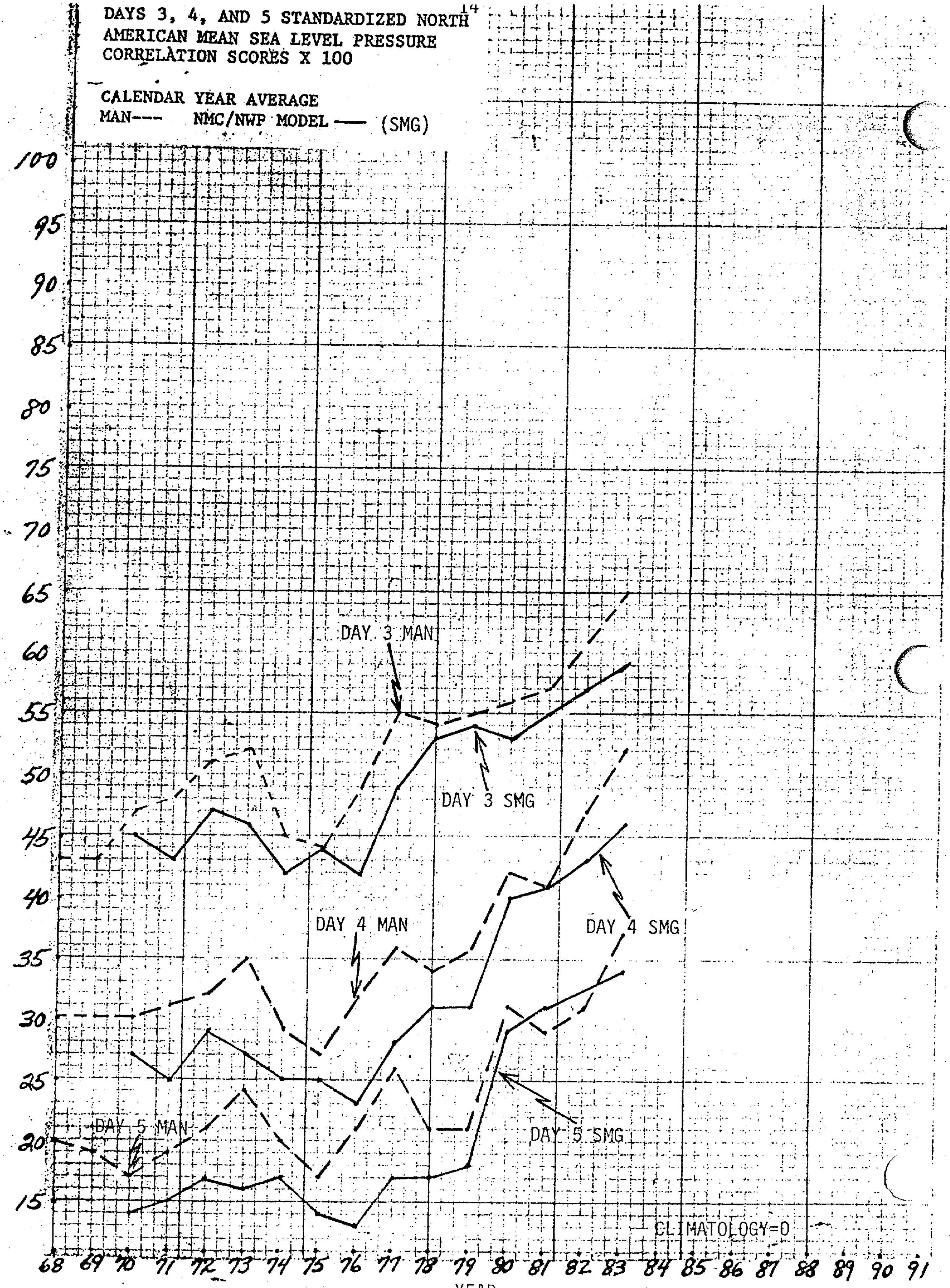
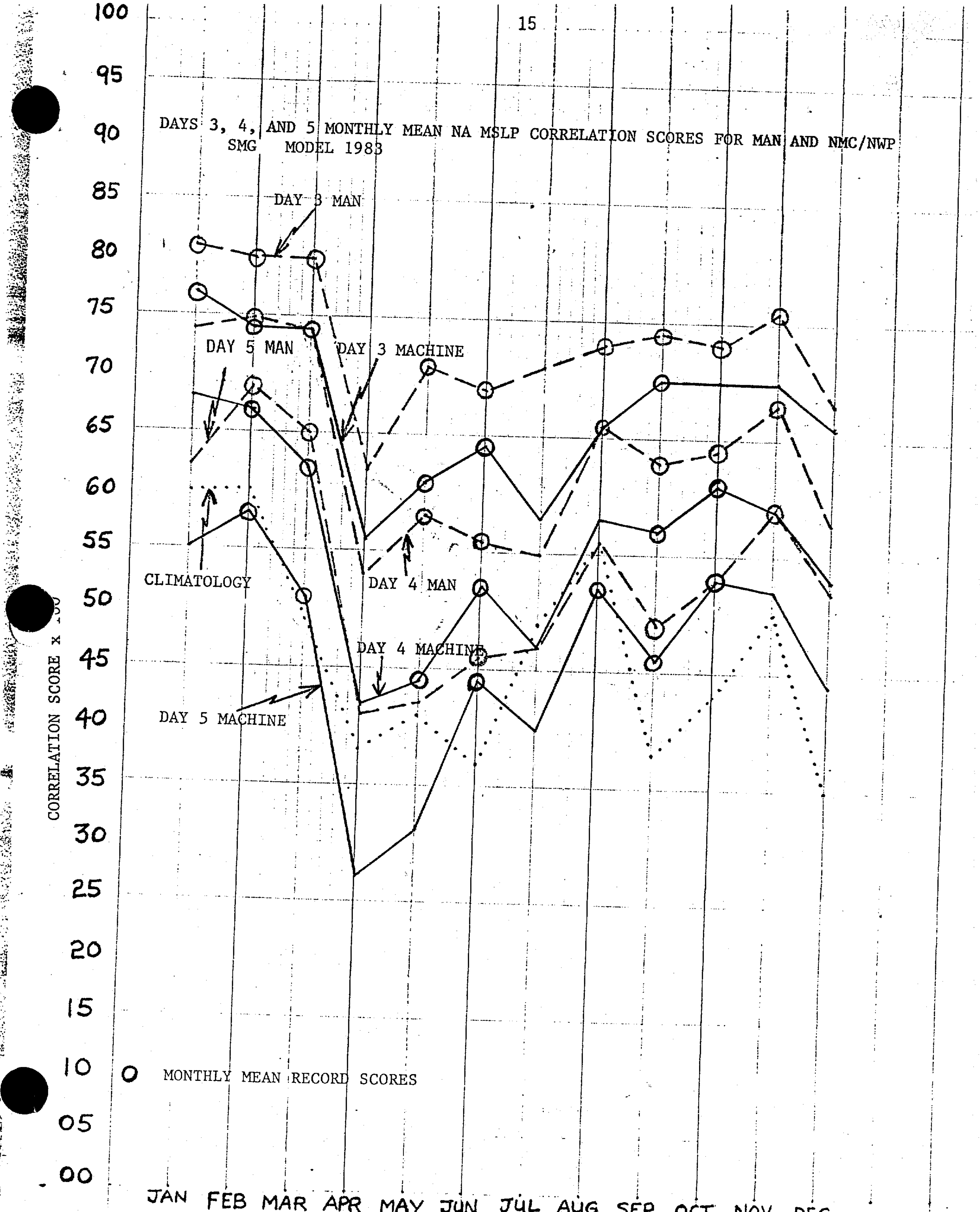

DAYS 3, 4, AND 5 STANDARDIZED NORTH AMERICAN MEAN SEA LEVEL PRESSURE CORRELATION SCORES X 100
CALENDAR YEAR AVERAGE
MAN--- NMC/NWP MODEL —— (SMG)
CORRELATION SCORE
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
DAY 3 MAN
DAY 3 SMG
DAY 4 MAN
DAY 4 SMG
DAY 5 MAN
DAY 5 SMG
CLIMATOLOGY=0
68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91
YEAR
Figure 4


DAYS 3, 4, AND 5 MONTHLY MEAN NA MSLP CORRELATION SCORES FOR MAN AND NMC/NWP
SMG MODEL 1983
DAY 3 MAN
DAY 5 MAN
DAY 3 MACHINE
CLIMATOLOGY
DAY 4 MAN
DAY 4 MACHINE
DAY 5 MACHINE
CORRELATION SCORE x 100
100
95
90
85
80
75
70
65
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O MONTHLY MEAN RECORD SCORES
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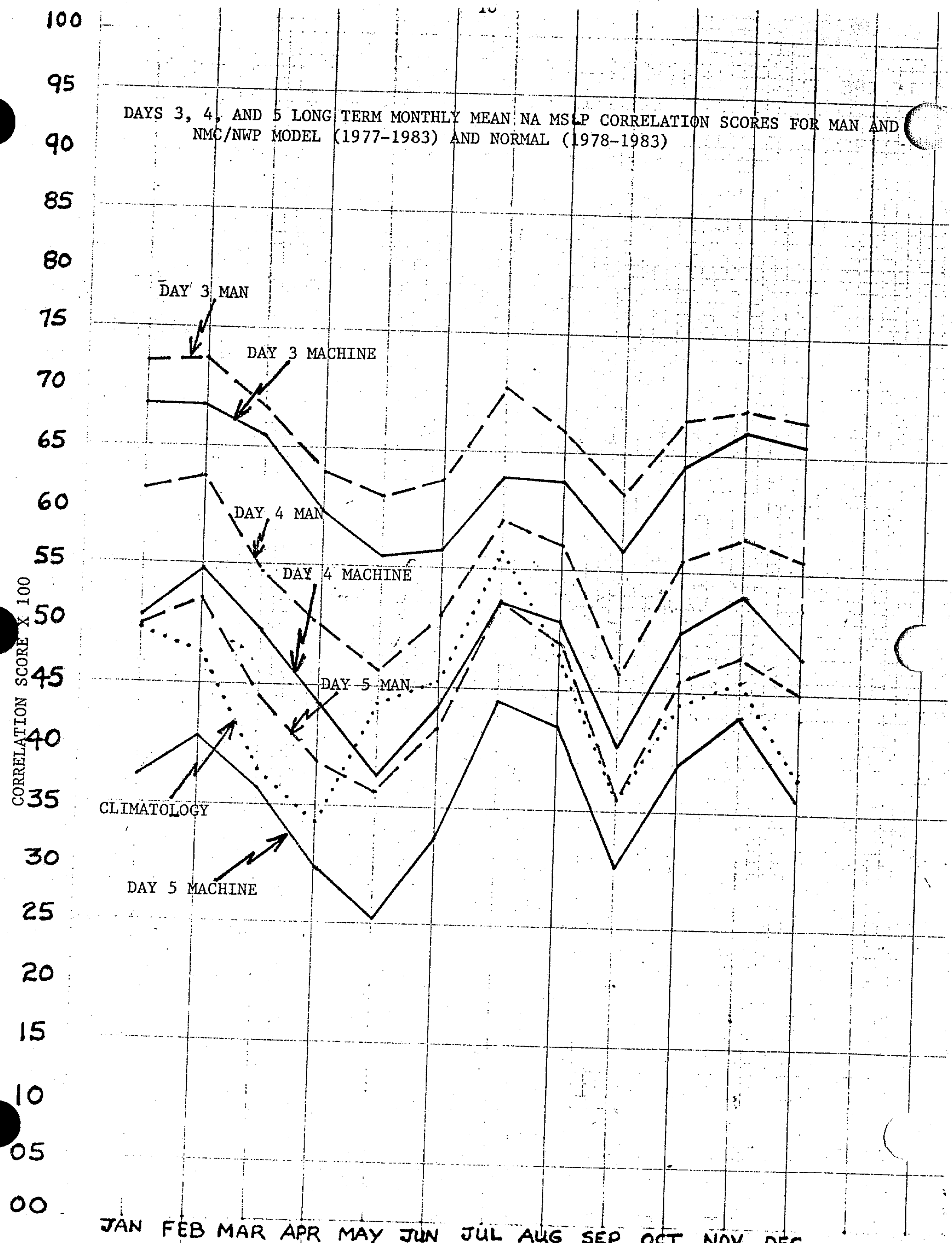
Figure 5


DAYS 3, 4, AND 5 LONG TERM MONTHLY MEAN NA MSLP CORRELATION SCORES FOR MAN AND NMC/NWP MODEL (1977-1983) AND NORMAL (1978-1983)
DAY 3 MAN
DAY 3 MACHINE
DAY 4 MAN
DAY 4 MACHINE
DAY 5 MAN
CLIMATOLOGY
DAY 5 MACHINE
CORRELATION SCORE X 100
100
95
90
85
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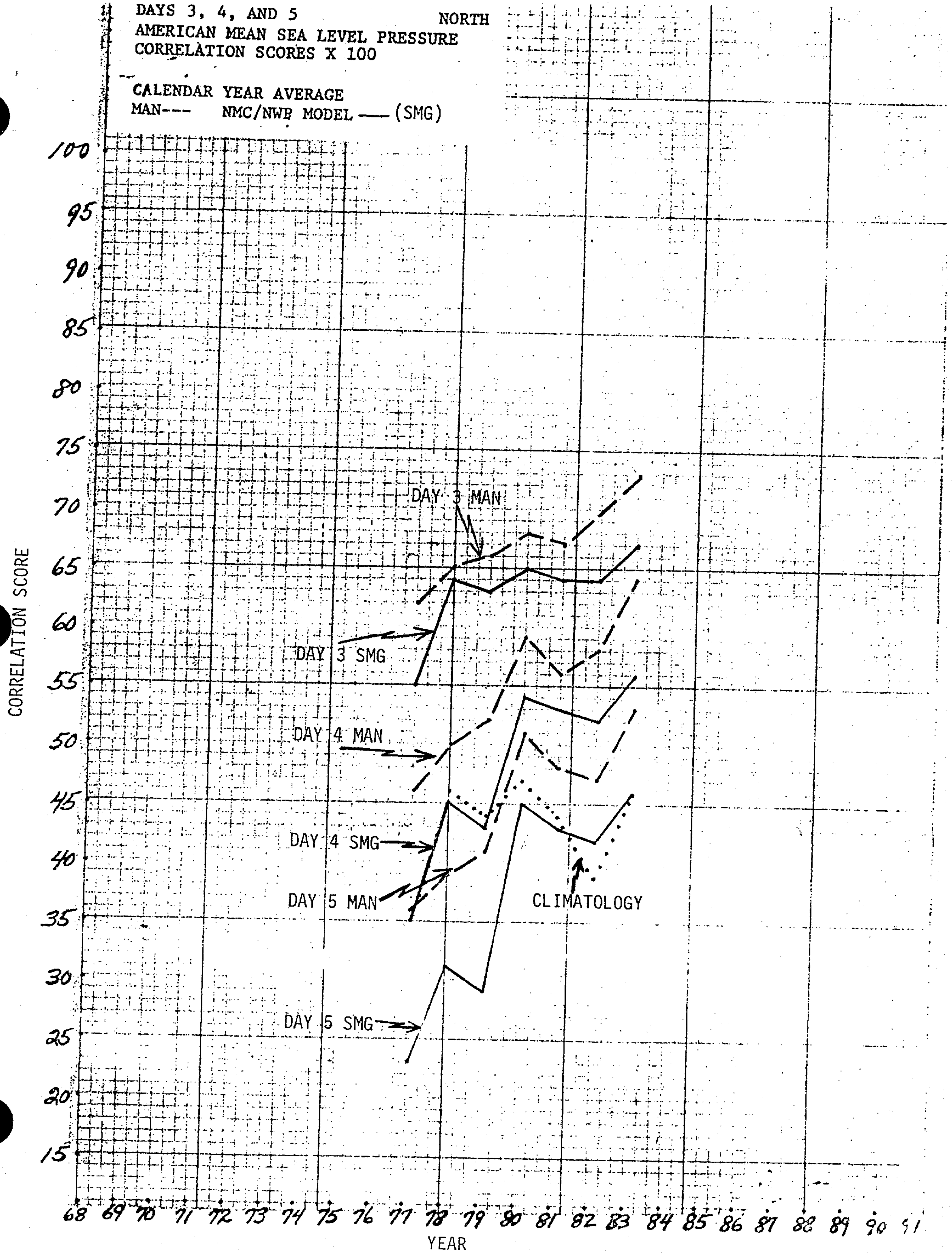
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC

Figure 6


DAYS 3, 4, AND 5 NORTH
AMERICAN MEAN SEA LEVEL PRESSURE
CORRELATION SCORES X 100
CALENDAR YEAR AVERAGE
MAN--- NMC/NWP MODEL —— (SMG)
CORRELATION SCORE
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
DAY 3 MAN
DAY 3 SMG
DAY 4 MAN
DAY 4 SMG
DAY 5 MAN
DAY 5 SMG
CLIMATOLOGY
68
69
70
71
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76
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83
84
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89
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YEAR

Figure 7

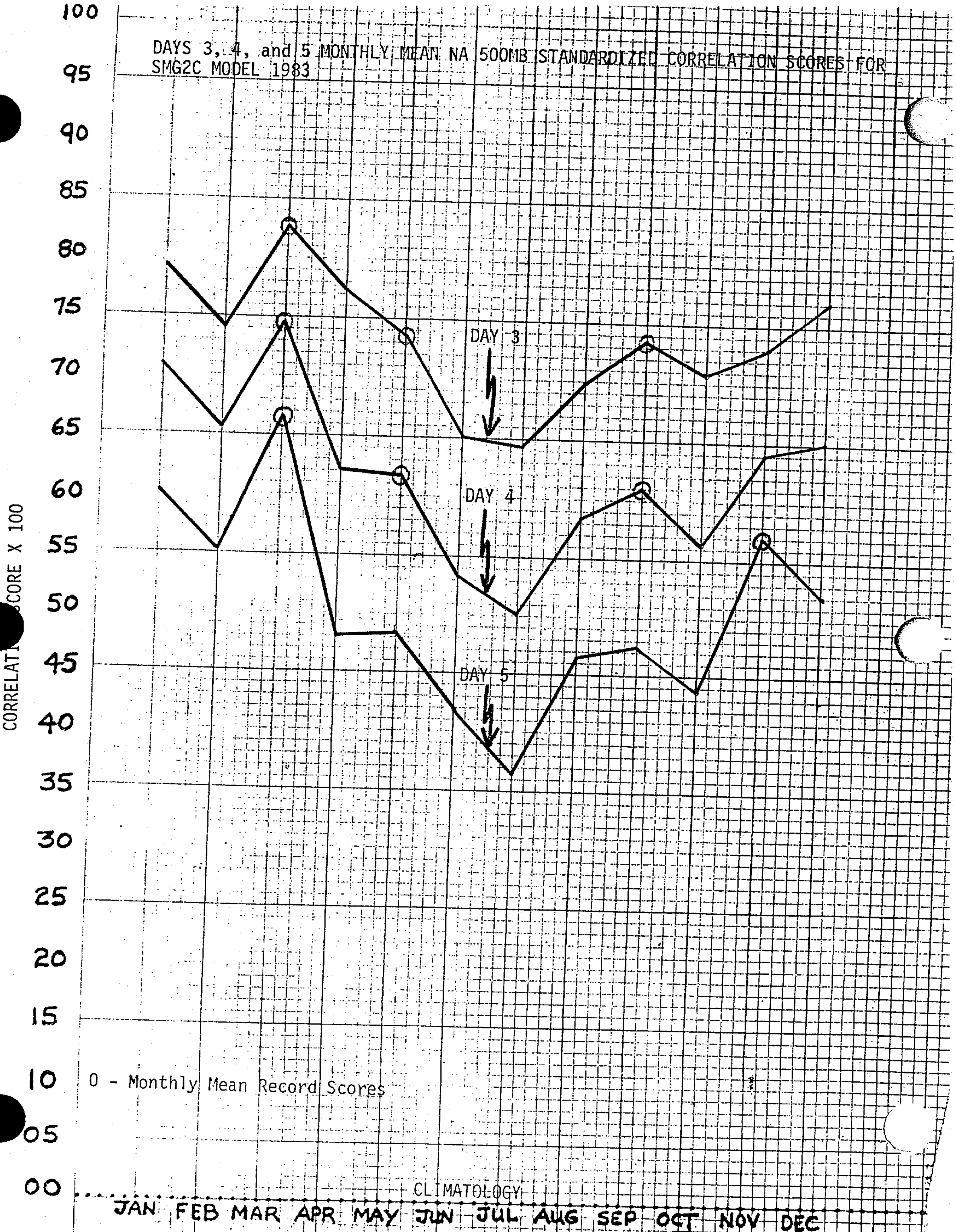
DAYS 3, 4, and 5 MONTHLY MEAN NA 500MB STANDARDIZED CORRELATION SCORES FOR SMG2C MODEL 1983
CORRELATION SCORE X 100
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
05
00
DAY 3
DAY 4
DAY 5
0 - Monthly Mean Record Scores
CLIMATOLOGY
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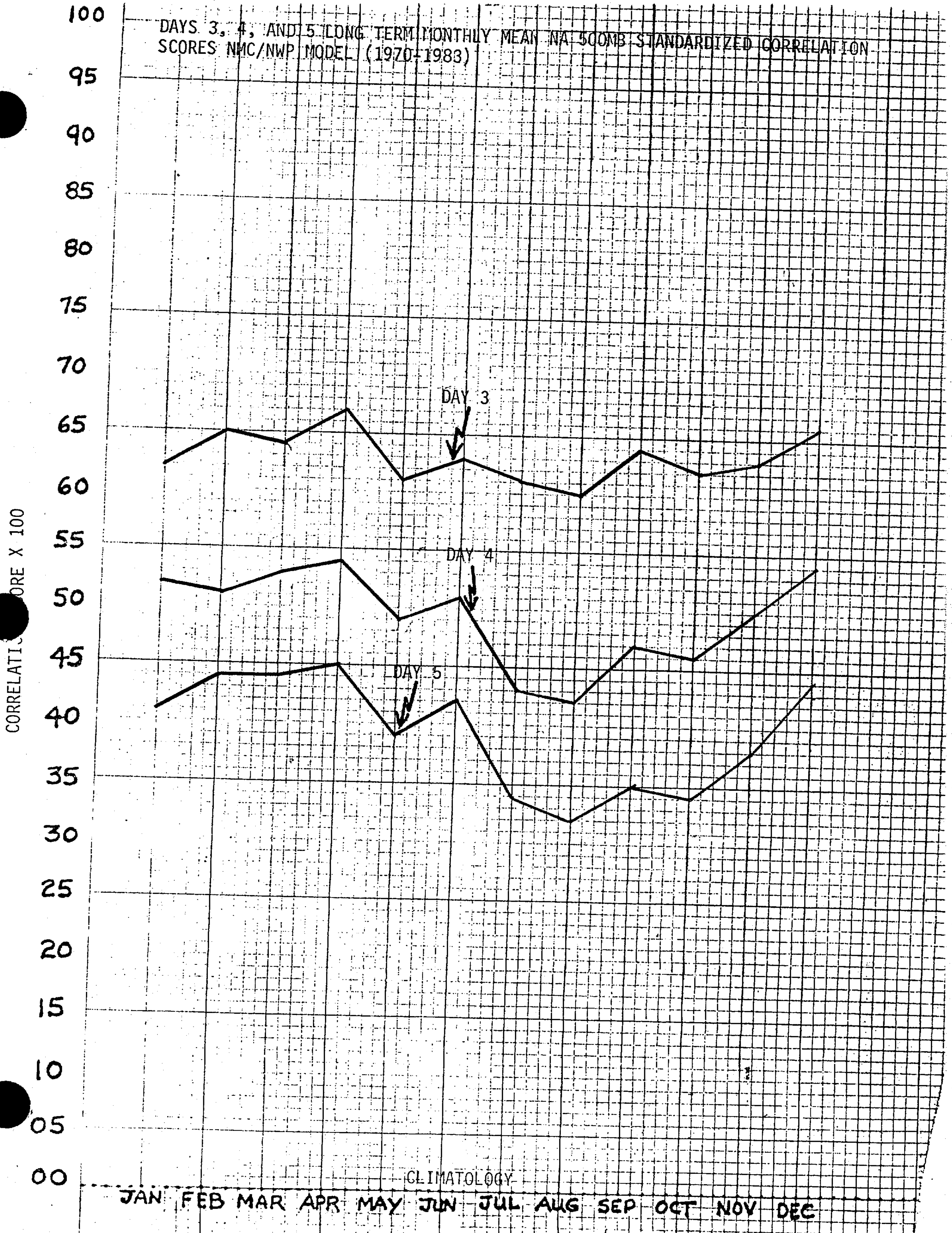
Figure 8


DAYS 3, 4, AND 5 LONG TERM MONTHLY MEAN NA 500MB STANDARDIZED CORRELATION SCORES NMC/NWP MODEL (1970-1983)
DAY 3
DAY 4
DAY 5
CLIMATOLOGY
CORRELATI ORE X 100
100
95
90
85
80
75
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65
60
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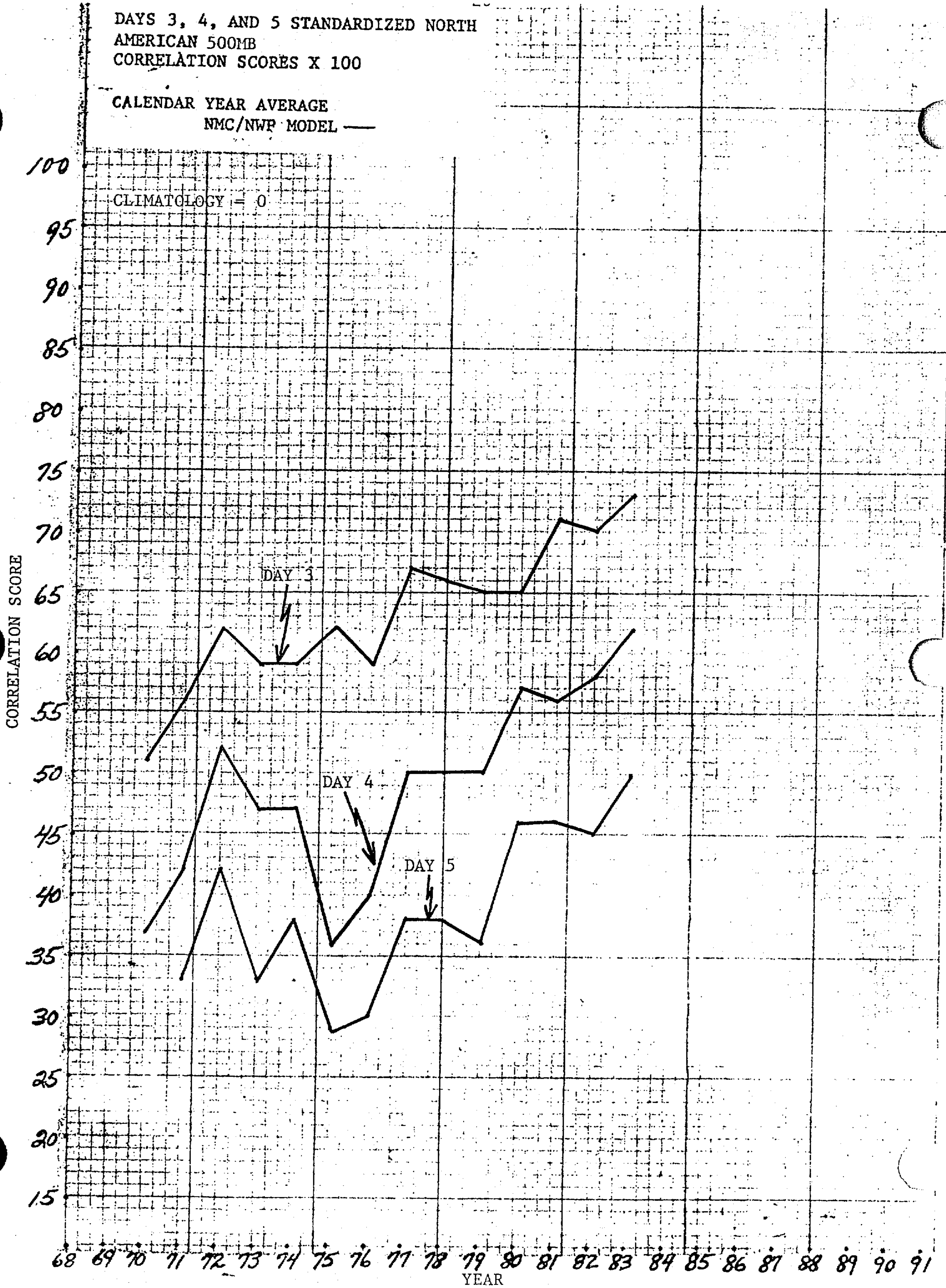
Figure 9


DAYS 3, 4, AND 5 STANDARDIZED NORTH
AMERICAN 500MB
CORRELATION SCORES X 100
CALENDAR YEAR AVERAGE
NMC/NWP MODEL
CLIMATOLOGY = 0
CORRELATION SCORE
100
95
90
85
80
75
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DAY 3
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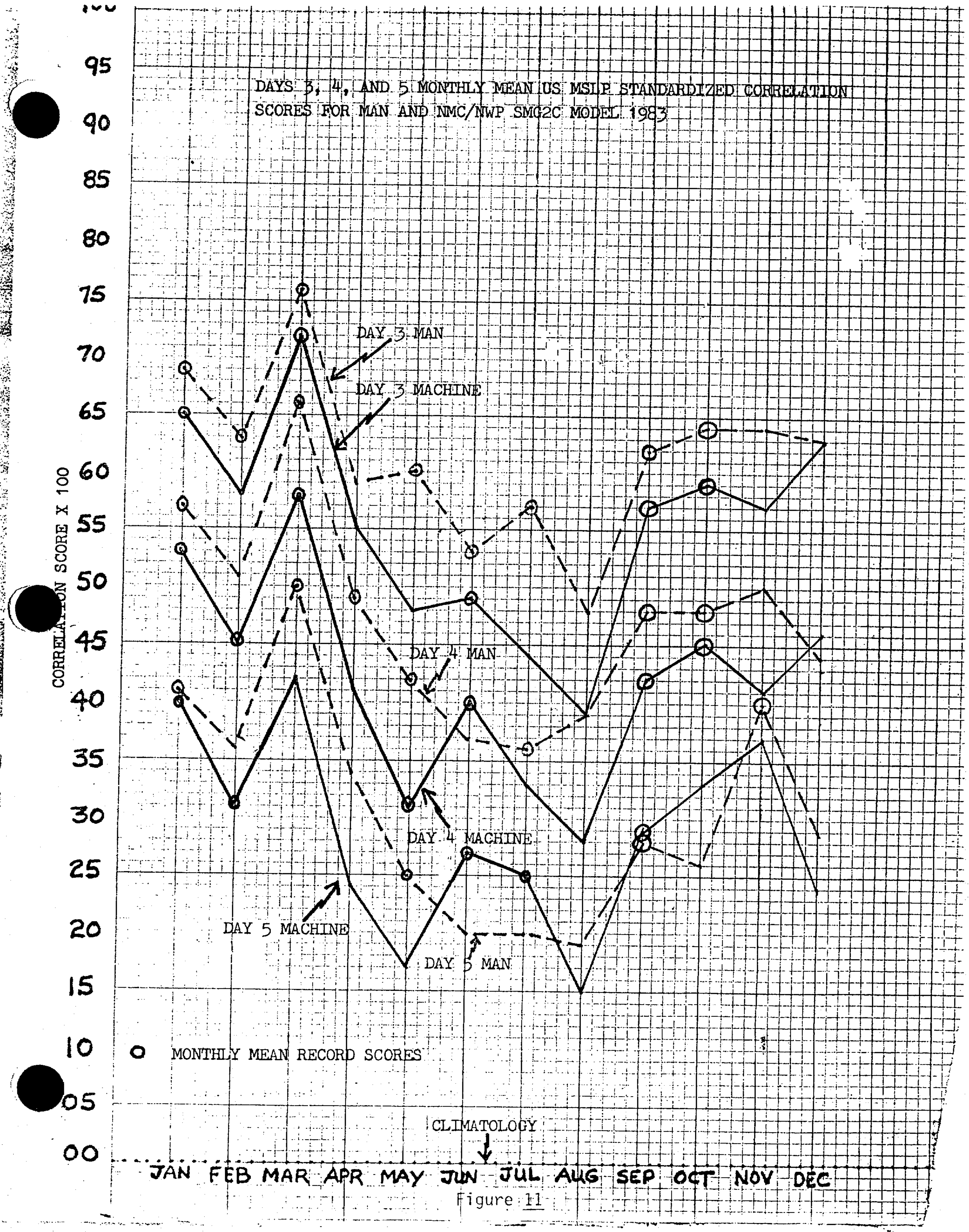
Figure 10


DAYS 3, 4, AND 5 MONTHLY MEAN US MSLP STANDARDIZED CORRELATION SCORES FOR MAN AND NMC/NWP SMG2C MODEL 1983
CORRELATION SCORE X 100
100
95
90
85
80
75
70
65
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50
45
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35
30
25
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DAY 3 MAN
DAY 3 MACHINE
DAY 4 MAN
DAY 4 MACHINE
DAY 5 MACHINE
DAY 5 MAN
MONTHLY MEAN RECORD SCORES
CLIMATOLOGY
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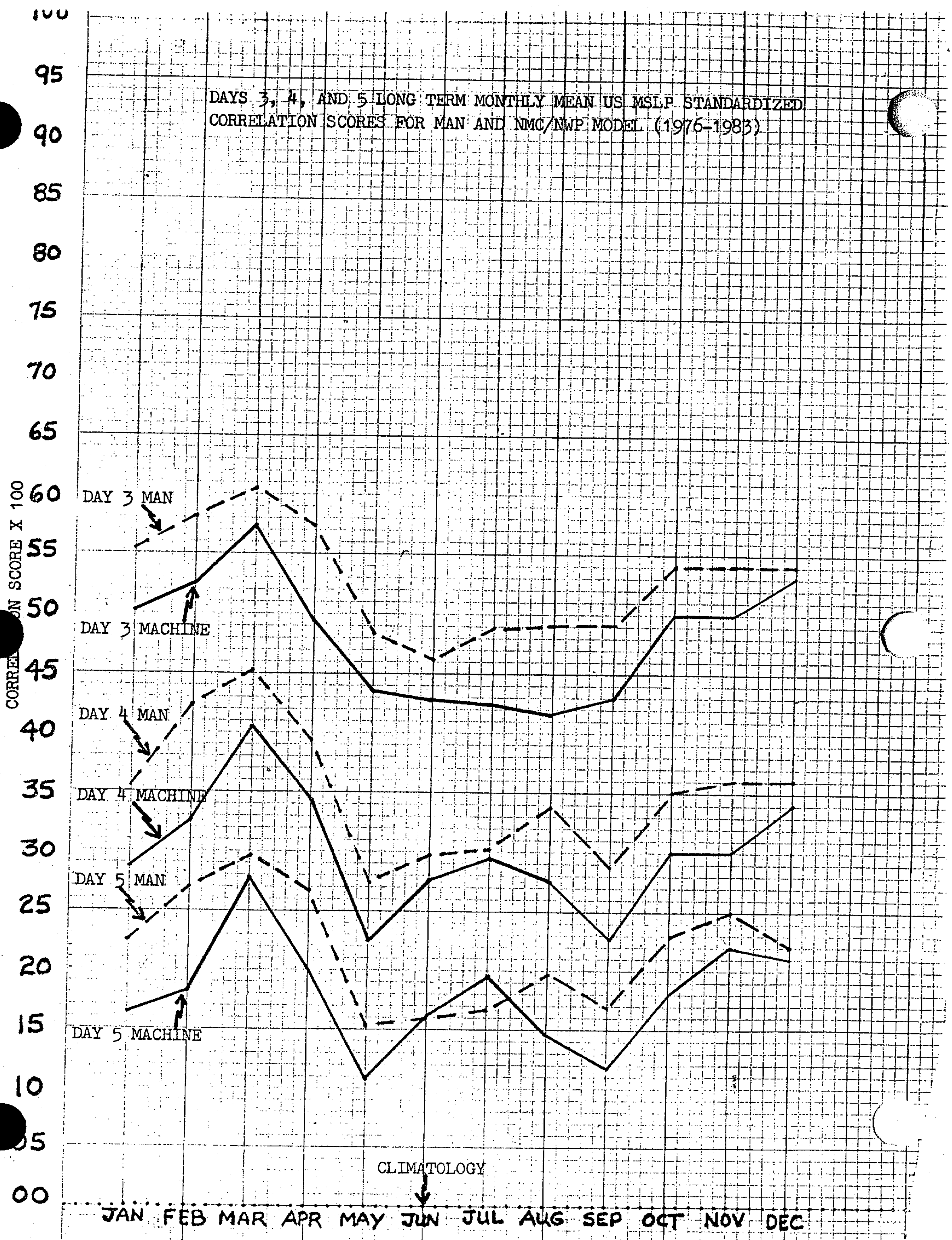
Figure 11


DAYS 3, 4, AND 5 LONG TERM MONTHLY MEAN US MSLP STANDARDIZED CORRELATION SCORES FOR MAN AND NMC/NWP MODEL (1976-1983)
CORRELATION SCORE X 100
100
95
90
85
80
75
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65
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50
45
40
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DAY 3 MAN
DAY 3 MACHINE
DAY 4 MAN
DAY 4 MACHINE
DAY 5 MAN
DAY 5 MACHINE
CLIMATOLOGY
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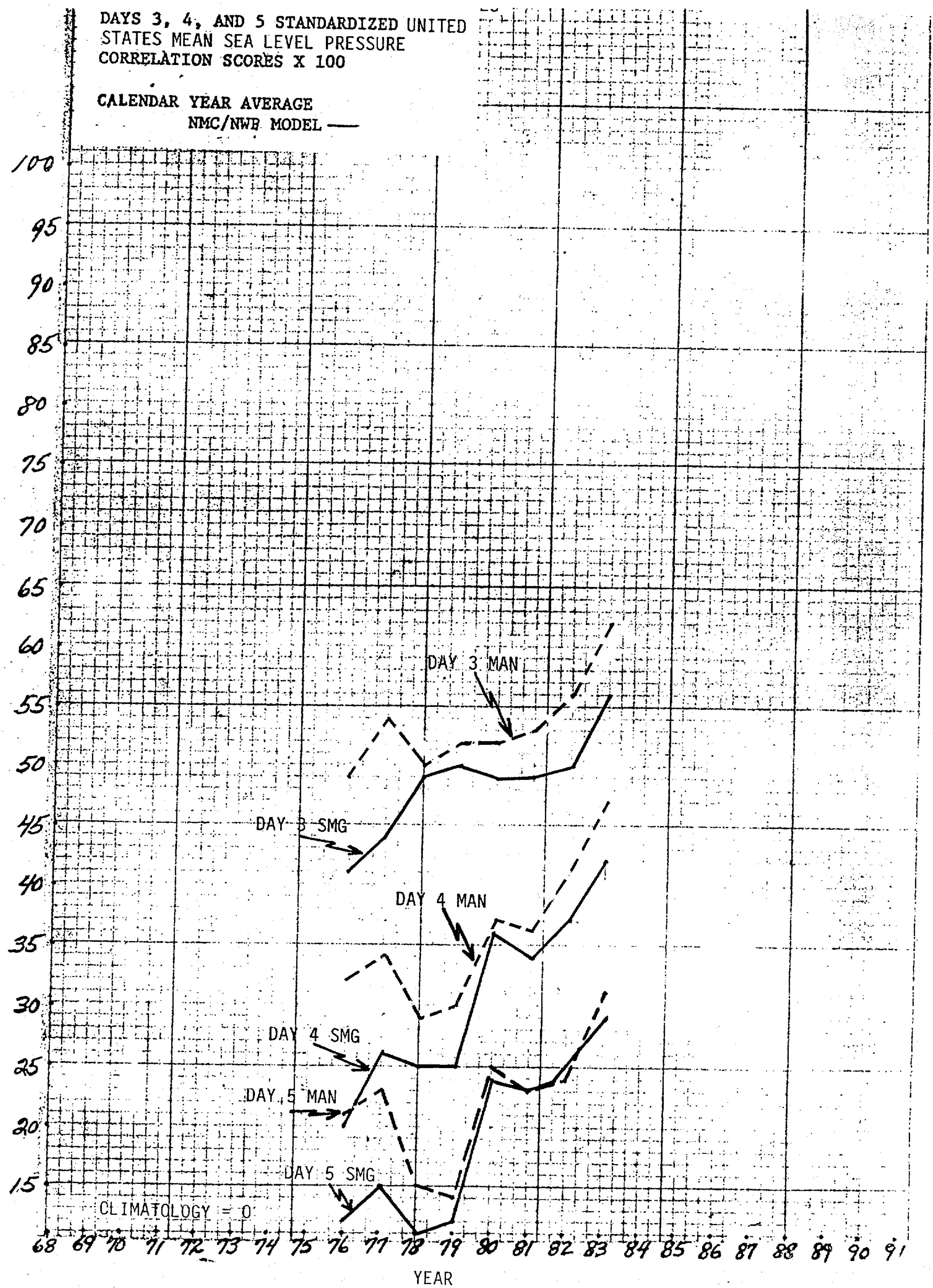
Figure 12


DAYS 3, 4, AND 5 STANDARDIZED UNITED STATES MEAN SEA LEVEL PRESSURE CORRELATION SCORES X 100
CALENDAR YEAR AVERAGE
NMC/NWB MODEL ——
CORRELATION SCORE
DAY 3 MAN
DAY 3 SMG
DAY 4 MAN
DAY 4 SMG
DAY 5 MAN
DAY 5 SMG
CLIMATOLOGY = 0
100
95
90
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70
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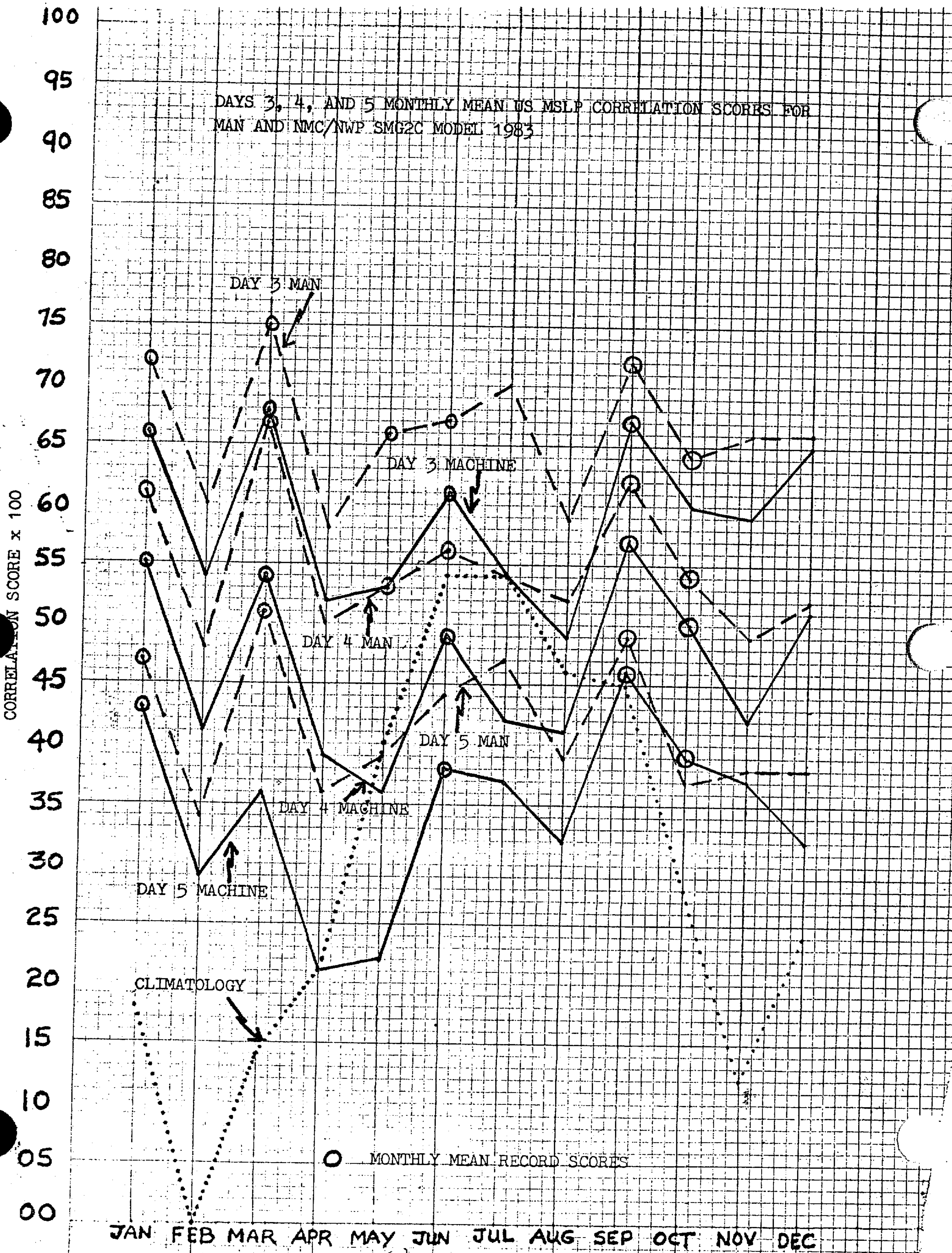
68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91
YEAR

Figure 13


DAYS 3, 4, AND 5 MONTHLY MEAN US MSLP CORRELATION SCORES FOR MAN AND NMC/NWP SMG2C MODEL 1983
CORRELATION SCORE x 100
100
95
90
85
80
75
70
65
60
55
50
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35
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15
10
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DAY 3 MAN
DAY 3 MACHINE
DAY 4 MAN
DAY 4 MACHINE
DAY 5 MAN
DAY 5 MACHINE
CLIMATOLOGY
MONTHLY MEAN RECORD SCORES
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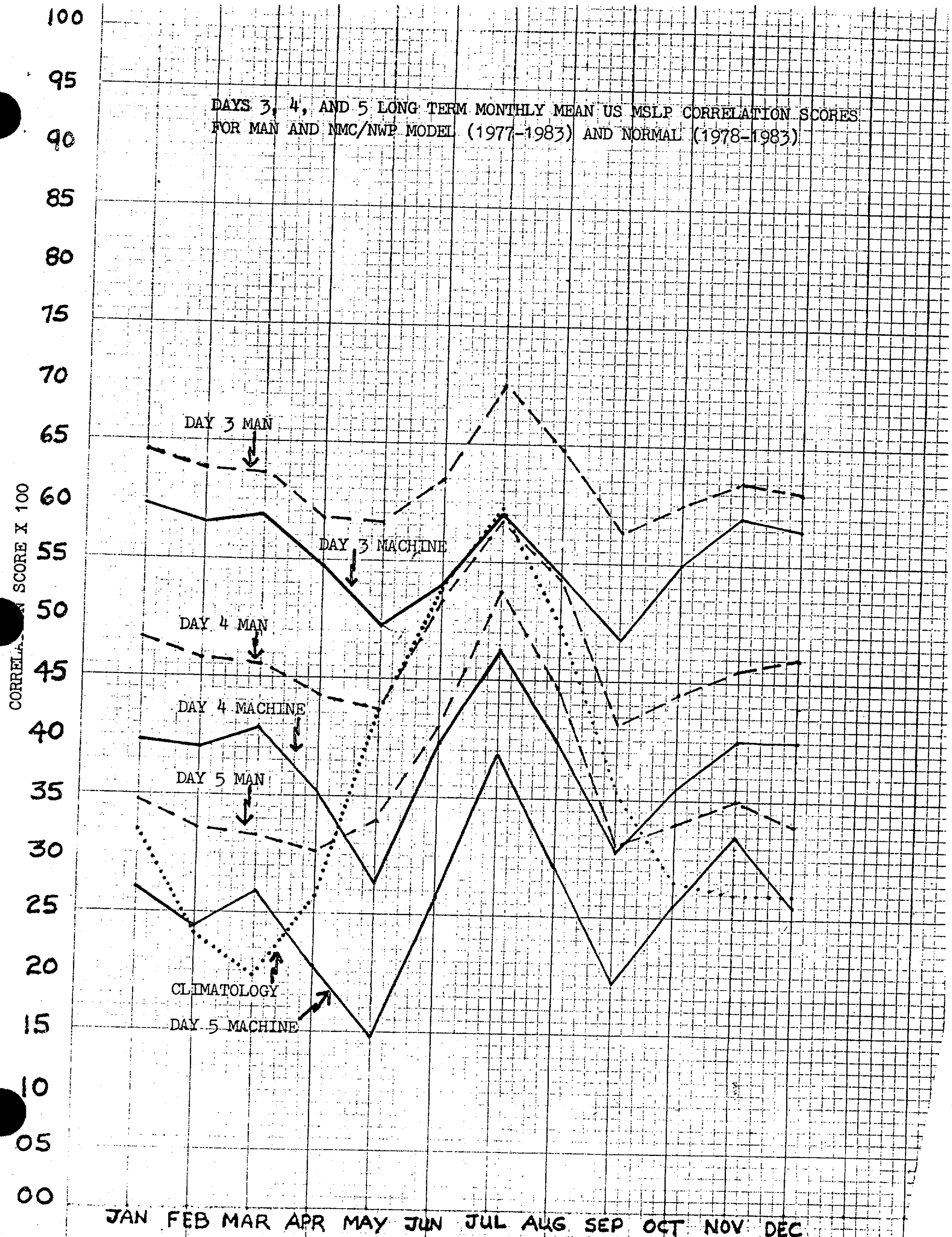
Figure 14


DAYS 3, 4, AND 5 LONG TERM MONTHLY MEAN US MSLP CORRELATION SCORES
FOR MAN AND NMC/NWP MODEL (1977-1983) AND NORMAL (1978-1983)
CORRELATION SCORE X 100
100
95
90
85
80
75
70
65
60
55
50
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30
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20
15
10
05
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DAY 3 MAN
DAY 3 MACHINE
DAY 4 MAN
DAY 4 MACHINE
DAY 5 MAN
CLIMATOLOGY
DAY 5 MACHINE
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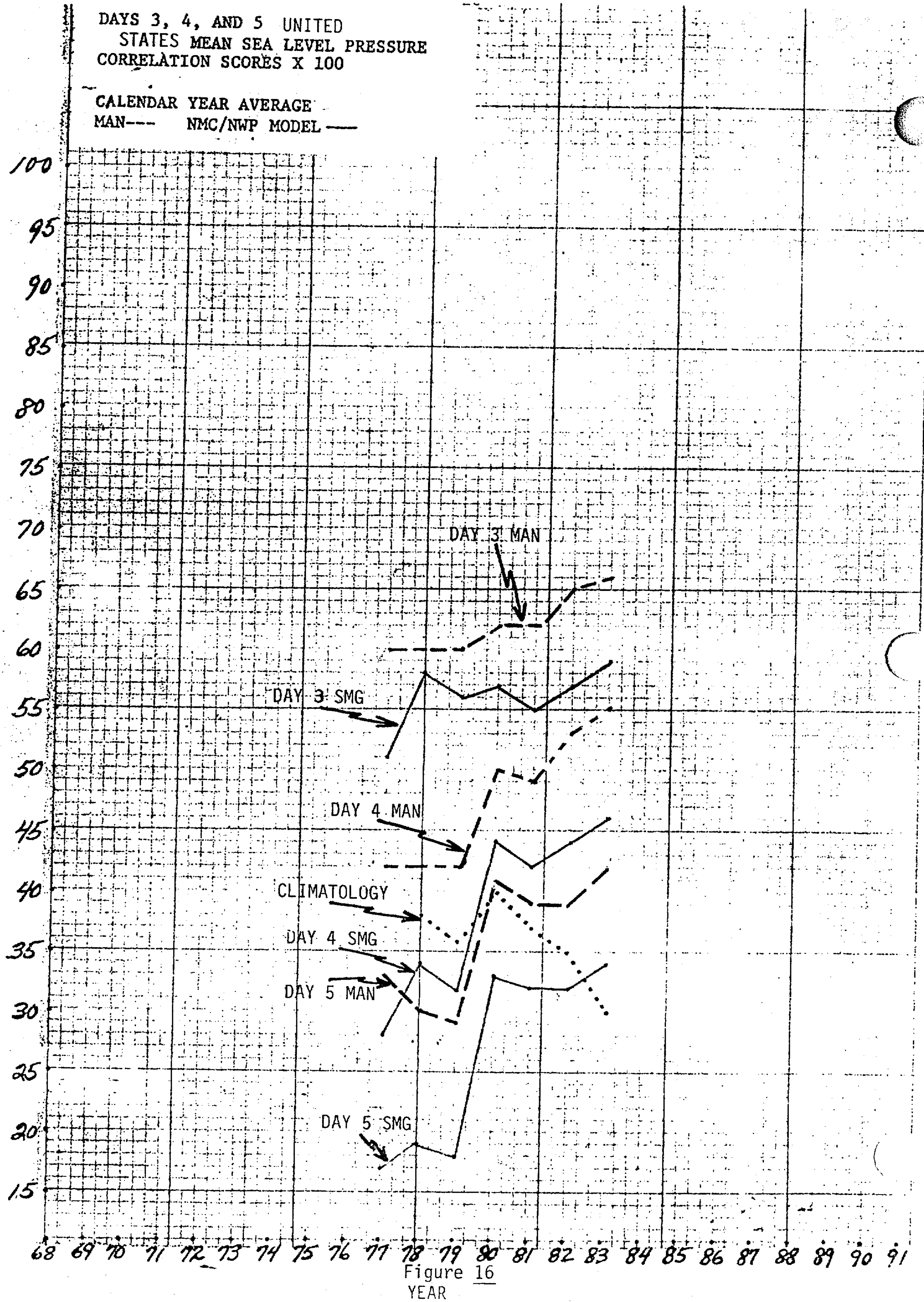
Figure 15


DAYS 3, 4, AND 5 UNITED STATES MEAN SEA LEVEL PRESSURE CORRELATION SCORES X 100
CALENDAR YEAR AVERAGE
MAN--- NMC/NWP MODEL ——
DAY 3 MAN
DAY 3 SMG
DAY 4 MAN
CLIMATOLOGY
DAY 4 SMG
DAY 5 MAN
DAY 5 SMG
CORRELATION SCORE
100
95
90
85
80
75
70
65
60
55
50
45
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35
30
25
20
15
68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91
YEAR

Figure 16

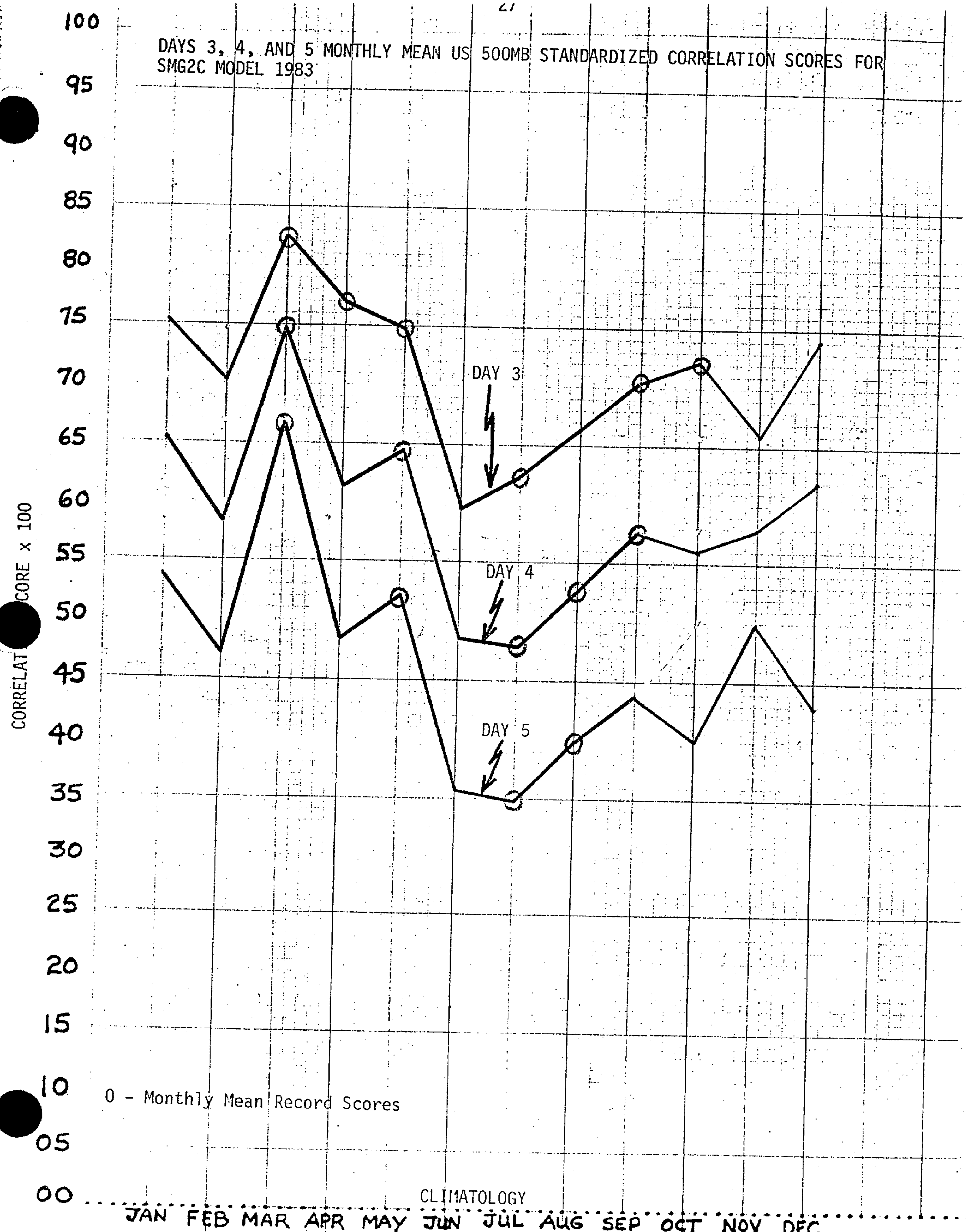

DAYS 3, 4, AND 5 MONTHLY MEAN US 500MB STANDARDIZED CORRELATION SCORES FOR SMG2C MODEL 1983
CORRELAT[redacted]CORE x 100
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
05
00
DAY 3
DAY 4
DAY 5
0 - Monthly Mean Record Scores
CLIMATOLOGY
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC

Figure 17

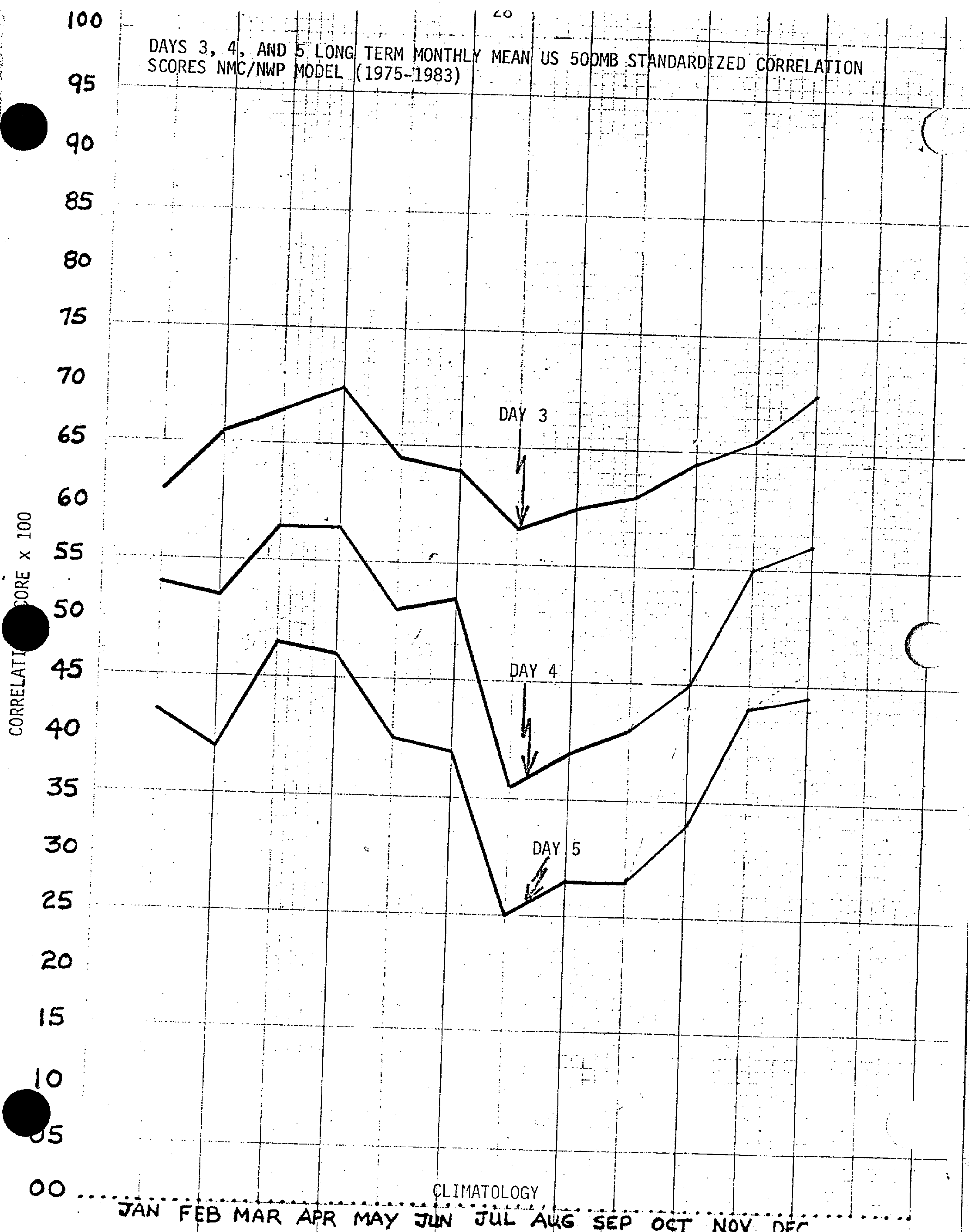

DAYS 3, 4, AND 5 LONG TERM MONTHLY MEAN US 500MB STANDARDIZED CORRELATION SCORES NMC/NWP MODEL (1975-1983)
CORRELATION SCORE x 100
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
05
00
DAY 3
DAY 4
DAY 5
CLIMATOLOGY
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC

Figure 18

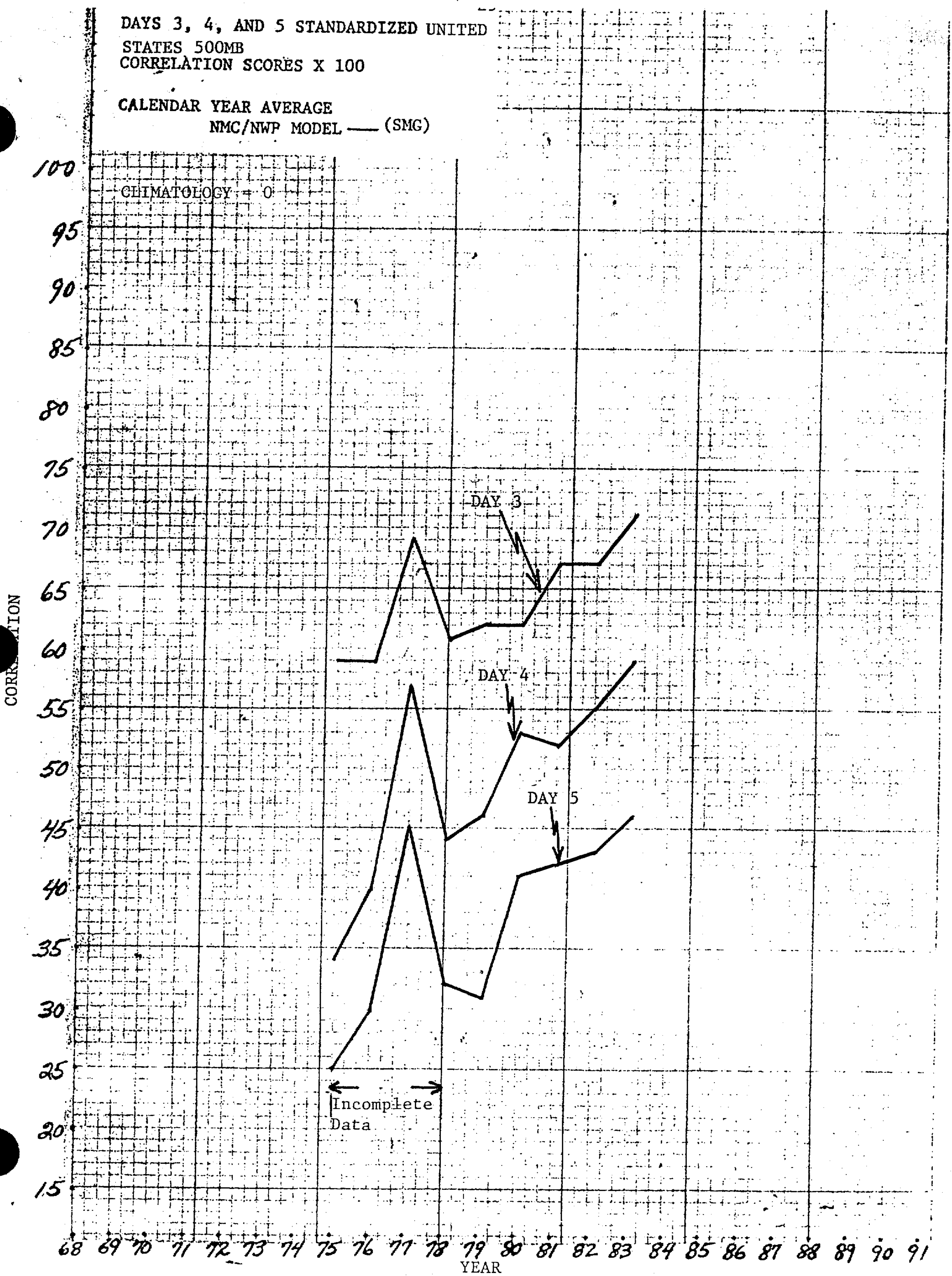

DAYS 3, 4, AND 5 STANDARDIZED UNITED
STATES 500MB
CORRELATION SCORES X 100
CALENDAR YEAR AVERAGE
NMC/NWP MODEL —— (SMG)
CLIMATOLOGY = 0
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
CORRELATION
DAY 3
DAY 4
DAY 5
Incomplete
Data
68
69
70
71
72
73
74
75
76
77
78
79
80
81
82
83
84
85
86
87
88
89
90
91
YEAR

Figure 19

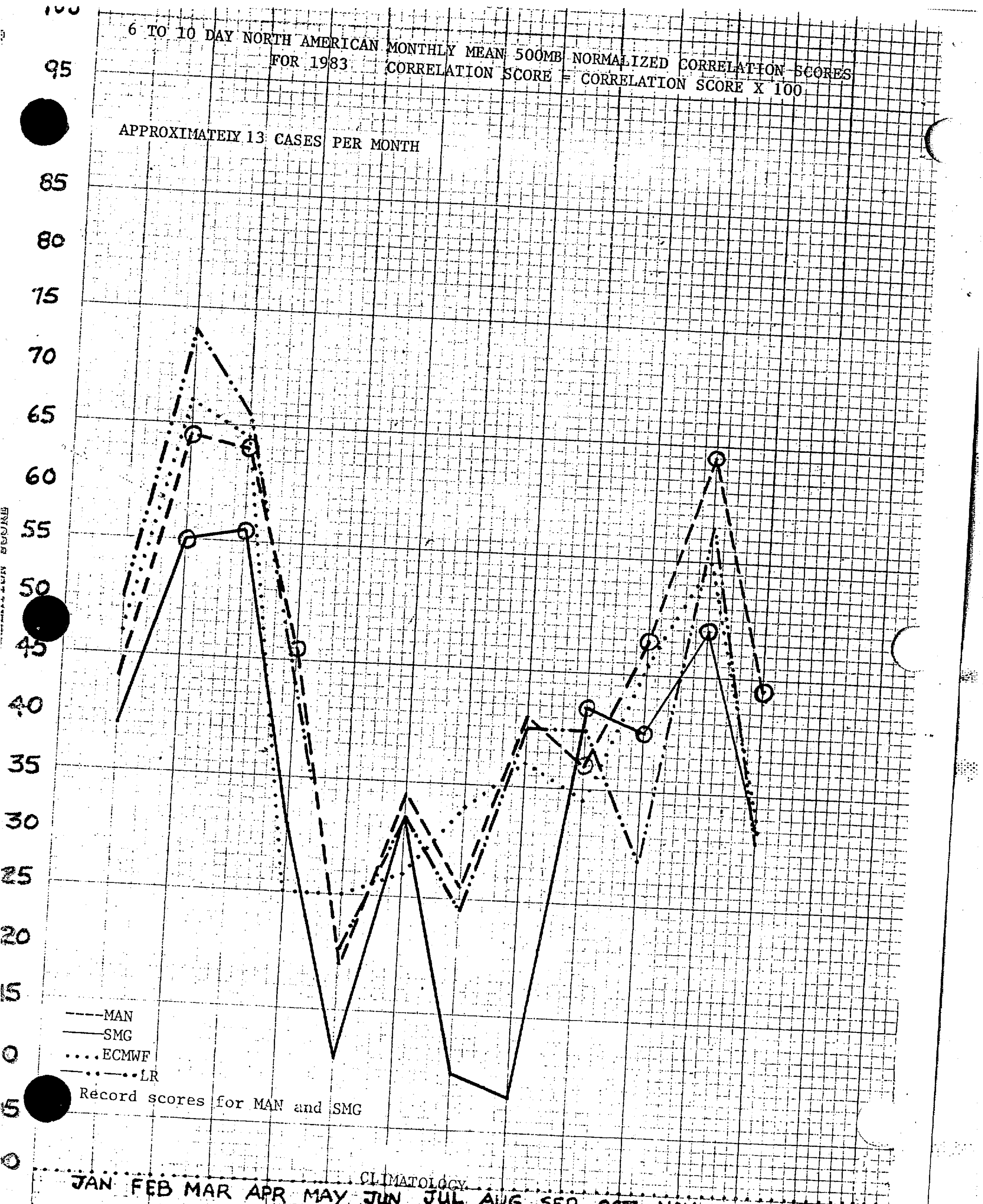

6 TO 10 DAY NORTH AMERICAN MONTHLY MEAN 500MB NORMALIZED CORRELATION SCORES
FOR 1983 CORRELATION SCORE = CORRELATION SCORE X 100
APPROXIMATELY 13 CASES PER MONTH
95
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
MAN
SMG
ECMWF
LR
Record scores for MAN and SMG
CLIMATOLOGY
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC

Figure 20

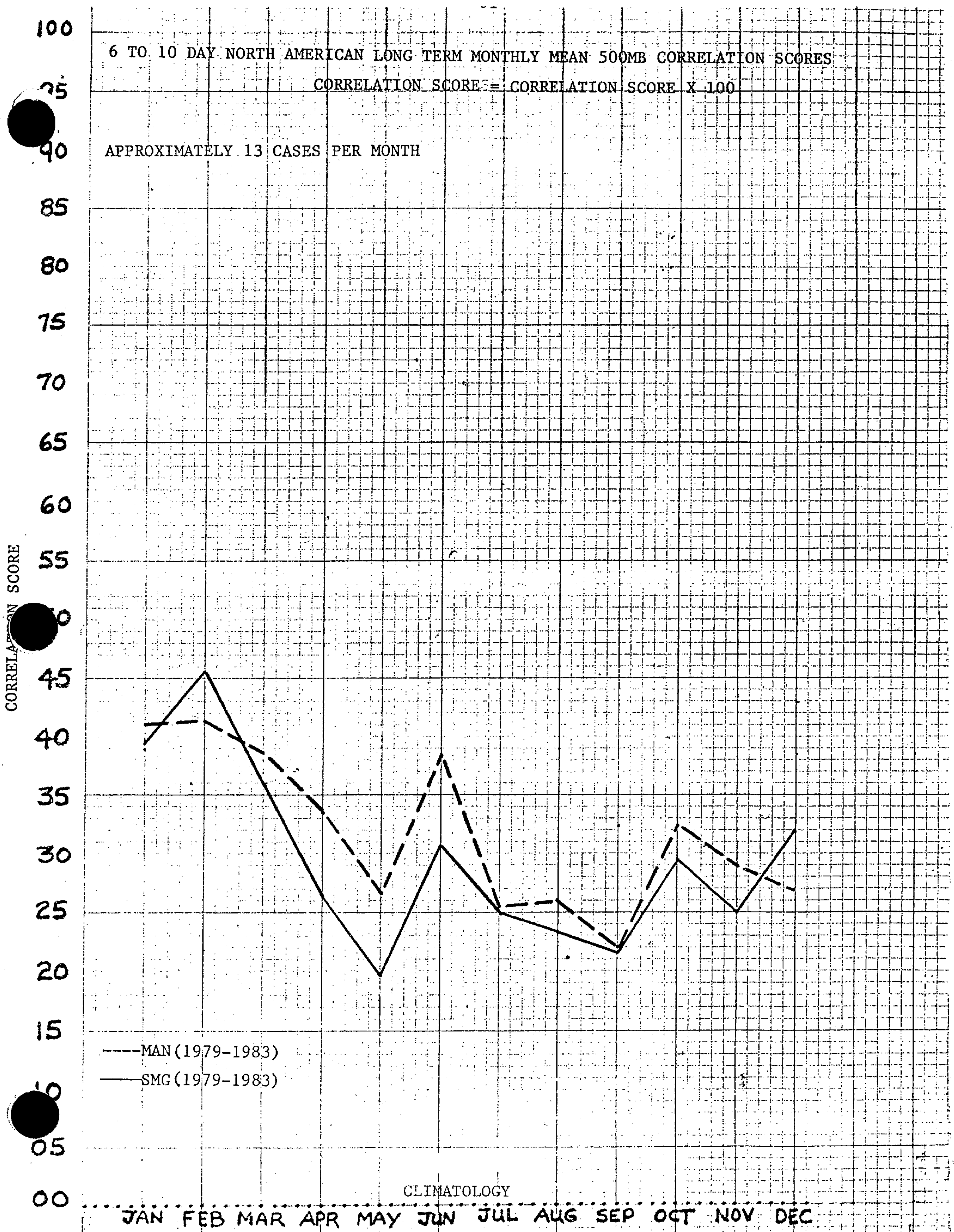

6 TO 10 DAY NORTH AMERICAN LONG TERM MONTHLY MEAN 500MB CORRELATION SCORES
CORRELATION SCORE = CORRELATION SCORE X 100
APPROXIMATELY 13 CASES PER MONTH
CORRELATION SCORE
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
05
00
----MAN(1979-1983)
——SMG(1979-1983)
CLIMATOLOGY
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC

Figure 21

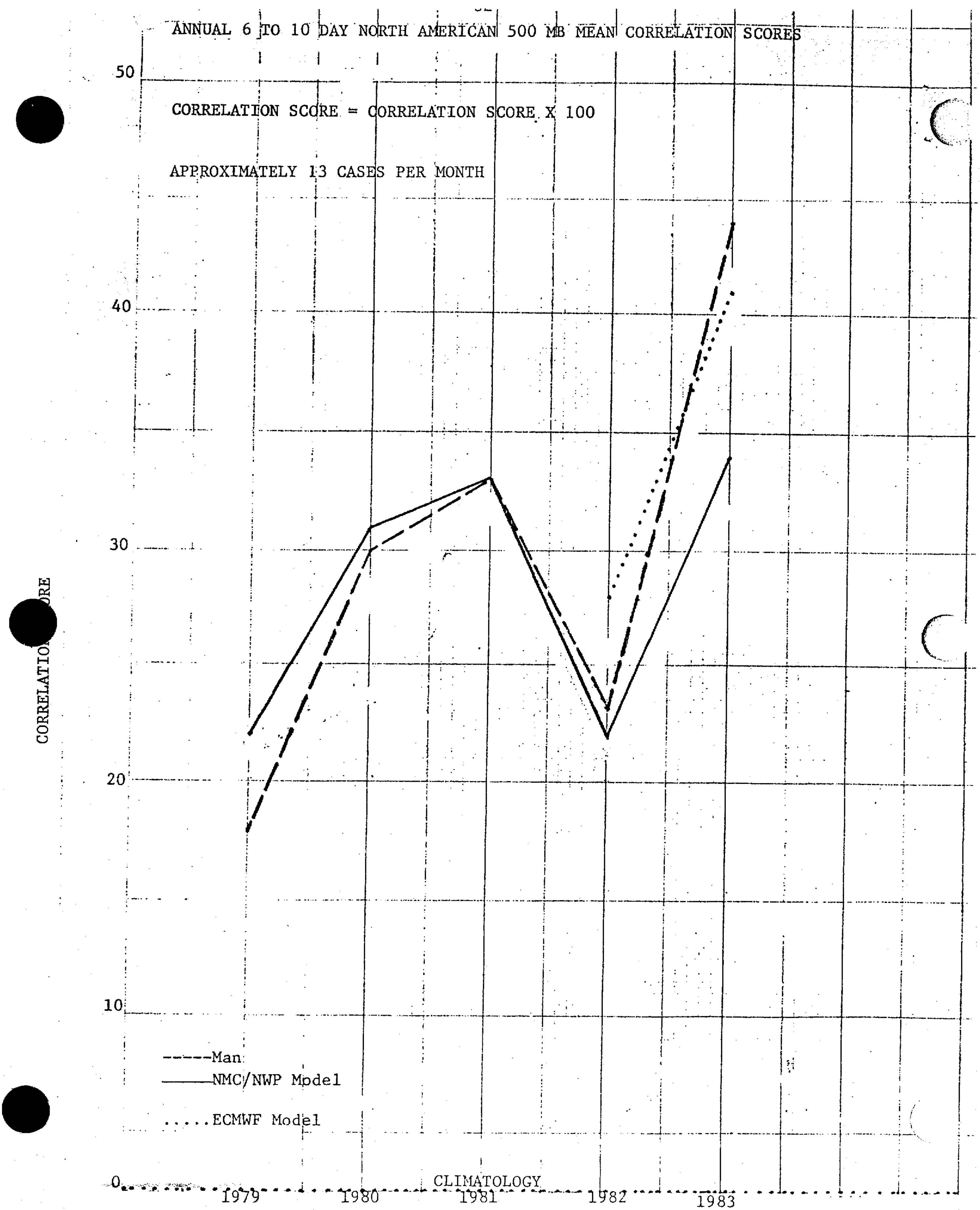
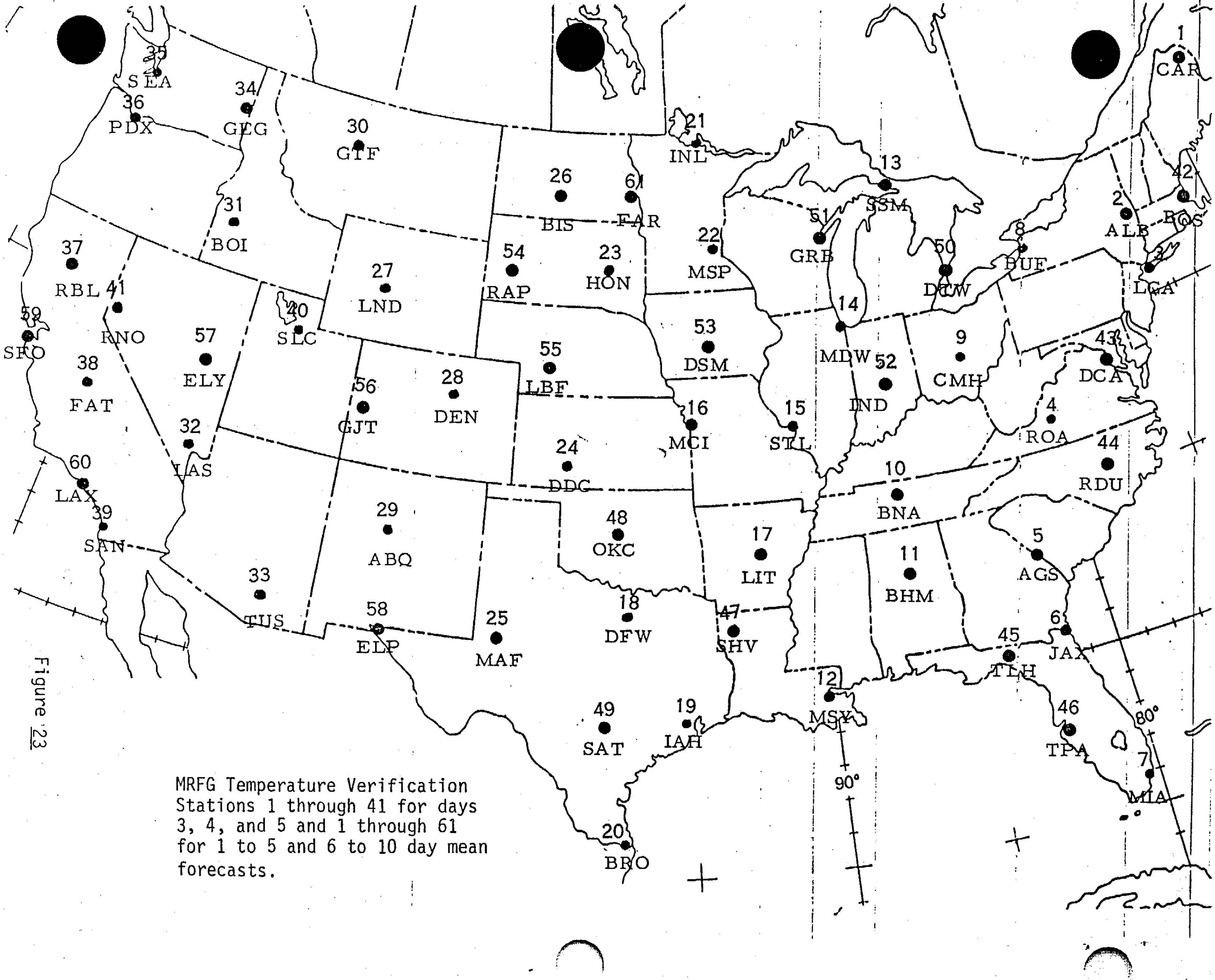

ANNUAL 6 TO 10 DAY NORTH AMERICAN 500 MB MEAN CORRELATION SCORES
CORRELATION SCORE = CORRELATION SCORE X 100
APPROXIMATELY 13 CASES PER MONTH
50
40
30
20
10
0
CORRELATION SCORE
------Man
——NMC/NWP Model
.....ECMWF Model
CLIMATOLOGY
1979
1980
1981
1982
1983

Figure 22

SECTION 2

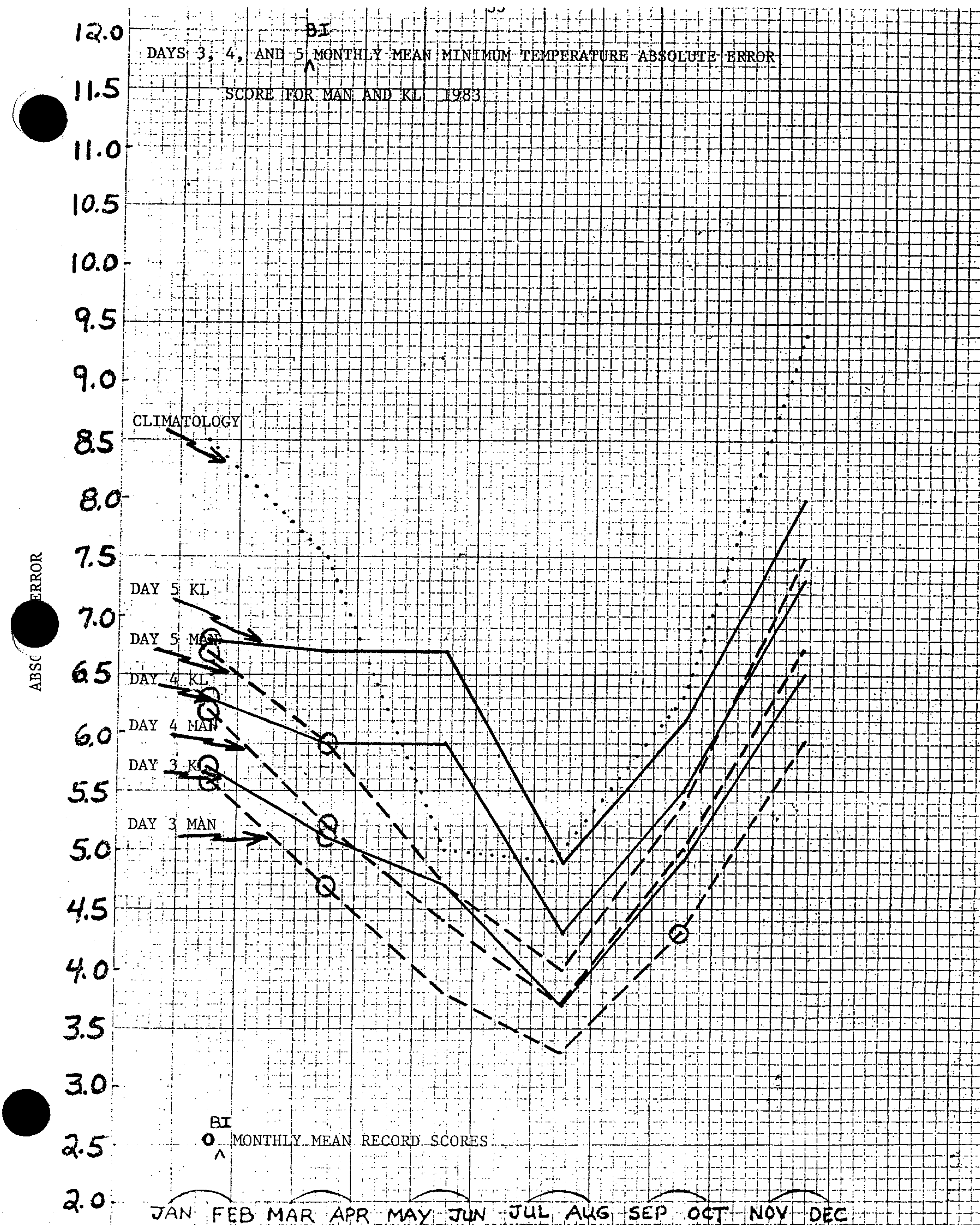
Man & Machine (KL Guidance)

Absolute Error Temperature Scores



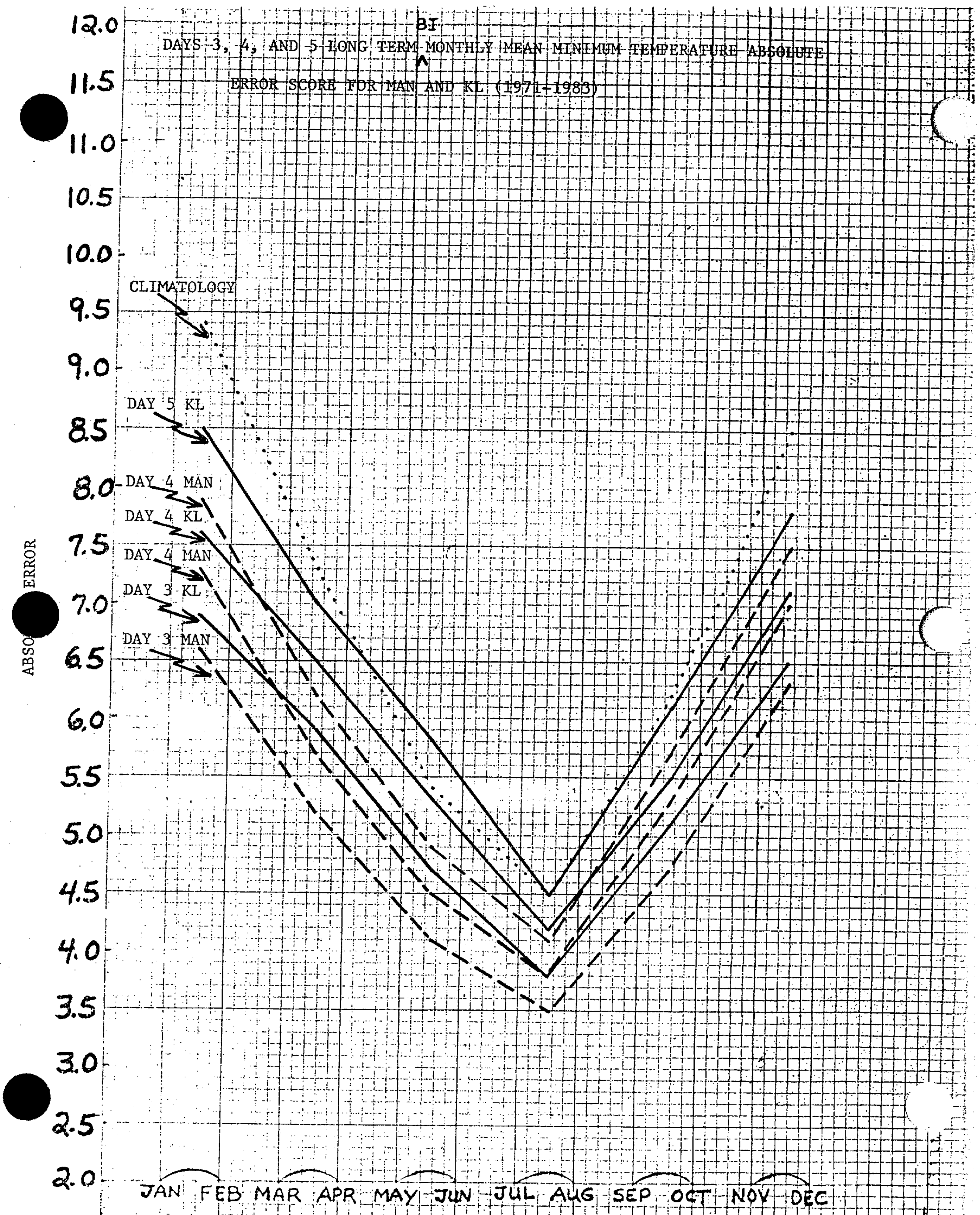
MRFG Temperature Verification Stations 1 through 41 for days 3, 4, and 5 and 1 through 61 for 1 to 5 and 6 to 10 day mean forecasts.

Figure 23



DAYS 3, 4, AND 5 MONTHLY MEAN MINIMUM TEMPERATURE ABSOLUTE ERROR
BI
SCORE FOR MAN AND KL 1983
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
ABSOLUTE ERROR
CLIMATOLOGY
DAY 5 KL
DAY 5 MAN
DAY 4 KL
DAY 4 MAN
DAY 3 KL
DAY 3 MAN
BI
O MONTHLY MEAN RECORD SCORES
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC

Figure 24.



BI
DAYS 3, 4, AND 5 LONG TERM MONTHLY MEAN MINIMUM TEMPERATURE ABSOLUTE
ERROR SCORE FOR MAN AND KL (1971-1983)
CLIMATOLOGY
DAY 5 KL
DAY 4 MAN
DAY 4 KL
DAY 4 MAN
DAY 3 KL
DAY 3 MAN
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

Figure 25

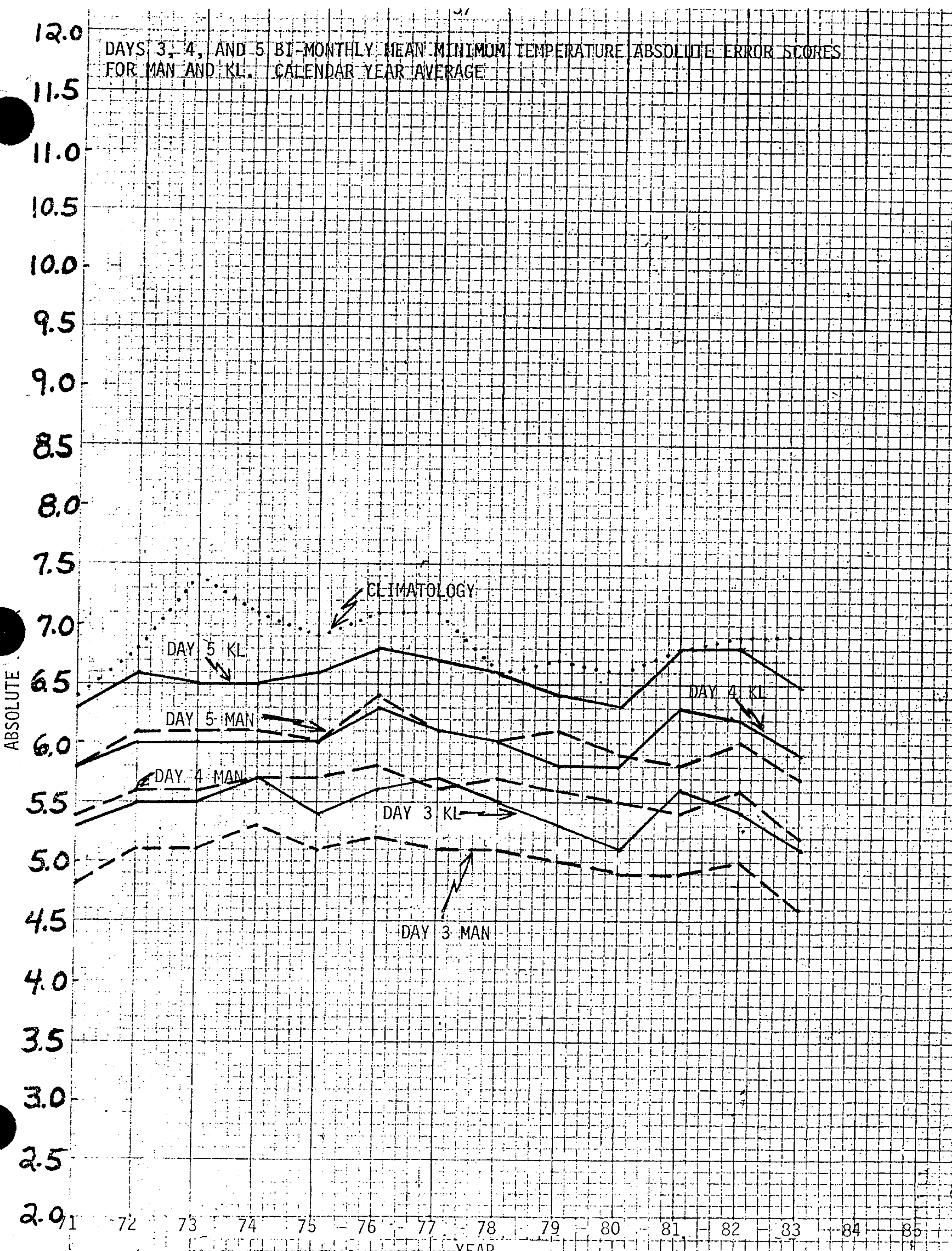

DAYS 3, 4, AND 5 BI-MONTHLY MEAN MINIMUM TEMPERATURE ABSOLUTE ERROR SCORES FOR MAN AND KL. CALENDAR YEAR AVERAGE
12.0
11.5
11.0
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
ABSOLUTE
CLIMATOLOGY
DAY 5 KL
DAY 5 MAN
DAY 4 KL
DAY 4 MAN
DAY 3 KL
DAY 3 MAN
71
72
73
74
75
76
77
78
79
80
81
82
83
84
85
YEAR

Figure 26

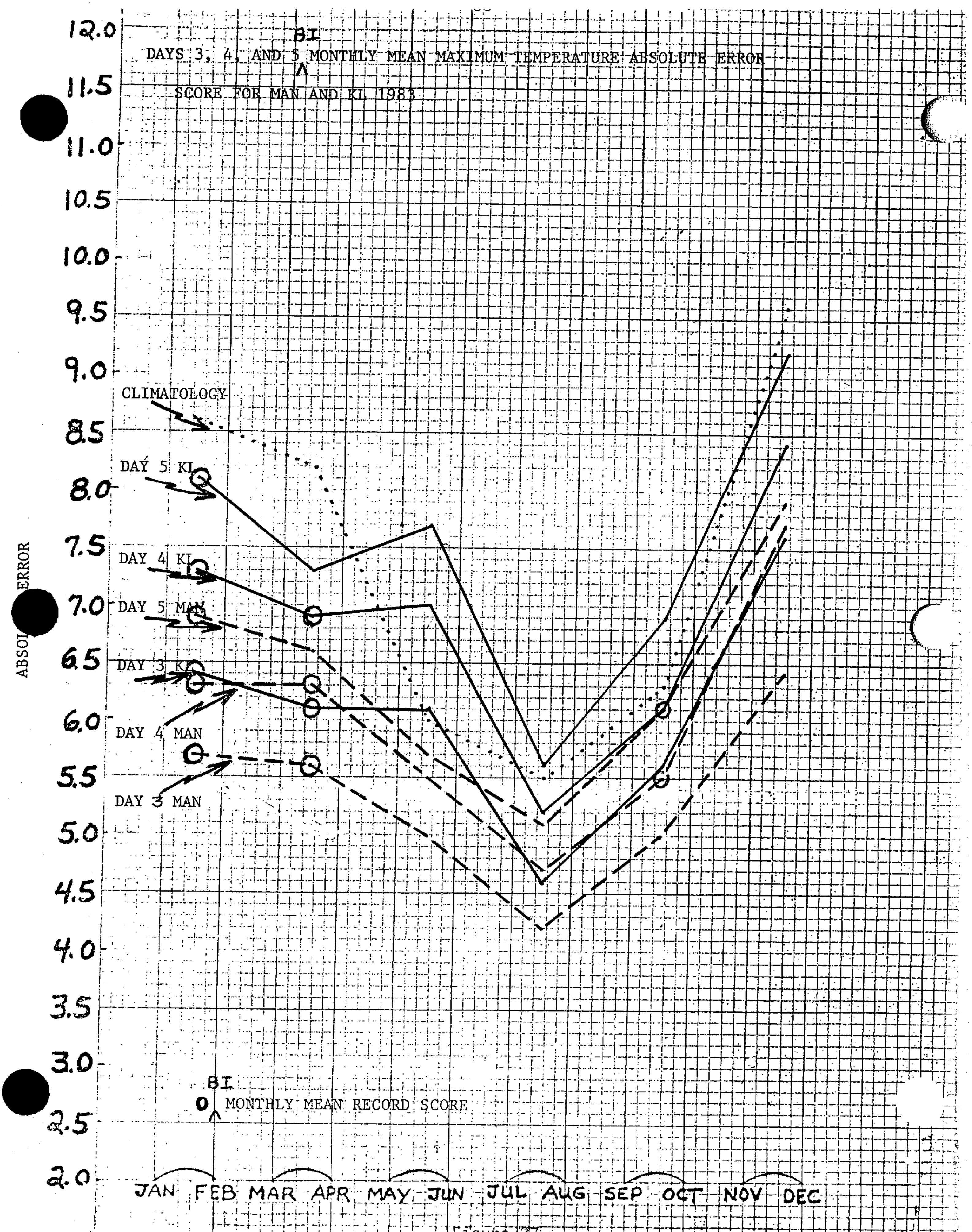

DAYS 3, 4, AND 5 MONTHLY MEAN MAXIMUM TEMPERATURE ABSOLUTE ERROR
SCORE FOR MAN AND KL 1983
BI
CLIMATOLOGY
DAY 5 KL
DAY 4 KL
DAY 5 MAN
DAY 3 KL
DAY 4 MAN
DAY 3 MAN
O MONTHLY MEAN RECORD SCORE
12.0
11.5
11.0
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC

Figure 27

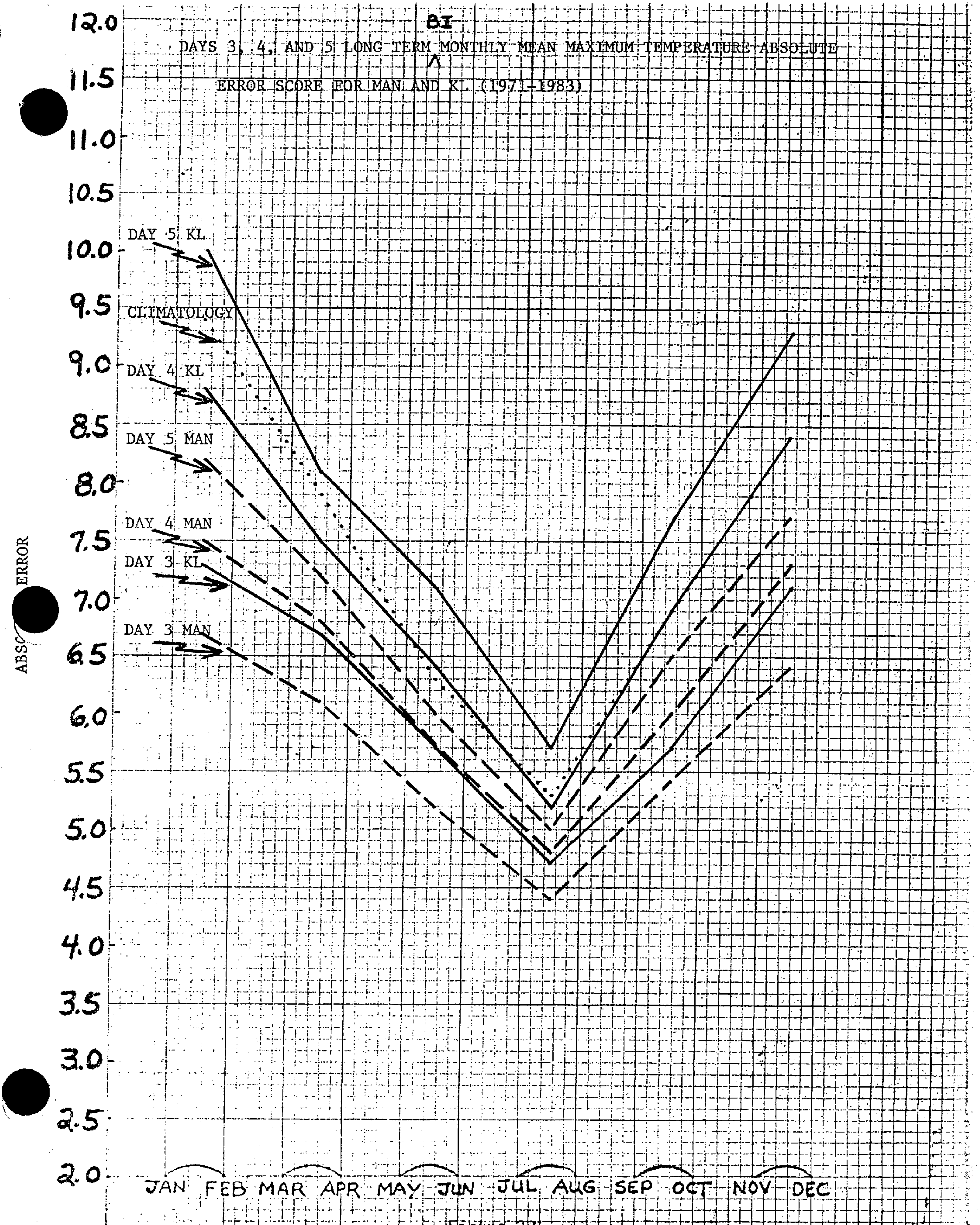

DAYS 3, 4, AND 5 LONG TERM MONTHLY MEAN MAXIMUM TEMPERATURE ABSOLUTE
ERROR SCORE FOR MAN AND KL (1971-1983)
DAY 5 KL
CLIMATOLOGY
DAY 4 KL
DAY 5 MAN
DAY 4 MAN
DAY 3 KL
DAY 3 MAN
ABS ERROR
12.0
11.5
11.0
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC

Figure 28

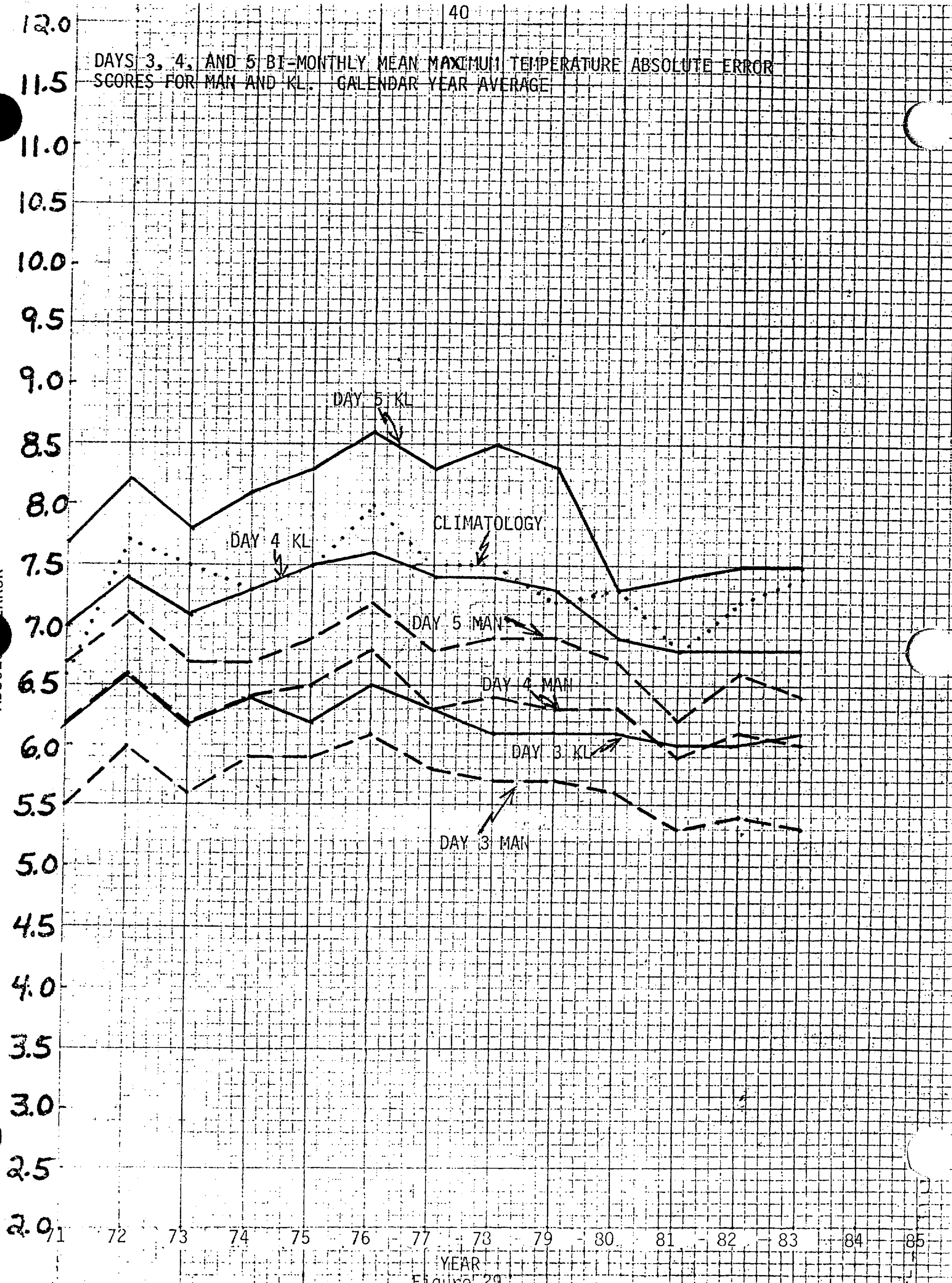

DAYS 3, 4, AND 5 BI-MONTHLY MEAN MAXIMUM TEMPERATURE ABSOLUTE ERROR SCORES FOR MAN AND KL. CALENDAR YEAR AVERAGE
12.0
11.5
11.0
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
ABSOL ERROR
DAY 5 KL
CLIMATOLOGY
DAY 4 KL
DAY 5 MAN
DAY 4 MAN
DAY 3 KL
DAY 3 MAN
71
72
73
74
75
76
77
78
79
80
81
82
83
84
85
YEAR

Figure 29

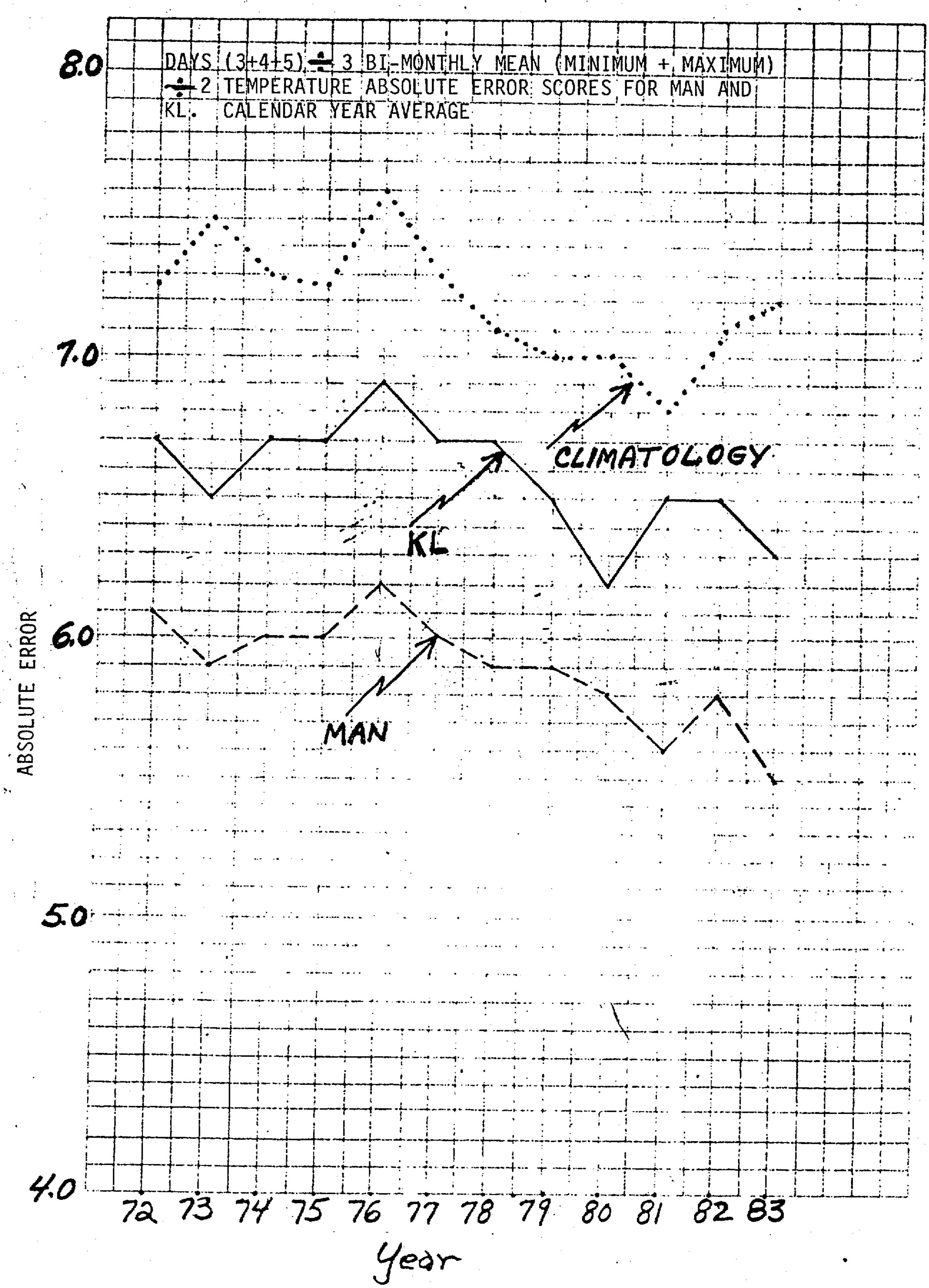

DAYS (3+4+5) ÷ 3 BI-MONTHLY MEAN (MINIMUM + MAXIMUM) ÷ 2 TEMPERATURE ABSOLUTE ERROR SCORES FOR MAN AND KL. CALENDAR YEAR AVERAGE
8.0
7.0
6.0
5.0
4.0
ABSOLUTE ERROR
CLIMATOLOGY
KL
MAN
72 73 74 75 76 77 78 79 80 81 82 83
Year

Figure 30

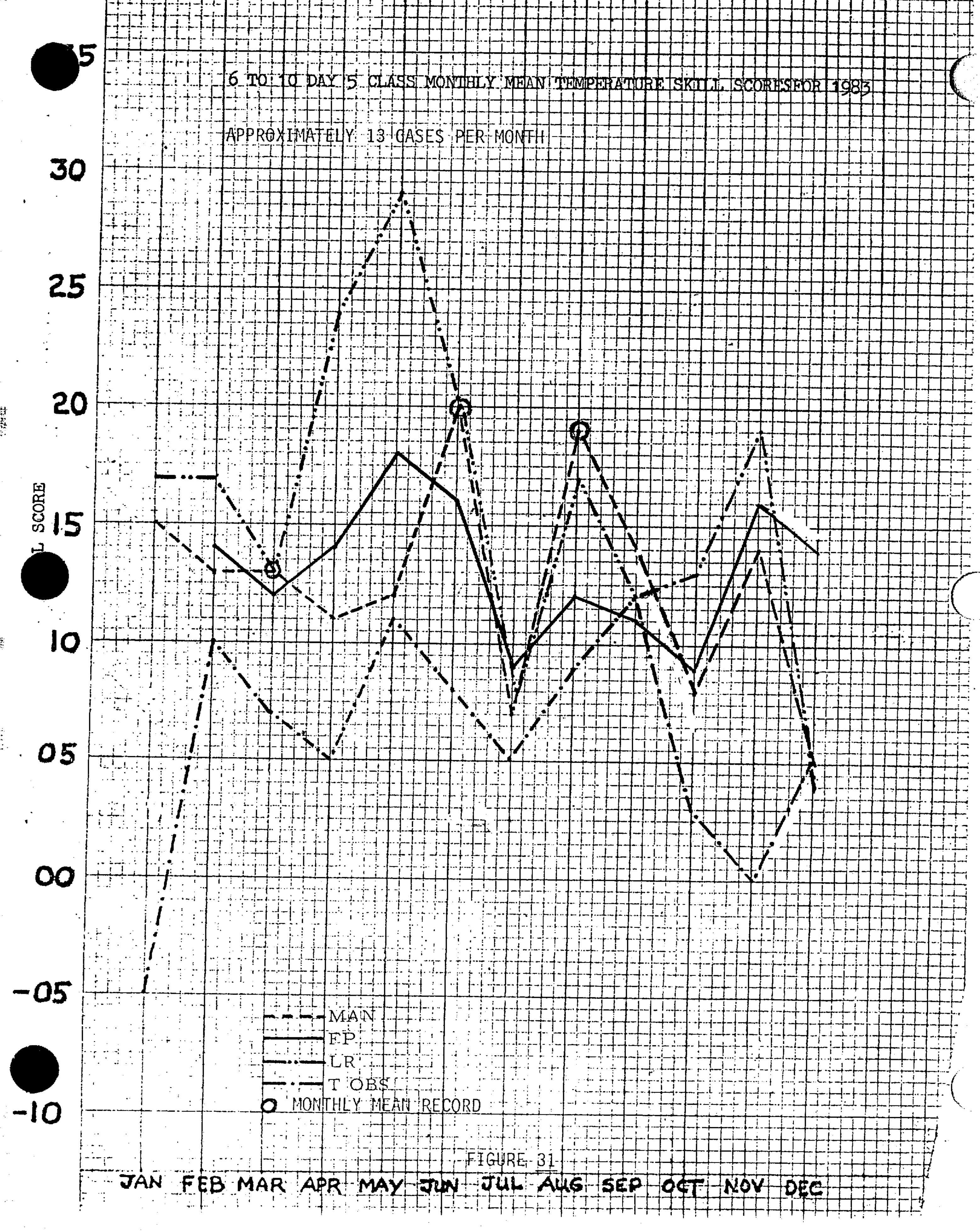

6 TO 10 DAY 5 CLASS MONTHLY MEAN TEMPERATURE SKILL SCORES FOR 1983
APPROXIMATELY 13 CASES PER MONTH
L SCORE
30
25
20
15
10
05
00
-05
-10
MAN
FP
LR
T OBS
MONTHLY MEAN RECORD
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC

FIGURE 31

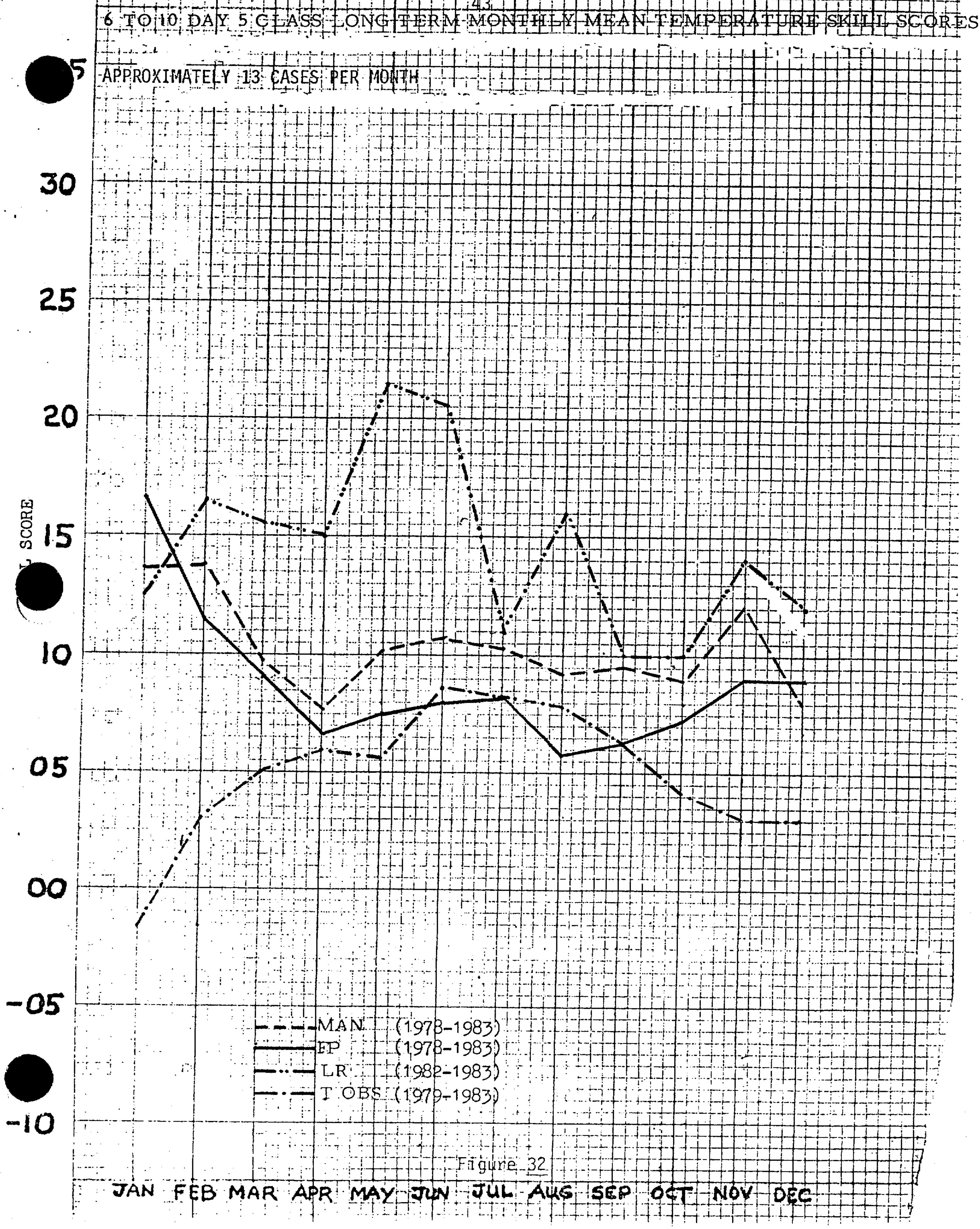

6 TO 10 DAY 5 CLASS LONG-TERM MONTHLY MEAN TEMPERATURE SKILL SCORES
APPROXIMATELY 13 CASES PER MONTH
SCORE
30
25
20
15
10
05
00
-05
-10
MAN (1978-1983)
FP (1978-1983)
LR (1982-1983)
T OBS (1979-1983)
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC

Figure 32

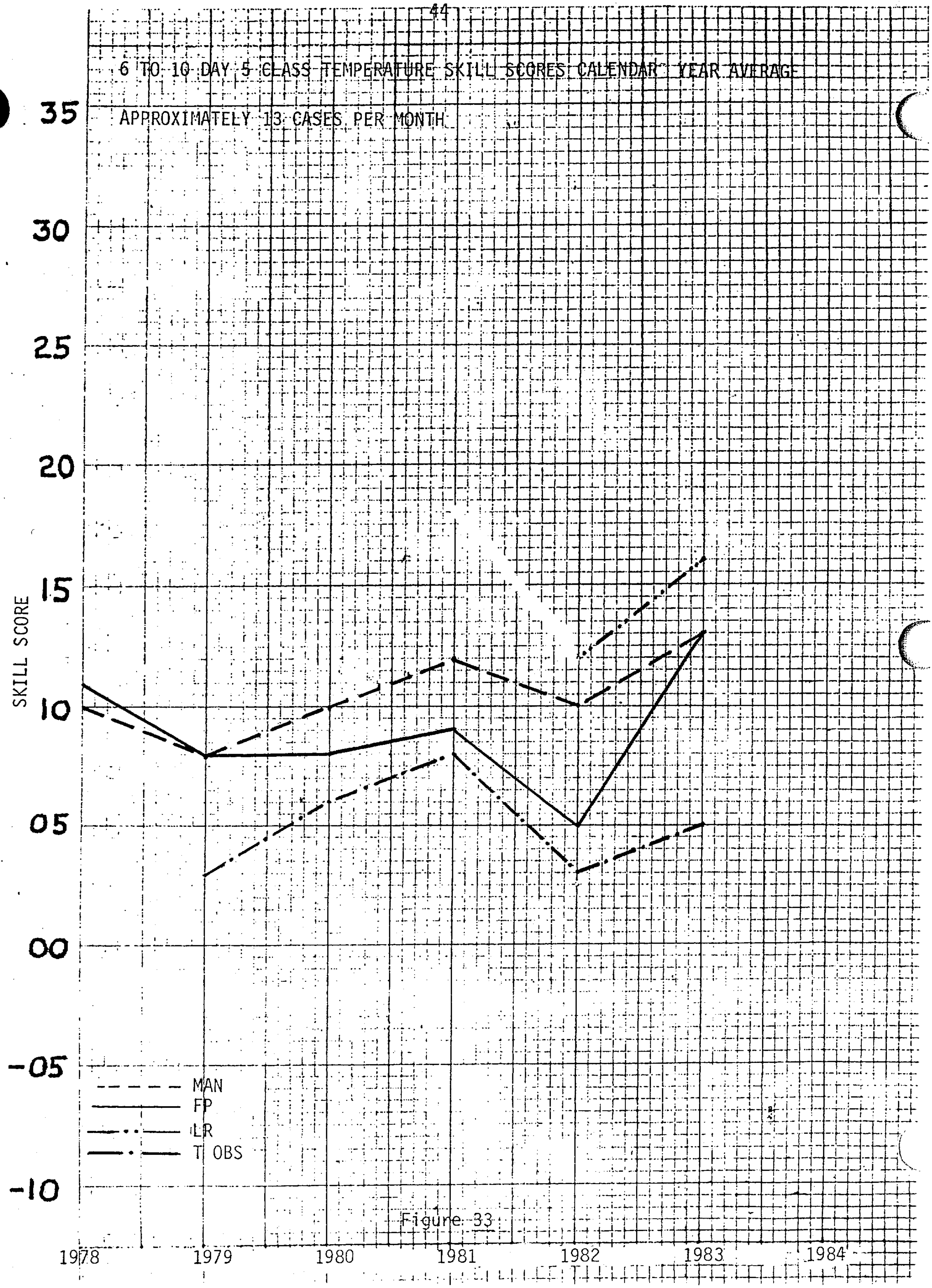

6 TO 10 DAY 5 CLASS TEMPERATURE SKILL SCORES CALENDAR YEAR AVERAGE
APPROXIMATELY 13 CASES PER MONTH
SKILL SCORE
35
30
25
20
15
10
05
00
-05
-10
MAN
FP
LR
T OBS
1978
1979
1980
1981
1982
1983
1984

Figure 33

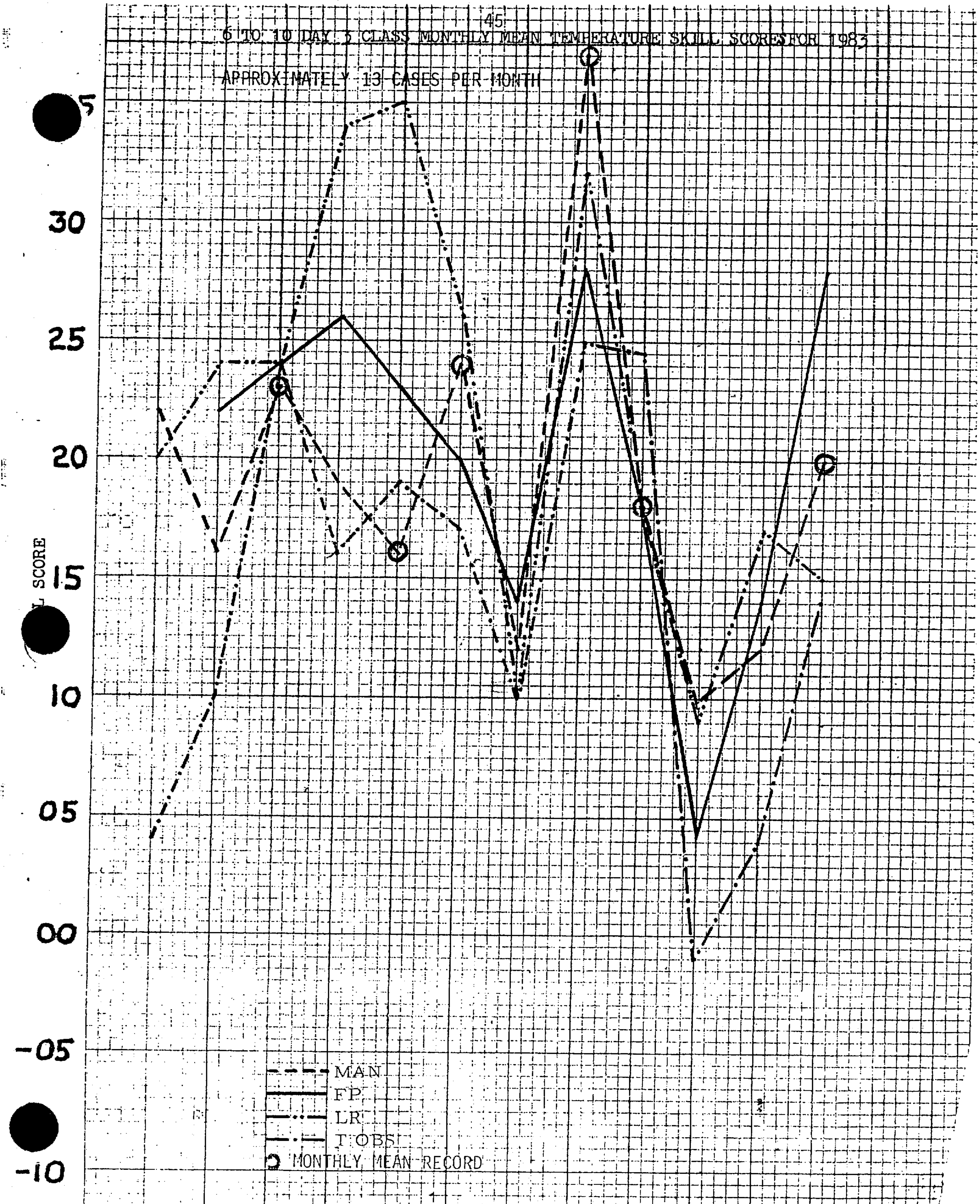

6 TO 10 DAY 3 CLASS MONTHLY MEAN TEMPERATURE SKILL SCORES FOR 1983
APPROXIMATELY 13 CASES PER MONTH
SCORE
30
25
20
15
10
05
00
-05
-10
MAN
FP
LR
T OBS
MONTHLY MEAN RECORD
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC

Figure 34

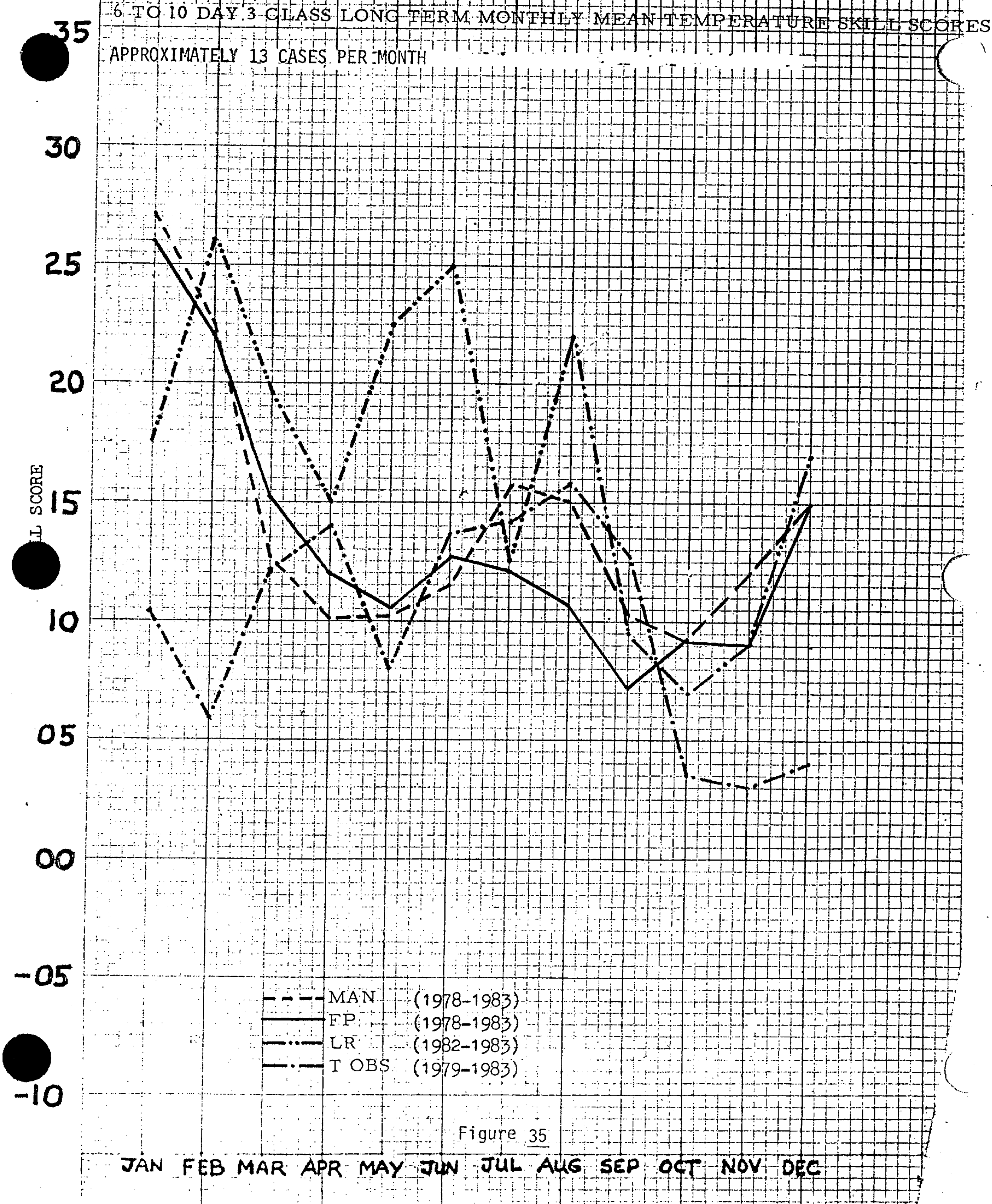

6 TO 10 DAY 3 CLASS LONG TERM MONTHLY MEAN TEMPERATURE SKILL SCORES
APPROXIMATELY 13 CASES PER MONTH
35
30
25
20
15
10
05
00
-05
-10
SCORE
MAN (1978-1983)
FP (1978-1983)
LR (1982-1983)
T OBS (1979-1983)
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC

Figure 35

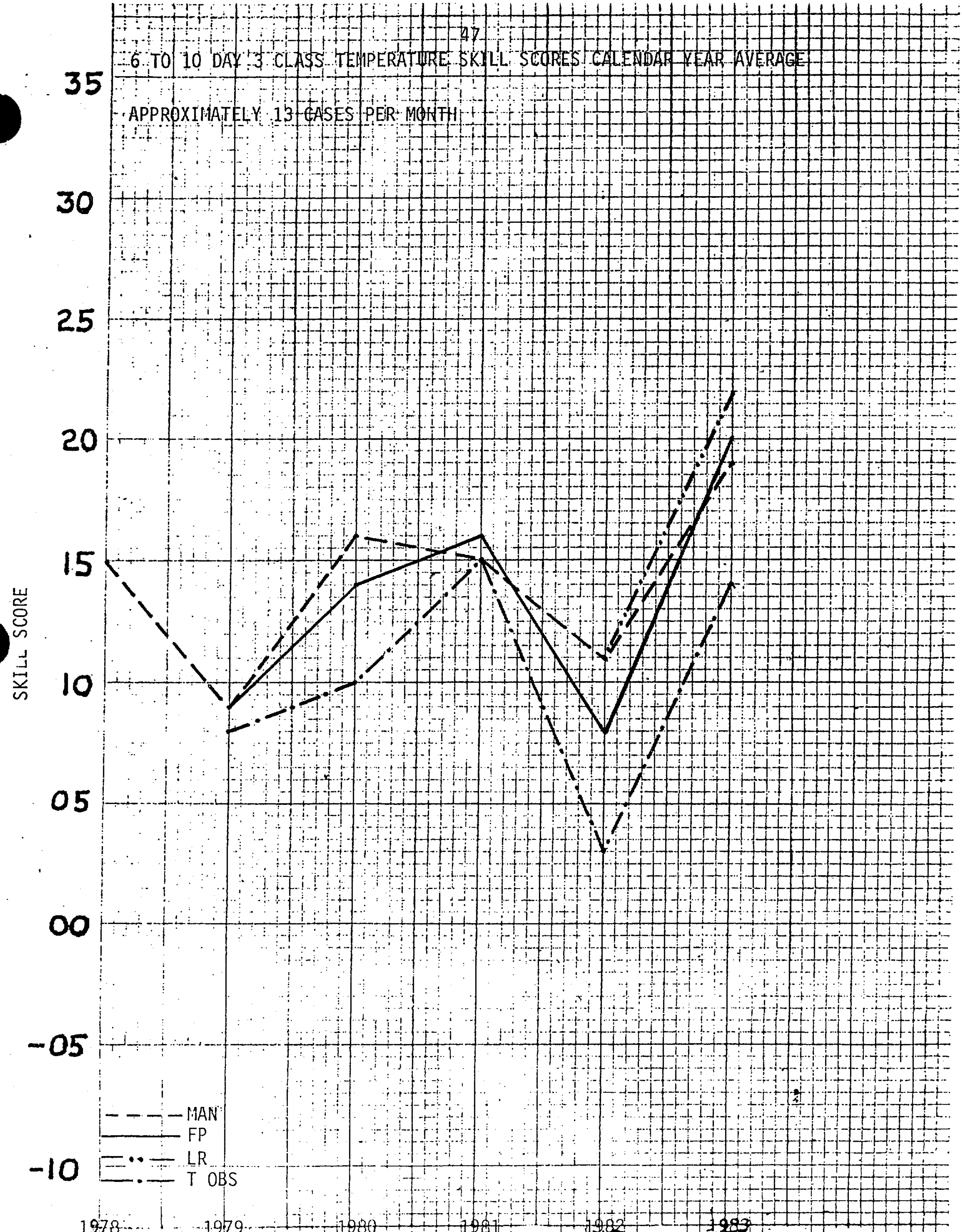

6 TO 10 DAY 3 CLASS TEMPERATURE SKILL SCORES CALENDAR YEAR AVERAGE
APPROXIMATELY 13 CASES PER MONTH
SKILL SCORE
35
30
25
20
15
10
05
00
-05
-10
MAN
FP
LR
T OBS
1978
1979
1980
1981
1982
1983

Figure 36

SECTION 3

Man & Climatology

Precipitation Skill Scores

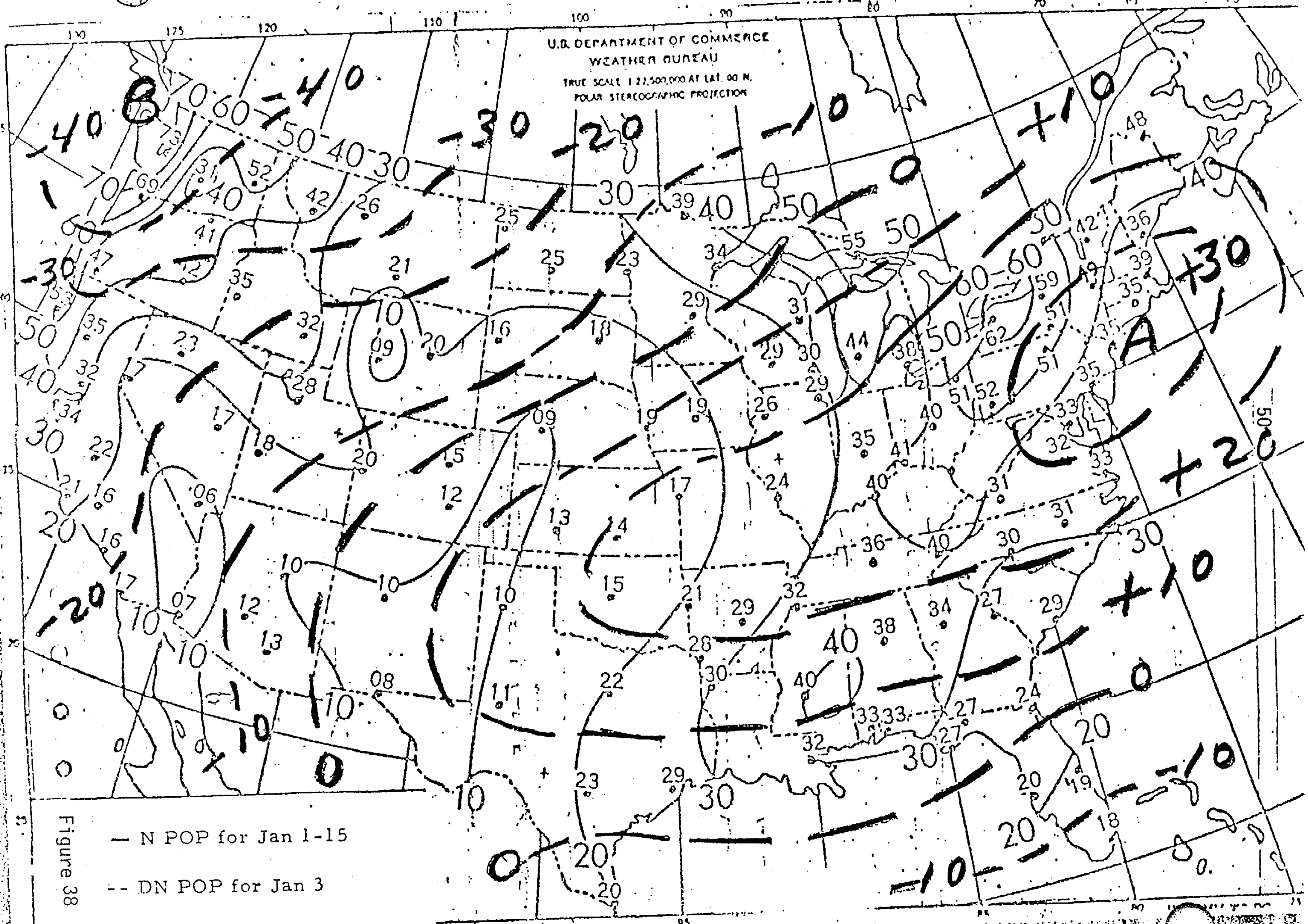

U.S. DEPARTMENT OF COMMERCE
WEATHER BUREAU
TRUE SCALE 1:22,500,000 AT LAT. 60 N.
POLAR STEREOGRAPHIC PROJECTION
— N POP for Jan 1-15
-- DN POP for Jan 3

Figure 38

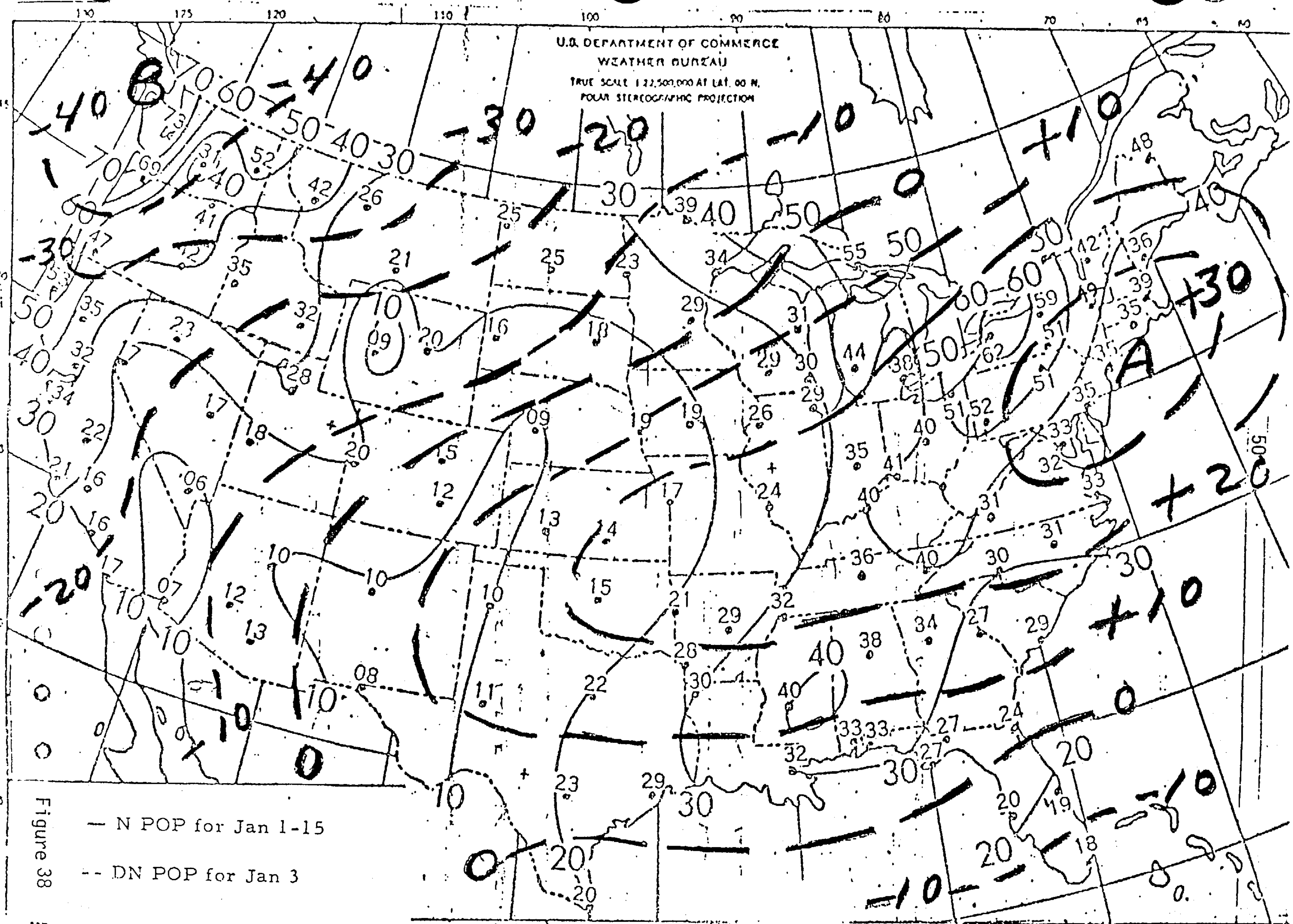

U.S. DEPARTMENT OF COMMERCE
WEATHER BUREAU
TRUE SCALE 1:22,500,000 AT LAT. 60 N.
POLAR STEREOGRAPHIC PROJECTION
— N POP for Jan 1-15
-- DN POP for Jan 3

Figure 38

DAYS 3, 4, AND 5 MONTHLY MEAN GILMAN PRECIPITATION SKILL SCORES FOR 1983

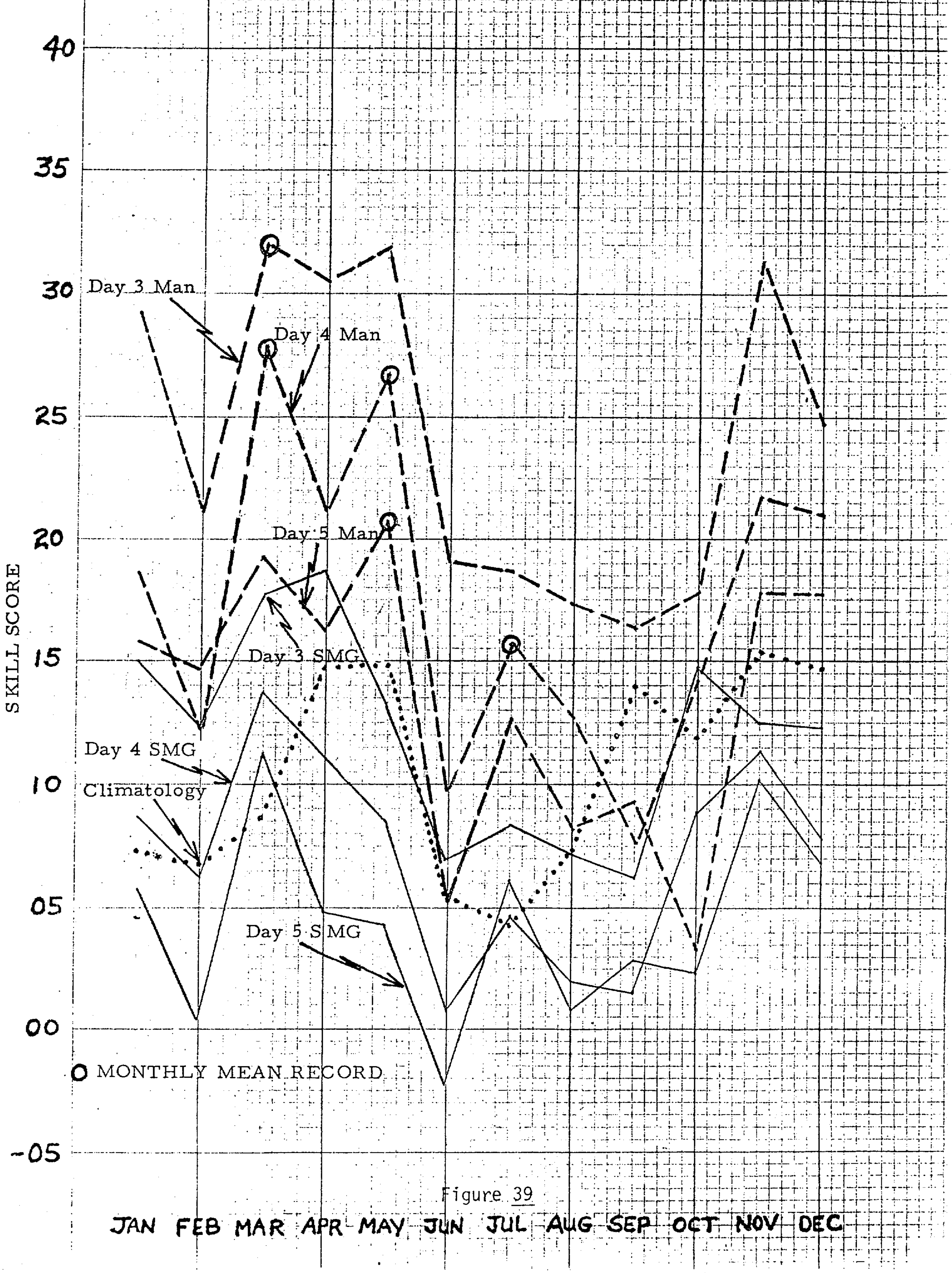


Figure 39

DAYS 3, 4, AND 5 LONG TERM MONTHLY MEAN GILMAN PRECIPITATION SKILL SCORES FOR 1970-1983

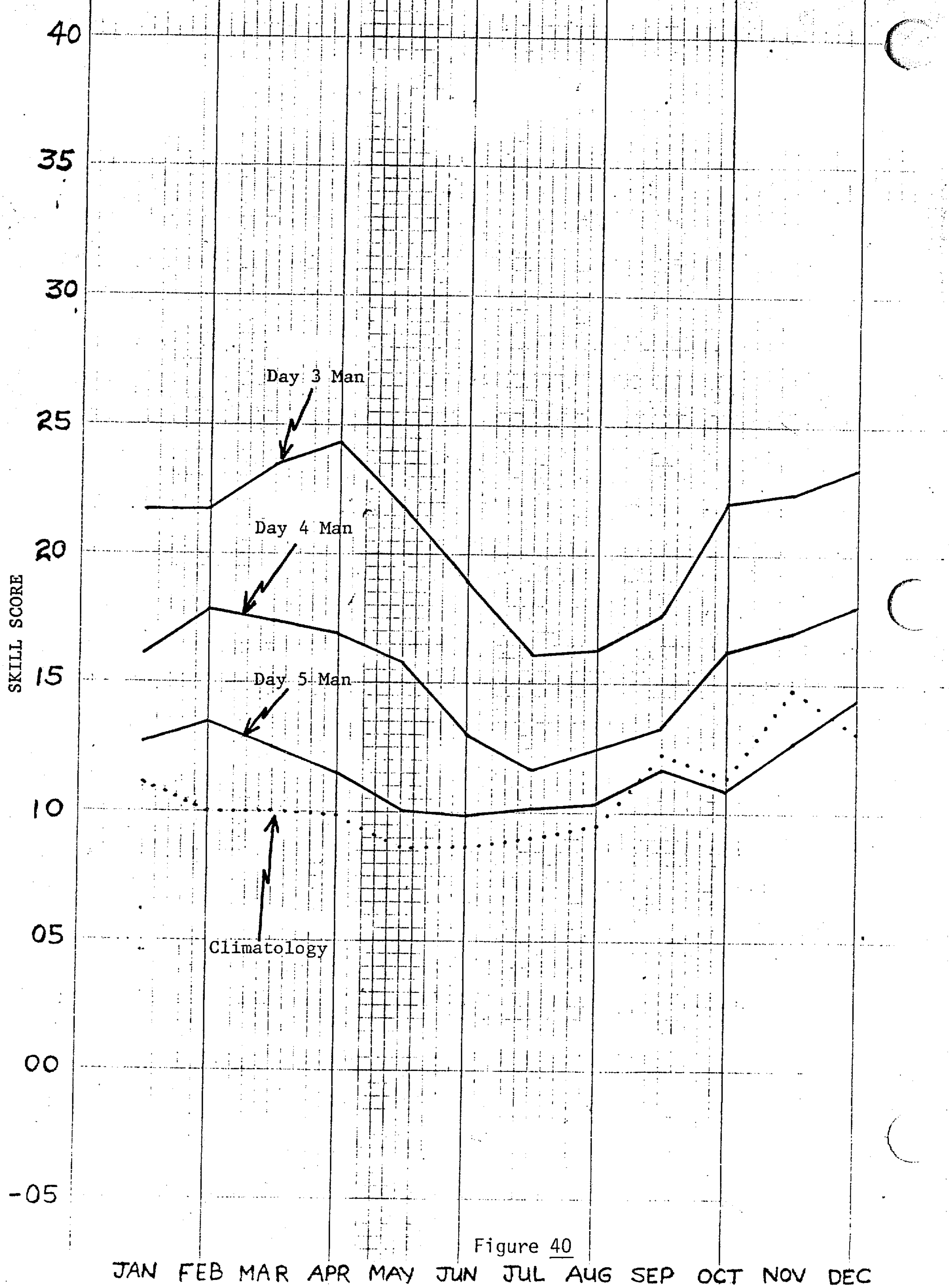


Figure 40

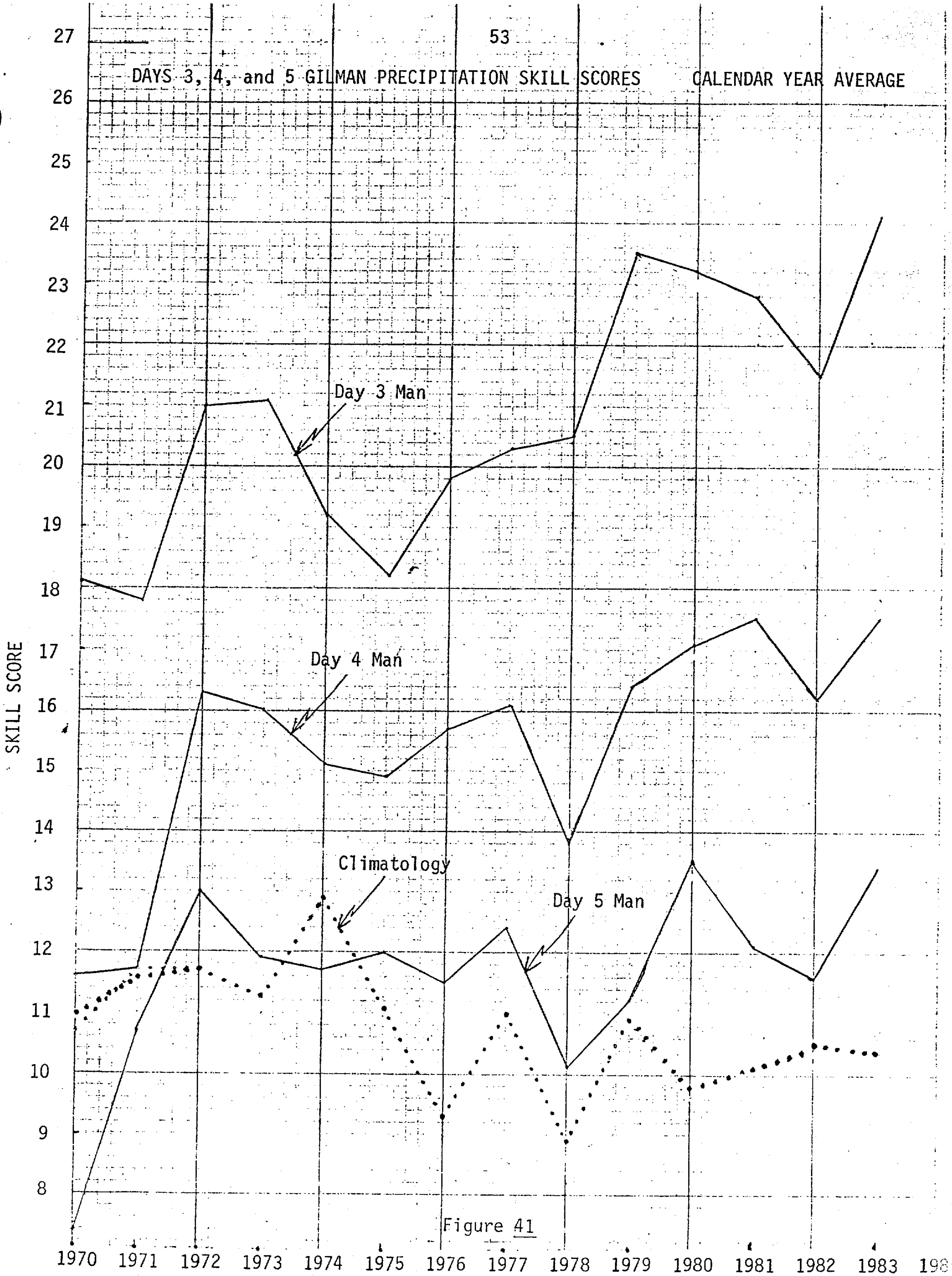

DAYS 3, 4, and 5 GILMAN PRECIPITATION SKILL SCORES
CALENDAR YEAR AVERAGE
SKILL SCORE
27
26
25
24
23
22
21
20
19
18
17
16
15
14
13
12
11
10
9
8
Day 3 Man
Day 4 Man
Climatology
Day 5 Man
1970
1971
1972
1973
1974
1975
1976
1977
1978
1979
1980
1981
1982
1983
198

Figure 41

NOAA FORM 59-4
(2-72)

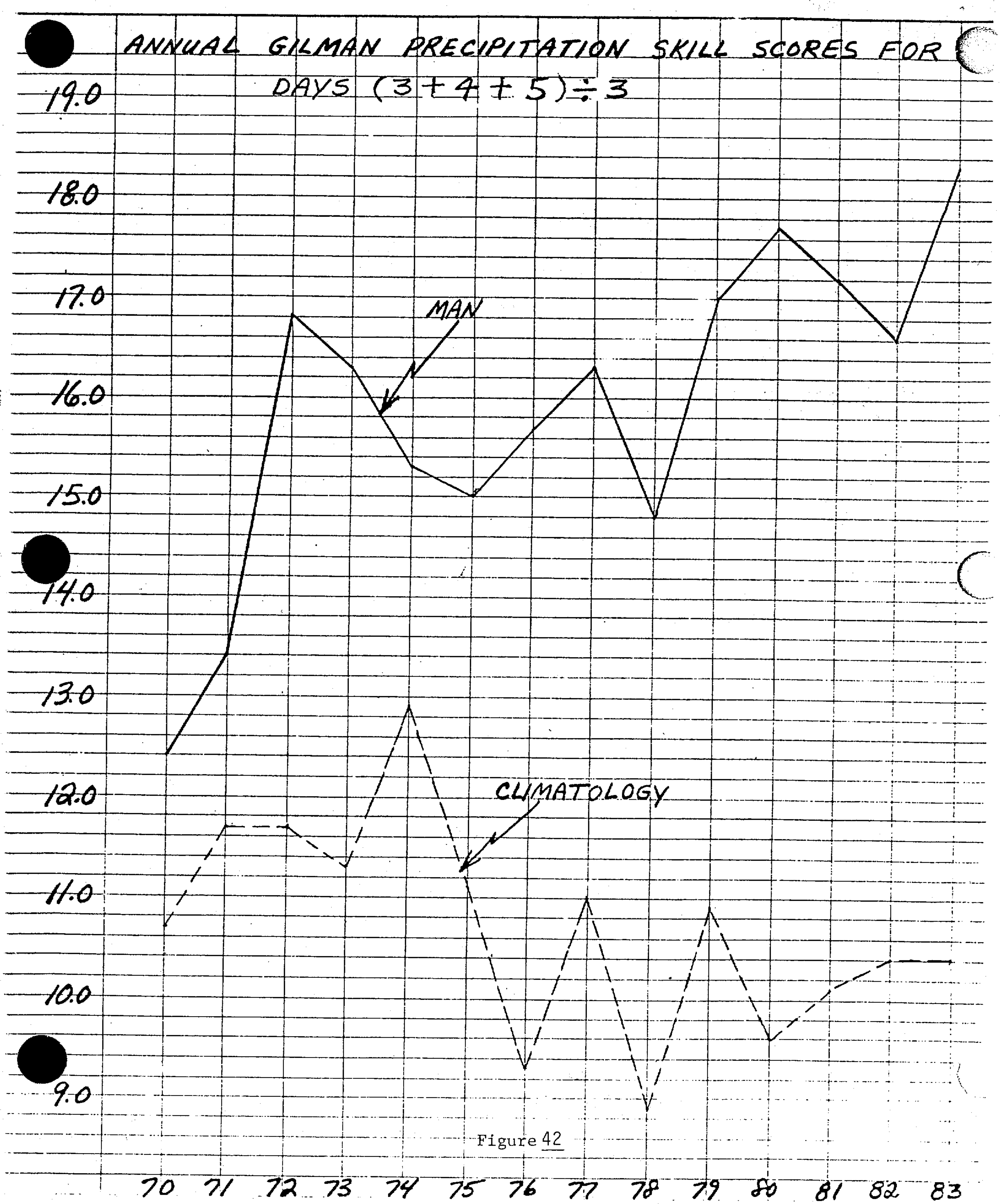


Figure 42

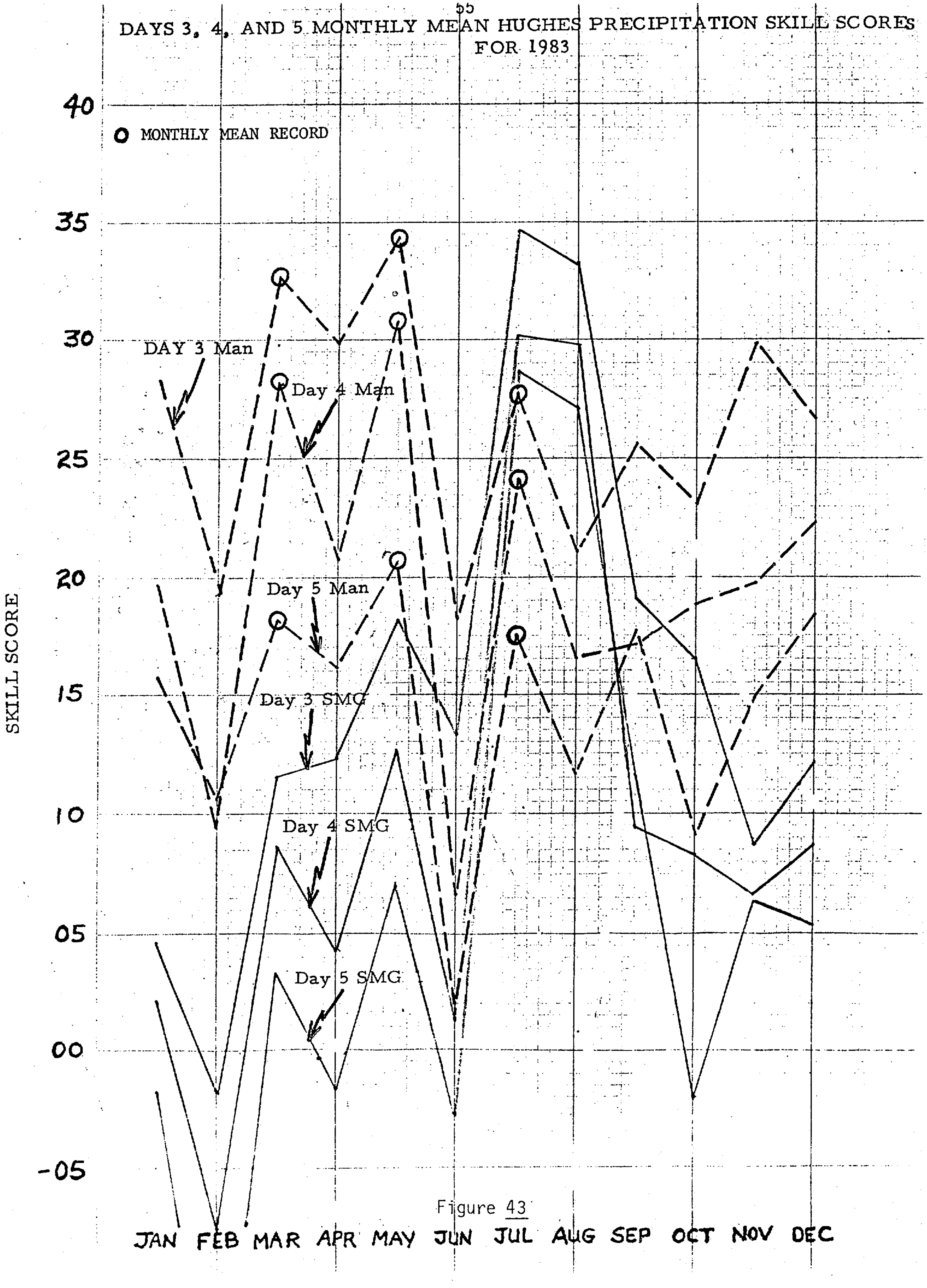
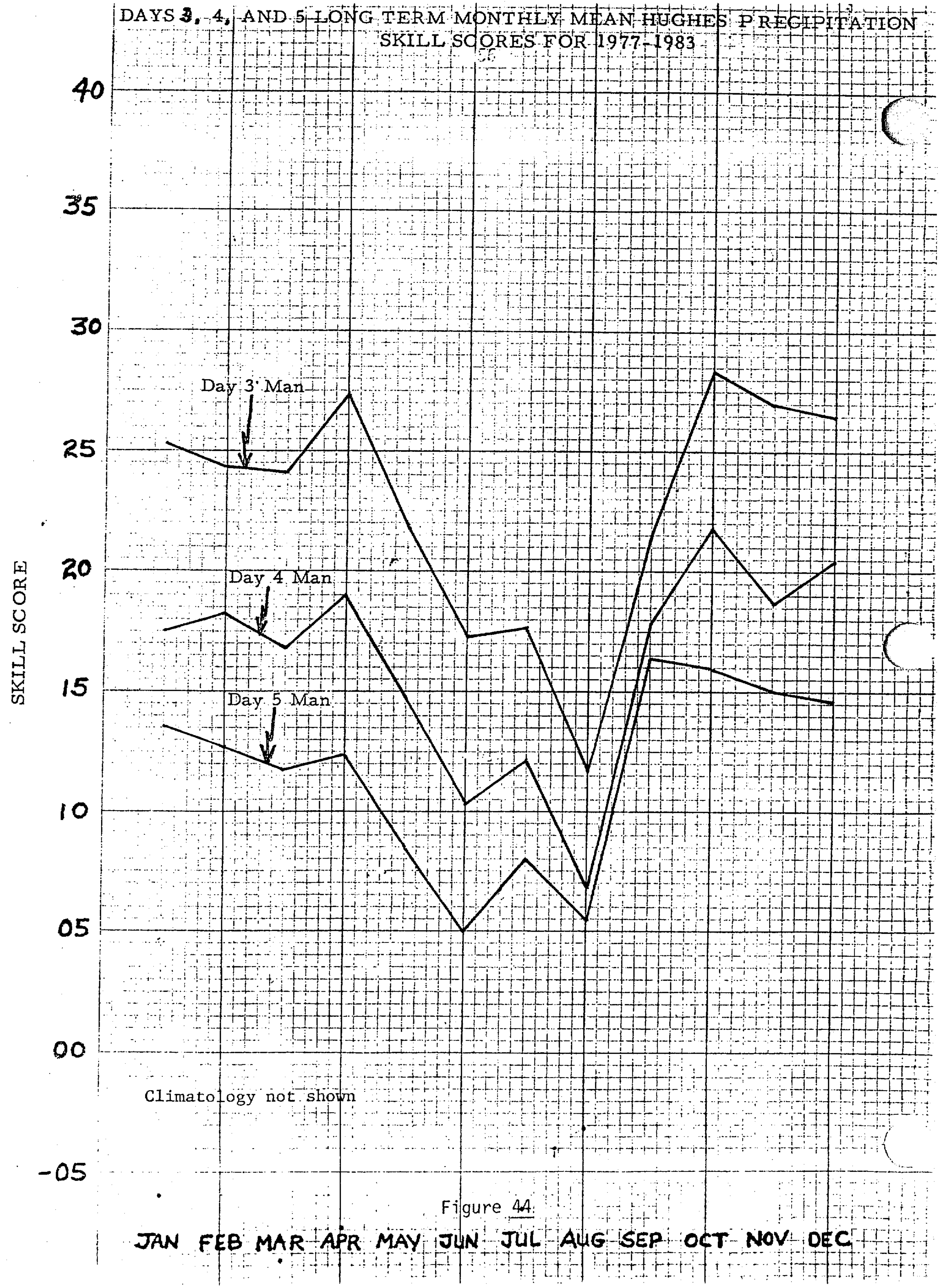

DAYS 3, 4, AND 5 MONTHLY MEAN HUGHES PRECIPITATION SKILL SCORES FOR 1983
MONTHLY MEAN RECORD
DAY 3 Man
Day 4 Man
Day 5 Man
Day 3 SMG
Day 4 SMG
Day 5 SMG
SKILL SCORE
40
35
30
25
20
15
10
05
00
-05
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC

Figure 43



DAYS 3, 4, AND 5 LONG TERM MONTHLY MEAN HUGHES PRECIPITATION
SKILL SCORES FOR 1977-1983
SKILL SCORE
40
35
30
25
20
15
10
05
00
-05
Day 3 Man
Day 4 Man
Day 5 Man
Climatology not shown
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC

Figure 44

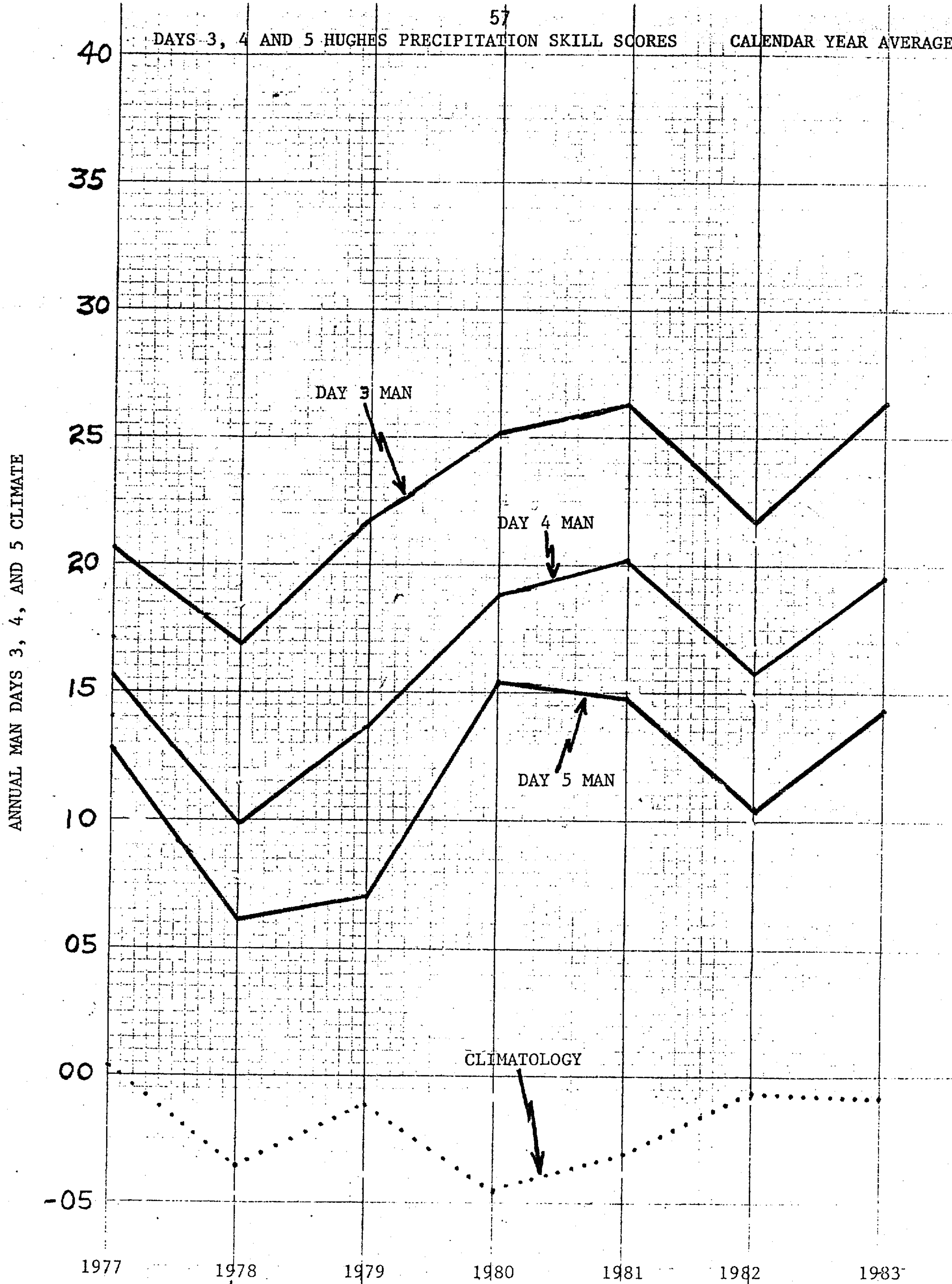

DAYS 3, 4 AND 5 HUGHES PRECIPITATION SKILL SCORES
CALENDAR YEAR AVERAGE
ANNUAL MAN DAYS 3, 4, AND 5 CLIMATE
40
35
30
25
20
15
10
05
00
-05
DAY 3 MAN
DAY 4 MAN
DAY 5 MAN
CLIMATOLOGY
1977
1978
1979
1980
1981
1982
1983

Figure 45

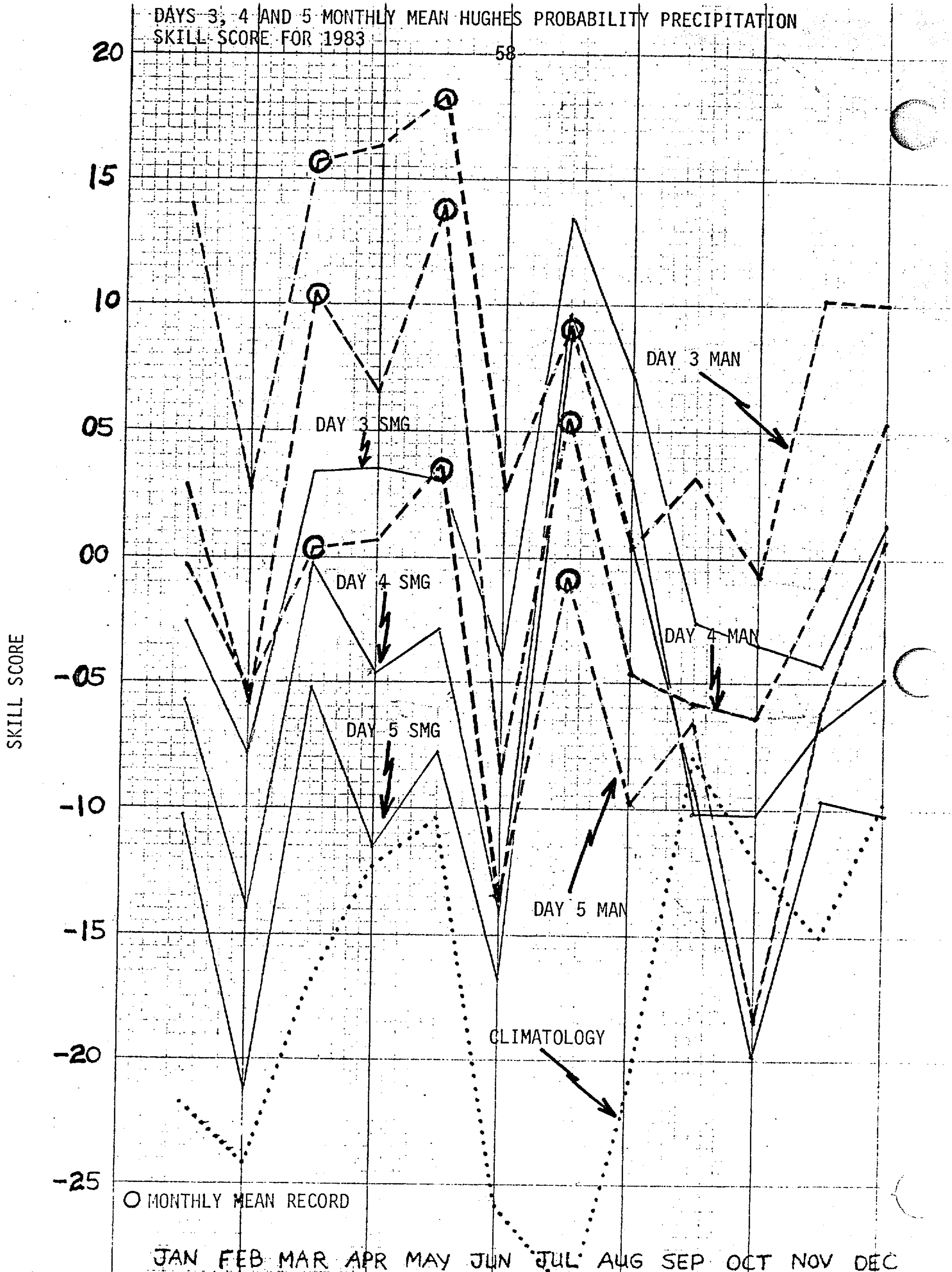

DAYS 3, 4 AND 5 MONTHLY MEAN HUGHES PROBABILITY PRECIPITATION
SKILL SCORE FOR 1983
SKILL SCORE
20
15
10
05
00
-05
-10
-15
-20
-25
DAY 3 SMG
DAY 4 SMG
DAY 5 SMG
DAY 3 MAN
DAY 4 MAN
DAY 5 MAN
CLIMATOLOGY
O MONTHLY MEAN RECORD
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC

Figure 46

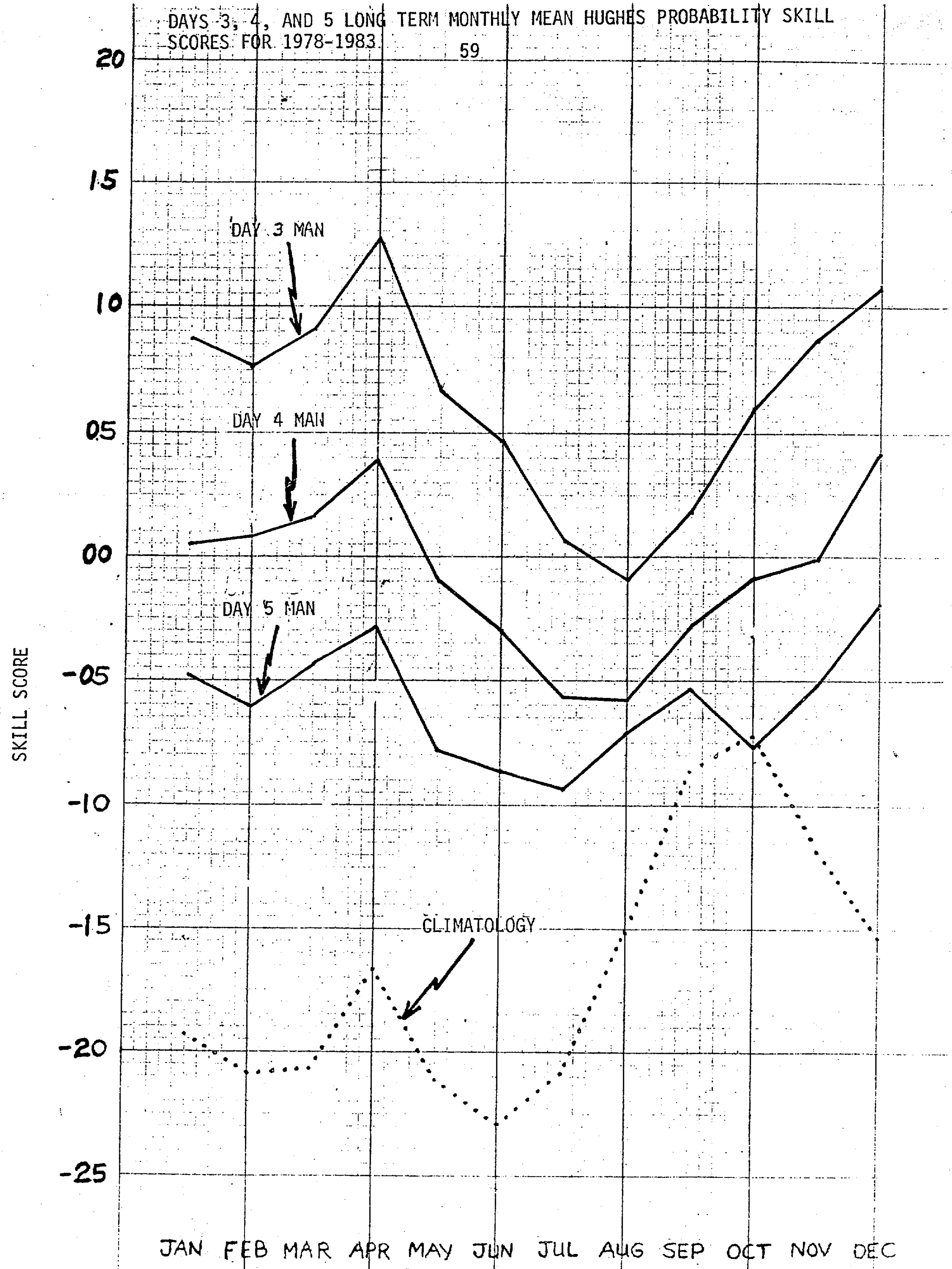

DAYS 3, 4, AND 5 LONG TERM MONTHLY MEAN HUGHES PROBABILITY SKILL SCORES FOR 1978-1983
DAY 3 MAN
DAY 4 MAN
DAY 5 MAN
CLIMATOLOGY
SKILL SCORE
20
15
10
05
00
-05
-10
-15
-20
-25
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC

Figure 47

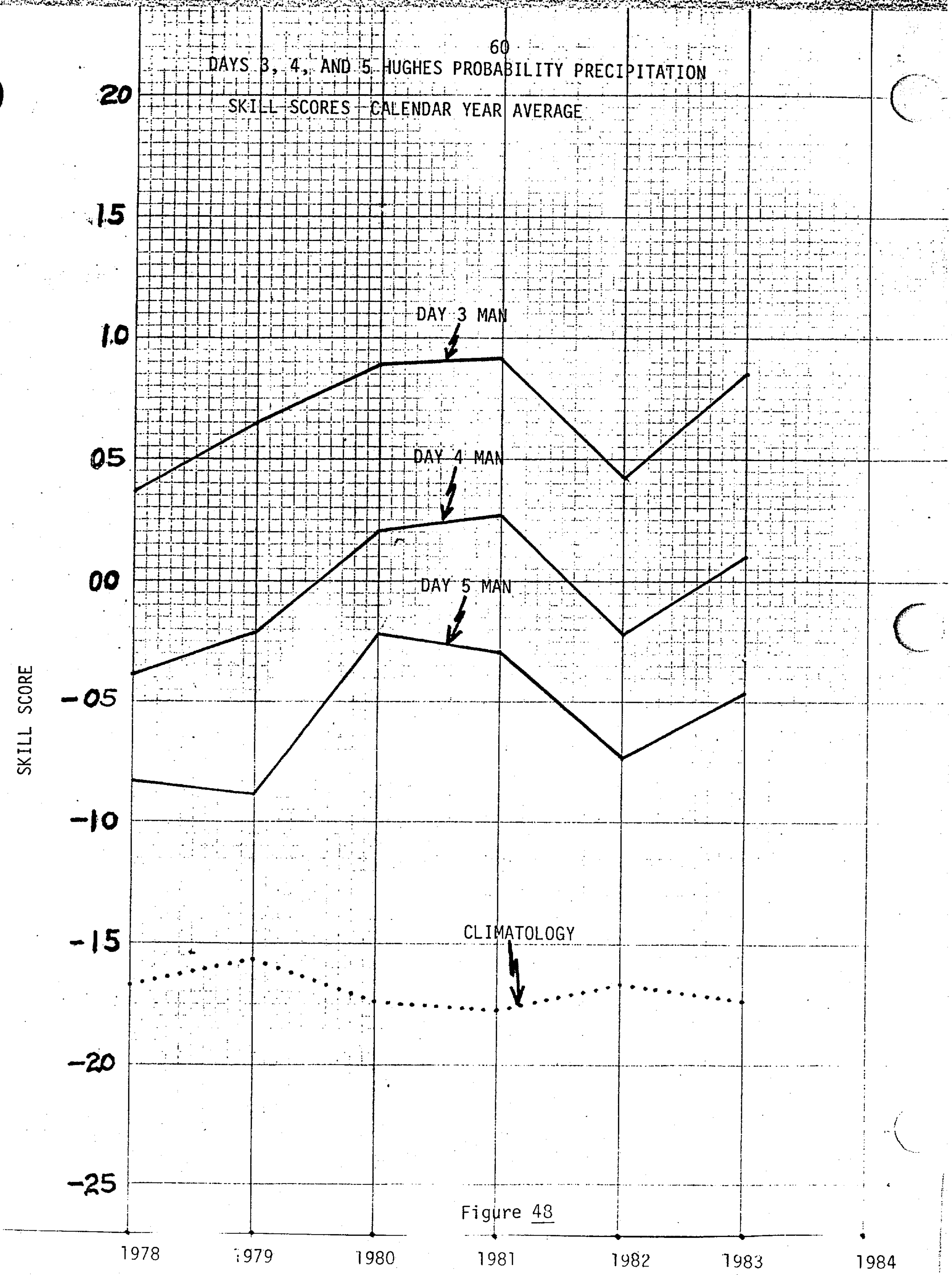

DAYS 3, 4, AND 5 HUGHES PROBABILITY PRECIPITATION
SKILL SCORES CALENDAR YEAR AVERAGE
SKILL SCORE
20
15
10
05
00
-05
-10
-15
-20
-25
DAY 3 MAN
DAY 4 MAN
DAY 5 MAN
CLIMATOLOGY
1978
1979
1980
1981
1982
1983
1984

Figure 48

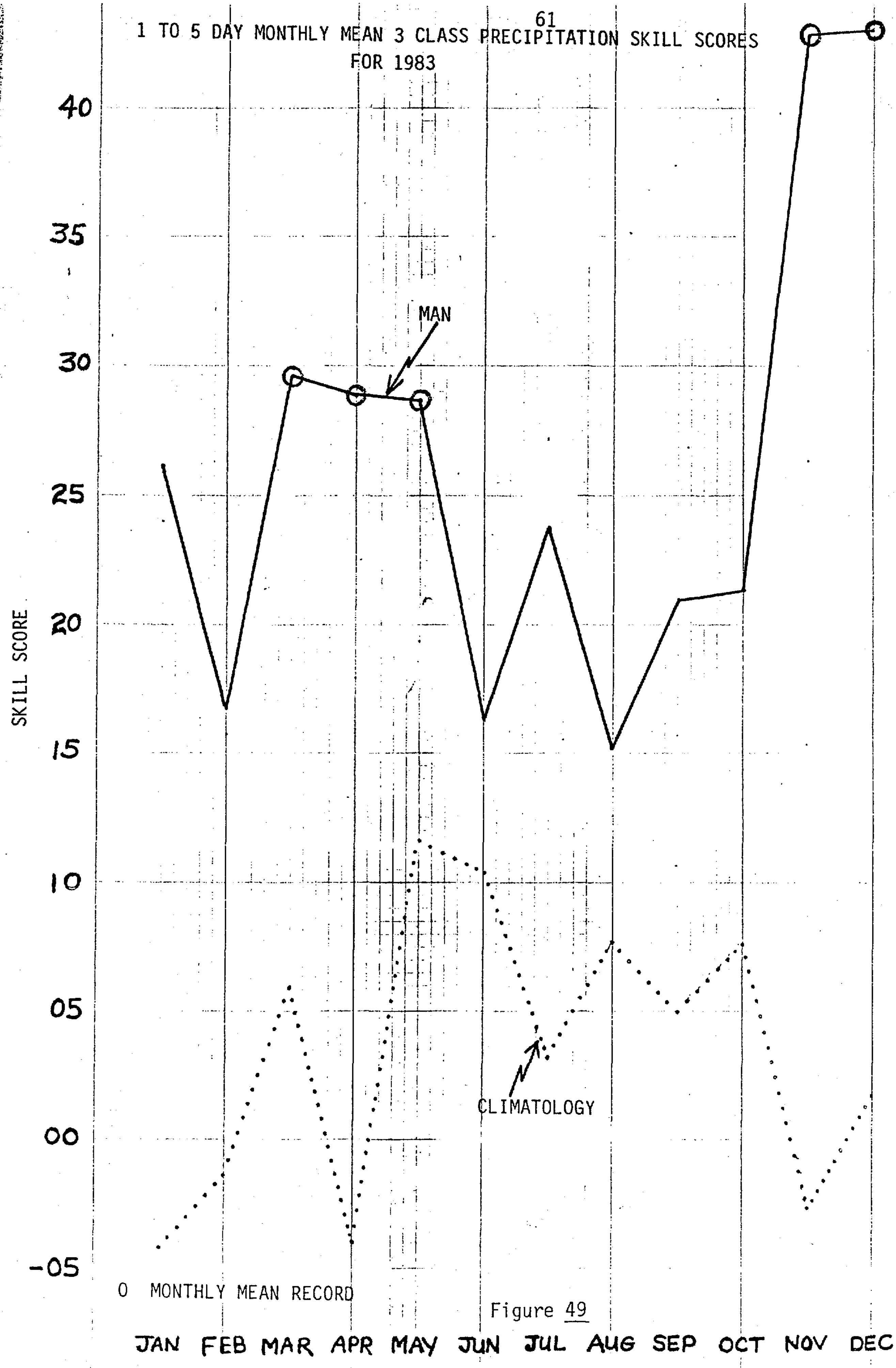

1 TO 5 DAY MONTHLY MEAN 3 CLASS PRECIPITATION SKILL SCORES
FOR 1983
SKILL SCORE
40
35
30
25
20
15
10
05
00
-05
MAN
CLIMATOLOGY
0 MONTHLY MEAN RECORD
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC

Figure 49

LONG TERM MONTHLY MEAN 1 TO 5 DAY 3 CLASS PRECIPITATION
SKILL SCORES FOR 1978-1983

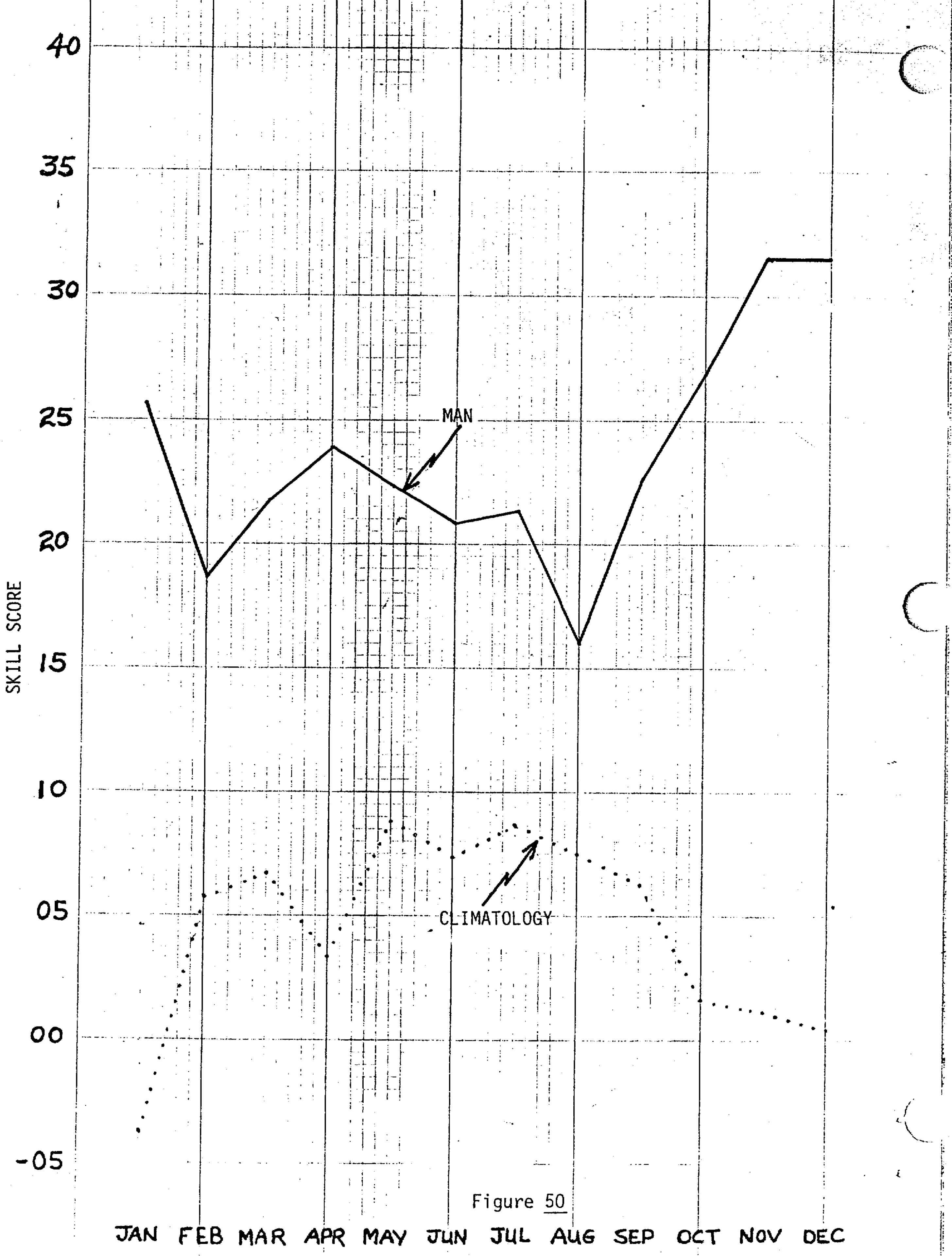


Figure 50

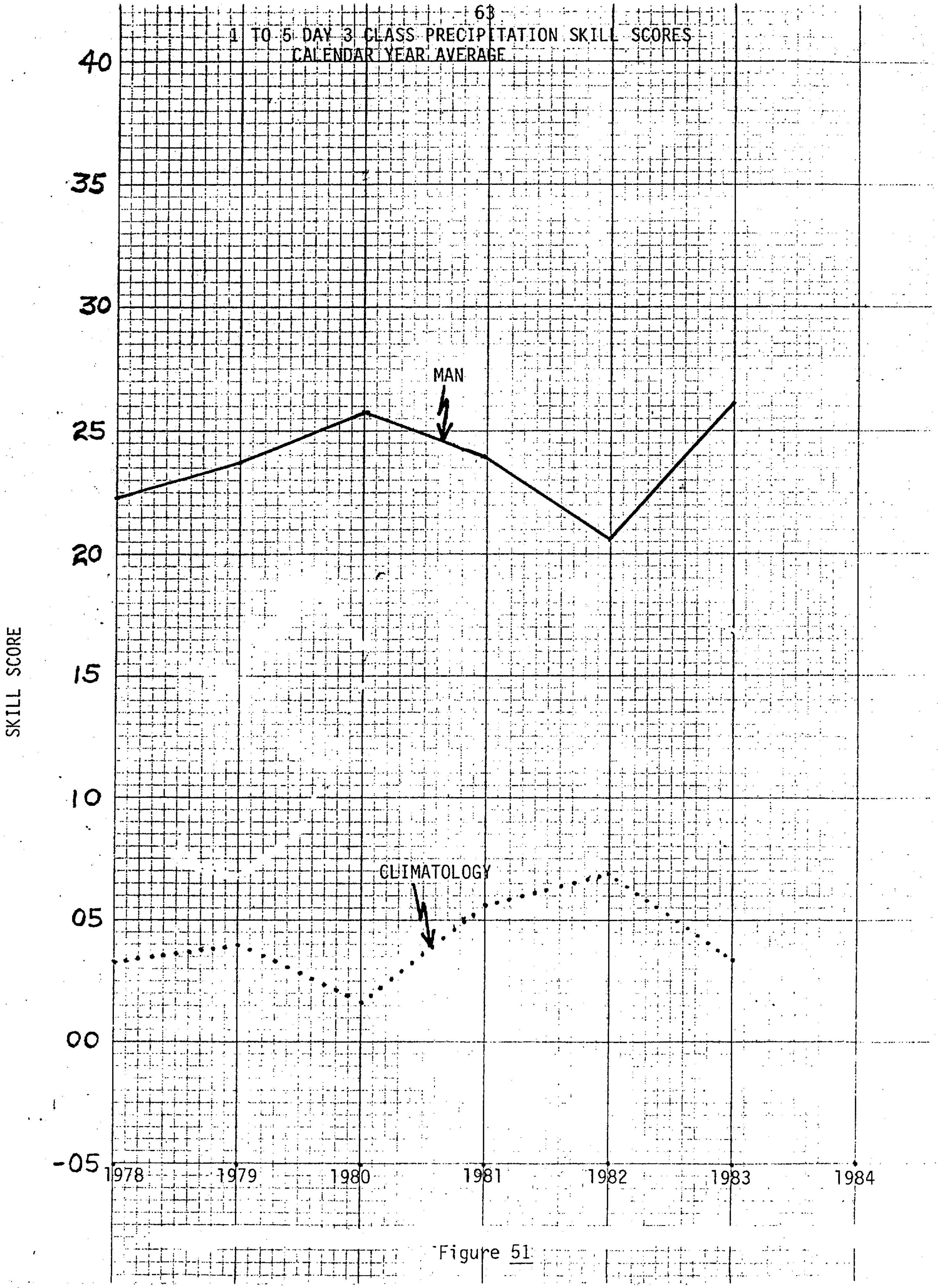

1 TO 5 DAY 3 CLASS PRECIPITATION SKILL SCORES
CALENDAR YEAR AVERAGE
SKILL SCORE
40
35
30
25
20
15
10
05
00
-05
MAN
CLIMATOLOGY
1978
1979
1980
1981
1982
1983
1984

Figure 51

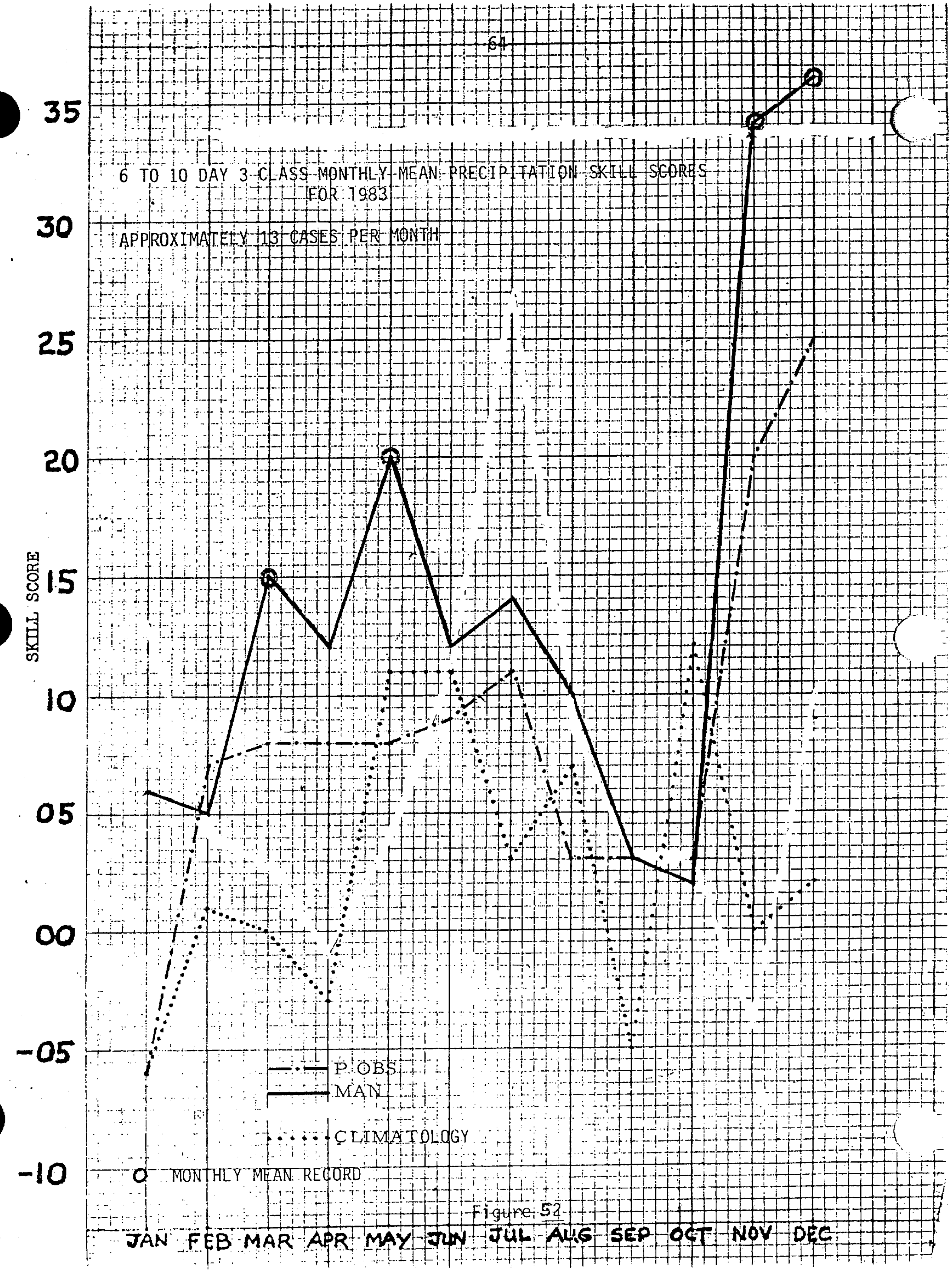

6 TO 10 DAY 3 CLASS MONTHLY MEAN PRECIPITATION SKILL SCORES FOR 1983
APPROXIMATELY 13 CASES PER MONTH
SKILL SCORE
35
30
25
20
15
10
05
00
-05
-10
P OBS
MAN
CLIMATOLOGY
O MONTHLY MEAN RECORD
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC

Figure 52

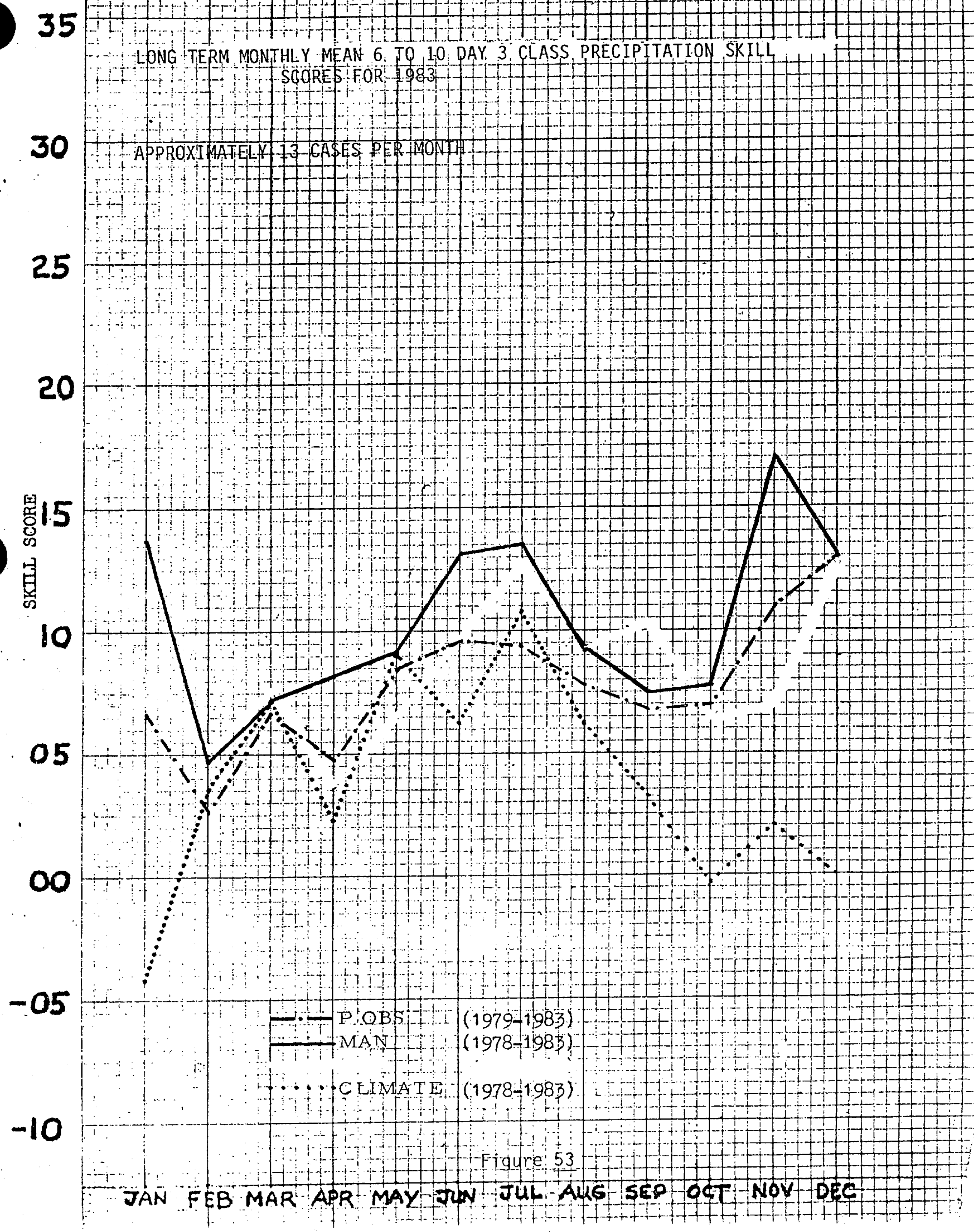

LONG TERM MONTHLY MEAN 6 TO 10 DAY 3 CLASS PRECIPITATION SKILL SCORES FOR 1983
APPROXIMATELY 13 CASES PER MONTH
SKILL SCORE
35
30
25
20
15
10
05
00
-05
-10
P. OBS (1979-1983)
MAN (1978-1983)
CLIMATE (1978-1983)
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC

Figure 53

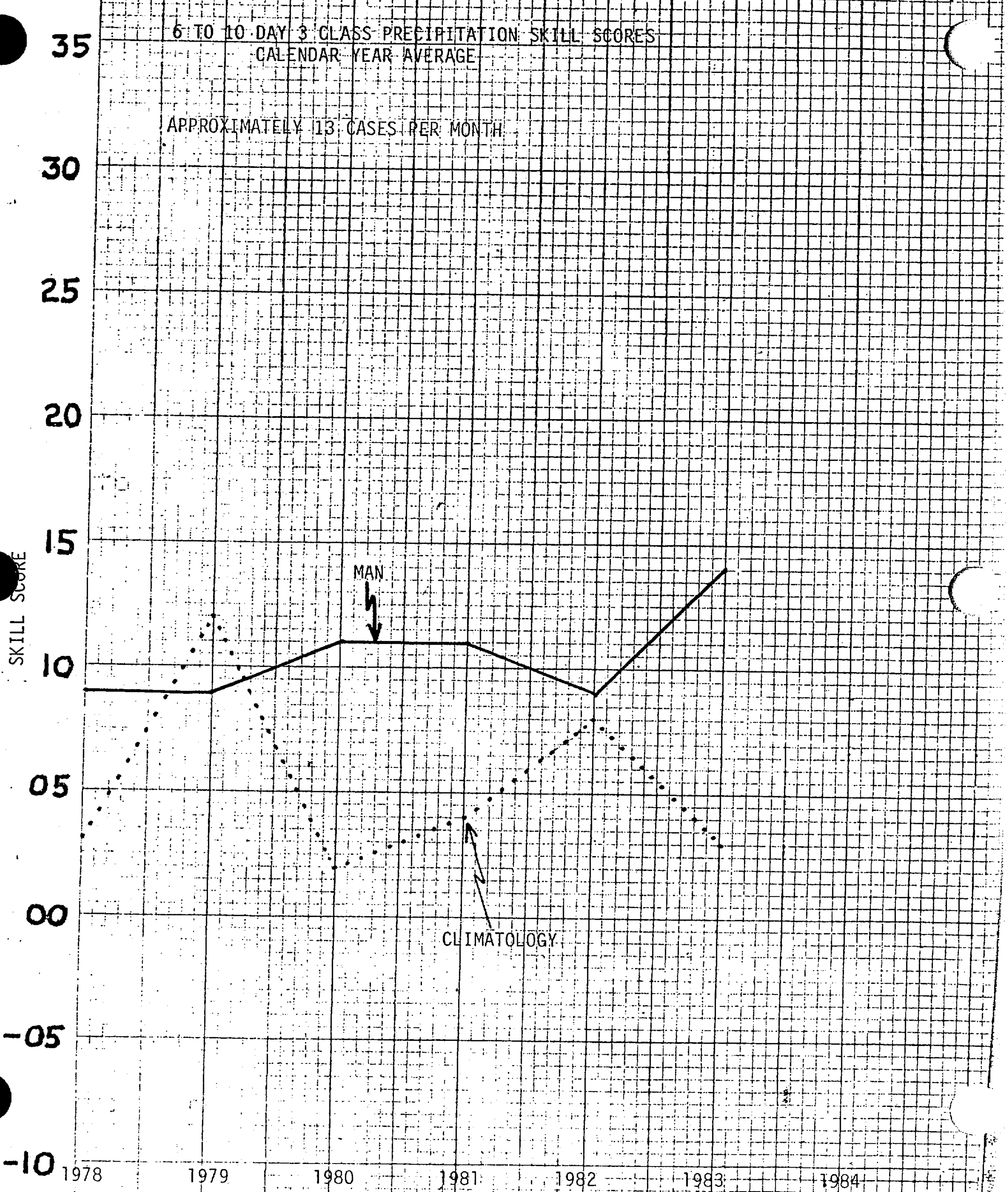

6 TO 10 DAY 3 CLASS PRECIPITATION SKILL SCORES
CALENDAR YEAR AVERAGE
APPROXIMATELY 13 CASES PER MONTH
SKILL SCORE
35
30
25
20
15
10
05
00
-05
-10
MAN
CLIMATOLOGY
1978
1979
1980
1981
1982
1983
1984

Figure 54

SECTION 4

Man & Machine (NMC/NWP Guidance)

Days 1 through 7 Monthly Mean Sea Level Pressure, 500 MB and

Absolute Error-Temperature Scores

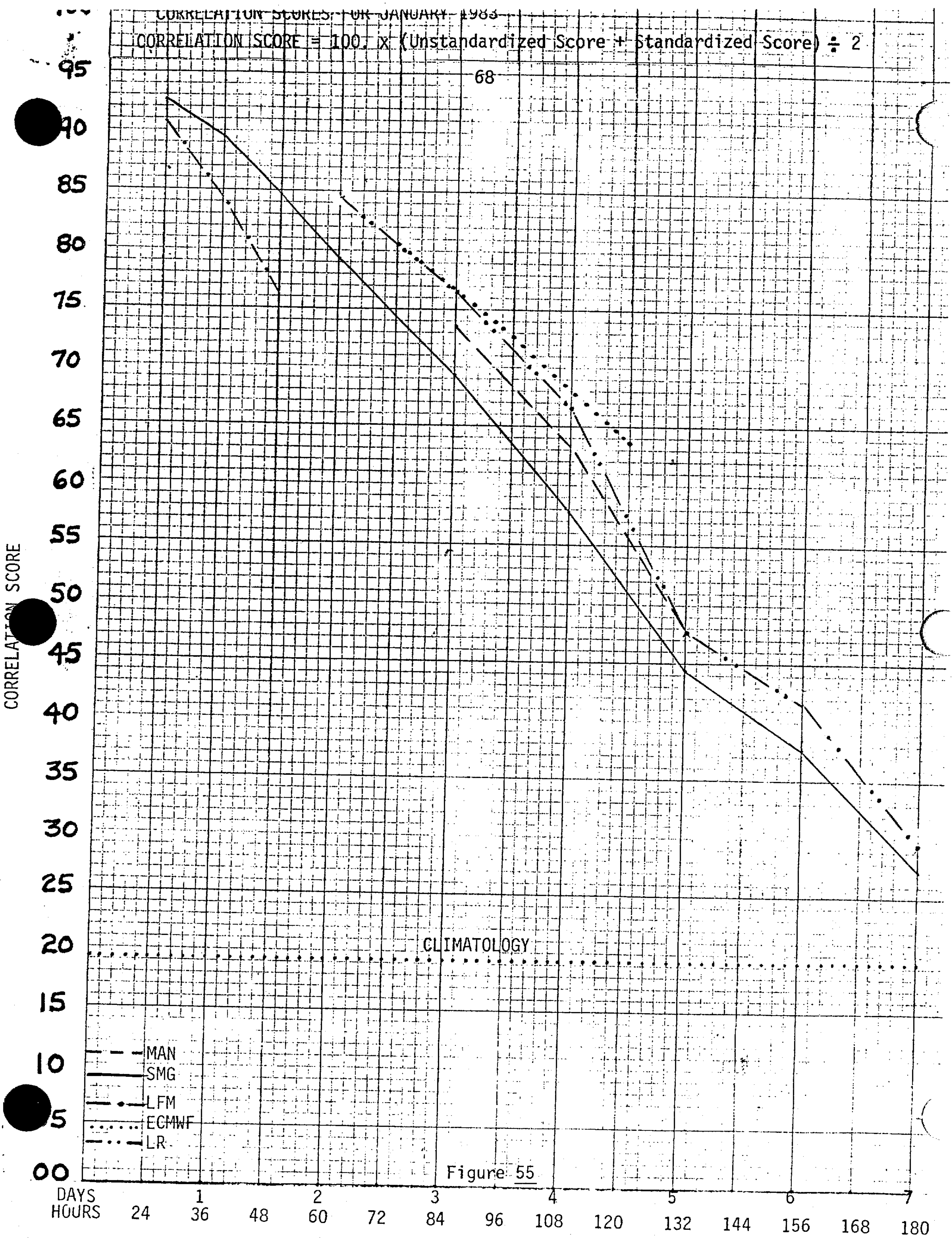

CORRELATION SCORES FOR JANUARY 1983
CORRELATION SCORE = 100. X (Unstandardized Score + Standardized Score) ÷ 2
CORRELATION SCORE
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
00
CLIMATOLOGY
MAN
SMG
LFM
ECMWF
LR
DAYS
HOURS
1
2
3
4
5
6
7
24
36
48
60
72
84
96
108
120
132
144
156
168
180

Figure 55

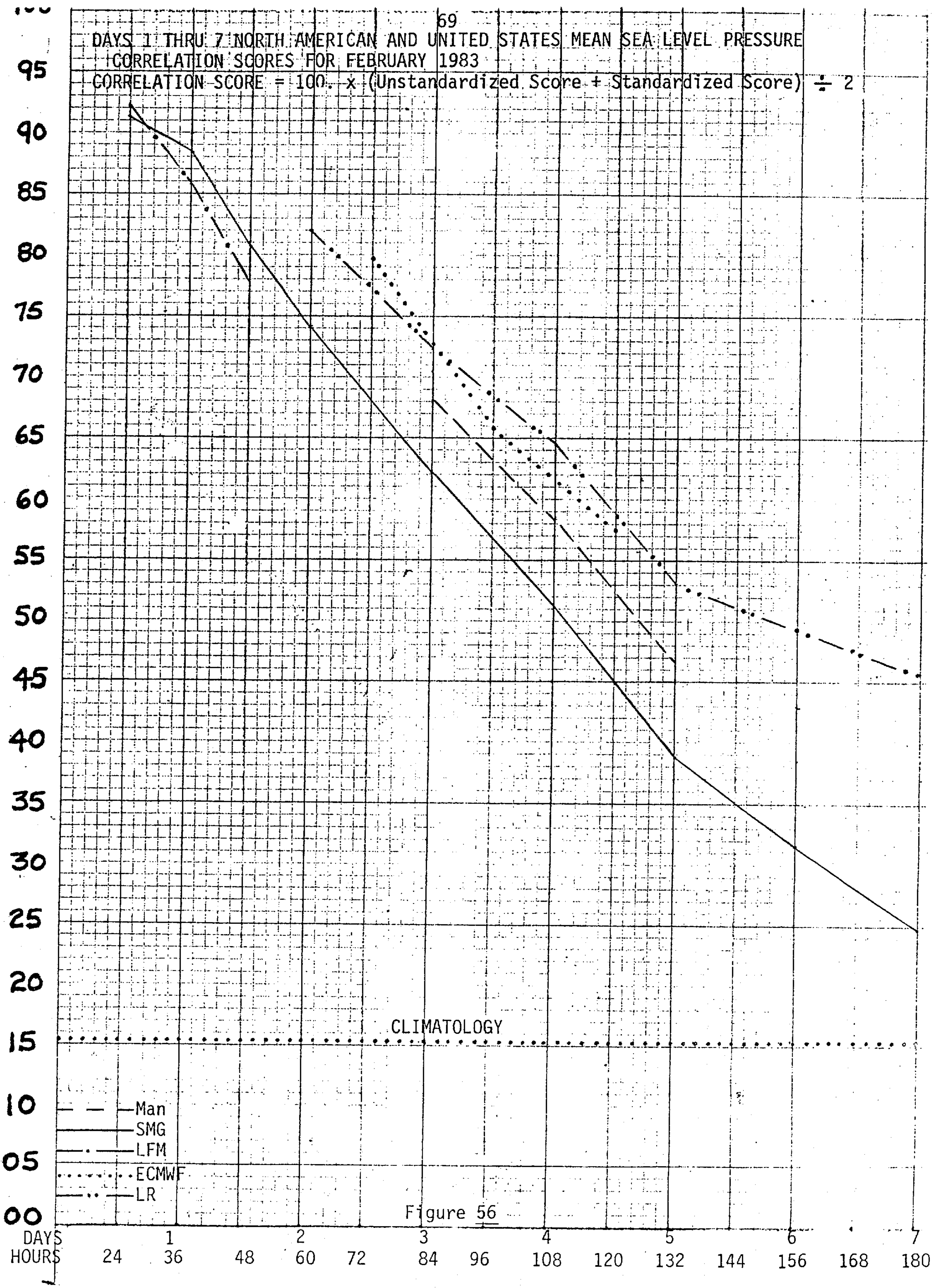

DAYS 1 THRU 7 NORTH AMERICAN AND UNITED STATES MEAN SEA LEVEL PRESSURE
CORRELATION SCORES FOR FEBRUARY 1983
CORRELATION SCORE = 100. x (Unstandardized Score + Standardized Score) ÷ 2
CORRELAT ORE
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
05
00
CLIMATOLOGY
Man
SMG
LFM
ECMWF
LR
DAYS
1
2
3
4
5
6
7
HOURS
24
36
48
60
72
84
96
108
120
132
144
156
168
180

Figure 56

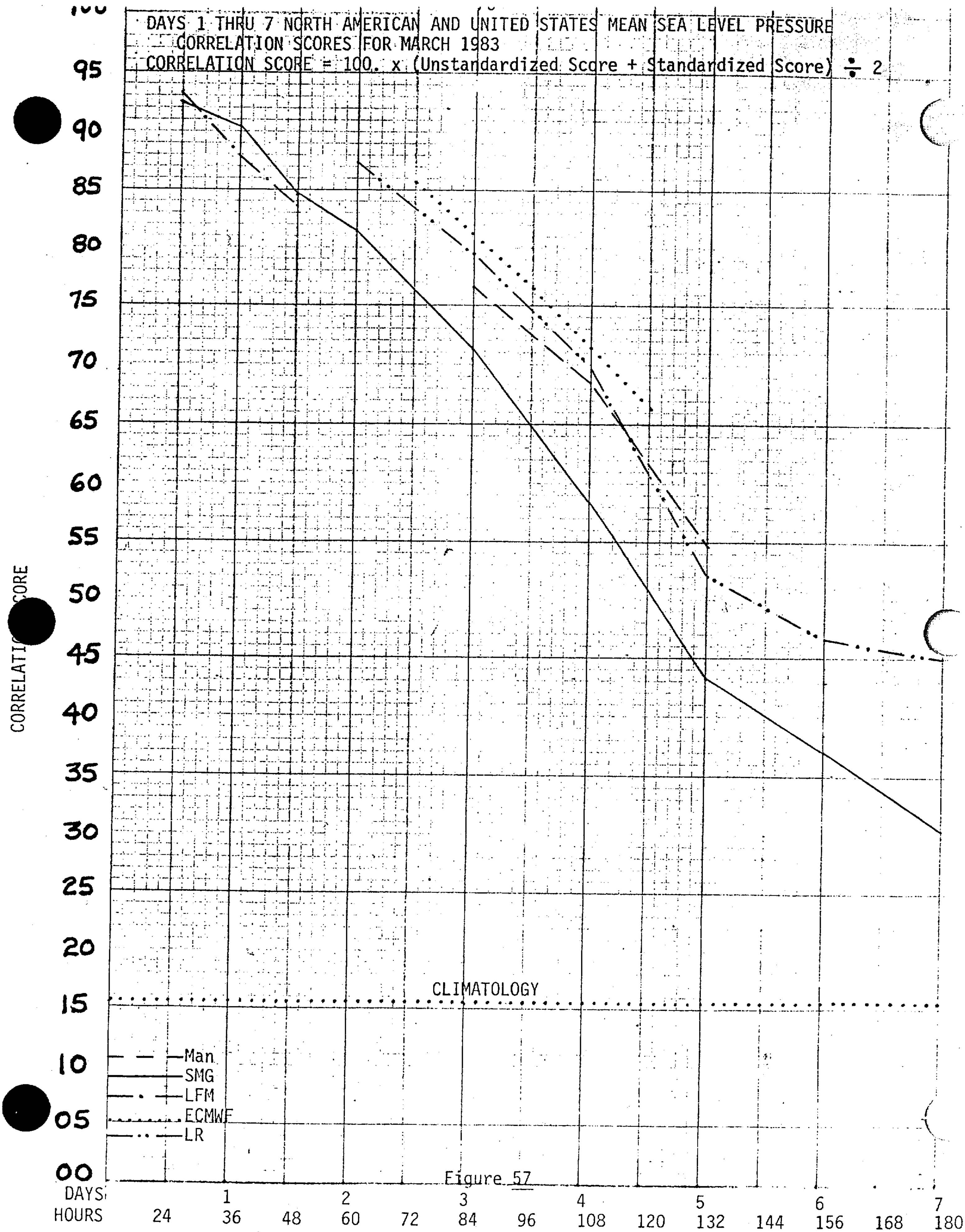

DAYS 1 THRU 7 NORTH AMERICAN AND UNITED STATES MEAN SEA LEVEL PRESSURE
CORRELATION SCORES FOR MARCH 1983
CORRELATION SCORE = 100. x (Unstandardized Score + Standardized Score) ÷ 2
CORRELATION SCORE
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
05
00
CLIMATOLOGY
Man
SMG
LFM
ECMWF
LR
DAYS
1
2
3
4
5
6
7
HOURS
24
36
48
60
72
84
96
108
120
132
144
156
168
180

Figure 57

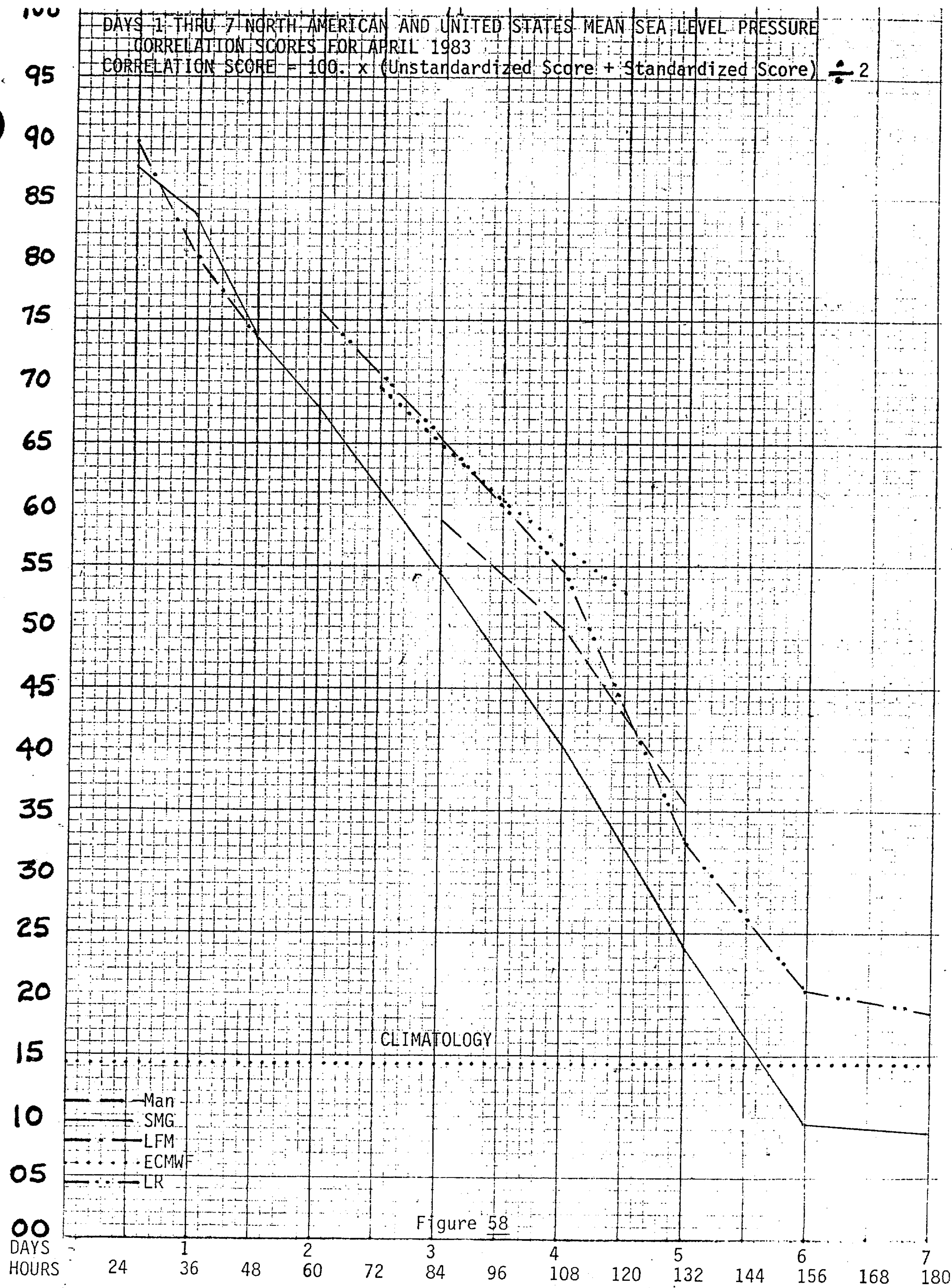

DAYS 1 THRU 7 NORTH AMERICAN AND UNITED STATES MEAN SEA LEVEL PRESSURE
CORRELATION SCORES FOR APRIL 1983
CORRELATION SCORE = 100. x (Unstandardized Score + Standardized Score) ÷ 2
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
05
00
CORRELAT CORE
CLIMATOLOGY
Man
SMG
LFM
ECMWF
LR
DAYS
HOURS
24
1
36
48
2
60
72
3
84
96
4
108
120
5
132
144
6
156
168
7
180

Figure 58

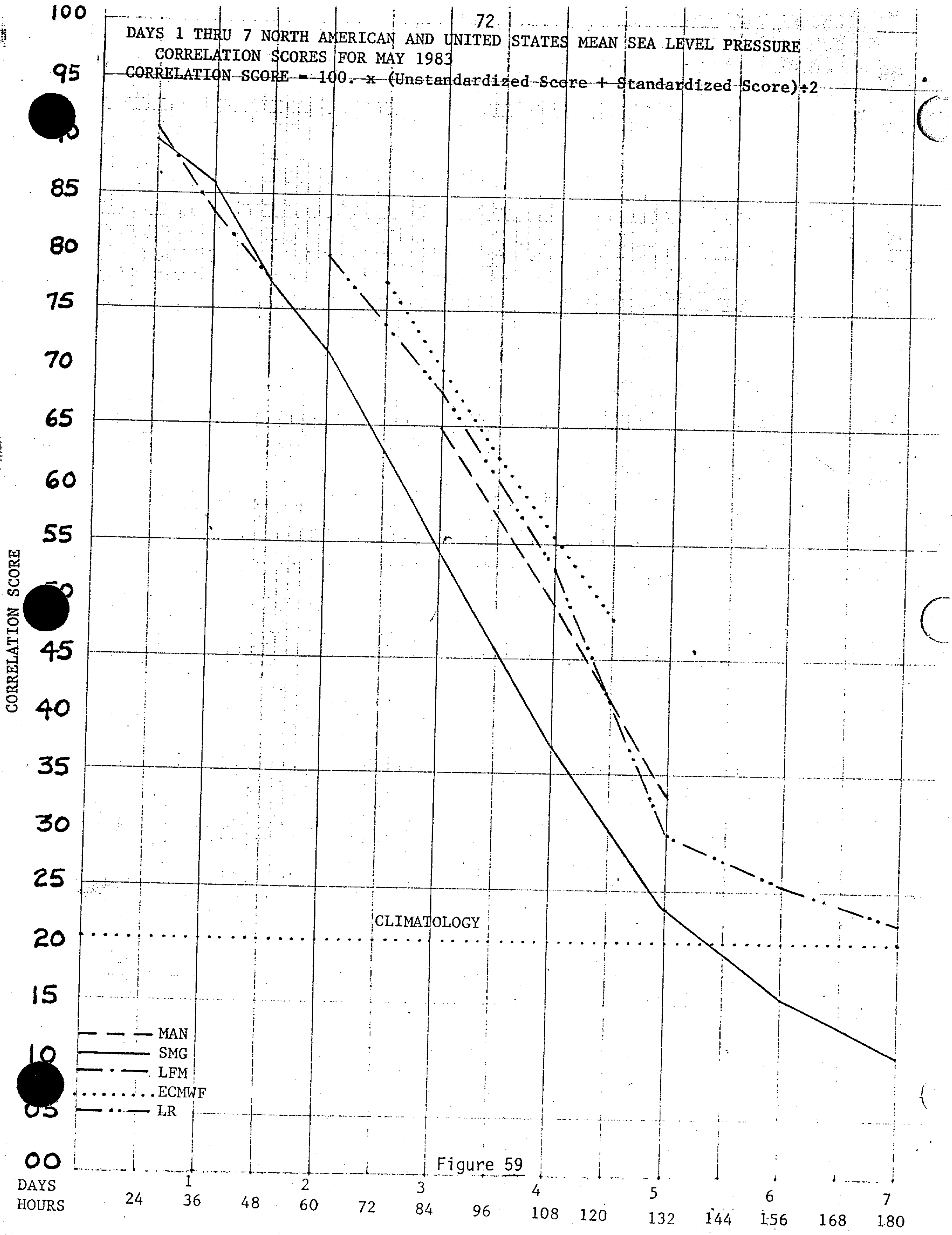

DAYS 1 THRU 7 NORTH AMERICAN AND UNITED STATES MEAN SEA LEVEL PRESSURE
CORRELATION SCORES FOR MAY 1983
CORRELATION SCORE = 100. x (Unstandardized Score + Standardized Score)÷2
CORRELATION SCORE
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
05
00
CLIMATOLOGY
MAN
SMG
LFM
ECMWF
LR
DAYS
HOURS
24
1
36
48
2
60
72
3
84
96
4
108
120
5
132
144
6
156
168
7
180

Figure 59

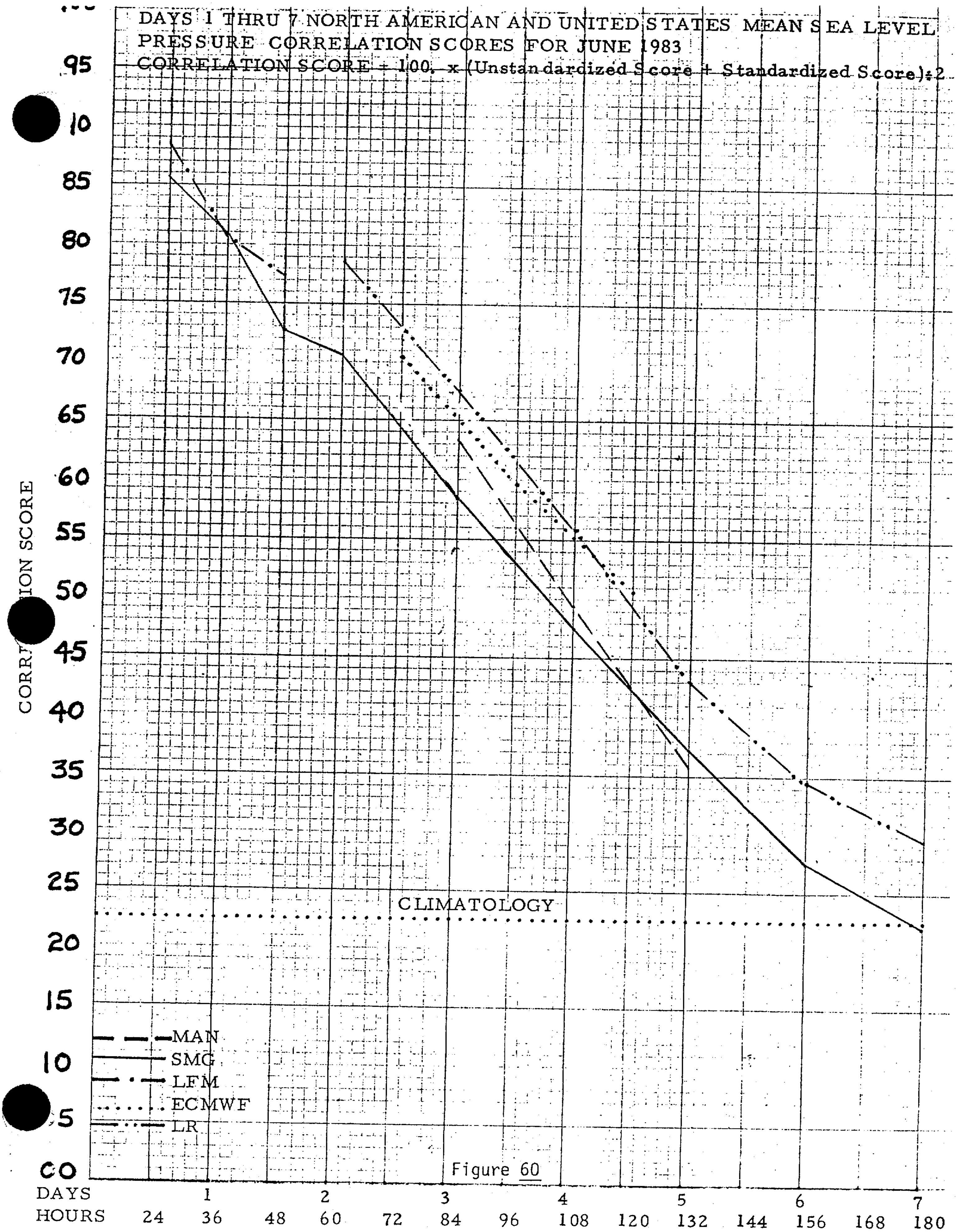
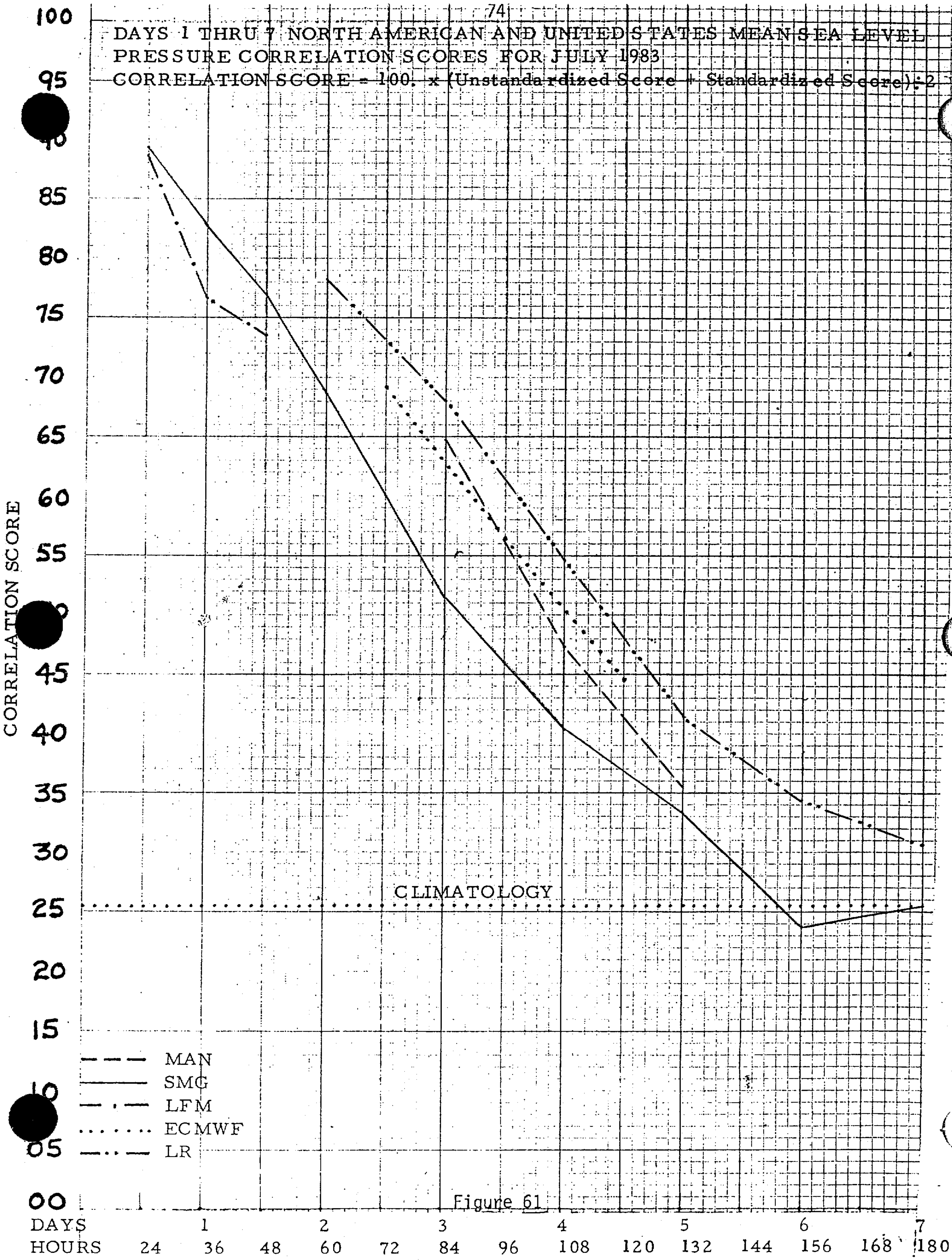

DAYS 1 THRU 7 NORTH AMERICAN AND UNITED STATES MEAN SEA LEVEL PRESSURE CORRELATION SCORES FOR JUNE 1983
CORRELATION SCORE = 100. x (Unstandardized Score + Standardized Score)÷2
CORRELATION SCORE
CLIMATOLOGY
MAN
SMG
LFM
ECMWF
LR
DAYS
HOURS
24 36 48 60 72 84 96 108 120 132 144 156 168 180
1 2 3 4 5 6 7
00 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95

Figure 60



DAYS 1 THRU 7 NORTH AMERICAN AND UNITED STATES MEAN SEA LEVEL PRESSURE CORRELATION SCORES FOR JULY 1983
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
ECMWF
LR
DAYS 1 2 3 4 5 6 7
HOURS 24 36 48 60 72 84 96 108 120 132 144 156 168 180

Figure 61

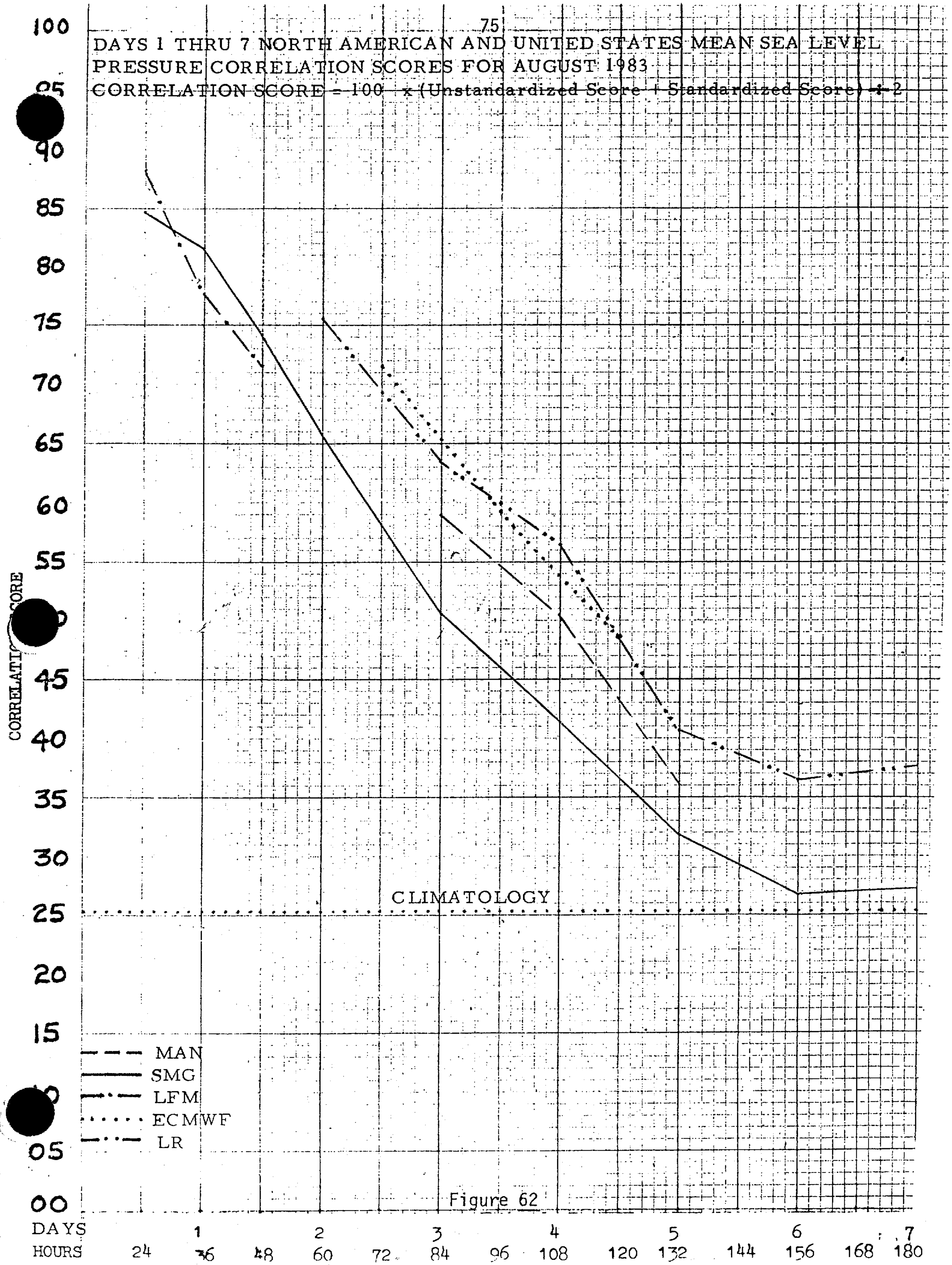

DAYS 1 THRU 7 NORTH AMERICAN AND UNITED STATES MEAN SEA LEVEL
PRESSURE CORRELATION SCORES FOR AUGUST 1983
CORRELATION SCORE = 100 x (Unstandardized Score + Standardized Score) ÷ 2
CORRELATION SCORE
100
95
90
85
80
75
70
65
60
55
45
40
35
30
25
20
15
05
00
CLIMATOLOGY
MAN
SMG
LFM
ECMWF
LR
DAYS 1 2 3 4 5 6 7
HOURS 24 36 48 60 72 84 96 108 120 132 144 156 168 180

Figure 62

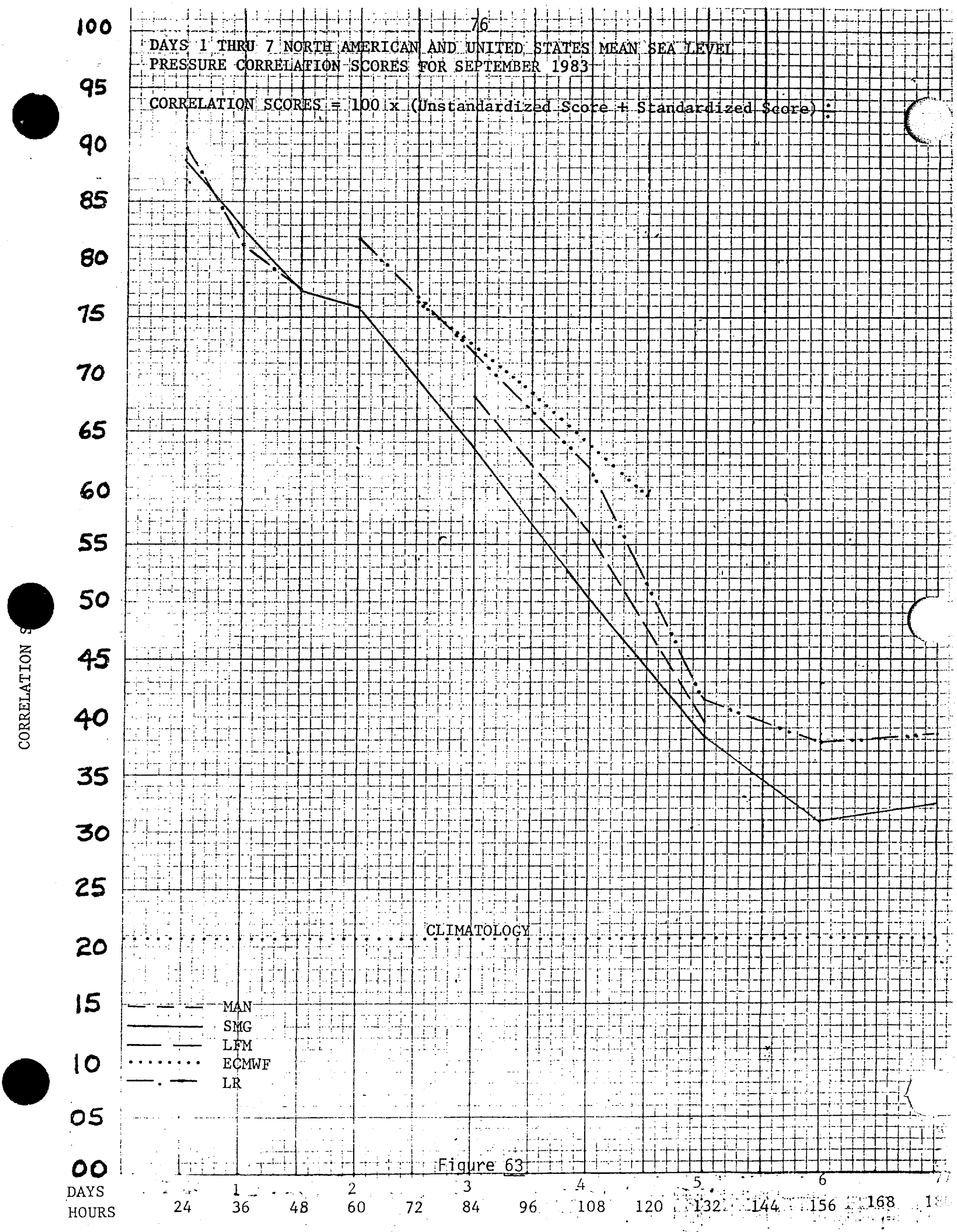

DAYS 1 THRU 7 NORTH AMERICAN AND UNITED STATES MEAN SEA LEVEL
PRESSURE CORRELATION SCORES FOR SEPTEMBER 1983
CORRELATION SCORES = 100 x (Unstandardized Score + Standardized Score) :
CORRELATION S
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
05
00
CLIMATOLOGY
MAN
SMG
LFM
ECMWF
LR
DAYS
1
2
3
4
5
6
HOURS
24
36
48
60
72
84
96
108
120
132
144
156
168

Figure 63

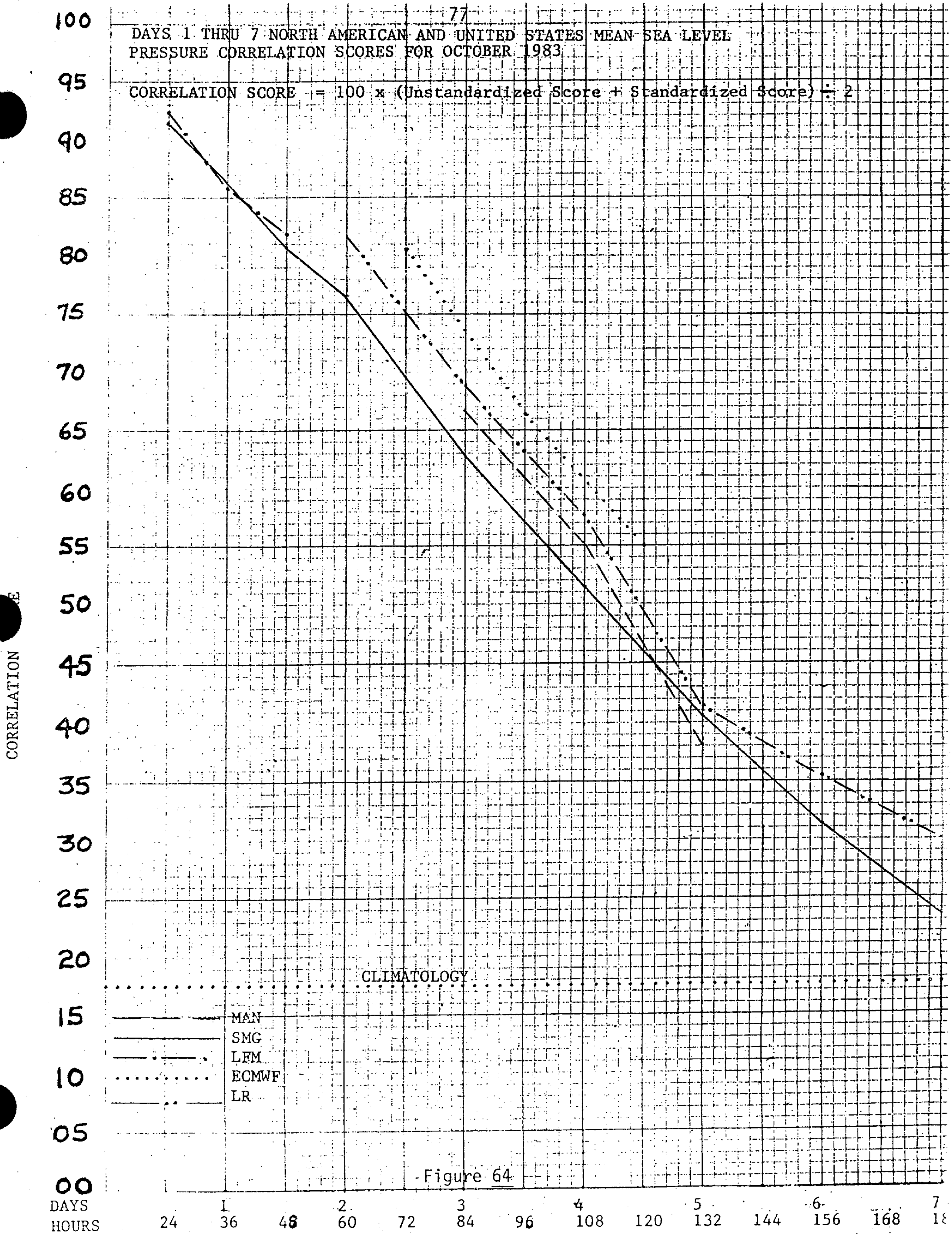

DAYS 1 THRU 7 NORTH AMERICAN AND UNITED STATES MEAN SEA LEVEL PRESSURE CORRELATION SCORES FOR OCTOBER 1983
CORRELATION SCORE = 100 x (Unstandardized Score + Standardized Score) ÷ 2
CORRELATION
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
05
00
CLIMATOLOGY
MAN
SMG
LFM
ECMWF
LR
DAYS
1
2
3
4
5
6
7
HOURS
24
36
48
60
72
84
96
108
120
132
144
156
168

Figure 64

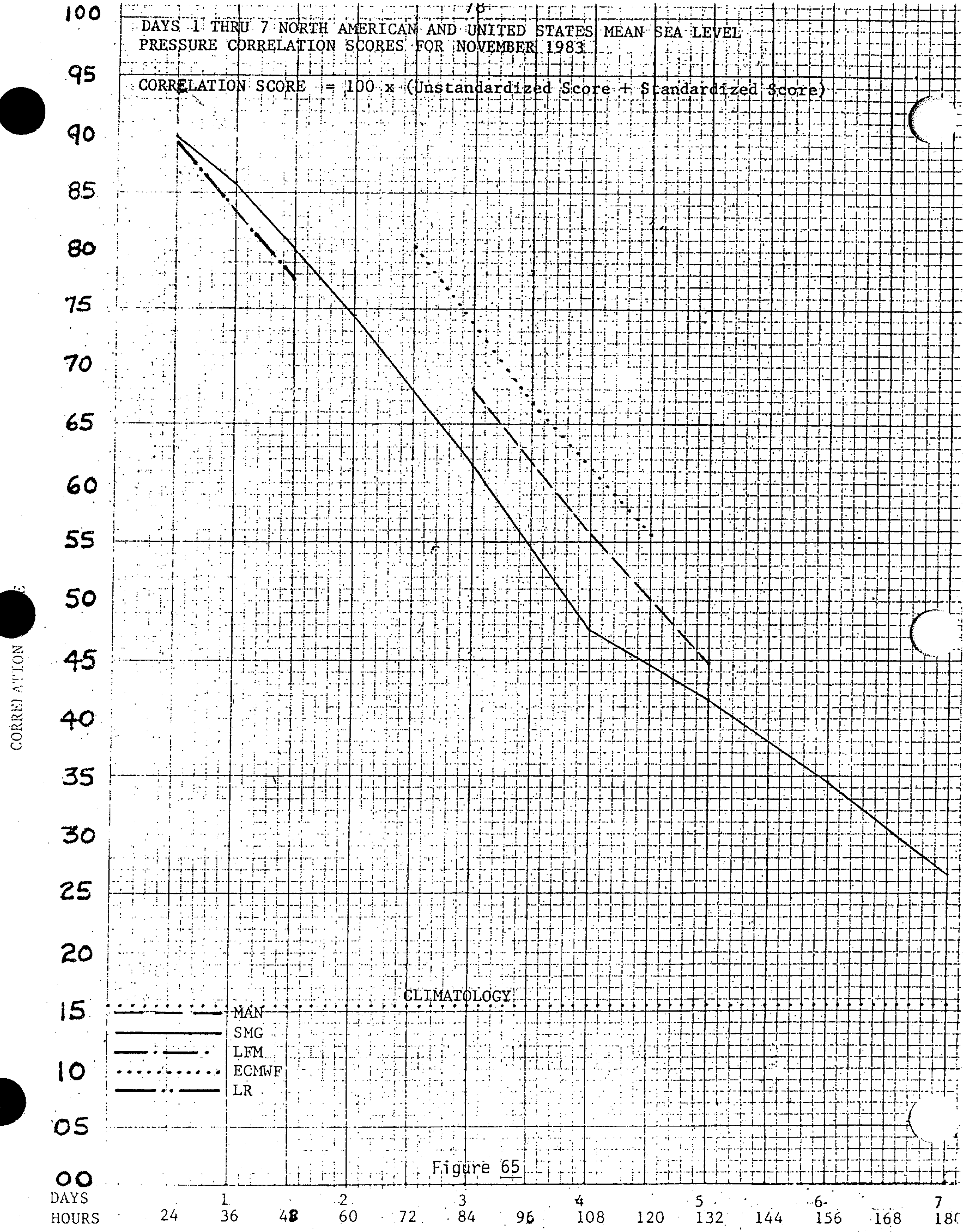

DAYS 1 THRU 7 NORTH AMERICAN AND UNITED STATES MEAN SEA LEVEL
PRESSURE CORRELATION SCORES FOR NOVEMBER 1983
CORRELATION SCORE = 100 x (Unstandardized Score + Standardized Score)
CORRELATION SCORE
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
05
00
CLIMATOLOGY
MAN
SMG
LFM
ECMWF
LR
DAYS
HOURS
1
2
3
4
5
6
7
24
36
48
60
72
84
96
108
120
132
144
156
168
180

Figure 65

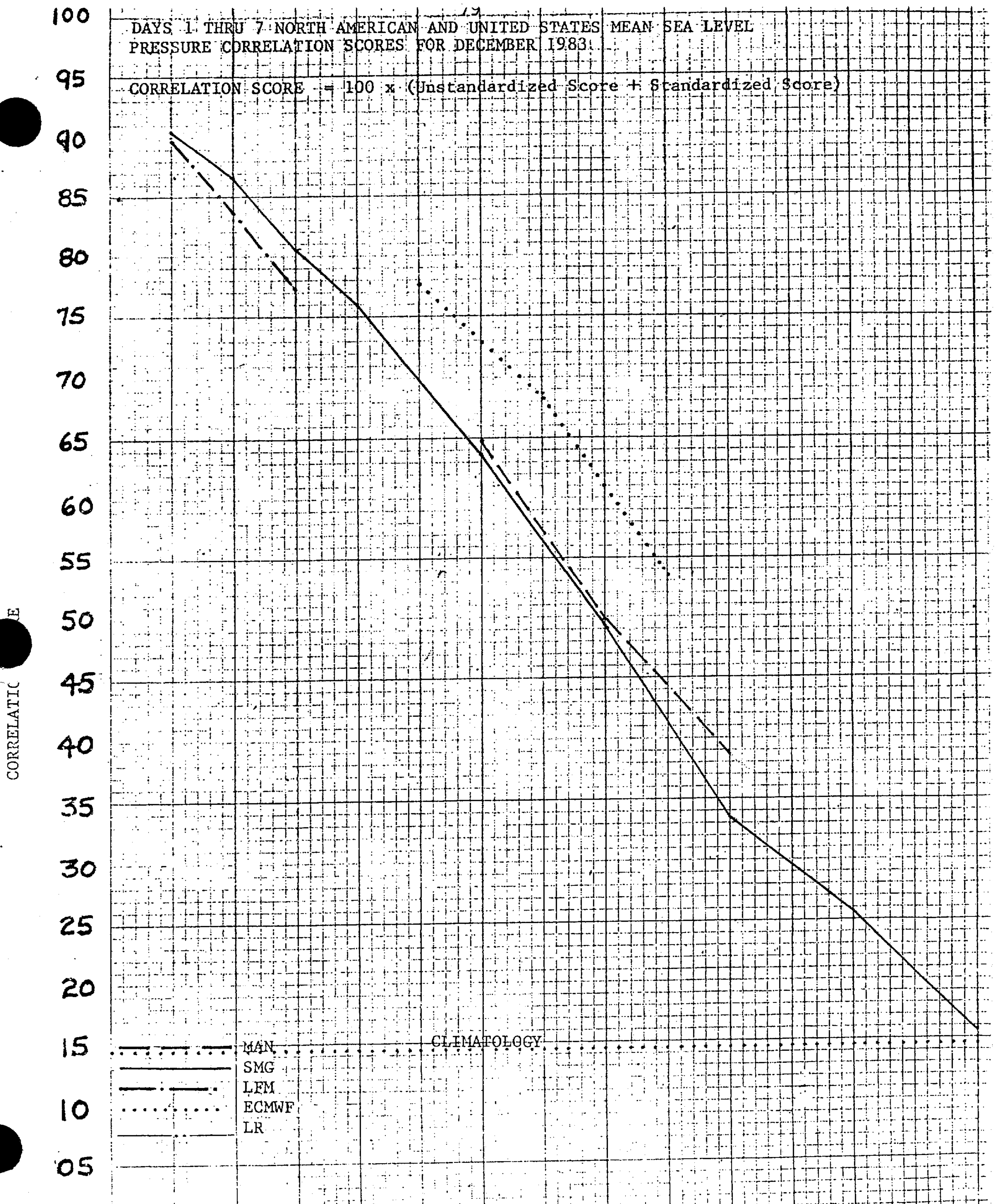

DAYS 1 THRU 7 NORTH AMERICAN AND UNITED STATES MEAN SEA LEVEL PRESSURE CORRELATION SCORES FOR DECEMBER 1983
CORRELATION SCORE = 100 x (Unstandardized Score + Standardized Score)
CORRELATIC E
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
05
00
CLIMATOLOGY
MAN
SMG
LFM
ECMWF
LR
DAYS
1
2
3
4
5
6
7
HOURS
24
36
48
60
72
84
96
108
120
132
144
156
168
18

Figure 66

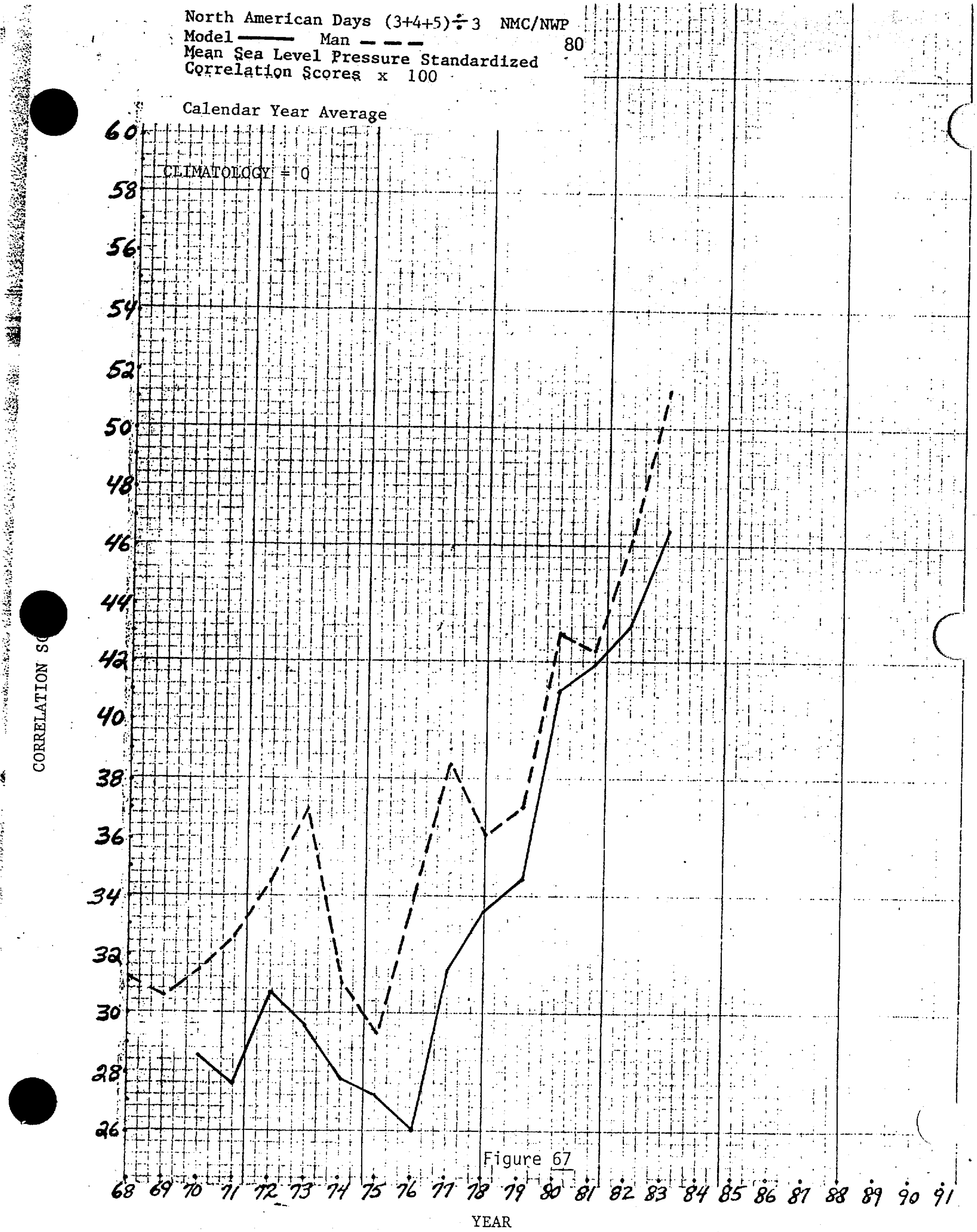

North American Days (3+4+5)÷3 NMC/NWP
Model ——— Man — — —
Mean Sea Level Pressure Standardized
Correlation Scores x 100
Calendar Year Average
CLIMATOLOGY = 0
60
58
56
54
52
50
48
46
44
42
40
38
36
34
32
30
28
26
68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91
YEAR
CORRELATION SC

Figure 67

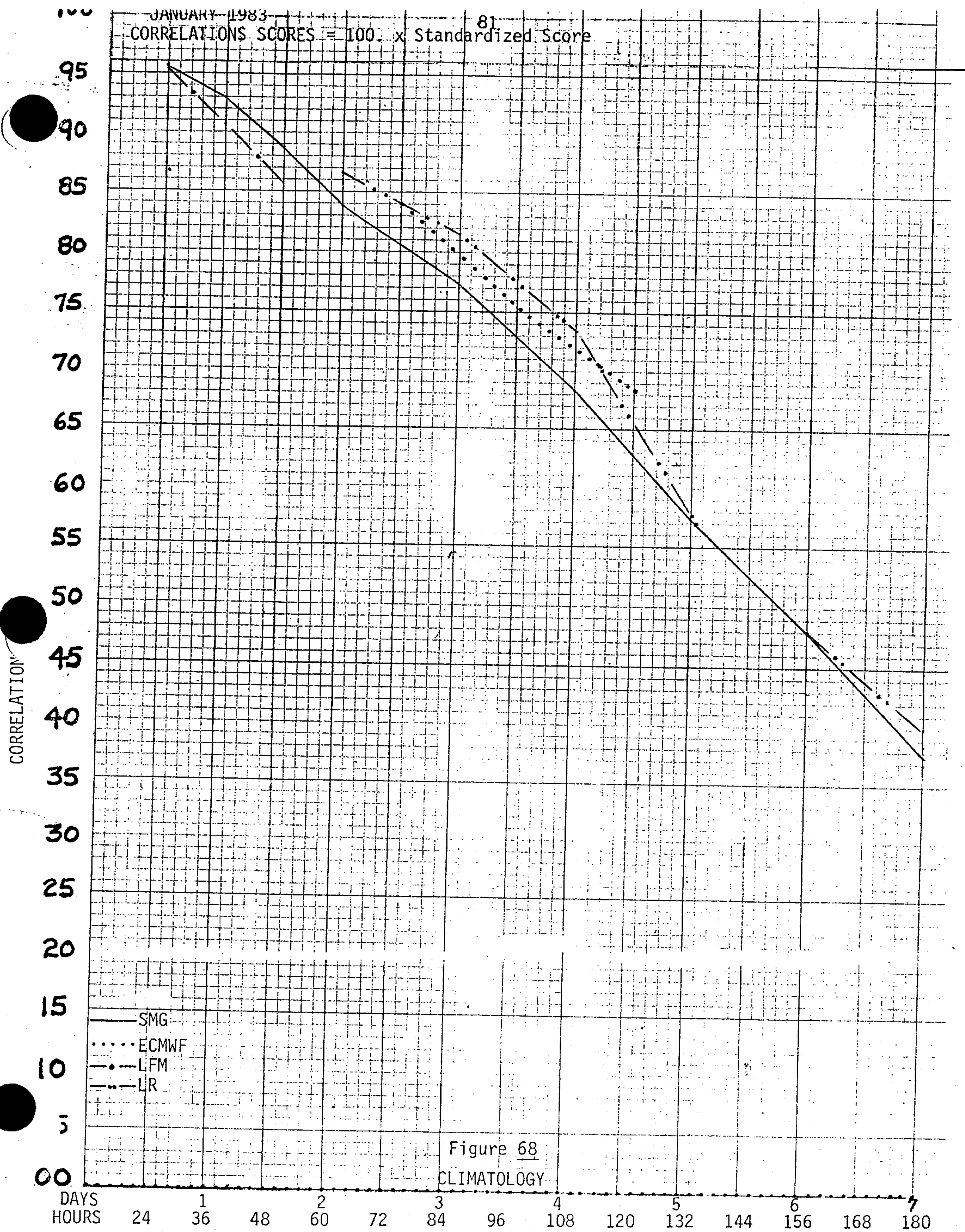
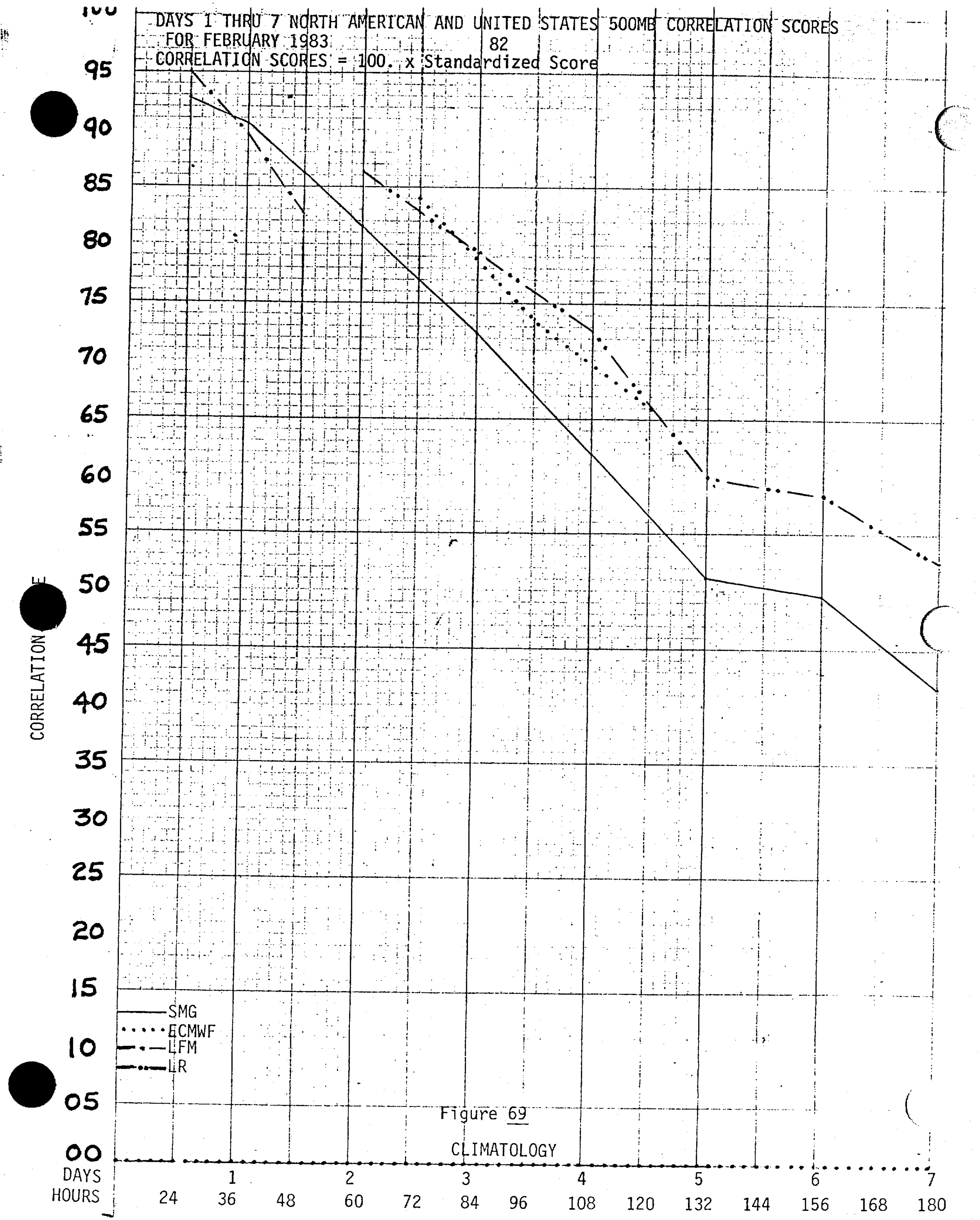

JANUARY 1983
CORRELATIONS SCORES = 100. x Standardized Score
CORRELATION
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
00
SMG
ECMWF
LFM
LR
CLIMATOLOGY
DAYS
HOURS
1
2
3
4
5
6
7
24
36
48
60
72
84
96
108
120
132
144
156
168
180

Figure 68



DAYS 1 THRU 7 NORTH AMERICAN AND UNITED STATES 500MB CORRELATION SCORES
FOR FEBRUARY 1983
CORRELATION 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
ECMWF
LFM
LR
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 69

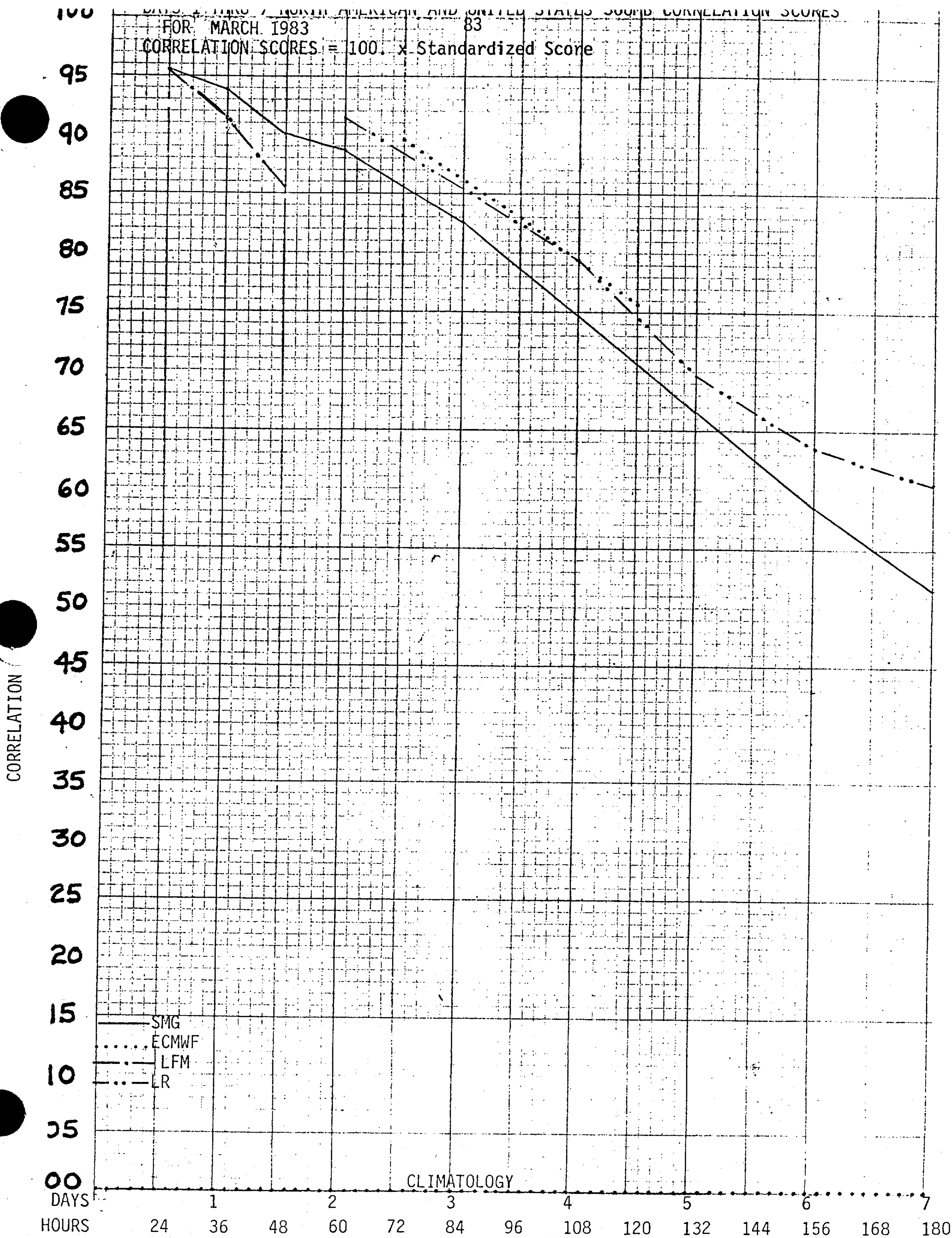

DAYS 1 THRU 7 NORTH AMERICAN AND UNITED STATES 500MB CORRELATION SCORES
FOR MARCH 1983
CORRELATION SCORES = 100. x Standardized Score
CORRELATION
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
05
00
SMG
ECMWF
LFM
LR
CLIMATOLOGY
DAYS
1
2
3
4
5
6
7
HOURS
24
36
48
60
72
84
96
108
120
132
144
156
168
180

Figure 70

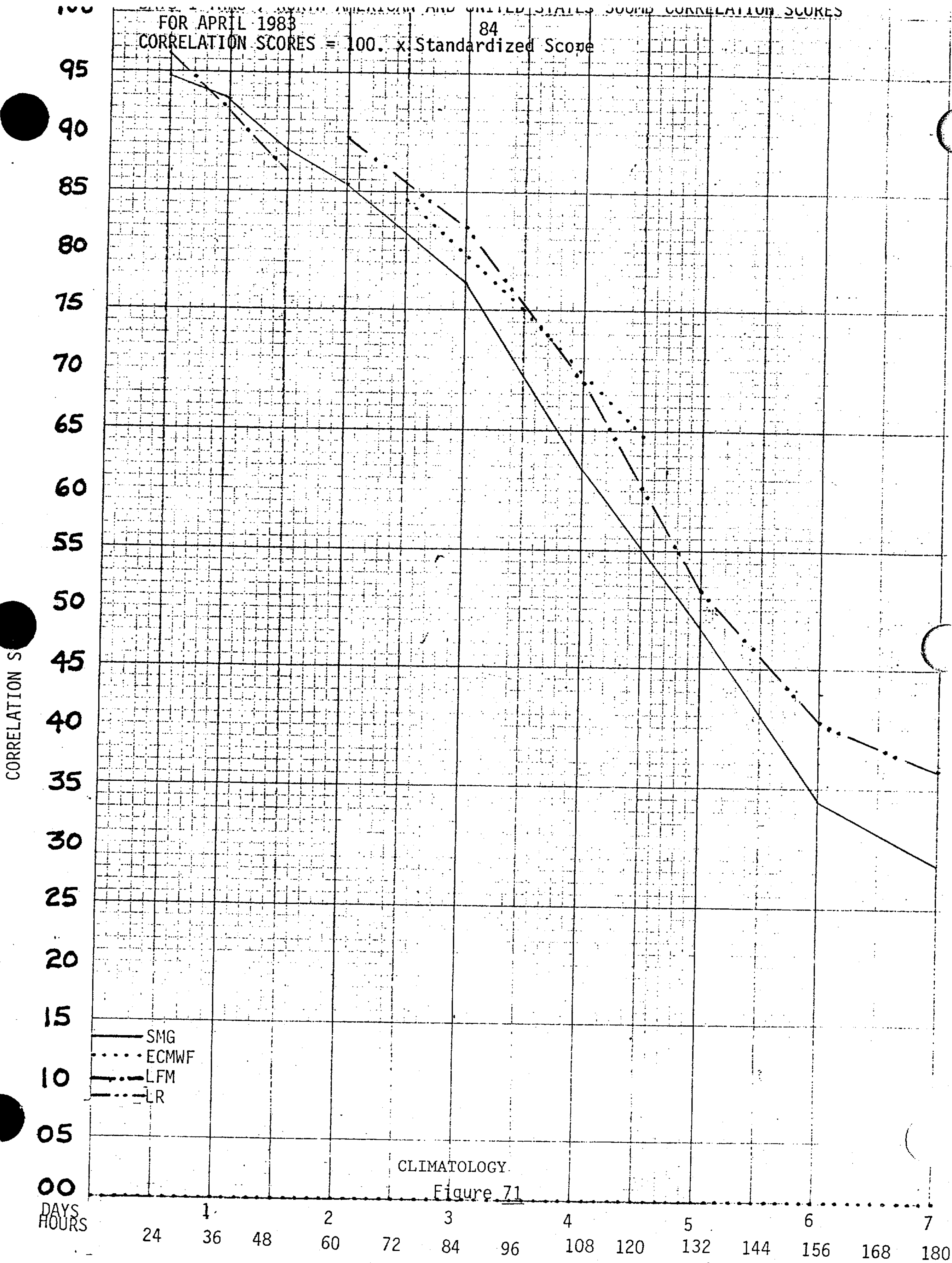
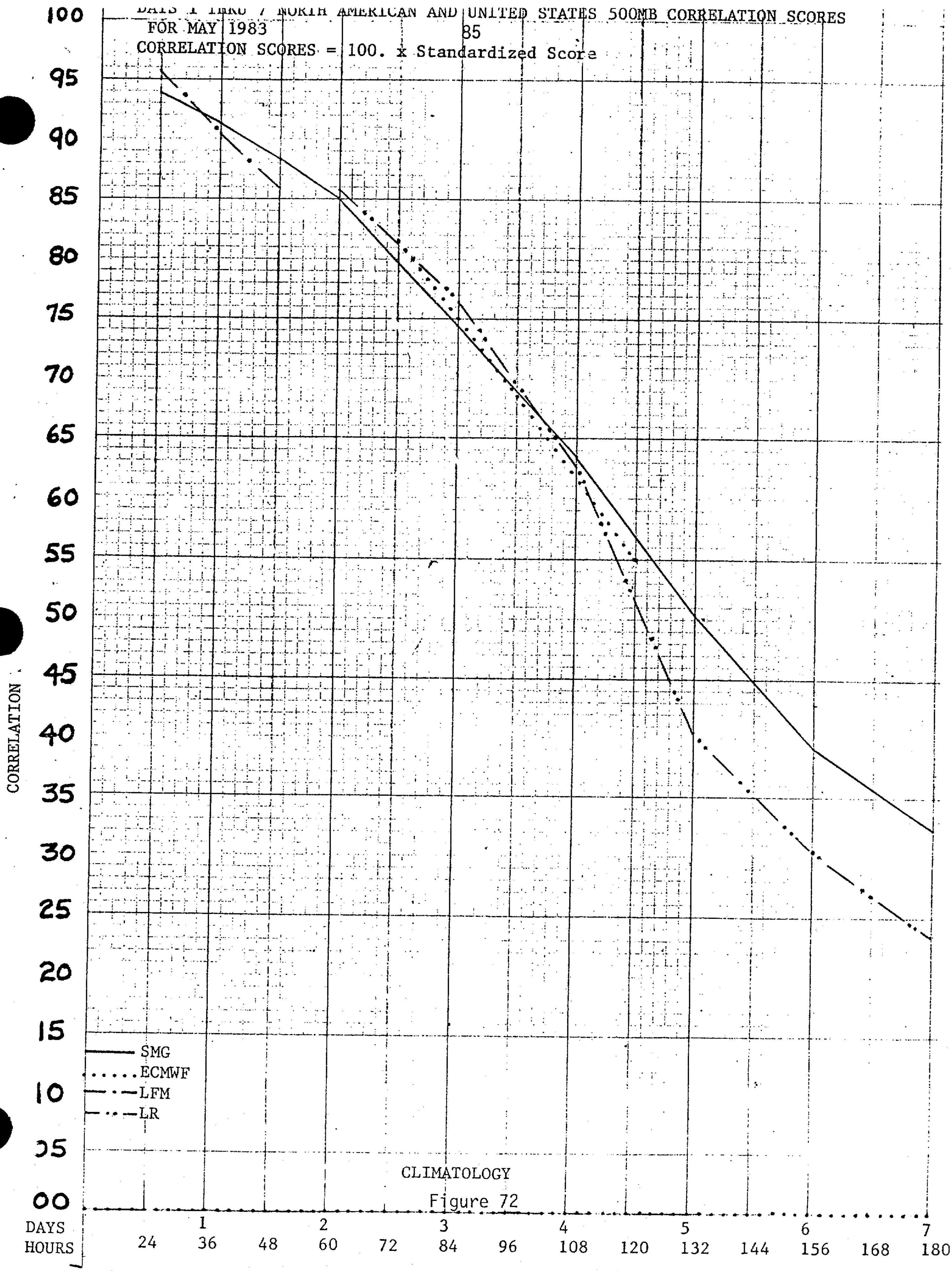

FOR APRIL 1983
84
CORRELATION SCORES = 100. x Standardized Score
CORRELATION S
SMG
ECMWF
LFM
LR
CLIMATOLOGY
DAYS
HOURS
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
05
00
1
2
3
4
5
6
7
24
36
48
60
72
84
96
108
120
132
144
156
168
180

Figure 71



DAYS 1 THRU 7 NORTH AMERICAN AND UNITED STATES 500MB CORRELATION SCORES
FOR MAY 1983
CORRELATION SCORES = 100. x Standardized Score
85
CORRELATION
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
05
00
SMG
ECMWF
LFM
LR
CLIMATOLOGY
DAYS
HOURS
1
2
3
4
5
6
7
24
36
48
60
72
84
96
108
120
132
144
156
168
180

Figure 72

DAYS 1 THRU 7 NORTH AMERICAN AND UNITED STATES 500MB CORRELATION SCORES FOR JUNE 1983

CORRELATION SCORES = 100. x Standardized Score

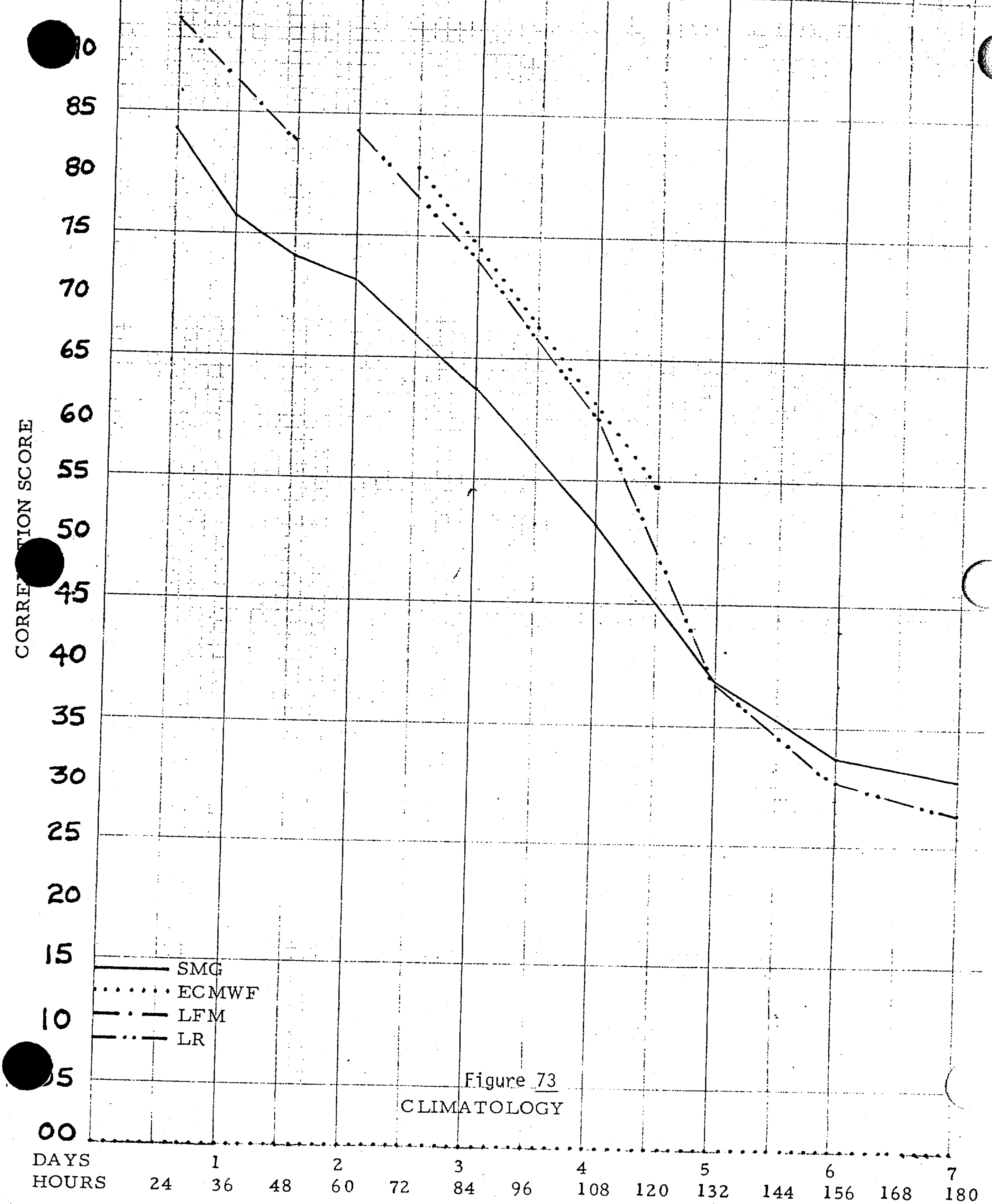


Figure 73
CLIMATOLOGY

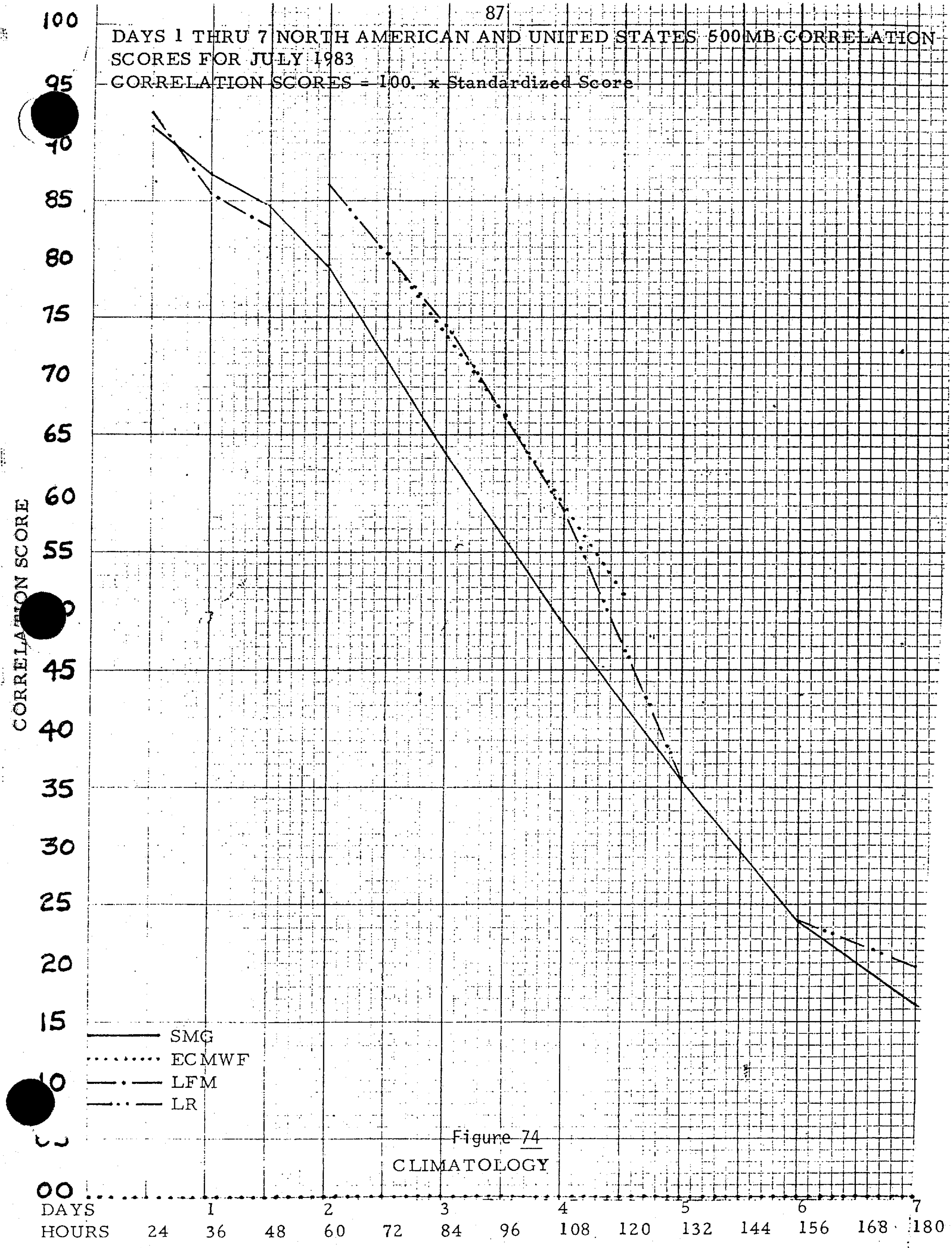


Figure 74

CLIMATOLOGY

DAYS 1 THRU 7 NORTH AMERICAN AND UNITED STATES 500MB CORRELATION SCORES FOR AUGUST 1983
CORRELATION SCORES = 100. x Standardized Score

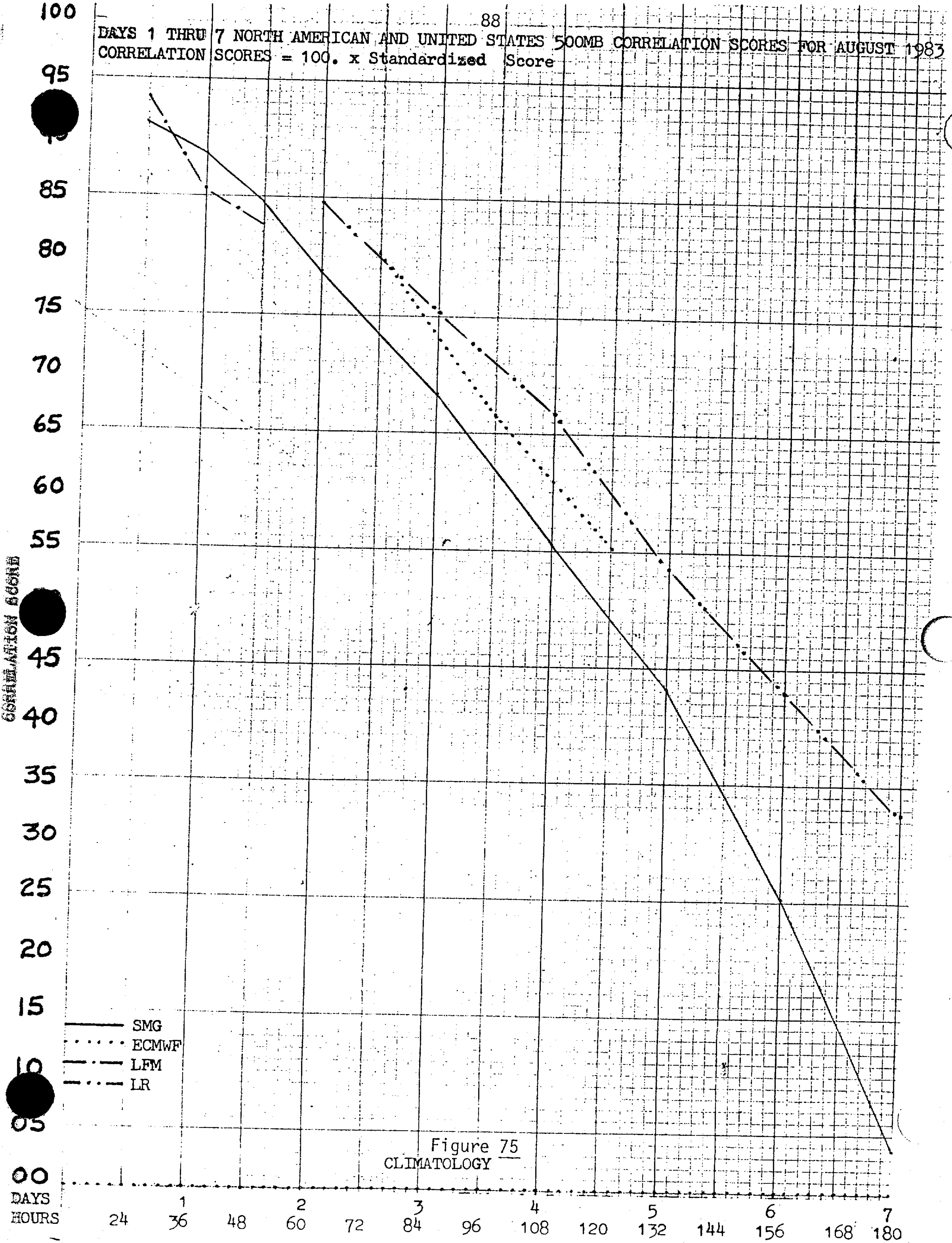


Figure 75
CLIMATOLOGY

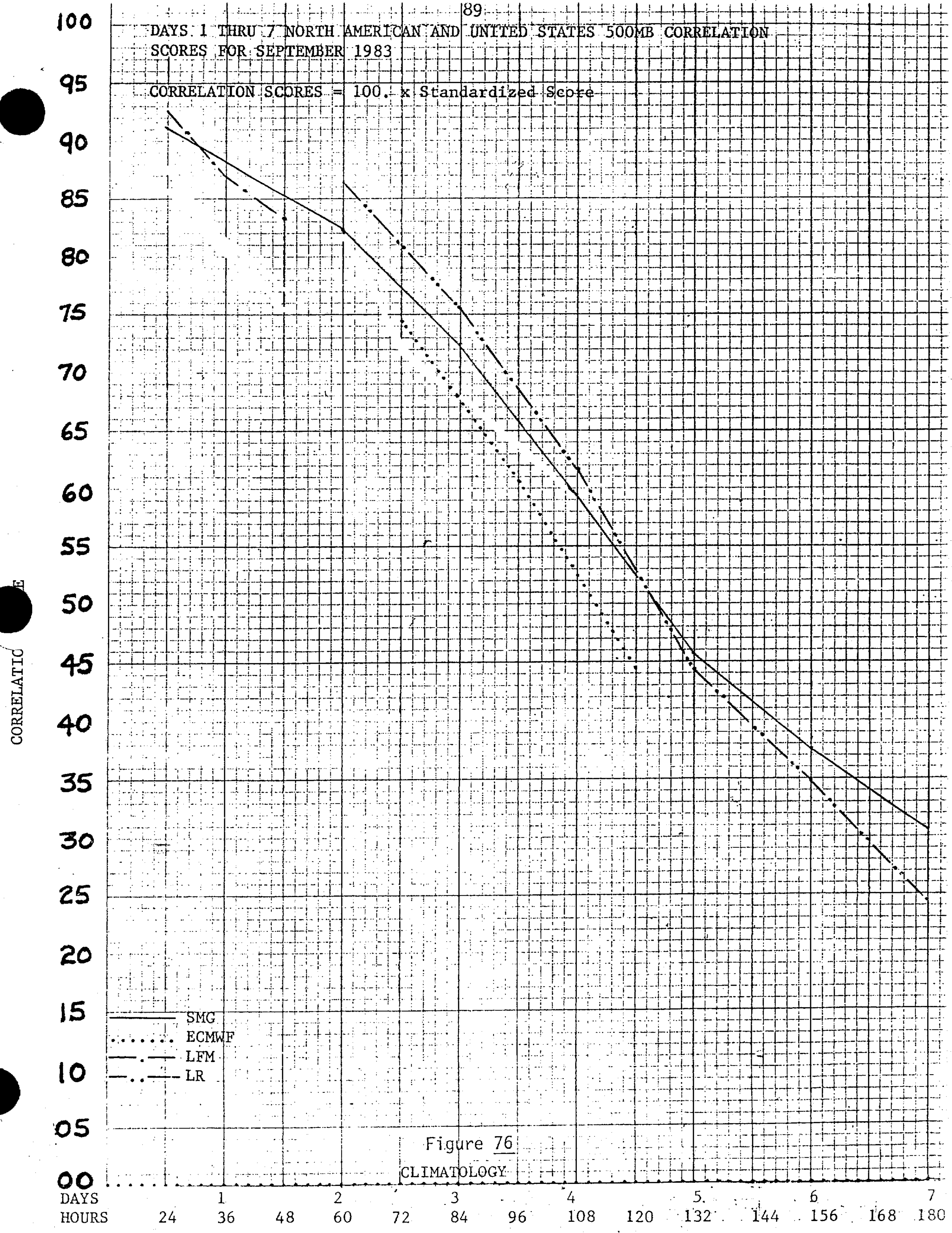

DAYS 1 THRU 7 NORTH AMERICAN AND UNITED STATES 500MB CORRELATION SCORES FOR SEPTEMBER 1983
CORRELATION SCORES = 100. x Standardized Score
CORRELATIO
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
05
00
SMG
ECMWF
LFM
LR
CLIMATOLOGY
DAYS 1 2 3 4 5 6 7
HOURS 24 36 48 60 72 84 96 108 120 132 144 156 168 180

Figure 76

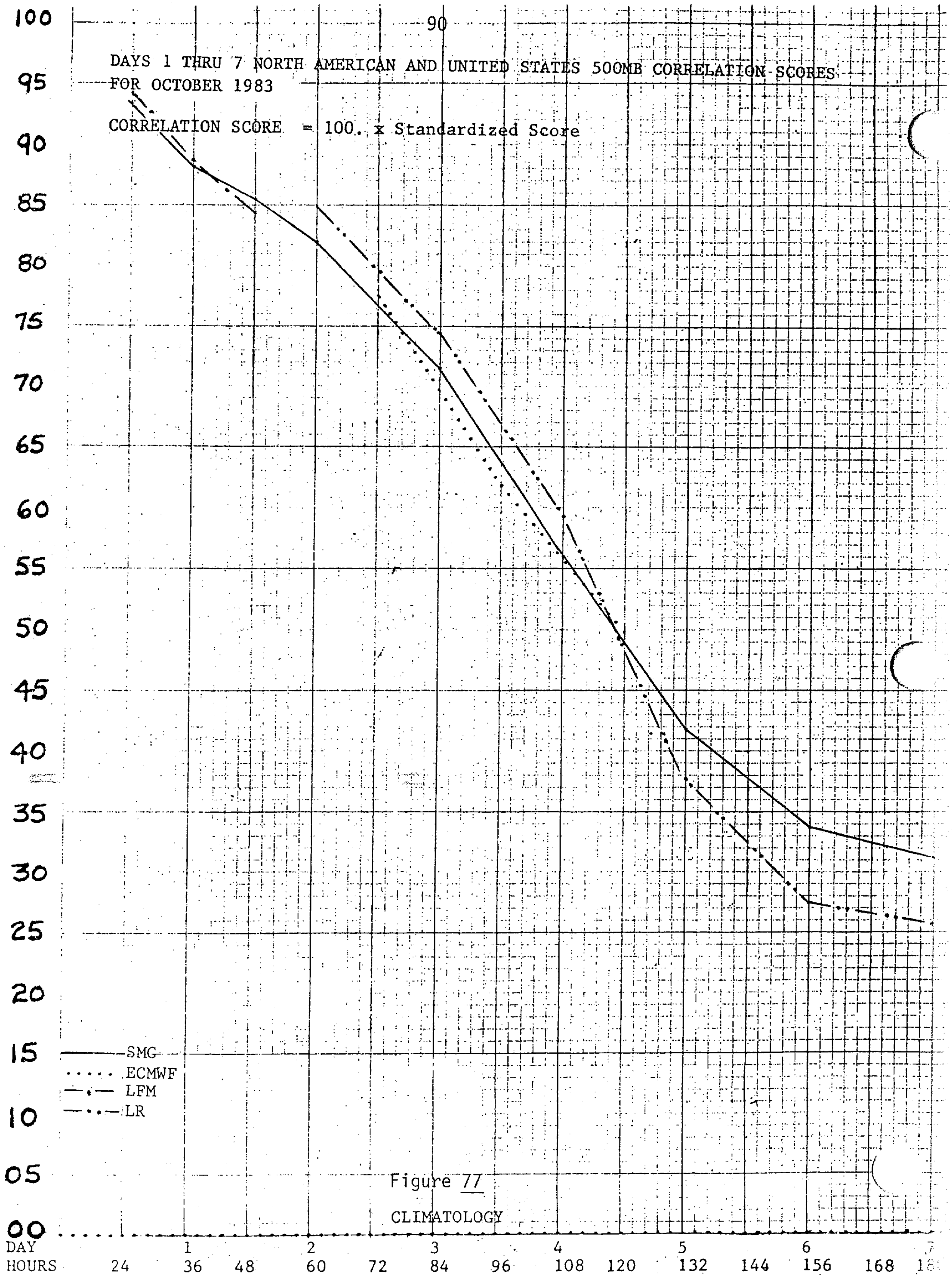

DAYS 1 THRU 7 NORTH AMERICAN AND UNITED STATES 500MB CORRELATION SCORES FOR OCTOBER 1983
CORRELATION SCORE = 100. x Standardized Score
CORRELATION SCORE
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
05
00
SMG
ECMWF
LFM
LR
CLIMATOLOGY
DAY 1 2 3 4 5 6 7
HOURS 24 36 48 60 72 84 96 108 120 132 144 156 168

Figure 77

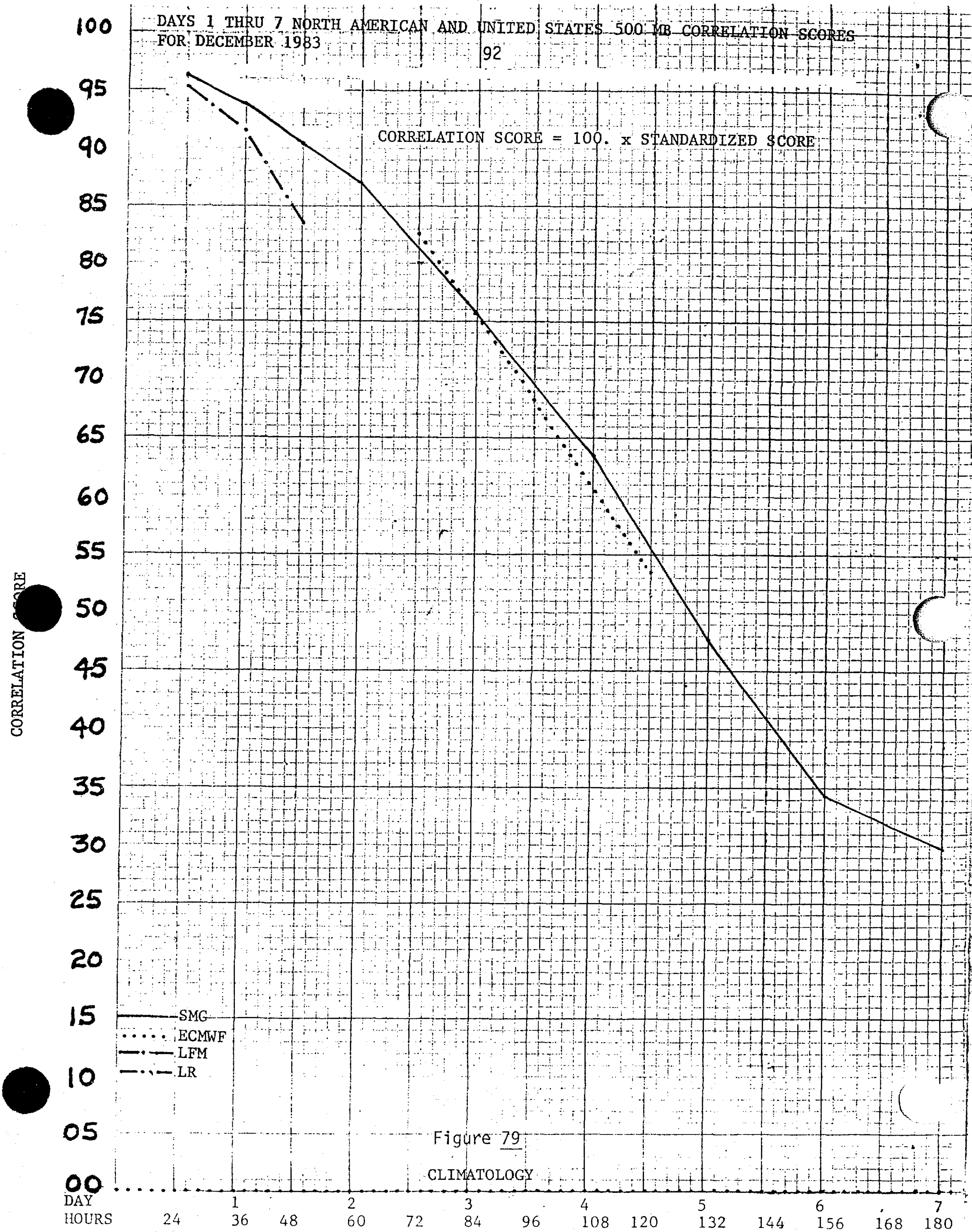

DAYS 1 THRU 7 NORTH AMERICAN AND UNITED STATES 500 MB CORRELATION SCORES
FOR DECEMBER 1983
CORRELATION SCORE = 100. x STANDARDIZED SCORE
CORRELATION SCORE
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
05
00
SMG
ECMWF
LFM
LR
CLIMATOLOGY
DAY
1
2
3
4
5
6
7
HOURS
24
36
48
60
72
84
96
108
120
132
144
156
168
180

Figure 79

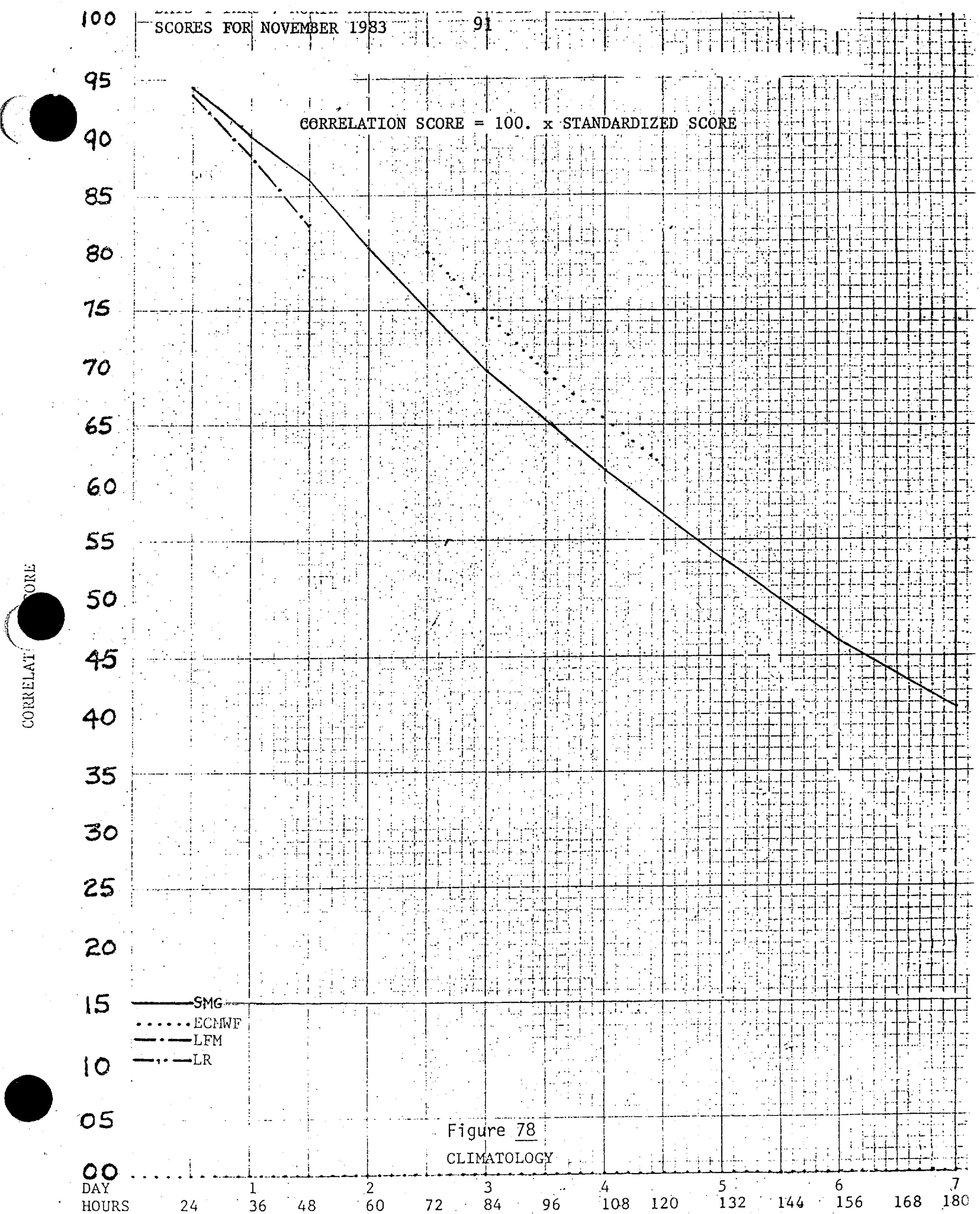
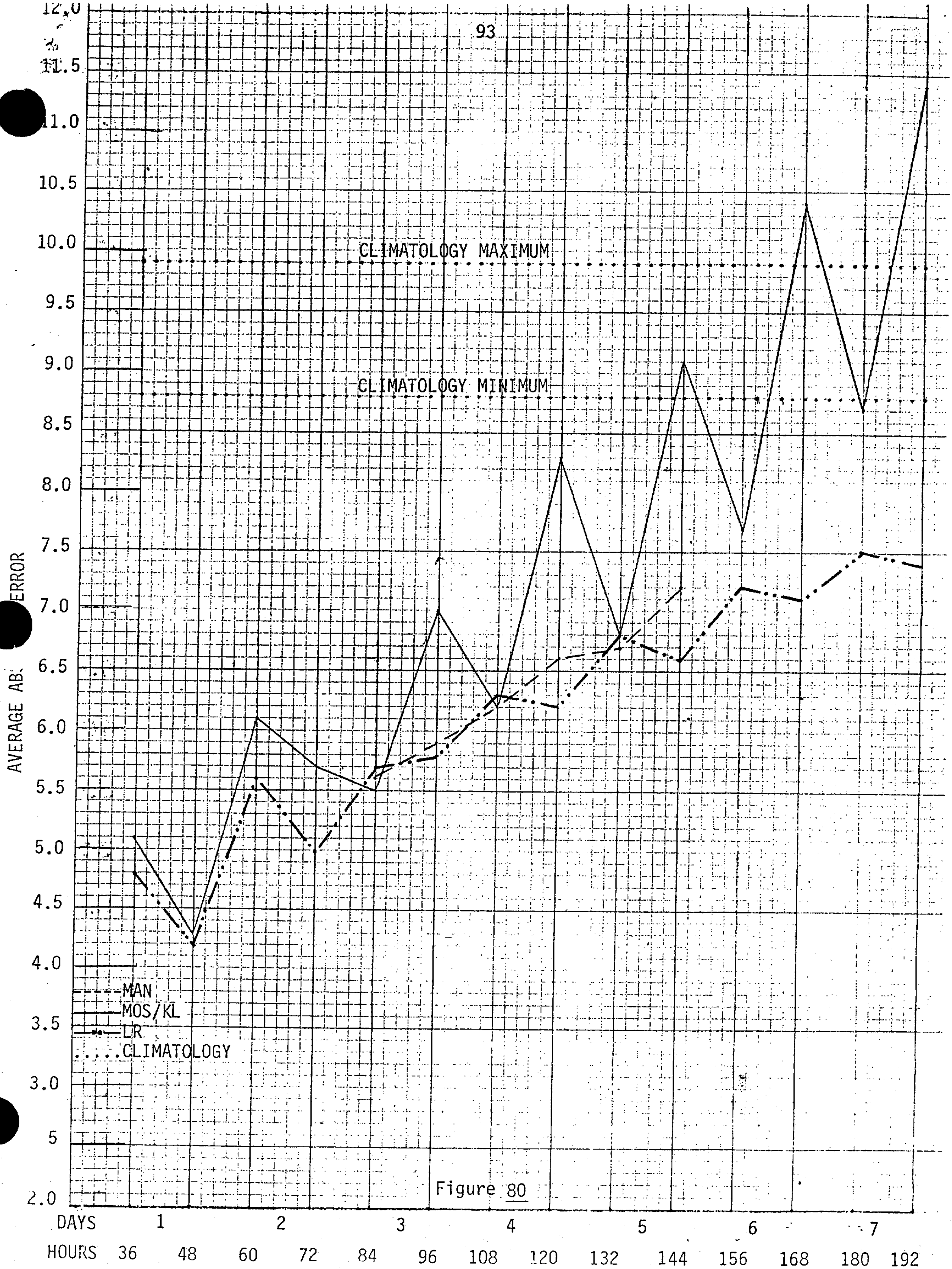


Figure 78

CLIMATOLOGY



AVERAGE AB 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
5
2.0
CLIMATOLOGY MAXIMUM
CLIMATOLOGY MINIMUM
MAN
MOS/KL
LR
CLIMATOLOGY
DAYS 1 2 3 4 5 6 7
HOURS 36 48 60 72 84 96 108 120 132 144 156 168 180 192

Figure 80

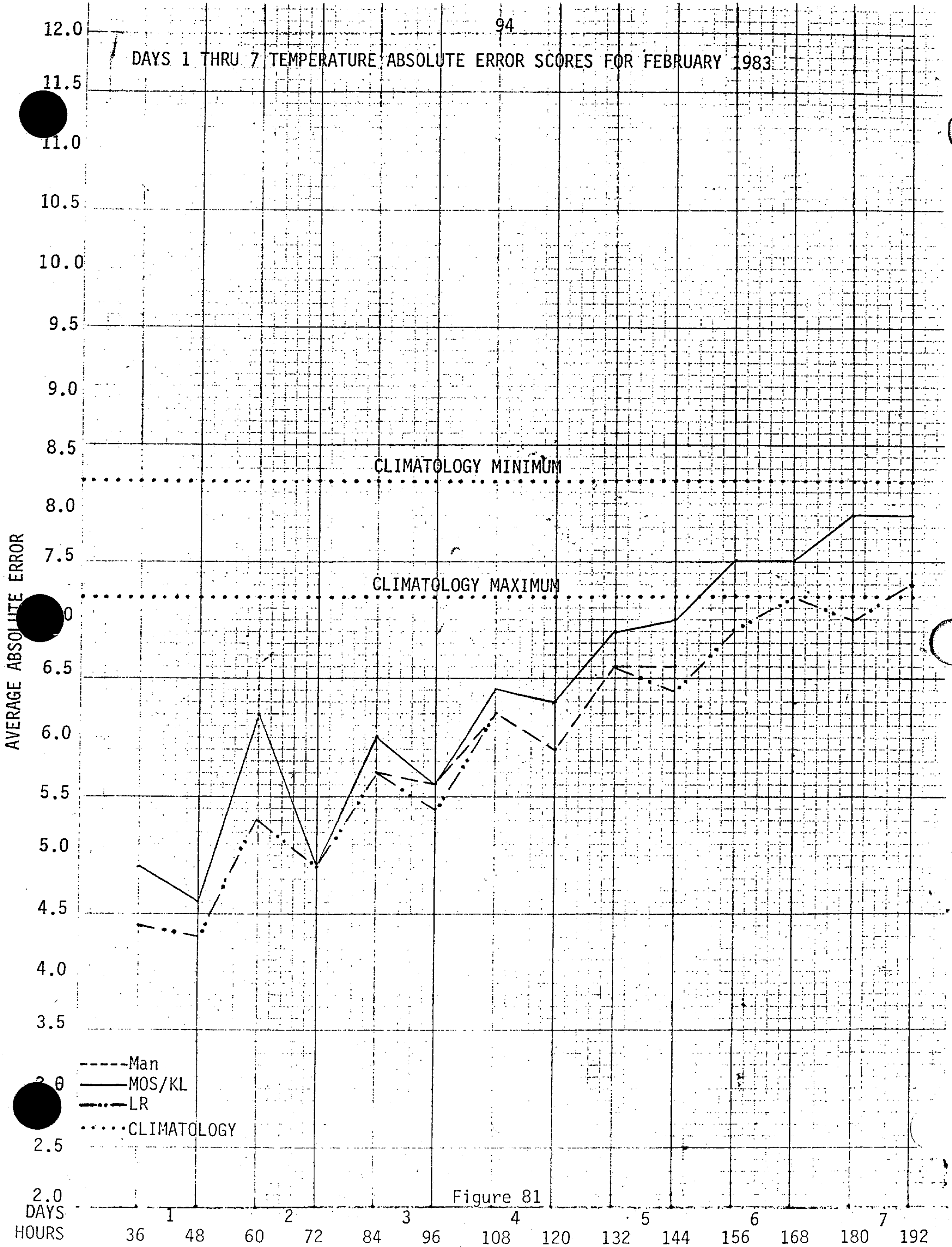

DAYS 1 THRU 7 TEMPERATURE ABSOLUTE ERROR SCORES FOR FEBRUARY 1983
AVERAGE ABSOLUTE ERROR
12.0
11.5
11.0
10.5
10.0
9.5
9.0
8.5
8.0
7.5
6.5
6.0
5.5
5.0
4.5
4.0
3.5
2.5
2.0
CLIMATOLOGY MINIMUM
CLIMATOLOGY MAXIMUM
Man
MOS/KL
LR
CLIMATOLOGY
DAYS
HOURS
1
2
3
4
5
6
7
36
48
60
72
84
96
108
120
132
144
156
168
180
192

Figure 81

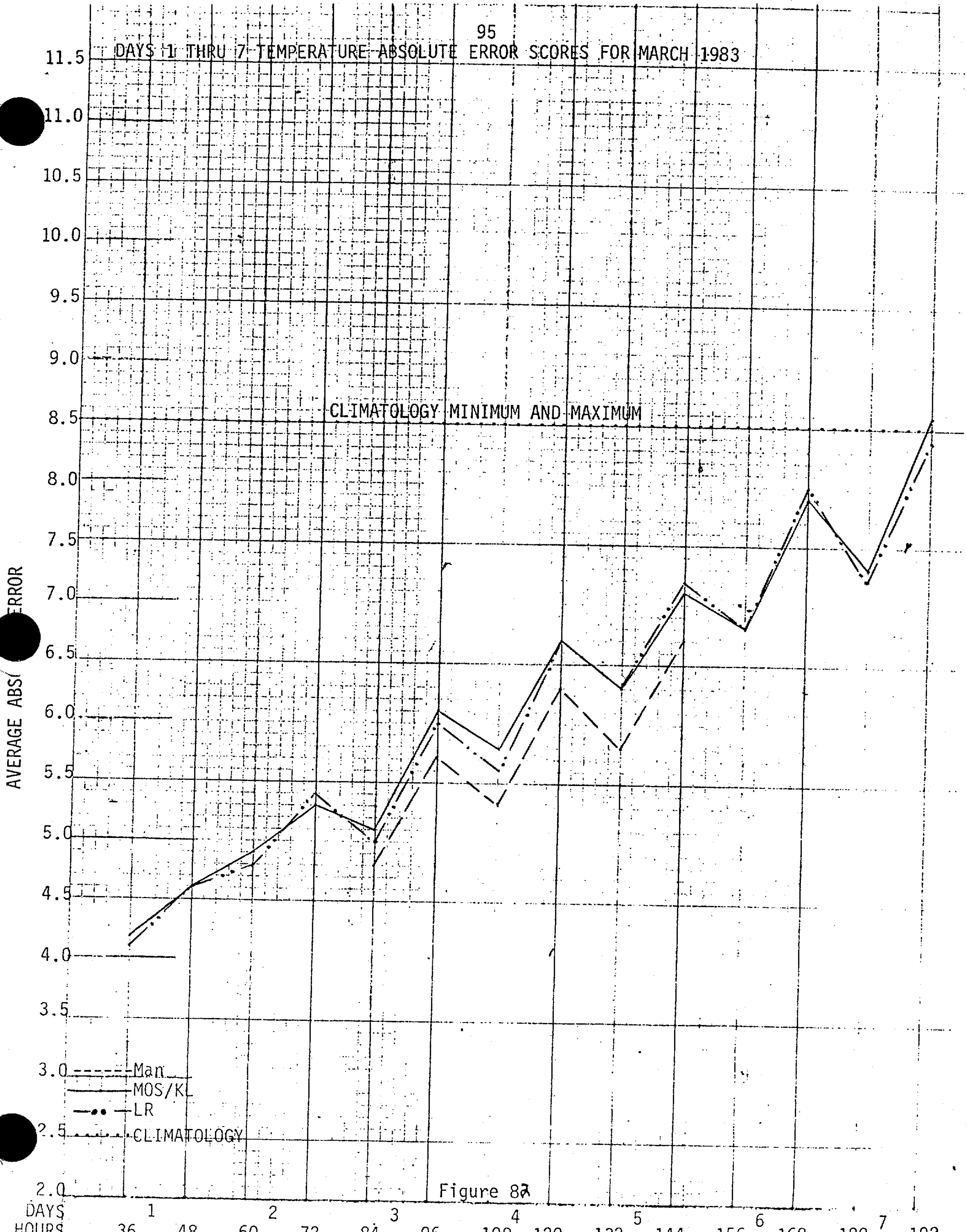

DAYS 1 THRU 7 TEMPERATURE ABSOLUTE ERROR SCORES FOR MARCH 1983
CLIMATOLOGY MINIMUM AND MAXIMUM
AVERAGE ABS ERROR
11.5
11.0
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
Man
MOS/KL
LR
CLIMATOLOGY
DAYS 1 2 3 4 5 6 7
HOURS 36 48 60 72 84 96 108 120 132 144 156 168 180 192

Figure 87

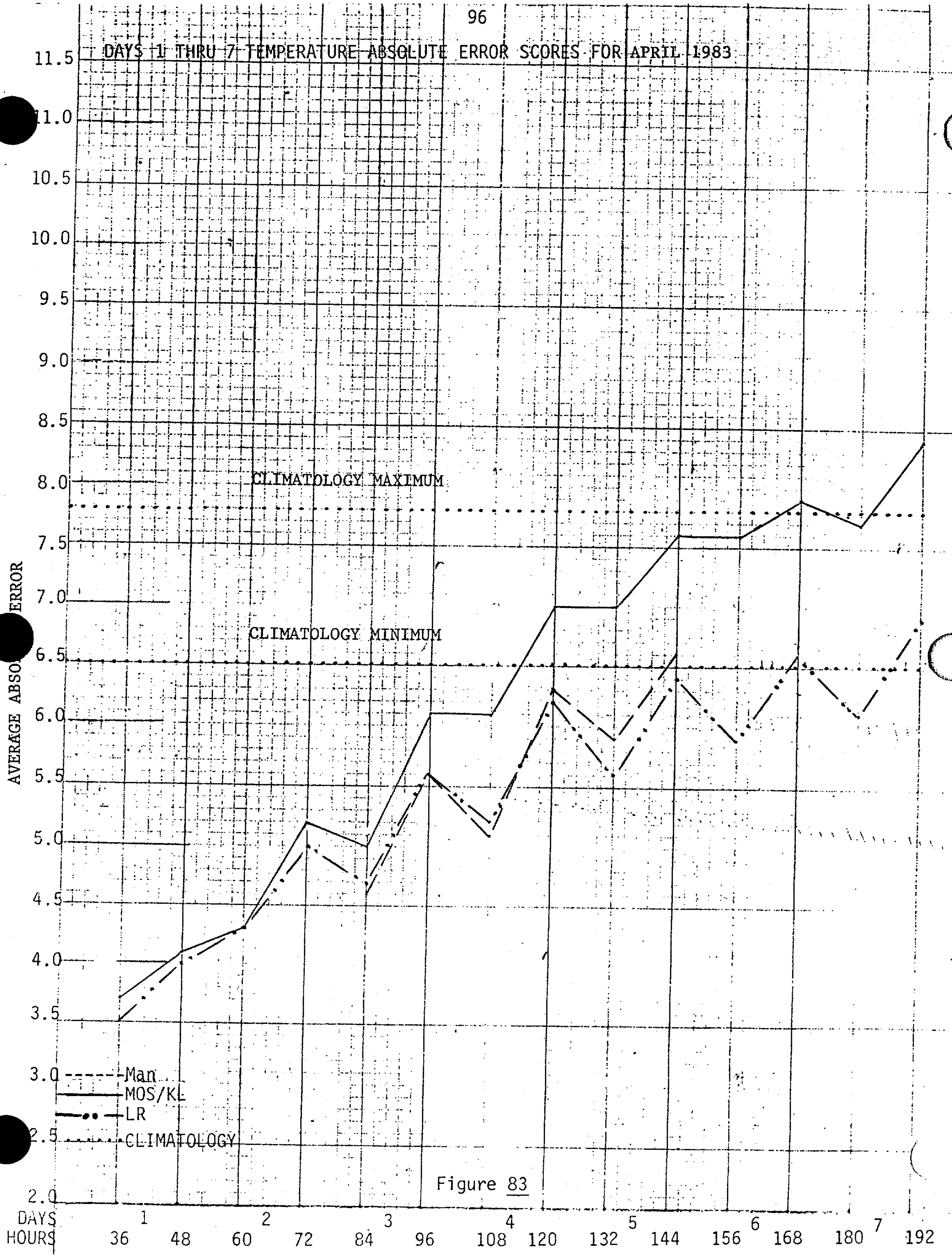

DAYS 1 THRU 7 TEMPERATURE ABSOLUTE ERROR SCORES FOR APRIL 1983
CLIMATOLOGY MAXIMUM
CLIMATOLOGY MINIMUM
AVERAGE ABSOLUTE ERROR
11.5
11.0
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
Man
MOS/KL
LR
CLIMATOLOGY
DAYS 1 2 3 4 5 6 7
HOURS 36 48 60 72 84 96 108 120 132 144 156 168 180 192

Figure 83

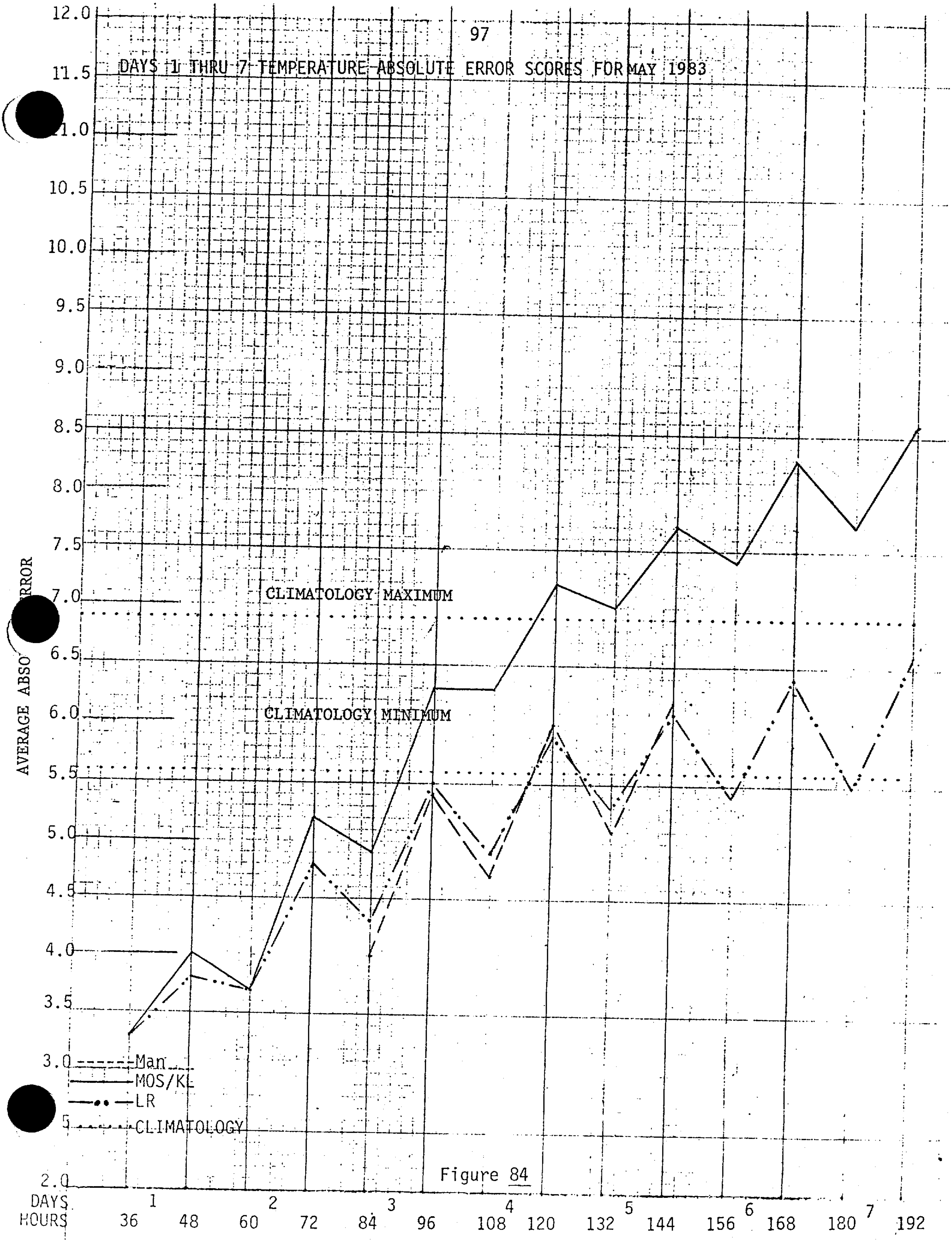

DAYS 1 THRU 7 TEMPERATURE ABSOLUTE ERROR SCORES FOR MAY 1983
AVERAGE ABSOLUTE ERROR
12.0
11.5
11.0
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
CLIMATOLOGY MAXIMUM
CLIMATOLOGY MINIMUM
Man
MOS/KL
LR
CLIMATOLOGY
DAYS 1 2 3 4 5 6 7
HOURS 36 48 60 72 84 96 108 120 132 144 156 168 180 192

Figure 84

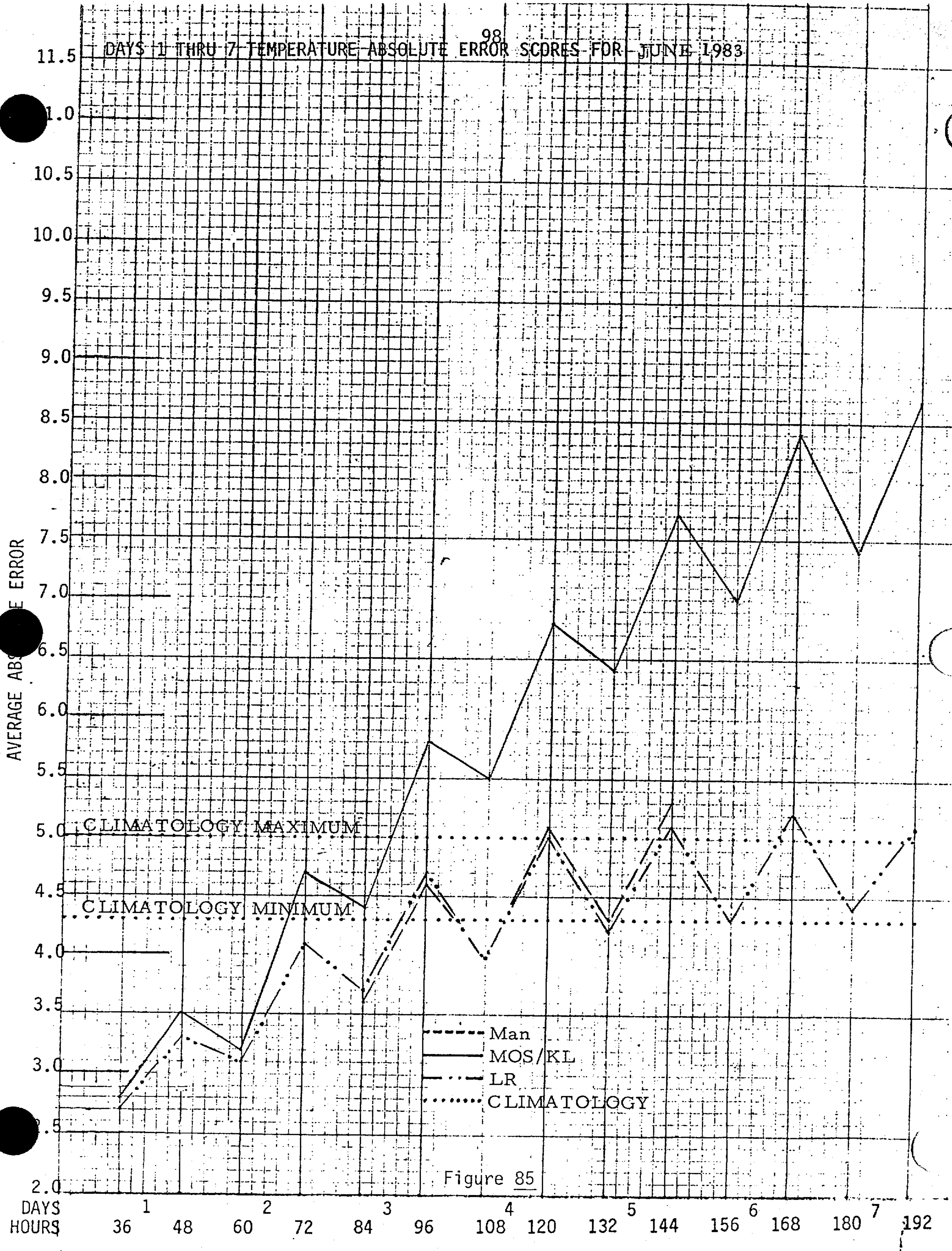

DAYS 1 THRU 7 TEMPERATURE ABSOLUTE ERROR SCORES FOR JUNE 1983
AVERAGE ABSOLUTE ERROR
11.5
11.0
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
CLIMATOLOGY MAXIMUM
CLIMATOLOGY MINIMUM
Man
MOS/KL
LR
CLIMATOLOGY
DAYS 1 2 3 4 5 6 7
HOURS 36 48 60 72 84 96 108 120 132 144 156 168 180 192

Figure 85

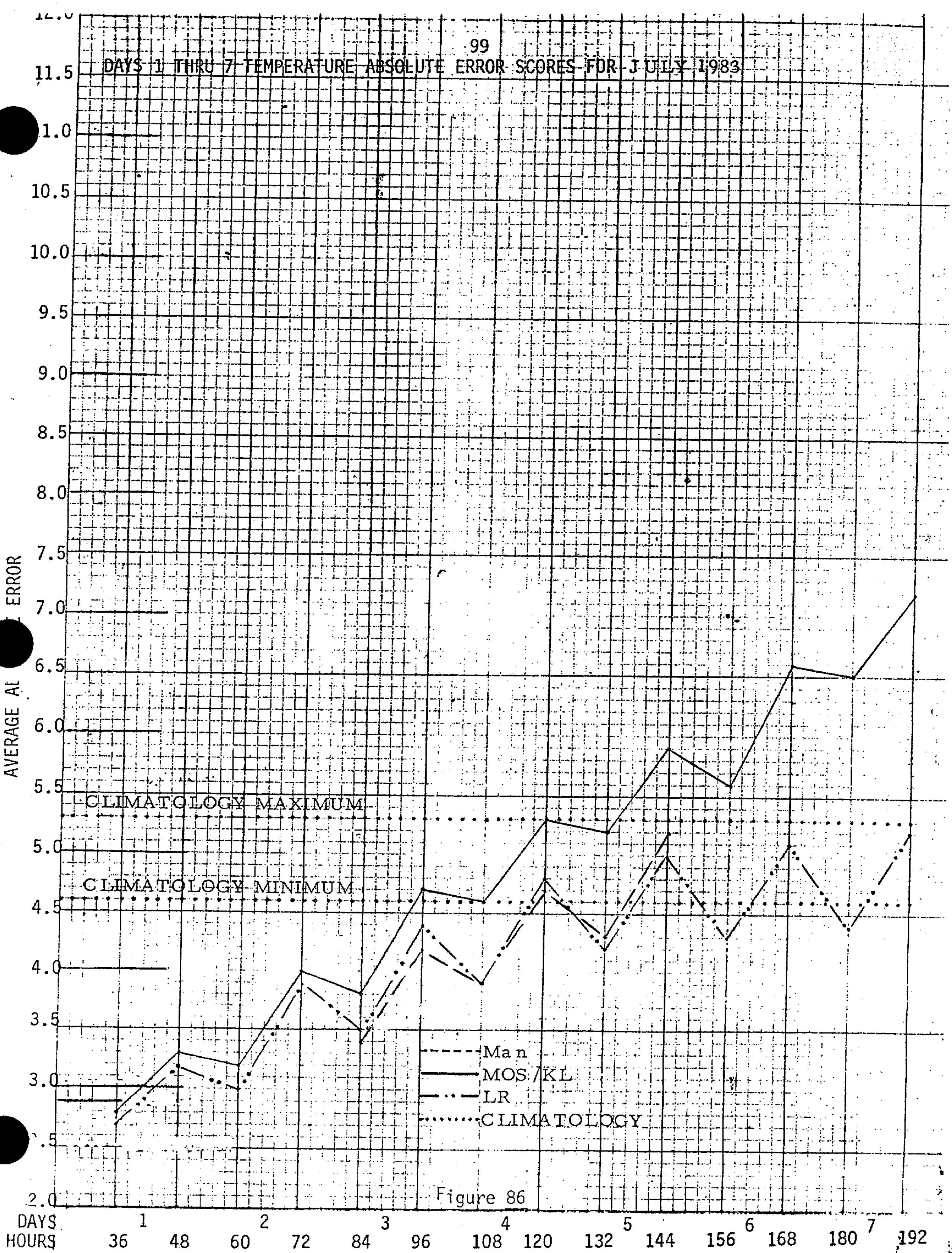

DAYS 1 THRU 7 TEMPERATURE ABSOLUTE ERROR SCORES FOR JULY 1983
AVERAGE A ERROR
CLIMATOLOGY MAXIMUM
CLIMATOLOGY MINIMUM
Man
MOS/KL
LR
CLIMATOLOGY
DAYS 1 2 3 4 5 6 7
HOURS 36 48 60 72 84 96 108 120 132 144 156 168 180 192
11.5 11.0 10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 .5 2.0

Figure 86

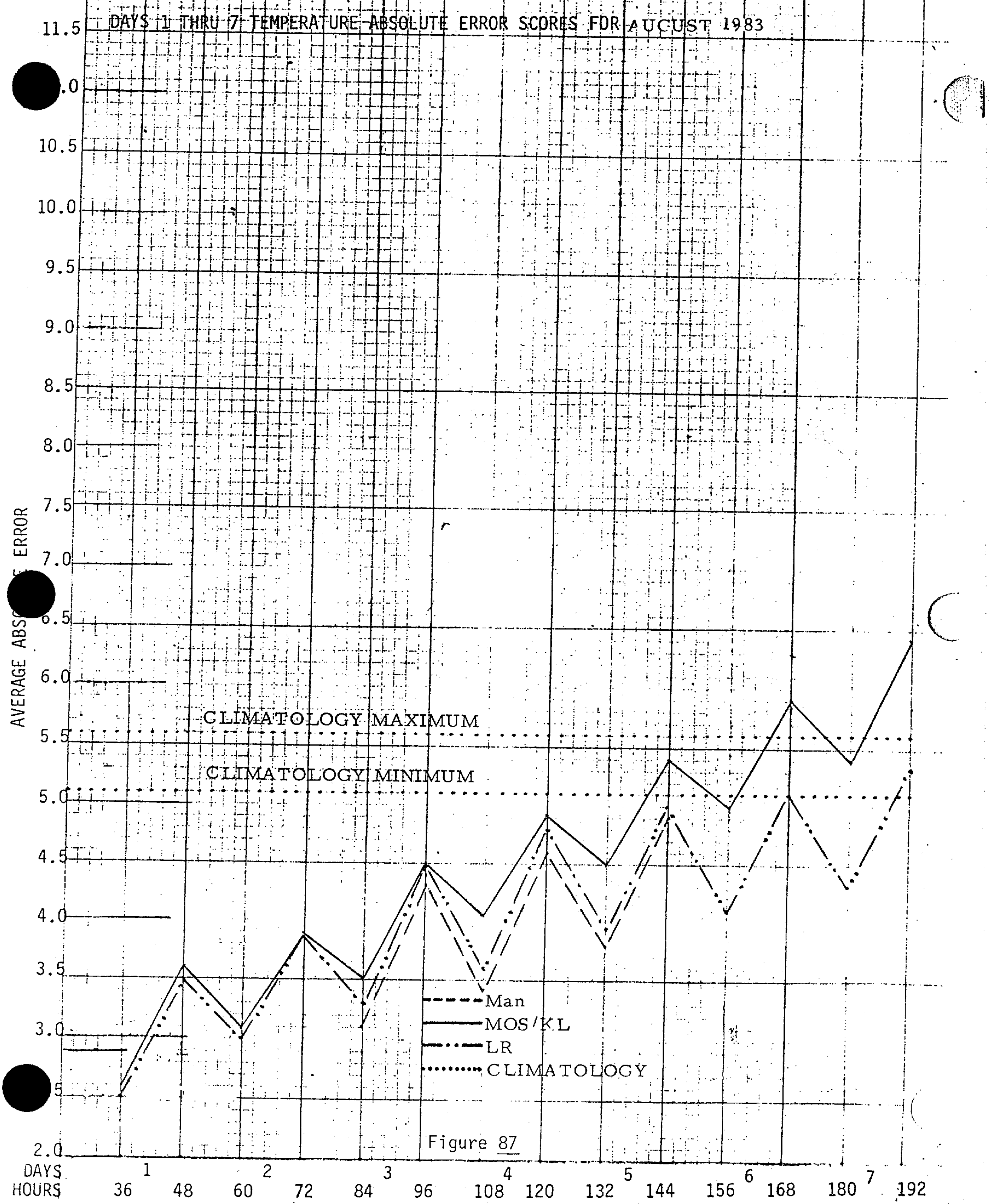
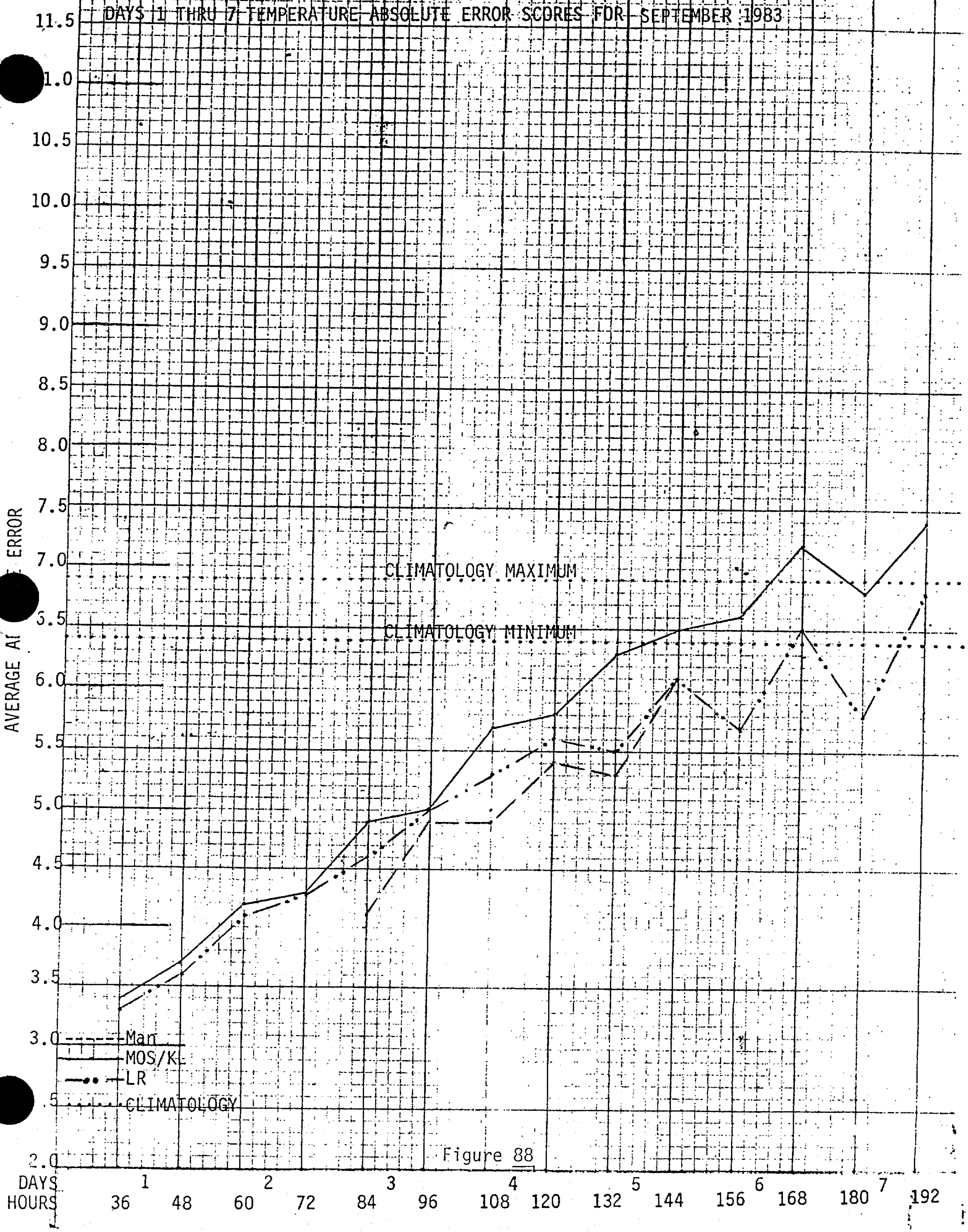

DAYS 1 THRU 7 TEMPERATURE ABSOLUTE ERROR SCORES FOR AUGUST 1983
AVERAGE ABSOLUTE ERROR
11.5
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.0
CLIMATOLOGY MAXIMUM
CLIMATOLOGY MINIMUM
Man
MOS/KL
LR
CLIMATOLOGY
DAYS 1 2 3 4 5 6 7
HOURS 36 48 60 72 84 96 108 120 132 144 156 168 180 192

Figure 87



DAYS 1 THRU 7 TEMPERATURE ABSOLUTE ERROR SCORES FOR SEPTEMBER 1983
AVERAGE ABSOLUTE ERROR
CLIMATOLOGY MAXIMUM
CLIMATOLOGY MINIMUM
Man
MOS/K
LR
CLIMATOLOGY
DAYS
HOURS
1
2
3
4
5
6
7
36
48
60
72
84
96
108
120
132
144
156
168
180
192

Figure 88

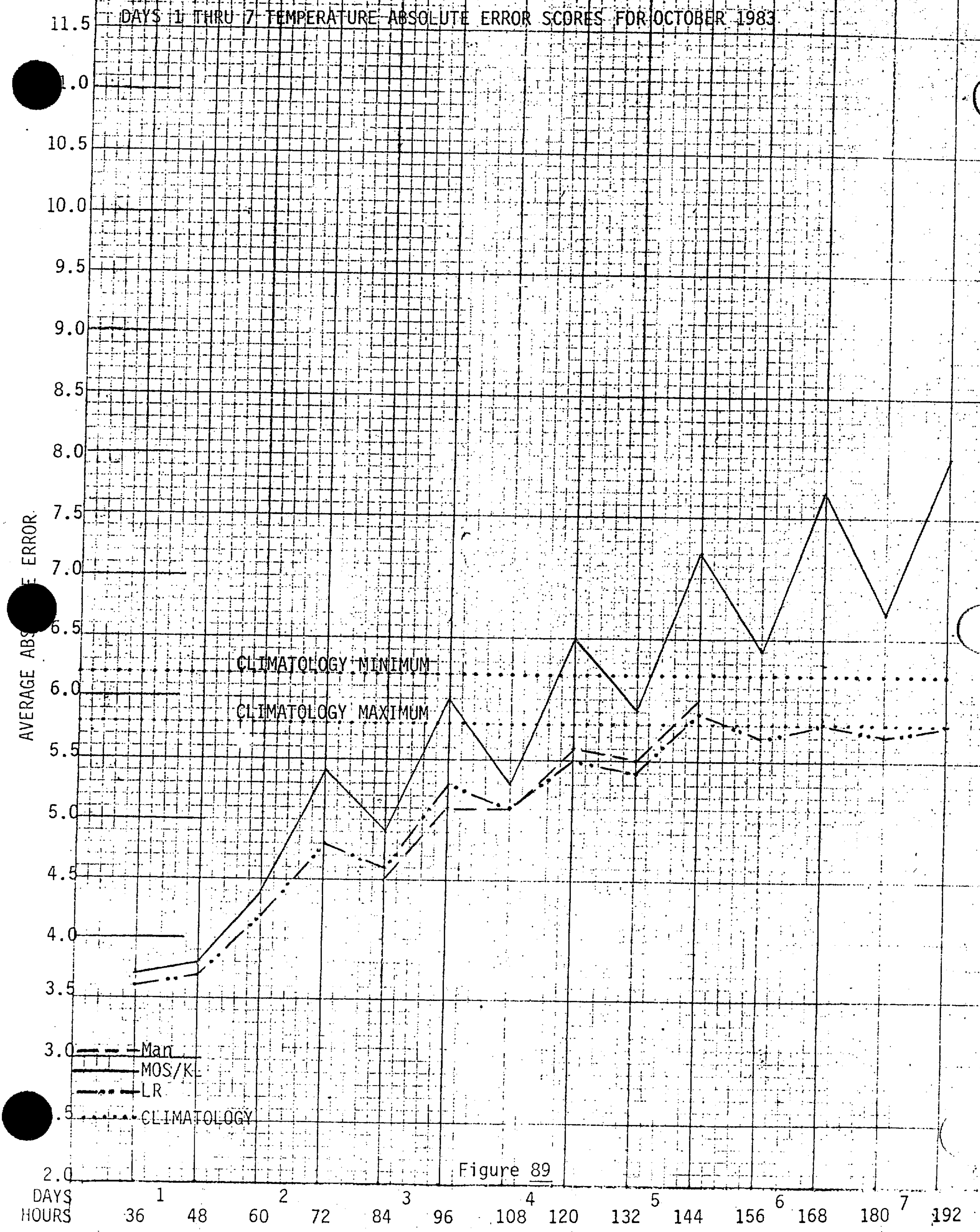

DAYS 1 THRU 7 TEMPERATURE ABSOLUTE ERROR SCORES FOR OCTOBER 1983
AVERAGE ABSOLUTE ERROR
11.5
11.0
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
CLIMATOLOGY MINIMUM
CLIMATOLOGY MAXIMUM
Man
MOS/KL
LR
CLIMATOLOGY
DAYS 1 2 3 4 5 6 7
HOURS 36 48 60 72 84 96 108 120 132 144 156 168 180 192

Figure 89

DAYS 1 THRU 7 TEMPERATURE ABSOLUTE ERROR SCORES FOR NOVEMBER 1983

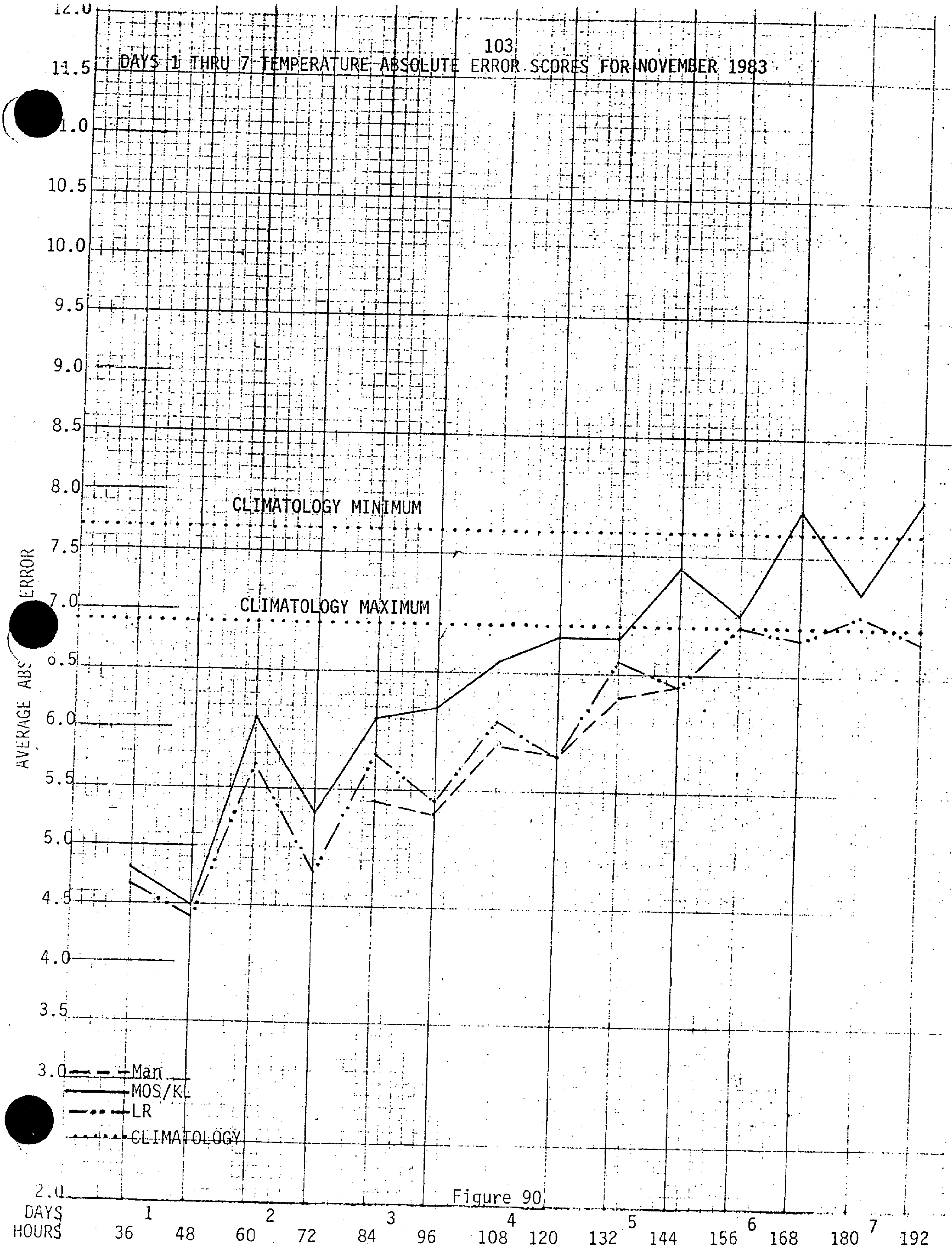


Figure 90

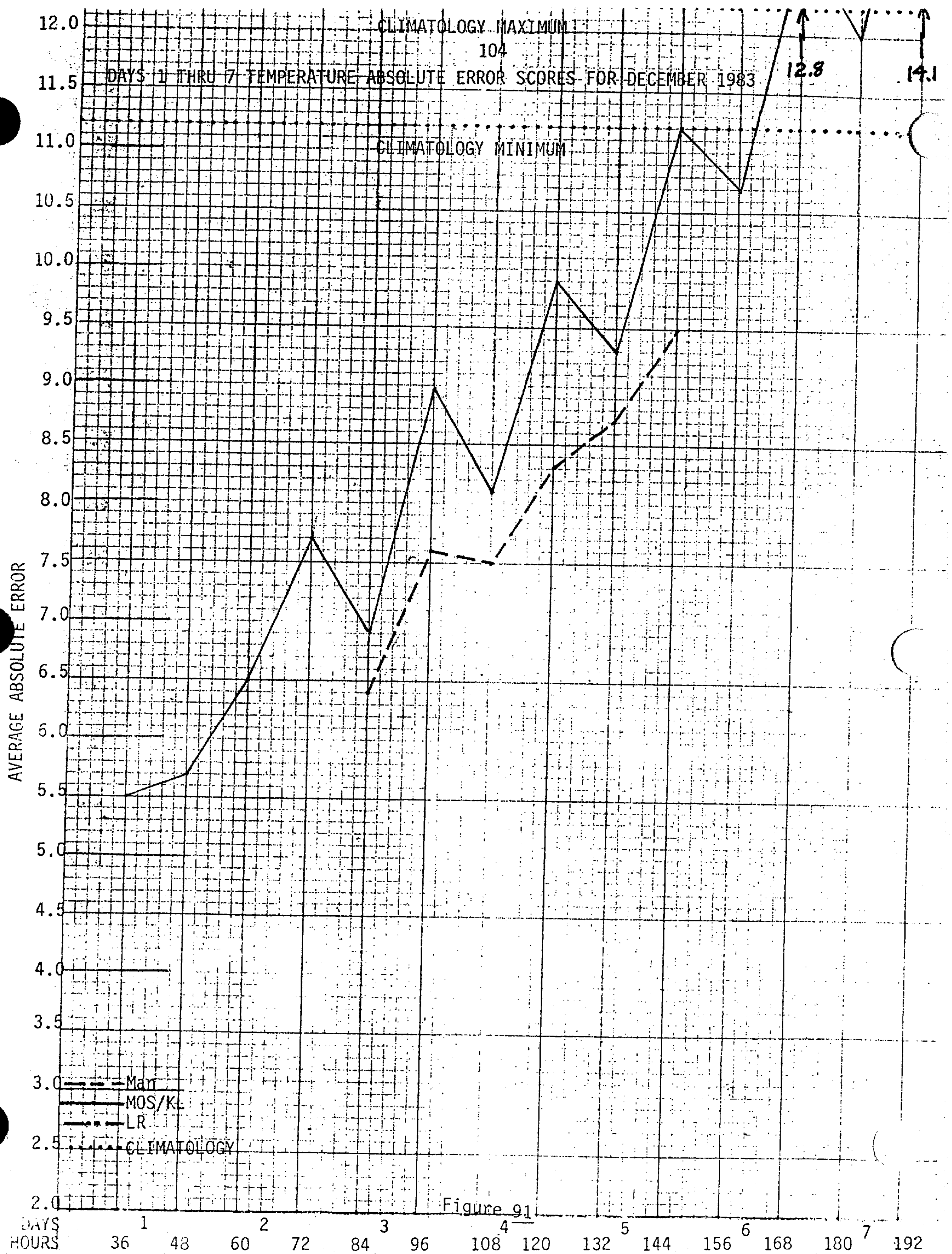

CLIMATOLOGY MAXIMUM
DAYS 1 THRU 7 TEMPERATURE ABSOLUTE ERROR SCORES FOR DECEMBER 1983
12.8
14.1
CLIMATOLOGY MINIMUM
AVERAGE ABSOLUTE ERROR
12.0
11.5
11.0
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
Man
MOS/KL
LR
CLIMATOLOGY
DAYS 1 2 3 4 5 6 7
HOURS 36 48 60 72 84 96 108 120 132 144 156 168 180 192

Figure 91

COMMENTS

SECTION 1 MSLP & 500 MB CORRELATION SCORES PAGES 10 TO 32

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 22 shows that, for the most part, the monthly mean scores during 1983 were higher (better) than the long term mean scores (note - the long term mean includes the 1983 scores). Also a comparison of the current long term mean scores (figures 3,6,9,12,15, and 18) with those published in NMC ON 271 of February 1983, indicates an upward trend. The many monthly mean record scores (figures 2,5,8,11,14,17, and 20) set by both the man and NMC/NWP model guidance resulted in 1983 being a record year for the days 3, 4, and 5 (figures 4,7,10,13,16, and 19) and 6 to 10 day (figure 22) forecasts.

No comment is made concerning the "betterment" of the man over the NMC/NWP model guidance except that it appears to be significant. The overall increase in skill of the guidance in 1983 seems to justify the changes made to/in the NMC/NWP model during the past year (see pages 2 and 3), though a better initial global analysis also could account for some of the improvement. Since the scores for the circulation are records, one might expect the derived forecasts of temperature and precipitation also to be records.

SECTION 2 TEMPERATURE ABSOLUTE ERROR AND SKILL SCORES PAGES 33 TO 47

In 1983, as usual, the bi-monthly mean absolute error minimum (figure 24) and maximum (figure 26) temperature scores for the man exhibited a clear superiority over the KL and climatology temperature forecasts for days 3, 4, and 5. The man minimum (figure 26) temperature scores for days 3, 4, and 5 were all-time records while the maximum (figure 29) scores tied the record for day 3 and were second for days 4 and 5.

The man 6 to 10 day 5 class (figure 32) and 3 class (figure 36) temperature skill scores were records in 1983. It should be noted (figures 31 and 34) that the FP scores were not available for January.

SECTION 3 PRECIPITATION SKILL SCORES PAGES 48 TO 66

The Gilman skill score, except for the problem mentioned in Appendix C, 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.

In 1983, as in recent years, the monthly mean Gilman (figure 39), Hughes (figure 43), and Hughes Probability (figure 46) precipitation skill scores for the man showed a clear superiority over climatology and the NMC/NWP model on days 3, 4, and 5. The man Gilman precipitation skill scores (figure 41) were a record for day 3, tied the record for day 4, and were second best for day 5. The Hughes skill (figure 45) and probability (figure 48) scores, however, are not quite so record breaking. The 1983 monthly mean 3 class precipitation skill scores for the man 1 to 5 day (figure 51) and 6 to 10 day (figure 54) forecasts were records.

SECTION 4 MSLP, 500 MB, AND TEMPERATURE SCORES FOR DAYS 1 THROUGH 7 PAGES 67 TO 104

Certainly consideration has to be given, after looking at figures 55 through 91, to producing (operationally) for public consumption man MSLP and temperature forecasts for days 6 and 7. It should be noted that for comparison purposes (operational utility) the ECMWF scores have to be "backed down" approximately 12 hours.

CONCLUSION

Figures 30, 42, and 67 quite effectively sum up the record breaking performance of the MRFG for 1983. The year 1984 promises to be an interesting year with the introduction of the SMG4C in October of 1983.

Acknowledgements

Thanks to Mrs. Evelyn Seek and Mrs. Donna Thomas for their help with the typing and to Eric McVicker for running off copies.

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

$$F = \frac{f-n}{\sigma} \qquad 0 = \frac{o-n}{\sigma}$$

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

$\overline{0}$ = average standardized observed across n grid points

$$\text{RMS F} = \sqrt{\overline{F^2}} \qquad \text{RMS 0} = \sqrt{\overline{0^2}}$$

$$\text{RMS Error} = \sqrt{\overline{(F-0)^2}}$$

$$\text{Average Absolute Error} = \overline{|F-0|}$$

$$\text{Correlation} = \frac{\overline{FO} - \overline{F}\,\overline{O}}{\sqrt{(\overline{F^2} - \overline{F}^2)(\overline{O^2} - \overline{O}^2)}} \quad \text{X100}$$

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 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

The 5 day mean 3 class temperature skill score simply "lumps" together the much below with the below and the much above with the above. The expected (E) then is equal to 1/4 X Below + 1/4 X Normal + 1/4 Above.

Appendix C

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.

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:

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

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

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 $p_i \cong F\frac{a_i}{\sum^{N} a_i}$ (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 D

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 E

The (Hughes) probability 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 F

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

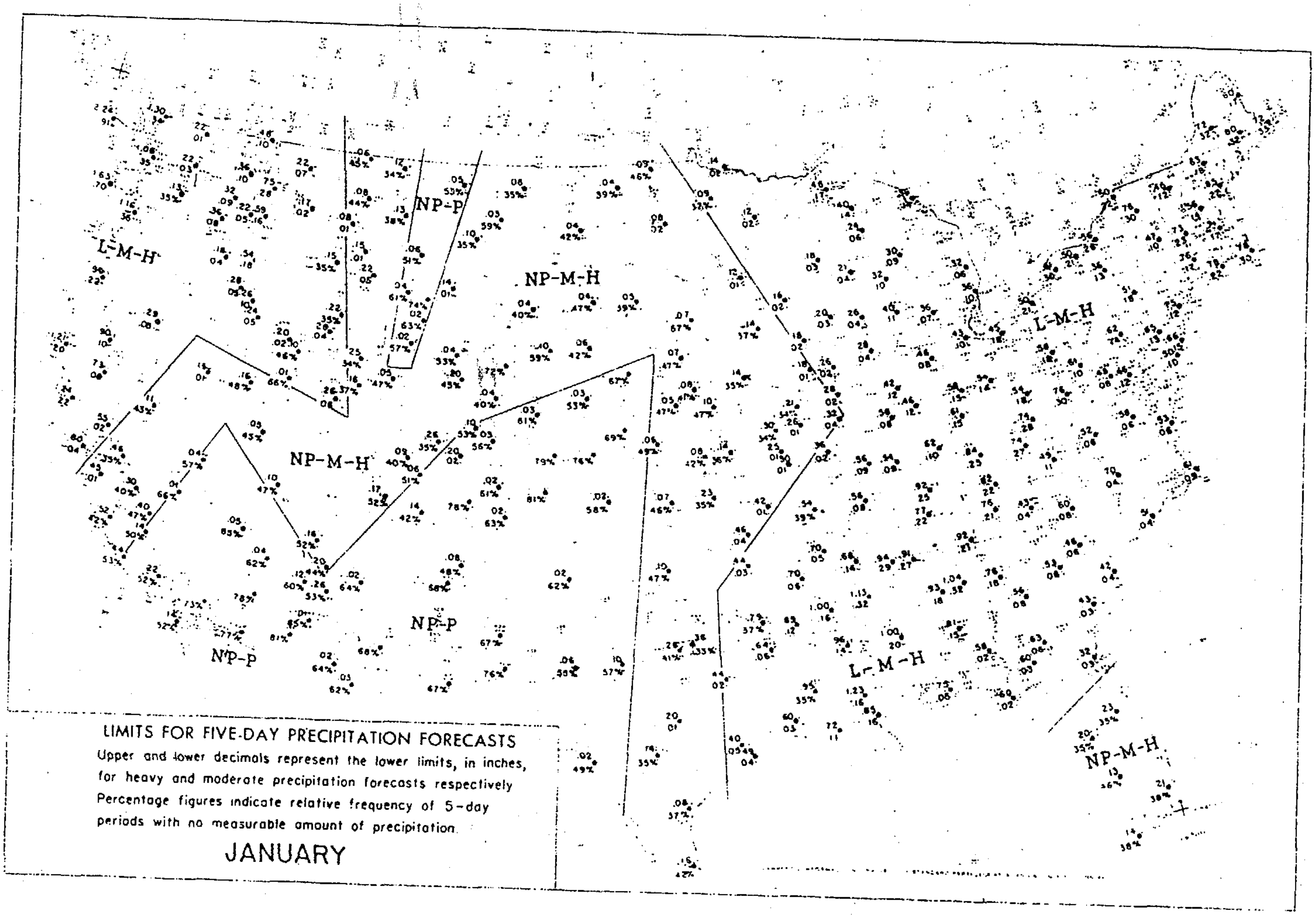
40% of (NP/M/H) = 28 x .40 = 11 stations coded as 1 and 8.5 coded as 2,3

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.



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