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CANADA

18pt.

LACOR

PROGRAM FOR STREAMFLOW CORRELATION

TECHNICAL BULLETIN No. 2

18pt.

14pt.

R. O'N. LYONS

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WATER RESOURCES BRANCH
DEPARTMENT OF NORTHERN AFFAIRS AND NATIONAL RESOURCES
OTTAWA, NOVEMBER 1965

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LACOR

PROGRAM FOR STREAMFLOW CORRELATION

MACHINE AND STORAGE REQUIREMENTS.

This program has been written and tested for a card IBM 1620 model I computer, with 40 k core storage, indirect addressing and automatic divide.

PROGRAM LANGUAGE.

FORTRAN II for IBM 1620.

RUNNING TIME.

The running time of the program depends on the number of years of record included as input, the number of years actually being correlated, the number of months being considered in the correlation, and the specified output. In the author's experience, times have varied from about two to five minutes per correlation. A rough estimate of running time, using full output on the 1620 model I computer, can be made by assuming four minutes per correlation.

DISCLAIMER.

No responsibility will be assumed by the Department of Northern Affairs and National Resources for use made of this program.

FEATURES.

Program LACOR is used to correlate streamflow records using the method described by Langbein (1960) in which the correlations are made in terms of the deviations in log units from the geometric mean of each calendar month's discharges. The geometric mean for a particular calendar month is the mean of the logarithms of the discharges for that month for the period under study.

The program uses records of monthly mean discharge at two gauging stations, picks out the months for which there are records at both stations, and uses only these months in determining the correlation constants. The program is designed to include a subroutine that, when specified, will use the resulting regression equation to estimate flows at the station specified as the dependent variable. Thus, it might be used to extend streamflow records as well as to test the relationships between them. The subroutine, named EXREC, will be described in a later report.

A number of correlations may be handled in one computer run. Each station record is preceded in the input card deck by a parameter card that specifies whether the record is to be used as an independent or dependent variable. The parameter card also specifies the amount of output data desired, whether or not the correlation is to be used to extend the dependent records, and which months of the year are to be included in the correlation (any number of months from 1 to 12 may be included in the correlation).

The program will store an independent record of 50 years length and will read dependent records of up to 50 years, but will use only the first twenty of these

years in which there is at least one month of matching records. The records need not be consecutive years, but they must be in chronological order.

INPUT DATA.

The program first reads an independent variable parameter card which specifies the name of the independent record following and also specifies how many dependent records are to be correlated against that station. The specified dependent records must follow the independent record in the input deck. Immediately preceding each of these dependent records is a dependent variable parameter card that checks the independent variable and specifies which months are to be considered for that correlation. Any number of independent records may be used in a run, with any number of dependent variables following each independent record.

1. Records.

Every station record must consist of the following:

(a) A title card giving the station name and station number.

Cols. 1-72	Station name	(alphameric)
Cols. 73-76	Excess ID	(ignored)
Cols. 77-80	Station number	(fixed point)

(b) A month heading card, to provide headings for each month column, immediately following the title card. This card is skipped in the program, but must be included in the input data.

(c) The flow data cards in chronological order.

Cols. 2- 5	Year name	(fixed point)
Cols. 6-10	Jan. flow	(floating point)

Cols. 11-15	Feb. flow	(floating point)
.....	.....	.....
Cols. 61-65	Dec. flow	(floating point)
Cols. 71-76	Ignored	
Cols. 77-80	Station number	(fixed point)

(d) An end card.

Cols. 1-76	Must be blank or zero
Cols. 77-80	Digits "9999"

2. Independent Parameter Cards.

This card defines the independent station, the number of dependent stations following, the type of output desired, and whether records are to be extended.

Cols. 1- 5	Ignored
Cols. 6-10	Station number
Cols. 11-15	Number of dependent variables following
Cols. 16-20	Mode of output "0" prints correlation constants only "1" prints correlation constants and deviations from mean logs.
Cols. 21-25	Subroutine switch "MODSB" (ignored unless subroutine EXREC is included).

3. Dependent Parameter Cards.

This card defines the dependent station, checks the independent station, and specifies which months are to be used in the correlation.

Cols. 1- 5	Ignored	
Cols. 6-10	Dependent station number	
Cols. 11-15	Independent station number	
Cols. 16-20	Ignored	
Cols. 21-23	Jan. active	(punch "1" if month to be considered, "0" if not to be considered).
Cols. 24-26	Feb. active	
.....	.....	
Cols. 54-56	Dec. active	

4. End of Job Card.

This card signals the end of a computer run.

Cols. 1- 5	Ignored
Cols. 7-10	Must have digits "9999"

OUTPUT DATA.

The program lists correlation data, as well as correlation results in its output. For each correlation there is a listing of the deviations from the mean logs for each month of each year where there are records at both the dependent and independent stations. For inactive months, "0.000" is printed, while "9.000" is printed for months with no record at either station. These are listed under the heading "Deviations from Mth. Mean Logs".

The correlation results are printed under the heading "Correlation Constants" and consist of the following data:

First line ... name of the dependent variable followed by its station number.

Second line .. name of the independent variable followed by its station number.

Third line ... SLOPE = the slope of the regression line

INTERCEPT = the intercept of the regression line on the Y axis

R = the coefficient of correlation

SE = the standard error of estimate

SD = the standard deviation of the dependent variable

At the end of the third line is printed the correlation number as "COR", the dependent station number, and the independent station number.

Fourth and Fifth lines ... give the monthly mean logs for the dependent station.

Sixth and Seventh lines .. give the monthly mean logs for the independent station.

Eighth line .. TOTX = the total of the deviations from the monthly mean logs for the independent variable.

TOTY = the total deviations from the monthly mean log for the dependent variable.

DTXX, DTYY and DTXY are the means of the squares or cross products of the variables.

PREPARATION OF INPUT DATA.

The input data deck for program LACOR must be made up as follows:

(a) an independent parameter card followed by

(b) the independent record, consisting of a title card, a month heading card, a number of flow data cards in chronological order, and an end-of-record card.

A number of dependent variables may follow, as specified in the independent parameter card. For each of these dependent variables there should be:

(c) a dependent variable card, followed by

(d) the dependent record, consisting of a title card, a month heading card, a number of flow data cards in chronological order, and an end-of-record card.

(e) After the specified number of dependent variables, there should be another series of cards as specified in (a) through (d) if more correlations are to be included in the run. If, however, there are no more correlations, an end-of-record card should be placed at the end of the deck to signal the end of the job.

PROGRAM MESSAGES.

Printout:

1. WRONG RECORD, READS (sta.no.), SHOULD READ (sta.no.)

   There is either a wrong station being correlated or a wrong station specified in parameter cards. The data should be checked.

2. INCORRECT DATA CARD IN (sta.no.)

   Check input cards in records for specified station.

3. WRONG INDEPENDENT VARIABLE SPECIFIED FOR STA (sta.no.)

   Either the dependent record is out of place or the parameter card is wrong.

4. DEP RECORD RUNS PAST END IND RECORD

   The dependent records are more recent than the independent records.

5. NO MATCHING RECORDS

   There are no matching months of records for the two stations specified. The program will move on to the next correlation.

6. MATCHING DEP YEARS EXCEED 20 _ (dependent sta.no.)_ _, _ (independent sta.no.)_ _

There are 20 or more years with at least one month of matching records. The program only uses the first 20 years of matching records. Thus the data should be examined to check that the desired 20-year period has been correlated.

Typewriter:

STOP 103	Data error, wrong station in input.
STOP 105	Wrong card included in input records.
STOP 106	Wrong independent variable specified for a correlation.
PAUSE 203	Negative flow.
STOP 201	The count of NDV (no. of dependent variables) has become negative. There is either a mistake on the independent parameter card or a machine error.
END OF JOB	All correlations up to the end card have been completed.

LIST OF VARIABLES

IXSTA	Independent station number.
NDV	The number of dependent records to be correlated with the current independent record.
MODE	Controls mode of printout (see program description).
MODSB	Controls subroutine EXREG; if MODSB = 0, subroutine is skipped.
ISTA	Used to store the station number of current card being read, for check with IXSTA or IYSTA.
IXYR (50)	Holds year name (eg. 1965) for independent records.
X (50, 12)	Monthly average discharges for independent station.
IYST	Dependent station number.
MACT (12)	Holds month active signal (if 0, ignore that month).
NX	Array number corresponding to the next IXYR to be checked.
IYYR (20)	Holds year name for dependent records.
Y (20, 12)	Monthly mean average discharges for the dependent station. Holds the log of the monthly discharge in the last half of the program.
SUMX (12)	Accumulates sums of independent variable (to compute mean).
SUMY (12)	Accumulates sums of dependent variable (to compute mean).
ZY (12)	Counts the number of matching months (to compute mean).
MZYR	Number of months within a year that have matching records for X & Y.
XTEMP (20, 12)	Holds values of X matching Y temporarily (for one correlation).
IXEND	Array number of the final year of independent records.
IYEND	Array number of the last year of dependent records matching independent records.
XMEAN	Monthly mean log of the independent flows.
YMEAN	Monthly mean log of the dependent flows.

TOTY	Accumulates total of Y - YMEAN (dependent variable).
TOTX	Accumulates total of XTEMP - XMEAN (independent variable).
TOTXX	Accumulates total of XTEMP squared.
TOTYY	Accumulates total of Y squared.
TOTXY	Accumulates total of XTEMP times Y.
T	Counter for number of values making the totals.
DTYY	Mean value of Y squared.
DTXX	Mean value of X squared.
DTXY	Mean value of XY.
R	Coefficient of correlation.
SLOPE	Slope of regression line.
PT	Intercept of regression line.
SD	Standard deviation of dependent data.
SE	Standard error of estimate.

NOTE: FORMAT 122 holds name of independent variable (XNAME in "H" mode).

FORMAT 123 holds name of dependent variable (YNAME in "H" mode).

FORTRAN PROGRAM LISTING

```
C     PROGRAM LACOR,  LANGBEINS METHOD OF CORRELATING STREAMFLOW RECORDS   LACOR
      DIMENSION X(50,12),Y(20,12),XTEMP(20,12),IXYR(50),IYYR(20),ZY(12),   LACOR
     1SUMX(12),SUMY(12),XMEAN(12),YMEAN(12), MACT(12),EY(12)               LACOR
      COMMON X,Y,XTEMP,IXYR,IYYR,ZY,SUMX,SUMY,XMEAN,YMEAN,MACT,EY          LACOR
      COMMON IXEND,IYEND,PT,SLOPE,MODE,MODSB,IXSTA,IYSTA,ISTA,NDV,I,J,M,   LACOR
     1NX,MZYR,TOTY,TOTX,TOTYY,TOTXX,TOTXY,T,DTYY,DTXX,DTXY,R,SD,SE,ISW,    LACOR
     2JSW                                                                  LACOR
C     READ INDEPENDENT PARAMETERS                                          LACOR
    1 READ 100,IXSTA,NDV,MODE,MODSB                                       LACOR
      IF(IXSTA-9999)73,99,73                                              LACOR
C     READ INDEPENDENT STA RECORDS                                         LACOR
   73 READ 122,ISTA                                                       LACOR
      IF(ISTA-IXSTA)2,3,2                                                 LACOR
    2 PUNCH 103,ISTA,IXSTA                                                LACOR
      STOP 103                                                            LACOR
    3 READ 107                                                            LACOR
      DO 71 I=1,50                                                        LACOR
      DO 71 J=1,12                                                        LACOR
   71 X(I,J)=0.0                                                          LACOR
      DO 7 I=1,50                                                         LACOR
      READ 104, IXYR(I),(X(I,M),M=1,12),ISTA                              LACOR
      IF(ISTA-IXSTA)4,7,4                                                 LACOR
    4 IF(ISTA-9999)5,6,5                                                  LACOR
    5 PUNCH 105,IXSTA                                                     LACOR
      STOP 105                                                            LACOR
    6 IXEND=I-1                                                           LACOR
      GO TO 8                                                             LACOR
    7 CONTINUE                                                            LACOR
      IXEND=50                                                            LACOR
      CALL RNOUT                                                          LACOR
C     READ DEPENDENT PARAMETERS                                           LACOR
    8 READ 101,IYSTA,ISTA,(MACT(M),M=1,12)                                LACOR
      PUNCH 125                                                           LACOR
      IF(IXSTA-ISTA)9,10,9                                                LACOR
    9 PUNCH 106,IYSTA                                                     LACOR
      STOP 106                                                            LACOR
C     READ DEPENDENT STA RECORDS                                          LACOR
   10 READ 123,ISTA                                                       LACOR
      IF(ISTA-IYSTA)75,11,75                                              LACOR
   75 PUNCH 103,ISTA,IYSTA                                                LACOR
      STOP 103                                                            LACOR
   11 READ 107                                                            LACOR
      NX=1                                                                LACOR
      DO 72 I=1,20                                                        LACOR
```

```
      DO 72 J=1,12                                                      LACOR
      XTEMP(I,J)=0.0                                                    LACOR
   72 Y(I,J)=0.0                                                        LACOR
C     INITIALIZE MEAN ACCUMULATORS                                      LACOR
      DO 74 I=1,12                                                      LACOR
      SUMX(I)=0.0                                                       LACOR
      SUMY(I)=0.0                                                       LACOR
   74 ZY(I)=0.0                                                         LACOR
      IF(MODSB-2)90,89,89                                               LACOR
   89 PUNCH 107                                                         LACOR
      PUNCH 117,IYSTA                                                   LACOR
      PUNCH 108                                                         LACOR
   90 DO 31 I=1,20                                                      LACOR
C     READ Y AND MATCH X, ONE YR AT A TIME                              LACOR
   12 READ 104,IYYR(I),(Y(I,M),M=1,12),ISTA                             LACOR
      IF(ISTA-IYSTA)13,17,13                                            LACOR
   13 IF(ISTA-9999)14,15,14                                             LACOR
   14 PUNCH 105,IYSTA                                                   LACOR
      STOP 105                                                          LACOR
   15 IYEND=I-1                                                         LACOR
      GO TO 81                                                          LACOR
   17 IF(MODSB-2)88,87,87                                               LACOR
   87 PUNCH 118,IYYR(I),(Y(I,M),M=1,12)                                 LACOR
C     MATCH Y AND X                                                     LACOR
   88 DO 18 J=NX,IXEND                                                  LACOR
      IF(IYYR(I)-IXYR(J))12,20,18                                       LACOR
   18 CONTINUE                                                          LACOR
      PUNCH 116                                                         LACOR
      IYEND=I-1                                                         LACOR
      IF(IYEND)93,93,79                                                 LACOR
   93 CALL RNOUT                                                        LACOR
      PUNCH 119                                                         LACOR
      GO TO 92                                                          LACOR
   20 NX=J                                                              LACOR
      MZYR=0                                                            LACOR
      DO 30 M=1,12                                                      LACOR
      IF(MACT(M))86,85,86                                               LACOR
   85 Y(I,M)=0.0                                                        LACOR
      GO TO 30                                                          LACOR
   86 IF(X(NX,M))21,21,22                                               LACOR
   21 Y(I,M)=0.0                                                        LACOR
      GO TO 30                                                          LACOR
```

```
      PUNCH 102,IXSTA                                                    LACOR
      PUNCH 111,(XMEAN(M),M=1,12)                                        LACOR
      PUNCH 124,TOTX,TOTY,DTXX,DTYY,DTXY                                 LACOR
C     EXTEND RECORDS IF REQUIRED                                         LACOR
C     READ NEXT DEPENDENT STATION                                        LACOR
   92 NDV=NDV-1                                                          LACOR
      IF(NDV)98,1,8                                                      LACOR
   98 STOP 201                                                           LACOR
   99 TYPE 999                                                           LACOR
      STOP                                                               LACOR
  100 FORMAT (5X,4I5)                                                    LACOR
  101 FORMAT (5X,2I5,5X,12I3)                                            LACOR
  102 FORMAT (31HMEAN MTHLY LOGS, MTHS 1-12, STA I5)                     LACOR
  103 FORMAT (19HWRONG RECORD, READS I5,12H SHOULD READ I5)              LACOR
  104 FORMAT (I5,12F5.0,11X,I4)                                          LACOR
  105 FORMAT (22HINCORRECT DATA CARD IN I6)                              LACOR
  106 FORMAT (31HWRONG IND VAR SPECIFIED FOR STA I5)                     LACOR
  107 FORMAT (80X)                                                       LACOR
  108 FORMAT (7X,3HJAN,3X,3HFEB,3X,3HMAR,3X,3HAPR,3X,3HMAY,3X,3HJUN,3X,  LACOR
     13HJUL,3X,3HAUG,3X,3HSEP,3X,3HOCT,3X,3HNOV,3X,3HDEC)                LACOR
  109 FORMAT (29HDEVIATIONS FROM MTH MEAN LOGS)                          LACOR
  110 FORMAT (I5,12F6.3)                                                 LACOR
  111 FORMAT (5X,12F6.3)                                                 LACOR
  112 FORMAT (21HCORRELATION CONSTANTS)                                  LACOR
  113 FORMAT (5X,6HSLOPE=F6.3,3X,10HINTERCEPT=F6.3,2X,2HR=F5.3,2X,3HSE=  LACOR
     1F5.3,2X,3HSD=F5.3,2X,3HCOR I5,1H/I4)                               LACOR
  114 FORMAT (27HMATCHING DEP YRS EXCEEDS 20 I5,I6)                      LACOR
  115 FORMAT (76X,I4)                                                    LACOR
  116 FORMAT (35HDEP RECORD RUNS PAST END IND RECORD)                    LACOR
  117 FORMAT (22HACTUAL RECORDS FOR STAI5)                               LACOR
  118 FORMAT (I5,12F6.0)                                                 LACOR
  119 FORMAT (19HNO MATCHING RECORDS)                                    LACOR
  122 FORMAT (72H                                                        LACOR
     1                    4X,I4)                                         LACOR
  123 FORMAT (72H                                                        LACOR
     1                    4X,I4)                                         LACOR
  124 FORMAT (5HTOTX=F7.3,2X,5HTOTY=F7.3,4X,5HDTXX=F9.3,4X,5HDTYY=F9.3,  LACOR
     14X,5HDTXY=F9.3)                                                    LACOR
  125 FORMAT (79X,1H+)                                                   LACOR
  999 FORMAT (10HEND OF JOB)                                             LACOR
      END                                                                LACOR
```

```
      SUBROUTINE RNOUT                                                  LACOR
C     RUN OUT EXTRA CARDS                                               LACOR
      DO 1 I=1,50                                                       LACOR
      READ 115,ISTA                                                     LACOR
      IF(ISTA-9999)1,2,1                                                LACOR
    1 CONTINUE                                                          LACOR
    2 RETURN                                                            LACOR
  115 FORMAT (76X,I4)                                                   LACOR
      END                                                               LACOR
```

SAMPLE INPUT

```
                                                                              NOV. 04 65
       2501    1    1
       NORTH SASKATCHEWAN RIVER NEAR ROCKY MOUNTAIN                                  ER   2501
        JAN FEB  MAR  APR  MAY  JUN  JUL  AUG  SEPT OCT  NOV  DEC                    ER   2501
  1945             791 1512 60761024011280 9896 6164 4438                            ER   2501
  1946             951 2065 58791410011610 8256 5458 2246                            ER   2501
  1947             890 2848 62161338014220 8335 5765 3688                            ER   2501
  1948             905 190914610178501194011760 4931 2630                            ER   2501
  1949             823 1634 4115 6060 8346 7298 3873 1869                            ER   2501
  1950             689 2080 28541428014210 8223 4962 1956                            ER   2501
  1951             614 2116 75231068015970 8518 6384 3551                            ER   2501
  1952            1321 4526 448716950147101164 0 5253 2875                           ER   2501
  1953             724 1668 595416480148501042 0 5794 2583 1845  953                 ER   2501
  1954  707 1022   914 1786 74271574015200145001202 0 4114 2500 2056                 ER   2501
  1955 1049 1145   977 2916 48851244013630 7514 4869 2086 1171  851                  ER   2501
  1956  799  681   771 1662 52001033011530 8919 4487 2159 1334  983                  ER   2501
  1957  726  615   692 1859 8800 9600 8115 7353 5390 3079 1658 1165                  ER   2501
  1958 1246 1071  1055 3112 9005142701467010270 5466 2546 1230 1163                  ER   2501
  1959 1079  922   902 1536 39721421013880 7523 4711 2657 1954 1304                  ER   2501
  1960  870  928  1174 1591 3854 907914410 8859 4082 2328 1255  889                  ER   2501
  1961  871  773   991 1068 6060135101031010670 4311 2910 1320 1200                  ER   2501
  1962  886  852   683 1550 4320 923011700 9980 5310 2490 1620  989                  ER   2501
  1963  793  790  1120 3110 4600123001490010900 6970 3160 1330 1040                  ER   2501
  1964 1030  896   758 1300 60501660014600 7370 5640                                 ER   2501
                                                                                          9999
       2403 2501       0  0  0  0  1  1  1  1  1  1  0  0
       CLEARWATER RIVER ABOVE LIMESTONE CREEK                                        ER   2403
        JAN FEB  MAR  APR  MAY  JUN  JUL  AUG  SEPT OCT  NOV  DEC                    ER   2403
  1959                          1386 1379  732  586  425                             ER   2403
  1960                      387  909 1090  707  391  288                             ER   2403
  1961                      660 1080  742  842  432  350                             ER   2403
  1962                      616  858  941  767  495  320                             ER   2403
  1963                      397 1240 1730  987  634  362                             ER   2403
  1964                      903 2180 1610  678  601  457                             ER   2403
                                                                                          9999
       9999
```

SAMPLE OUTPUT

NOV. 04 65

NORTH SASKATCHEWAN RIVER NEAR ROCKY MOUNTAIN 2501

DEVIATIONS FROM MTH MEAN LOGS

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1959	0.000	0.000	0.000	0.000	9.000	.066	.022	-.082	-.033	-.005	0.000	0.000
1960	0.000	0.000	0.000	0.000	-.103	-.128	.038	-.011	-.095	-.063	0.000	0.000
1961	0.000	0.000	0.000	0.000	.092	.044	-.106	.068	-.071	.033	0.000	0.000
1962	0.000	0.000	0.000	0.000	-.054	-.120	-.051	.039	.018	-.034	0.000	0.000
1963	0.000	0.000	0.000	0.000	-.026	.003	.053	.078	.136	.069	0.000	0.000
1964	0.000	0.000	0.000	0.000	.092	.134	.044	-.091	.044	9.000	0.000	0.000

CLEARWATER RIVER ABOVE LIMESTONE CREEK 2403

DEVIATIONS FROM MTH MEAN LOGS

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1959	0.000	0.000	0.000	0.000	9.000	.058	.061	-.027	.056	.089	0.000	0.000
1960	0.000	0.000	0.000	0.000	-.162	-.124	-.040	-.042	-.119	-.079	0.000	0.000
1961	0.000	0.000	0.000	0.000	.069	-.049	-.207	.033	-.076	.004	0.000	0.000
1962	0.000	0.000	0.000	0.000	.039	-.149	-.104	-.006	-.017	-.033	0.000	0.000
1963	0.000	0.000	0.000	0.000	-.151	.010	.160	.102	.090	.019	0.000	0.000
1964	0.000	0.000	0.000	0.000	.205	.255	.129	-.060	.067	9.000	0.000	0.000

CORRELATION CONSTANTS

CLEARWATER RIVER ABOVE LIMESTONE CREEK 2403

NORTH SASKATCHEWAN RIVER NEAR ROCKY MOUNTAIN 2501

SLOPE= 1.153 INTERCEPT= 0.000 R= .802 SE= .063 SD= .107 COR 2403/2501

MEAN MTHLY LOGS, MTHS 1-12, STA 2403

0.000 0.000 0.000 0.000 2.750 3.083 3.077 2.891 2.711 2.539 0.000 0.000

MEAN MTHLY LOGS, MTHS 1-12, STA 2501

0.000 0.000 0.000 0.000 3.689 4.086 4.120 3.959 3.706 3.430 0.000 0.000

TOTX= 0.000 TOTY= 0.000 DTXX= .183 DTYY= .378 DTXY= .211

REFERENCE

Langbein, W.B., 1960. Hydrologic data networks and methods of extrapolating or extending available hydrologic data. Hydrologic Networks and Methods. W.M.O. Flood Control Series No. 15.

```
   22 IF(Y(I,M))23,30,24                                                LACOR
   23 PAUSE 203                                                         LACOR
      Y(I,M)=0.0                                                        LACOR
      GO TO 30                                                          LACOR
C     IF X AND Y BOTH +VE, ACCUMULATE LOG SUMS                          LACOR
   24 XTEMP(I,M)=X(NX,M)                                                LACOR
      IF(XTEMP(I,M)-1.0)26,25,26                                        LACOR
   25 XTEMP(I,M)=1.00001                                                LACOR
   26 XTEMP(I,M)=0.43429448*LOGF(XTEMP(I,M))                            LACOR
      SUMX(M)=SUMX(M)+XTEMP(I,M)                                        LACOR
   29 Y(I,M)=0.43429448*LOGF(Y(I,M))                                    LACOR
      SUMY(M)=SUMY(M)+Y(I,M)                                            LACOR
      ZY(M)=ZY(M)+1.0                                                   LACOR
      MZYR=MZYR+1                                                       LACOR
   30 CONTINUE                                                          LACOR
      IF(MZYR)31,12,31                                                  LACOR
   31 CONTINUE                                                          LACOR
      PUNCH 114,IYSTA,IXSTA                                             LACOR
      IYEND=20                                                          LACOR
   79 CALL RNOUT                                                        LACOR
C     COMPUTE MEANS                                                     LACOR
   81 DO 34 M=1,12                                                      LACOR
      IF(MACT(M))82,32,82                                               LACOR
   82 IF(ZY(M))32,32,33                                                 LACOR
   32 XMEAN(M)=0.0                                                      LACOR
      YMEAN(M)=0.0                                                      LACOR
      GO TO 34                                                          LACOR
   33 XMEAN(M)=SUMX(M)/ZY(M)                                            LACOR
      YMEAN(M)=SUMY(M)/ZY(M)                                            LACOR
   34 CONTINUE                                                          LACOR
C     COMPUTE DEVIATIONS AND ACCUMULATE SUMS                            LACOR
   39 TOTY=0.0                                                          LACOR
      TOTX=0.0                                                          LACOR
      TOTYY=0.0                                                         LACOR
      TOTXX=0.0                                                         LACOR
      TOTXY=0.0                                                         LACOR
      T=0.0                                                             LACOR
      DO 42 M=1,12                                                      LACOR
      IF(MACT(M))84,42,84                                               LACOR
   84 DO 42 I=1,IYEND                                                   LACOR
      IF(XTEMP(I,M))41,40,41                                            LACOR
   40 XTEMP(I,M)=9.0                                                    LACOR
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      Y(I,M)=9.0                                                        LACOR
      GO TO 42                                                          LACOR
   41 XTEMP(I,M)=XTEMP(I,M)-XMEAN(M)                                    LACOR
      Y(I,M)=Y(I,M)-YMEAN(M)                                            LACOR
      T=T+1.0                                                           LACOR
      TOTX=TOTX+XTEMP(I,M)                                              LACOR
      TOTY=TOTY+Y(I,M)                                                  LACOR
      TOTXX=TOTXX+(XTEMP(I,M)**2)                                       LACOR
      TOTYY=TOTYY+(Y(I,M)**2)                                           LACOR
      TOTXY=TOTXY+(XTEMP(I,M)*Y(I,M))                                   LACOR
   42 CONTINUE                                                          LACOR
C     PRINT DEVIATIONS IF NECESSARY                                     LACOR
      IF(MODE-1)46,43,43                                                LACOR
   43 PUNCH 107                                                         LACOR
      PUNCH 122,IXSTA                                                   LACOR
      PUNCH 109                                                         LACOR
      PUNCH 108                                                         LACOR
      DO 44 I=1,IYEND                                                   LACOR
   44 PUNCH 110,IYYR(I),(XTEMP(I,M),M=1,12)                             LACOR
      PUNCH 107                                                         LACOR
      PUNCH 123,IYSTA                                                   LACOR
      PUNCH 109                                                         LACOR
      PUNCH 108                                                         LACOR
      DO 45 I=1,IYEND                                                   LACOR
   45 PUNCH 110,IYYR(I),(Y(I,M),M=1,12)                                 LACOR
C     COMPUTE CORRELATION CONSTANTS                                     LACOR
   46 DTYY=TOTYY-(TOTY**2)/T                                            LACOR
      DTXX=TOTXX-(TOTX**2)/T                                            LACOR
      DTXY=TOTXY-(TOTX*TOTY)/T                                          LACOR
      R=((DTXY**2)/(DTYY*DTXX))**0.5                                    LACOR
      SLOPE=DTXY/DTXX                                                   LACOR
      PT=(TOTY-SLOPE*TOTX)/T                                            LACOR
      SD=(DTYY/(T-1.0))**0.5                                            LACOR
      SE=SD*(1.0-R**2)**0.5                                             LACOR
C     CORRELATION CONSTANTS OUTPUT                                      LACOR
      PUNCH 107                                                         LACOR
      PUNCH 112                                                         LACOR
      PUNCH 123,IYSTA                                                   LACOR
      PUNCH 122,IXSTA                                                   LACOR
      PUNCH 113,SLOPE,PT,R,SE,SD,IYSTA,IXSTA                            LACOR
      PUNCH 102,IYSTA                                                   LACOR
      PUNCH 111,(YMEAN(M),M=1,12)                                       LACOR
```