AgRISTARS

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JSC-18599

Early Warning and Crop Condition Assessment

A Joint Program for Agriculture and Resources Inventory Surveys Through Aerospace Remote Sensing

January 1983

METCOR4 - A PROGRAM TO SIMULATE METSAT DATA

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Job Order 72-456

This report describes the Alarm Development activities of the Early Warning project of the AgRISTARS program

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LOCKHEED ENGINEERING AND MANAGEMENT SERVICES COMPANY, INC.

Under Contract NAS 9-15800

For

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15. Supplementary Notes

The Agriculture and Resources Inventory Surveys Through Aerospace Remote Sensing is a joint program of the U.S. Department of Agriculture, the National Aeronautics and Space Administration, the National Oceanic and Atmospheric Administration (U.S. Department of Commerce), the Agency for International Development (U.S. Department of State), and the U.S. Department of the Interior.

18. Abstract

METCOR4 extracts radiation data from computer tapes provided by J. V. Dave and computes radiance as would be recorded by the NOAA6 and NOAA7 meteorological satellites (Metsat). Three different atmospheres, each with different aerosol concentration, are considered with the viewing geometry of the satellites and the expected solar geometry.

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PREFACE

The Agriculture and Resources Inventory Surveys Through Aerospace Remote Sensing (AgRISTARS) program is a multiyear program of research, development, evaluation, and application of aerospace remote sensing for agricultural resources, which began in fiscal year 1980. This program is a cooperative effort of the U.S. Department of Agriculture, the National Aeronautics and Space Administration, the National Oceanic and Atmospheric Administration (U.S. Department of Commerce), the Agency for International Development (U.S. Department of State), and the U.S. Department of the Interior.

CONTENTS

ACRONYMS

AgRISTARS	Agriculture Resources Inventory Surveys Through Aerospace Remote Sensing
CMS	Conversation Monitor System
EODL	Earth Observations Data Laboratory
JSC	Lyndon B. Johnson Space Center
Metsat	meteorological satellite
NASA	National Aeronautics and Space Administration

1. GENERAL INFORMATION

1.1 SYSTEM NAME

This program is METCOR4, a program to simulate data from the visible and infrared bands of the meteorological satellites (Metsat's).

1.2 PRIMARY USER

The primary user of this system is the Early Warning/Crop Condition Assessment project of the Agriculture and Resources Inventory Surveys Through Aerospace Remote Sensing (AgRISTARS) program.

1.3 DEVELOPING ORGANIZATION

Personnel of Lockheed Engineering and Management Services Company, Inc., (LEMSCO) developed the software that is reported in this document.

1.4 COMPUTER FACILITY

This program runs under the Conversation Monitor System (CMS) on the AS/3000 in the Earth Observation Data Laboratory (EODL) computer facility at the National Aeronautics and Space Administration (NASA), Lyndon B. Johnson Space Center (JSC), Houston, Texas.

2. PROGRAM DESCRIPTION

2.1 PURPOSE OF PROGRAM

The purpose of the program is to establish applicability of the J. V. Dave dataset (ref. 1) for simulating the radiances recorded by satellites, considering the interaction between atmosphere and geometry effects. The Dave dataset is used especially to investigate the uncertainty in interpretation of output at the extremities of the Metsat scanline.

2.2 USAGE

The computer program resides in UIC FR100 on the AS/3000 CMS computer system located at NASA-JSC, Building 17. The METCOR4 FORTRAN program is provided in appendix A. It is controlled by an EXEC program which establishes input and output file designations. The METCOR4 EXEC program is presented in appendix B.

METCOR4 is executed by typing METCOR4 N1 N2 N3 N4, where N1 and N2 are the top and bottom atmosphere tape numbers, N3 = run number, and N4 = model number. N3 and N4 should be carefully selected to preserve files as controlled by the EXEC. In appendix C is the list of tapes.

3. INPUT

3.1 TAPES

Two tapes from the EODL Library will be mounted with the TAPMOUNT instructions. The two tapes are those with Dave's data at the top and bottom of one of five models of atmospheres. The top tape is designated as TAP1 and the bottom tape as TAP2 on the TAPMOUNT; e.g., TAPMOUNT 7670 TAP1 RO 1600.

3.2 TERMINAL

The program interacts with the user, asking for the solar zenith angle and the delazimuth angle of the target. (Delazimuth is the horizontal angle between the scanline direction and the solar plane direction.)

4. PROCESSING

4.1 INTERACTIVE

The program is designed to be operated in the interactive mode. The user should organize runs to rewind the sets of two tapes repeatedly until all combinations of viewing and solar geometry are satisfied for the model being exercised.

4.2 ERROR

When reading the tapes and a read error occurs, a message is written on the terminal. The message specifies the unit number, spectral interval, and solar angle of the record error. The processing is halted if error is encountered when the spectral interval is within either of the Metsat band's spectral limits.

4.3 EXECUTION FLOWCHART

A flowchart of the model is provided in figure 4-1.

5. OUTPUT

All output is written to disk files as controlled by the EXEC program:

Unit	File name
3	SORTX MODELY
6	MYMSG LIST
7	DAVEMET MODEL
8	TESTX OUTY
9	WVL78 S191 (Not used)

Unit 9 is obsolete, having been used to perform a simulation of data in a spectral interval of the S191 Skylab spectrometer. Output of units 6 and 8 is used to check program performance. The processed data of the program are written on unit 7. The completed files consists of 216 records (12 sets of 18 lines of data). The 18 lines of data consist of 18 look angles on the scan-line. The 12 sets are derived from the two Sun angles bracketing the input solar zenith angle, two bands of Metsat, and the three reflectance values: 0, 0.15, and 0.30.

Each record is defined as follows:

Column	Type of data
3-12	Pixel position on scanline
13-22	Radiance (mW/cm^2-micron-steradian)
23-28	Solar zenith angle (degrees)
29-35	Band number
36-43	Surface reflectance
44-51	

These records are sorted such that each set of 18 lines of data is referenced where X is the run number and Y is the model number of the atmosphere model.

6. REFERENCES

1. Dave, J. V.: Extensive Datasets of the Diffuse Radiation in Realistic Atmosphere Models with Aerosol and Common Absorbing Gases. Solar Energy, Vol. 21, 1978, pp. 361-369.

APPENDIX A

METCOR4 FORTRAN PROGRAM

```
C ********************************************************************** MET00010
C *                                                                    * MET00020
C *      VERSION  4   THIS PROGRAM PRODUCES A METSAT DATA SET  FROM    * MET00030
C *   THE RADIATION INTENSITY TABLES OF J. V. DAVE                     * MET00040
C *    THIS VERSION COMPUTES LOCATION OF DATA IN TABLE FROM INPUT      * MET00050
C *                                                                    * MET00060
C ********************************************************************** MET00070
C                                                                        MET00080
      DIMENSION TRANS(17,2),A(3,4,2,9),B(3,4,2,9),C(3,4,2,9),INXTR(17,2)MET00090
     *,NT(2),E(680),ESTAR(20),EST(9),EI(18),EIST(9)                     MET00100
     *,IIZ(20),ARC(9),BL(3,4,2,9),CL(3,4,2,9)                           MET00110
     * ,RADIZ(9),SFCREF(3),SHORT1(8),SHORT2(8),EIST1(8)                 MET00120
      EQUIVALENCE (EI(2),SHORT1(1)),(EIST(2),EIST1(1)),(EI(11),SHORT2(1)MET00130
     *)                                                                 MET00140
       INTEGER ZELO,ZEHI,AZLO,AZHI                                      MET00150
      INTEGER SOLANG(7)                                                 MET00160
      REAL LAT,LONG,IZ                                                  MET00170
      DATA SOLANG /0,30,45,60,70,75,80/                                 MET00180
      DATA IIZ /90,89,88,87,86,85,83,81,79,77,75,70,65,60,50,40,30,     MET00190
     * 20,10,0/                                                         MET00200
      DATA SFCREF /.0375,.075,.1125/                                    MET00210
      DATA A/216*0.0/                                                   MET00220
      DATA B/216*0.0/                                                   MET00230
      DATA BL/216*0.0/                                                  MET00240
C     DATA TM/2*0.0/                                                    MET00250
      DATA NT /9,17/                                                    MET00260
      INTEGER AZZ,DELAZI,ZE,ZEN,AZ                                      MET00270
      DATA INXTR /1,2,3,4,5,6,7,8,9,8*0,8,9,10,11,12,13,14,15,          MET00280
     * 16,17,18,19,20,21,22,23,24/                                      MET00290
      DATA TRANS /.10,.60,.78,.82,.97,.95,.80,.10,.03,8*0.,             MET00300
     * .28,.78,.97,.99,.995,.99,.99,.94,.88,.87,.86,.86,.84,.78,.65,.37 MET00310
     *,.10/                                                             MET00320
      WRITE(16,195)                                                     MET00330
 195  FORMAT(' WRITE SOLAR ZENITH ANGLE ,AZIMUTHANGLE BETWEEN'          MET00340
     *,/, ' SCANLINE AND SOLAR PLANE,2I4')                              MET00350
      READ(15,196)ZEN,DELAZI                                            MET00360
 196  FORMAT(2I4)                                                       MET00370
C     WRITE(16,197)                                                     MET00380
C197  FORMAT( 'WRITE LATITUDE,LONGITUDE,DAY OF YEAR,TIME OF DAY,4F6.1') MET00390
C     READ(15,198)LAT,LONG,DOY,TIME                                     MET00400
C198  FORMAT(4F6.1)                                                     MET00410
C     CALL EPHEM (LAT,LONG,DOY,TIME,IZZ,AZZ)                           MET00420
C    PIX = PIXEL POSITION ON SCANLINE'                                 MET00430
C    ZEN = SOLAR ZENITH ANGLE                                          MET00440
C    AZZ = SOLAR AZIMUTH ANGLE, REFERENCE NORTH                        MET00450
C    DELAZI = DELTA AZIMUTH;SOLAR AZIMUTH - SCANLINE AZIMUTH           MET00460
C    IZ = LOOK ANGLE FROM SURFACE TO SATELLITE                         MET00470
C     CALL SATANG (LAT,LONG,METSAT,IZ,SCNANG,PIX)                      MET00480
      NU=99                                                             MET00490
C    KK1 = WORD SKIP TO AZIMUTH COLUMN (DELTA SUN, LOOK PLANES)        MET00500
C    ZE = WORD SKIP TO LOOK ANGLE                                      MET00510
C  NL =  LOCATION OF 1ST WORD IN EI ARRAY                              MET00520
      ZE = 12                                                           MET00530
      IZE = 11                                                          MET00540
      DO 1 I = 12,20                                                    MET00550
      IF(IZ.GT.IIZ(I)) GO TO 30                                         MET00560
   1  IZE =I                                                            MET00570
  30  CONTINUE                                                          MET00580
      M=0                                                               MET00590
      CALL BRACKT (ZEN,DELAZI,ZEHI,ZELO,AZHI,AZLO)                      MET00600
      IF(ZELO.EQ.0)ZELO=1                                               MET00610
      KK1 = 20 * (AZLO - 1)                                             MET00620
      KK2 = 20 * (AZHI -1)                                              MET00630
      NL = KK1 + ZE                                                     MET00640
      NL2 = KK2 + ZE                                                    MET00650
      DATA ARC/0.,165.9,327.8,488.8,645.6,795.3,933.2,978.,1023.5/      MET00660
      DO 100 I = 1,39                                                   MET00670
C                                                                       MET00680
C    READ ONLY DATA RECORDS WHICH CONTAIN SPECTRAL INTERVALS WITHIN     MET00690
C     NOAA6 - NOAA7 BANDS 1 AND 2.                                      MET00700
C                                                                       MET00710
      IF(I.LT.16.OR.I.GT.39)GO TO 80                                    MET00720
      M = M + 1                                                         MET00730
C     WRITE(16,70)I,M                                                   MET00740
 70   FORMAT(2X,' CHECKPOINT ',2I5)                                     MET00750
C                                                                       MET00760
C    READ  RECORDS, FOR SOLAR ZENITH ANGLES                            MET00770
C    FRM TWO TAPES, ONE FOR THE TOP AND ONE FOR THE BOTTOM OF THE ATMOSPHMET00780
C                                                                       MET00790
```

```
      IF(K.EQ.MX)WRITE(7,93) ARCPIX,C(N,J,L,II),SOLANG(J),L,SFCREF(N)    MET01590
      ARCL=1024.5-ARC(II)                                               MET01600
C     IF(I.EQ.29)                                                       MET01610
C    * WRITE(9,99) I,J,K,L,M,N,IT,RL,RF,AL,TRANS(K,L),A(N,J,L,II),EST(ITMET01620
C    *),CK1,CK2,CK3,CK4                                                 MET01630
C99     FORMAT(7I5,/,2X,1P6E12.5,/,30X,1P4E12.5)                       MET01640
      IF(K.EQ.MX)WRITE(7,93)ARCL,CL(N,J,L,II),SOLANG(J),L,SFCREF(N)     MET01650
93     FORMAT(2X,F10.2,F10.6,2I6,F7.4)                                  MET01660
 4    CONTINUE                                                          MET01670
 5    CONTINUE                                                          MET01680
      GO TO 20                                                          MET01690
 10   CONTINUE                                                          MET01700
 20   CONTINUE                                                          MET01710
 50   CONTINUE                                                          MET01720
      GO TO 100                                                         MET01730
C                                                                       MET01740
C   SKIP OVER SPECTRAL INTERVALS NOT IN METSAT BANDS                    MET01750
C                                                                       MET01760
 80   DO 85 J=1,7                                                       MET01770
      NU=1                                                              MET01780
      READ(NU,91,ERR=501) IDUM                                          MET01790
 91   FORMAT(I4)                                                        MET01800
 89    CONTINUE                                                         MET01810
      NU=2                                                              MET01820
      READ(NU,92,ERR=502) IDUM,DUM                                      MET01830
 92   FORMAT(I14/1PE10.3)                                               MET01840
 85   CONTINUE                                                          MET01850
C     WRITE(16,70)I,J                                                   MET01860
 100  CONTINUE                                                          MET01870
      GO TO 1000                                                        MET01880
C                                                                       MET01890
C   ERROR EXITS                                                         MET01900
C                                                                       MET01910
 500  WRITE(16,94) NU,I,J                                               MET01920
 94   FORMAT(' READ ERROR ON UNIT ',I1,' AT SPECTRAL INTERVAL ',I2,     MET01930
     *' SOLAR ANGLE ',I1)                                               MET01940
      GO TO 1000                                                        MET01950
 501  WRITE(16,94)NU,I,J                                                MET01960
      READ(1,91)IDUM                                                    MET01970
      GO TO 89                                                          MET01980
 502  WRITE(16,94)NU,I,J                                                MET01990
      READ(2,92)IDUM,DUM                                                MET02000
      GO TO 85                                                          MET02010
 1000 CONTINUE                                                          MET02020
      REWIND 7                                                          MET02030
      CALL SORT4                                                        MET02040
      STOP                                                              MET02050
      END                                                               MET02060
      SUBROUTINE BRACKT (IZ,AZI,ZEHI,ZELO,AZHI,AZLO)                    MET02070
C   THIS SUBROUTINE COMPUTES THE LOCATION IN THE DAVE DATASET OF THE     MET02080
C    RADIANCE VALUES GIVEN BY THE SOLAR ZENITH ANGLE, AND               MET02090
C    THE DELTA AZIMUTH ANGLE.                                           MET02100
C   THE HIGH AND LOW PARAMETERS BRACKETING THE DESIRED IS COMPUTED.     MET02110
      INTEGER ZEHI,ZELO,AZHI,AZLO,ZI(7),AZZ(34),AZI                     MET02120
      DATA ZI /0,30,45,60,70,75,80/                                     MET02130
      DATA AZZ /0,1,2,3,4,5,6,7,8,9,10,12,14,16,18,20,25,30,35,40,      MET02140
     *50,60,70,80,90,100,110,120,130,140,150,160,170,180/               MET02150
C     IZ = SOLAR ZENITH ANGLE                                           MET02160
C     AZI = AZIMUTH ANGLE BETWEEN SCAN LINE ANDD SOLAR PLANE DEFINED    MET02170
C     BY SURFACE  POINT, SUN, AND EARTH CENTER.                         MET02180
C                                                                       MET02190
      ZEHI=2                                                            MET02200
      ZELO=1                                                            MET02210
       DO 200 JJ =1,7                                                   MET02220
      IF(IZ.GE.ZI(JJ))GO TO 200                                         MET02230
      ZEHI = JJ                                                         MET02240
      ZELO = JJ-1                                                       MET02250
      GO TO 201                                                         MET02260
  200 CONTINUE                                                          MET02270
      ZEHI = 7                                                          MET02280
      ZELO = 7                                                          MET02290
  201 IF (AZI.GT.180)AZI = AZI-180                                      MET02300
      AZHI = 34                                                         MET02310
      AZLO = 1                                                          MET02320
      IF(AZI.EQ.0)GO TO 20                                              MET02330
      DO 202 KK = 1,34                                                  MET02340
      IF(AZI.GE.AZZ(KK))GO TO 202                                       MET02350
      AZLO = KK - 1                                                     MET02360
      GO TO 203                                                         MET02370
```

APPENDIX B

METCOR4 EXEC PROGRAM

FILE: METCOR4 EXEC A

```
&CONTROL OFF
&IF &INDEX NE 4 &GOTO -EXPMSG
FIL 1 TAP1 (RECFM FB LRECL 10000 BLOCK 10000 PERM
FIL 2 TAP2 (RECFM FB LRECL 16750 BLOCK 16750 PERM
FIL 3 DISK SORT&4 MODEL&3 A (PERM
FIL 6 DISK MYMSG LIST (PERM
FIL 7 DISK DAVEMET4 MODEL (PERM
FIL 8 DISK TEST&4 OUT4 (PERM
FIL 9 DISK WVL78&4 S191&3 (PERM
FIL 15 TERMINAL (PERM
FIL 16 TERMINAL (PERM
LOAD METCOR4 (CLEAR
START
&IF &RETCODE = 0 &GOTO -CLOSE
L MYMSG LIST A1
&STACK RT
&TYPE EXECUTION ERROR,SEE MYMSG LIST FOR REASON
&EXIT
-CLOSE
&TYPE PROGRAM COMPLETED, PROCESSED DATA IN  SORT&4 MODEL&3
&EXIT
-EXPMSG
&BEGTYPE
    THE CALL FORMAT FOR THIS EXEC IS*

         METCOR4 &TAPE1 &TAPE2 ARG1 ARG2

         WHERE*
              &TAPE1 IS TOP  DAVE TAPE
              &TAPE2 IS BOTTOM DAVE TAPE
              ARG1 IS THE MODEL NO.
              ARG2 IS THE RUN NO.

&END
&EXIT
```

APPENDIX C

LIST OF TAPES IN DAVE DATASET

APPENDIX C

LIST OF TAPES IN DAVE DATASET[a]

EODL tape number	Layer, km	Atmospheric model no.	Aerosol	Ozone[d]	Water vapor[e]
7661	[b]0	1			
7662	1	1			
7663	2	1	0	0	0
7664	3	1			
7665	[c]60	1			
7666	0	2			
7667	1	2			
7668	2	2	0	0.308	2.96
7669	3	2			
7670	60	2			
7671	0	3			
7672	1	3			
7685	2	3	1.98 E-7	0.308	2.96
7673	3	3			
7674	60	3			
7675	0	4			
7676	1	4			
7677	2	4	9.907 E-8	0.308	2.96
7678	3	4			
7679	60	4			
7680	0	5			
7681	1	5			
7682	2	5	4.673 E-6	0.308	2.96
7683	3	5			
7684	60	5			

[a]The J. V. Dave dataset is defined in reference 1 of this document, including the terms aerosol, ozone, and water vapor.

[b]Bottom of atmosphere

[c]Top of atmosphere

[d]atm-cm

[e]gm cm^{-2}

APPENDIX D

METCOR OUTPUT: SORT50 MODEL2

FILE: SORT50 MODEL2 A CONVERSATIONAL MONITOR SYSTEM

1.00	1.634186	0	1	0
46.50	1.427841	0	1	0
91.30	1.296055	0	1	0
229.20	1.150999	0	1	0
378.90	1.086238	0	1	0
535.70	1.058517	0	1	0
696.70	1.048318	0	1	0
858.60	1.045205	0	1	0
1024.50	1.044661	0	1	0
1190.40	1.045205	0	1	0
1352.30	1.048318	0	1	0
1513.30	1.058517	0	1	0
1670.10	1.086238	0	1	0
1819.80	1.150999	0	1	0
1957.70	1.296055	0	1	0
2002.50	1.427841	0	1	0
2048.00	1.634186	0	1	0
1.00	7.733099	0	1	15
46.50	7.707852	0	1	15
91.30	7.699649	0	1	15
229.20	7.708914	0	1	15
378.90	7.733654	0	1	15
535.70	7.760238	0	1	15
696.70	7.783472	0	1	15
858.60	7.798358	0	1	15
1024.50	7.803283	0	1	15
1190.40	7.798358	0	1	15
1352.30	7.783472	0	1	15
1513.30	7.760238	0	1	15
1670.10	7.733654	0	1	15
1819.80	7.708914	0	1	15
1957.70	7.699649	0	1	15
2002.50	7.707852	0	1	15
2048.00	7.733099	0	1	15
1.00	13.925917	0	1	30
46.50	14.084682	0	1	30
91.30	14.202106	0	1	30
229.20	14.368214	0	1	30
378.90	14.483921	0	1	30
535.70	14.565695	0	1	30
696.70	14.622886	0	1	30
858.60	14.656089	0	1	30
1024.50	14.666564	0	1	30
1190.40	14.656089	0	1	30
1352.30	14.622886	0	1	30
1513.30	14.565695	0	1	30
1670.10	14.483921	0	1	30
1819.80	14.368214	0	1	30
1957.70	14.202106	0	1	30
2002.50	14.084682	0	1	30
2048.00	13.925917	0	1	30
1.00	2.242955	30	1	0
46.50	1.958941	30	1	0
91.30	1.759933	30	1	0
229.20	1.496898	30	1	0
378.90	1.324221	30	1	0
535.70	1.194996	30	1	0
696.70	1.088785	30	1	0
858.60	0.996970	30	1	0
1024.50	0.916794	30	1	0
1190.40	0.849322	30	1	0
1352.30	0.798777	30	1	0
1513.30	0.773268	30	1	0
1670.10	0.786518	30	1	0
1819.80	0.864490	30	1	0
1957.70	1.061969	30	1	0
2002.50	1.242573	30	1	0
2048.00	1.521702	30	1	0
1.00	7.480356	30	1	15
46.50	7.352441	30	1	15
91.30	7.259026	30	1	15
229.20	7.128589	30	1	15
378.90	7.032483	30	1	15
535.70	6.950408	30	1	15
696.70	6.872568	30	1	15
858.60	6.796087	30	1	15
1024.50	6.720684	30	1	15
1190.40	6.648436	30	1	15
1352.30	6.582558	30	1	15

FILE: SORT50 MODEL2 A CONVERSATIONAL MONITOR SYSTEM

535.70	0.275350	30	2	0
696.70	0.250427	30	2	0
858.60	0.228833	30	2	0
1024.50	0.209836	30	2	0
1190.40	0.193653	30	2	0
1352.30	0.181247	30	2	0
1513.30	0.174456	30	2	0
1670.10	0.176621	30	2	0
1819.80	0.193942	30	2	0
1957.70	0.240117	30	2	0
2002.50	0.283782	30	2	0
2048.00	0.353556	30	2	0
1.00	3.742671	30	2	15
46.50	3.761098	30	2	15
91.30	3.777215	30	2	15
229.20	3.799543	30	2	15
378.90	3.811279	30	2	15
535.70	3.814158	30	2	15
696.70	3.809824	30	2	15
858.60	3.799527	30	2	15
1024.50	3.784024	30	2	15
1190.40	3.764347	30	2	15
1352.30	3.740643	30	2	15
1513.30	3.713264	30	2	15
1670.10	3.682100	30	2	15
1819.80	3.646601	30	2	15
1957.70	3.606269	30	2	15
2002.50	3.583820	30	2	15
2048.00	3.561346	30	2	15
1.00	6.967194	30	2	30
46.50	7.078215	30	2	30
91.30	7.160689	30	2	30
229.20	7.269829	30	2	30
378.90	7.334575	30	2	30
535.70	7.370900	30	2	30
696.70	7.387217	30	2	30
858.60	7.388260	30	2	30
1024.50	7.376253	30	2	30
1190.40	7.353078	30	2	30
1352.30	7.318034	30	2	30
1513.30	7.270004	30	2	30
1670.10	7.205397	30	2	30
1819.80	7.116883	30	2	30
1957.70	6.989739	30	2	30
2002.50	6.900936	30	2	30
2048.00	6.785870	30	2	30