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August 1981

DESCRIPTION OF THE FORTRAN IMPLEMENTATION OF THE SPRING SMALL GRAINS PLANTING DATE DISTRIBUTION MODEL

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16. Abstract

The Spring Small Grains Planting Date Distribution Model has been coded in the Fortran programming language. In this document, program PLDRVR, which implements the model, is described in detail and a copy of the code is included in the appendix. Each subroutine is described in a separate section and includes information on its purpose, calling procedure, local variables, and input/output devices.

This document supplements the companion document, User's Guide to Spring Small Grains Planting Date Distribution Model, which contains a general description of the code and a test case input and output files.

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This report describes crop stage development estimation activities of the Supporting Research project of the AgRISTARS program.

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For

Earth Resources Research Division

Space and Life Sciences Directorate

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
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PREFACE

The Agriculture and Resources Inventory Surveys Through Aerospace Remote Sensing is a 6-year 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 National Aeronautics and Space Administration, the U.S. Agency for International Development, and the U.S. Departments of Agriculture, Commerce, and the Interior.

The work which is the subject of this document is performed within the Earth Resources Research Division, Space and Life Sciences Directorate, at the Lyndon B. Johnson Space Center, National Aeronautics and Space Administration. Under Contract NAS 9-15800, personnel of Lockheed Engineering and Management Services Company, Inc., performed the tasks which contributed to the completion of this research.

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1. INTRODUCTION

The computer program PLDRVR implements the Hodges-Artley Spring Small Grains Planting Date Distribution Model (ref. 1). This document supplements the user's guide (ref. 2) with detailed information with respect to the PLDRVR program. Sample input and output files are available in reference 2.

2. PROGRAM DESCRIPTION

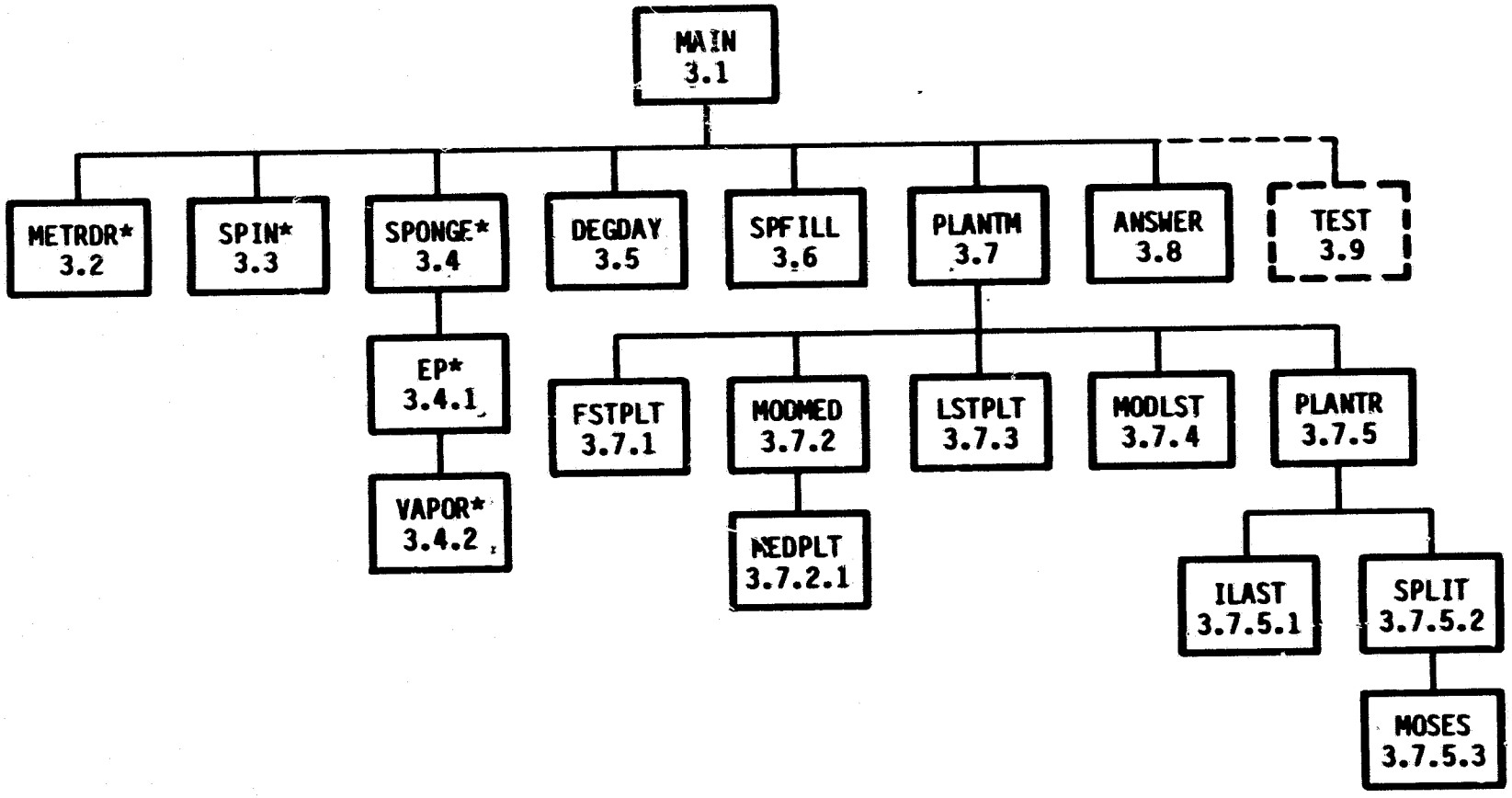
The PLDRVR program is written in the Fortran programming language. It was developed at the NASA Johnson Space Center on the Earth Observations Division Laboratory System AS/3000 computer. The system has an IBM Fortran-H compiler and the Conversational Monitoring System (CMS).

Figure 1 illustrates the arrangement of the program components. The program has four major parts: input (METRDR and SPIN); parameter calculation (SPONGE, DEGDAY, and SPFILL); planting model (PLANTM and its subprogram family); and output (ANSWER and, optionally, TEST). The main program calls each of these subroutines once during each iteration. The program stops when the end of the meteorological data file is reached.

Three intrinsic functions are utilized: MOD, the integer remaindering function, in SPLIT and MOSES; EXP, the exponential function, in VAPOR; and FLOAT, the integer-to-floating point conversion function, in MOSES.

Input is from two disk files which are defined in CMS as units 19 and 20. These files contain initial values for the sponge variable and meteorological data, respectively. Output is to two disk files which are defined in CMS as units 7 and 8. File 7 contains a year's list of the meteorological variables and model parameters to aid the verification of the implementation.

The PLDRVR program requires a virtual machine with less than one megabyte of storage. The amount of temporary disk space required to execute the program depends mainly on the size of the meteorological data set.



*The original code for these subprograms was written by M. H. Trenchard, Lockheed/EMSCO.

Figure 1.- Hierarchy of Subprograms in the PLDRVR program. Dashed/box denotes an optional subroutine. Numbers refer to the sections in which each subprogram is discussed.

3. COMPLETE SUBPROGRAM INFORMATION

A complete description of each subprogram in the PLDRVR program is included in this section. It should be noted that all variables are single precision and that there are no common blocks.

3.1 MAIN

The purpose of the MAIN program is to access the input, parameter calculating, model, and output subroutines for a location, and to return to the top of the program and repeat the process for each location in the meteorological data file.

CALLING PROCEDURE: Not applicable.

INPUT PARAMETERS: Not applicable.

OUTPUT PARAMETERS: Not applicable.

REFERENCED BY: Not applicable.

SUBPROGRAMS REFERENCED: Subroutines ANSWER, DEGDAY, METRDR, PLANTM, SPFILL, SPIN, SPONGE, and, optionally, TEST.

INPUT/OUTPUT DEVICES: None.

ARRAYS: MDL(100), PARMS(4,366), PLANT(22), and WX(6,366).

LOCAL VARIABLES: The following abbreviations are used in tables throughout this document:

A = alphanumeric
I = integer
R = real

Local variables for the MAIN program are as follows:

Name	Type	Description
CAP	R	Water-holding capacity of the sponge (moisture variable). Initialized in a data statement.
CRD	I	Crop reporting district of the segment.

Name	Type	Description
DIV	A	State climatological division of the weather station. Declared as an integer.
IPD	I	Initial planting date found by the model.
ISEG	I	Segment identification number.
LAT	R	Latitude of the weather station.
LPD	I	Last planting date found by the model.
MDL	I	100-element array of the planting days found by the model. All elements initialized to 0 in a data statement.
MPD	I	Median planting date found by the model.
NUMPD	I	The total number of planting dates found by the model.
PARMS	R	4-by-366 array of parameters used by the planting model. For PARMS (I,J), J is the day of year and I refers to a particular variable: 1, sponge-precipitation variable; 2, drought threshold for range-adjusted base 32°F growing degree days; 3, base 32°F growing degree days; and 4, range-adjusted base 32°F growing degree days. All elements are initialized to 9999 in a data statement.
PINDEX	I	Number of representative dates found by the model.
PLANT	I	22-element array of the representative dates found by the model.
SPINIT	R	Starting value for the sponge.
ST	I	State identification number for the segment.
WX	R	6-by-366 array of daily meteorological variables. For WX(I,J), J is the day of the year and I refers to a particular weather variable: 1, maximum temperature, °F; 2, minimum temperature, °F; 3, precipitation (liquid equivalent), inches; 4, defined by user; 5, defined by user; and 6, sponge value, inches. All elements initialized to 9999 in a data statement.
YR	I	Year of the weather data.

3.2 METRDR

The METRDR subroutine reads meteorological data for one location and year and puts them into the WX array, and ends the program after the last set of meteorological data has been read and run through the planting model.

CALLING PROCEDURE: CALL METRDR(ISEG,WX,LAT,DIV,YR,ST,CRD)

INPUT PARAMETERS: None.

OUTPUT PARAMETERS: CRD, DIV, ISEG, LAT, ST, WX, and YR

REFERENCED BY: The METRDR subroutine is referenced by the MAIN program.

SUBPROGRAMS REFERENCED: None.

INPUT/OUTPUT DEVICES: Unit 20, file of meteorological data for input.

ARRAYS: P(16), T(2,10), and WX(6,366)

LOCAL VARIABLES:

Name	Type	Description
CRD	I	Crop reporting district of the segment.
DIV	A	State climatological division of the weather station.
ISEG	I	Segment identification number.
IYR	I	Year of the weather data. Read from the data and control cards on unit 20.
J	I	DO loop index.
JD	I	Day of year.
K	I	Loop index.
LAT	R	Latitude of weather station.

Name	Type	Description
NCARDS	I	Loop counter of the number of data cards read from unit 20.
ND	I	Day-of-year counter.
P	I	16-element array for temporary holding of precipitation data.
ST	I	State identification number for the segment.
T	I	2-by-10 array for temporary holding of maximum and minimum temperatures. For T(I,J), J is the day of the year, I = 1 for maximum temperatures, and I = 2 for minimum temperatures.
WX	R	6-by-366 array of daily meterological variables. For WX (I,J), J is the day of the year and I refers to a particular weather variable: 1, maximum temperature, °F; 2, minimum temperature, °F; 3, precipitation (liquid equivalent), inches; 4, defined by user; 5, defined by user; and 6, sponge value, inches.
YR	I	Year for which weather data was obtained.

3.3 SPIN

The SPIN subroutine initializes the sponge at a given location and year, either at half-capacity or at a value read from a file.

CALLING PROCEDURE: CALL SPIN(STN,YR,SPINIT,CAP)

INPUT PARAMETERS: CAP, STN, YR

OUTPUT PARAMETERS: SPINIT

REFERENCED BY: The SPIN routine is referenced by the MAIN program.

SUBPROGRAMS REFERENCED: None.

INPUT/OUTPUT DEVICES: Unit 19, file of locations and values at which to initiate the sponge for a specific location.

ARRAYS: None.

LOCAL VARIABLES:

Name	Type	Description
CAP	R	Water-holding capacity of the sponge.
ID	I	Identification number of the sponge value in file 19.
SPINIT	R	Initial value for the sponge.
STN	R	Location identification number from MAIN program.
VALUE	R	Initial value of the sponge read from file 19.
YR	I	Year for which the weather data were obtained.

3.4 SPONGE

The SPONGE subroutine calculates daily values of the sponge and puts them into the WX array.

CALLING PROCEDURE: CALL SPONGE(WX,CAP,SPINIT)

INPUT PARAMETERS: CAP, SPINIT, and WX

OUTPUT PARAMETERS: WX (row 6 only)

REFERENCED BY: The SPONGE subroutine is referenced by the MAIN program.

SUBPROGRAMS REFERENCED: Function EP.

INPUT/OUTPUT DEVICES: None.

ARRAYS: WX(6,366)

LOCAL VARIABLES:

Name	Type	Description
CAP	R	Water-holding capacity of the sponge.
JD	I	DO loop index (day of year).
PPN	R	Daily precipitation value, inches.
SPINIT	R	Starting value for the sponge.
TN	R	Daily minimum temperature, °F.
TX	R	Daily maximum temperature, °F.
WX	R	6-by-366 array of daily meteorological variables. For WX(I,J), J is the day of the year and I refers to a particular weather variable: 1, maximum temperature, °F; 2, minimum temperature, °F; 3, precipitation (liquid equivalent), inches; 4, defined by user; 5, defined by user; and 6, sponge value, inches.

3.4.1 EP

The EP function estimates monthly pan evaporation from maximum and minimum temperatures using the Trenchard algorithm.

CALLING PROCEDURE: EP(TX,TN)

INPUT PARAMETERS: TN, TX

OUTPUT PARAMETERS: Not applicable.

REFERENCED BY: The EP function is referenced by subroutine SPONGE.

SUBPROGRAMS REFERENCED: Function VAPOR.

INPUT/OUTPUT DEVICES: None.

ARRAYS: None.

LOCAL VARIABLES:

Name	Type	Description
TN	R	Minimum temperature in °F.
TX	R	Maximum temperature in °F.

3.4.2 /APOR

The purpose of the VAPOR function is to calculate the saturation vapor pressure over water in millibars at a temperature in degrees Fahrenheit.

CALLING PROCEDURE: VAPOR(T)

INPUT PARAMETERS: T

OUTPUT PARAMETERS: Not applicable.

REFERENCED BY: The VAPOR function is referenced by function EP.

SUBPROGRAMS REFERENCED: Machine function EXP.

INPUT/OUTPUT DEVICES: None.

ARRAYS: None.

LOCAL VARIABLES:

Name	Type	Description
T	R	Temperature in °F.

3.5 DEGDAY

The purpose of the DEGDAY subroutine is to accumulate growing degree days and range-adjusted growing degree days from a starting date with a specified base temperature and put the daily values into the PARMS array.

CALLING PROCEDURE: CALL DEGDAY(WX,START,BASE,PARMS)

INPUT PARAMETERS: BASE, START, AND WX

OUTPUT PARAMETERS: PARMS (rows 3 and 4)

REFERENCED BY: The DEGDAY subprogram is referenced by the MAIN program.

SUBPROGRAMS REFERENCED: None.

INPUT/OUTPUT DEVICES: None.

ARRAYS: PARMS(4,366) and WX(6,366)

LOCAL VARIABLES:

Name	Type	Description
BASE	R	Base temperature of the growing degree days.
DD	R	One day's degree day value.
I	I	DO loop index (day of year).
PARMS	R	4-by-366 array of parameters used by the planting model. For PARMS(I,J), J is the day of year and I refers to a particular variable: 1, sponge-precipitation variable; 2, drought threshold for range-adjusted base 32°F growing degree days; 3, base 32°F growing degree days; and 4, range-adjusted base 32°F growing degree days.
R2GDD	R	One day's range-adjusted degree day value.

Name	Type	Description
START	I	Day of year on which to begin degree day accumulation.
TM	R	Daily mean temperature.
TN	R	Daily minimum temperature.
TX	R	Daily maximum temperature.
WX	R	6-by-366 array of daily meteorological variables. For WX(I,J), J is the day of the year and I refers to a particular weather variable: 1, maximum temperature, °F; 2, minimum temperature, °F; 3, precipitation (liquid equivalent), inches; 4, defined by user; 5, defined by user; and 6, sponge value, inches.
Y	R	Cumulator of growing degree days.
Z	R	Cumulator of range-adjusted growing degree days.

3.6 SPFILL

The purpose of subroutine SPFILL is to calculate the drought threshold for the range-adjusted growing degree days and the sponge-precipitation variable and put their daily values into the PARMS array.

CALLING PROCEDURE: CALL SPFILL(WX,PARMS)

INPUT PARAMETERS: WX

OUTPUT PARAMETERS: PARMS (rows 1 and 2)

REFERENCED BY: The SPFILL subprogram is referenced by the MAIN program.

SUBPROGRAMS REFERENCED: None.

INPUT/OUTPUT DEVICES: None.

ARRAYS: PARMS(4,366) and WX(6,366)

LOCAL VARIABLES:

Name	Type	Description
DELT	I	Number of days since last increase or saturation in the sponge. Current day counts as one day.
I	I	DO loop index (day of year).
IB	I	First date of sponge wetting or saturation period.
IDAY	I	Day-of-year counter in determination or LASTSP.
INDEX	I	DO loop index (day of year).
LASTSP	I	Last day of sponge wetting or saturation period.

Name	Type	Description
PARMS	R	4-by-366 array of parameters used by the planting model. For PARMS(I,J), J is the day of year and I refers to a particular variable: 1, sponge-precipitation variable; 2, drought threshold for range-adjusted base 32°F growing degree days; 3, base 32°F growing degree days; and 4, range-adjusted base 32°F growing degree days.
PRE	R	Sum of daily precipitation during the period of in which the sponge is increased or saturated.
WX	R	6-by-366 array of daily meteorological variables. For WX(I,J), J is the day of the year and I refers to a particular weather variable: 1, maximum temperature, °F; 2, minimum temperature, °F; 3, precipitation (liquid equivalent), inches; 4, defined by user; 5, defined by user; and 6, sponge value, inches.

3.7 PLANTM

The purpose of the PLANTM subroutine is to serve as a driver for the planting model subprograms.

CALLING PROCEDURE: CALL PLANTM(WX,PARMS,IPD,MPD,LPD,PLANT,PINDEX,MDL,NUMPD)

INPUT PARAMETERS: PARMS and WX

OUTPUT PARAMETERS: IPD, LPD, MDL, MPD, NUMPD, PINDEX, and PLANT

REFERENCED BY: The PLANTM subroutine is referenced by the MAIN program.

SUBPROGRAMS REFERENCED: Integer functions FSTPLT, LSTPLT, and MODLST and subroutines MODMED and PLANTR.

INPUT/OUTPUT DEVICES: None.

ARRAYS: MDL(100), PARMS(4,366), PLANT(22), and WX(6,366)

LOCAL VARIABLES:

Name	Type	Description
IPD	I	Initial planting date found by the model (original and final estimates).
LPD	I	Last planting date found by the model.
MDL	I	100-element array of the planting days found by the model.
MPD	I	Median planting date found by the model.
N	I	Number of modeled planting days between the first planting date and the median date.
NEWPD	I	Revised estimate of the initial planting date (includes the check for drought).

Name	Type	Description
NUMPD	I	Initially, the number of planting dates between the median and the last planting dates (12 in the nondrought situation). It is then added with N to give the total number of planting dates found by the model.
PARMS	R	4-by-366 array of parameters used by the planting model. For PARMS(I,J), J is the day of year and I refers to a particular variable: 1, sponge-precipitation variable; 2, drought threshold for range-adjusted base 32°F growing degree days; 3, base 32°F growing degree days; and 4, range-adjusted base 32°F growing degree days.
PINDEX	I	Number of representative dates found by the model.
PLANT	I	22-element array of the representative dates found by the model.
WX	R	6-by-366 array of daily meteorological variables. For WX(I,J), J is the day of the year, and I refers to a particular weather variable: 1, maximum temperature, °F; 2, minimum temperature, °F; 3, precipitation (liquid equivalent), inches; 4, defined by user; 5, defined by user; and 6, sponge value, inches.

3.7.1 FSTPLT

The purpose of the integer function FSTPLT is to find the first planting date by either of two algorithms (with or without the drought adaptation).

CALLING PROCEDURE: FSTPLT(WX,PARMS,ITYPE)

INPUT PARAMETERS: ITYPE, PARMS, and WX

OUTPUT PARAMETERS: Not applicable.

REFERENCED BY. The FSTPLT integer function is referenced by the PLANTM subprogram.

SUBPROGRAMS REFERENCED: None.

INPUT/OUTPUT DEVICES: None.

ARRAYS: PARMS(4,366) and WX(6,366)

LOCAL VARIABLES:

Name	Type	Description
ITYPE	I	Flag for algorithm type: 0, original algorithm (ref. 1); 1, modified algorithm for drought.
JD	I	DO loop index (day of year).
PARMS	R	4-by-366 array of parameters used by the planting model. For PARMS(I,J), J is the day of year and I refers to a particular variable: 1, sponge-precipitation variable; 2, drought threshold for range-adjusted base 32°F growing degree days; 3, base 32°F growing degree days; and 4, range-adjusted base 32°F growing degree days.

Name	Type	Description
WX	R	6-by-366 array of daily meteorological variables. For WX(I,J), J is the day of the year and I refers to a particular weather variable: 1, maximum temperature, °F; 2, minimum temperature, °F; 3, precipitation (liquid equivalent), inches; 4, defined by user; 5, defined by user; and 6, sponge value, inches.

3.7.2 MODMED

The purpose of the MODMED subroutine is to determine the number of planting days between the initial and median planting days and thus obtain the median planting date.

CALLING PROCEDURE: CALL MODMED(WX,PARMS,IPD,NEWPD,MPD,N)

INPUT PARAMETERS: IPD, NEWPD, PARMS, and WX

JUTPUT PARAMETERS: MPD and N

REFERENCED BY: The MODMED subroutine is referenced by subroutine PLANTM.

SUBPROGRAMS REFERENCED: Function MEDPLT.

INPUT/OUTPUT DEVICES: None.

ARRAYS: PARMS(4,366) and WX(6,366)

LOCAL VARIABLES:

Name	Type	Description
IPD	I	Initial planting date found by the model without a check for drought.
MPD	I	Median planting date found by the model.
N	I	Time in modeled planting dates between initial and median planting dates.
NEWPD	I	Revised estimate of the initial planting date (includes check for drought).

Name	Type	Description
PARMS	R	4-by-366 array of parameters used by the planting model. For PARMS(I,J), J is the day of year and I refers to a particular variable: 1, sponge-participation variable; 2, drought threshold for range-adjusted base 32°F growing degree days; 3, base 32°F growing degree days; and 4, range-adjusted base 32°F growing degree days.
WX	R	6-by-366 array of daily meteorological variables. For WX(I,J), J is the day of the year and I refers to a particular weather variable: 1, maximum temperature, °F; 2, minimum temperature, °F; 3, precipitation (liquid equivalent), inches; 4, defined by user; 5, defined by user; and 6, sponge value, inches.

3.7.2.1 MEDPLT

The purpose of the MEDPLT function is to established the median planting date as occurring a certain number of days after the first planting date.

CALLING PROCEDURE: MEDPLT(WX,PARMS,IPD,N)

INPUT PARAMETERS: IPD, N, PARMS, and WX

OUTPUT PARAMETERS: Not applicable.

REFERENCED BY: The MEDPLT function is referenced by subroutine MODMED.

SUBPROGRAMS REFERENCED: None.

INPUT/OUTPUT DEVICES: None.

ARRAYS: PARMS(4,366) and WX(6,366)

LOCAL VARIABLES:

Name	Type	Description
I	I	Counter of modeled planting dates.
IPD	I	Initial planting date found by the model.
N	I	Number of planting days between the initial and median planting days.
PARMS	R	4-by-366 array of parameters used by the planting model. For PARMS(I,J), J is the day of the year and I refers to a particular variable: 1, sponge-precipitation variable; 2, drought threshold for range-adjusted base 32°F growing degree days; 3, base 32°F growing degree days; and 4, range-adjusted base 32°F growing degree days.

Name	Type	Description
WX	R	6-by-366 array of daily meteorological variables. For WX(I,J), J is the day of the year and I refers to a particular weather variable: 1, maximum temperature, °F; 2, minimum temperature, °F; 3, precipitation (liquid equivalent), inches; 4, defined by user; 5, defined by user; and 6, sponge value, inches.

3.7.3 LSTPLT

The purpose of integer function LSTPLT is to establish the last planting date as occurring a certain number of days after the median.

CALLING PROCEDURE: LSTPLT(IFIRST,WX,PARMS,NUMPD)

INPUT PARAMETERS: IFIRST, NUMPD, PARMS, and WX

OUTPUT PARAMETERS: Not applicable.

REFERENCED BY: The LSTPLT integer function is referenced by subroutine PLANTM.

SUBPROGRAMS REFERENCED: None.

INPUT/OUTPUT DEVICES: None.

ARRAYS: PARMS(4,366) and WX(6,366)

LOCAL VARIABLES:

Name	Type	Description
IFIRST	I	Day from which to locate the last planting date.
JD	I	GO TO loop index (day of year).
N	I	Counter of modeled planting dates.
NUMPD	I	The number of planting dates between the median and final planting dates.
PARMS	R	4-by-366 array of parameters used by the planting model. For PARMS(I,J), J is the day of the year and I refers to a particular variable: 1, sponge-precipitation variable; 2, drought threshold for range-adjusted base 32°F growing days; 3, base 32°F growing degree days; and 4, range-adjusted base 32°F growing degree days.

Name	Type	Description
WX	R	6-by-366 array of daily meteorological variables. For WX(I,J), J is the day of the year and I refers to a particular weather variable: 1, maximum temperature, °F; 2, minimum temperature, °F; 3, precipitation (liquid equivalent), inches; 4, defined by user; 5, defined by user; and 6, sponge value, inches.

3.7.4 MODLST

The purpose of integer function MODLST is to check for drought on the last planting day, and, if there is a drought, to recalculate the last planting day.

CALLING PROCEDURE: MODLST(WX,PARMS,LDAY,NUMPD)

INPUT PARAMETERS: LDAY, NUMPD, PARMS, and WX

OUTPUT PARAMETERS: NUMPD

REFERENCED BY: The MODLST integer function is referenced by subroutine PLANTM.

SUBPROGRAMS REFERENCED: None.

INPUT/OUTPUT DEVICES: None.

ARRAYS: PARMS(4,366) and WX(6,366)

LOCAL VARIABLES:

Name	Type	Description
FLAG	I	Precipitation event flag.
I	I	DO loop index (day of year).
JD	I	GO TO loop index (day of year).
LDAY	I	Initial estimate of the last planting date.
NUMPD	I	The number of planting dates between the median and final dates.

Name	Type	Description
PARMS	R	4-by-366 array of parameters used by the planting model. For PARMS(I,J), J is the day of year and I refers to a particular variable: 1, sponge-precipitation variable; 2, drought threshold for range-adjusted base 32°F growing degree days; 3, base 32°F growing degree days; and 4, range-adjusted base 32°F growing degree days.
WX	R	6-by-366 array of daily meteorological variables. For WX(I,J), J is the day of the year and I refers to a particular weather variable: 1, maximum temperature, °F; 2, minimum temperature, °F; 3, precipitation (liquid equivalent), inches; 4, defined by user; 5, defined by user; and 6, sponge value, inches.

3.7.5 PLANTR

The purpose of the PLANTR subroutine is to determine the series (strings) of consecutive planting days within the planting period and to obtain dates which represent the strings and the planting period.

CALLING PROCEDURE: CALL PLANTR(WX,PARMS,ISTART,MEDIAN,PLANT,PINDEX,NUMPD,MDL)

INPUT PARAMETERS: ISTART, MEDIAN, NUMPD, PARMS, and WX

OUTPUT PARAMETERS: MDL, PINDEX, and PLANT

REFERENCED BY: The PLANTR subroutine is referenced by subroutine PLANTM.

SUBPROGRAMS REFERENCED: Subroutines ILAST and SPLIT.

INPUT/OUTPUT DEVICES: None.

ARRAYS: IFIRST(22), LAST(22), LENGTH(22), MDL(100), PARMS(4,366), PLANT(22), and WX (6,366)

LOCAL VARIABLES:

Name	Type	Description
I	I	DO loop index and index of modeled planting date strings.
IFIRST	I	22-element array of first dates in each string of planting dates.
IIIPD	I	Third representative date for a string of planting dates.
IIPD	I	Second representative date for a string of planting dates.
IN1	I	Length of time (days) between a solitary planting date and the end of the previous string of planting dates.
IN2	I	Length of time (days) between a solitary planting date and the beginning of the next string of planting dates.

Name	Type	Description
IPD	I	First representative date for a string of planting dates.
ISTART	I	Initial planting date found by the model.
LAST	I	22-element array of last dates in each string of planting dates.
LENGTH	I	22-element array of the number of days in each string of planting dates.
LTOTAL	I	Total number of planting days [the sum of the length (I)'s].
MDL	I	100-element array of the planting days found by the model.
MEDIAN	I	Median planting date found the model.
NSTRNG	I	Number of strings of planting dates.
NUMPD	I	The total number of planting dates to be found by the model.
PARMS	R	4-by-366 array of parameters used by the planting model. For PARMS(I,J), J is the day of year and I refers to a particular variable: 1, sponge-precipitation variable; 2, drought threshold for range-adjusted base 32°F growing degree days; 3, base 32°F growing degree days; and 4, range-adjusted base 32°F growing degree days.
PINDEX	I	Number of representative dates found by the model.
PLANT	I	22-element array of the representative dates found by the model.
WX	R	6-by-366 array of daily meteorological variables. For WX(I,J), J is the day of the year and I refers to a particular weather variable: 1, maximum temperature, °F; 2, minimum temperature, °F; 3, precipitation (liquid equivalent), inches; 4, defined by user; 5, defined by user; and 6, sponge value, inches.

3.7.5.1 ILAST

The purpose of the ILAST subroutine is to determine the last day in a series (string) of consecutive planting days.

CALLING PROCEDURE: CALL ILAST(IFIRST,LAST,N,WX,PARMS,LTOTAL,NUMPD,MDL)

INPUT PARAMETERS: IFIRST, LTOTAL, NUMPD, PARMS, and WX

OUTPUT PARAMETERS: LAST, MDL, and N

REFERENCED BY: The ILAST subroutine is referenced by subroutine PLANTR.

SUBPROGRAMS REFERENCED: None.

INPUT/OUTPUT DEVICES: None.

ARRAYS: MDL(100), PARMS(4,366), and WX(6,366)

LOCAL VARIABLES:

Name	Type	Description
IFIRST	I	Day from which to locate the last planting date.
JD	I	GO TO loop index (day of year).
LAST	I	Last date in a string of planting dates.
LTOTAL	I	Total number of planting dates.
MDL	I	100-element array of the planting days found by the model.
N	I	Length of planting date string in days.
NUMPD	I	The total number of planting dates to be found by the model.

Name	Type	Description
PARMS	R	4-by-366 array of parameters used by the planting model. For PARMS(I,J), J is the day of year and I refers to a particular variable: 1, sponge-precipitation variable; 2, drought threshold for range-adjusted base 32°F growing degree days; 3, base 32°F growing degree days; and 4, range-adjusted base 32°F growing degree days.
WX	R	6-by-366 array of daily meteorological variables. For WX(I,J), J is the day of the year and I refers to a particular weather variable: 1, maximum temperature, °F; 2, minimum temperature, °F; 3, precipitation (liquid equivalent), inches; 4, defined by user; 5, defined by user; and 6, sponge value, inches.

3.7.5.2 SPLIT

The purpose of subroutine SPLIT is to split a series (string) of consecutive planting days into substrings based on the overall length of the string, and to obtain dates which represent these substrings of days.

CALLING PROCEDURE: CALL SPLIT(IF,MED,IL,N,DAY1,DAY2,DAY3)

INPUT PARAMETERS: IF, IL, MED, and N

OUTPUT PARAMETERS: DAY1, DAY2, and DAY3

REFERENCED BY: The SPLIT subroutine is referenced by subroutine PLANTR.

SUBPROGRAMS REFERENCED: Function MOSES and machine function MOD.

INPUT/OUTPUT DEVICES: None.

ARRAYS: None.

LOCAL VARIABLES:

Name	Type	Description
DAY1	I	First representative date for a string of planting dates.
DAY2	I	Second representative date for a string of planting dates.
DAY3	I	Third representative date for a string of planting dates.
IF	I	First day in first substring of planting days.
IIF	I	First day in second substring of planting days.
IIIF	I	First day in third substring of planting days.
IL	I	Last day in a string of planting days.
K	I	Length of first substring of planting days.
KK	I	Length of second substring of planting days.

Name	Type	Description
KKK	I	Length of third substring of planting days.
KKMOD	I	Flag for odd or even length of substrings: 0 if even, nonzero if odd.
MED	I	Overall median planting date found by the model.
N	I	Length of planting date string in days.

3.7.5.3 MOSES

The purpose of the MOSES function is to determine the median of a series (string) of consecutive days. In the event of a string of even length, the median is rounded toward the overall median.

CALLING PROCEDURE: MOSES(N,II,MED,IL)

INPUT PARAMETERS: II, IL, MED, and N

OUTPUT PARAMETERS: Not applicable.

REFERENCED BY: The MOSES function is referenced by subroutine SPLIT.

SUBPROGRAMS REFERENCED: Machine functions MOD and FLOAT.

INPUT/OUTPUT DEVICES: None.

ARRAYS: None.

LOCAL VARIABLES:

Name	Type	Description
II	I	First day in substring.
IL	I	Last day in substring.
IREMDR	I	Flag for odd or even length of substring: 0 if even, nonzero if odd.
MED	I	The overall median planting date found by the model.
N	I	Length of planting date string in days.

3.8 ANSWER

The purpose of subroutine ANSWER is to write the results of the model for one location to a disk file.

CALLING PROCEDURE: CALL ANSWER(YR,ISEG,IPD,MPD,LPD,PLANT,PINDEX,MDL,NUMPD)

INPUT PARAMETERS: IPD, SEG, LPD, MDL, MPD, NUMPD, PINDEX, PLANT, and YR

OUTPUT PARAMETERS: None.

REFERENCED BY: The ANSWER subroutine is referenced by the MAIN program.

SUBPROGRAMS REFERENCED: None.

INPUT/OUTPUT DEVICES: Unit 7.

ARRAYS: MDL(100), PARMS(4,366), and PLANT(22)

LOCAL VARIABLES:

Name	Type	Description
I	I	DO loop index (day of year).
IPD	I	Initial planting date found by the model.
ISEG	I	Segment identification number.
LPD	I	Last planting date found by the model.
MDL	I	100-element array of the planting days found by the model.
MPD	I	Median planting date found by the model.
NUMPD	I	The total number of planting dates found by the model.

Name	Type	Description
PARMS	R	4-by-366 array of parameters used by the planting model. For PARMS(I,J), J is the day of year and I refers to a particular variable: 1, sponge-precipitation variable; 2, drought threshold for range-adjusted base 32°F growing degree days; 3, base 32°F growing degree days; and 4, range-adjusted base 32°F growing degree days.
PINDEX	I	Number of representative dates found by the model.
PLANT	I	22-element array of the representative dates found by the model.
YR	I	Year for which the weather data were obtained.

3.9 TEST

The purpose of the TEST subroutine is to aid the checking of program implementation by writing the daily values of WX and PARMS arrays to a disk file.

CALLING PROCEDURE: CALL TEST(WX,PARMS,ISEG)

INPUT PARAMETERS: ISEG, PARMS, and WX

OUTPUT PARAMETERS: None.

REFERENCED BY: The TEST subroutine is referenced by the MAIN program.

SUBPROGRAMS REFERENCED: None.

INPUT/OUTPUT DEVICES: Unit 8.

ARRAYS: PARMS(4,366) and WX(6,366)

LOCAL VARIABLES:

Name	Type	Description
I	I	DO loop index (day of year).
ISEG	I	Segment identification number.
J	I	DO loop index.
PARMS	R	4-by-366 array of parameters used by the planting model. For PARMS(I,J), J is the day of year and I refers to a particular variable: 1, sponge-precipitation variable; 2, drought threshold for range-adjusted base 32°F growing degree days; 3, base 32°F growing degree days; and 4, range-adjusted base 32°F growing degree days.

Name	Type	Description
WX	R	6-by-366 array of daily meteorological variables. For WX(I,J), J is the day of the year and I refers to a particular weather variable: 1, maximum temperature, °F; 2, minimum temperature, °F; 3, precipitation (liquid equivalent), inches; 4, defined by user; 5, defined by user; and 6, sponge value, inches.

4. REFERENCES

1. Hodges T.; and Artley, J. A.: Spring Small Gains Planting Date Distribution Model. JSC-16858, LEMSCO-16018, March 1981.

2. Hodges, T.; and Artley, J. A.: User's Guide to Spring Small Grains Planting Date Distribution Model. LEMSCO-16669, 1981.

APPENDIX

PLDRVR FORTRAN CODE

```
C   PROGRAM IMPLEMENTS THE HODGES-ARTLEY ALGORITHM FOR SPRING SMALL
C   GRAINS PLANTING DISTRIBUTION
      REAL WX(6,366),LAT,PARMS(4,366)
C   WX(I,J) WHERE J IS JULIAN DATE AND I IS AS FOLLOWS:
C       I=1. MAXIMUM TEMPERATURE              **********************************
C       I=2. MINIMUM TEMPERATURE              **WX IS FILLED IN SUBROUTINES
C       I=3. PRECIPITATION                    **METDRV AND SPONGE
C       I=4. OPEN                             **********************************
C       I=5. OPEN
C       I=6. SPONGE
C   PARMS(I,J) WHERE J IS JULIAN DATE AND I IS AS FOLLOWS:
C         I=1. SPONGE/PRECIPITATION VARIABLE
C         I=2. DROUGHT GDD32R THRESHHOLD. 45*SPONGE
C         I=3. GROWING DEGREES DAYS (GDD). BASE 32
C         I=4. RANGE-ADJUSTED GROWINGE DEGREE DAYS (GDD32R). BASE 32
C    PARMS IS FILLED WITHSUBROUTINES DEGDAY AND SPFILL
        INTEGER YR,PLANT(22),PINDEX,ST,CRD,MDL(100)
        DATA MDL/100*0/,PARMS/1464*9999.0/
        DATA WX/2196*9999.0/
        DATA CAP/8.0/
C   CAP IS THE TOTAL MOISTURE CAPACITY OF THE SPONGE
C
C   INPUT FILES:
C               FILE 19 SPONGE VALUES-- INITIAL VALUES OF SPONGE. USUALLY
C                       THE VALUE ON THE END OF THE PREVIOUS YEAR.  OTHERWISE
C                       THE SPONGE IS INITIALIZED AT HALF-FULL.  VALUES ARE
C                       BY SEGMENT.
C                 FILE 20 YEAR MET -- YEAR'S WEATHER DATA BY SEGMENT
C   OUTPUT FILE:  FILE 7 -- THE OUTPUT FROM HODGES-ARTLEY SPRING
C                       GRAINS PLANTING ALGORITHM
C
    1 CONTINUE
        CALL METDRV(ISEG,WX,LAT,DIV,YR,ST,CRD)
C   FILL PART OF WX.  ALL VARIABLES ARE OUTPUT
C   ISEG=SEGMENT NUMBER. LAT=STATION LATITUDE,YR=YEAR
        CALL SPIN(ISEG,YR,SPINIT,CAP)
C   GET INITIAL VALUE FOR THE SPONGE (SPINIT) FOR THIS YEAR
        CALL SPONGE(WX,CAP,SPINIT)
C   PUT DAILY VALUES OF SPONGE INTO WX
        CALL DEGDAY(WX,1.,32.0,PARMS)
C   CALCULATE CUMULATIVE GROWING DEGREE DAYS FROM DAY 1, WITH A BASE
C   OF 32 DEG. F. AND PUT ANSWERS IN PARMS. DO FOR REGULAR AND RANGE
C   ADJUSTED GROWING DEGREE DAYS.
        CALL SPFILL(WX,PARMS)
C   FILL PARMS WITH THE DAILY SPONGE/PRECIPITATION VARIABLE AND DROUGHT
C   THRESHHOLD OF GDD32R.
        CALL PLANTM(WX,PARMS,IPD,MPD,LPD,PLANT,PINDEX,MDL,NUMPD)
C   RUN THE PLANTING MODEL WITH WX AND PARMS ELEMENTS. OUTPUT IS
C   IPD-INITIAL PLANTING DATE. MPD-MEDIAN PLANTING DATE. LPD-LAST
C   PLANTING DATE. PLANT-DATES WHICH REPRESENT THE MODELED PERIOD.
C   PINDEX-NUMBER OF REPRESENTATIVE DATES. MDL-EACH MODELED PLANTING DAY
C   IN THE PERIOD. NUMPD-NUMBER OF DAYS IN THE PERIOD.
C   PASS THESE VALUES (WITH IDENTIFICATION) TO ANSWER FOR OUTPUT.
        CALL ANSWER(YR,ISEG,IPD,MPD,LPD,PLANT,PINDEX,MDL,NUMPD)
C   HERE, SUBROUTINE TEST MAY BE CALLED SO THAT VALUES IN
C   WX AND PARMS CAN BE CHECKED.
        GO TO 1
        END
C
C   ***************FILL PARMS ARRAY*****************************************
        SUBROUTINE SPFILL (WX,PARMS)
C
C   SUBROUTINE CALCULATES THE SPONGE/PRECIPITATION PARAMETER FOR THE YEAR
C   ACCORDING TO THE HODGES-ARTLEY PLANTING DATE ADJUSTMENT ALGORITHM
C    IT ALSO CALCULATES THE DROUGHT GDD32R THRESHHOLD VALUE (45*SPONGE)
C
C   WX IS INPUT OF STANDARD MET. ARRAY, PARMS IS OUTPUT
        REAL WX(6,366),PARMS(4,366)
C   CALCULATE THE DROUGHT GDD32R THRESHHOLD VALUES FOR EACH DAY
        DO 5 INDEX = 1, 366
    5   PARMS(2,INDEX) = 45.*WX(6,INDEX)
C   CALCULATE THE DAILY VALUE OF THE SPONGE/PRECIPITATION VARIABLE
        DO 100 INDEX = 1, 366
C
C    FIND LASTSP, THE LAST DAY OF SPONGE INCREASE
C
        IDAY = INDEX + 1
   10   IDAY = IDAY - 1
        IF (IDAY .LT. 1) GO TO 15
```

```
      IF (WX(6,IDAY-1) .LT. WX(6,IDAY)) GO TO 20
      IF (WX(6,IDAY) .EQ. 0.0 .AND. WX(6,IDAY-1) .EQ. 0.0) GO TO 20
      GO TO 10
   15 IDAY = 1
   20 CONTINUE
      LASTSP = IDAY
C
C  FIND IB, THE FIRST DATE OF SPONGE WETTING PERIOD
C
      IB = LASTSP
   35 IF (WX(6,IB) .LT. WX(6,IB-1)) GO TO 40
      IB = IB - 1
      IF (IB .GT. 0) GO TO 35
      IB = 1
   40 CONTINUE
      IB = IB + 1
C
C  SUM DAILY PRECIPITATION DURING THE PERIOD OF INCREASING OR SATURATED
C  SPONGE.
      PRE = 0.
      DO 60 I=IB,LASTSP
       PRE = PRE + WX(3,I)
   60  CONTINUE
C
      DELT = INDEX - LASTSP + 1
C  DELT IS THE LENGTH OF TIME SINCE THE LAST SPONGE INCREASE (DEFINED
C  WITH THE LAST DAY AS DAY 1).
      PARMS(1,INDEX) = WX(6,LASTSP)*PRE/DELT
C  STORE SPVAR VALUE FOR TODAY IN PARMS(1,INDEX)
  100 CONTINUE
      RETURN
      END
C
      SUBROUTINE DEGDAY(WX,START,BASE,PARMS)
C  SUBROUTINE CALCULATES GROWING DEGREES DAYS (GDD) AND RANGE-ADJUSTED
C  GROWING DEGREE DAYS (GDDR).  THE DEGREE DAYS ARE ACCUMULATED FROM THE
C  STARTING DATE START WITH A BASE TEMPERATURE OF BASE. WX MUST HAVE
C  THE MET. DATA IN STANDARD POSITIONS.
C  THE DAILY VALUES OF GDD AND GDDR ARE PLACED IN ARRAY PARMS
      REAL WX(6,366),PARMS(4,366)
      INTEGER START
      Y=0.
      Z=0.
      DO 5 I=1,366
       IF(WX(1,I).GE.9999.0)RETURN
       IF(I.LT.START)GO TO 5
       TX=WX(1,I)
       TN=WX(2,I)
       TM=(TX+TN)/2.
C TM-MEAN TEMPERATURE, TX-MAXIMUM TEMPERATURE, TN-MINIMUM TEMPERATURE.
C
C  TODAY'S DEGREE DAYS ARE DD, ALWAYS POSITIVE
       DD=TM-BASE
       IF(DD.LT.0.)DD=0.
       Y = Y + DD
       PARMS(3,I) = Y
C
C  TODAY'S DEGREE DAYS WITH THE RANGE ADJUSTMENT (1% OF THE DAILY RANGE)
C   ARE R2GDD, ALWAYS POSITIVE
       R2GDD=DD-.01*(TX-TN)**2
       IF(R2GDD.LT.0.)R2GDD=0
       Z=Z+R2GDD
       PARMS(4,I)=Z
C
    5  CONTINUE
      RETURN
      END
C
C************PLANTING SUBROUTINES*****************************************
      SUBROUTINE PLANTM(WX,PARMS,IPD,MPD,LPD,PLANT,PINDEX,MDL,NUMPD)
C  SUBROUTINE TO IMPLEMENT THE HODGES-ARTLEY SPRING SMALL GRAINS
C  PLANTING DATE DISTRIBUTION MODEL
      REAL WX(6,366),PARMS(4,366),PLANT(22)
      INTEGER MDL(100),FSTPLT
      IPD = FSTPLT(WX,PARMS,0)
C  NON-DROUGHT SITUATION--INITIAL PLANTING DATE
      NEWPD = FSTPLT(WX,PARMS,1)
C  RECALCULATE THE INITIAL PLANTING DATE--CHECK FOR DROUGHT
      CALL MODMPD(WX,PARMS,IPD,NEWPD,MPD,N)
```

```
FILE: PLDRVR   FORTRAN  A                          CONVERSATIONAL MONITOR SYSTEM

C  CALCULATE MEDIAN PLANTING DATE MPD. N IS NUMBER OF DAYS FROM NEWPD TO
C  MPD.
C  NUMPD IS THE NUMBER OF MODELED PLANTING DAYS BETWEEN THE MEDIAN AND
C  LAST MODELED PLANTING DATES
      NUMPD = 12
      LPD = LSTPLT(MPD,WX,PARMS,NUMPD)
      LPD = MODLST(WX,PARMS,LPD,NUMPD)
C  NUMPD IS NOW RESET TO THE TOTAL NUMBER OF MODELED PLANTING DATES
      NUMPD = NUMPD + N
      IPD = NEWPD
      CALL PLANTR(WX,PARMS,IPD,MPD,PLANT,PINDEX,NUMPD,MDL)
C  OBTAIN DAYS WHICH REPRESENT THE MODELED PLANTING PERIOD.
      RETURN
      END
      SUBROUTINE PLANTR(WX,PARMS,ISTART,MEDIAN,PLANT,PINDEX,NUMPD,MDL)
      REAL WX(6,366), PARMS(4,366)
      INTEGER PINDEX,IFIRST(22),LAST(22),LENGTH(22),PLANT(22),MDL(100)
C  FIND FIRST DAY, THEN WORK FORWARD TO GET STRINGS OF PLANTING DATES
C  NSTRNG=NUMBER OF STRINGS
C  LENGTH(I)=LENGTH OF ITH STRING
C
      IFIRST(1) = ISTART
      LTOTAL = 0
      NSTRNG = 0
      DO 200 I = 1, 22
  200 LENGTH(I) = 0
      I = 1
C
C  FIND FIRST AND LAST DAYS AND NUMBER OF PLANTING DAYS IN EACH STRING
C
  250 CALL ILAST(IFIRST(I),LAST(I),LENGTH(I),WX,PARMS,LTOTAL,NUMPD,MDL)
      LTOTAL = LTOTAL + LENGTH(I)
      NSTRNG = NSTRNG + 1
      IF (LTOTAL .EQ. NUMPD) GO TO 300
      I = I + 1
      IFIRST(I) = LAST(I-1) + 1
      GO TO 250
C
C  CHECK FOR SOLITARY PLANTING DAYS AND ASSIGN TO NEAREST STRING
  300 IF (NSTRNG .EQ. 1) GO TO 400
      I = 0
  320 I = I + 1
      IF (LENGTH(I) .GT. 1) GO TO 390
      IF (I .EQ. 1) GO TO 360
      IF (I .EQ. NSTRNG) GO TO 365
C
C  SOLITARY PLANTING DATE IN BETWEEN TWO STRINGS
C  DETERMINE NEAREST STRING
      IN1 = IFIRST(I) - LAST(I-1)
      IN2 = IFIRST(I+1) - IFIRST(I)
      IF (IN1 .GT. IN2) GO TO 360
      IF (IN2 .GT. IN1) GO TO 365
C  IF A TIE, ASSIGN TO STRING NEAREST TO THE MEDIAN
      IF (IFIRST(I) .LT. MEDIAN) GO TO 360
      IF (IFIRST(I) .GT. MEDIAN) GO TO 365
      GO TO 360
C
C  SOLITARY PLANTING DATE AT BEGINNING OF THE SERIES
C
  360 IFIRST(I+1) = IFIRST(I)
      LENGTH(I+1) = LENGTH(I+1) + 1
      LENGTH(I) = 0
      GO TO 390
C
C  SOLITARY PLANTING DATE AT END
C
  365 LAST(I-1) = IFIRST(I)
      LENGTH(I-1) = LENGTH(I-1) + 1
      LENGTH(I) = 0
      GO TO 390
C
C  DO THE NEXT STRING
  390 IF (I .LT. NSTRNG) GO TO 320
  400 CONTINUE
C  SPLIT STRINGS TO OBTAIN REPRESENTATIVE PLANTING DATES
C
      PINDEX = 0
      DO 500 I = 1, NSTRNG
        IF (LENGTH(I) .EQ. 0) GO TO 500
```

```
      CALL SPLIT(IFIRST(I),MEDIAN,LAST(I),LAST(I)-IFIRST(I)+1,IPD,IIPD,
     & IIIPD)
      PINDEX = PINDEX+1
      PLANT(PINDEX) = IPD
      IF (IIPD .NE. 0) PINDEX = PINDEX + 1
      IF (IIPD .NE. 0) PLANT(PINDEX) = IIPD
      IF (IIIPD .NE. 0) PINDEX = PINDEX + 1
      IF (IIIPD .NE. 0) PLANT(PINDEX) = IIIPD
  500 CONTINUE
C
C
      RETURN
      END
C
C ******** F I R S T   D A T E   C A L C U L A T I O N ******************
      INTEGER FUNCTION FSTPLT(WX,PARMS,ITYPE)
C  THIS FUNCTION FINDS THE INITIAL PLANTING DATE FOR THE HODGES-ARTLEY
C  PLANTING DATES MODEL. (FIRST DAY ONCE GDD32R EXCEEDS 180 OR, IF
C  SPONGE IS LESS THAN 4., WHEN GDD32R EXCEEDS CORRECTED VALUE OF
C  GDD32R IN PARMS(2,JD), AND SPVAR IS LESS THAN OR EQUAL TO 2.).)
      INTEGER FSTPLT
      REAL WX(6,366),PARMS(4,366)
C  ITYPE=0 FOR ORIGINAL ALGORITHM, ITYPE=1 FOR ALGORITHM WITH DROUGHT.
      IF (ITYPE .EQ. 1) GO TO 4
C
C  THE NO-MOISTURE (ORIGINAL) ALGORITHM
      DO 3 JD = 1,366
      FSTPLT = JD
C  CHECK PLANTING INITIATION CRITERIA--
C  180. IS THE GDD32R THRESHHOLD CONSTANT, 2.0 IS THE SPONGE/PRECIPITA-
C  TION VARIABLE THRESHHOLD.
      IF (PARMS(4,JD) .GE. 180.000 .AND. PARMS(1,JD) .LE. 2.00) GO TO 7
    3 CONTINUE
      RETURN
C
C  ALGORITHM WHICH INCLUDES MOISTURE/DROUGHT CONDITIONS
    4 CONTINUE
      DO 5 JD = 1, 366
      FSTPLT = JD
C  CHECK PLANTING INITIATION CRITERIA
C   GDD32R >= 180 AND SPVAR <=2
C     OR, IF SPONGE < 4., GDD32R >= 45*SPONGE AND SPVAR <= 2.
      IF ((WX(6,JD) .GE. 4.00) .AND.
     &  (PARMS(4,JD) .GE. 180.000 .AND. PARMS(1,JD) .LE. 2.00)) GO TO 7
      IF ((WX(6,JD) .LT. 4.00) .AND.
     &  (PARMS(4,JD) .GE. PARMS(2,JD) .AND. PARMS(1,JD) .LE. 2.00))
     &                GO TO 7
    5 CONTINUE
    7 RETURN
      END
C
C ****************** M E D I A N   D A T E   C A L C U L A T I O N *****
      SUBROUTINE MODMED(WX,PARMS,IPD,NEWPD,MPD,N)
C  THIS SUBROUTINE COMPUTES THE MEDIAN MODELED PLANTING DATE,
C  AND COUNTS THE NUMBER N OF DAYS BETWEEN THE INITIAL AND MEDIAN P DAYS
      REAL WX(6,366),PARMS(4,366)
C N IS THE NUMBER OF MODELED PLANTING DAYS BETWEEN INITIAL AND MEDIAN
C   MODELED PLANTING DAYS
      N = 10
C   N IS 10 IN AMPLE MOISTURE SITUATIONS
      IF (NEWPD .GE. IPD) GO TO 100
C  FIND THE NUMBER OF PLANTING DAYS TO THE MEDIAN DATE ESTIMATE (ROUND
C  UP TO NEXT DAY)
      N = N + 0.5 + 0.5*(IPD-NEWPD)
  100 MPD = MEDPLT(WX,PARMS,NEWPD,N)
      RETURN
      END
      FUNCTION MEDPLT(WX,PARMS,IPD,N)
C  THIS FUNCTION FINDS THE MEDIAN PLANTING DATE ACCORDING TO THE HODGES-
C  ARTLEY PLANTING DATE ALGORITHM.  (NTH DAY OF SPVAR LESS THAN OR
C  EQUAL TO 2 ONCE THE INITIAL PLANTING DATE IS DETERMINED)
      REAL WX(6,366),PARMS(4,366)
      MEDPLT = IPD
      I = 0
C  CHECK PLANTING DATE CITERIA
   10 IF (PARMS(1,MEDPLT) .LE. 2.0) I = I + 1
      IF (I .LT. N) MEDPLT = MEDPLT + 1
      IF (I .LT. N) GO TO 10
      RETURN
```

```
      END
C
C ************** L A S T   D A T E   C A L C U L A T I O N **************
      INTEGER FUNCTION LSTPLT(IFIRST,WX,PARMS,NUMPD)
C  CALCULATES THE LAST PLANTING DATE AS OCCURRING NUMPD PLANTING DAYS
C  AFTER THE 1ST MODELED PLANTING DAY IFIRST.
      REAL WX(6,366),PARMS(4,366)
      JD = IFIRST - 1
      N = 0
  100 JD = JD + 1
C  CHECK PLANTING DATE CRITERIA
      IF (PARMS(1,JD) .LE. 2.0) N = N + 1
      LSTPLT = JD
      IF (N .GT. NUMPD) RETURN
      GO TO 100
      END
      INTEGER FUNCTION MODLST(WX,PARMS,LDAY,NUMPD)
      REAL WX(6,366),PARMS(4,366)
      INTEGER FLAG
C  SUBROUTINE CHECKS FOR EXTREMELY DRY CONDITIONS ON THE LAST MODELED
C  PLANTING DAY AND, IF NEEDED, RECALCULATES THE LAST PLANTING DATE.
      MODLST = LDAY
C  CHECK THE SPONGE FOR DRYNESS. RETURN IF IT IS MOIST.
      IF (WX(6,LDAY) .GE. 1.00) RETURN
C
C   DROUGHT!!!!
      I = 0
      FLAG = 0
      NUMPD = NUMPD - 1
      JD = LDAY - 1
  100 JD = JD + 1
C  CHECK PLANTING DATE CRITERIA
      IF (PARMS(1,JD) .LE. 2.0) I = I + 1
      IF (PARMS(1,JD) .LE. 2.0) NUMPD = NUMPD + 1
C  IF ENOUGH PRECIPITATION OCCURS BEFORE A CRITICAL VALUE OF GDD32R,
C    THEN RESET THE DAY COUNTER AND SET THE FLAG TO THE 1ST RAINY DAY
      IF (FLAG .EQ. 0 .AND.
     &     (  (WX(3,JD) .GE. 0.30 .AND. PARMS(4,JD) .LT. 600.00) .OR.
     &        (WX(3,JD) .GE. 0.75 .AND. PARMS(4,JD) .LT. 800.00))) I=1
      IF (FLAG .EQ. 0 .AND.
     &  (  (WX(3,JD) .GE. 0.30 .AND. PARMS(4,JD) .LT. 600.00) .OR.
     &     (WX(3,JD) .GE. 0.75 .AND. PARMS(4,JD) .LT. 800.00)) FLAG=JD
      IF (I .LE. 10) GO TO 100
      MODLST = JD
      RETURN
      END
C ****** D E T E R M I N E   R E P R E S E N T A T I V E   D A T E S ***
      SUBROUTINE ILAST(IFIRST,LAST,N,WX,PARMS,LTOTAL,NUMPD,MDL)
      REAL WX(6,366),PARMS(4,366)
      INTEGER MDL(100)
C  DETERMINE LAST, THE LAST PLANTING DATE IN THE STRING
C  DETERMINE N, THE NUMBER OF PLANTING DATES IN THE STRING
    5 JD = IFIRST - 1
      N = 0
   10 JD = JD + 1
      IF (PARMS(1,JD) .LE. 2.0) N = N+1
      IF(PARMS(1,JD).LE.2.0) MDL(N+LTOTAL)=JD
      IF ((N+LTOTAL) .EQ. NUMPD) GO TO 20
      IF (PARMS(1,JD) .LE. 2.0) GO TO 10
C  FIRST DAY IS WET, SO RESET THE FIRST DATE AND START OVER
      IF (N .LT. 1) IFIRST = IFIRST + 1
      IF (N .LT. 1) GO TO 5
C  SINGLE WET DAY--IGNORE IT
      IF (PARMS(1,JD+1) .LE. 2.0) GO TO 10
C  MULTIPLE WET DAYS--END OF STRING.  RESET THE JULIAN DATE AND RETURN.
      JD = JD - 1
   20 LAST = JD
      RETURN
      END
      SUBROUTINE SPLIT(IF,MED,IL,N,DAY1,DAY2,DAY3)
      INTEGER DAY1,DAY2,DAY3
C RETURNS UP TO 3 DATES TO REPRESENT STRINGS OF PLANTING DATES
C  VALUES ARE DAY1, DAY2, DAY3
C  K'S ARE SUBSTRING LENGTHS
C  IF'S ARE FIRST DAYS IN SUBSTRINGS
      DAY1 = 0
      DAY2 = 0
      DAY3 = 0
      IF (N .GT. 15) GO TO 15
```

```
      IF (N .GT. 10) GO TO 10
C  STRING IS UP TO 10 DAYS LONG -- ONE REPRESENTATIVE DAY
      DAY1 = IF + MOSES(N,IF,MED,IL)
      RETURN
C  STRING IS 11-15 DAYS LONG
C  TWO REPRESENTATIVE DAYS
   10 K = N/2
      KK = N - K
      IIF = IF + K
      DAY1 = IF + MOSES(K,IF,MED,(IIF-1))
      DAY2 = IIF + MOSES(KK,IIF,MED,IL)
      RETURN
C  STRING IS 16+ DAYS LONG
C  THREE REPRESENTATIVE DAYS
   15 K = N/3
      KK = N - K
      KKMOD = MOD(KK,2)
C  ONE EXTRA DAY -- ASSIGN IT TO CENTER SUBSTRING
      IF (KKMOD .NE. 0) KK = K + 1
      IF (KKMOD .NE. 0)  KKK = K
C  TWO EXTRA DAYS -- SHIFT TO LATER DATES
      IF (KKMOD .EQ. 0) KK = K + 1
      IF (KKMOD .EQ. 0)  KKK = K + 1
      IIF = IF + K
      IIIF = IIF + KK
      DAY1 = IF + MOSES(K,IF,MED,(IIF-1))
      DAY2 = IIF + MOSES(KK,IIF,MED,(IIIF-1))
      DAY3 = IIIF + MOSES(KK,IIIF,MED,IL)
      RETURN
      END
      FUNCTION MOSES(N,II,MED,IL)
C  DETERMINE NUMBER OF DAYS TO MEDIAN OF STRING OF LENGTH N
C  EVEN STRINGS' MEDIAN IS SHIFTED TOWARD THE OVERALL MEDIAN PLANTING
C  DATE (MED)
      MOSES = FLOAT(N)/2. - 0.5
      IREMDR = MOD(N,2)
      IF (IREMDR.EQ.0 .AND. II.LE.MED .AND. IL.LE.(MED+MOSES))
     &          MOSES = MOSES + 1
      RETURN
      END
C
C ******** O U T P U T   S U B R O U T I N E S **************************
      SUBROUTINE ANSWER(YR,ISEG,IPD,MPD,LPD,PLANT,PINDEX,MDL,NUMPD)
C  ALL CALLING PARAMETERS ARE INPUT PARAMETERS.  THE
C  SUBROUTINE PRODUCES ONLY PRINTED OUTPUT---THE RESULTS OF THE MODEL
C  YR (YEAR), ISEG (SEGMENT NUMBER), ARE LOCATION IDENTIFIERS
C  IPD, MPD, LPD, AND ARRAYS PLANT AND MDL ARE MODEL RESULTS
C  PLANT CONTAINS THE REPRESENTATIVE DAYS
C  MDL CONTAINS ALL MODELED PLANTING DATES
C  PINDEX IS THE NUMBER OF DAYS WHICH REPRESENT THE PLANTING PERIOD
C    (THE NUMBER OF USEFUL DATES IN PLANT)
C  NUMPD IS THE NUMBER OF MODELED PLANTING DATES IN THE PLANTING
C  PERIOD (THE NUMBER OF DATES IN MDL FOR THIS SEGMENT)
      REAL PARMS(4,366)
      INTEGER MDL(100),YR,PLANT(22),PINDEX
      WRITE(7,7000) YR,ISEG,IPD,MPD,LPD,(PLANT(I),I=1,PINDEX)
C    WRITE YEAR, SEGMENT NUMBER, INITIAL PLANTING DATE, MEDIAN
C PLANTING DATE, LAST PLANTING DATE, AND THE PINDEX NUMBER OF REPRE-
C SENTATIVE DATES GENERATED BY THE MODEL
 7000 FORMAT(I2,1914)
      WRITE(7,7010) (MDL(I),I=1,NUMPD)
C  WRITE THE MODELED PLANTING DATES (THERE ARE NUMPD OF THEM, BUT
C  AT LEAST 22)
 7010 FORMAT(2014)
      RETURN
      END
C
      SUBROUTINE TEST(WX,PARMS,ISEG)
C  TEST WRITES MAXIMUM AND MINIMUM TEMPERATURES, PRECIPITATION, SPONGE,
C  SPONGE/PRECIPITATION VARIABLE, GDD32R*45, GDD, AND GDD32R TO FILE 8.
C  ISEG IS AN IDENTIFIER.
C  WX AND PARMS ARE STANDARD ARRAYS.
      REAL WX(6,366),PARMS(4,366)
      DO 10 I=90,150
        WRITE(8,8000) ISEG,I,(WX(J,I),J=1,3),WX(6,I),(PARMS(J,I),J=1,4)
   10 CONTINUE
 8000 FORMAT(2I4,4F7.2)
      RETURN
      END
```

```
C
C ********* F I L L   W X   A R R A Y **********************************
      SUBROUTINE METRD2(ISEG,WX,LAT,DIV,YR,ST,CRD)
      REAL WX(6,366)
      INTEGER T(2,10),YR,ST,CRD,P(16)
      REAL LAT
C  READ HEADER CARD
      READ(20,20000,END=99)ISEG,ST,LAT,CRD,DIV
20000 FORMAT(I4,4X,I2,5X,F5.2,42X,I2,12X,A4)
      DO 10 NCARDS=1,25
C  READ PRECIPITATION CARDS
      READ(20,20001,END=99) JD,P,IYR
20001 FORMAT(6X,I3,1X,16I4,4X,I2)
       IF (NCARDS .EQ. 1) YR=IYR
       IF(JD.EQ.-99)GO TO 15
       DO 5 J=1,16
        ND=JD+J-1
        IF(ND.GT.366)GO TO 10
C  AT THE END OF THE YEAR, READ THE FLAG CARD BEFORE PROCEEDING TO
C  THE TEMPERATURE DATA
        WX(3,ND)=P(J)*0.01
     5  CONTINUE
    10  CONTINUE
    15 CONTINUE
C    READ TEMPERATURE DATA
      DO 25 NCARDS=1,38
       READ(20,20002,END=99)JD,((T(K,J),K=1,2),J=1,10)
20002 FORMAT(6X,I3,2013)
       IF(JD.EQ.-88)RETURN
       DO 20 J=1,10
        ND=JD+J-1
        IF(ND.GT.366)GO TO 25
        WX(1,ND)=T(1,J)*1.0
        WX(2,ND)=T(2,J)*1.0
    20  CONTINUE
    25  CONTINUE
      RETURN
    99 STOP
      END
      SUBROUTINE SPIN(STN,YR,SPINIT,CAP)
C  GIVEN THE LOCATION (STN) AND YEAR (YR), READ FROM FILE 19
C THE INITIAL VALUE FOR THE SPONGE.  USUALLY, THIS IS THE VALUE ON THE
C LAST DAY OF THE PREVIOUS YEAR FOR THE LOCATION.  IF THERE IS NO VALUE,
C THE SPONGE IS INITIALIZED AT HALF-CAPACITY (CAP/2).
      INTEGER STN,YR,ID
C  SPINIT IS THE OUTPUT PARAMETER OF THE INITIAL VALUE OF SPONGE.
      SPINIT = CAP/2.0
C  DEFAULT VALUE OF SPINIT IS HALF CAPACITY
      IF(YR.LT.80)RETURN
C  ONLY YEARS AFTER 1980 HAVE INITIAL VALUES.
    5 READ(19,19000,END=10)ID,VALUE
19000 FORMAT(I5,F5.2)
      IF (ID .EQ. STN) SPINIT = VALUE
C  MATCH CURRENT ID WITH STN TO GET PROPER VALUE OF SPINIT
      GO TO 5
   10 REWIND 19
      RETURN
      END
      SUBROUTINE SPONGE(WX,CAP,SPINIT)
C    THE SPONGE MOISTURE VARIABLE.  M.H. TRENCHARD.
C   INPUT STANDARD WX ARRAY OF METEOROLOGICAL VARIABLES
C       SPONGE CAPACITY CAP, AND STARTING VALUE OF SPONGE SPINIT.
C   OUTPUT DAILY SPONGE VALUES IN WX(*,4)
      REAL WX(6,366)
      SPONGE=SPINIT
      DO 5 JD=1,366
C    CALCULATE DAILY VALUES
      TX=WX(1,JD)
      TN=WX(2,JD)
      PPN=WX(3,JD)
C  TX-MAXIMUM TEMPERATURE (F),TN-MINIMUM TEMPERATURE (F), PPN-PRECIPITA-
C  TION (IN).
      SPONGE=SPONGE+PPN-EP(TX,TN)*SPONGE/(30.0*CAP)
C EP IS TRENCHARD'S MONTHLY PAN EVAPORATION FUNCTION--DIVIDE BY 30 DAYS
C  TO GET A DAILY VALUE
      IF(SPONGE.GT.CAP)SPONGE=CAP
      IF(SPONGE.LT.0.0)SPONGE=0.0
    5 WX(6,JD)=SPONGE
      RETURN
```

```
      END
      FUNCTION EP(TX,TN)
C     M.H.TRENCHARD:S MONTHLY PAN EVAPORATION FUNCTION EP.
C     INPUT MAXIMUM AND MINIMUM TEMPERATURES (TX AND TN) IN DEG. F.
C     OUTPUT PAN EVAPORATION IN INCHES.
C     USE VAPOR FUNCTION TO CALCULATE SATURATION VAPOR PRESSURE
      EP=0.2163+0.3473*VAPOR(TX)-0.2644*VAPOR(TN)
      IF(TX.LE.32.0)EP=0.0
C     NO EVAPORATION IF THE MAXIMUM TEMPERATURE IS BELOW FREEZING.
      RETURN
      END
      FUNCTION VAPOR(T)
C     M.H.TRENCHARD:S FUNCTION TO CALCULATE SATURATION VAPOR PRESSURE OVER
C     WATER. INPUT TEMPERATURE T IN DEG. F. OUTPUT VAPOR PRESSURE IN
C     MB.
      VAPOR=6.11*EXP((-1.760042621E05+5.59760791E03*T-2.45077263E0
     1*T**2)/(1.254162E05+273*T))
      RETURN
      END
```