An interface for running crop models over gridded land surfaces

Technical Report

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Detailed Plan for DSSAT User Interface

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1. INTRODUCTION

The objective of the project is to develop a user interface for running a stripped-down DSSAT crop models. The work will develop a GUI system that will accomplish three tasks. First, it will provide users a venue to input large volumes of climate scenario, soil and weather data; second, it will optimize the available computer resources to run parallel multiple instances of the DSSAT crop model over very large number of grids for up to global scale[1]; and third, display the outputs. The graphical user interface will be developed using Visual Basic.

This document describes different types of files that are used in the DSSAT model and in the interface. It then describes the process in detail.

2. FILE STRUCTURE

2.1 DSSAT Files:

[1] *Note*: Phase 1 of the project will be a case study in which the number of grids (pixels) will be limited to a user specified regional scale, which should later be transferrable to a global level in Phase 2 of the project. In Phase 1 the whole system will be tested by running one crop through the software using a global gridded data (<0.5^{o}).

The files are organized into input, output and experiment performance data files (Table 1).

Model inputs are organized to allow some flexibility in their use with specific models. The input files are FILEX, FILEW, FILES, FILEC, FILEG, and FILEE. The descriptions can be found Table 1.

The experiment performance files are needed only when simulated results are to be compared with data recorded in a particular experiment. In some cases, however, they could be used as input files to 'reset' some variables during the course of a simulation run. They could also be used to record time series of pests or pest damage to the crop, which could be used as input to crop models.

There are various model output files, but for the purpose of this interface since we are dealing with a very large number of pixels, we are only going to save the summary simulation output file, which will have a good amount of information useful for post processing. The "summary" output files will be renamed by the program so that more information can be saved in each file name. This will help in identifying and differentiating between the summary file of each pixel.

Table 1 Crop Model Input and Experiment Files.

Internal File Name	Example File Name(s)	External Description
INPUT FILES		
FILEX	UFGA8801.SBX	Experiment details file for a specific experiment (e.g., soybean at UFGA): Contains data on treatments, field conditions, crop management and simulation controls
Weather and Soil		
FILEW	UFGA8801.WTH	Weather data, daily, for a specific (e.g.,UFGA) station and time period (e.g., for one year)
FILES	SOIL.SOL	Soil profile data for a group of experimental sites in general (e.g.,SOIL.SOL) or for a specific institute (e.g., UF.SOL)
Crop and Cultivar		
FILEC	SBGRO045.CUL[1]	Cultivar/variety coefficients for a particular crop species and model; e.g., soybean for the 'GRO' model,version 045
FILEE	SBGRO045.ECO[1,2]	Ecotype specific coefficients for a particular crop species and model; e.g., soybean for the 'GRO' model,version 045
FILEG	SBGRO045.SPE[1]	Crop (species) specific coefficients for a particular model; e.g., soybean for the 'GRO' model, version 045
EXPERIMENT DATA FILES		
FILEA	UFGA8801.SBA	Average values of performance data for a soybean experiment. (Used for comparison with summary model results.)
FILET	UFGA8801.SBT	Time course data (averages) for a soybean experiment. (Used for graphical comparison of measured and simulated time course results.)
[1] *These names reflect a standard naming convention in which the first two spaces are for the crop code, the next three characters are for the model name, and the final three are for model version.*		
[2] *Not all crop models use the ECO file.*		

For the purpose of this project only the files affected will be modified. The main file that is impacted is "FILEX" and is discussed in detail below.

2.1.1 FILEX File:

One main file, referred to as FILEX, documents the inputs to the models for each "experiment" to be simulated. The file heading contains the experiment code and name, the treatment combinations, and details of the experimental conditions (field characteristics, soil analysis data, initial soil water and inorganic nitrogen conditions, seedbed preparation and planting geometries, irrigation and water management, fertilizer management, organic residue applications, chemical applications, tillage operations, environmental modifications, harvest management), and simulation controls.

When the FILEX is set up, for each pixel there are a number of treatments corresponding to the different soil types (eg, FAJC, FARE, FAXH). This file will also include which outputs user wants to see, and only those will be included in the .OSU file. Simulations are done for these treatments, and then post-processing calculates area-weighted average yields etc.

mz_clip0101 - Notepad

File Edit Format View Help

```
*EXP.DETAILS: CLIP0101SN MAIZE FOR CLIP WINDOW

*TREATMENTS                        -------------FACTOR LEVELS------------
@N R O C TNAME.................... CU FL SA IC MP MI MF MR MC MT ME MH SM
 11 0 0                             1  1  0  1  1  0  1  0  0  0  0  0  1
 21 0 0                             1  2  0  2  1  0  1  0  0  0  0  0  1
 31 0 0                             1  3  0  3  1  0  1  0  0  0  0  0  1
 41 0 0                             1  4  0  4  1  0  1  0  0  0  0  0  1

*CULTIVARS
@C CR INGENO CNAME
 1 MZ IB2270 KATUMANI
 2 BN IB0022 DIACOL CALIMA

*FIELDS
@L ID_FIELD WSTA....  FLSA  FLOB  FLDT  FLDD  FLDS  FLST SLTX   SLDP ID_SOIL
  1CLIP0001 02010101 -99.0     0 IB000     0     0 00000 -99     180 FAAF000001
  2CLIP0002 02010101 -99.0     0 IB000     0     0 00000 -99     180 FAFP000001
  3CLIP0003 02010101 -99.0     0 IB000     0     0 00000 -99     180 FAGD000001
  4CLIP0004 02010101 -99.0     0 IB000     0     0 00000 -99     180 FAJD000001
@L ...........XCRD ...........YCRD .....ELEV .............AREA .SLEN .FLWR .SLAS
  1        0.00000         0.00000      0.00               0.0     0   0.0   0.0
  2        0.00000         0.00000      0.00               0.0     0   0.0   0.0
  3        0.00000         0.00000      0.00               0.0     0   0.0   0.0
  4        0.00000         0.00000      0.00               0.0     0   0.0   0.0

*INITIAL CONDITIONS
@C   PCR ICDAT  ICRT  ICND  ICRN  ICRE  ICWD ICRES ICREN ICREP ICRIP ICRID
 1    MZ 01291    10     0  1.00  1.00   1.8    10  0.80  0.00   100    15
@C  ICBL  SH2O  SNH4  SNO3
 1     7 0.113   0.1   0.1
 1    25 0.121   0.1   0.1
 1    50 0.163   0.1   0.1
 1    75 0.190   0.1   0.1
 1   100 0.171   0.1   0.1
 1   150 0.167   0.1   0.1
 1   200 0.180   0.1   0.1
@C   PCR ICDAT  ICRT  ICND  ICRN  ICRE  ICWD ICRES ICREN ICREP ICRIP ICRID
```

Figure 1: Sample of FILEX

2.2 Input File Naming Conventions

The convention has two parts: 1) the file extension which is used to specify the type of file; and 2) the prefix which is used to identify the contents of the file.

Following is a list of extensions and prefixes.

Extensions

.WTH Weather data file
.SOL Soil profile data file
.CUL Cultivar/variety specific coefficient file
.ECO Ecotype specific coefficient file
.SPE Crop (species) specific coefficient file
.OUT Output file generated by the crop model
.LST A list file - provides a list of either experiments, weather data sets or soil data sets
.ccX Experiment details file (i.e., FILEX)
.ccA Average values of observation data
.ccT Time course data (averages)

Prefixes

For most model input files and experiment observation files, the prefix is constructed from an institute code (2 characters), a site code (2 characters), the year of the experiment (2 characters) and an experiment number (2 characters). For example, an experiment conducted by the University of Florida (UF) at Gainesville (GA) in 1988 (88) would yield a file prefix of UFGA8801.

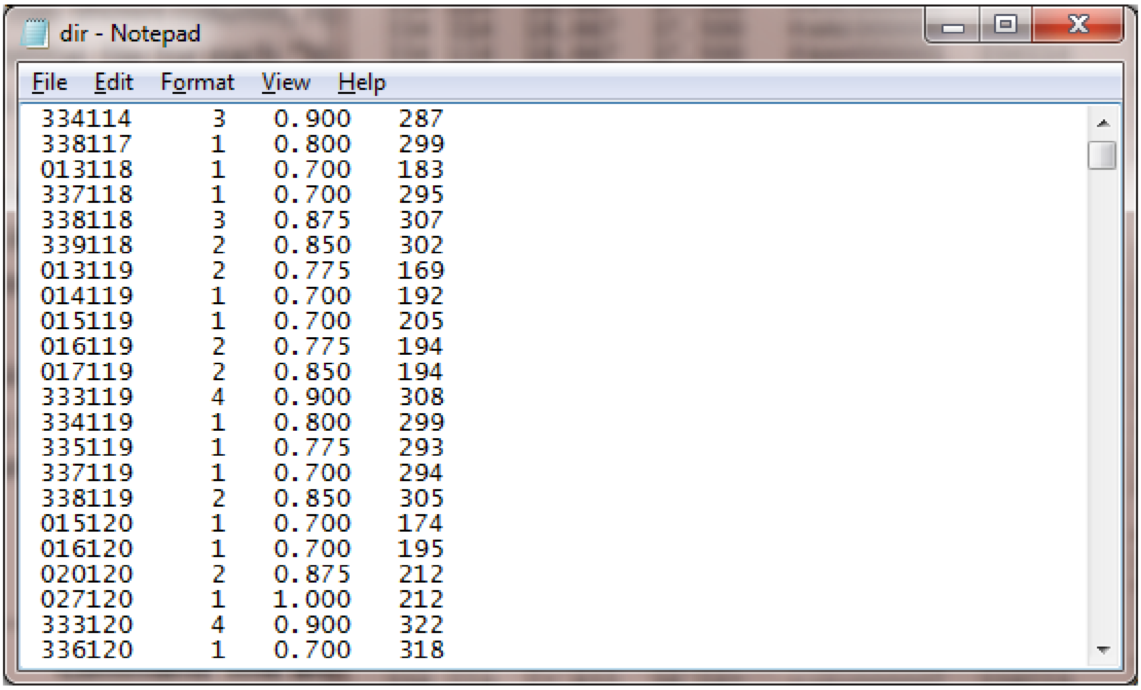
2.3 Files used by GUI

2.3.1 DIR.DAT: The file DIR.DAT shows one record per pixel. The first 6 character show the column-row combination (3 digits each), then the number of soil profiles in each FAO mapping unit(1 digit), the percentage of the pixel that is in agriculturally suitable soils, and the day of year for the “standard” start of simulation date. Layout of the file is shown in Table 2.

Table 2: Layout of “dir.dat” file

Field	Type	Length
column	Numeric	3
Row	Numeric	3
space	Character	5
number of soil profiles in each FAO mapping unit	Numeric	1
space	Character	3
percentage of the pixel that is in agriculturally suitable soils	Decimal	(1,3)
space	Character	3
day of year for the “standard” start of simulation date	Numeric	3

Figure 2 shows an example of “dir.dat” file. In the example, the first row represents a pixel that is column 334, row 114. It has 3 soils in the mapping unit that make up 90% of the pixel. For this pixel, the season start date is close to day 287.




```
334114     3   0.900   287
338117     1   0.800   299
013118     1   0.700   183
337118     1   0.700   295
338118     3   0.875   307
339118     2   0.850   302
013119     2   0.775   169
014119     1   0.700   192
015119     1   0.700   205
016119     2   0.775   194
017119     2   0.850   194
333119     4   0.900   308
334119     1   0.800   299
335119     1   0.775   293
337119     1   0.700   294
338119     2   0.850   305
015120     1   0.700   174
016120     1   0.700   195
020120     2   0.875   212
027120     1   1.000   212
333120     4   0.900   322
336120     1   0.700   318
```

Figure 2: Sample of “dir.dat” file

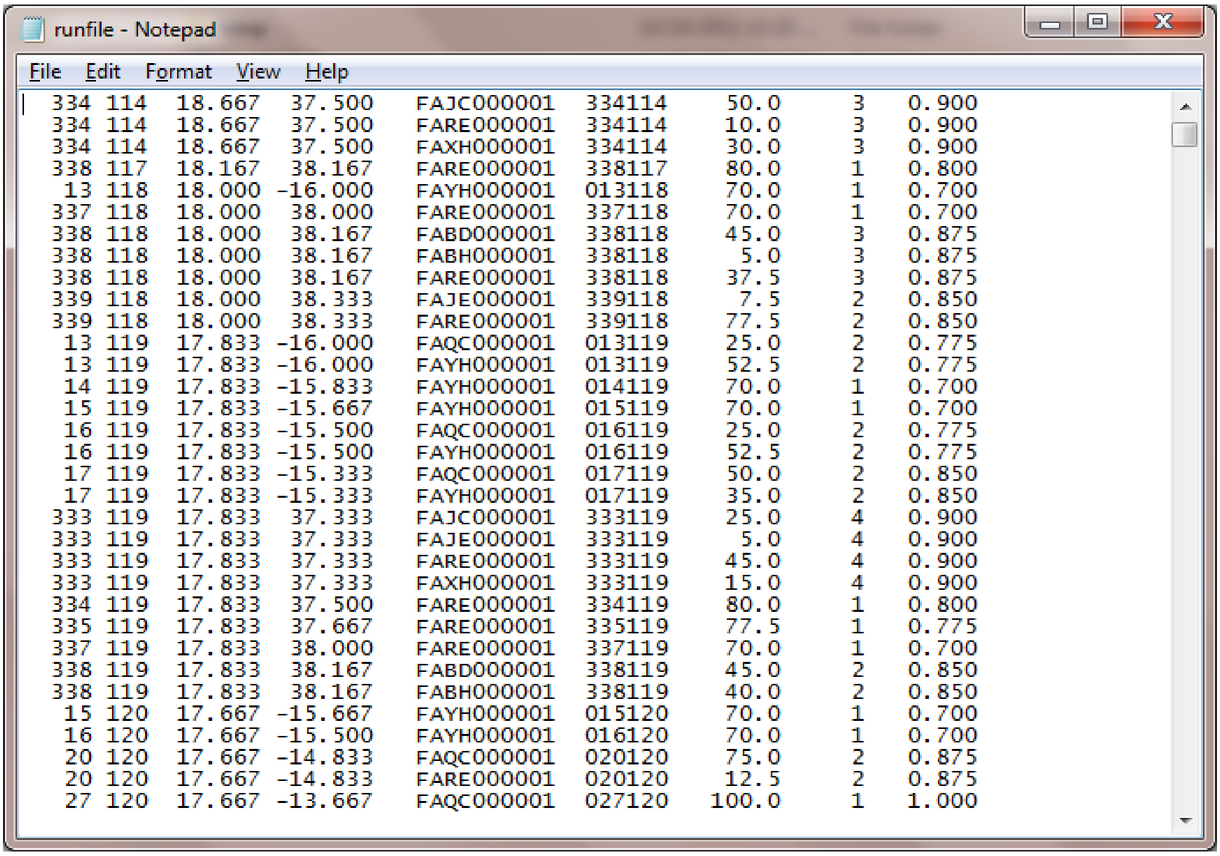
2.3.2 RUNFILE.DAT: The detailed file RUNFILE.DAT will control most of the simulation work. Table 3 shows the layout and is as follows: column, row, latitude, longitude, soil code (which has to be put into the FILEX experimental file for each “treatment” of the experiment), col/row combination, percentage of mapping unit in this soil type, number of agricultural soils in this mapping unit, and the percentage of the pixel that is in agriculturally suitable soils.

Table 3: Layout for “runfile.dat”

Field	**Type**	**Length**
space	Character	2
column	Numeric	3
space	Character	1
Row	Numeric	3
space	Character	2
Latitude	Decimal	2,3
space	Character	2
longitude	Decimal	2,3
space	Character	3
Soil code	Character	10
column	Numeric	3
Row	Numeric	3
space	Character	2

percentage of mapping unit in this soil type	Decimal	3,1
space	Character	5
number of soil profiles in each FAO mapping unit	Numeric	1
space	Character	3
percentage of the pixel that is in agriculturally suitable soils	Decimal	(1,3)
space	Character	3
day of year for the "standard" start of simulation date	Numeric	3

For each pixel there are a number of treatments corresponding to the different soil types (eg, FAJC, FARE, FAXH). There will be one row in RUNFILE.DAT for each treatment (as shown in Figure 3). This file will also be useful for post processing, since it will have information at pixel level for each treatment.



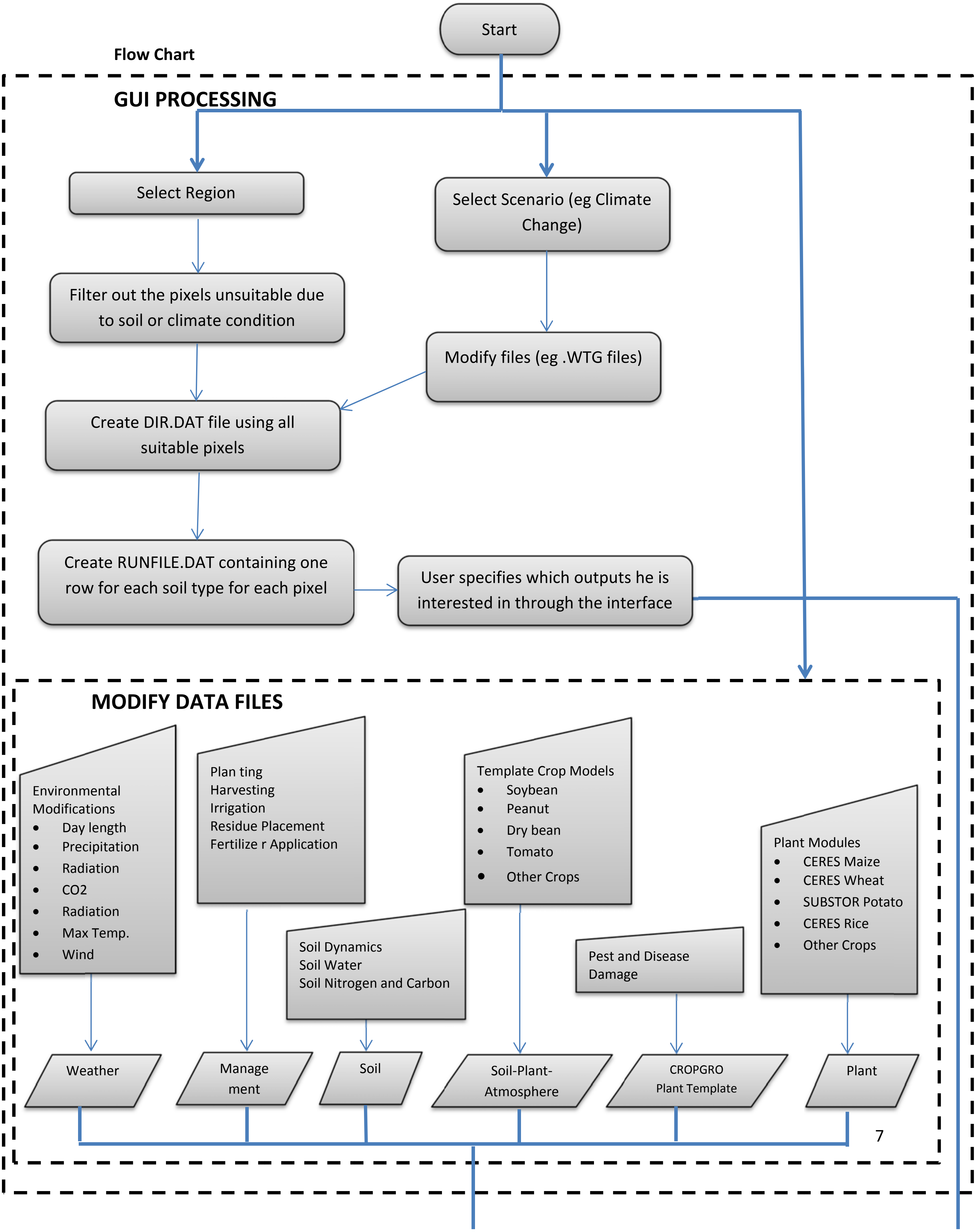

```
334 114  18.667  37.500  FAJC000001  334114   50.0  3  0.900
334 114  18.667  37.500  FARE000001  334114   10.0  3  0.900
334 114  18.667  37.500  FAXH000001  334114   30.0  3  0.900
338 117  18.167  38.167  FARE000001  338117   80.0  1  0.800
 13 118  18.000 -16.000  FAYH000001  013118   70.0  1  0.700
337 118  18.000  38.000  FARE000001  337118   70.0  1  0.700
338 118  18.000  38.167  FABD000001  338118   45.0  3  0.875
338 118  18.000  38.167  FABH000001  338118    5.0  3  0.875
338 118  18.000  38.167  FARE000001  338118   37.5  3  0.875
339 118  18.000  38.333  FAJE000001  339118    7.5  2  0.850
339 118  18.000  38.333  FARE000001  339118   77.5  2  0.850
 13 119  17.833 -16.000  FAQC000001  013119   25.0  2  0.775
 13 119  17.833 -16.000  FAYH000001  013119   52.5  2  0.775
 14 119  17.833 -15.833  FAYH000001  014119   70.0  1  0.700
 15 119  17.833 -15.667  FAYH000001  015119   70.0  1  0.700
 16 119  17.833 -15.500  FAQC000001  016119   25.0  2  0.775
 16 119  17.833 -15.500  FAYH000001  016119   52.5  2  0.775
 17 119  17.833 -15.333  FAQC000001  017119   50.0  2  0.850
 17 119  17.833 -15.333  FAYH000001  017119   35.0  2  0.850
333 119  17.833  37.333  FAJC000001  333119   25.0  4  0.900
333 119  17.833  37.333  FAJE000001  333119    5.0  4  0.900
333 119  17.833  37.333  FARE000001  333119   45.0  4  0.900
333 119  17.833  37.333  FAXH000001  333119   15.0  4  0.900
334 119  17.833  37.500  FARE000001  334119   80.0  1  0.800
335 119  17.833  37.667  FARE000001  335119   77.5  1  0.775
337 119  17.833  38.000  FARE000001  337119   70.0  1  0.700
338 119  17.833  38.167  FABD000001  338119   45.0  2  0.850
338 119  17.833  38.167  FABH000001  338119   40.0  2  0.850
 15 120  17.667 -15.667  FAYH000001  015120   70.0  1  0.700
 16 120  17.667 -15.500  FAYH000001  016120   70.0  1  0.700
 20 120  17.667 -14.833  FAQC000001  020120   75.0  2  0.875
 20 120  17.667 -14.833  FARE000001  020120   12.5  2  0.875
 27 120  17.667 -13.667  FAQC000001  027120  100.0  1  1.000
```

Figure 3: Sample of "runfile.dat" file

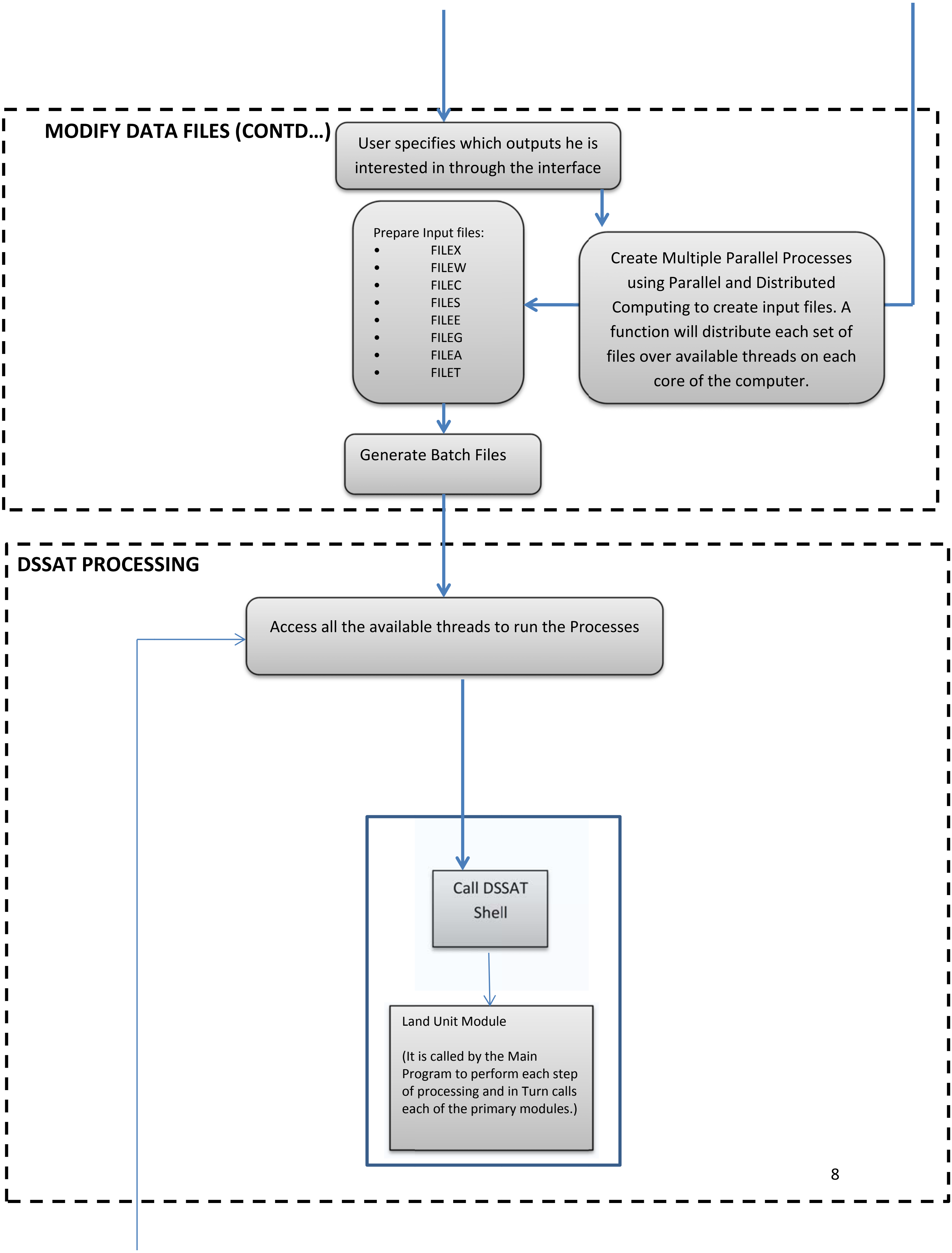
3. PROCESS DESCRIPTION

The following pages (Figure 4) show the flow chart and the flow of the complete interface program. (***Note:*** The display of outputs still needs to be discussed with the user.)

Flow Chart



Start
GUI PROCESSING
Select Region
Select Scenario (eg Climate Change)
Filter out the pixels unsuitable due to soil or climate condition
Modify files (eg .WTG files)
Create DIR.DAT file using all suitable pixels
Create RUNFILE.DAT containing one row for each soil type for each pixel
User specifies which outputs he is interested in through the interface
MODIFY DATA FILES
Environmental Modifications
Day length
Precipitation
Radiation
CO2
Radiation
Max Temp.
Wind
Plan ting
Harvesting
Irrigation
Residue Placement
Fertilize r Application
Template Crop Models
Soybean
Peanut
Dry bean
Tomato
Other Crops
Soil Dynamics
Soil Water
Soil Nitrogen and Carbon
Pest and Disease Damage
Plant Modules
CERES Maize
CERES Wheat
SUBSTOR Potato
CERES Rice
Other Crops
Weather
Manage ment
Soil
Soil-Plant-Atmosphere
CROPGRO Plant Template
Plant


MODIFY DATA FILES (CONTD…)
User specifies which outputs he is interested in through the interface
Prepare Input files:
• FILEX
• FILEW
• FILEC
• FILES
• FILEE
• FILEG
• FILEA
• FILET
Create Multiple Parallel Processes using Parallel and Distributed Computing to create input files. A function will distribute each set of files over available threads on each core of the computer.
Generate Batch Files
DSSAT PROCESSING
Access all the available threads to run the Processes
Call DSSAT Shell
Land Unit Module
(It is called by the Main Program to perform each step of processing and in Turn calls each of the primary modules.)

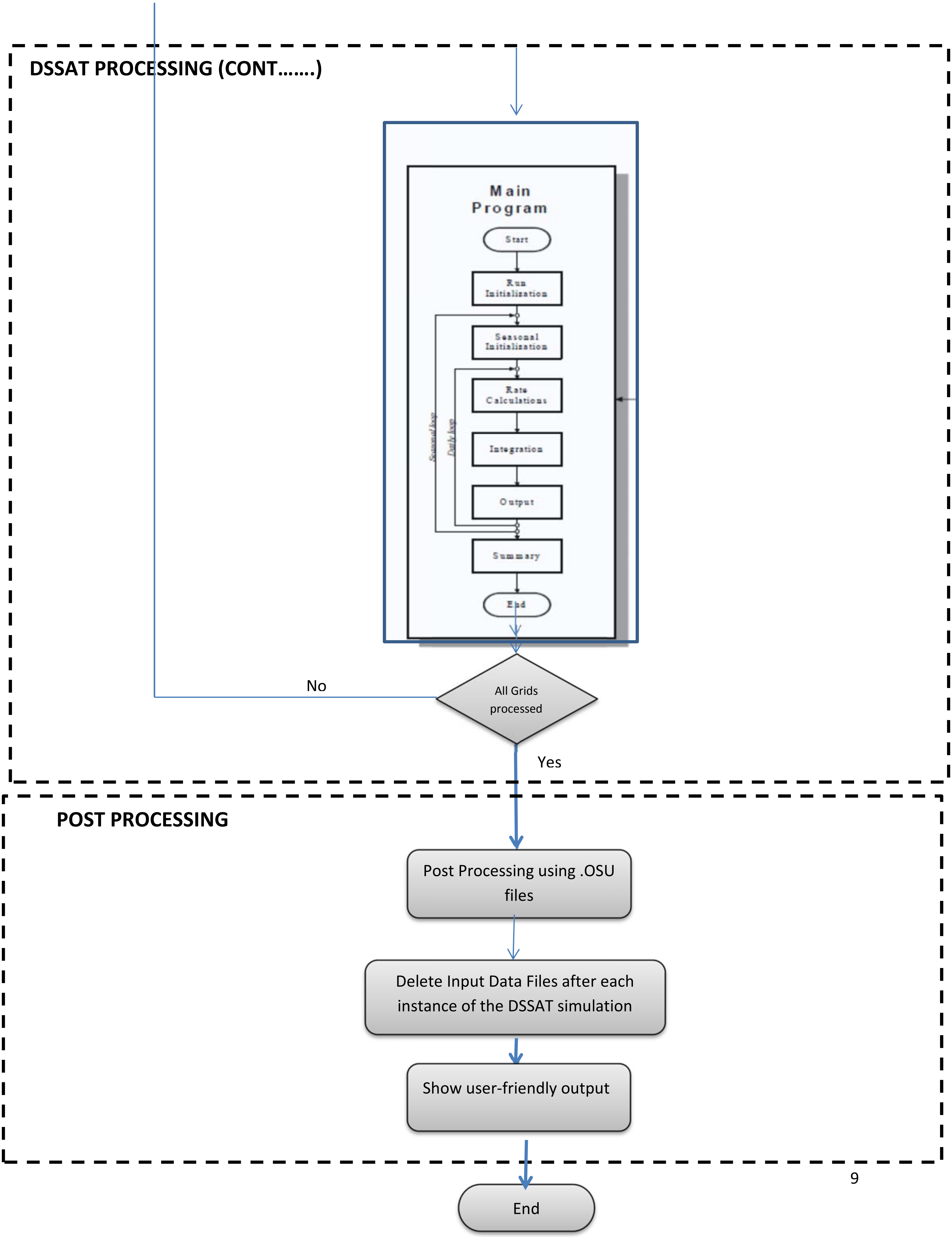

DSSAT PROCESSING (CONT…….)
Main Program
Start
Run Initialization
Seasonal Initialization
Rate Calculations
Integration
Output
Summary
End
Seasonal loop
Daily loop
All Grids processed
No
Yes
POST PROCESSING
Post Processing using .OSU files
Delete Input Data Files after each instance of the DSSAT simulation
Show user-friendly output
End

Figure 4: Flow chart of the GUI and DSSAT process (prev. page)

3.1 Explanation of the flow chart

The following sections will explain the flow chart design as well as show a few proposed screen shots. Actual screen designs may be different as the interface is being developed, and the users will be consulted throughout the process.

3.1.1 GUI Processing

The first step is to setup the data. This involves three processes as shown in the first block of flow chart – GUI PROCESSING. The three processes are:

1. Select region
2. Select Scenario
3. Modify data files

1. <u>Select Region:</u>

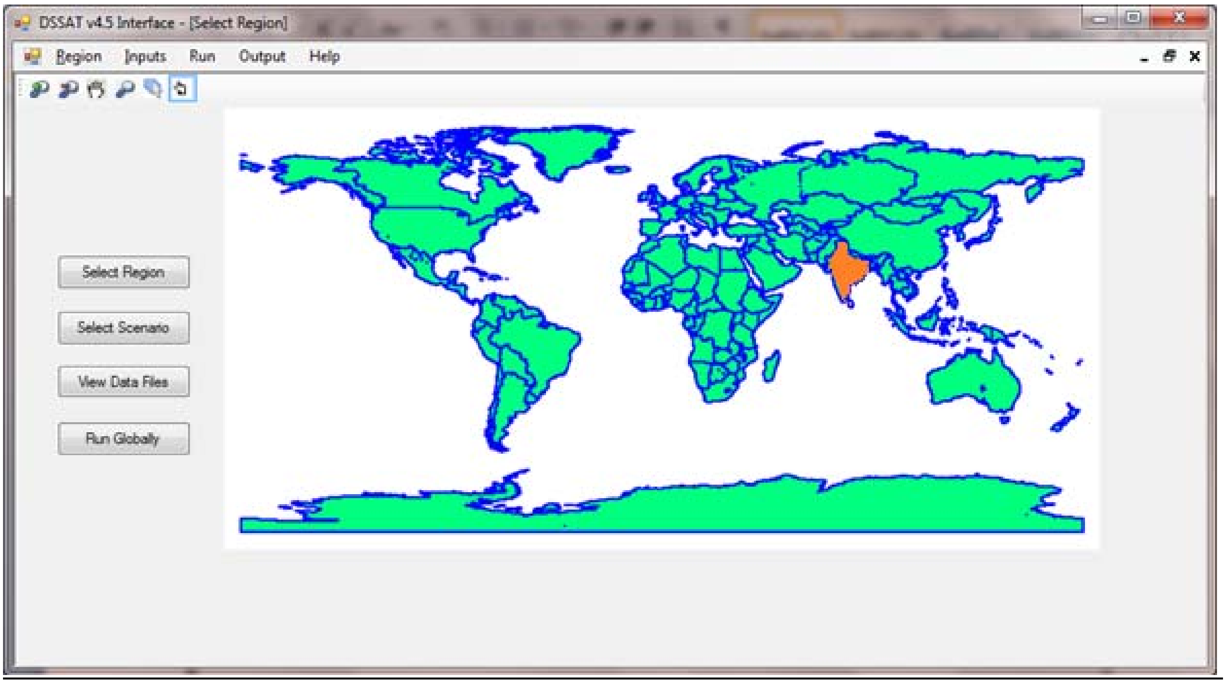


Figure 5: Select Region for Simulation

The user begins by selecting the region for simulations. User can click on a region and zoom in and out. He can select a region along the grid lines to run the DSSAT model simulations (as shown in Figure 5). For Phase 1 of the project, the user will have access to a user specified region of the map. The remaining

map area will be disabled. In Phase 2 the whole region will be clickable, and the user will be able to select up to the global level for running DSSAT simulations.

2. Select Scenario:

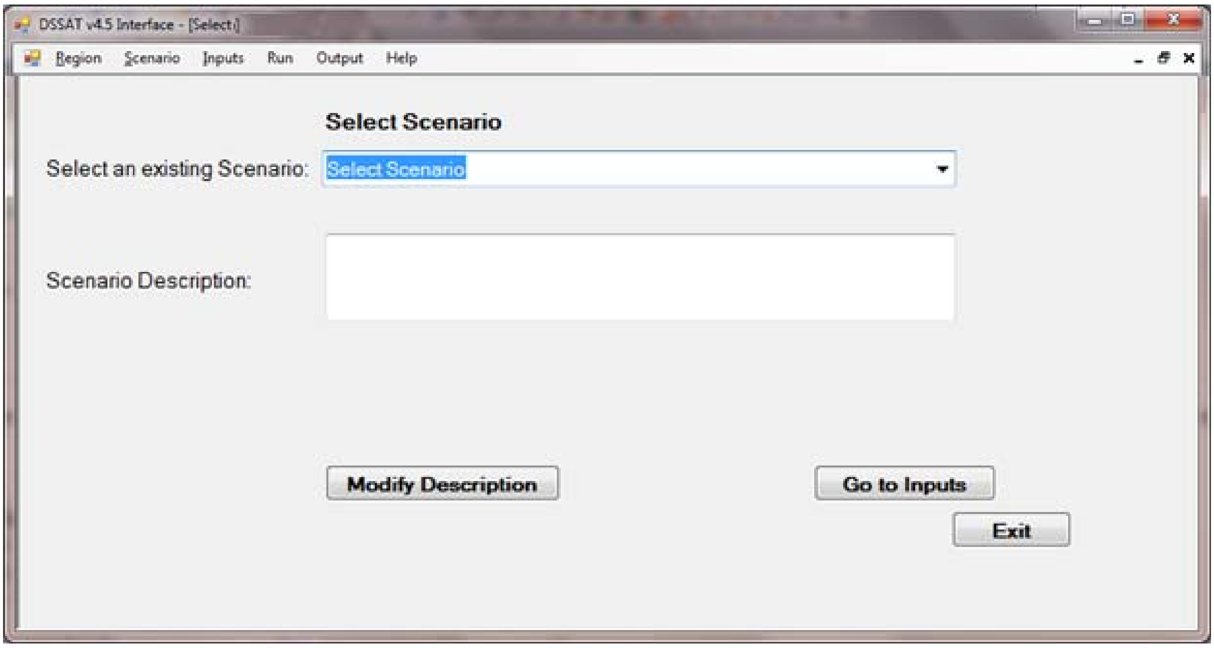


Figure 6: Select Scenario Screen

After selecting the region for simulation, the user will have an option to select a scenario (Figure 6). A set of default data files will be there for each scenario type.

The user can change some scenario parameters, which will result in a change to the related files in all of the selected region's grids. For example, if the user makes an adjustment for the CO2 parameter in the Climate change scenario, then all weather (.WTG) files will be changed by the program accordingly.

The scenarios should be such that the users can do studies for applications such as following:

1) Impact assessment of climate change and

2) Benefits of several adaptation options such as varieties, dates of sowing, irrigation and nitrogen management and their interactions;

3) Assessing values of simple traits in different management and climate change scenarios

Note: Details of scenario types need to be discussed with the user.

The user will be provided with screens to modify scenario parameters (Figure 7).

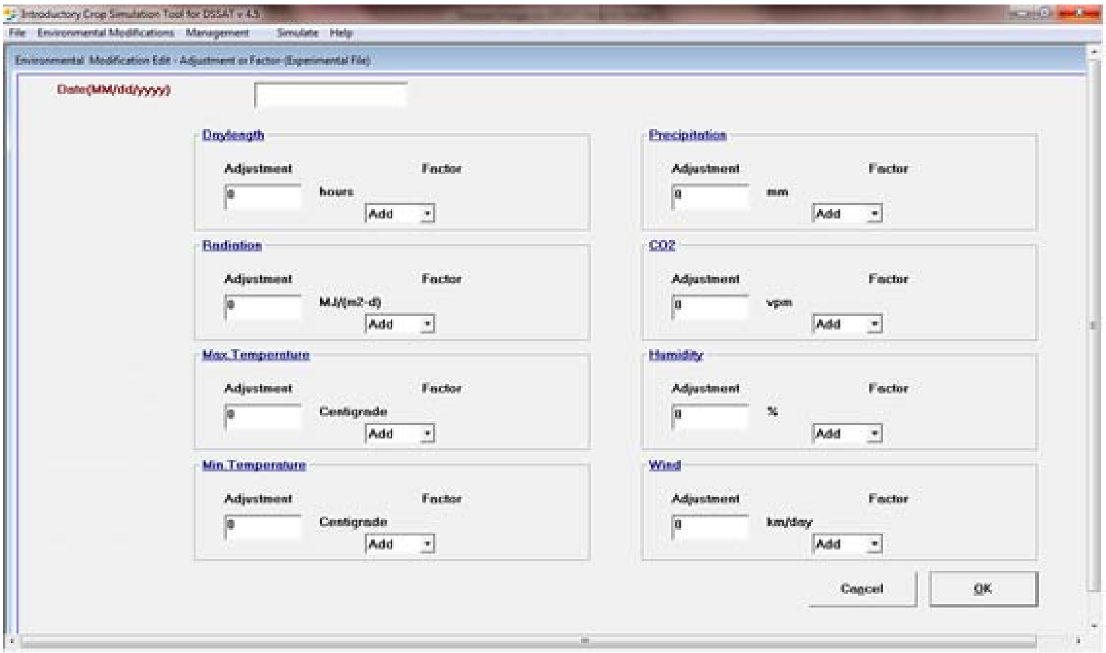


Figure 7: Example of a screen for modifying scenario parameters

3. Modify data files

User will also be provided with access to data files (Figure 8). The user will be able to select the individual data files for each pixel and run the model based on his selection.

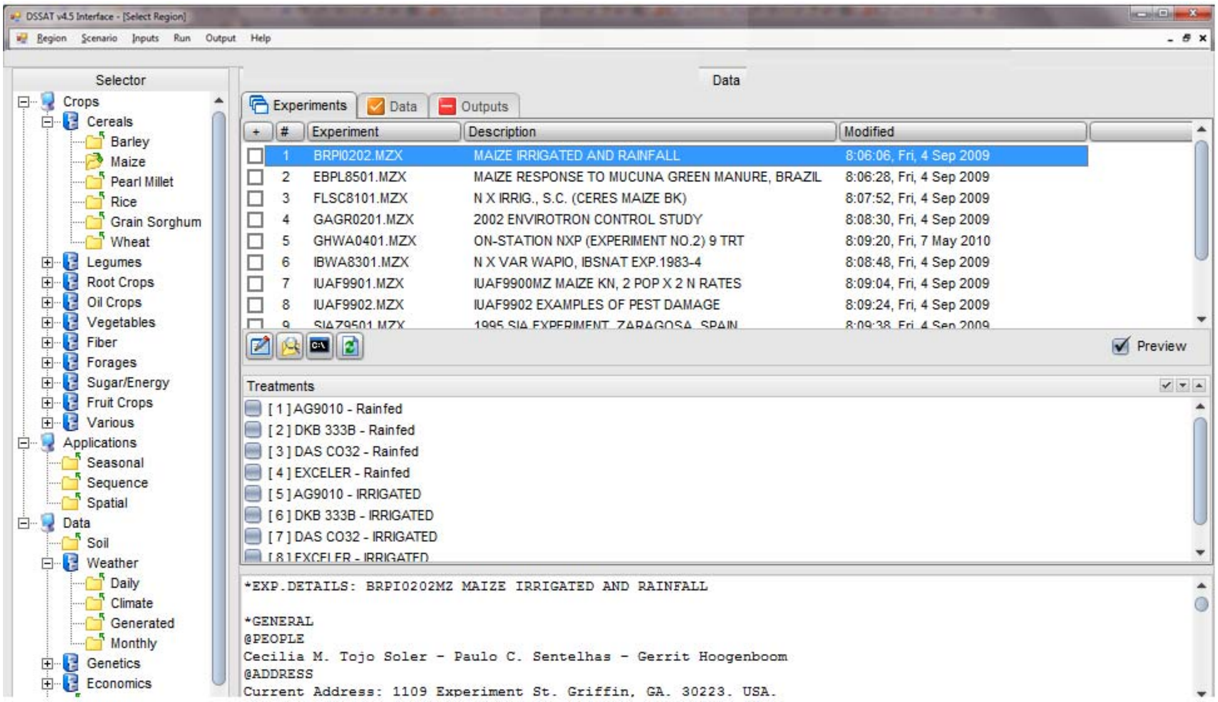


Figure 8: Data Files View

Various screens will be available for the user to make changes to data parameters (Figures 9 & 10):

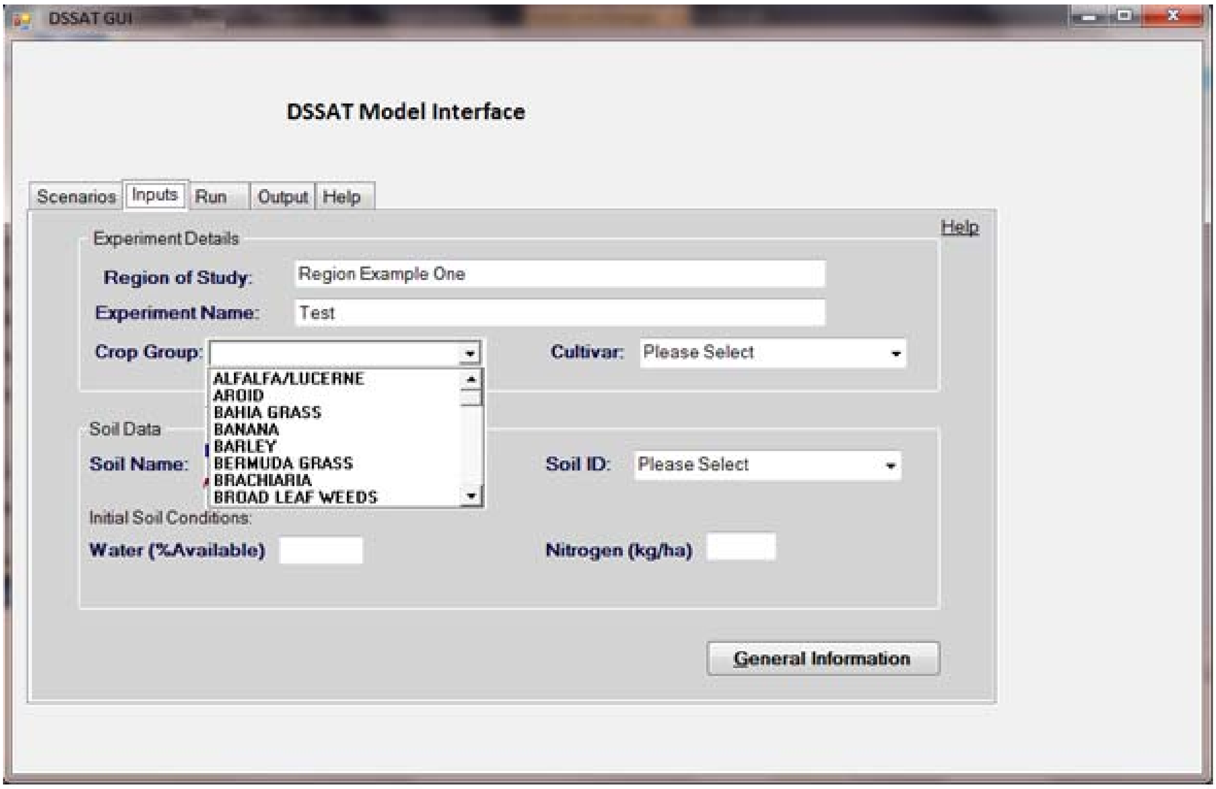


Figure 9: Example screen 1 for inputs parameters change

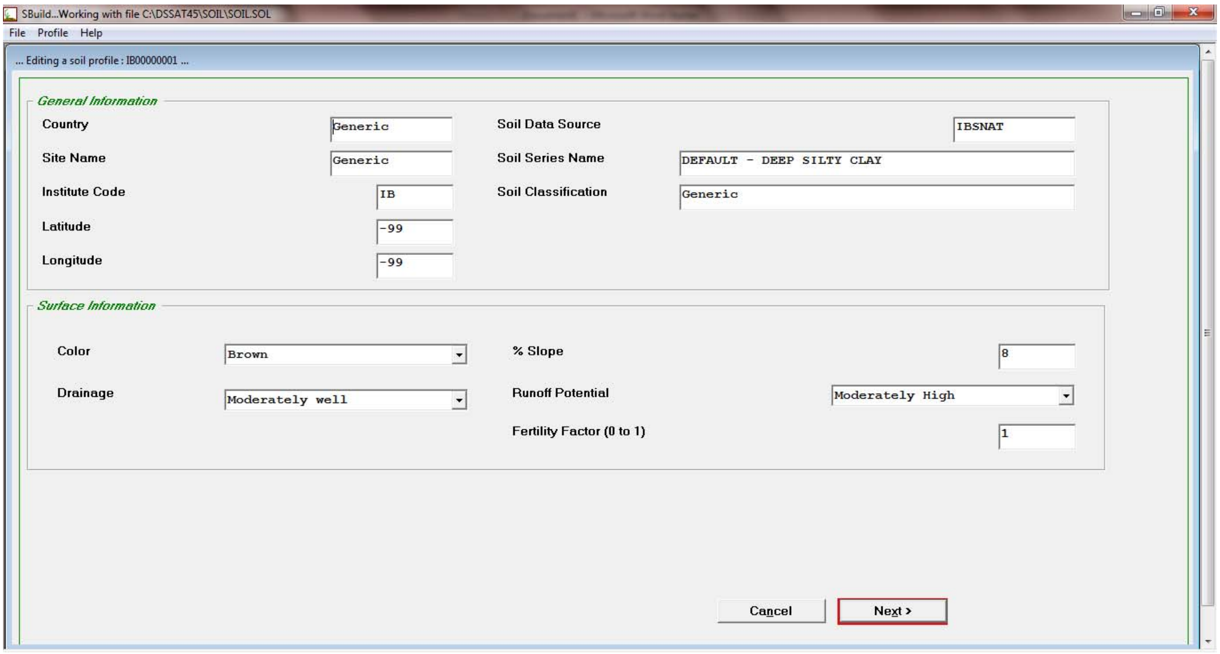


Figure 10: Example screen 2 for inputs parameters change

The above steps will help to collect data. This data will be used in the creation of input files which will be fed into the DSSAT shell.

As shown in the flow chart, after data collection, DIR.DAT file will be created with an entry for each pixel. Also, RUNFILE.DAT will be created with an entry for each soil treatment type for each pixel. These files will be used for generating the FILEX file and also the batch files for each individual pixel. After this, the user will be able to specify which outputs he is interested in, and only those entries will be made in the summary output (.OSU) files.

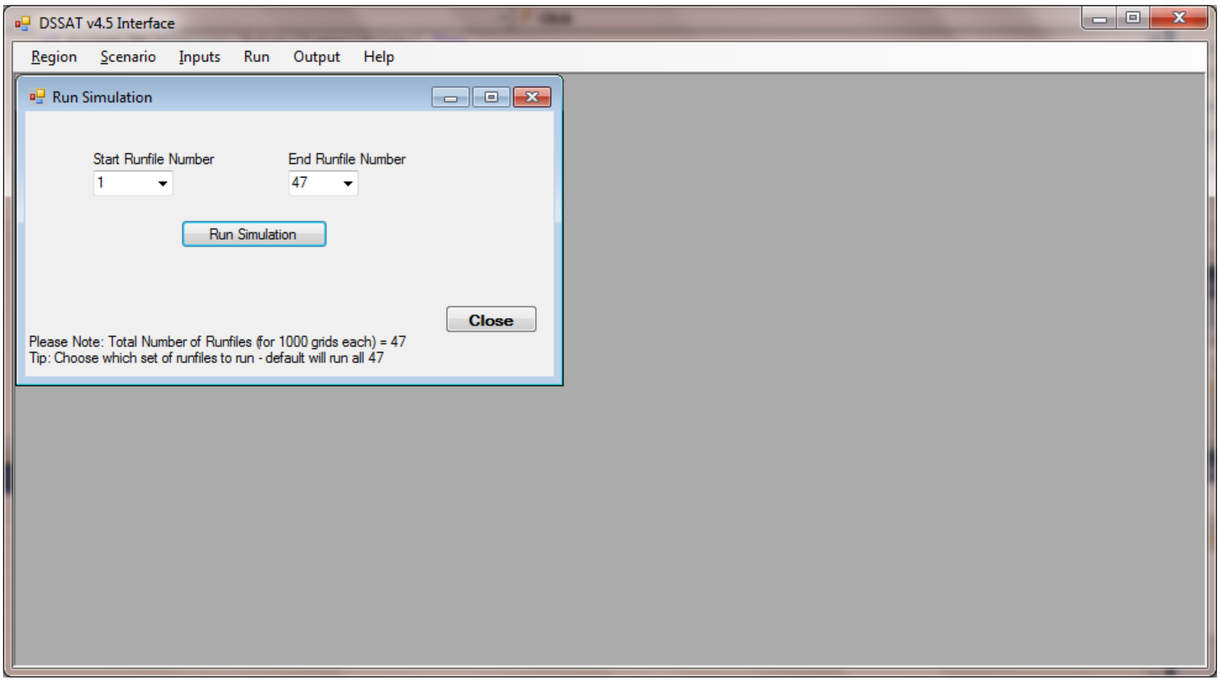
3.1.2 DSSAT Processing

Once the input files and batch files are created, the process is ready for DSSAT simulations for each pixel. Each instance of the simulation will run as follows:

"C:\temp> c:\dssat45\dscsm045 N dssbatch.v45"

The interface program will access all the available threads in different cores of the computer to run the individual DSSAT simulation processes. All this processing will be done in the background. DSSAT shell will remain the same. Any changes to the DSSAT processing are out of scope for this project.

From the front end, the program can be run from the Run menu item which will open up a 'Run Simulation' window as shown below.



3.1.3 Post Processing

Once the simulation has completed for all grids, we will have a set of Summary Output files (.OSU) for each grid. The other files generated by DSSAT processing will be deleted by the program. The filenames for Summary output files will be replaced with names that can identify each pixel's output file individually. The data from these OSU files can be used based on the post processing requirements, which still need to be discussed with the user.

After post processing is complete, different utilities will be used to clean up the computing space used during processing. The cleanup utilities will be using RUNFILE.DAT as a reference.

4. CONCLUSION

The Graphical User Interface will provide users with tools to simultaneously modify large amounts of data and run DSSAT simulations over large regions of interest. This will be very useful for different studies, such as Climate Change impact in a region; or benefits of several adaptation options such as varieties, dates of sowing, irrigation and nitrogen management and their interactions.

5. OUTSTANDING QUESTIONS AND ISSUES

5.1 What are the possible scenarios?

5.2 How to determine which pixels are suitable or unsuitable based on soil or climate conditions?

5.3 Appearance of Interface screens may be different from the ones shown above, will be finalized after more discussion with the users.

5.4 User will be asked which outputs he wants to be displayed in the results. Need clarification on what options to be given to the user.

5.5 Post Processing results – what all to display?

6. ACKNOWLEDGEMENTS

Dr. Philip Thornton (International Livestock Research Institute): For his guidance and help in the design and functionality layout.

DSSAT v4.5 Documentation: Hoogenboom, G., J.W. Jones, P.W. Wilkens, C.H. Porter, K.J. Boote, L.A. Hunt, U. Singh, J.L. Lizaso, J.W. White, O. Uryasev, F.S. Royce, R. Ogoshi, A.J. Gijsman, and G.Y. Tsuji. 2010. Decision Support System for Agrotechnology Transfer (DSSAT) Version 4.5 [CD-ROM]. University of Hawaii, Honolulu, Hawaii.

Dr. Pramod Aggarwal: For providing the users' perspective and requirements for the complete project, and also facilitating knowledge sharing with people who have experience working with DSSAT.

Appendix 1

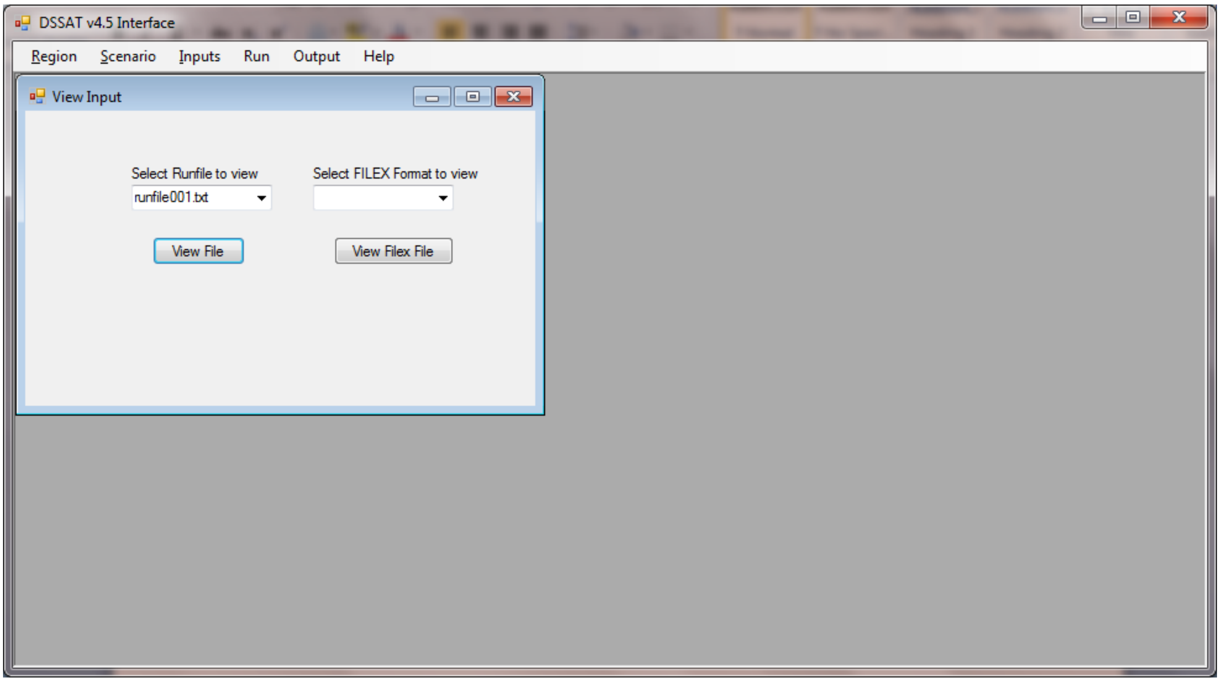
DSSAT Global Interface

DSSAT Global User Interface is free software developed for the International Livestock Research Institute (ILRI) (http://www.ilri.org/). This user friendly interface is developed using Visual Basic 2010, and is used to run stripped down DSSAT crop models. It provides users a venue to input large amount of climate scenarios, soil and weather data, then optimize the available computer resources to run in parallel multiple instances of DSSAT over a very large number of grids for up to a global scale. It can then be used to create output spreadsheets based on the user's preference of output to be displayed.

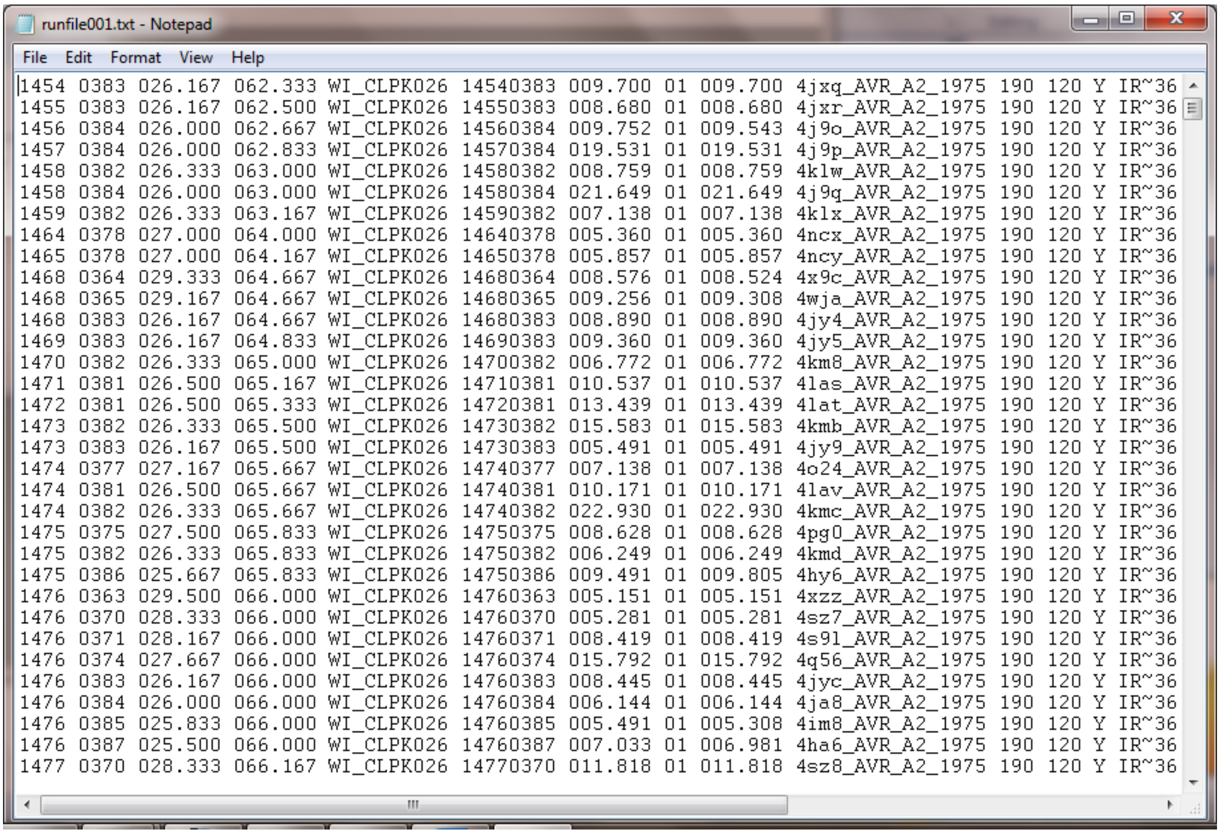
Following are a few screenshots from the DSSAT Global Interface:

View Input screen

This screen allows users to view different runfiles which will be used as driver files to run the interface in multiple instances.



Example of a runfile (each grid has a separate row):



runfile001.txt - Notepad

File Edit Format View Help

```
1454 0383 026.167 062.333 WI_CLPK026 14540383 009.700 01 009.700 4jxq_AVR_A2_1975 190 120 Y IR~36
1455 0383 026.167 062.500 WI_CLPK026 14550383 008.680 01 008.680 4jxr_AVR_A2_1975 190 120 Y IR~36
1456 0384 026.000 062.667 WI_CLPK026 14560384 009.752 01 009.543 4j9o_AVR_A2_1975 190 120 Y IR~36
1457 0384 026.000 062.833 WI_CLPK026 14570384 019.531 01 019.531 4j9p_AVR_A2_1975 190 120 Y IR~36
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1459 0382 026.333 063.167 WI_CLPK026 14590382 007.138 01 007.138 4klx_AVR_A2_1975 190 120 Y IR~36
1464 0378 027.000 064.000 WI_CLPK026 14640378 005.360 01 005.360 4ncx_AVR_A2_1975 190 120 Y IR~36
1465 0378 027.000 064.167 WI_CLPK026 14650378 005.857 01 005.857 4ncy_AVR_A2_1975 190 120 Y IR~36
1468 0364 029.333 064.667 WI_CLPK026 14680364 008.576 01 008.524 4x9c_AVR_A2_1975 190 120 Y IR~36
1468 0365 029.167 064.667 WI_CLPK026 14680365 009.256 01 009.308 4wja_AVR_A2_1975 190 120 Y IR~36
1468 0383 026.167 064.667 WI_CLPK026 14680383 008.890 01 008.890 4jy4_AVR_A2_1975 190 120 Y IR~36
1469 0383 026.167 064.833 WI_CLPK026 14690383 009.360 01 009.360 4jy5_AVR_A2_1975 190 120 Y IR~36
1470 0382 026.333 065.000 WI_CLPK026 14700382 006.772 01 006.772 4km8_AVR_A2_1975 190 120 Y IR~36
1471 0381 026.500 065.167 WI_CLPK026 14710381 010.537 01 010.537 4las_AVR_A2_1975 190 120 Y IR~36
1472 0381 026.500 065.333 WI_CLPK026 14720381 013.439 01 013.439 4lat_AVR_A2_1975 190 120 Y IR~36
1473 0382 026.333 065.500 WI_CLPK026 14730382 015.583 01 015.583 4kmb_AVR_A2_1975 190 120 Y IR~36
1473 0383 026.167 065.500 WI_CLPK026 14730383 005.491 01 005.491 4jy9_AVR_A2_1975 190 120 Y IR~36
1474 0377 027.167 065.667 WI_CLPK026 14740377 007.138 01 007.138 4o24_AVR_A2_1975 190 120 Y IR~36
1474 0381 026.500 065.667 WI_CLPK026 14740381 010.171 01 010.171 4lav_AVR_A2_1975 190 120 Y IR~36
1474 0382 026.333 065.667 WI_CLPK026 14740382 022.930 01 022.930 4kmc_AVR_A2_1975 190 120 Y IR~36
1475 0375 027.500 065.833 WI_CLPK026 14750375 008.628 01 008.628 4pg0_AVR_A2_1975 190 120 Y IR~36
1475 0382 026.333 065.833 WI_CLPK026 14750382 006.249 01 006.249 4kmd_AVR_A2_1975 190 120 Y IR~36
1475 0386 025.667 065.833 WI_CLPK026 14750386 009.491 01 009.805 4hy6_AVR_A2_1975 190 120 Y IR~36
1476 0363 029.500 066.000 WI_CLPK026 14760363 005.151 01 005.151 4xzz_AVR_A2_1975 190 120 Y IR~36
1476 0370 028.333 066.000 WI_CLPK026 14760370 005.281 01 005.281 4sz7_AVR_A2_1975 190 120 Y IR~36
1476 0371 028.167 066.000 WI_CLPK026 14760371 008.419 01 008.419 4s9l_AVR_A2_1975 190 120 Y IR~36
1476 0374 027.667 066.000 WI_CLPK026 14760374 015.792 01 015.792 4q56_AVR_A2_1975 190 120 Y IR~36
1476 0383 026.167 066.000 WI_CLPK026 14760383 008.445 01 008.445 4jyc_AVR_A2_1975 190 120 Y IR~36
1476 0384 026.000 066.000 WI_CLPK026 14760384 006.144 01 006.144 4ja8_AVR_A2_1975 190 120 Y IR~36
1476 0385 025.833 066.000 WI_CLPK026 14760385 005.491 01 005.308 4im8_AVR_A2_1975 190 120 Y IR~36
1476 0387 025.500 066.000 WI_CLPK026 14760387 007.033 01 006.981 4ha6_AVR_A2_1975 190 120 Y IR~36
1477 0370 028.333 066.167 WI_CLPK026 14770370 011.818 01 011.818 4sz8_AVR_A2_1975 190 120 Y IR~36
```
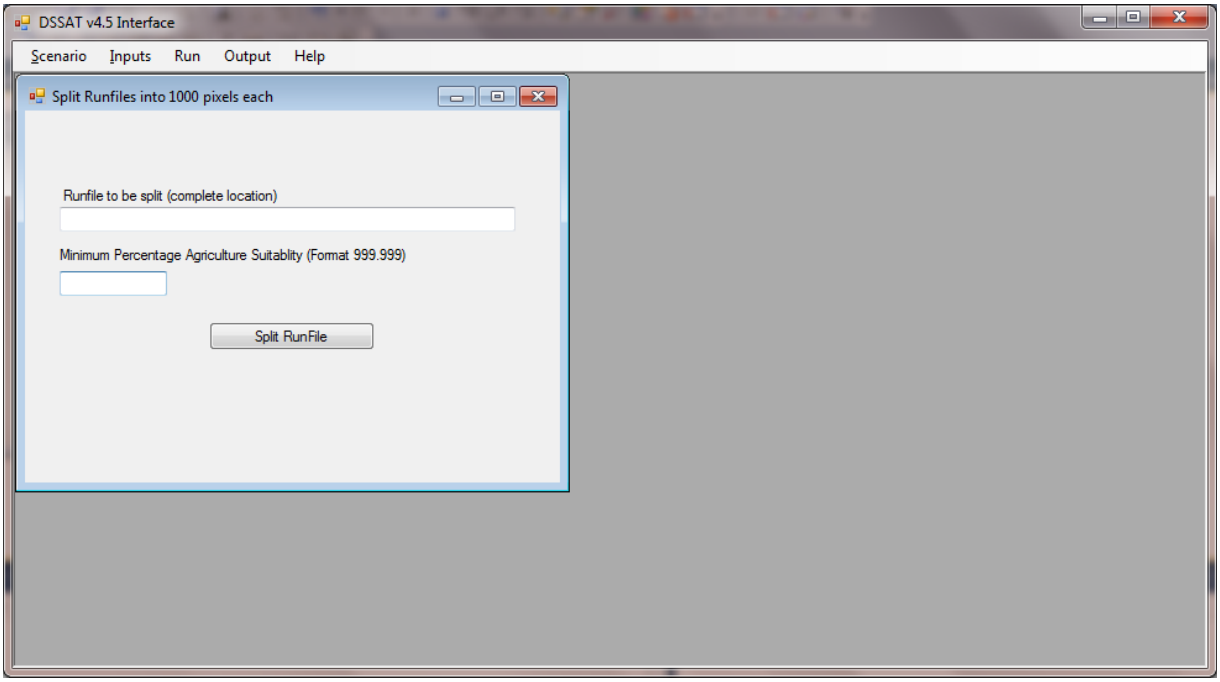
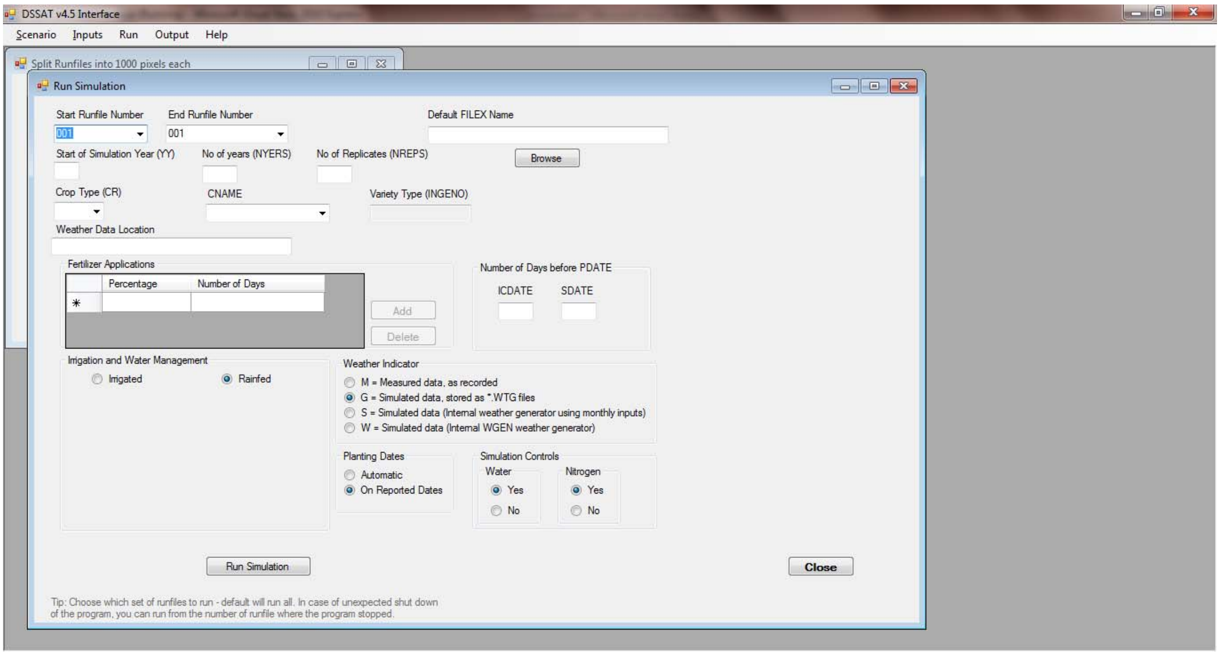

Split Runfile into 1000 pixels each:

This screen allows users to split a runfile created for a very large region into smaller runfiles which can be processed smoothly in the parallel running scenario. This also ensures that the directories storing large amounts of irrelevant outputs can be cleaned up in stages. The user can ignore some rows to be selected into the split runfiles, based on the Minimum Percentage Agriculture Suitability.



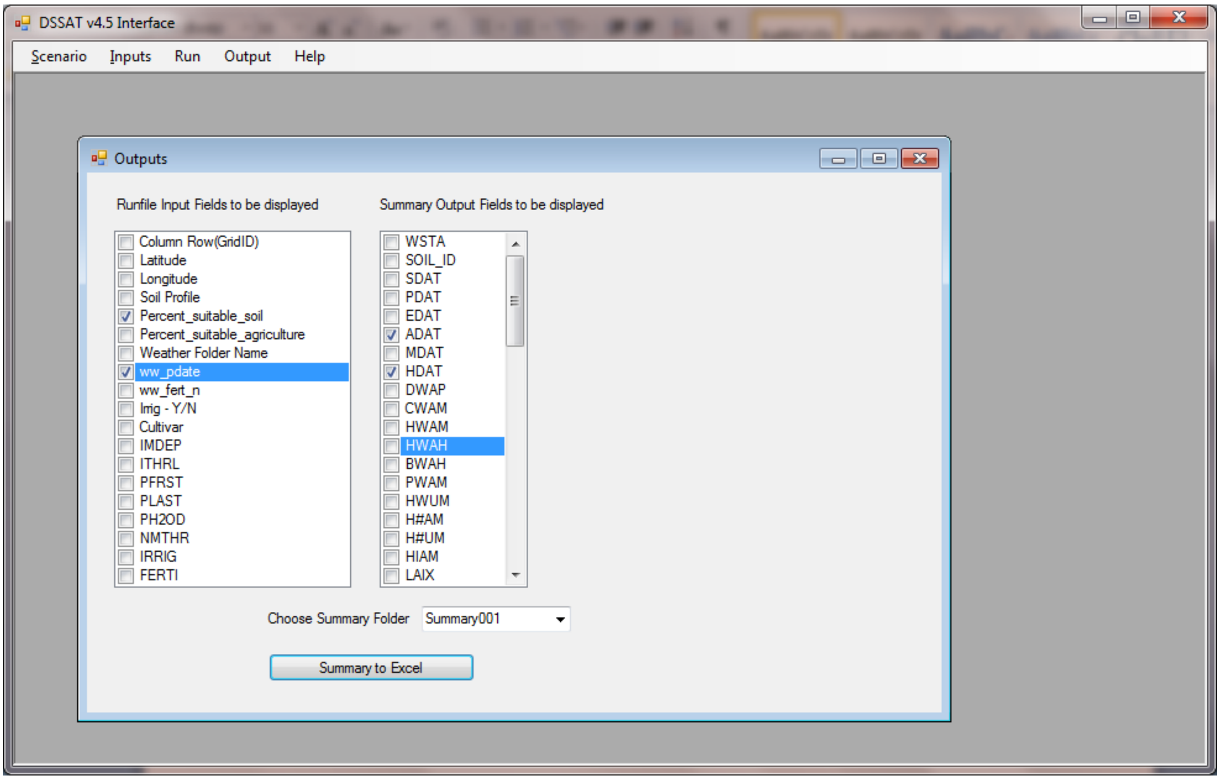
Run Simulation Screen:

This is the main screen where most of the processing is done. Users are asked to select the runfiles they want to run, and also the default FILEX name and location, based on which FILEX will be created for each grid. Then they need to input information for various fields. Remaining information is derived from the runfile. Based on all the runfile and user input parameters, FILEX is created for each grid. Then multiple instances of DSSAT run simultaneously for each separate grid. The results are stored in different folders, out of which only Summary files are retained. After running one runfile (a set of 1000 grids) the directories get cleaned up and the process begins for the next runfile.

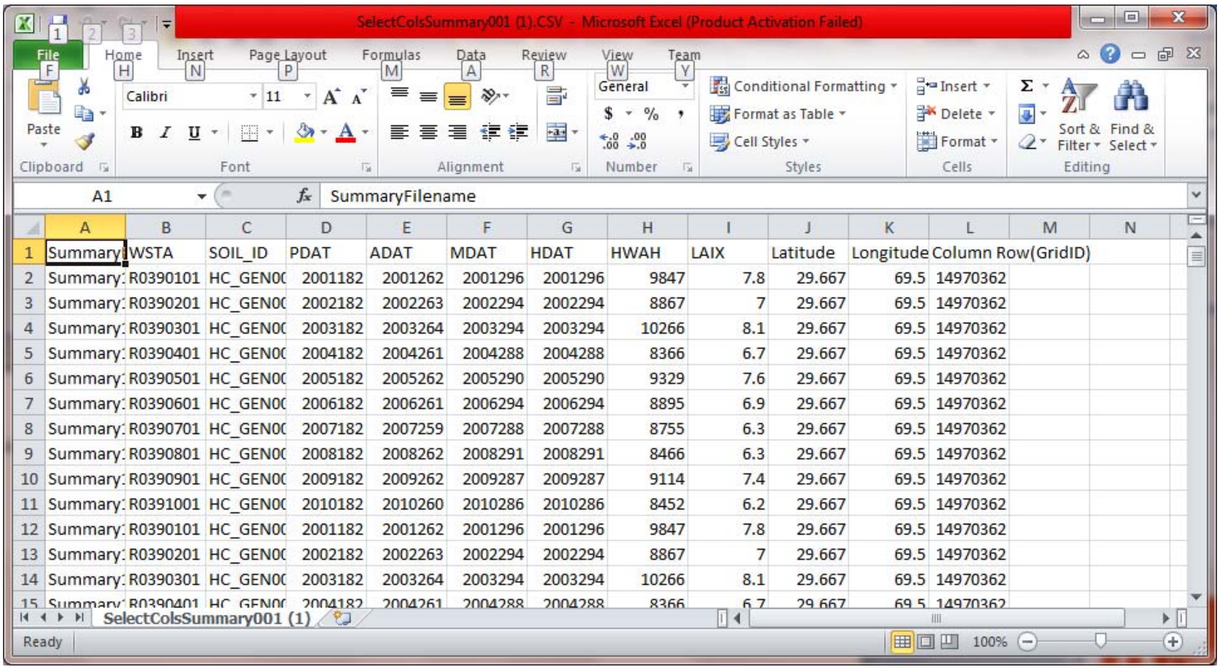


Output Screen:

This is the screen where users can select which fields they want to view for output. The fields can be chosen from the Runfile and also from the Summary outputs. Based on the fields selected, a CSV file is created for the user.



Example of a Select Columns Output file:



	A	B	C	D	E	F	G	H	I	J	K	L
1	Summary	WSTA	SOIL_ID	PDAT	ADAT	MDAT	HDAT	HWAH	LAIX	Latitude	Longitude	Column Row(GridID)
2	Summary:	R0390101	HC_GEN0(	2001182	2001262	2001296	2001296	9847	7.8	29.667	69.5	14970362
3	Summary:	R0390201	HC_GEN0(	2002182	2002263	2002294	2002294	8867	7	29.667	69.5	14970362
4	Summary:	R0390301	HC_GEN0(	2003182	2003264	2003294	2003294	10266	8.1	29.667	69.5	14970362
5	Summary:	R0390401	HC_GEN0(	2004182	2004261	2004288	2004288	8366	6.7	29.667	69.5	14970362
6	Summary:	R0390501	HC_GEN0(	2005182	2005262	2005290	2005290	9329	7.6	29.667	69.5	14970362
7	Summary:	R0390601	HC_GEN0(	2006182	2006261	2006294	2006294	8895	6.9	29.667	69.5	14970362
8	Summary:	R0390701	HC_GEN0(	2007182	2007259	2007288	2007288	8755	6.3	29.667	69.5	14970362
9	Summary:	R0390801	HC_GEN0(	2008182	2008262	2008291	2008291	8466	6.3	29.667	69.5	14970362
10	Summary:	R0390901	HC_GEN0(	2009182	2009262	2009287	2009287	9114	7.4	29.667	69.5	14970362
11	Summary:	R0391001	HC_GEN0(	2010182	2010260	2010286	2010286	8452	6.2	29.667	69.5	14970362
12	Summary:	R0390101	HC_GEN0(	2001182	2001262	2001296	2001296	9847	7.8	29.667	69.5	14970362
13	Summary:	R0390201	HC_GEN0(	2002182	2002263	2002294	2002294	8867	7	29.667	69.5	14970362
14	Summary:	R0390301	HC_GEN0(	2003182	2003264	2003294	2003294	10266	8.1	29.667	69.5	14970362
15	Summary:	R0390401	HC_GEN0(	2004182	2004261	2004288	2004288	8366	6.7	29.667	69.5	14970362

Appendix 2

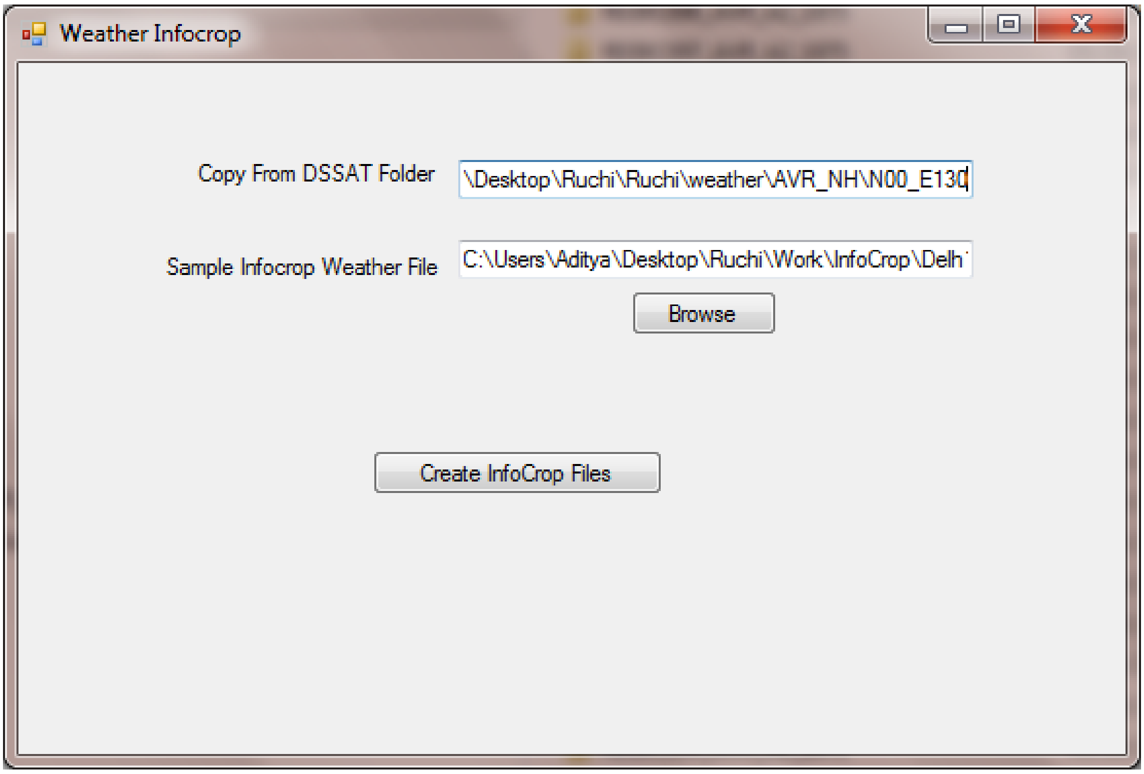
Infocrop Global Interface

The Infocrop Global Interface enables users to run stripped down InfoCrop models. It provides users a venue to input large volumes of cimate scenario, soil and weather data, then optimize the available computer resources to run in parallel multiple instances of the crop multiple over a very large number of grids up to global scale and then finally display the outputs.

InfoCrop, a generic crop model, simulates the effects of weather, soils, agronomic management (planting, nitrogen, residues and irrigation) and major pests on crop growth, yield, soil carbon, nitrogen and water, and greenhouse gas emissions. This paper presents results of its evaluation in terms of its validation for rice and wheat crops in contrasting agro-environments of tropics, sensitivity to the key inputs, and also illustrates two typical applications of the model. Eleven diverse field experiments, having treatments of location, seasons, varieties, nitrogen management, organic matter, irrigation, and multiple pest incidences were used for validation. Grain yields in these experiments varied from 2.8 to 7.2 ton ha^{-1} in rice and from 3.6 to 5.5 ton ha^{-1} in wheat. The results indicated that the model was generally able to explain the differences in biomass, grain yield, emissions of carbon dioxide, methane and nitrous oxides, and long-term trends in soil organic carbon, in diverse agro-environments. The losses in dry matter and grain yield due to different pests and their populations were also explained satisfactorily. There were some discrepancies in the simulated emission of these gases during first few days after sowing/transplanting possibly because of the absence of tillage effects in the model. The sensitivity of the model to change in ambient temperature, crop duration and pest incidence was similar to the available field knowledge. The application of the model to quantify multiple pests damage through iso-loss curves is demonstrated. Another application illustrated is the use of InfoCrop for analyzing the trade-offs between increasing crop production, agronomic management strategies, and their global warming potential.

A Weather utility tool was created to convert the weather files generated for use in DSSAT model to the format required for the InfoCrop model.

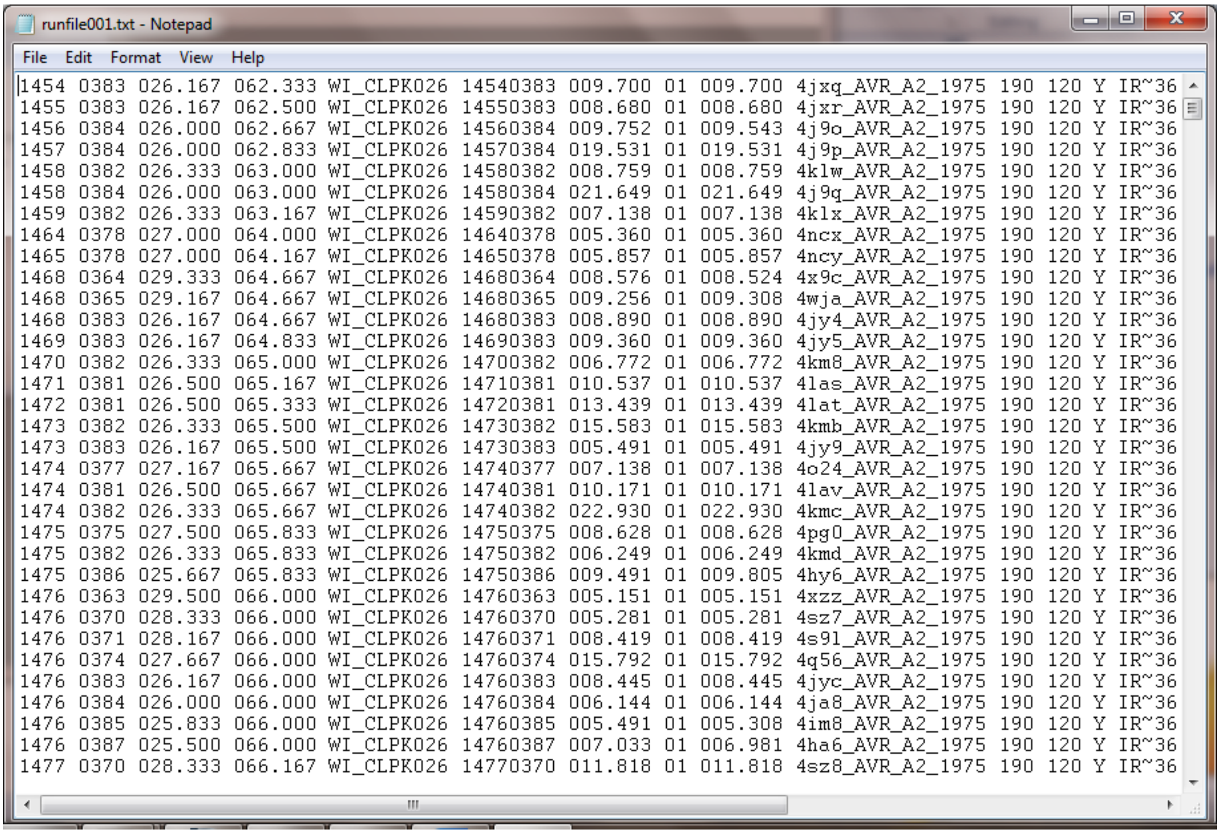
Weather Utility:



Following are a few screenshots from the Infocrop Global Interface:

Runfile controls most of the simulation work. The layout and is as follows: column, row, latitude, longitude, soil code (which has to be put into the FILEX experimental file for each “treatment” of the experiment), col/row combination, percentage of mapping unit in this soil type, number of agricultural soils in this mapping unit, and the percentage of the pixel that is in agriculturally suitable soils.

Example of a runfile (each grid has a separate row):



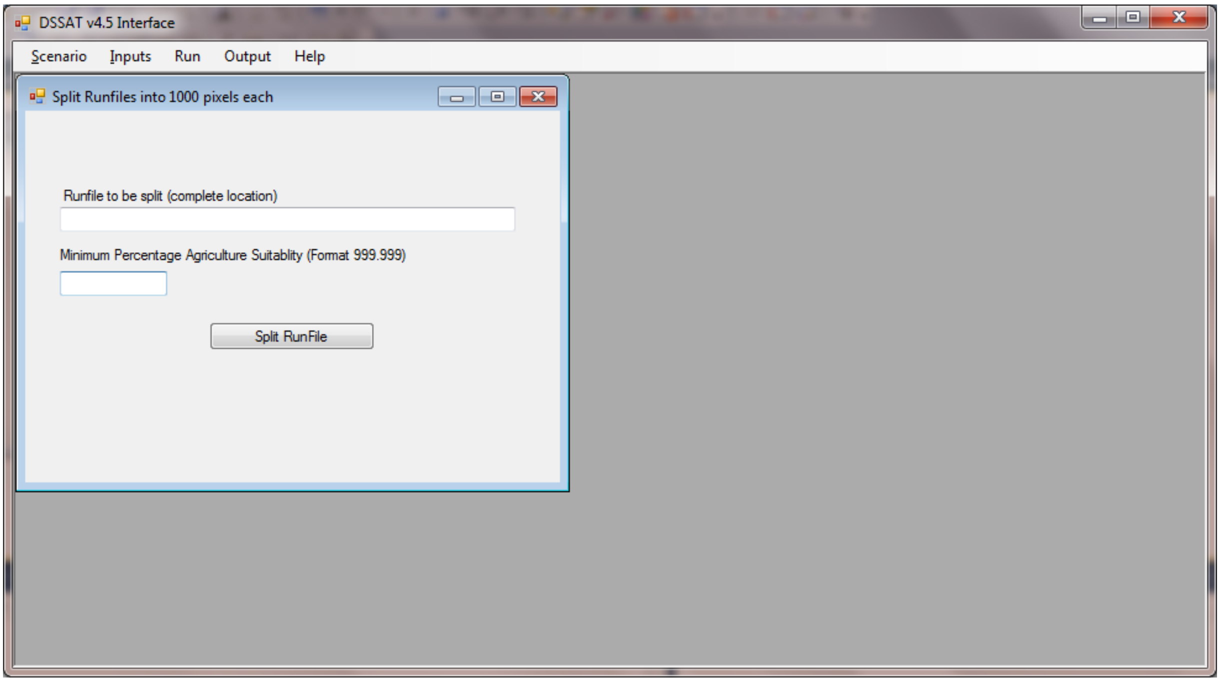
runfile001.txt - Notepad

File Edit Format View Help

```
1454 0383 026.167 062.333 WI_CLPK026 14540383 009.700 01 009.700 4jxq_AVR_A2_1975 190 120 Y IR~36
1455 0383 026.167 062.500 WI_CLPK026 14550383 008.680 01 008.680 4jxr_AVR_A2_1975 190 120 Y IR~36
1456 0384 026.000 062.667 WI_CLPK026 14560384 009.752 01 009.543 4j9o_AVR_A2_1975 190 120 Y IR~36
1457 0384 026.000 062.833 WI_CLPK026 14570384 019.531 01 019.531 4j9p_AVR_A2_1975 190 120 Y IR~36
1458 0382 026.333 063.000 WI_CLPK026 14580382 008.759 01 008.759 4klw_AVR_A2_1975 190 120 Y IR~36
1458 0384 026.000 063.000 WI_CLPK026 14580384 021.649 01 021.649 4j9q_AVR_A2_1975 190 120 Y IR~36
1459 0382 026.333 063.167 WI_CLPK026 14590382 007.138 01 007.138 4klx_AVR_A2_1975 190 120 Y IR~36
1464 0378 027.000 064.000 WI_CLPK026 14640378 005.360 01 005.360 4ncx_AVR_A2_1975 190 120 Y IR~36
1465 0378 027.000 064.167 WI_CLPK026 14650378 005.857 01 005.857 4ncy_AVR_A2_1975 190 120 Y IR~36
1468 0364 029.333 064.667 WI_CLPK026 14680364 008.576 01 008.524 4x9c_AVR_A2_1975 190 120 Y IR~36
1468 0365 029.167 064.667 WI_CLPK026 14680365 009.256 01 009.308 4wja_AVR_A2_1975 190 120 Y IR~36
1468 0383 026.167 064.667 WI_CLPK026 14680383 008.890 01 008.890 4jy4_AVR_A2_1975 190 120 Y IR~36
1469 0383 026.167 064.833 WI_CLPK026 14690383 009.360 01 009.360 4jy5_AVR_A2_1975 190 120 Y IR~36
1470 0382 026.333 065.000 WI_CLPK026 14700382 006.772 01 006.772 4km8_AVR_A2_1975 190 120 Y IR~36
1471 0381 026.500 065.167 WI_CLPK026 14710381 010.537 01 010.537 4las_AVR_A2_1975 190 120 Y IR~36
1472 0381 026.500 065.333 WI_CLPK026 14720381 013.439 01 013.439 4lat_AVR_A2_1975 190 120 Y IR~36
1473 0382 026.333 065.500 WI_CLPK026 14730382 015.583 01 015.583 4kmb_AVR_A2_1975 190 120 Y IR~36
1473 0383 026.167 065.500 WI_CLPK026 14730383 005.491 01 005.491 4jy9_AVR_A2_1975 190 120 Y IR~36
1474 0377 027.167 065.667 WI_CLPK026 14740377 007.138 01 007.138 4o24_AVR_A2_1975 190 120 Y IR~36
1474 0381 026.500 065.667 WI_CLPK026 14740381 010.171 01 010.171 4lav_AVR_A2_1975 190 120 Y IR~36
1474 0382 026.333 065.667 WI_CLPK026 14740382 022.930 01 022.930 4kmc_AVR_A2_1975 190 120 Y IR~36
1475 0375 027.500 065.833 WI_CLPK026 14750375 008.628 01 008.628 4pg0_AVR_A2_1975 190 120 Y IR~36
1475 0382 026.333 065.833 WI_CLPK026 14750382 006.249 01 006.249 4kmd_AVR_A2_1975 190 120 Y IR~36
1475 0386 025.667 065.833 WI_CLPK026 14750386 009.491 01 009.805 4hy6_AVR_A2_1975 190 120 Y IR~36
1476 0363 029.500 066.000 WI_CLPK026 14760363 005.151 01 005.151 4xzz_AVR_A2_1975 190 120 Y IR~36
1476 0370 028.333 066.000 WI_CLPK026 14760370 005.281 01 005.281 4sz7_AVR_A2_1975 190 120 Y IR~36
1476 0371 028.167 066.000 WI_CLPK026 14760371 008.419 01 008.419 4s91_AVR_A2_1975 190 120 Y IR~36
1476 0374 027.667 066.000 WI_CLPK026 14760374 015.792 01 015.792 4q56_AVR_A2_1975 190 120 Y IR~36
1476 0383 026.167 066.000 WI_CLPK026 14760383 008.445 01 008.445 4jyc_AVR_A2_1975 190 120 Y IR~36
1476 0384 026.000 066.000 WI_CLPK026 14760384 006.144 01 006.144 4ja8_AVR_A2_1975 190 120 Y IR~36
1476 0385 025.833 066.000 WI_CLPK026 14760385 005.491 01 005.308 4im8_AVR_A2_1975 190 120 Y IR~36
1476 0387 025.500 066.000 WI_CLPK026 14760387 007.033 01 006.981 4ha6_AVR_A2_1975 190 120 Y IR~36
1477 0370 028.333 066.167 WI_CLPK026 14770370 011.818 01 011.818 4sz8_AVR_A2_1975 190 120 Y IR~36
```

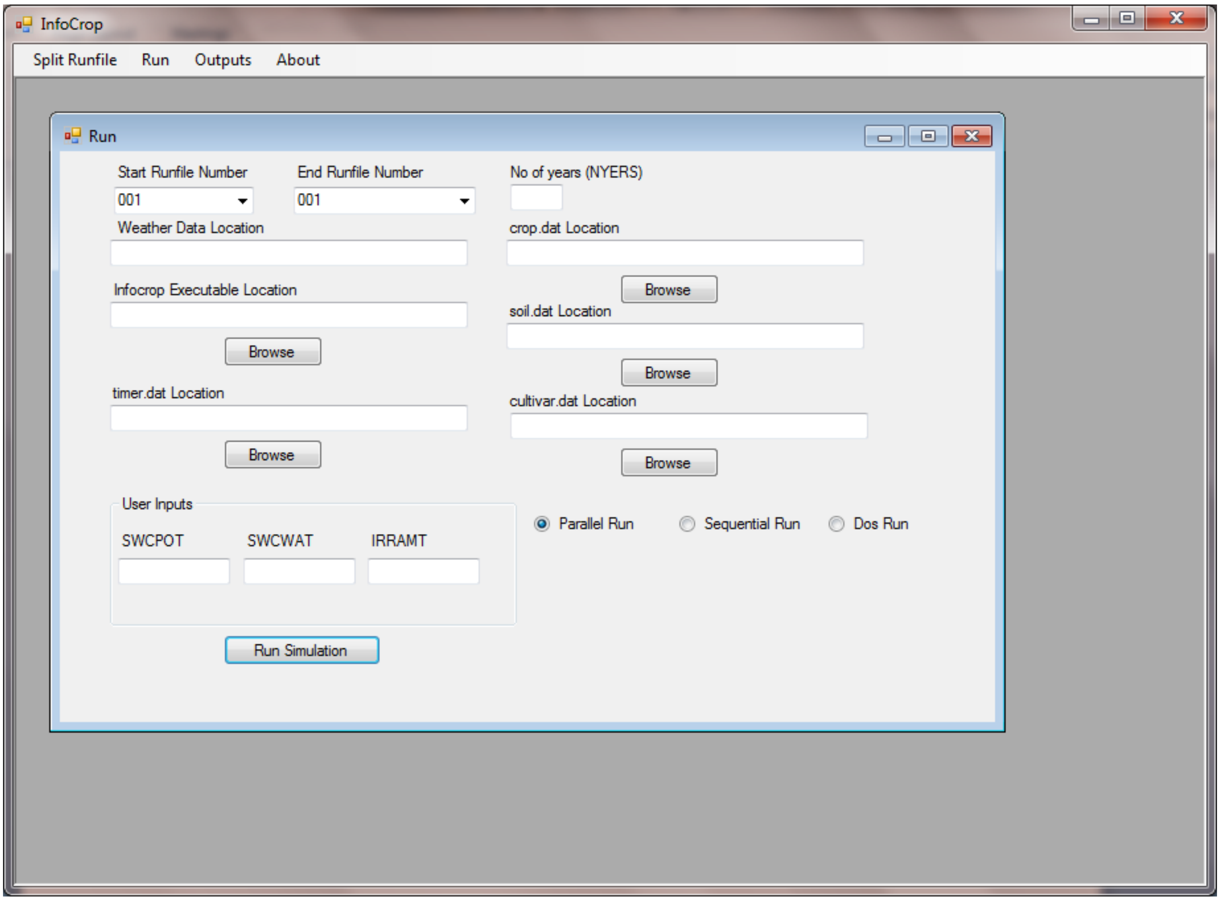
Split Runfile into 1000 pixels each:

This screen allows users to split a runfile created for a very large region into smaller runfiles which can be processed smoothly in the parallel running scenario. This also ensures that the directories storing large amounts of irrelevant outputs can be cleaned up in stages. The user can ignore some rows to be selected into the split runfiles, based on the Minimum Percentage Agriculture Suitability.



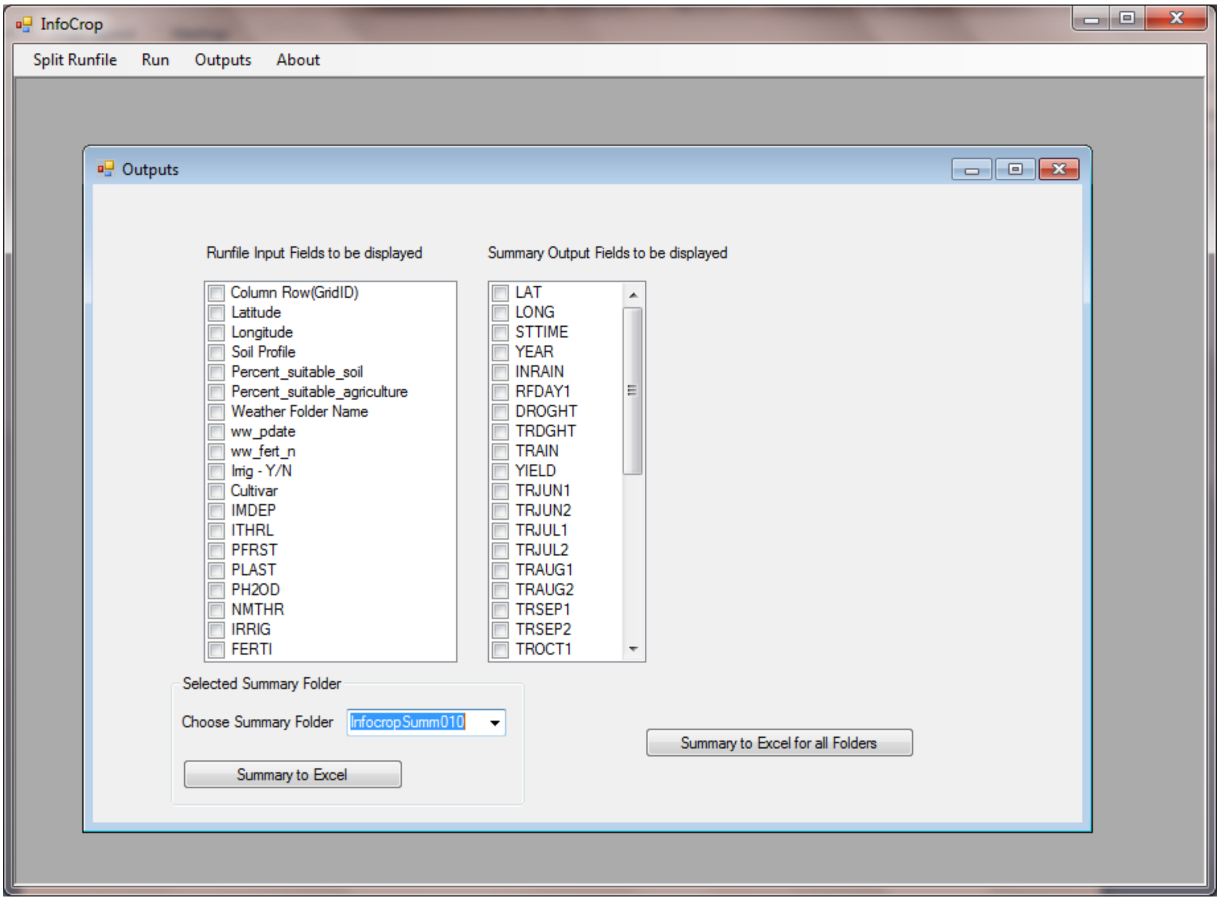
Run Simulation Screen:

This is the main screen where most of the processing is done. Users are asked to select the runfiles they want to run, and also the default names and locations for crop, soil, cultivar and timer files. Then they need to input information for some fields. Remaining information is derived from the runfile. Based on all the runfile and user input parameters, model.dat and reruns.dat files are created for each grid. Then multiple instances of Infocrop run simultaneously for each separate grid. The results are stored in different folders, out of which only Summary files are retained. After running one runfil (a set of 1000 grids) the directories get cleaned up and the process begins for the next runfile.

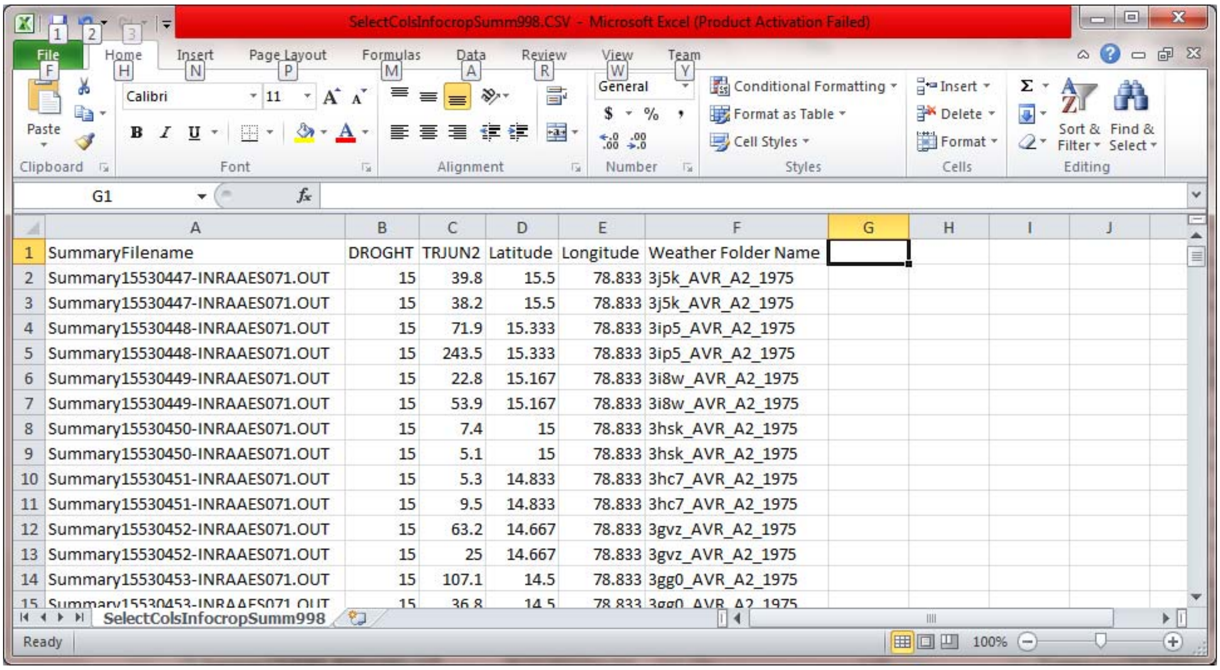


Output Screen:

This is the screen where users can select which fields they want to view for output. The fields can be chosen from the Runfile and also from the Summary outputs. Based on the fields selected, a CSV file is created for the user.



Example of a Select Columns Output file:



SummaryFilename	DROGHT	TRJUN2	Latitude	Longitude	Weather Folder Name
Summary15530447-INRAAES071.OUT	15	39.8	15.5	78.833	3j5k_AVR_A2_1975
Summary15530447-INRAAES071.OUT	15	38.2	15.5	78.833	3j5k_AVR_A2_1975
Summary15530448-INRAAES071.OUT	15	71.9	15.333	78.833	3ip5_AVR_A2_1975
Summary15530448-INRAAES071.OUT	15	243.5	15.333	78.833	3ip5_AVR_A2_1975
Summary15530449-INRAAES071.OUT	15	22.8	15.167	78.833	3i8w_AVR_A2_1975
Summary15530449-INRAAES071.OUT	15	53.9	15.167	78.833	3i8w_AVR_A2_1975
Summary15530450-INRAAES071.OUT	15	7.4	15	78.833	3hsk_AVR_A2_1975
Summary15530450-INRAAES071.OUT	15	5.1	15	78.833	3hsk_AVR_A2_1975
Summary15530451-INRAAES071.OUT	15	5.3	14.833	78.833	3hc7_AVR_A2_1975
Summary15530451-INRAAES071.OUT	15	9.5	14.833	78.833	3hc7_AVR_A2_1975
Summary15530452-INRAAES071.OUT	15	63.2	14.667	78.833	3gvz_AVR_A2_1975
Summary15530452-INRAAES071.OUT	15	25	14.667	78.833	3gvz_AVR_A2_1975
Summary15530453-INRAAES071.OUT	15	107.1	14.5	78.833	3gg0_AVR_A2_1975
Summary15530453-INRAAES071.OUT	15	36.8	14.5	78.833	3gg0_AVR_A2_1975