GRAPHICAL USER INTERFACE FOR *SNTHERM*

by

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ABSTRACT

A snowmelt modelling PC interface was developed with widely used, off-the-shelf spreadsheet and database software packages. While this application was designed for the snowmelt model *SNTHERM* (U.S. Army Cold Regions Research and Engineering Laboratory), the programming concepts and design were general enough to be applied to other environmental models. Extensive screen design utilities and programming capabilities make current software applications strong candidates for Graphical User Interface development.

The modelling interface consisted of six major functions: (1) database query screens for plotting and exporting data, (2) automated creation of two required model input files with menu and mouse driven screens, (3) modelling file management, (4) automatic plotting of the model input and output data, (5) running *SNTHERM*, and (6) automated sensitivity analysis graphics of model parameters.

INTRODUCTION

The fate and transport of contaminants in soils surrounding the Department of Energy's Rocky Flats Plant, near Golden, Colorado, is being investigated. As part of this environmental study, a snowmelt monitoring system has been installed. This system consists of a micrometeorological tower which measures solar energy components, profiles of atmospheric temperature, relative humidity and wind speeds, snowmelt and snow depth. There are four additional locations along a transect of 150 m where atmospheric, snow and soil temperatures, wind speed, snowmelt and snow depth are recorded. These four locations are referred to as 'pits' and are coupled with subsurface time domain reflectometry and tensiometer soil moisture measurement networks.

Since the snowmelt monitoring system was installed in late 1993, fifteen snowfall events of more that 10 cm have occurred. Each event was isolated, and required an average of 3.3 days to completely melt. To assist with the modelling of this snow dataset, a snowmelt model Graphical User Interface (GUI) was developed. An important goal was to develop a system that could help manage the modelling of multiple snowfall events at multiple modelling points.

Another goal was to assess the suitability of off-the-shelf Windows™[3] software packages in GUI development for environmental science. The GUI presented here was developed with standard database/spreadsheet packages already used in-house: Microsoft® FoxPro® 2.6 and Microsoft® Excel® 4.0. Data processing and the vast majority of interface screens were developed with FoxPro®, while plotting of data was handled using Excel®.

[3] Commercial names are for information purposes only and are not an endorsement by the authors.

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The Snow Main Menu is presented in Figure 1. This menu is divided into two sections: 'Snow Measurement Database' options and 'Snowmelt Modelling' tools.

Snow Measurement Database Screens

The three options in the database section are used to access the Snow Measurement Database. The database query screens have been divided into three field instrument categories: snow data, solar/wind data, and temperature/relative humidity data. An example of a database query screen is shown in Figure 2. This screen allows the user to select the desired sensor and period to process. Options include viewing/printing the raw data, exporting to various file formats, and plotting the selected data. There are two plotting options to choose from. The 'Auto Plot' option will plot the current selection. The 'Plot Data' option executes a menu driven spreadsheet graphing macro. This allows the user to plot archived files, or make selections from multiple database query screens while plotting them at the same time. Other options on the database query screens include packing the database and setting processing defaults. These defaults include the form of the time stamp used when creating export files and turning on/off data filtering. An example of an automated plot is shown in Figure 3. The plotting macro gives the user the option to print the current plot, continue to the next plot, or return to the query screen.

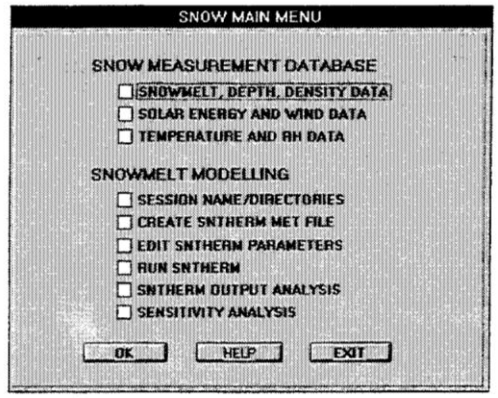

Figure 1 - Snow Main Menu

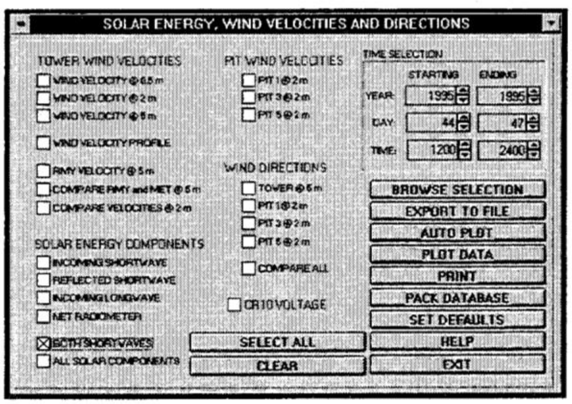

Figure 2 - Database Query Screen for Solar and Wind Data

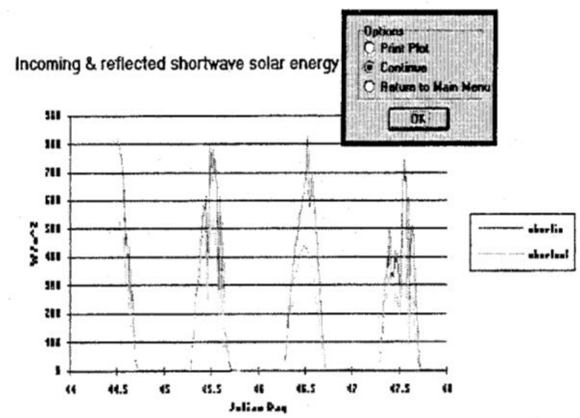

Figure 3 - Automated Plot of Short-wave Solar Data

Snowmelt Modelling Screens

The first of the snowmelt modelling options is 'Session Name/Directories.' This screen (Figure 4) allows the user to provide a default 'session' name for all of the associated input/output files. It also allows the user to select specific directories for locating/storing current modelling code and model input/output files.

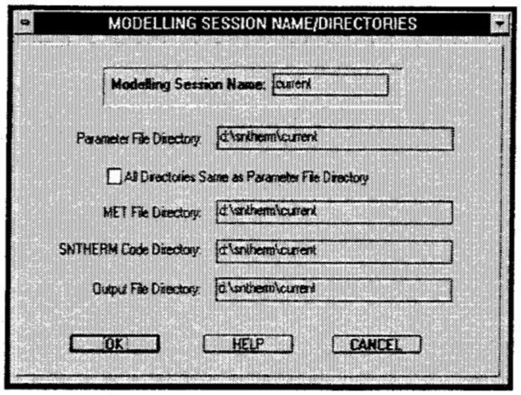

Figure 4 - Modelling Session Names Screen

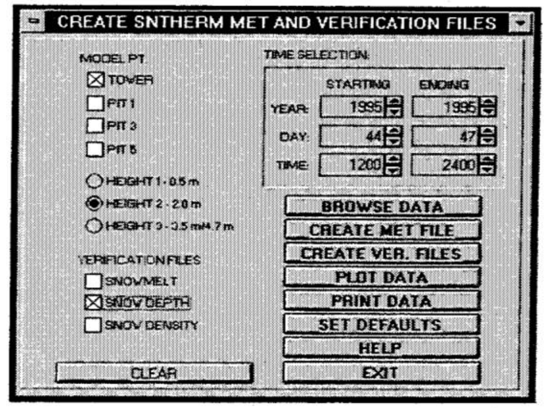

Figure 5 - Create SNTHERM Met File Screen

Selecting the 'Create *SNTHERM* MET File' from the Snow Main Menu displays the screen in Figure 5. Based upon the period selected and the location of the desired instruments, the appropriate data is extracted in the required file format. This screen is also used to produce 'verification' files from the database. The verification files include measured field data on snowmelt, snow depth, and snow density.

The *SNTHERM* parameters and model settings are edited by selecting the 'Edit *SNTHERM* Parameters' option. When this is selected the '*SNTHERM* Main Menu' is displayed (not shown here). This menu divides the *SNTHERM Layer.in* input file into four categories: parameters/settings, input/output options, convergence criteria, and snow-pack description. An example of these, the *SNTHERM* parameters screen, is shown in Figure 6. This screen is used to update the physical model parameters, which are divided into four categories. Each parameter is constrained by a lower/upper limit if appropriate. The help screen for this screen will be expanded to offer definitions and equations for each parameter.

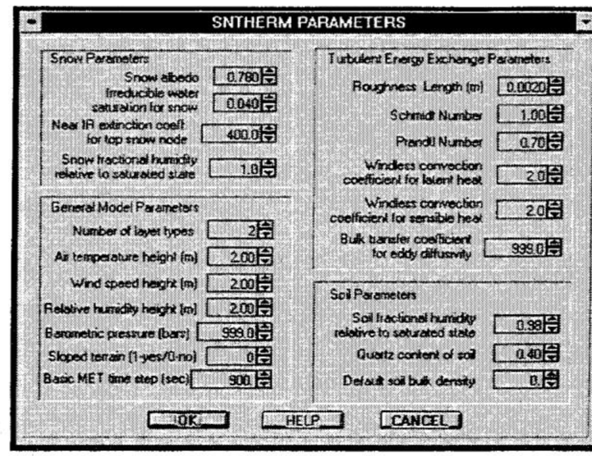

Figure 6 - Edit SNTHERM Parameters Screen

The snowmelt model is executed by selecting the 'Run SNTHERM' option. This option displays the current contents of the *filename* file (screen not shown). This file specifies the input/output file names used by *SNTHERM*, and defaults to the modelling session names. Once the file names are confirmed or updated, *SNTHERM* is executed by pressing a 'run' button.

The modelling predictions of *SNTHERM* can be compared with measured field data by selecting the '*SNTHERM* Output Analysis' option. This option displays the screen shown in Figure 7. This feature extracts the appropriate data from the *SNTHERM* output and assembles a plot (Figure 8), comparing it to the verification files mentioned above. The printing options are the same as for the database query plots.

The final modelling option is the '*SNTHERM* Sensitivity Analysis' screen (Figure 9). This feature is used as a learning tool for understanding the sensitivity of *SNTHERM* to parameter settings. To assess how the model handles different weather conditions, any combination of input files can be used. Plots similar to the database query/output analysis options can be automatically produced.

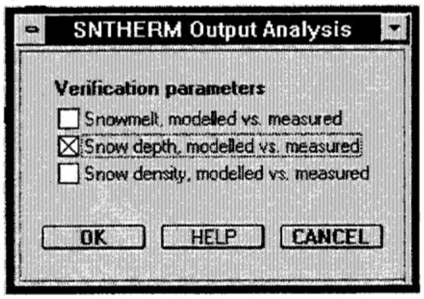

Figure 7 - SNTHERM Output Analysis Screen

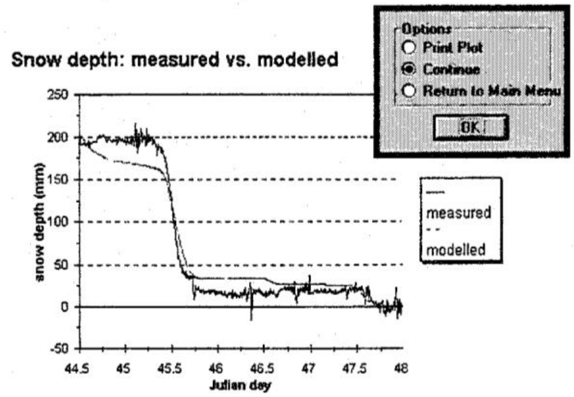

Figure 8 - Automated Plot of SNTHERM Output

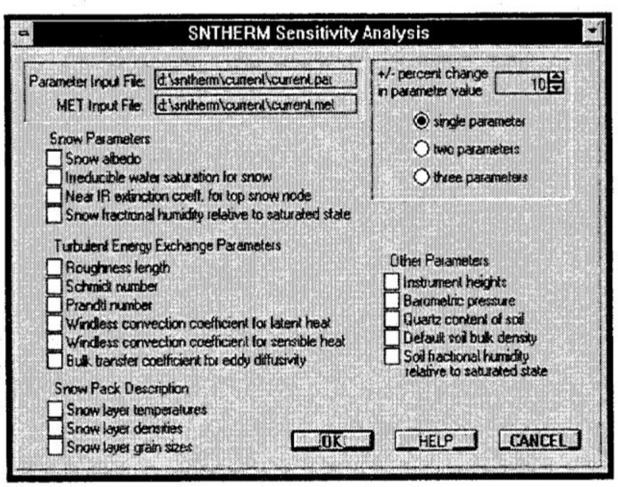

Figure 9 - SNTHERM Sensitivity Analysis Screen

DISCUSSION AND CONCLUSIONS

Using off-the-shelf spreadsheet/ database applications for custom environmental software development has advantages and disadvantages when compared with 'starting from scratch' with a general programming language. The lack of operating system portability is an important disadvantage when considering this development platform. While these packages are loaded with features, occasionally there are subtle details missing, e.g. using sub/superscripts in plots. In addition, programming syntax, debugging features, variable memory management and linking screens with the rest of the source code is often convoluted.

However, there are many important advantages of this GUI development method. The various computer tasks of modelling (analyzing collected data and model output, input file preparation, file management) can be converted to automated computer tools one at a time. This modular approach allows continual enhancements to be made. Possible expansions for this GUI package include interaction with other environmental models, statistical packages, and 'final proof' graphics.

The main advantage is that a customized, functional and efficient application can be developed quickly. Standard features responsible for this are screen design utilities and macro recording capabilities. As recently as a few years ago, programming graphic software was extremely labor intensive. Creation of interface screens that used to take hours, can be made in a few minutes with current software packages.