Building Simulation

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A COMPUTER APPLICATION FOR WEATHER DATA MANIPULATION

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ABSTRACT

The aim of this work is to present a computer application that was developed to be a user-friendly interface that simplifies the manipulation of weather data files. The computer code is capable of creating and editing .EPW (EnergyPlus) and .TMY2 (Typical Meteorological Year II) weather files and making some translation between the two formats. It is part of an academic project that comprises the development of a series of applications, which together will consist of a complete interface for illumination/Thermal Comfort simulations using the EnergyPlus engine.

INTRODUCTION

Every building simulation software needs some kind of weather data to perform the calculations. These data are generally presented in a table form that indexes time to physical parameters, such as Dry Bulb Temperature or Sky Luminance.

Due to the great number of parameters, the data always result in big files, unable to be easily manipulated without the help of a computer application. The TMY2 format, which contains hourly values of solar radiation and meteorological elements for an one-year period, when tabulated in a spreadsheet-like format, takes no less than 94 columns and 8760 lines (823440 cells) of data. A new weather format adopted by both ESP-r (in the UK) and EnergyPlus (in U.S.) can be even bigger considering the possibility of using its new sub-hour time step through the format's minute field. A full year description in such "minute" format would take 75 columns and 525600 lines (39420000 cells) of data. In order to avoid such massive amount of information be number-crunched by the simulation tool, the format smartly includes fields that sets the start and end dates of the typical weather patterns, allowing sub-year description files. This allows holding the files within reasonable sizes.

Despite the differences of formats, the task of manipulating these files is intrinsically hard to deal with. Although both formats have a simple structure and are archived in plain ASCII text format, the non-tabulated aspect of the data set make them extremely difficult to read or write. Although it is not impossible to import or export the data from or to an spreadsheet or database program to edit them (particularly in the case of .EPW files), some fields are not easier to work within this kind of application. Translation procedures are even harder to be carried out. The best approach is to develop a specific software to manipulate weather data that must be capable of: a) reading pre-written data; b) allowing data entry; c) performing some kind of visualization of the information of the weather elements; d) translating between two or more formats; and e) making all this through an user-friendly interface. The software that was developed is intended to have all these characteristics and was entitled "Kuaray" (the tupi language word for "sun").

SOFTWARE STRUCTURE

The software was developed in Object-Pascal (Borland Delphi Version 3.0), resulting after compilation in a single application of about 1.0 MB requiring Wintel 32bit platform to be run.

The application is structured as shown in figure 1. Each of the five modules has specific functions, here defined:

1) File Module: responsible for the input/output operations and the allocation of memory for the creation of new "empty" weather data for editing and future saving.

2) Table Module: responsible for the display of the weather data retrieved through the File Module. This module is operative only if there is data in the computer memory.

3) Plot Module: responsible for the display of the weather data in graphical format. This module is operative only if there is data in computer

memory, retrieved through the File Module.

4) Edit Module: responsible for the entry of new data (in the case of a "empty" file) or modification of old data (in the case of an existing file). This module is operative in two situations: The user must have just created a brand new "empty" file (therefore allocating a corresponding memory) or an existing weather file must have been opened and data resides in memory.

5) Utils Module: responsible for processing the translations between the two weather formats. This module is operative only if there is data in computer memory, retrieved through the File Module.

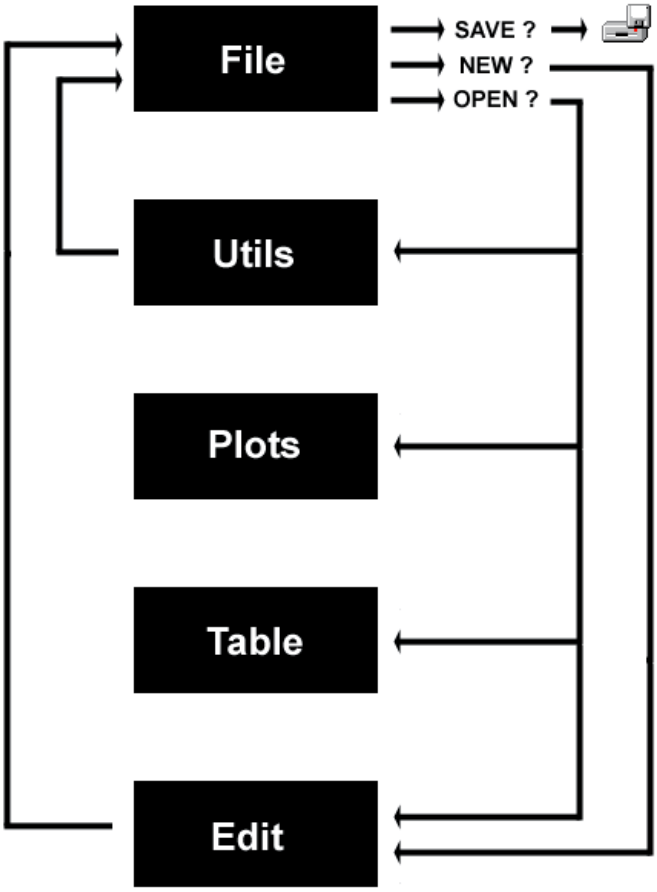

Figure 1 – Structure of the software application

SOFTWARE DESCRIPTION

The five modules are in fact five different application windows that can be accessed by pressing a corresponding button in the lower right corner of the application main window.

The first one is the File module. Through this window, the user can perform the three possible tasks involving weather file management, i. e.:

1) to retrieve existing .EPW or .TMY2 files saved on disk;
2) to save a recently created or recently modified weather file;
3) to create a brand new (clean of data) weather file;

The first two options are straightforward tasks, since the formats of the files are in both cases already defined. When creating a new file instead, the user is immediately asked to choose from one of the two formats in order to the software may reserve different data fields for each case. Creating a .TMY2 is somewhat simpler because this format does not allow variations, consisting of a fixed array of pre-determined records (a full one year-period data). By the other hand, .EPW files are much more flexible and can assume a great variation in the extension of the weather data descripted. So the application must be informed about these "time" parameters for the right creation of the new empty file. This is carried out by showing another window where the relevant information must be entered by the user. The aspect of the File window is shown in figure 2.

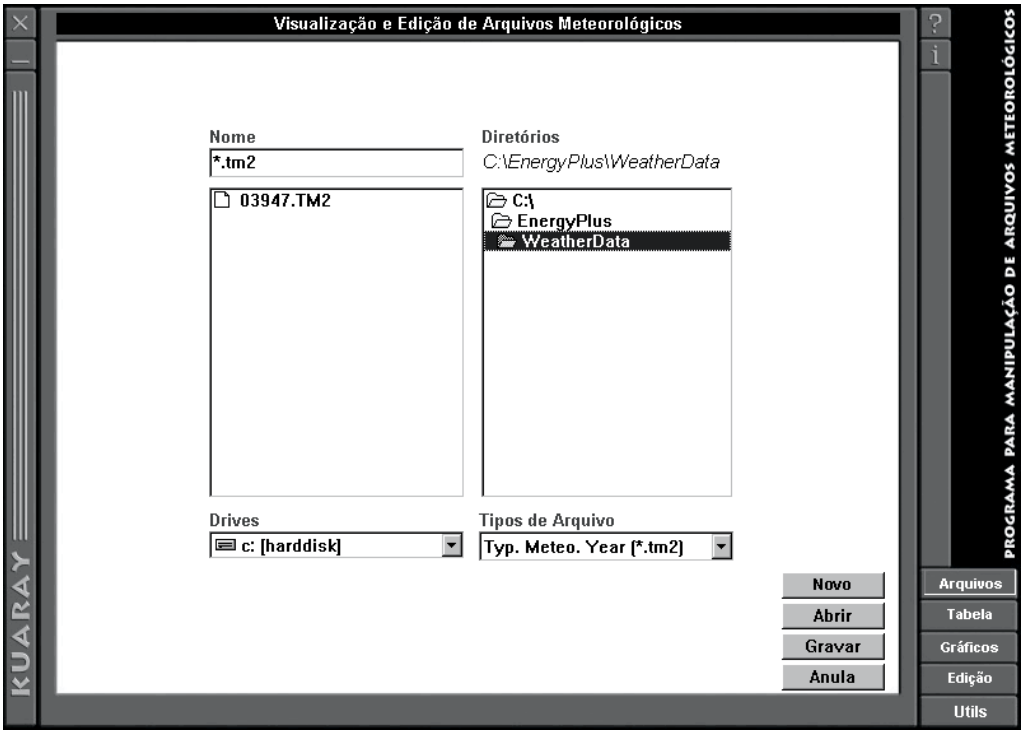

Figure 2 – The File Module window

The second module is the visualization window that is accessed by the Table button. When active, this window displays the entire weather data that was retrieved in the computer memory by opening (through the File module) a weather file. The aspect of the grid, i. e., the fields and the records displayed, depends on the type of file opened (.TMY2 or .EPW). The user can browse all the fields like in a standard spreadsheet program, but he can not edit any of the data. As he browsers the table a brief description of the type of data he is accessing is presented in the lower left part of the window to help him, since the titles of the fields in the grid are all very simple, like "DRH/dv" for Diffuse Horizontal Radiation/DataValue and so on. Figure 3 shows an example of visualization of a .TMY2 file data.

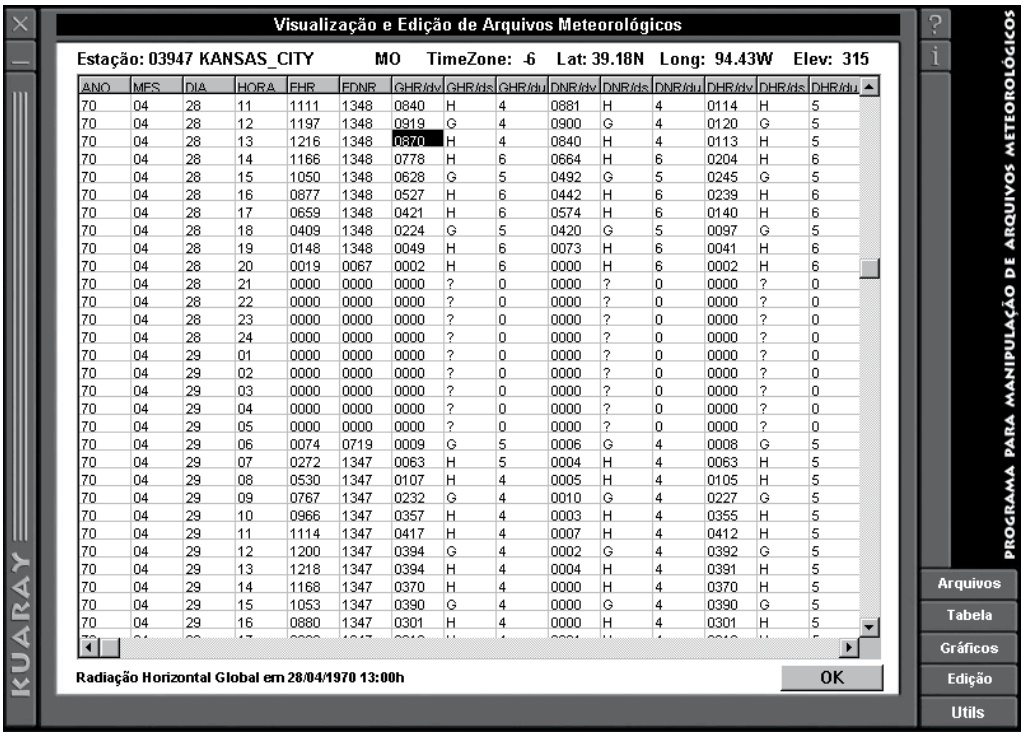

Figure 3 – The Table Module window

Another window is the Plots module. When accessed, this module allows the user to visualize the weather data in a graphical style. The software can plot all kind of data that are value related. When .TMY2 data format is in memory, the plots assume an hourly distribution (full one-day period). When a .EPW file was retrieved, the application automatically chooses between a similar hourly distribution (if the #Records/Intervals in an hour is no greater then 6) or a minute-step distribution (full one-hour period). In all these situations, the user can choose the exact period he wants to view/plot by modifying the corresponding values for month/day/minute in the editboxes that exist in the window. The parameter to be plotted is also chosen through another editbox that contains all the possible weather elements. Made all these choices (month/day/minute and parameter) an "Execute" button must be pressed to perform the presentation of the graphics. Example on figure 4.

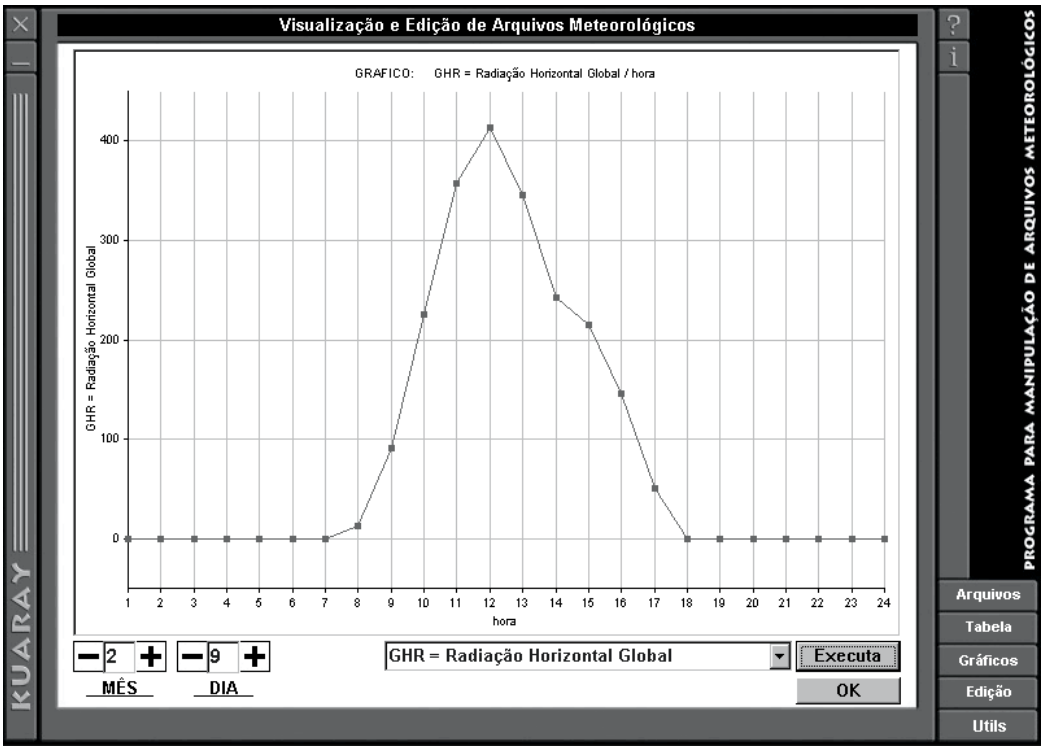

Figure 4 – The Plots Module window

The edit module is very similar to the Table module, except that each grid cell is editable (so that any data can be modified).

If the content in computer memory is supposed to be a new file, all the cells will be blank and the data can then be inserted. Here is where the application really helps the user. Although one could write that kind of data directly to a text file, such task would be laborious and far from error proof. The possibility of viewing the records in a table distribution, where titles and times are correlated in columns and lines of data, eases the filling of all the grid cells with the correct information. The task may still be very time consuming, but the possibility of error is significantly reduced.

Differently, if the contents in memory represent an already existing weather file, the modifying task is generally quick, simple and direct. The user just has to browse the table to locate the data to be modified and type in the new value. In both cases (after finishing the edition of a new or an existing file) the modified table must be saved to disk (through the File module) in order to preserve the new data.

The last module is called Utils and is accessed when the user wants to translate a weather file from its original format to a different one. Currently, this version of Kuaray only allows a limited transformation of .TMY2 files in .EPW files. Two kinds of translation are possible:

1) Full-Year conversion: here the whole .TMY2 data is translated to the .EPW format. This is done by fixing in 1 hour the Time Step Data Periods and #Number of records/Intervals fields. Other time related parameters of the .EPW format is also modified to conform to the way they are considered in the .TMY2 format, i. e., a Time Step of 1 hour and

a 365 day period for the weather description.

2) Sub-Year conversion: here only part of the one-year period data of a .TMY2 file is extracted to generate a sub-year weather description. The user can choose the length of the new period by setting the Start Month/Day and End Month/Day fields of the new .EPW file to be created. All other .TMY2 parameters are maintained such the Time Step of 1 hour and so on. This option allows the creation of smaller files when a full year weather description is not necessary, as it commonly happens when a researcher is simulating the building behavior under heavy hot summer conditions. Only the months under certain weather conditions could then be considered, freeing the computer of dealing with (in this case) useless data.

CONCLUSIONS

In all times during the development process, it was our concern that the software would be characterized by a friendly usability and capable of running under a commonly used operational system.

We believe this goal has been achieved and the computer application here presented can be considered a useful tool for assisting the work of manipulating weather files in .TMY2 and .EPW formats. Mainly if this work is the creation of a completely new weather file of a location, when all new data must be typed in entirely. Such is the common case of Brazilian users that usually do not have access to these data already formatted for utilization.

Although the main purpose was to produce a program to help the creation of .EPW (EnergyPlus) weather files from raw data, other useful capabilities were added to the code, such as the possibility of reading .TMY2 (Typical Meteorological Years II) weather files and some translation between the two formats. In addition, it was implemented a module that make it possible for the user to visualize any parameter of the data in an hourly or sub-hourly graphical plots.

For the immediate future, we plan to incorporate a more sophisticated translation module, in order to make the software capable of to convert .EPW to .TMY2 files. This new module will also be able to compute data interpolations under a .TMY2 to .EPW translation process with different time steps.

Anyway, we like to think the effort of developing this tool represents a positive initiative in the building simulation scenario.

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