PVSYST
PHOTOVOLTAIC SOFTWARE

Version 8

Meteorological Data Handling

PVsyst SA
www.pvsyst.com

Contents

1 Meteorological Data Management

1.1 Introduction to meteorological data management

This tutorial will guide you through the different options to manage and organize meteorological data in PVsyst and explain the importation of data from external sources.

Special care should be taken when importing and generating these data since they represent the main source of uncertainty for the simulation. We recommend using only data from reliable sources and to always perform some basic crosschecks on them, as will be explained in this tutorial. This will make sure that there is no serious mistake that could compromise the quality of the results.

Self-measured data should only be used if the measurements were performed with proper equipment that has been installed, carefully calibrated and the results analyzed by qualified experts.

1.1.1 Data organization

Input Data

The first input that PVsyst needs is the geographical location. This will determine the sun path over the year and allow to interpolate meteorological data for places where no direct measurements were taken.

The meteorological data that is used as input for the simulation consists of the following quantities:

- Horizontal global irradiation (required).
- Average external ambient temperature (required).
- Horizontal diffuse irradiation (optional).
- Wind velocity (optional).

The first two quantities, namely the horizontal global irradiation and average external ambient temperature must be supplied as inputs to the simulation. There is no good way to estimate them just from the geographical location.

The other two quantities can either also be supplied as external measured data or, in case there are no good measurements available, they are estimated by PVsyst with the help of established models.

Synthetic generation of hourly data

The simulation of PVsyst is done in hourly steps over a whole year. The built-in data from Meteonorm comes in monthly increments. It is therefore necessary to artificially generate the hourly values from the monthly ones. PVsyst uses special algorithms to generate the hourly values for the meteorological data. Most of the external data sources provide data directly in hourly values for full years (i.e., TMY from PVGIS or NSRDB).

***.SIT and *.MET files**

PVsyst stores the geographical location together with the monthly meteorological data in one file for each site. These files have the extension '.SIT'. You can have more than one

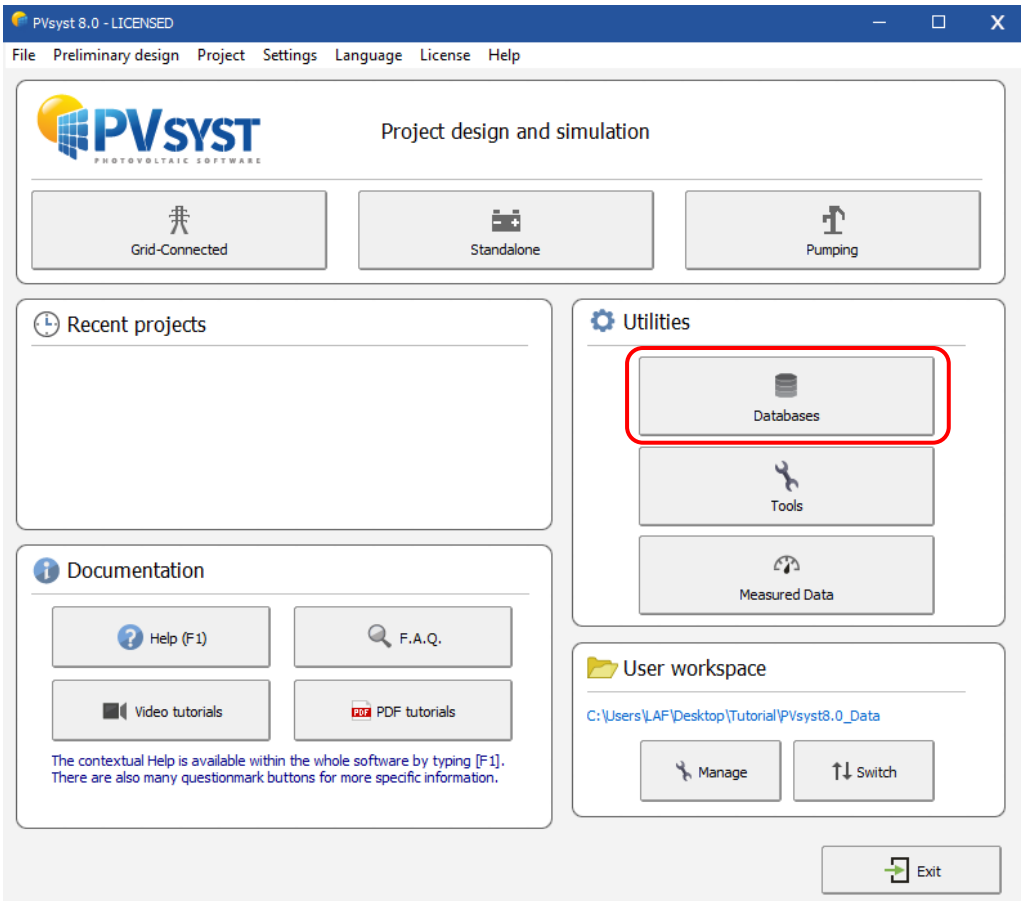
file for each site if you have monthly data from different sources or from different years that you would like to compare. The hourly data is stored in files with the extension '.MET' and here too you can have more than one file per site to compare different years or different data sources.

Data Sources

The built-in meteorological data source of PVsyst is the Meteonorm monthly database. Meteonorm delivers monthly meteorological data for almost every spot on the globe and PVsyst will use this source by default if no other is explicitly specified. As a last resort, if Meteonorm returns errors, it is also possible to choose satellite data from the legacy NASA-SSE. Furthermore, PVsyst has access to several public sources directly available from the Web like PVGIS, NSRDB among others. Self-measured data and data from other providers like national meteorological offices may also be imported from text files (or .csv) using a tool that can be adapted to different data formats.

1.1.2 Opening the meteorological data management options

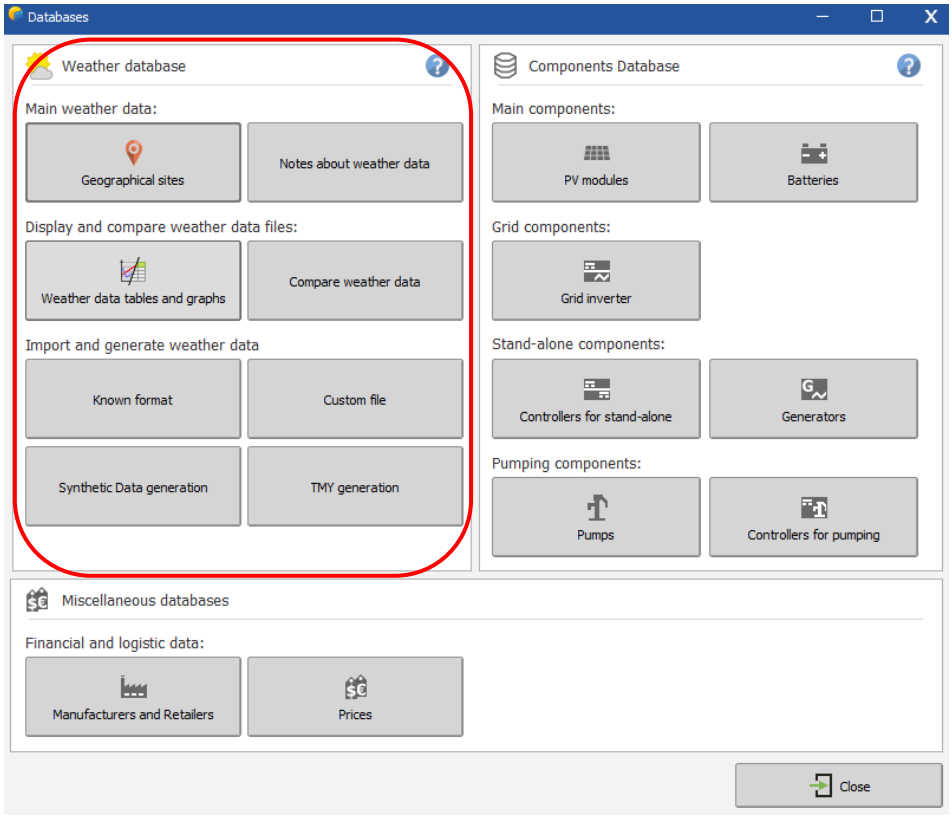
All manipulations and visualizations of the meteorological data are accessed through the "Databases" option in the main window:



After clicking on this button, the Database Window will pop up on the screen. The left side contains options related to meteorological data, including the following options:

- Geographical sites: Monthly data management.
- Synthetic data generation: Generate hourly values from the monthly data.
- Weather tables and graphs: Visualization and crosschecks of the hourly data.

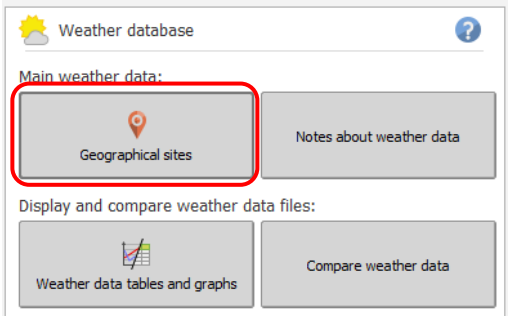
- Compare weather data: Compare different meteorological files.
- Known format: Import meteorological data from predefined sources.
- Custom file: Import meteorological data with custom format.



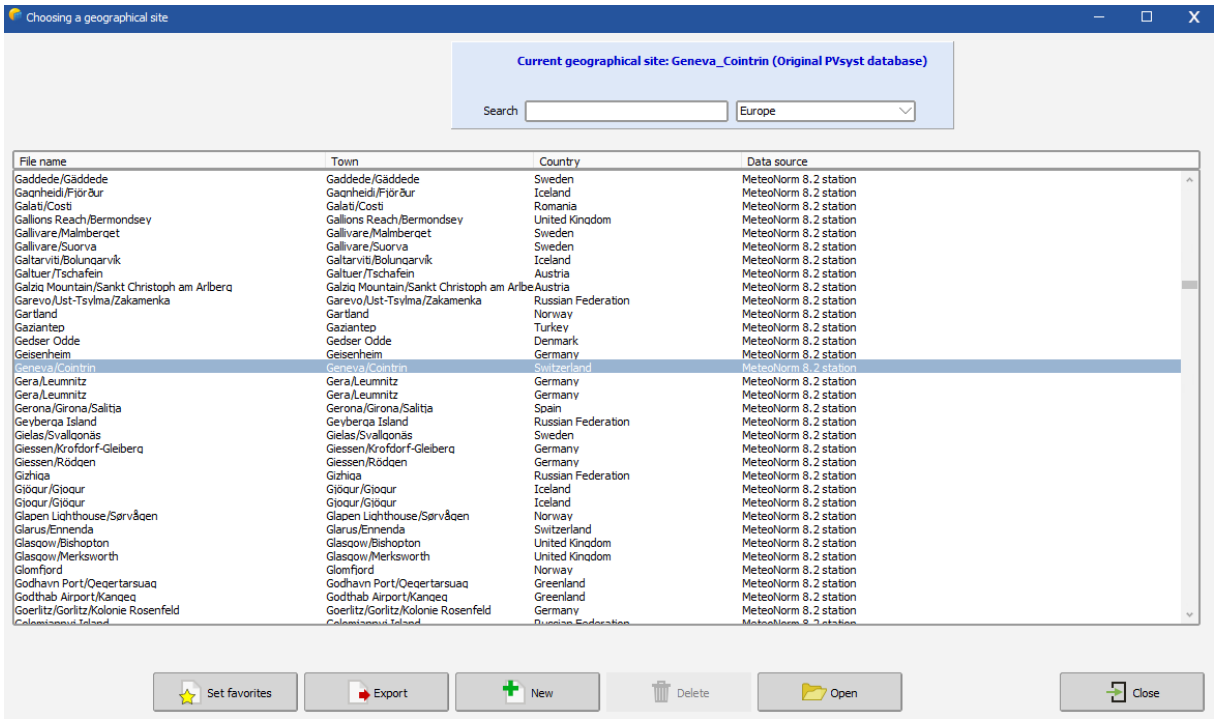
1.2 Geographical sites

The main database is given as objects including the geographical coordinates and associated monthly meteorological data. These objects are stored as files with the name *.SIT, situated in the workspace in the subfolder \Sites\.

Click on "Geographical sites":

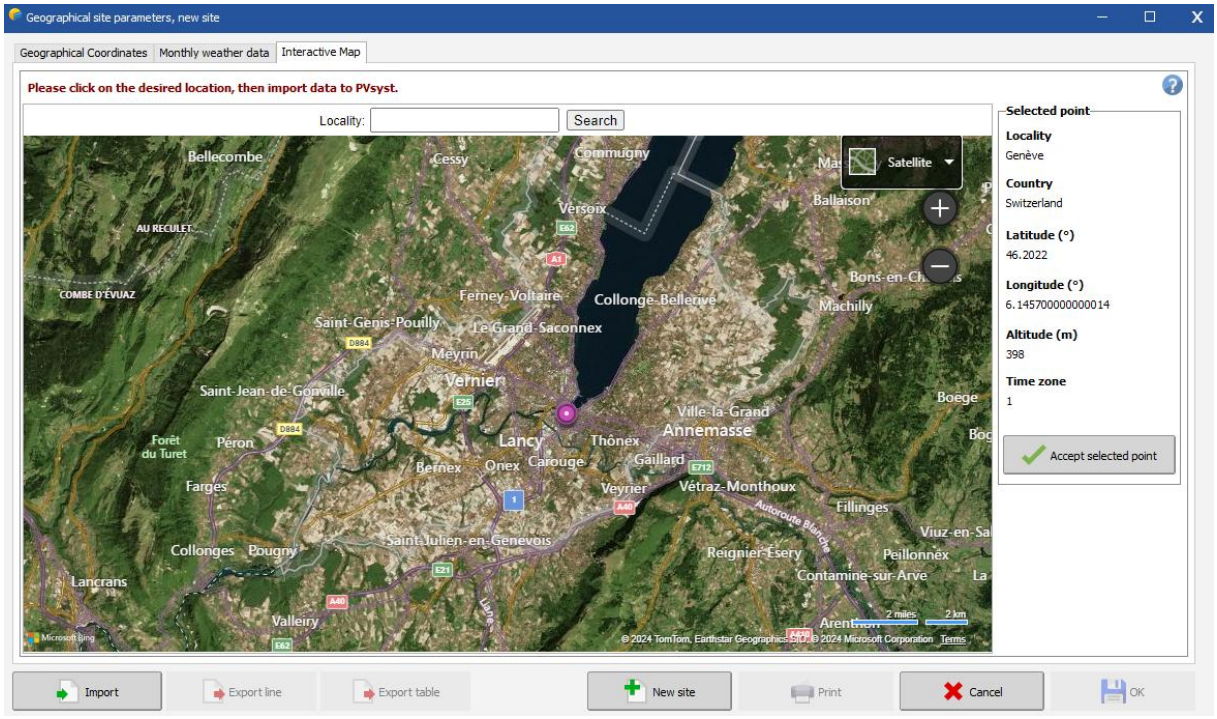


You will get a dialog with a list of choices of the geographical site, where you can choose the country or region of interest and a given station. The first column is the name of the site, the second column is the country in which the site is located and the third one describes the source of the monthly meteorological data.



To create a new site for a project, click on ‘New’. You will get a window with the geographical site parameters that contains three tabs:

- Geographical Coordinates
- Monthly weather data
- Interactive Map



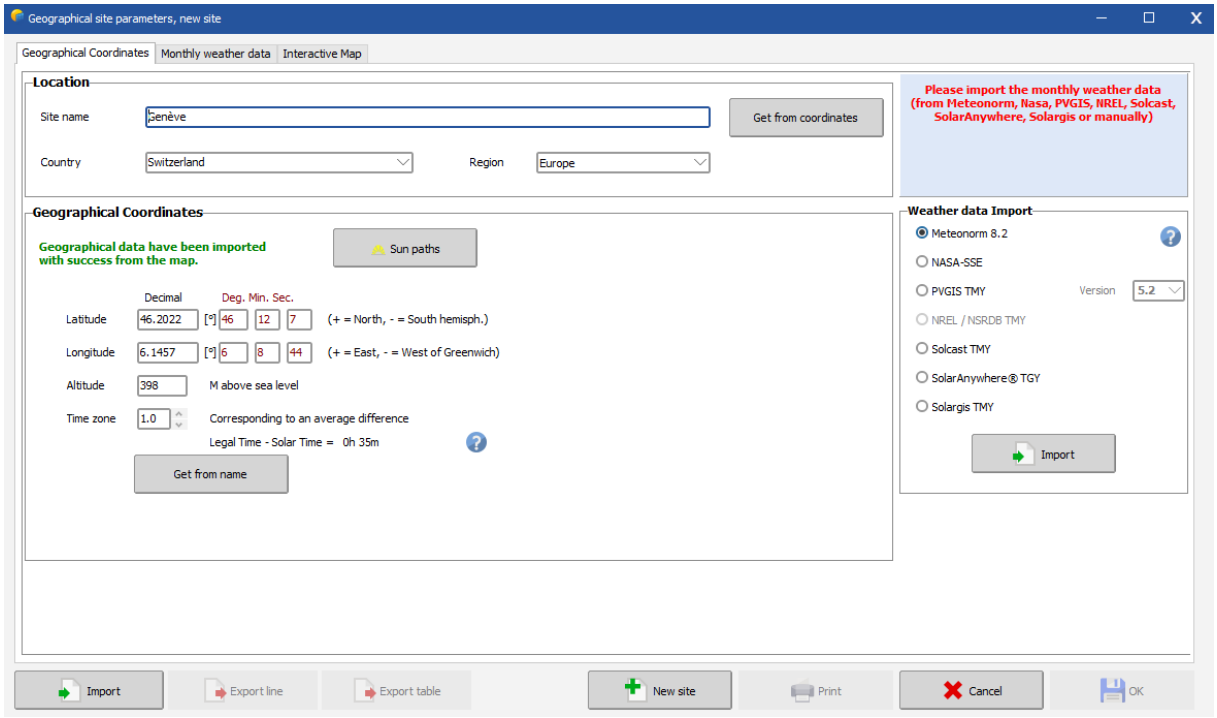
The "Interactive Map" tab allows you to select interactively the location of your site using Google maps. You can click on the map to choose the site location. You can zoom in and out of the map, and you can use the search field to find the name of a place. When the

red mark is at the desired place, click on “Import” to transfer the location to the “Geographical Coordinates” tab.

In case of internet connection problems, you can always define the coordinates and all site information in the “Geographical Coordinates” tab without using the map.

In the tab "Geographical coordinates" you define:

- Site name: Choose a name for the site of your project
- Country and Region: Normally you do not need to change this
- Geographical Coordinates: The Latitude, Longitude, Altitude (which uniquely define the (x,y,z) coordinates of a given point of the earth), and the time zone. Ex: for central Europe, the wintertime corresponds to UTC+1, while the summertime is UTC+2. You can obtain accurate Latitude/Longitude coordinates from your GPS or Google Earth.



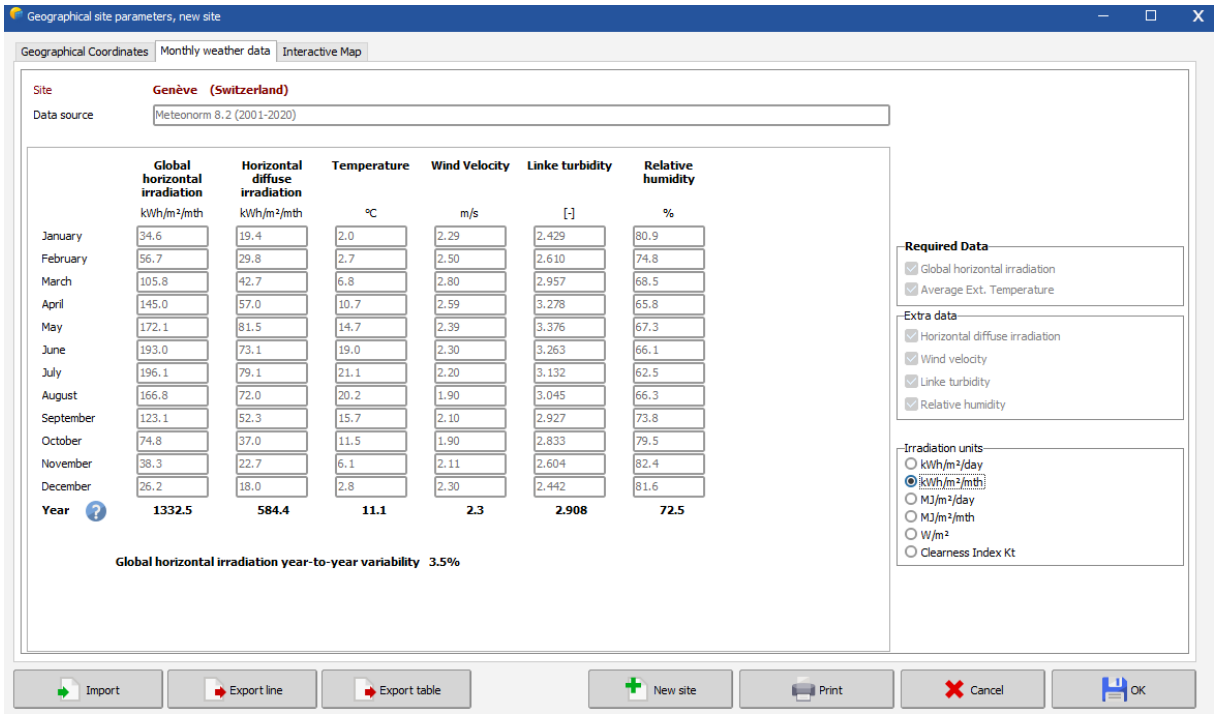
In this dialog you can also:

- observe the sun paths corresponding to your site,
- import/export the site data with "copy/paste" (for example into or from a spreadsheet like EXCEL),
- print a complete form with the data of this site.
- If you define a new site (by its geographical coordinates), PVsyst will import by default the data from METEONORM, which is a reliable source for monthly meteorological data.

Once the monthly data has been imported, the "Monthly weather" tab will display the monthly values. Values for Global irradiance and Temperature are mandatory input for the simulation. Global diffuse and wind velocity are optional. They will be evaluated by models when necessary.

- Data source: Describe the source of the monthly meteorological data, PVsyst will fill this field when you import the data from a predefined source.
- Irradiation units: You can choose the units in which the global and diffuse irradiation values are displayed. This is useful to import or compare to data sources that use units differently from the PVsyst default.
- Data fields: You can edit these values by hand. If data are given as lines or columns in a spreadsheet, you can "paste" entire columns at a time.

After defining or modifying a site, the program will ask whether you want to keep your modifications, and if so, it will modify or create a new site in the database (i.e., a new file in the \Sites\ directory).



Managing Favorites

The sites will normally have a white background in the selection list. Green entries are sites that have been defined as favorites by the user. New sites that are created by the user are put into favorites by default. They can be removed from the list of favorites by clicking on ‘Set Favorites’, selecting the site from the list and clicking on ‘Close Favorites’. In the same way, you can add more sites to the list of favorites.

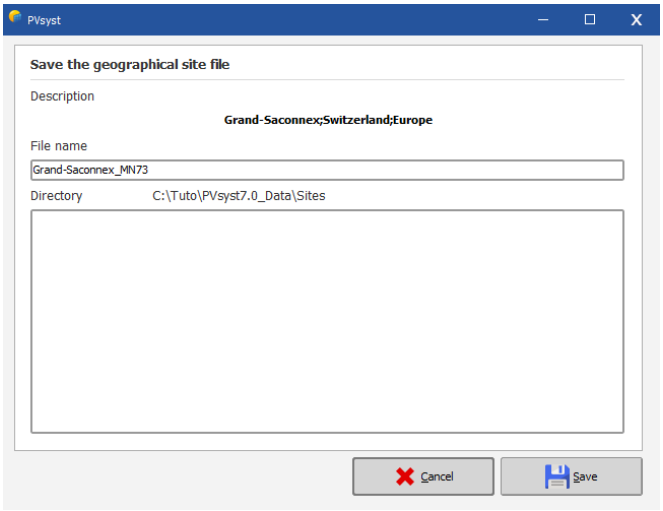
1.2.1 PVsyst’s built-in database

The built-in site database of PVsyst is based on the METEONORM database, defining about 2'500 "Stations" where measured irradiances on the ground are available.

In Meteonorm, data of all other sites are interpolated between the three nearest stations and satellite data. For most of the European countries, all the measured stations available in Meteonorm are in the PVsyst built-in database. But for many other regions of

the world, the measured "Stations" are very scarce and Meteonorm uses satellite data to complete this information.

Besides the built-in database, PVsyst also offers tools to easily import meteorological data from many other sources. This will be described in the “Importing data from predefined sources”chapter.



The year 1990

In PVsyst, we have adopted the convention to label all data which don't correspond to really measured data at a given time as 1990. This is the case, namely, of all synthetic hourly data or TMY data files.

1.3 Synthetic data generation

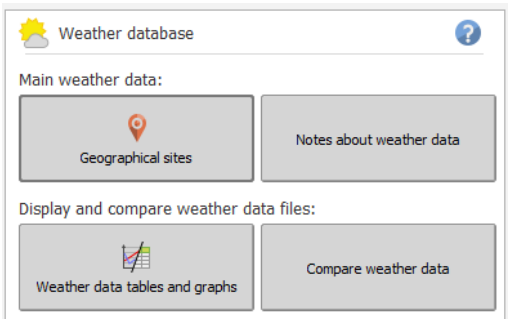
The simulation process in PVsyst operates on hourly values. If no measured hourly data is available, PVsyst constructs a set of hourly meteorological data from the monthly values. The hourly data will be stored in *.MET files that reside in the \Meteo\ directory.

For the irradiance, the synthetic generation of hourly values from monthly averages is performed by using stochastic models that have been developed by the Collares-Pereira team in the 1980's. This model first generates a sequence of daily values and then a sequence of 24-hourly values per day, using Markov transition matrices.

For the temperature, there is no model predicting the temperature evolution in terms of the daily irradiation, as the temperatures are mostly governed by atmospheric circulations. Therefore, the sequence of daily temperature is mostly random, with constraints on the transition from one day to the other. Within a day, the temperature profile is well correlated to the irradiance. This results in a sinusoidal-like shape over 24 h, with an amplitude proportional to the daily irradiation and a phase shift of around 3 hours with respect to the highest solar angle (the warmest hours are at around 3:00 solar time).

Please note that the generation of the hourly values is a fully random process, two successive generations performed with the same monthly data will result in different hourly values. When performing simulations of grid-connected systems, this may produce variations of 0.5 to 1% in the yearly result.

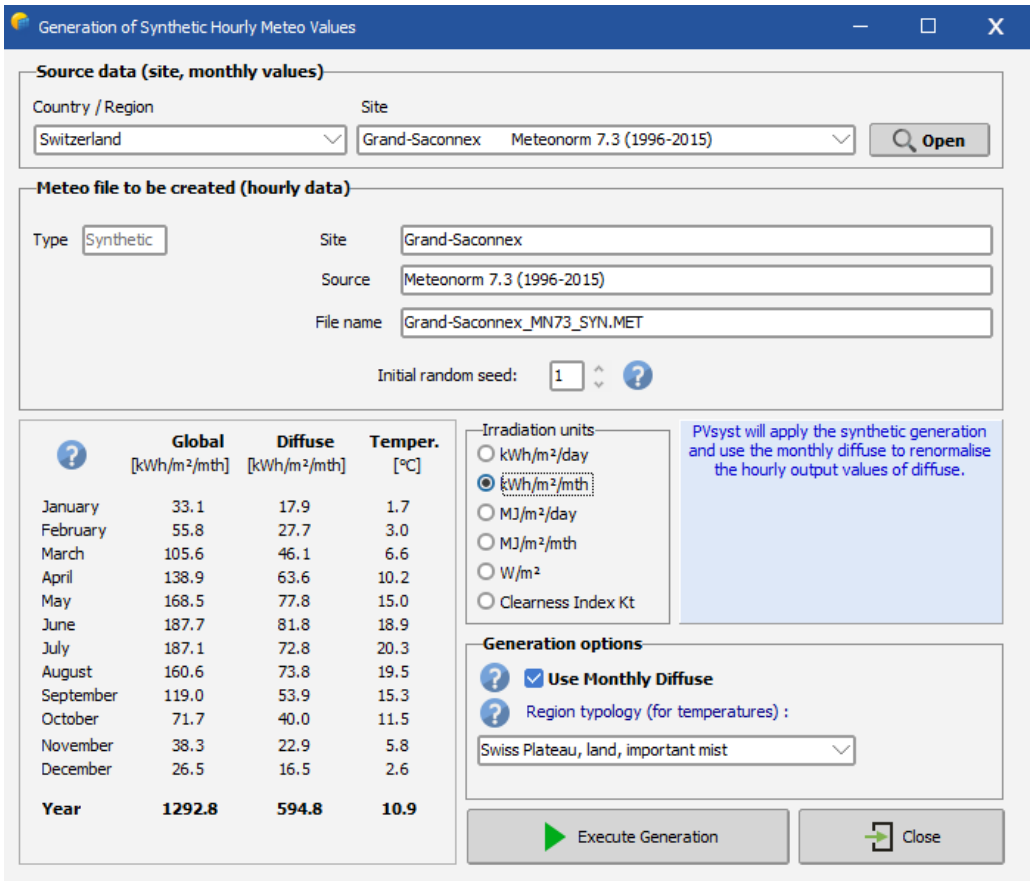
To generate a synthetic hourly file, head to the “Synthetic data generation” dialog.



First, choose a site holding a monthly meteorological data. Now you can specify:

- Site name: This is the site name that will be used in the .MET file. You can name it differently from the one used in the .SIT file if you want to generate more than one .MET file for the same site. This site name will be visible if you select a meteorological file for your project.
- Source: The source of the data. This is automatically filled in and normally you do not need to change this. This information will also be visible when you select a meteorological file for your project.
- File name: Select a unique name for a new file or overwrite an existing one.

Press the “Execute Generation” button.



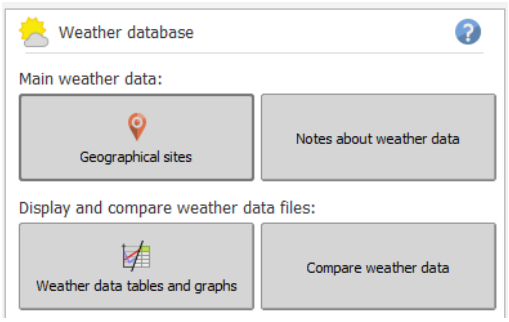
The successful generation of the data is acknowledged by a message

There are some options that you will never modify in principle, such as the:

- "Use monthly diffuse": The diffuse part is evaluated using the Liu-Jordan hourly correlation. At the end of each month, the diffuse values are renormalized in order to match the specified monthly diffuse.
- Region topology: The temperature model that is used by PVsyst was established using Swiss data, with a detailed analysis of climate type dependence. It is possible to choose one of the topology types that are defined for this model, but the differences between all these options are very small (slight coupling differences between irradiance and amplitude, or inertial shifts). If you are not sure which option to use, select the PVsyst default “Swiss Plateau, land, important mist”.

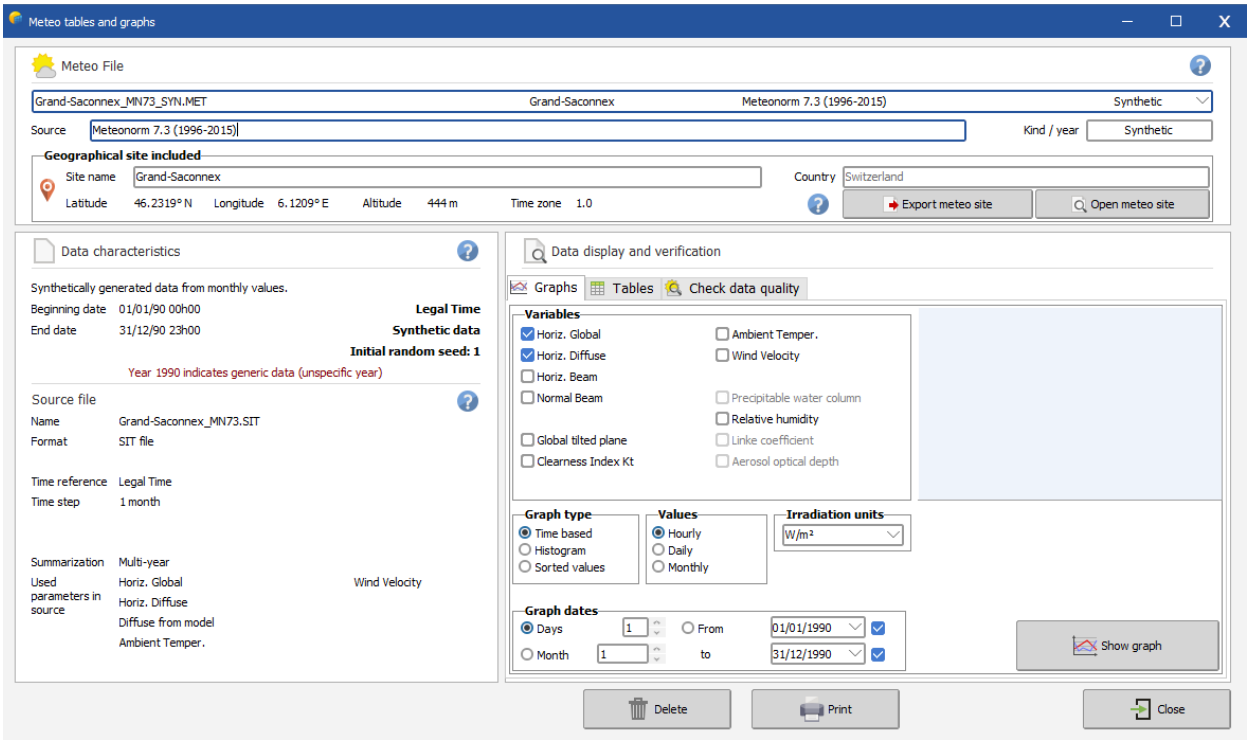
1.4 Meteorological tables and graphs

In PVsyst, the hourly values are stored in *.MET files, that can be found in the \Meteo\ subfolder in your workspace. To visualize their contents, you must use the button “Weather Tables and Graphs” in the "Tools" group.



The “Weather Data Tables and Graphs” dialog will appear on the screen. After choosing a meteorological file, information on the site is shown at the top and the type of data is displayed on the left side of the dialog.

On the right side, it is possible to select graphical ("Graphs") or table ("Tables") output. Both options allow you to look at hourly, daily or monthly values. The third tab, “Check data quality” allows you to perform deeper analysis on the data quality. This step is very important, especially if you imported data with custom format.



1.4.1 Graphical output

When the tab “Graphs” is selected you can first select the Graph type:

- Time based: Plots the data values against time.
- Histogram: Plots a distribution of the values.
- Sorted values: Displays all values in decreasing order.

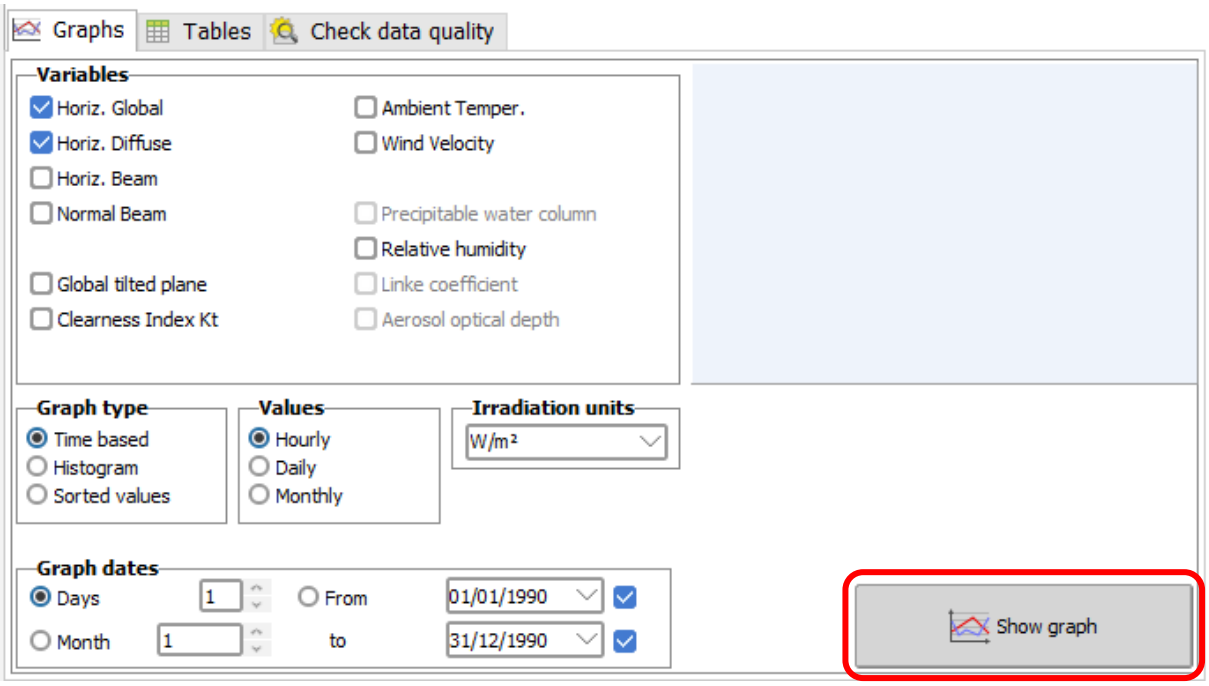
The main preselected variables are:

- Horizontal global irradiance.
- Horizontal diffuse irradiance.

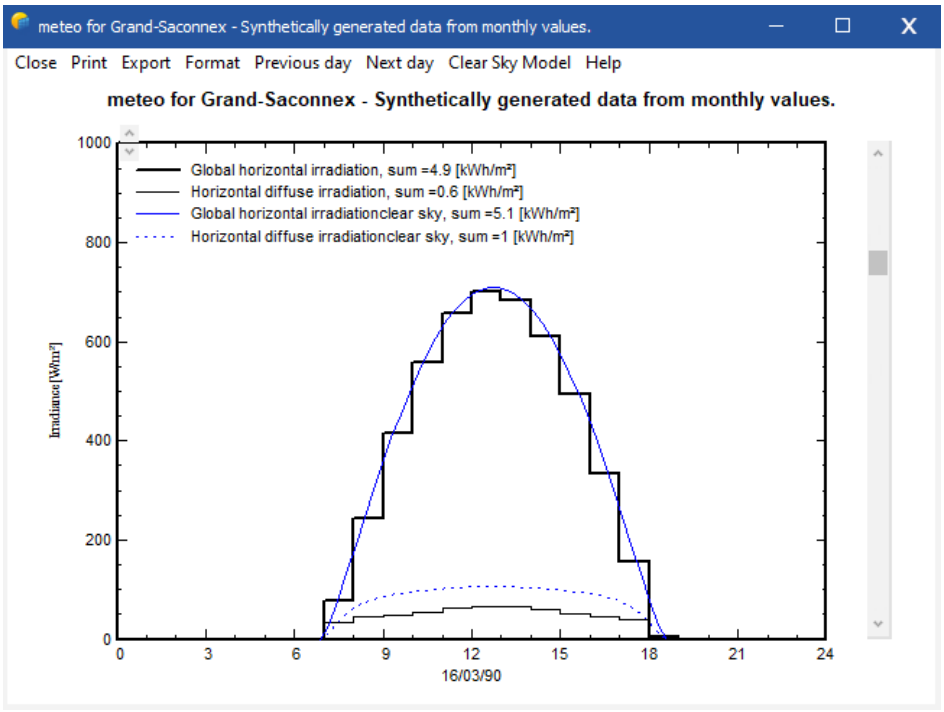
Note that since some of the other options exclude each other you will not be able to select all the variables at the same time.

1.4.1.1 Graphs of hourly values

In the "Graph" tab, choose "Time based", "Hourly", "Horiz. Global" and "Horiz. Diffuse" (default selection) and click the " Show graph" button.

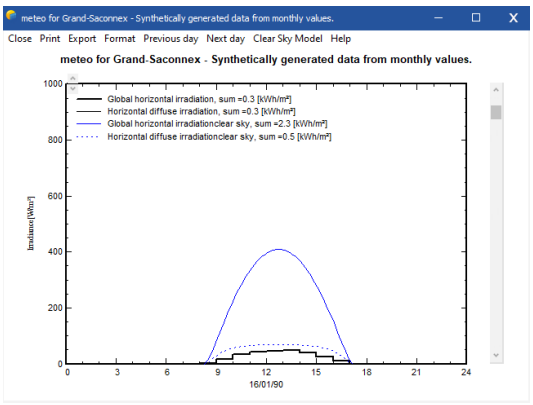


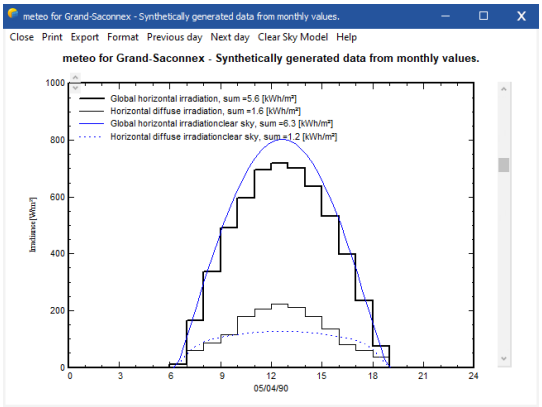
This opens a graph with the hourly meteorological values, and you can walk through your entire data using the Scrollbar on the right. The plot includes a blue line that represents the Clear sky model, superimposed on your data. It is very important that the data is not shifted on the time axis with respect to the blue line. This will always be the case for the synthetic data or the data imported from known sources using the "Import weather data" tool.



However, this may be different for personal data that is imported with the "custom files" tool. If the data does not match the Clear sky model and are shifted toward morning or evening, this indicates that the time stamps of the data does not match the PVsyst standard and all the models using solar geometry will not work properly.

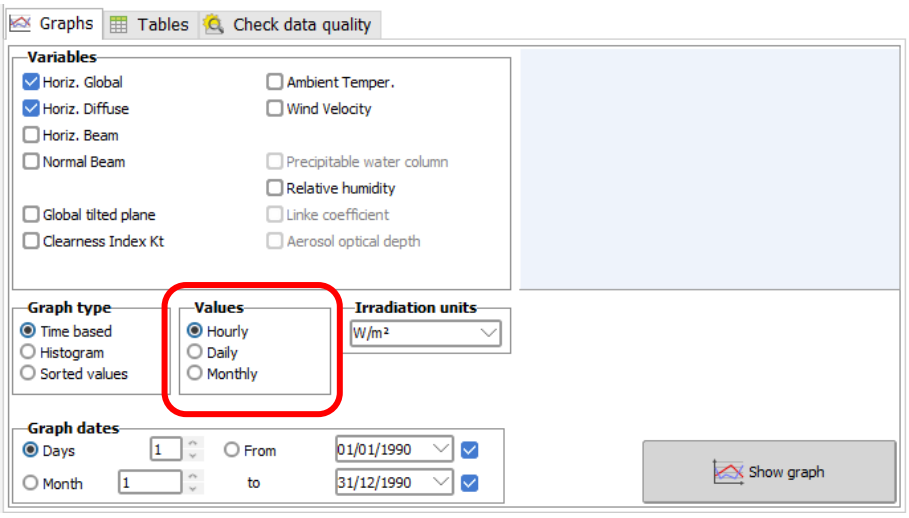
When walking through the year, you will see that clear conditions, where the horizontal global irradiation matches the clear sky model correspond to a low diffuse component. When the sun becomes hazy and the horizontal global irradiation is well below the blue line of the clear sky model, the diffuse part increases. The difference between the global and the diffuse components corresponds to the beam component.





1.4.1.2 Graphs of daily values

To get a plot with daily values, select “Daily” in the “Values” selection.



You will get a scatter plot of the irradiation values against the day of the year. Each point represents the irradiance for a single day in [kWh/m^2/day].

The blue envelope curve describes the Clear sky model. This plot gives a quick crosscheck of the quality of the data. The Clear sky model is an upper limit for the measured irradiance, and none of the points should exceed this curve significantly (more than 3-5%). If larger discrepancies are seen, this indicates that the data are not good.

1.4.2 Tables

You can also present your data as tables. You can choose up to 8 values to be put into the table at the same time, including the irradiance on a tilted plane (transposition model) or the normal beam component (for concentration).

As for each data table in PVsyst, you have the possibility to:

Print the table: You will get the Print dialog, where you can add comments to the header of the table and specify the time range for which you want to print the values.

Export / Copy as text: This will "copy" the full table to the clipboard, from where so you can "Paste" it directly into an external spreadsheet like MS Excel. Remember that in MS EXCEL, the imported data will usually be gathered in one single column. To expand the data to cells you have to use the standard EXCEL options for importing data: menu “Data” / "Convert...", and here you should choose “Delimited” / “Semicolon” separator.
NB: The data will be copied with a decimal point. If you are using decimal commas (international preferences in Windows), you will perhaps have to change all points to commas.

Export / Copy as image: Will copy a bitmap image of the table to the clipboard, from where you can paste it into a report.

2 Importing Meteorological data from predefined sources

In PVsyst, it is also possible to import meteorological data from external sources. There is a set of predefined data sources where importing has been semi-automatized.

To access this option, click the "Known format" button in the Meteorological database window.

The “Import Weather Data” dialog will pop up, giving access to the easy-to-use tools to import meteorological data from predefined sources. If you press F1, you will obtain a detailed description of the available data sources. After choosing a source, clicking on “Information for importing” button will open the online help window with detailed procedure to import the data. Please follow it carefully and pay attention to the messages written in red at the top of the screen throughout your progress.

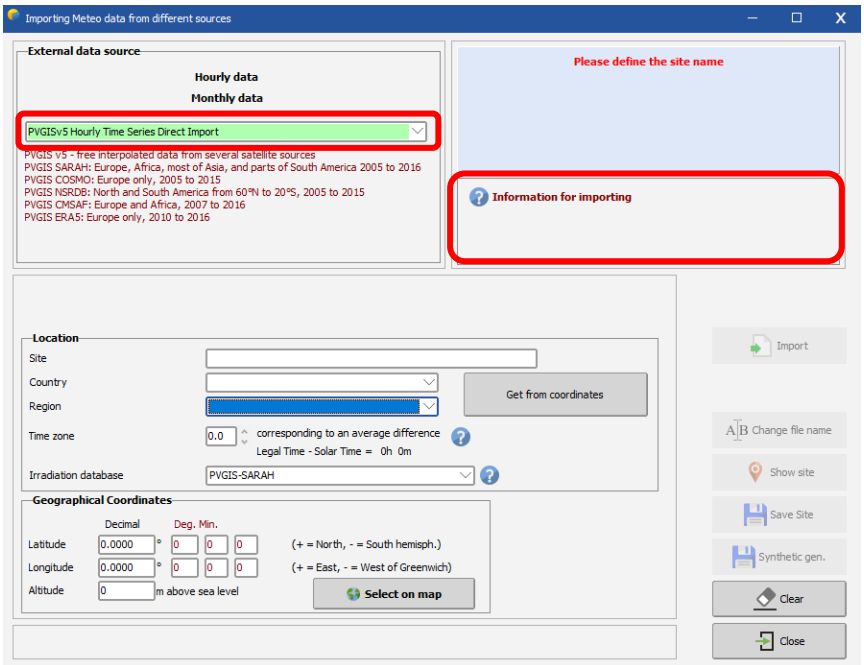
The data from the different sources are not always completely comparable. The PVsyst online help includes a comparison of such data for 12 sites from the north to the south of Europe.

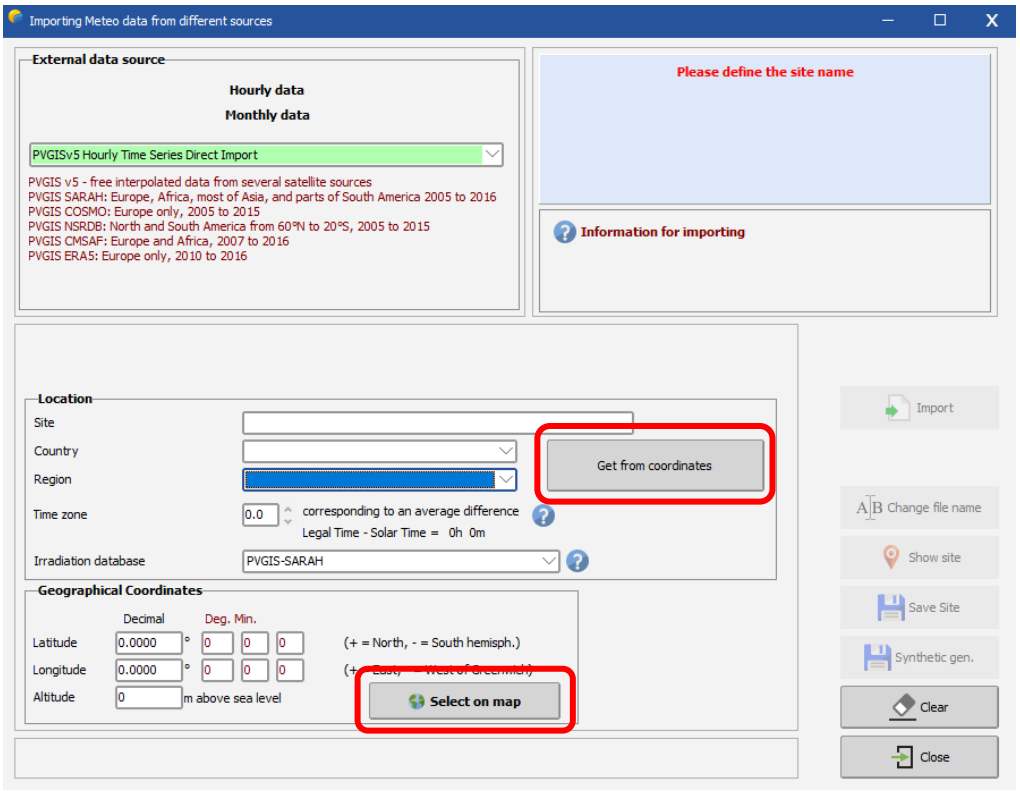
The following section contains an example on how to import meteorological data from the PVGIS project.

2.1 Importing PVGIS Data

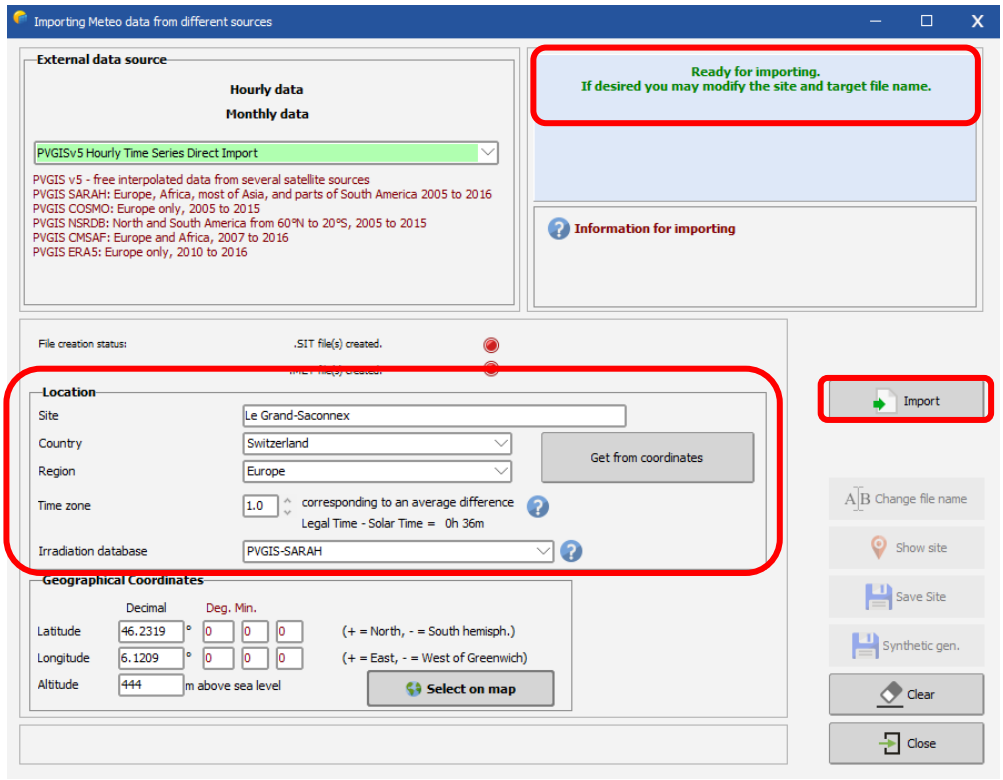
PVGIS (PhotoVoltaic Geographical Information System) is a research, demonstration and policy-support instrument for solar energy resource, part of the SOLAREC action at the JRC Renewable Energies unit of the European Communities (Ispra). You will find a complete description of this project at https://ec.europa.eu/jrc/en/pvgis . The PVGIS database covers Europe, Africa, most of Asia, part of South America, central and North America with data from NSRDB.

Importing PVGIS data is automatic after choosing the coordinates manually of from the map.

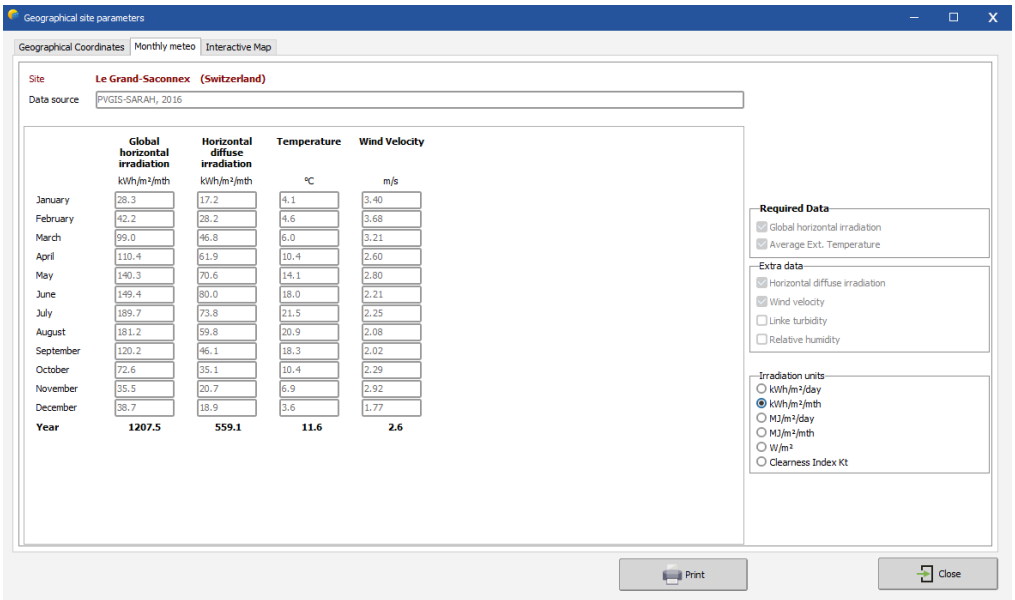




After setting the coordinates and the rest of the data, click on the “Import” button to obtain a full timeseries for 10+ years of hourly data. A separate .MET file is created for each year imported.



When the .MET files have been saved, you can press “Save Site” to save a site with monthly data based on the average of the timeseries. After saving the site, you can generate a synthetic hourly meteorological file based on the average of the timeseries by pressing the “Synthetic gen.” button. The dialog “Generation of Synthetic Hourly Weather Values” will pop up. Click on “Execute Generation” and PVsyst will create the .MET file with the hourly values based on the monthly averages of the timeseries.



3 Importing Meteorological data from custom file

If none of the predefined data sources contain satisfactory data for your project or if you have access to a better data source, you can import this data to PVsyst from custom files.

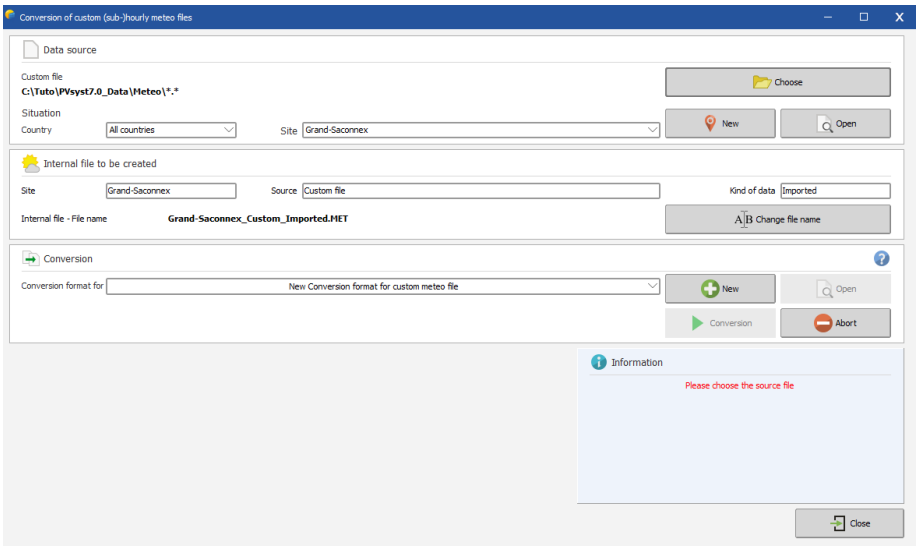
Please note that measuring and analyzing meteorological data is a complex and difficult task. It is very easy to get biased or wrong results due to wrong calibration of instruments or inadequate analysis tools. If you want to use self-measured data, please make sure that it has been measured with adapted equipment and analyzed by an expert with the necessary skills. Always perform basic crosschecks on the data as explained in this tutorial. The meteorological data is at the origin of the main uncertainties of the simulation. Poorly measured or processed data can lead to significant deviations of the results.

To import custom meteorological data, click on “Custom file” in the Database window:

The “Conversion of custom (sub-) hourly weather files” dialog will pop up.

Carefully follow each step from the conversatiion dialog.

- Choose your source file, which can reside anywhere on your disk.
- Choose an existing site or create a new site to link the resulting .MET file to the correct coordinates.
- Give a significant name to the internal file to be created. This will identify the file in the meteorological or measured data list boxes. Please carefully choose this title since you will not be able to change it after conversion.
- Choose an existing or create a new format file that will tell how PVsyst must read the file.
- In some cases (depending on the format file), the program will still ask for the beginning date or the year.



This list is not exhaustive. For detailed instructions, please refer to the online help of PVsyst. When you are ready, press the "Start Conversion" button.

During execution, a control executing window displays the contents of the source-file's line currently being processed, as well as the converted meteorological values, which will

be transcribed on the internal destination-file. After conversion, you are advised to check your file with the "Tables and Graphs" tool (either for meteorological or for measured data files), and carefully check the time shift of your data.

3.1 Detailed example of importing a custom file

For this example, we will use the file “PVsyst_Standard_Geneva_GPI.csv” that can be found in the PVsyst workspace under “Templates” (if missing, “Manage” your workspace and press “Reload templates”). The file contains meteorological data for the year 2006 in hourly steps for Geneva in Switzerland. There are several quantities stored in this file, among which there is the ambient temperature and the Global irradiance measured on a plane with a tilt of 30°. These two are the values that we will be using in the present example.

After opening “Databases” in the main PVsyst window and selecting “Custom file”, you will get the “Conversion of custom (sub-) hourly weather files” dialog, which is divided into four fields:

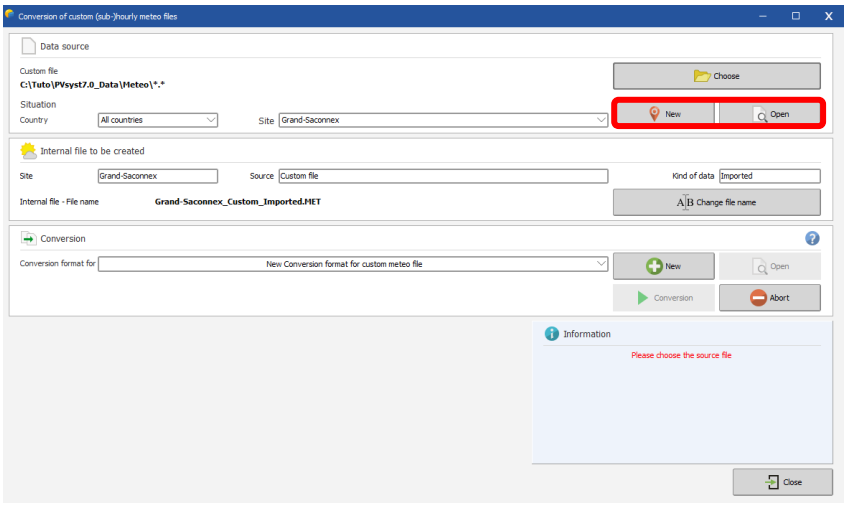
- Data Source.
- Hourly file to be created.
- Conversion.
- Info – Warning.

We will go through the first three fields in detail. The “Info – Warning” field will give you information and hints to guide you through the different steps that are required to import the data successfully.

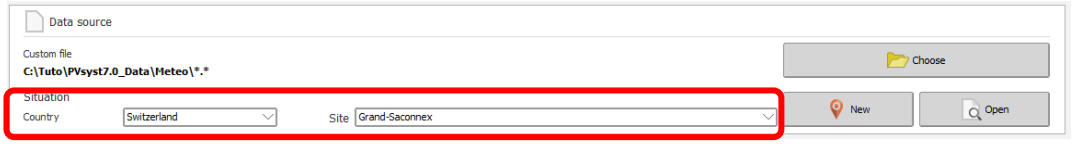
Data Source

When you import meteorological data, you will take an existing text file with the data and create a new file in the PVsyst format with hourly meteorological values. This file will be of type *.MET and it will be associated to the site that you select in “Data Source”. You can have several files with hourly values associated to the same site. Make sure that you have already created the site to which you want to attach the *.MET file that will be created.

In the dialog click on “Choose”. A file selection dialog will pop up where you can search for the data file. The default filter will display files of type *.DAT, *.TXT and *.CSV.



Once you have selected the file, you specify a site for this data. To select the site, you first select a country or region to narrow down the choices in the “Site” drop down list.



Next you give a small description of the data that will be attached to the output file. This information will be displayed in PVsyst in dialogs or reports as description of the Meteorological file (*.MET file).

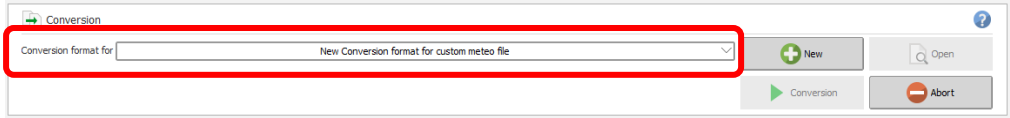
You have three fields for which PVsyst proposes default values and that you can complete or change to any text you want. It is recommended to give short descriptions, so that they will fit into the dialog fields. The three fields are:

- Site: The default will be the site name chosen in “Data Source”, but you can change or complete the name in this field.
- Source: Here, you should put a short label describing from where the data has been retrieved, e.g., the source filename, or “Measured on site”, or “Provided by Meteo Inc.”, etc.
- Year/kind: Default is “imported”. Give a short label with the year for which this data is valid, and if it is hourly, daily or even sub-hourly data. Try not to exceed the visible width of the field, so you can read this label easily in other PVsyst dialogs.

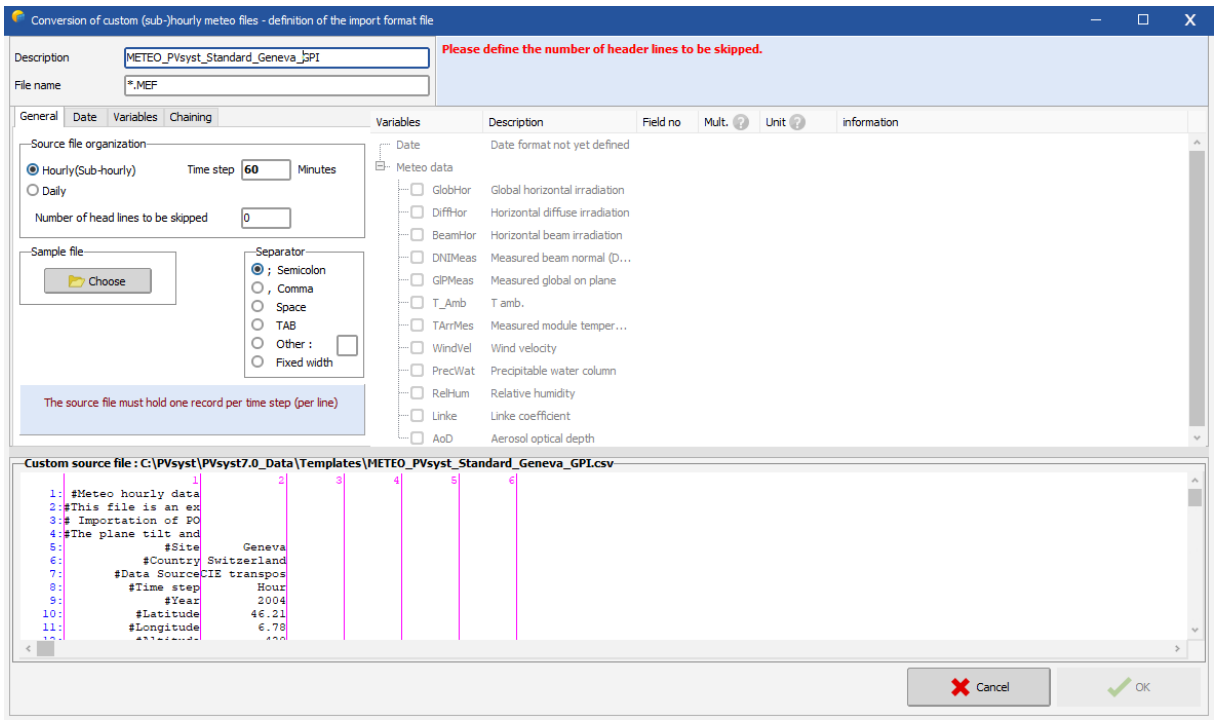
You can specify the output filename. PVsyst proposes a filename generated from the site name in the “Data Source” field. If your source file contains several data sets for the same site, like for different years or measurements in the horizontal and tilted plane, you are advised to change the output filename to something that will identify which portion of the data is being imported.

Define the data format

You need to tell PVsyst what kind of data will be imported from the text file and where to find the data fields in the file. This information will be stored in an internal PVsyst file of type *.MEF, stored in \Meteo\. You can create as many of these format protocol files as you like.



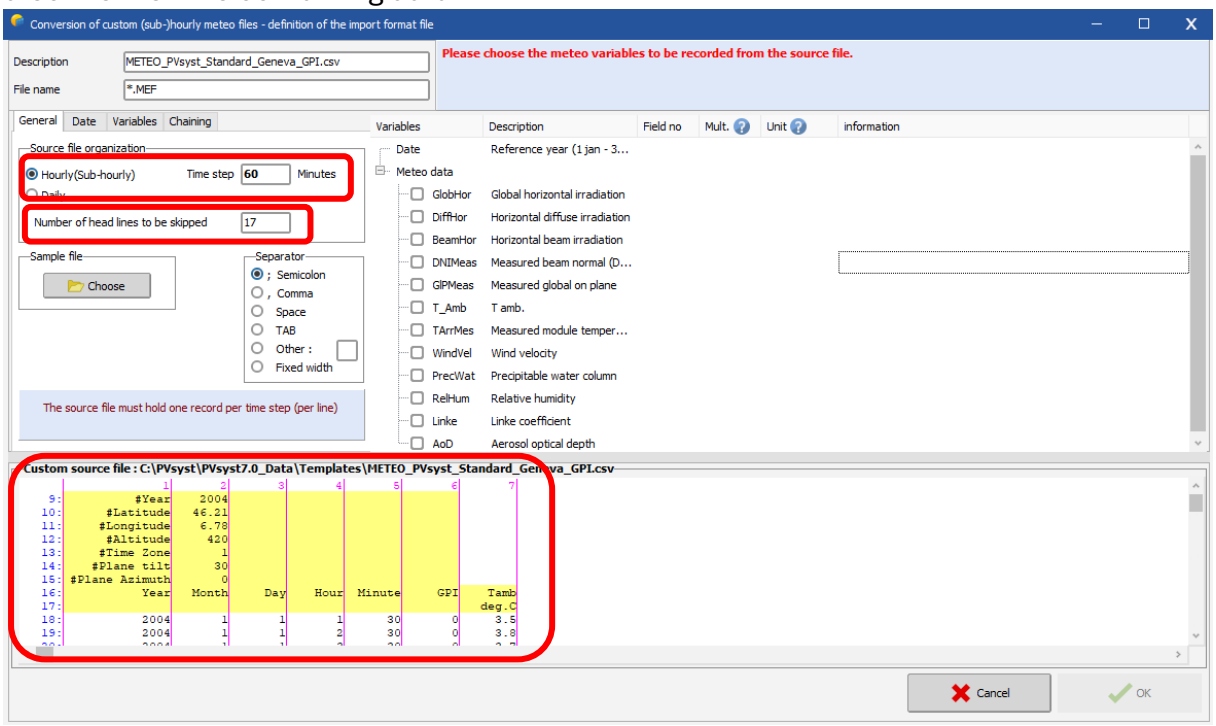
The dialog “Conversion of custom (sub) hourly weather files – definition of the import format file” will pop up. It contains a field “Format description” where you must give a name that will identify this format protocol. The dialog contains four different tabs, “General”, “Date Format”, “Weather Variables” and “Chaining files”. We will investigate the first three tabs in detail. The last tab, “Chaining files”, is needed if your data is distributed among several files and will not be described in this example. The lower part of the dialog gives visual feedback on how the format file that is being defined will apply to the content of the data source file. Here, you can quickly check if the different values have been selected properly or if there are problems with the format definition.



“General”

For the example file containing hourly data, you can leave the default selection “(Sub)-hourly data” with a time step of 60 min. The demo file also uses the default separator, which is a semicolon. In the lower part of the window, you can check that the columns containing the data starting from line 20 of the file. Therefore, in the field “Number of headlines to be skipped”, enter 19. In the bottom display, the background of the skipped

lines will now turn yellow and you can check that the first line with white background is also the first line containing data.



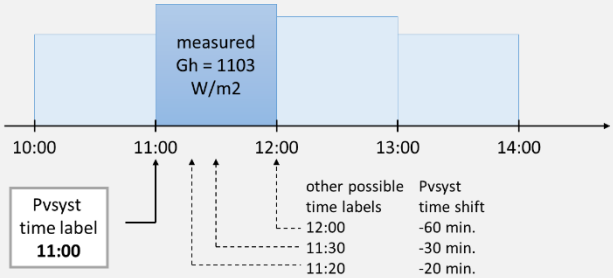
“Date Format”

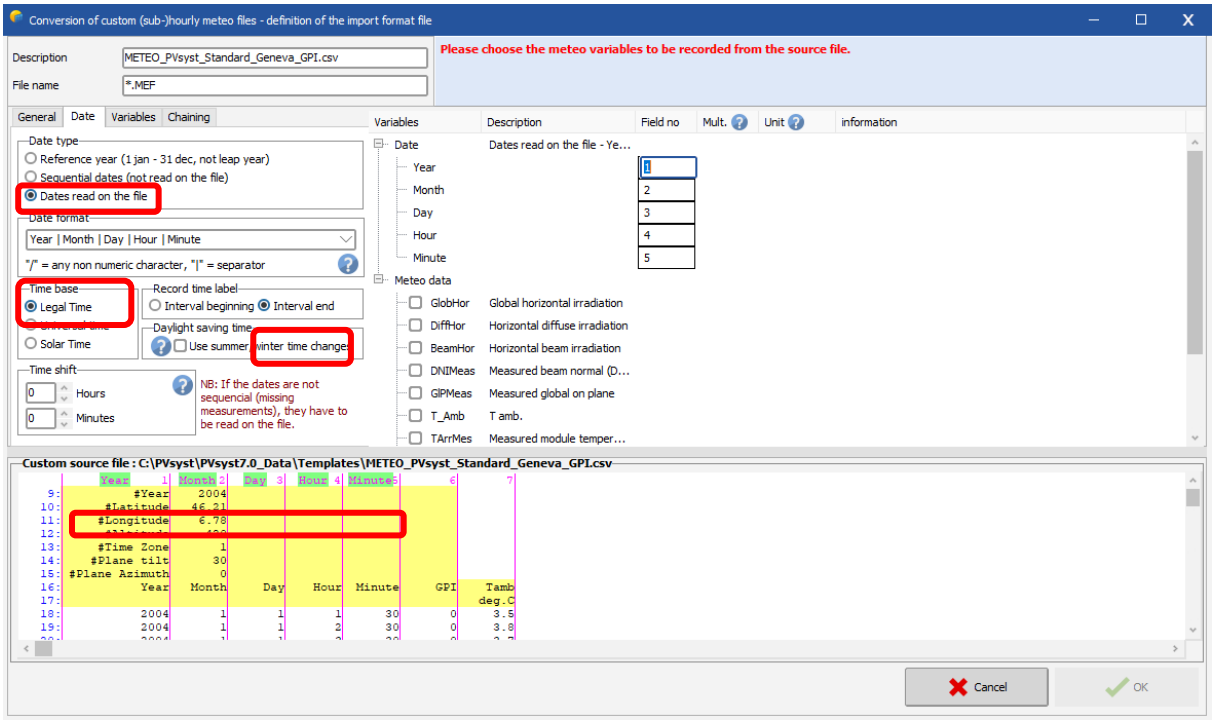
In this tab you specify how to read the time of your file. If possible, it is always better to select “Dates read on the file” to read the time, the other options “Reference year” and “Sequential dates” are very sensitive: any missing line of data introduces a time shift for all remaining lines of data. For our example, you need to select “Dates read on the file” and choose the adequate format from the drop-down list “Date format”. In this case it is “DD/MM/YY/hh/mm”, which means that the date is ordered as Day/Month/Year/hour/minute, and that date and time are not in separate columns. The slashes are wildcards and represent any non-numeric character except for the column separators.

On the right, in the column “Field no”, specify the column where the timestamp can be found, which is “1” in our example. In the bottom part of the dialog, you will see a green header for the specified column. Finally, you need to specify how the time label is related to the measurements. In our example, the time labels correspond to the end of the measurement.

Time Labels

In PVsyst, any hourly value with a time stamp should be representative for the hour that follows the moment given by the time stamp. Thus, if for example the irradiance is measured and averaged over an hour, and then labelled with a timestamp corresponding to the end or middle of this interval, this will lead to a time shift.





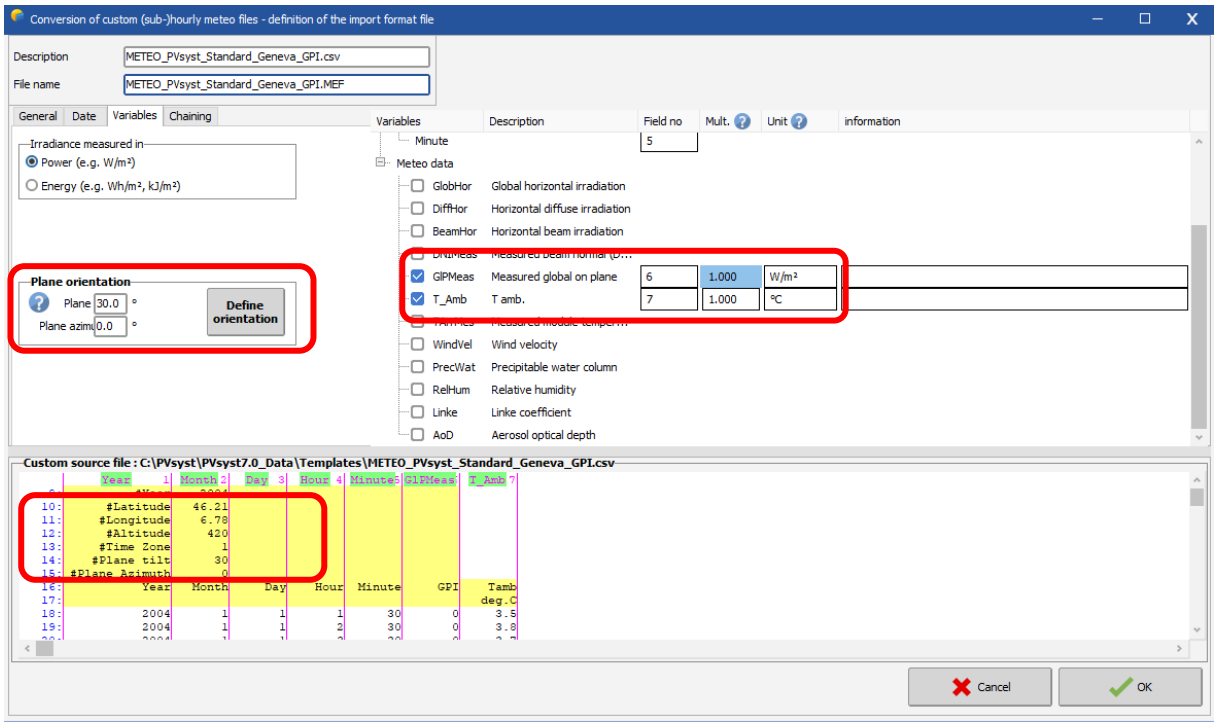
"Variables" selection

For the example, you need to select "Global on tilted plane" and "Ambient temperature" in the right list. For each selected variable, the column for "Field no" in which the variable can be found in the file must be filled. In our example, these are the columns 3 for the Irradiance and 4 for the temperature. The default units for these variables are W/m2 and °C respectively. If the data comes in different units, you have the possibility to specify a factor which will be multiplied to the values. In our example file, the units correspond to the default values and we can leave 1.000 as factor. Once you have specified a field number for a variable, you will see that the corresponding column in the bottom part of the dialog gets a green header with the variable name. This allows to quickly verify if the given values are correct.

“Variables”

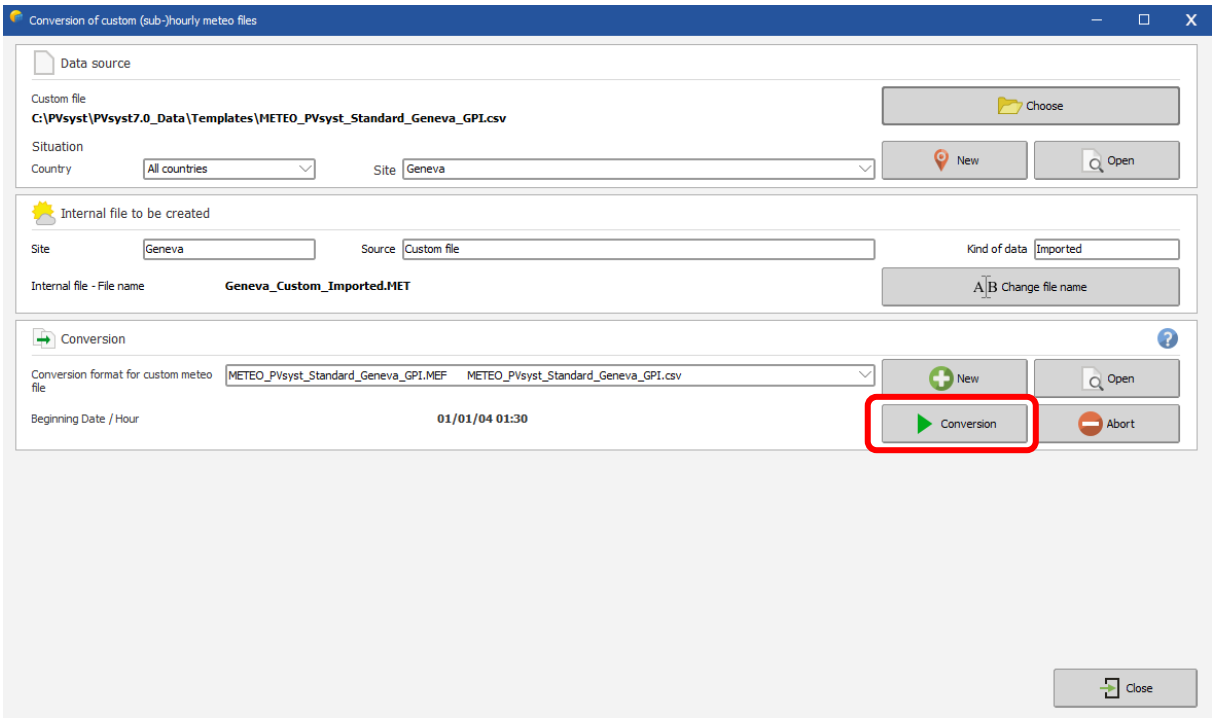
Since the measurements are for an inclined plane, you must specify tilt and azimuth of the plane in the “Variables” tab. In the field “Plane orientation”, enter 30° for the tilt and leave the azimuth at zero (south). Note that this field will only be present if a variable for an inclined plane has been selected in the right part of the dialog.

When all the specifications of the format file have been entered, define a proper description and file name then click on “OK” and you will be asked to save the newly defined format file. You can change a last time the filename before clicking on “Save”. If a file with the same name already exists, you will be asked to confirm to overwrite it.



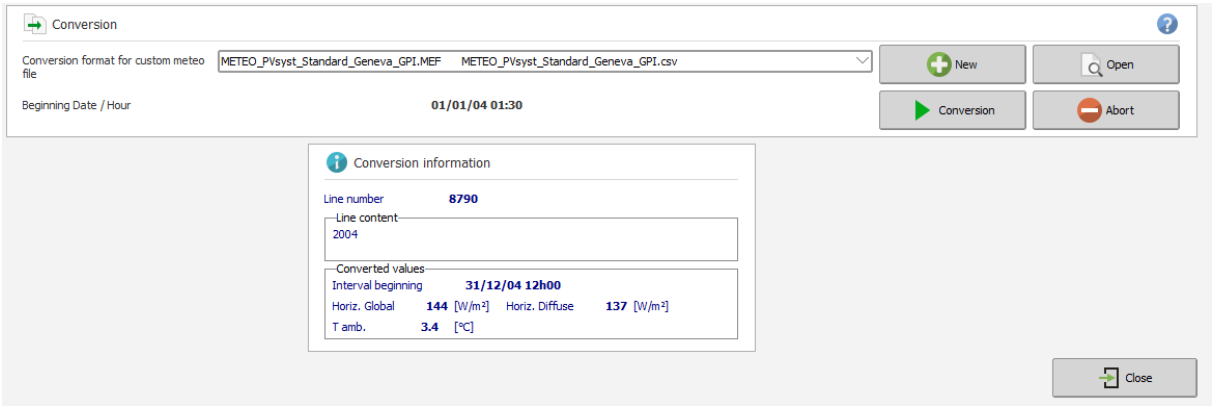
After successfully saving the format file you will get back to the “Conversion of custom weather (sub)-hourly files” dialog.

You can now click on “Start Conversion” to import the data from the custom file.



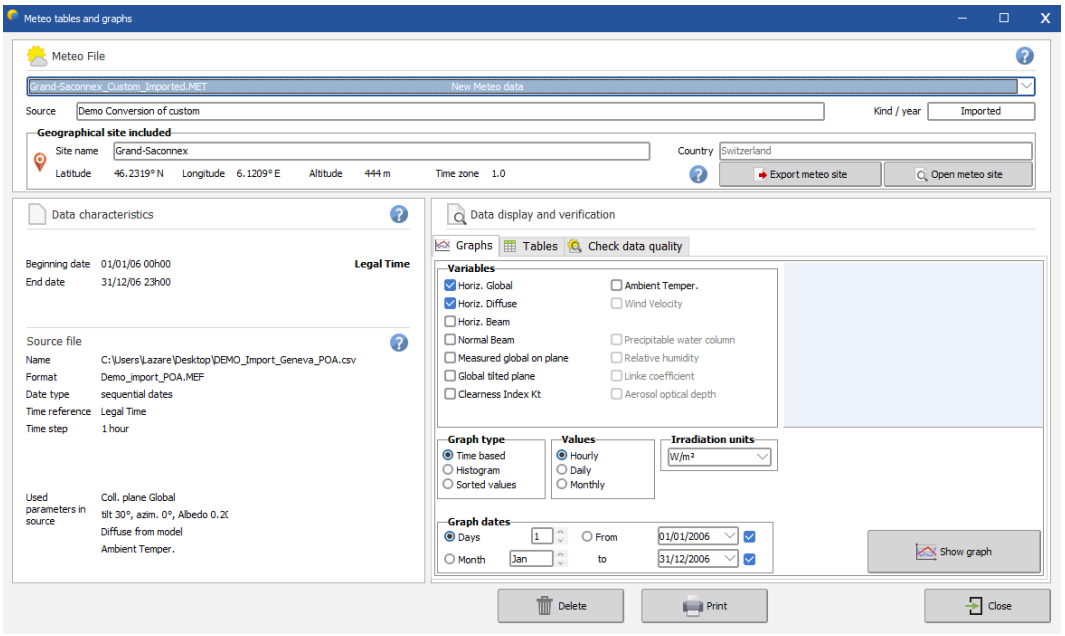
In the example file, the timestamp in the last line of data is already the first hour of the following year (2007). You will be prompted with a corresponding warning message that you acknowledge by clicking on “Yes”. When the conversion is finished, click on “OK”.

The conversion is now finished, you should carefully check if the result does not contain any obvious error or inconsistency. A prompt asking if you want to open the dialog for visualizing the meteorological data will pop up. Click on “Yes” to open the dialog.



Check the imported data

You should always perform some basic checks on the meteorological data that you want to use for a simulation of a PV installation. PVsyst offers a variety of tools to do this, for instance the "Weather tables and graphs" dialog will pop up when you select "Yes" in the final prompt after importing a custom file as described in the previous paragraph.



The upper part of the dialog indicates two fields: "Source" and "Kind/Year", that you filled up when creating the file. Below them, there is detailed information on the site to which this meteorological file has been associated.

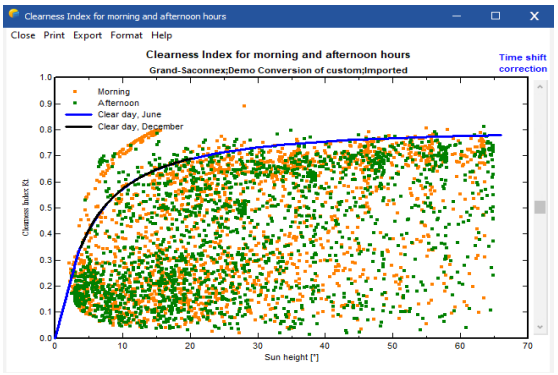
On the left, you will see the time range covered by the data and some of the details of the original file from which the data was imported and that you defined in the format file.

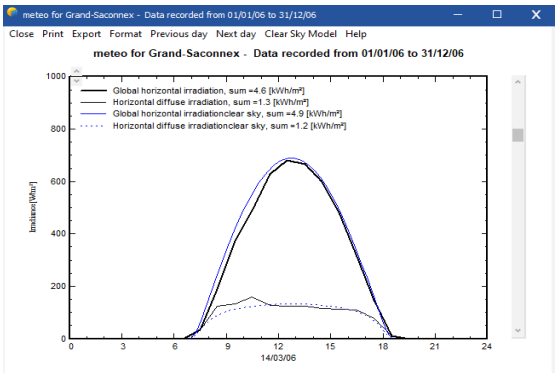
The right side of the dialog contains the options to visualize the meteorological data and is subdivided into three tabs. Select the "Check data quality" tab. The tab contains a small control plot displaying the time shift that PVsyst estimates for the imported data. In the current example, it should be close to zero.

There are two more ways to visualize a possible time shift from the data. The first one is to look at the clearness index for morning and afternoon hours. The orange dots show the clearness index as a function of the sun height in the morning, while the green dots show the same information for times after 12:00. Both colors should follow roughly the same distribution.

The second possibility is to compare the daily evolution of the measured irradiation (global and diffuse) to the clear sky model. If you press on the button "Monthly best clear days", you will get a plot like as presented in **Erreur ! Source du renvoi introuvable.**.

PVsyst selects for each month of the year, the day that fits best to the clear sky model. You can scroll through these 12 plots with the scrollbar on the right. You should see no significant horizontal shift between the measured data in black and the clear sky model in blue.





The third control plot “Best clear days Ktcs” displays the sorted Ktcs of all days of the year. The Ktcs is the clearness index referenced to the clear day model (not to the extraterrestrial). This graph gives an idea of the calibration of the irradiance sensor: the best days of the data should be close (within 5%) of the clear sky model, i.e., Ktcs=1.