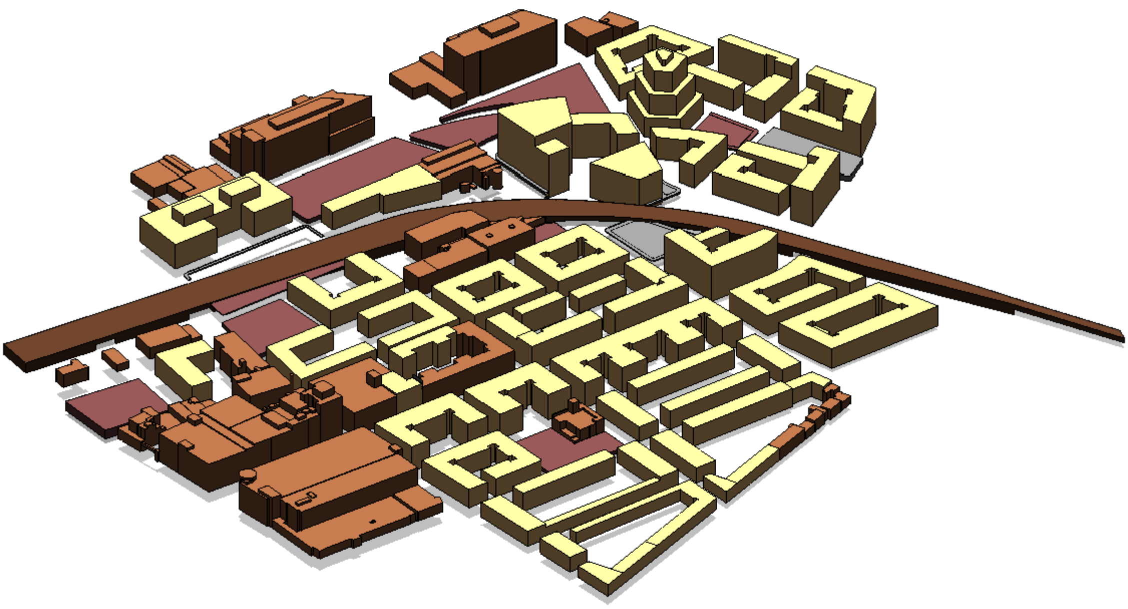
Heliodon

Version 2.7-03 (24/08/2011)



Heliodon2 Documentation

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Install and configure Heliodon

Requirements

Heliodon will work fine on most recent computers but remember Heliodon is a 3D environment that is very demanding on graphics and CPU resources (as all 3D software). So computers with low capabilities may not be well-adapted for running Heliodon. The minimum requirements are listed below.

- Windows XP, Vista or Seven
- 500 Mb of free space on HDD (on c:\ partition)
- Video card compatible with OpenGL (most recent cards are compatible)
- 3-button mouse (+wheel)
- Microsoft Visual C++ 2005 Redistributable Package (x86) [download]

Check Microsoft website for more information.

Microsoft Visual C++ package

Microsoft Visual C++ 2005 Redistributable Package contains libraries required for Heliodon to run properly. You may download it here. Check Microsoft website for more information. Open it and follow the procedure. Once installed, you won't need to install again. Note that this package may already be installed on your computer (several software rely on Microsoft Visual C++ 2005 Redistributable Package).

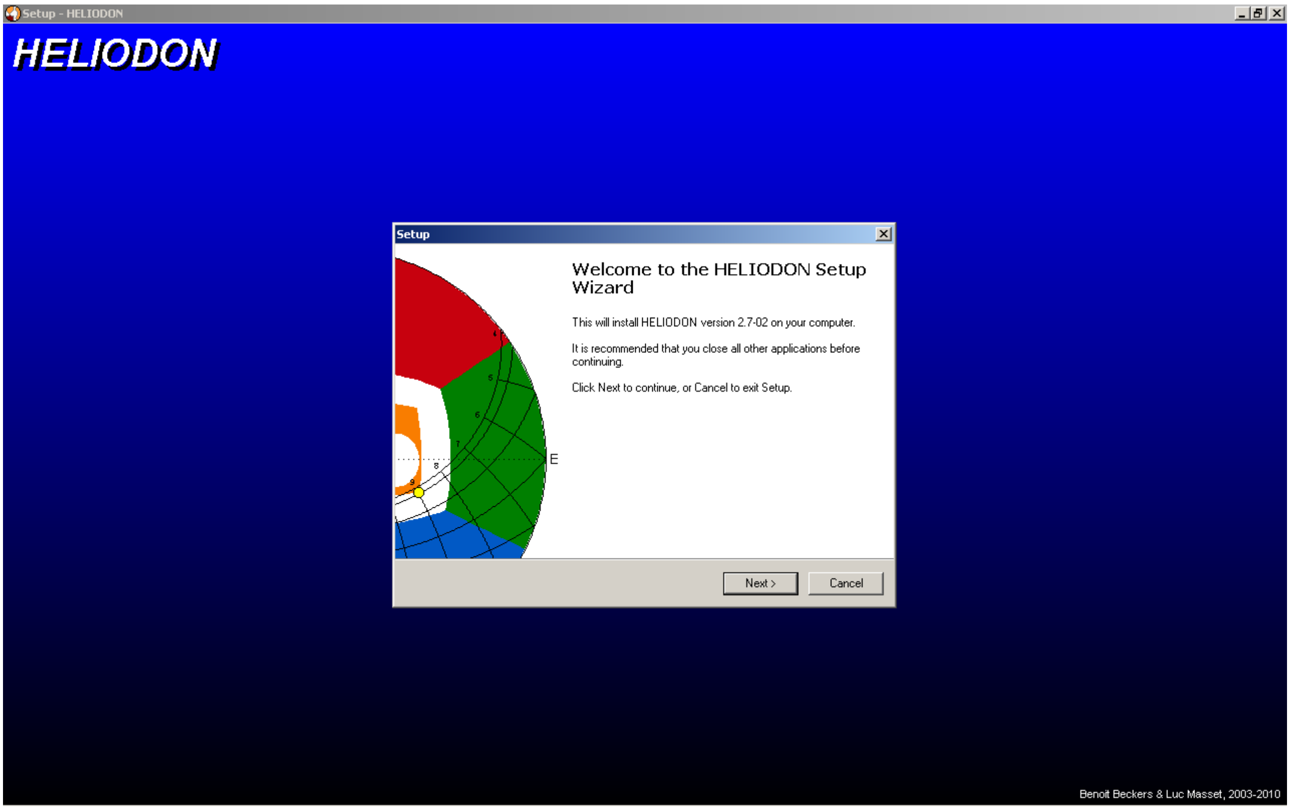
Gaphic card

The biggest problem that you may face is a graphic card that does not handle correctly OpenGL graphic language. In this case, drawings may not appear correctly (colors, shapes) or some elements may not appear at all (such as the view point, sun etc). There is no list of certified graphic cards for Heliodon. Just note that we never experienced issues with NVidia graphic cards but we did with other brands such as ATI or Intel cards. This does not mean that these cards won't work with Heliodon but you may experience problems with them.

In case you have graphic issues, try to *update the driver* of your graphic card. In most cases, this solves the problem.

Install

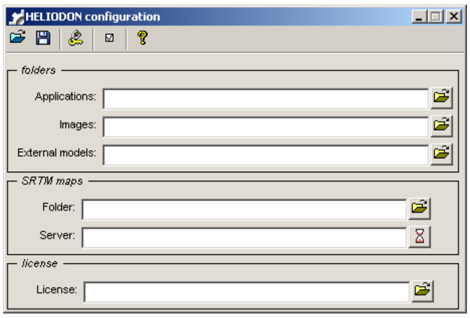
First you must download the install package on Heliodon website. Open it and follow the install procedure by clicking "next" button.



Once installed, you will have an "Heliodon2" menu in Programs and an Heliodon2 icon on Windows Desktop. You may already use Heliodon "as is", default parameters should work well or you may want to configure Heliodon before using it.

Configure

In the Heliodon2 menu, run the "Config" shortcut. The following interface brings up (it may take a few seconds to appear). Several things can be set here. Complete descriptions are given below.



Application folder

The application folder contains the Heliodon models. This is the default folder when you will open or save in Heliodon. Leaving this field blank means that the Windows folder "My Documents" or simply "Documents" (this depends on Windows language, Mis Documentos, Mes Documents, etc) will be used. Use button on the right to select another folder.

Image folder

The image folder contains the images that you may import in Heliodon as background images. Leave blank for using "My Documents" folder.

External models folder

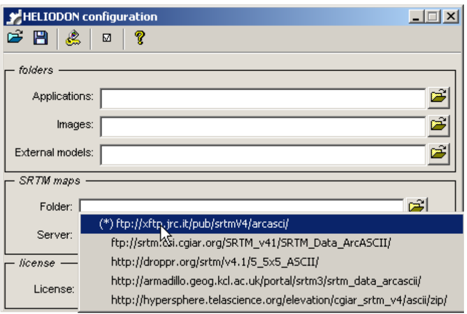
This folder is intended to contain all the external models that you may import in Heliodon. This includes :

- STL files (.stl)
- DEM Ascii files (.asc, .txt)
- DEM XYZ files (.xyz)
- Shapefiles (.shp)

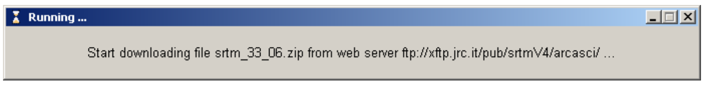
See section "Import external objets" for more informations.

SRTM maps

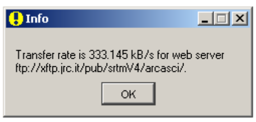
SRTM maps are free DEMs (Digital Elevation Models) that you may import inside Heliodon (see Import Free DEM). The SRTM maps folder is intended to receive the files downloaded from the net. Leave blank for using "My Documents" folder.



SRTM maps may be downloaded for free on several servers. Depending on your location and your internet connection, one server may be faster than another one. Use the list of servers (right-click in the "server" field, see above) to select a SRTM maps server. You may try the connection by using the ⧖ button. A small SRTM patch is being downloaded while the following message appears.



In case the download is successful, the following message appears.



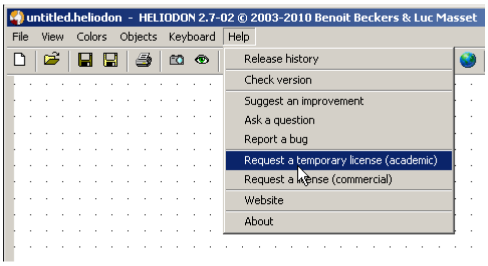
It gives you an idea of the transfer rate so that you may test the different proposed SRTM map servers. In case you get an error, it means that the server did not answer in due time.

License

When you don't set a license, Heliodon works in DEMO mode. That means that there are some restrictions in the use of Heliodon:

1. you cannot create more than 20 objects (panels, prisms, ...);
2. you cannot import external models (STL, DEMS, shapefiles).

Even with these limitations, you may yet create complex models with Heliodon. Nevertheless, to be able to import external models and build more complex scenes, you need a license. Requiring a full Heliodon license may be done thanks to the Help menu of main Heliodon windows.



Once you have a valid license file (nammed file.heliodon.lic), use the button to the place on disk where the file is located. Do not use a mobile hard drive or a USB key for your license, otherwise you will need this device to be connected to run Heliodon. Instead, use a folder in the hard drive of the computer (the "My Documents" folder for example). *Do not either place the license in the Heliodon folder (Program Files\Heliodon2)* since this folder is swept away when a new version of Heliodon is installed.

Assumptions

Foreword

In Heliodon, we make several assumptions in the models we use. Below is the list of the main assumptions and simplifications. Note that the goal of these assumptions is mainly to reduce the computation time in order to have quick answers and results. The purpose of Heliodon is not to be as precise as a GPS solution but to allow a fast study of available daylight and solar energy. In future releases of Heliodon, we may reconsider one or more of these assumptions (on user demands for instance) but never at the cost of losing interactivity and reactivity of the software.

Latitude and longitude

The geographic position is defined by the latitude and longitude. In most GIS software, you can see latitude and longitude changing while moving the mouse over the map. In Heliodon, even if we move the viewpoint along X and Y axes, latitude and longitude remain constant. We implicitly assume that the studied zone is small enough so that the variations of latitude and longitude are small.

This implies that the sun trajectories (in the stereographic projection) remain the same even if we go up and down along the Y axis (latitude increases/decreases). This has an impact on the daylight simulations. Both the duration of the day and the solar fluxes change with the latitude. In Heliodon, they remain equal.

This also implies that the official time remains constant even if you move the viewpoint position. In the "real World", official time does change with geolocation (both latitude and longitude).

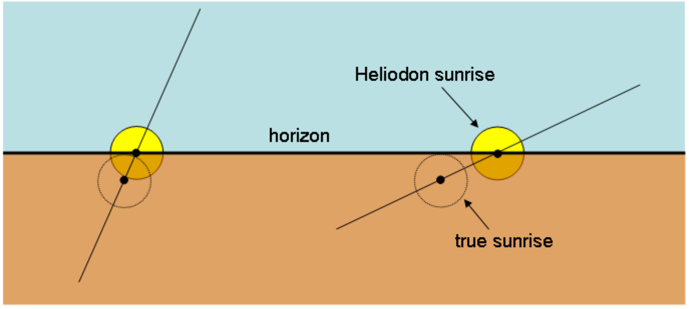
Time

You may chose between solar and official time. The solar time is the time you may observe with a sundial. It only depends on the sun position (azimuthal angle). Official time is the time given by a watch. It is based on the mean solar time. Difference between apparent and mean solar times is given by the equation of time that takes into account the Earth's orbit (ellipse) and the inclination of the Earth's axis (obliquity of the ecliptic). Time difference has a maximum of more or less +14 minutes in February and -16 minutes in November.

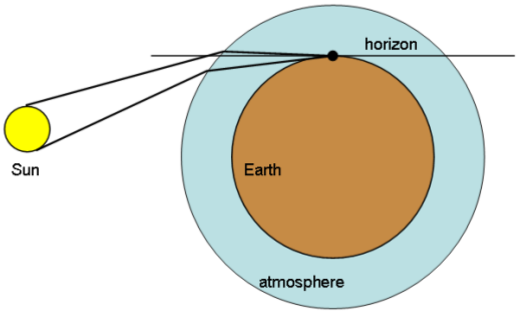
In Heliodon, we have chosen an approximation of the true equation of time (see here). It gives a sufficiently precise result (a few seconds).

Sunrise and sunset

The sun is not punctual. It is seen from Earth's surface with an angle of about 0.5°. In the stereographic projection, the trajectories represent the trajectories of the sun center. As a consequence, true sunrise occurs sooner than the sunrise indicated in Heliodon. At contrary, true sunset occurs later than sunrise given by Heliodon. The difference depends on the way the sun crosses the horizon. For sunrise, if it climbs quickly (regions near the equator), the difference is small (about one minute). If its trajectory is almost parallel to the horizon (near the poles), the difference is much greater as illustrated by the figure below.



In addition, there is a optical effect due to the refraction of the Earth's atmosphere. We can see the sun before it actually crosses the horizon as illustrated on the figure below. Note that this effect also depends on the altitude of the studied point since the refraction depends on the height of the atmosphere layer.



You can check this website for a complete method of computing sun trajectories as well as sunrise and sunset time. You may also find a lot of websites giving sunrise and sunset hours. They usually give data similar to what you may obtain with Heliodon.

Sun flux

There are several different models to compute the solar irradiance, i.e. the solar flux arriving at a given point on Earth surface. The model we use in Heliodon is a simple one. It takes into account the absorption of Earth's atmosphere (see this paper in Spanish or this document in French). The solar irradiance is given by

$$S_p = S_{p0}\,\tau^m \quad \text{with } m = \frac{e^{-\frac{A}{A_0}}}{\cos\psi}$$

with

- S_p the solar irradiance,
- S_{p0} the extraterrestrial solar irradiance (1367 W/m²),
- the transmittance coefficient of the atmosphere (0.7),
- A the altitude,
- A_0 the reference altitude (8200),
- the zenith angle.

In Heliodon, these coefficients above are constant for a given simulation, even the altitude. Indeed, for a mesh, we consider a mean altitude, even if the mesh is 1000 meters high. Note that, with no terrain, the altitude of an object is its mean altitude with respect to ground plus the altitude of ground itself (as indicated in the projection window, use key "a" to set the altitude). Let us take an example: a panel of 10 meters high lies at 500 meters of the ground and the ground altitude is 300 meters; in the calculation, we use an altitude *A* equal to 805 meters.

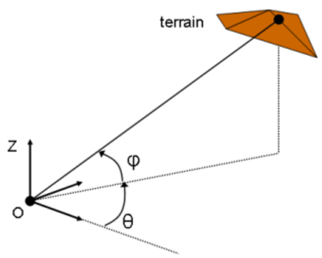
Energy received on ground

The simplification made on altitude does not apply when we compute the energy received by the terrain (F11 key). In highlands, the terrain altitude may greatly vary so that it is inexact to consider a mean altitude. Rather, the flux is computed with the actual altitude. The mesh used for the terrain is the terrain model itself, i.e. a triangle mesh. Each triangle is colored according to the energy (or daylight) received at its center point.

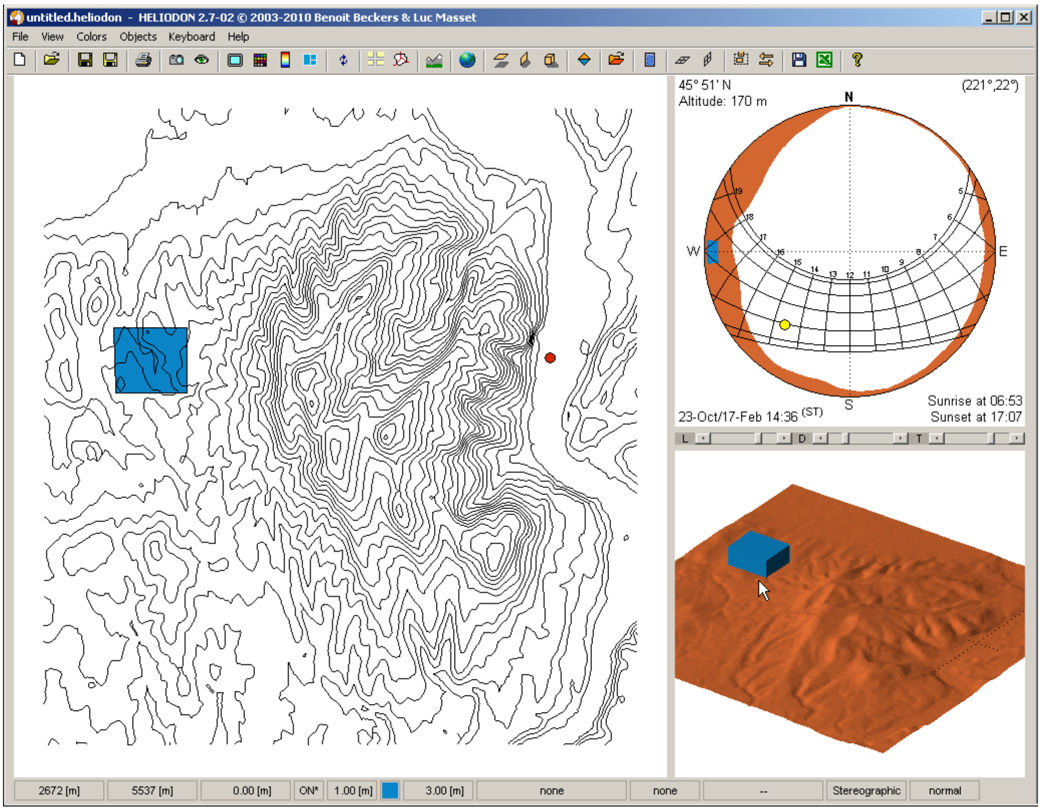
Terrain mask

The mask due to the terrain is not computed the same way other object masks are computed. In the projection, the 3D coordinates of an object are projected on a plane (2D). All projections belong to the azimuthal projection family, i.e. there is a projection center. To ensure that hidden objects are not visible (behind visible ones), we add a third coordinate to the two coordinates of the projection: the distance to the center of projection. This way, hidden parts of the scene are correctly displayed. This method may take several seconds to compute the projection if the scene is complex.

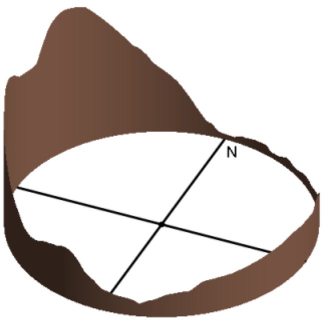
The terrain is usually composed of many triangles and vertices. Thus the same method of computing the masks cannot be applied to the terrain if we want to achieve a small display time. Instead we compute the terrain mask as a "curtain". From the center point, we compute in each direction (let us say each degree, angle   ) the highest point of the terrain mesh in term of elevation angle   .



A point of the curtain, given by its two angular coordinates (,), is projected as it was at an infinite distance. So the terrain mask always lies under the masks of the objects of the scene. In the example below, the mask of the prismatic building is seen in the projection although it is behind the hill compared to the projection center (the view point).



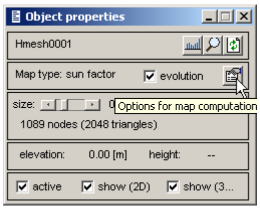
The image below shows how the curtain looks like for the above scene. You may find more details on the method in the DEA Thesis of Olivier Collin (in French).



Calculation parameters

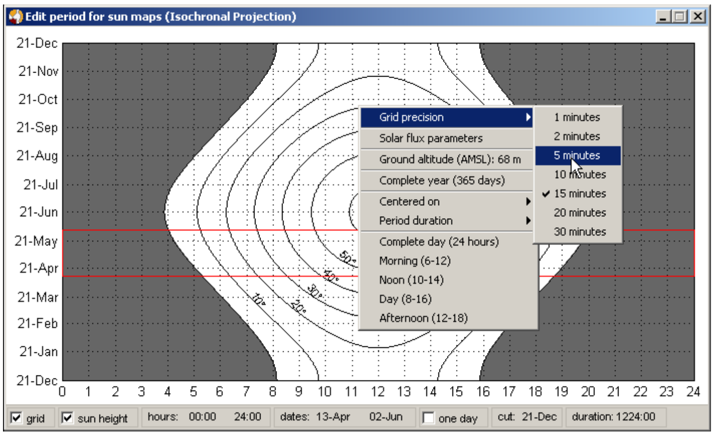
Stereographic projection

The calculation parameters may be set by clicking the parameter button in the properties dialog box for meshes (see below) or by pressing key "F7" in the main Heliodon window.



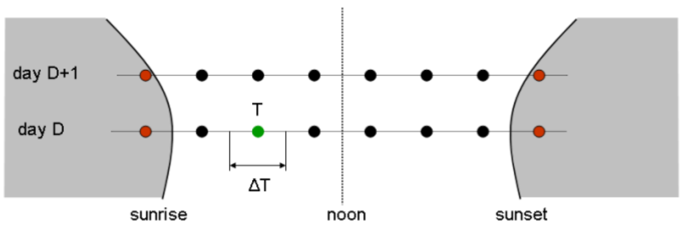
Graphical window

The calculation parameters are set within the graphic window below. It represents the whole year as a 2D plot with hours in abscissae and dates in ordinates. The night corresponds to the grayed zones. Right-click on the graphic to access the menu. The period of study is representes by the red rectangle.



Grid precision

The calculation is made on a grid of points in X (time) and Y (dates). The computation is made for each day of the period at several time steps. The time step (along X) may be chosen within the menu (1, 2, ... , 30 minutes).



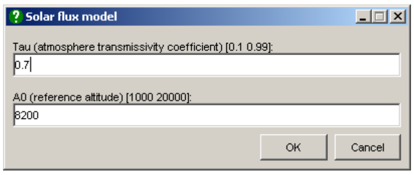
On above figure, the computation points are represented for day D and day D+1. The points are distributed regularly along axis X and set with the time step duration ΔT. The points located in the night regions (red points) are discarded. For the remaining points, the position of the sun corresponding to the date and the time is computed and that gives the direction of the sun rays. With a given direction, we compute if the rays are intercepted or not for each point of the map. If the ray is not intercepted, we had ΔT to the sunlight duration and F.ΔT to the received solar energy, F being the solar flux for this particular sun ray direction.

Solar flux

The sun flux is computed with a simple formula that accounts for the absorption of the athmosphere (see assumptions section). The two parameters that the user can modify are:

- the transmittance coefficient of the atmosphere (0.7),
- A_0 the reference altitude (8200),

When you click on "solar flux parameters" in the menu, the following dialog box appears.

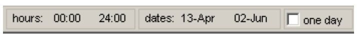


Ground altitude (AMSL)

The ground altitude (Above Mean Sea Level) is used when you study a point on earth located at a given altitude (for example the town of Mexico at 2250 meters AMSL). The altitude changes the obtained solar flux. Note that, when you have a terrain model, the actual altitude is computed and taken into account, the ground altitude having no effect then.

Period duration

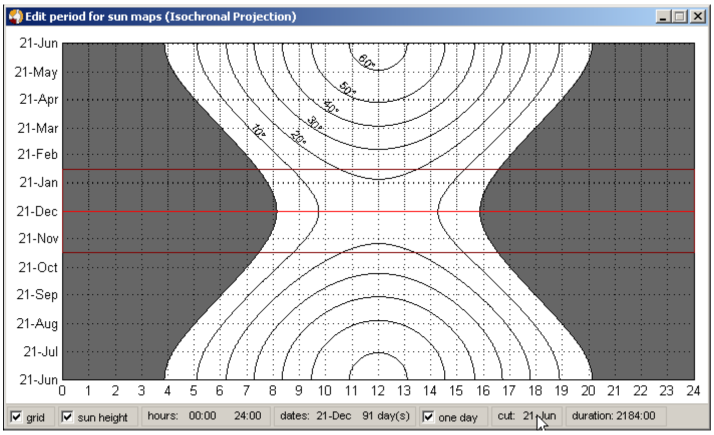
All the other items in the parameters menu are used to set the period duration. It can be the whole year (365 days, leap year are not taken into account), a period centered on a particular day, only the morning or the afternoon, … You can also set the period interactively by click-and-drag on the period limits (the red rectangle). Use left click to translate the period (not changing its duration) or middle-click to extend/reduce the period.



You may also use the buttons above to set the start/stop date and hour. Right-click on the field and a dialog box appears where you can set the date or the hour. A "one-day period" is a period centered on a given date and for which you set the duration (one day, one week, one month, &hellip).

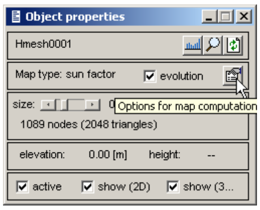
Cut date

The cut date is the starting and ending date of the Y axis. You may choose between December 21th (the default) or June 21th. Right-click on the field to change the cut date. This does not change the results but this allows the selection of particular periods. For example, if we need to study a period of three months centered on the Winter solstice, we change the cut date to June 21th and then we are able to select the desired period (see below).



Equivalent and orthographic projections

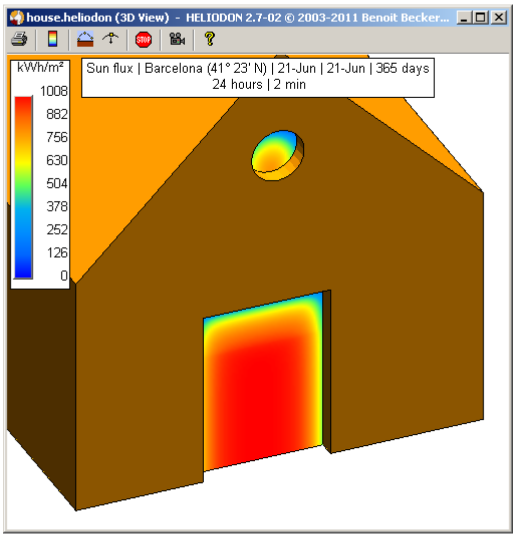
For both projections, there is only one parameter: the grid size. The computation is based on a cartesian grid of points in the projection circle (see below). Each point corresponds to a direction in space. Starting from a node of the map, a ray each direction, factor (sky factor or view factor) is (



Colored maps

Colored maps

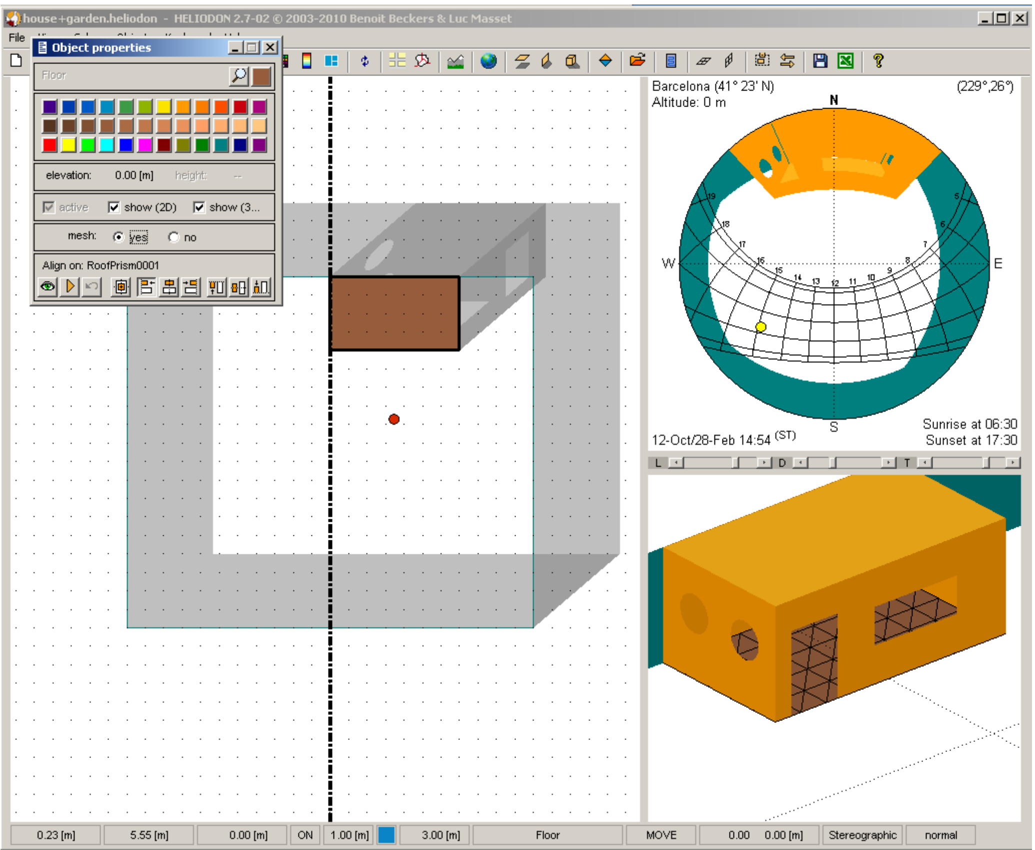
Colored maps are widely used in Heliodon to display various results (sunlight time, solar energy, sky factor, ...). Most of the results are displayed on meshes that lie on the objects of the scene. To show the variation of a quantity (energy, time, ...), the mesh is colored according to the the value of the quantity. Figure below illustrates the energy received on the door and the circular window during the entire year in Barcelona.



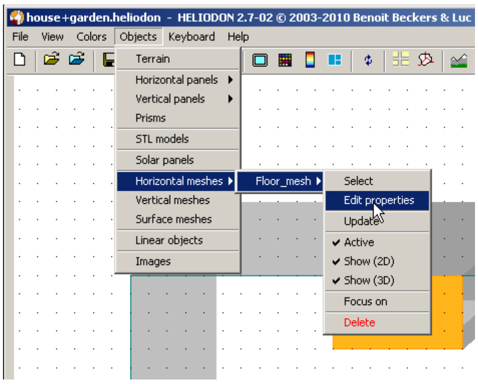
Maps on objects

For most Heliodon objects, the map is created in the Object properties dialog box. Either double click the object in the 2D view then use the right click to open the dialog box, or double right-click the object in the 3D view or use the Objects menu and select Edit properties in the menu.

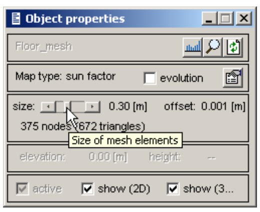
On the example below, we have created a simple scene with a house (a roof and four walls with a door and several windows and a garden with fences). We have also created an horizontal panel for the house's floor. After selecting the floor, we create a mesh on the floor by checking "yes" in the mesh field of the properties dialog box as illustrated below.



At this point, a mesh object named "Floor_mesh" is created on the horizontal panel named "Floor". Select the mesh object for example thanks to the Objects menu. Note that a mesh created on an horizontal panel goes in the "Horizontal meshes" object family.



Once selected, the following dialog box appears. You may change several parameters of the mesh object.



Update

The refresh button launches the calculation for the mesh. Depending on the projection you have chosen, the results are:

- **Stereographic**: sunlight time or solar energy/flux
- **Equivalent**: sky factor (solid angles of sky openings)
- **Orthographic**: view factor (sky diffuse solar energy)

Evolution

When checked, the results for each step size are kept so that you may visualize the evolution of the results during the studied period. This only applies when the stereographic projection is selected (thus for solar aspects). See the evolution section for details.

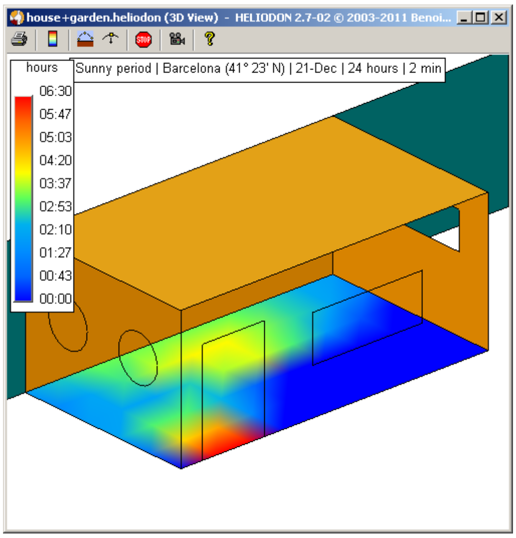
Options for calculation

You may change the calculation parameters (step size, period duration, ...). See the calculation parameters section for details.

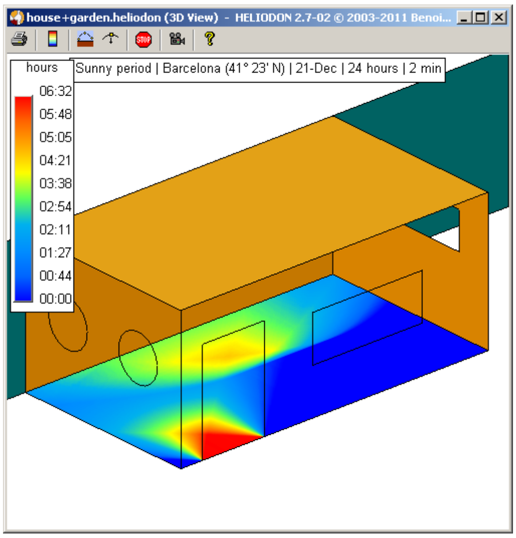
Size

You can set the size of the mesh elements (triangles) by dragging the cursor left (smaller) or right (greater). The number of nodes and elements of the mesh are displayed below. If you want, you may set an exact value by clicking the size value. Note that the calculation time increases with the number of nodes. So, by default, the element size is high so that there are few elements. If you need a more precise result, decrease the element size.

In the example below, the mesh size is the default (the greatest possible size). The mesh is composed of 60 nodes and 90 triangles. One can see that the result is "ugly". The zones with different values are not well marked.



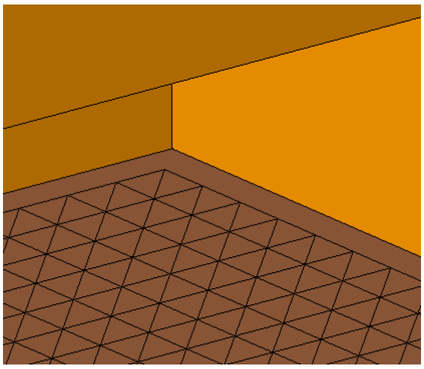
If we set the smallest possible value (best possible resolution), the mesh is composed of 39300 nodes and 77778 triangles. Now the result is "nice" and we are able to see clearly the different zones of the map.



It is not mandatory to set the best resolution since it costs in calculation time. Note that the results are numerically correct with a small resolution although they do not look good. Also note that the process of decreasing the element size is not linear: if you decrease the size by a factor 2, you increase the number of nodes almost by a factor 4 and, consequently, the calculation time also increases by a factor 4.

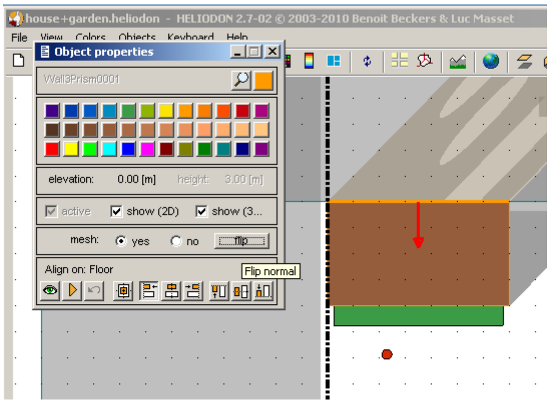
Offset

By default, the mesh presents an offset from the limits of the real object it is associated with. This is a security to avoid exceeding the limits of the actual objects. The default value (one millimeter) should be enough in most situations. An offset of 0.1 (10 centimeters) is shown on the figure below for the floor mesh.

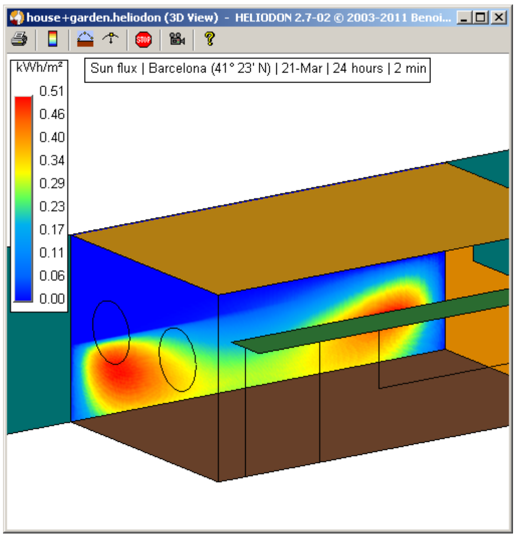


Meshes on vertical panels

A vertical panel has two sides on which we may create a mesh. In the properties dialog box, you may select the proper side of the vertical panel using the flip button. The red arrow indicates the chosen side.

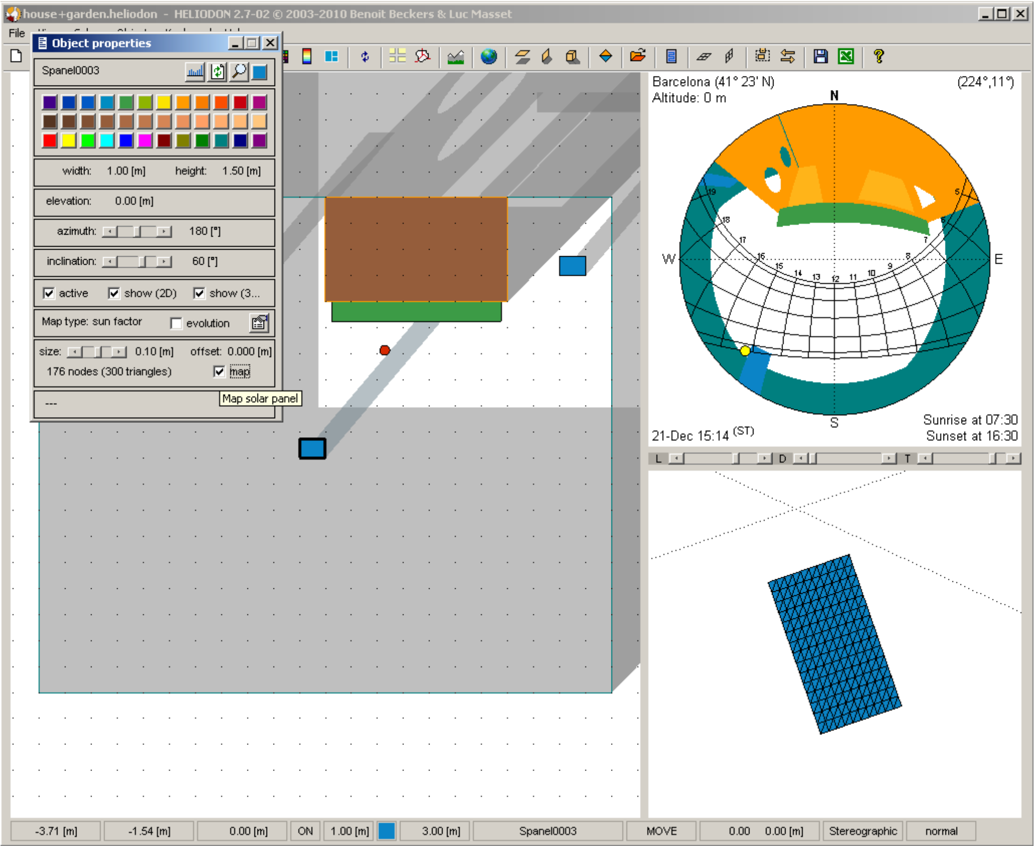


In the example below, we have created a mesh on the back wall of the house. The mesh is colored with the solar energy received at the equinox (March 21st).

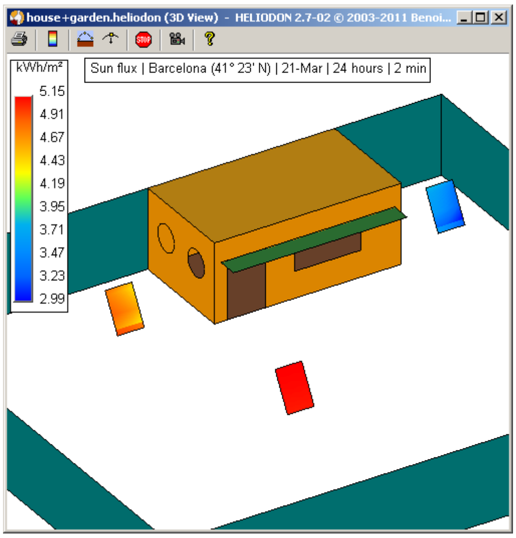


Solar panels

A solar panel is naturally a receiving surface so it automatically has a mesh attached to it. As seen below in the properties dialog box, you may disable the mesh by unchecking the map checkbox. Otherwise, the properties of the mesh are the same as any other meshes.

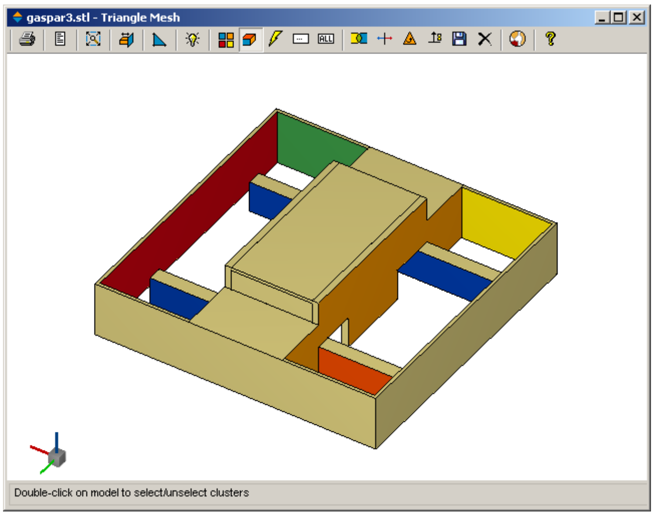


On the figure below, we compare the energy received by the same solar panel at three different positions (in the middle of the garden and near the house).

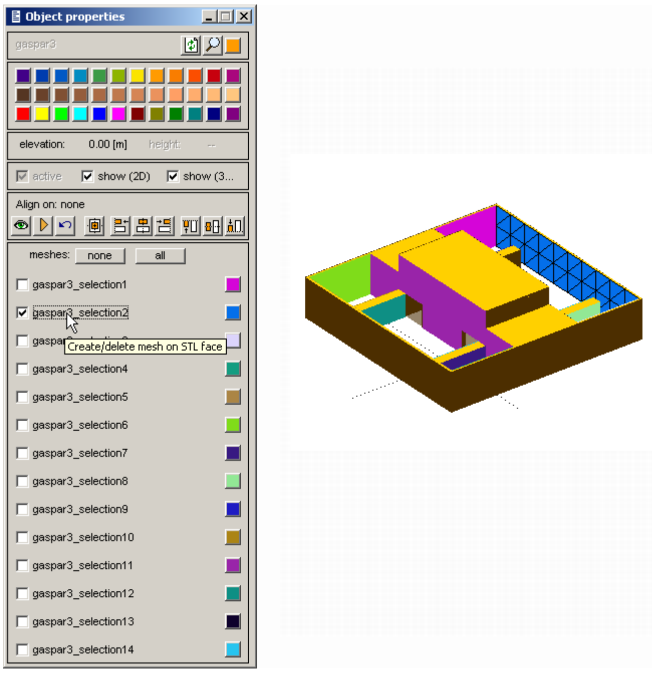


Meshes on STL surfaces

When you import an STL model within Heliodon, you can select plane surfaces (geometric features). The example below illustrates the model of a house on which we have selected several plane surfaces (colored surfaces).



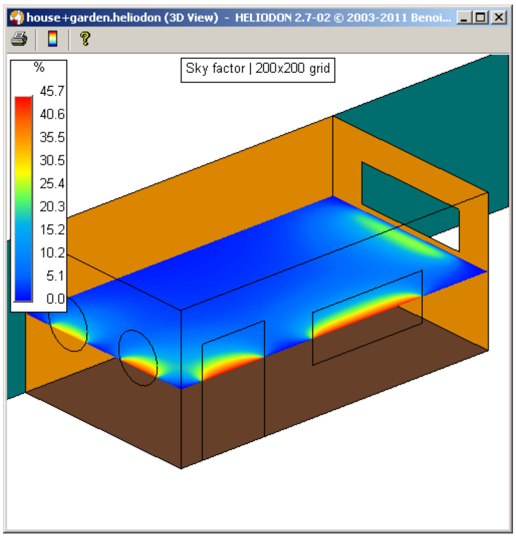
Once you turn back in Heliodon main window and you select the STL model, the properties dialog box looks like below. You may select the surfaces one by one (or all at a time) and create a mesh on them.



Checking the second surface ("gaspar3_selection2", the light blue one), we create a mesh on the blue surface. After the mesh is created, you can modify its parameters as usual.

Independent meshes

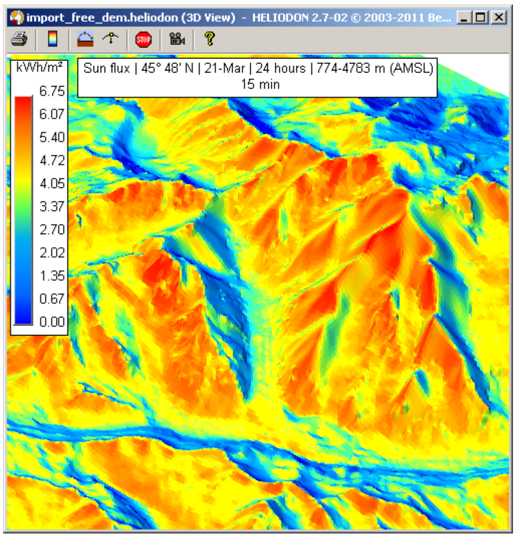
Rather than creating a mesh on an object, you may create an independant mesh, horizontal or vertical. You have to create the mesh just as you can create an horizontal or a vertical panel. One the mesh is created, go to the properties dialog and modify its parameters as usual. The example below shows an horizontal mesh that measures the sky factor (sky openings) at 1.5 meters from the ground.



Unlike meshes on real objects, you may modify independant meshes like moving, lifting, ... From a physical point of view, independant meshes, that we also call *virtual meshes*, are different from the object meshes (see next section below).

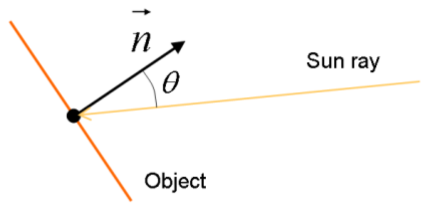
Terrain mesh

Finally, the terrain may also be colored with a map representing the variation of a given quantity. So far, it is only possible to color the terrain with sunlight time or solar energy (under the stereographic projection). The figure below illustrates the zone of the Mont Blanc colored with the received solar energy. To calculate the map on the terrain, use the F11 key.

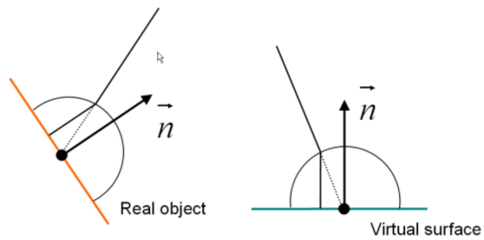


Real or virtual meshes

As shown above, there is a great difference between meshes on real objetcs and independant meshes: meshes on real objects take into account the direction normal to the object. This means that, when we compute for example the solar energy, the direction of the sun rays with respect to the direction perpendicular to the object surface (we simply call it the surface normal) influences the amount of energy received by the surface. The law is in cos( ) where is the angle between the normal to the surface and the ray direction. A virtual mesh receives energy regardless the direction the rays come from.



Similarly, when we compute sunlight time, the sun is only visible from one side of the surface mesh while, for an independant mesh, it is visible from both side. Finally, for sky factors and view factors, the projection is made on the surface plane for a surface mesh while it is always made on a virtual horizontal surface for independant meshes, as shown below in the case of the orthographic projection (view factor).



To sum up, *the real meshes, for which the normal is accounted for*, are:

- Mesh on horizontal panel
- Mesh on vertical panel
- Solar panel
- Mesh on STL surface
- Mesh on terrain

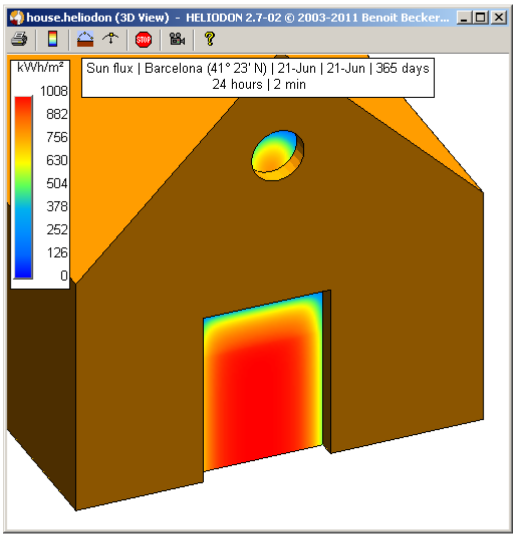
while *the virtual meshes, for which the normal has no effect*, are:

- Horizontal mesh
- Vertical mesh

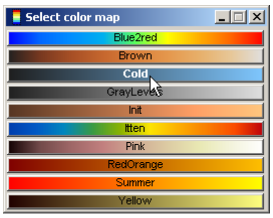
Manage colormaps

Colormaps

Colored maps are widely used in Heliodon to display various results (sunlight time, solar energy, sky factor, ...). Most of the results are displayed on meshes that lie on the objects of the scene. To show the variation of a quantity (energy, time, ...), the mesh is colored according to the the value of the quantity. Figure below illustrates the energy received on the door and the circular window during the entire year in Barcelona.



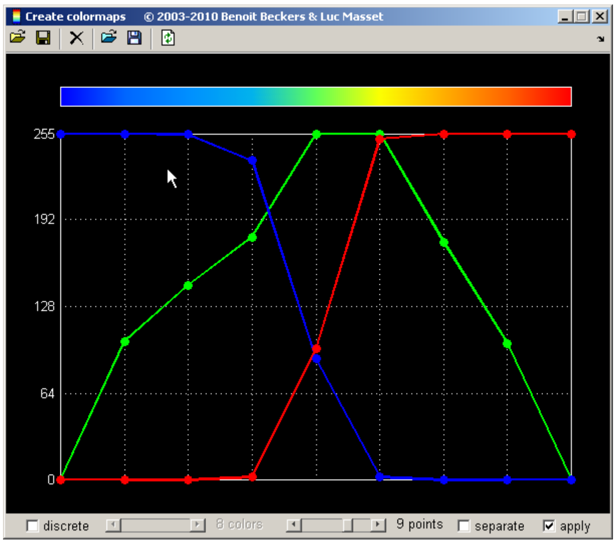
In the above example, the colormap is composed of colors going from blue (lowest values) to red (highest values) passing by green, yellow and orange colors (for average values). This blue to red colormap is the most used in scientific vizualisation but you may need to use different colormaps according to your specific needs. In Heliodon, you have several predefined colormaps. Use the F5 key whenever you want to choose another colormap. The following window appears.



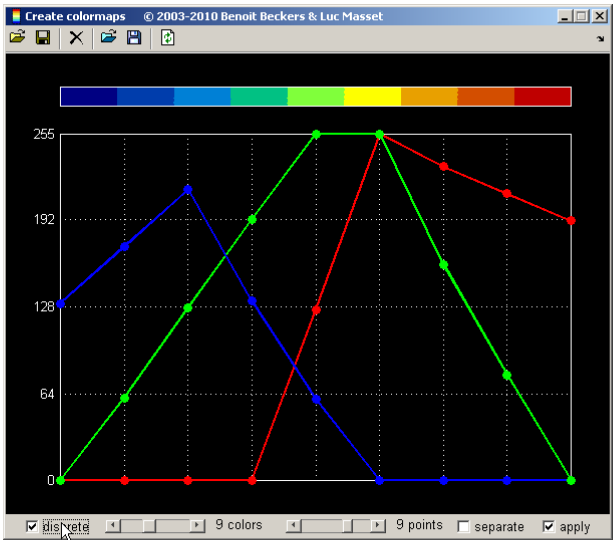
Click on a button to select the corresponding colormap. You may call the colormap selector from any Heliodon window where there are colored maps. Note that the choice of a colormap is not permanent, except in the main Heliodon window.

Create a colormap

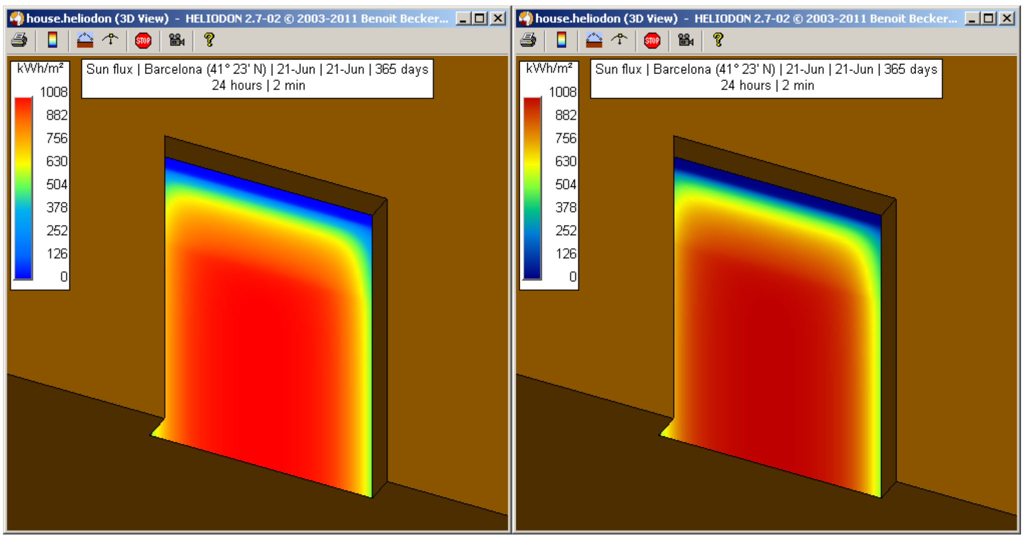
To create your own colormap, click on the button. The following window appears. The current colormap is displayed in the form of three color channels: the red, the green and the blue channels. You may change the colors of the colormap by changing the color components (R, G and B) at the control points (9 points in this case).



For example, we will change the colors to have a smaller blue region and darker extreme blue and red colors. You may check the "discrete" button to see 9 distinct colors (in fact colors of the control points).

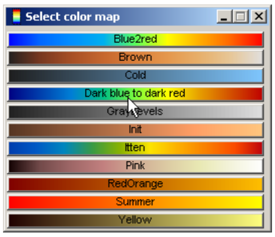


The changes made at the colormap are applied directly to the Heliodon window as illustrated on figure below (original colormap on the left, modified one on the right).

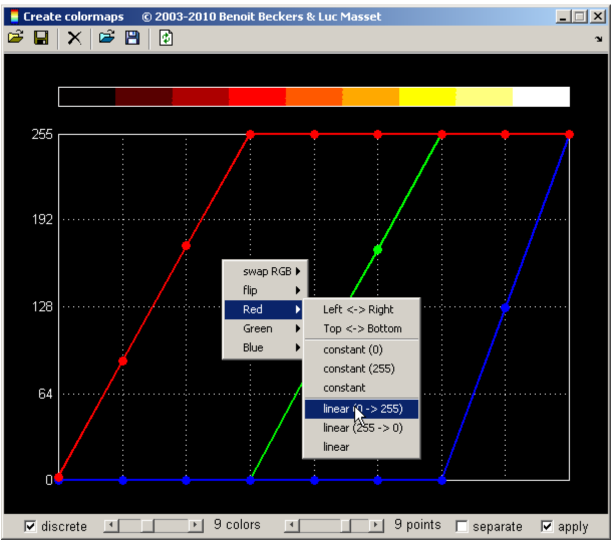


At this point, this new colormap will only be accessible for the Heliodon model you are working on. If you want to reuse this colormap subsequently, you have to save it.

The new colormap is now saved in the Heliodon library under "Dark blue to dark red". You can now use it whenever you want.



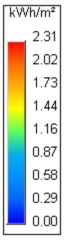
When you want to create a new colormap, you may either start from the one you are currently using or load a colormap from the Heliodon library or import a standard colormap (use the button). To set the color components, you may also use the menu (right click within the window).



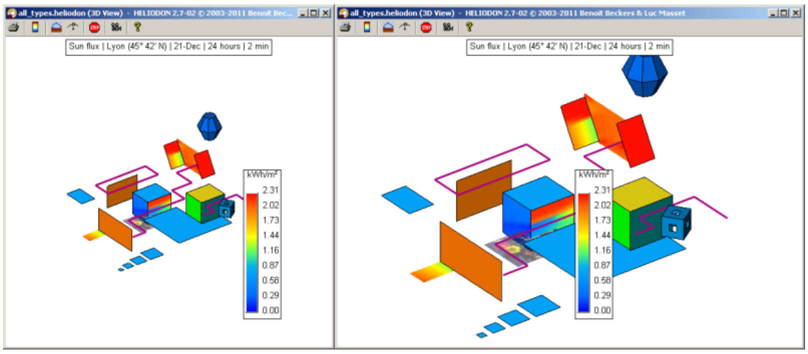
Left click within the horizontal colorbar to get the information on a given color, i.e. its RGB components as well as it HSV components (Hue, Saturation and Value) as illustrated below.

Colorbar

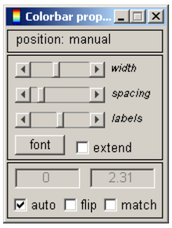
When one or more colored maps are displayed (3D window, isochrone view), a colorbar is also drawn to indicate the correspondence between colors and values and to show the units of the results.



The colorbar may be moved: click on the colorbar with the left mouse button, keep button pressed, drag the colorbar to the proper position, release button. Note that, doing this, the colorbar has an absolute position from the bottom left corner of the window. If you resize the window, the absolute position is kept so the position is not good any more as illustrated below (setting colorbar position on the left, resizing window on the right). A better way is to set a predefined position (see below).



You may set several parameters of the colorbar by left clicking on it. This brings up a dialog box next to the window.

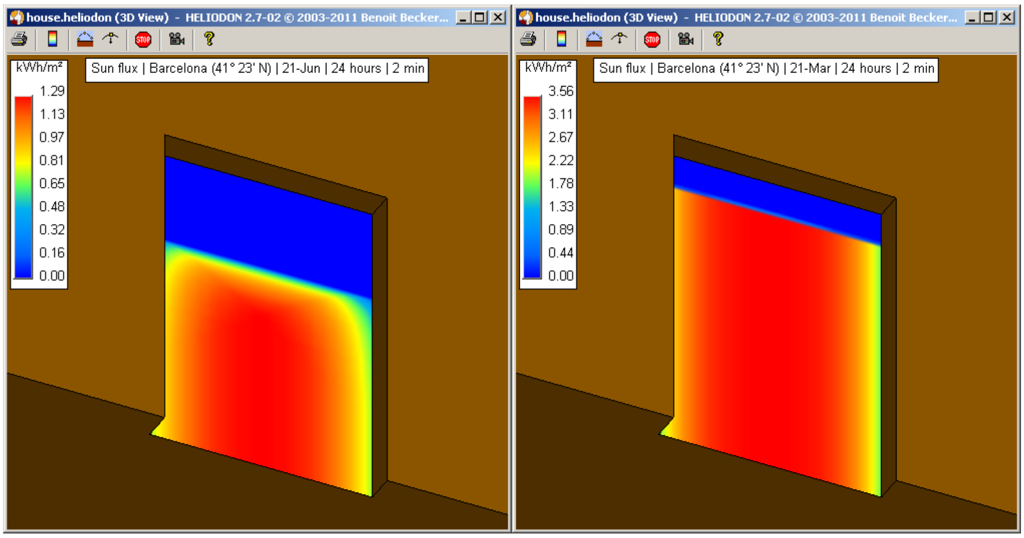


Below are the main parameters of the colorbar.

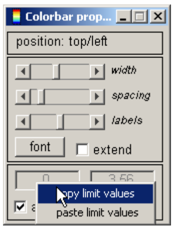
- **Position**: manual or predefined (right-click to display the menu)
- **Spacing**: space between the labels
- **Labels**: number of labels to display
- **Font**: set the labels and title font (size, bold, ...)
- **Extend**: check this to force the colorbar to take entire window's height
- **Auto**: set the min and max values automatically or set them by filling the fields above
- **Flip**: flip colormap (from blue to red becomes from red to blue)
- **Match**: display a number of unique colors equal to the number of labels minus one

Color limits

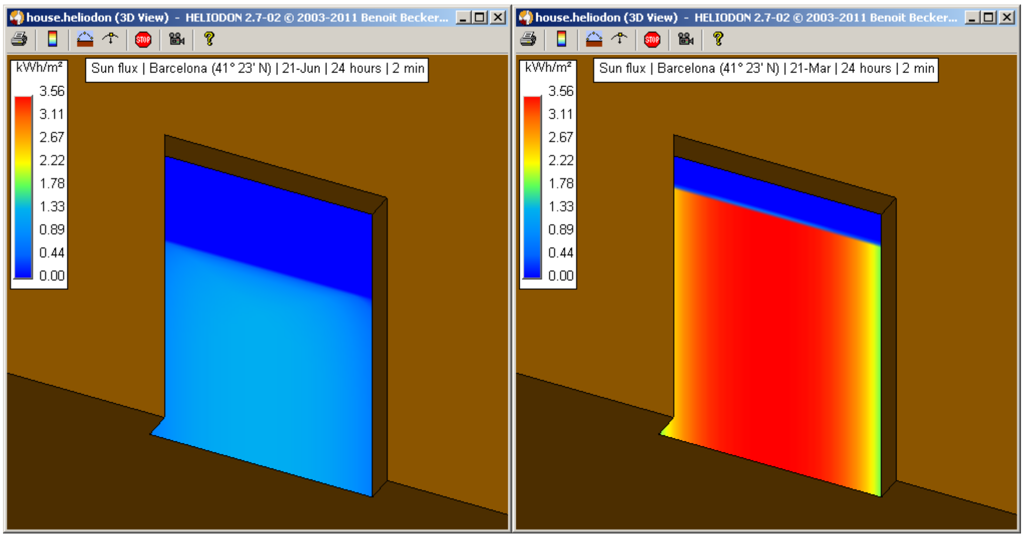
In auto mode, the program sets the min and max values according to the computated results (i.e. the min and max values of the results). Usually, you don't have to change this setting but, in some situation, you may have to set them manually. For example, if you want to compare two results. In the two figures below, we have computed the energy received on the door respectively on summer solstice (June 21st) and spring equinox (March 21st) at Barcelona. The colormap used is the same, so you have the red color corresponding to 1.29 kWh/m² at summer solstice and 3.56 kWh/m² for the equinox. This is due to the fact that the sun rays are more perpendicular to the door for the equinox than for the summer solstice.



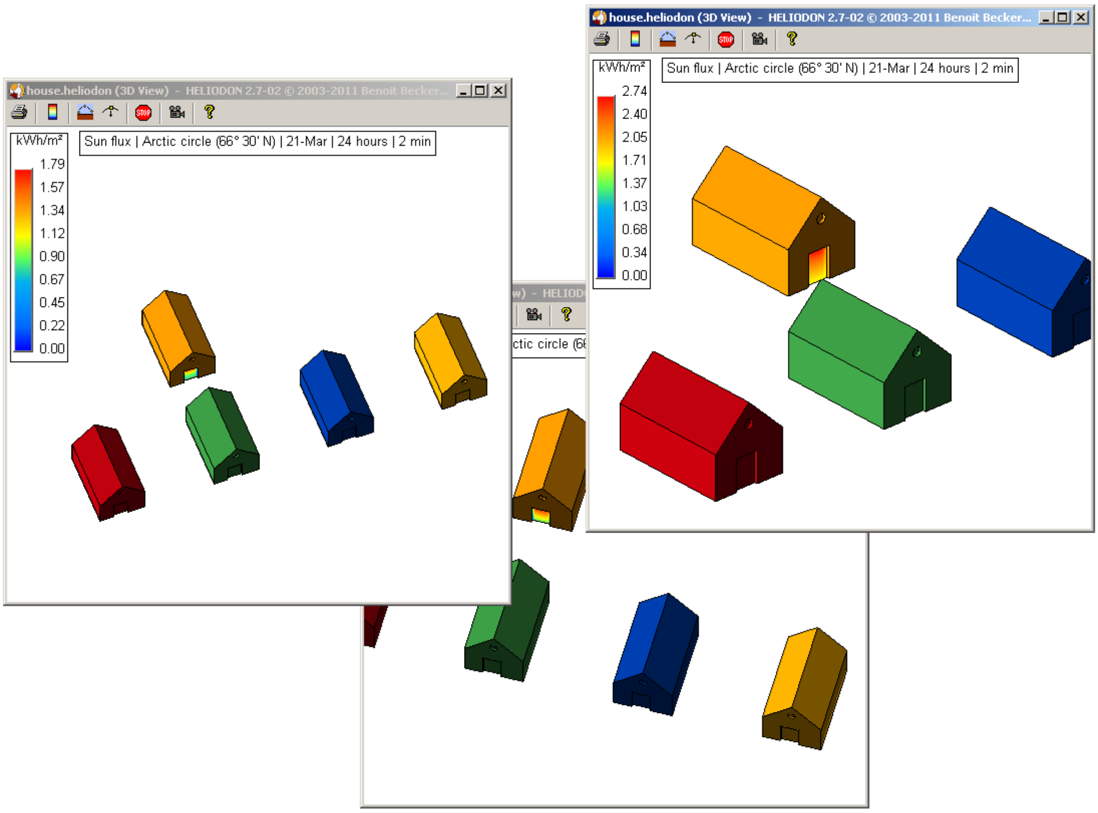
To be able to compare more easily, you can copy the limit values from the equinox case with a right click on the min or max fields as illustrated below.



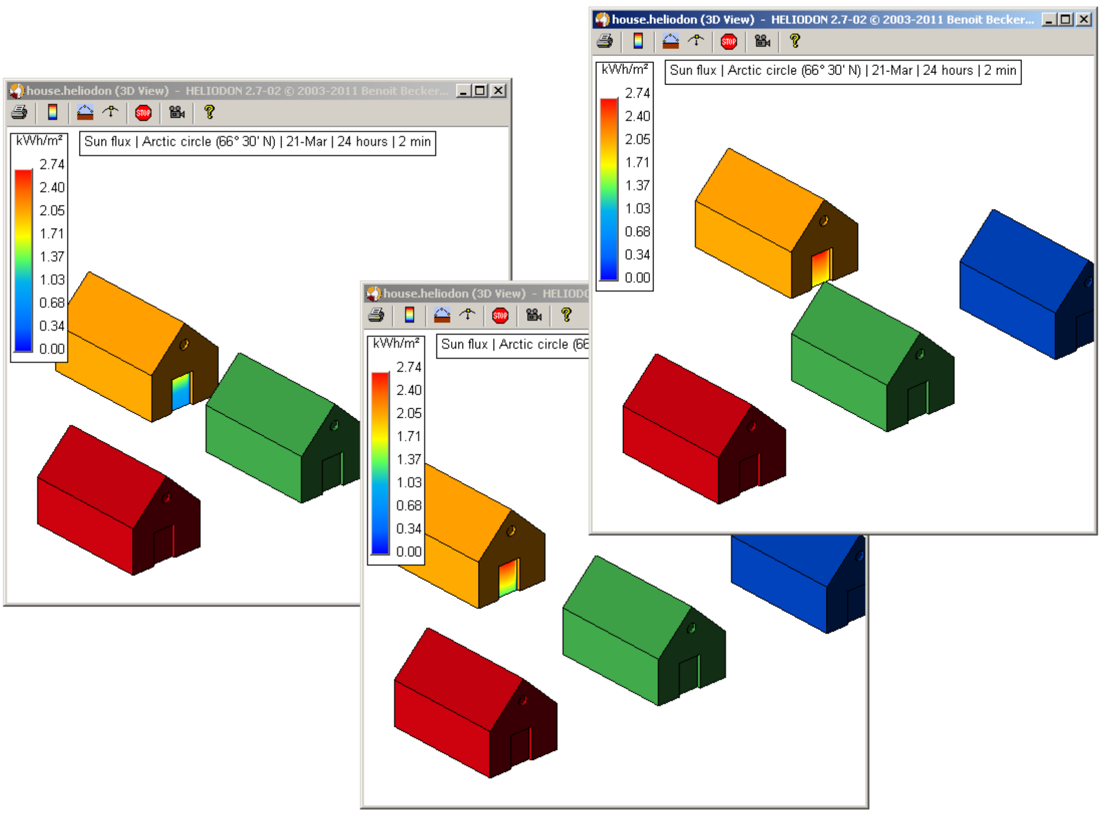
Then you open the colorbar properties of the solstice case and you paste the values. This sets the same limits for both case so that the results of the solstice case remain in the blue colors.



For the 3D windows only, another way to set automatically the color limits is to use the F4 key. Let us suppose we have computed the solar energy for several configurations: the position of the orange house has changed between the three studied cases (see below).

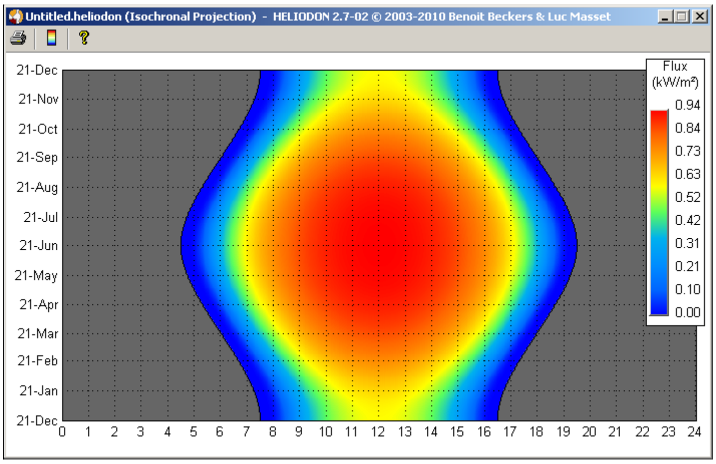


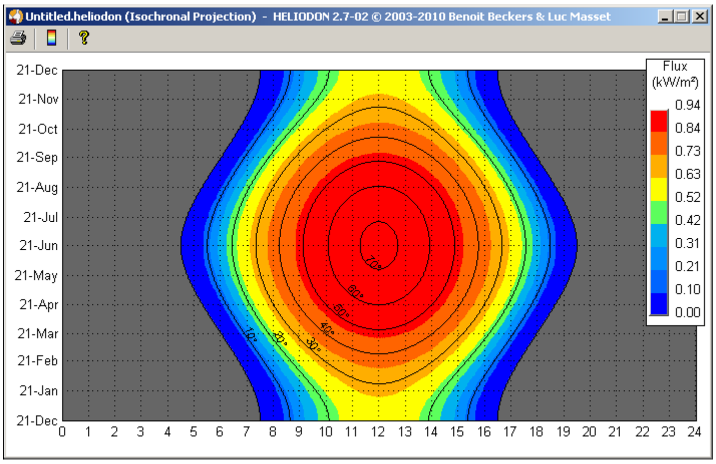
We must select one case as reference (the 3D window corresponding to the highest values for example, the case on the right) and push the F4 key. All the opened 3D windows will be forced the same limits values as the reference case. Here, not only the limit values are copied but also the colormap and the view itself (camera position, camera target and zoom level) are copied. This allows a very easy comparison of several cases.



Match colors

By default, Heliodon uses a continuous colormap (i.e. a colormap of 256 colors). If you want the variations within the map to be more clearly marked, you may check the "match" parameter. In this case, the map is colored with a colormap with fewer colors, the number of which is the number of labels of the colorbar minus one. The figures below show the solar flux along the entire year in Barcelone with an isochrone projection. You can see the difference between a continuous colormap and a "matched" colormap (with 9 colors, 10 labels in the colorbar).

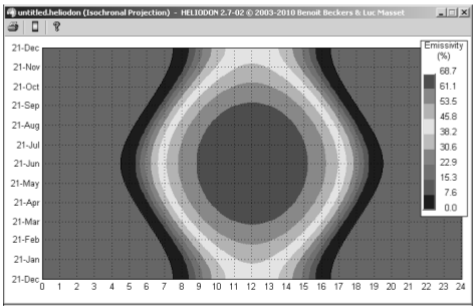


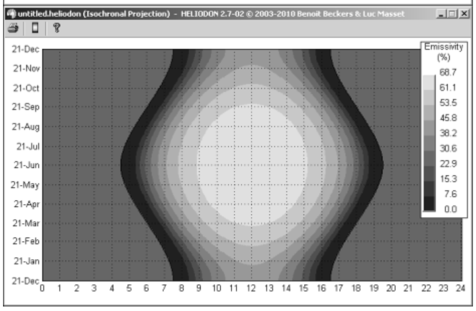


Note that, when we use a matched colormap, the limits between the different colors highlit contour corresponding to isovalues of the quantity displayed (here the solar flux). On this particular projection, we may also notice that the curves indicating the sun height (in degrees) are similar to the contours of the solar flux.

Remarks

- Using a matched colormap implies that the renderer of the window is Z-buffer, which is slower than the default renderer OpenGL.
- Colors you see on the screen look sometimes very different that the ones you obtain with a color printer. You may need to modifiy some colormaps to fit you printed works.
- The GrayLevels colormap is adapted when you want to print Heliodon results in black and white. Otherwise, dark colors (red and blue colors in case of the blue to red colormap) will look the same (almost black) on the final result as illustrated below.


untitled.heliodon (Isochronal Projection) - HELIODON 2.7-02 © 2003-2010 Benoit Beckers & Luc Masset
Emissivity (%)
68.7
61.1
53.5
45.8
38.2
30.6
22.9
15.3
7.6
0.0
21-Dec
21-Nov
21-Oct
21-Sep
21-Aug
21-Jul
21-Jun
21-May
21-Apr
21-Mar
21-Feb
21-Jan
21-Dec
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24


untitled.heliodon (Isochronal Projection) - HELIODON 2.7-02 © 2003-2010 Benoit Beckers & Luc Masset
Emissivity (%)
68.7
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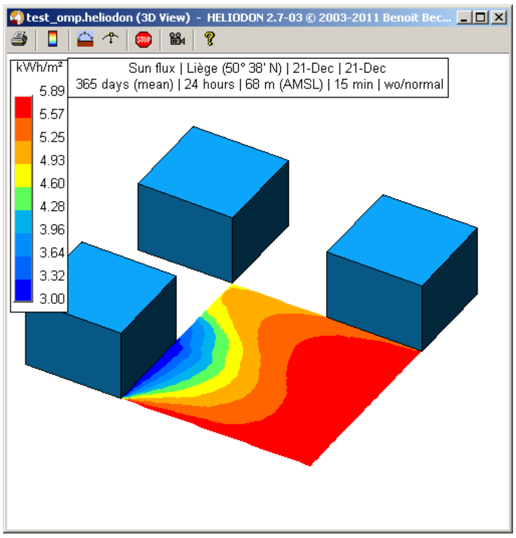
22.9
15.3
7.6
0.0
21-Dec
21-Nov
21-Oct
21-Sep
21-Aug
21-Jul
21-Jun
21-May
21-Apr
21-Mar
21-Feb
21-Jan
21-Dec
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24

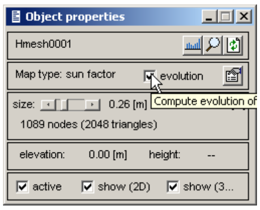
Time evolution

Setting

When a colored map is produced (sunlight or solar energy), the global result, i.e. over the period of study, is displayed at each node of the map allowing to see the differences at different locations.



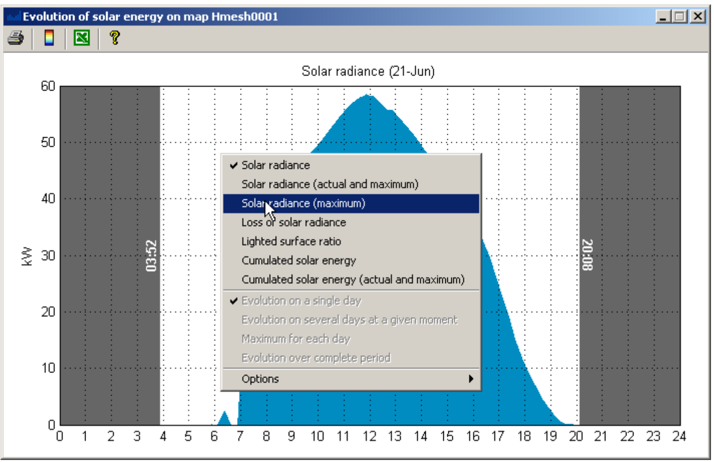
With this type of drawing, one cannot see the evolution of the result with time along the day or with the date along the year. In the properties dialog box of all types of meshes, you can check the "evolution" field.



Now when you update the colored map (key "F9" or refresh button), the global results are computed and displayed as usual but results in function of time are also computed. To display these new results, use the chart button). Note that, when you choose to compute the time evolution, the computation time increases.

One-day period

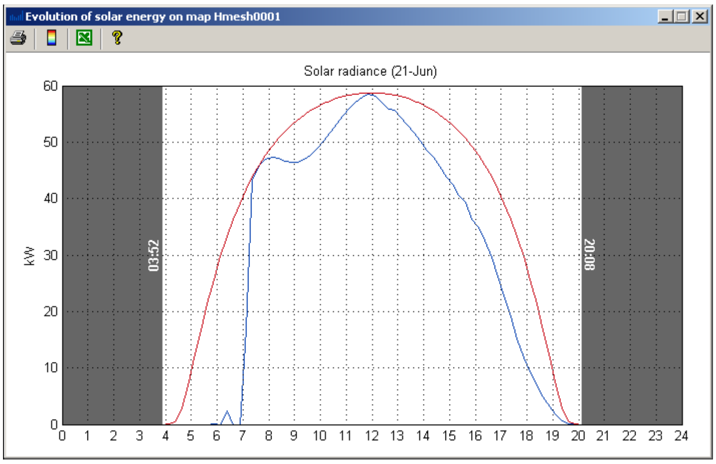
Several results are available depending on the study period you set. Let us start with a one-day period. In this case, you can only check the evolution of results in function of time over a day. When you press the chart button , the window below appears.



The graphic shows the evolution of the result with time (from 0:00 to 24:00). The night is represented as two grayed zones. Sunrise and sunset hours are displayed respectively on the left and on the right. A right-click within the window (except on the curves) brings up the menu. At the end are the display options.

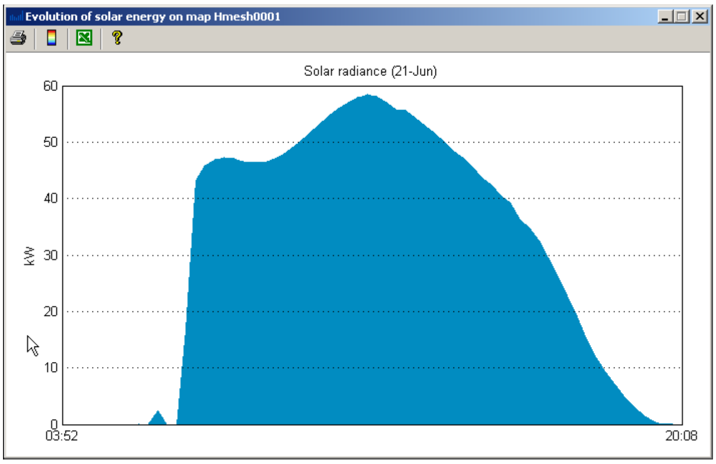
Curve type

You may choose between solid curves (as figure above) or curves (illustrated below).



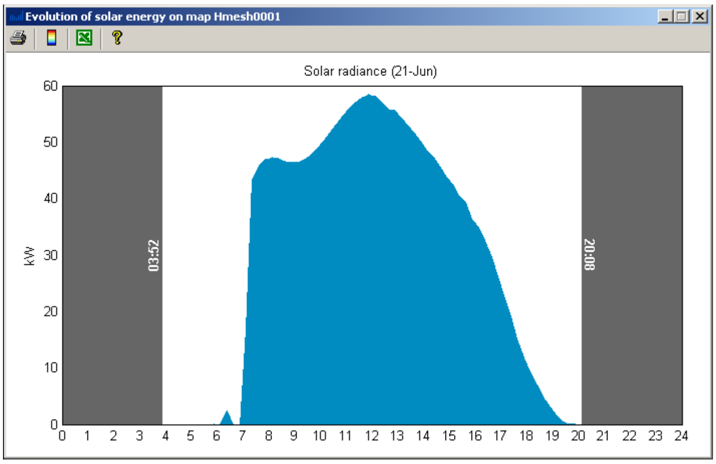
Night

You may choose either to display the night (between 0:00 and 24:00) or to display only the day (between sunrise and sunset). Note that, in this case, the scale of the graphic will change when passing from one day to the next one since the day duration changes.



Grid

You may choose to display the grid or not.

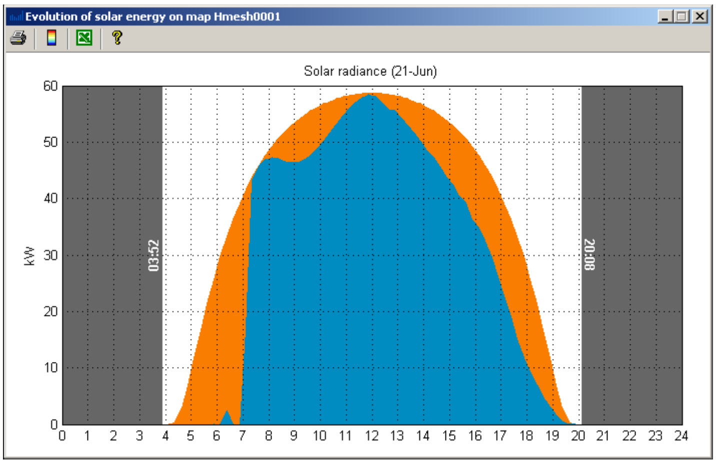


Solar radiance

The solar radiance is the energy received by the mesh (in kW). It takes into account the obstruction of the masks (other objects, terrain).

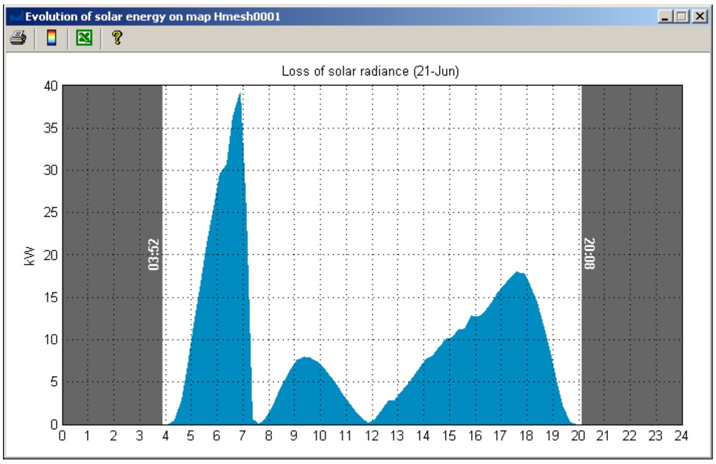
Maximum solar radiance

The maximum solar radiance is the theoretical energy received by the mesh (in kW), i.e. without any masks. You can easily check the moments of the day when the sun is masked and how important the obstruction is.



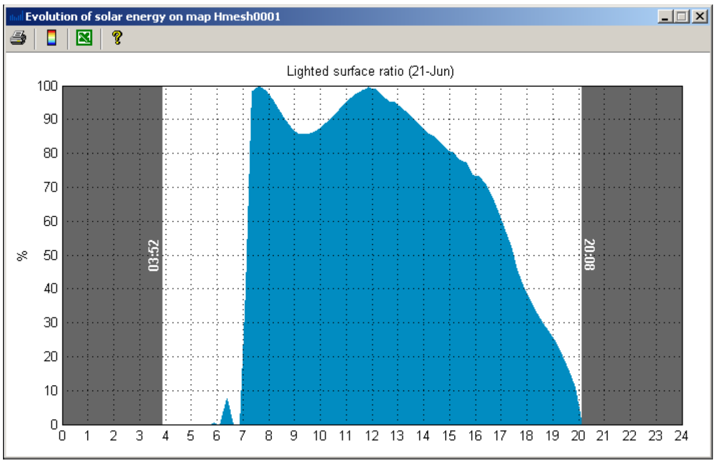
Loss of solar radiance

This is the loss of the energy (in kW) due to the masks.



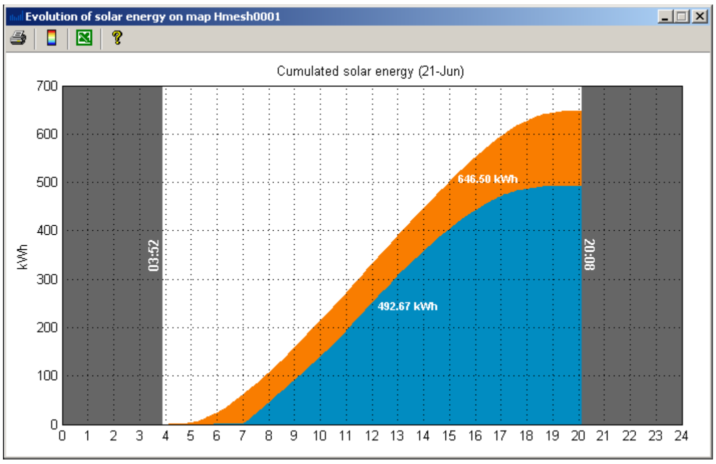
Lighted surface ratio

This graphic shows the ratio of the mesh surface that is hit by the sun rays along the day. This figure is particularly important for photovoltaic panels for which the efficiency greatly decreases when panels are partially shaded.



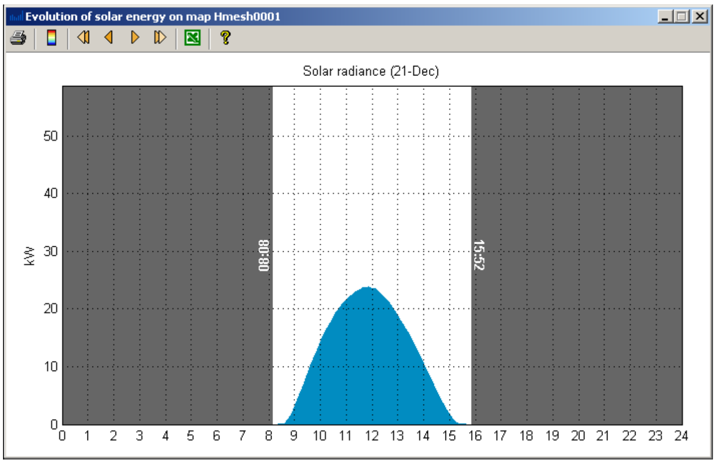
Cumulated solar energy

The cumulated solar energy is the sum of the energy received along the day. On the figure below, both the actual and theoretical cumulated energies are displayed.

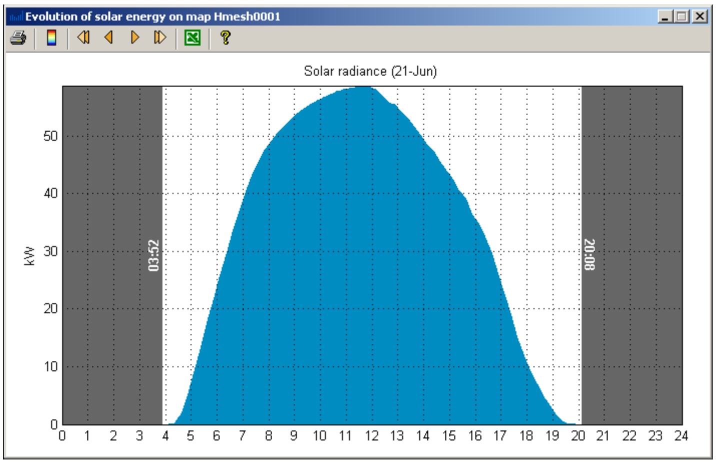


Evolution over several days

When the study period has several days, you may also check the evolution of the results day by day. Select for example the solar radiance. Use the arrow buttons to advance or go back in the dates. You may also press key "space" to go forward and key "backspace" to go backward. You can impose the scale of the drawing to the maximum value over the period (see Options menu) to ease the comparison between different days. The figure below gives the solar radiance on December 21th.



The figure below gives the solar radiance on June 21th.

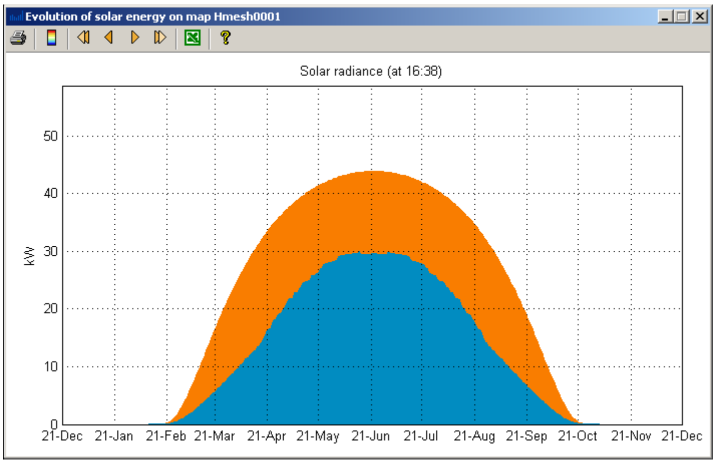


Evolution on a single day

The results are displayed for each day successively.

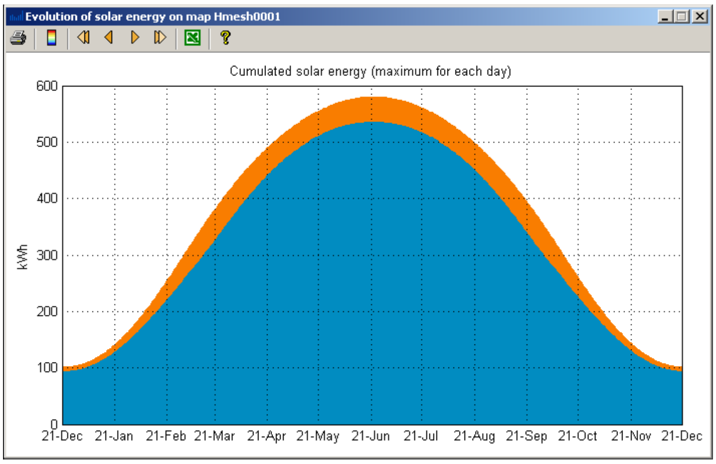
Evolution on several days

The results are displayed on the whole period at a given moment (time) of the day. Also use keys "space" and "backspace" to select the desired time. The figure below illustrates the solar radiance (actual and maximum) at 16:38 along the whole year.



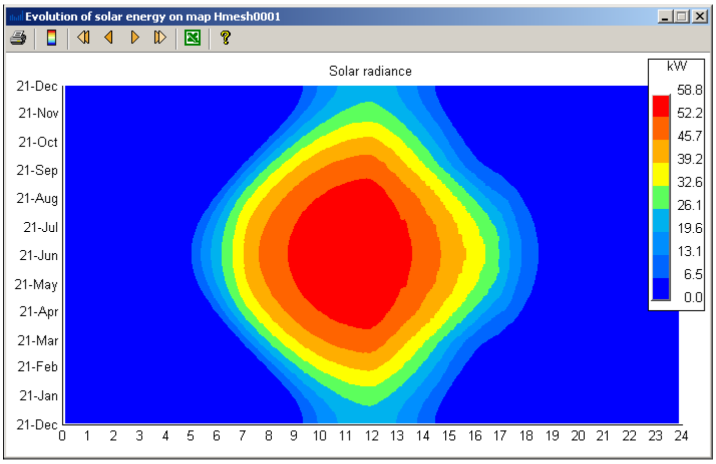
Maximum for each day

This shows the evolution of the maximum of the selected result (radiance, loss, surface ratio) along the year. The figure below illustrates the cumulated energies (actual and maximum).

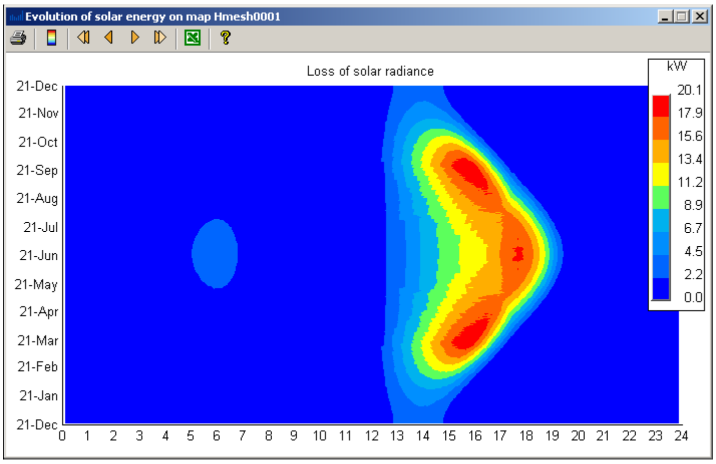


Evolution over complete period

This shows the evolution of selected result (radiance, loss, surface ratio) as a colored map and not a curve, thus in function of the time (abscissae) and date (ordinates). The figure below illustrates the solar radiance. You may notice the distorsions on the right side. They ccorrespond to the loss of received energy that occur during the afternoon.



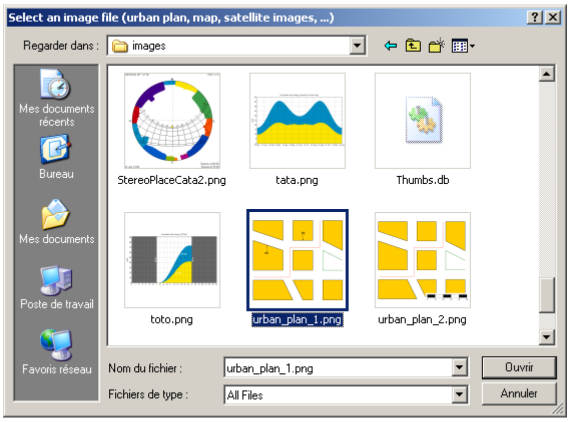
The figure below shows the loss of energy. It is clear that the sun is mostly masked in the afternoon all the year and shortly in the early morning during summer.



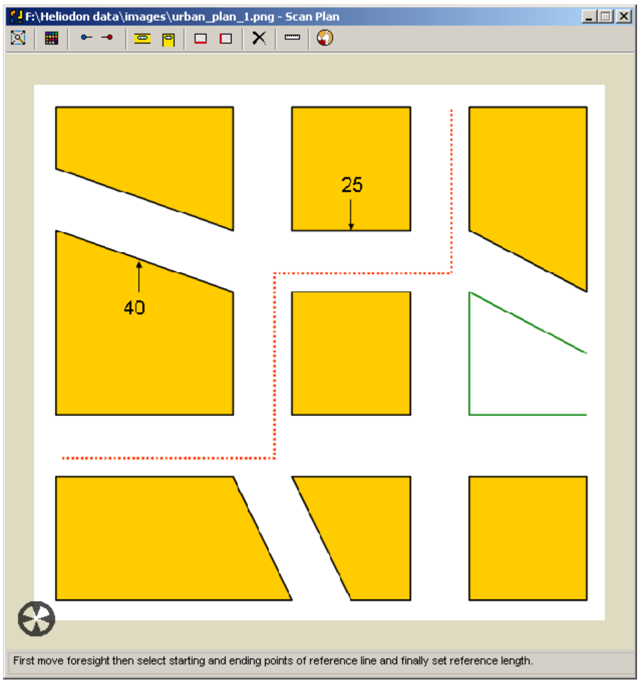
Add an image object

Import an image

In Heliodon, you may insert an image as background. This can be urban plans, satellite images, ... Insert an image using the button of the top toolbar. You will first have to chose the image. Several types of images are allowed (PNG, BMP, TIFF, ...).

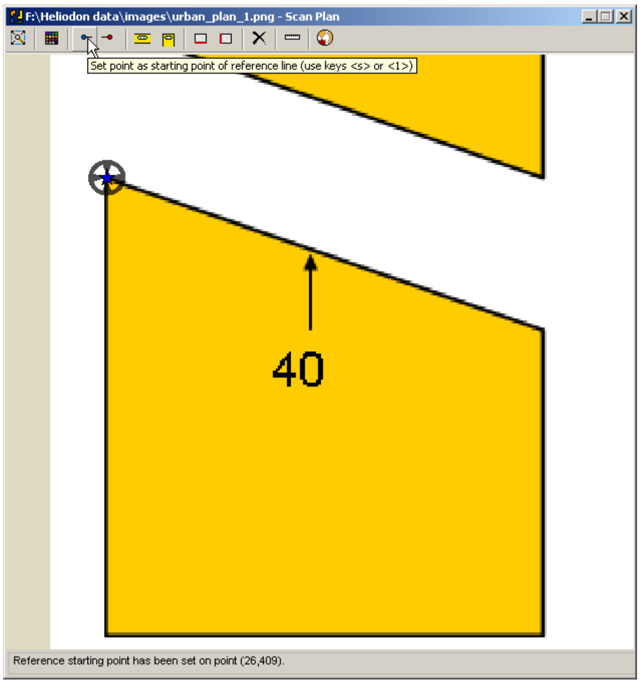


The window below appears.

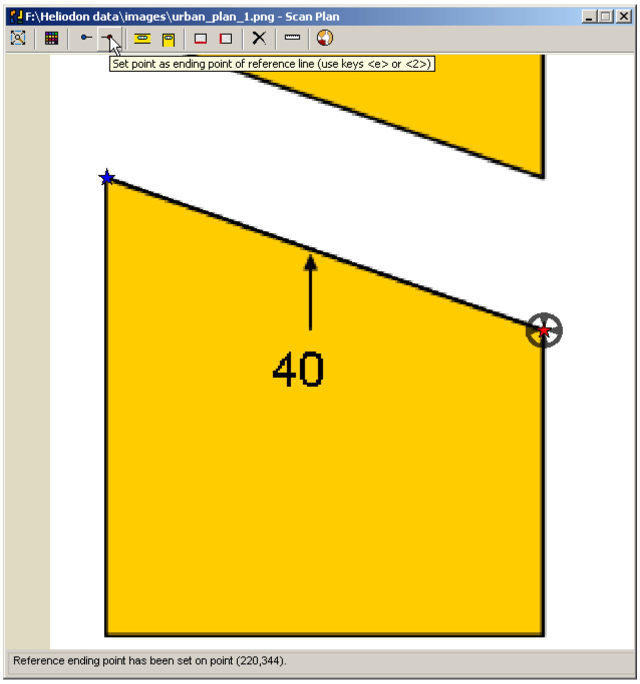


In order to insert an image, you mainly need to set the plan scale, i.e. set the actual length of a reference line chosen on the image. In this window, you may zoom/unzoom using the middle mouse button and move the image with the left mouse button just like in the 2D view of the main Heliodon window.

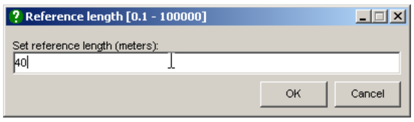
For this example, we have the plan of urban district for which we know the size of several building fronts (one with a 40 meters length and another with a 25 meters length). First, you have to set the starting point of the reference line. Just double-click on the first point of the building front and use the button to set the first point of the reference line (the red star).



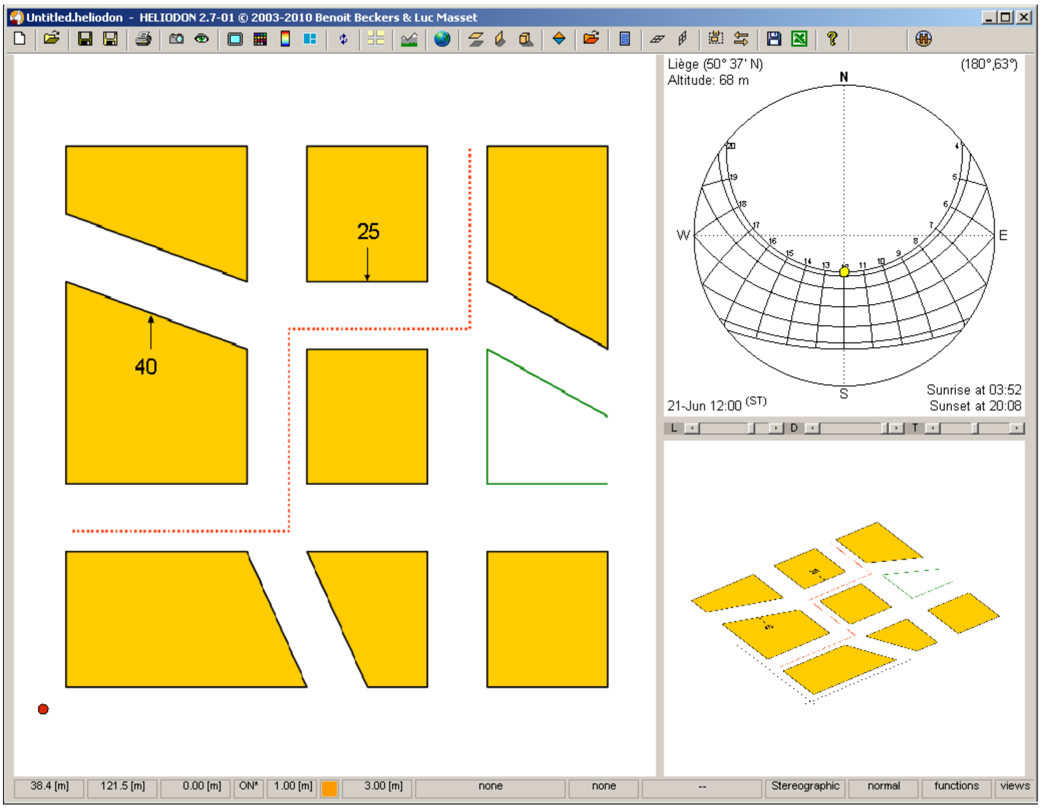
Rather than double-clicking, you may also move the foresight manually. Now you need to set the second point of the reference line. Position the foresight at the end of the building front and use the button to set the reference end point (blue star).



The reference line as well as the foresight are in black color. If you don't see them on the image (for example if the background of the image is also in black), you may change their color with the button . Once the reference line has been chosen, you then have to set its actual length. Use the button and type in its length, 40 meters here.



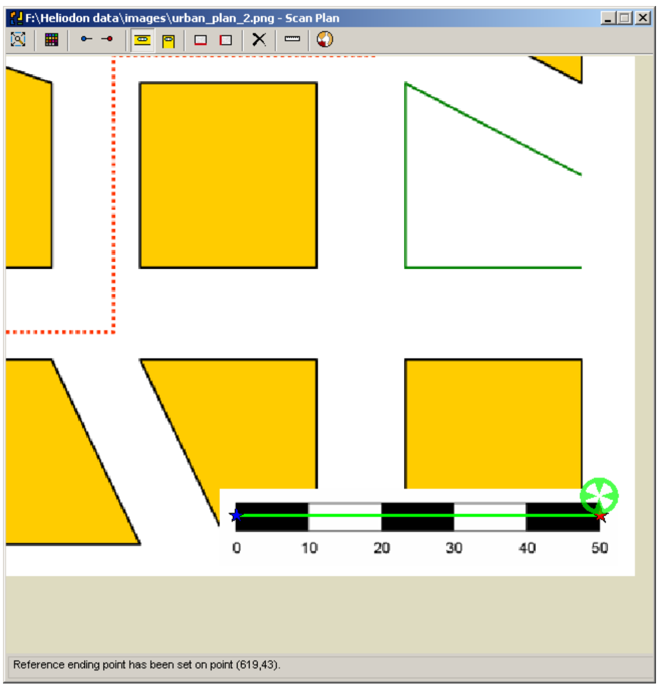
Now you may return to Heliodon main window using the button and the image object is created.



The lower left corner of the image is positioned on (0,0). As for any object, you may translate the image at the desired position. Double-clik on the image to select it and use right mouse button to set its properties (show/hide, transparency).

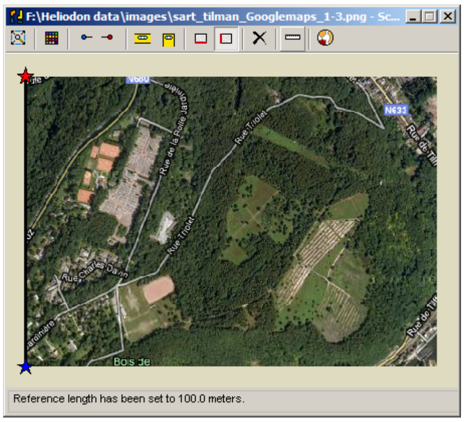
Use the plan scale

Plans often contain a scale. The scale can be used to set the reference length as described below. We use another image of the same plan with a scale drawing. You can force the program to use a horizontal reference line with the button . Now you may select the starting and ending points of the reference line without paying attention to their Y-position. The reference line will always be an horizontal line. Note that if the scale is vertical, you may use the vertical reference button .



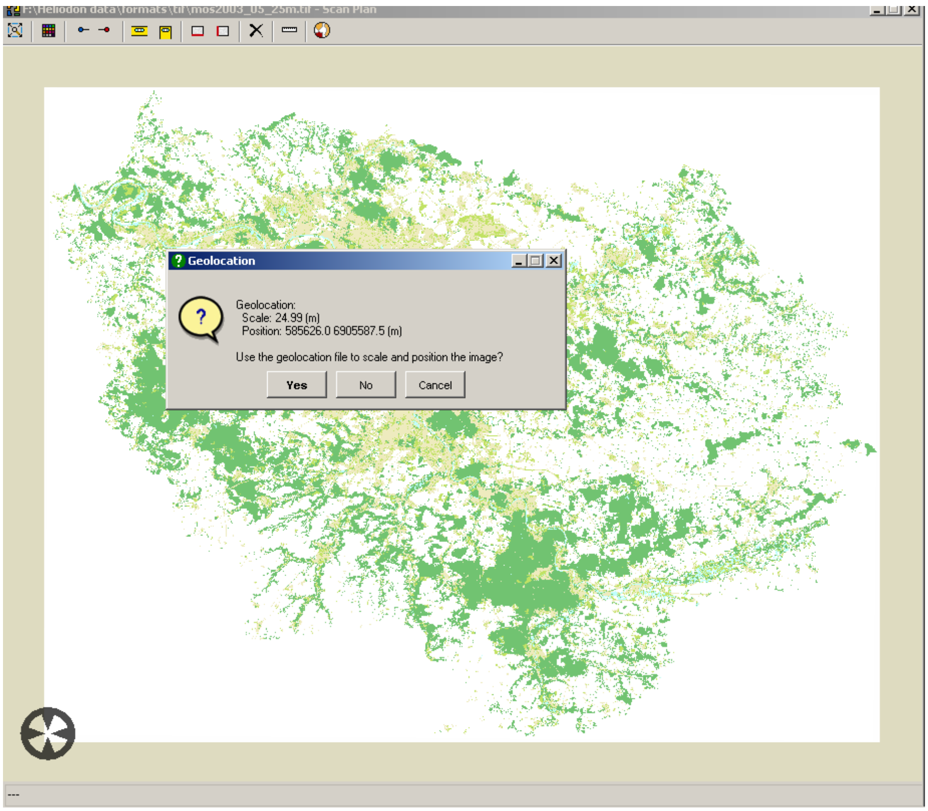
Aerial images

On aerial images, there is not always an object (a bridge, a road, ...) that you may use as reference line, at least for a precise referencing. Instead, you may know the actual length of the lower/upper or left/right border. In this case, just use the buttons ▭ or ▭ to set the corresponding border as the reference line. On the example below (the image is taken from Google Maps), the image size is 450 x 300 pixels. We know that the vertical border corresponds to 100 meters.



Images with geolocation

Images (.tif, .jpg ...) may come with a geolocation file (.tfw, .jgw ...) which gives their position and scaling. Heliodon detects such images and proposes to use the positioning and scaling data of the geolocation file to insert the image at the correct position and with the correct scale.



More information are available here. Examples of geolocation images are available on the Ile-de-France (Paris) website.

Import free DEM

DEM (Digital Elevation Models) covering the entire globe are made available for free by the Consortium for Spatial Information (CGIAR-CSI). You may visit their website. In Heliodon, you may import these DEMs in your model. Read their disclaimer below before using this material.

Legal disclaimer from CGIAR-CSI:

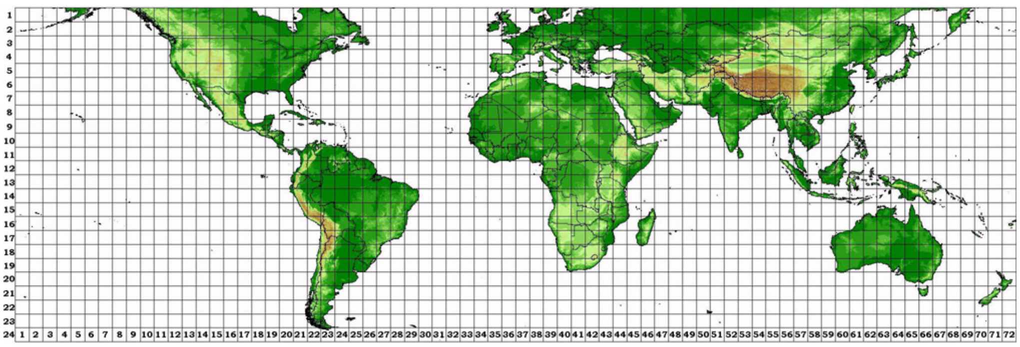
We kindly ask any users to cite this data in any published material produced using this data, and if possible link web pages to the CIAT-CSI SRTM website (http://srtm.csi.cgiar.org).

Citations should be made as follows:

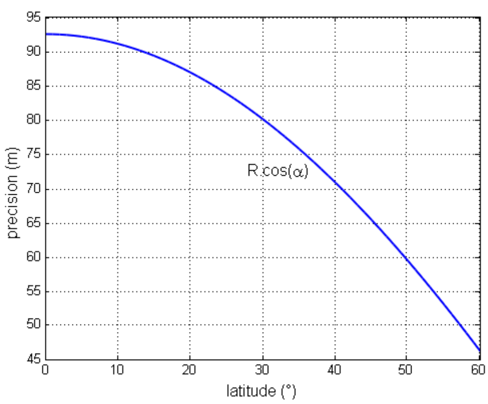
Jarvis A., H.I. Reuter, A. Nelson, E. Guevara, 2008, Hole-filled seamless SRTM data V4, International Centre for Tropical Agriculture (CIAT), available from http://srtm.csi.cgiar.org.

SRTM patches

Free DEMs are available in the form of ARC-ASCII files. Each file contains a patch of 6000x6000 points covering an area of 5x5° in both latitude and longitude. There are 72 patches along the globe (each 5°) and 24 along a meridian (from 60°N to 60°S).

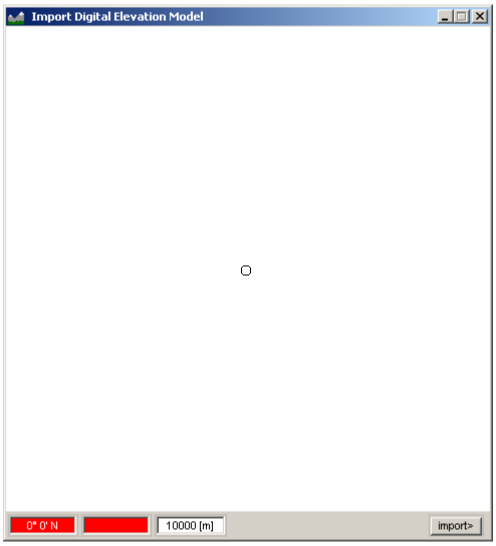


The spatial precision varies with the latitude. The lowest spatial precision is about 90 meters (at equator level) while the highest is about 45 meters (at latitude 60°). Along a meridian, the precision remains equal (90 m). The figure below gives the evolution of the precision with the latitude (with Earth globe considered as a sphere of radius 6,356,752 meters).



Latitude and longitude

First, click on the button . The window below opens.

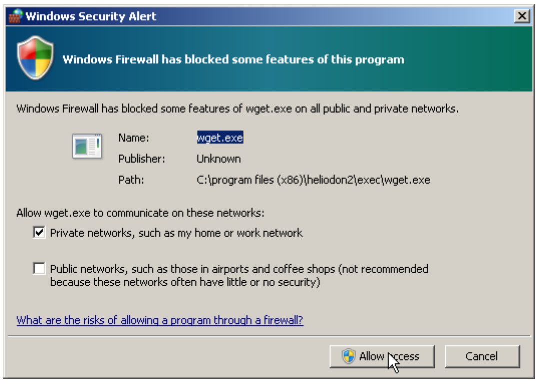


The two bottom fields are filled in red because the latitude/longitude do not corespond to a valid DEM (outside range or inside oceans or seas). You have first to select the latitude and longitude of the point you want to study. Let us chose the Mont Blanc, the highest mountain of Europe, that lies at 45° 50' 1" N and 6° 51' 54" E. Note that you may enter latitude and longitude angles with decimal notation. In this case, East corresponds to a negative value (see figure below).

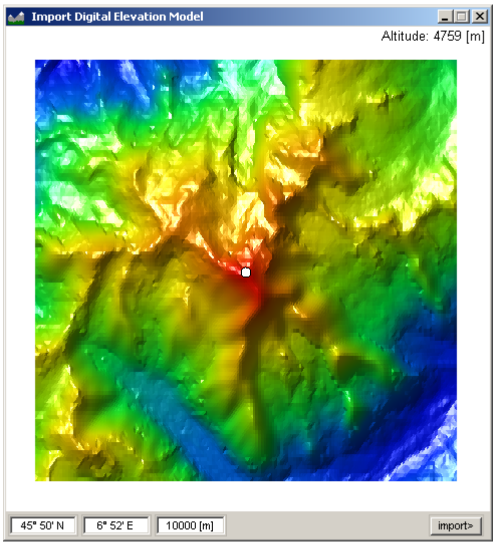
Now the two fields are now colored in white because the coordinates that we have entered correspond to a valid patch. A button is added in the middle of the window to indicate that the file is not downloaded yet.

Download

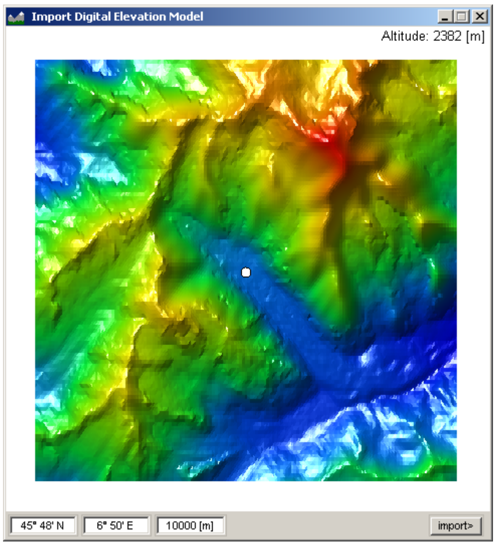
Press the download button to start downloading the file(s) from the net. In case you use a firewall, when you download a patch for the fist time the dialog below brings up.



You need to allow the process wget.exe to connect to the net by clicking the "Allow access" button (see Install/Configure section). After a few seconds (depending on your connection speed), the area of the Mont Blanc is displayed. The colors indicate the altitude (from lowest in blue to highest in red). The center of the area is the white point. Its altitude is indicated in the upper right corner, 4759 meters here. This is lower than the actual Mont Blanc top (4810 m) since the given latitude/longitude do not correspond exactly to the moutain top. The highest point of the patch is 4783 meters. This value is close to the actual top altitude since we have an horizontal precision of about 90 meters.

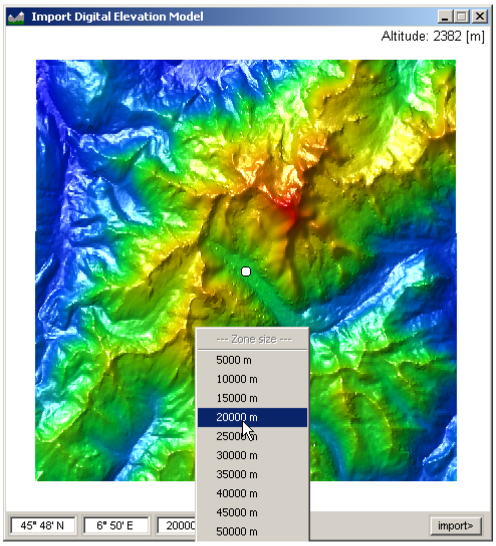


You may left-click on a map point to display its altitude (upper right corner). You may also move the center of the map with a double-click. This way you can "travel" the map in order to select its correct location. Here, we have centered the map on the "Glacier de la Lée Blanche" (altitude 2382 m).



Zone size

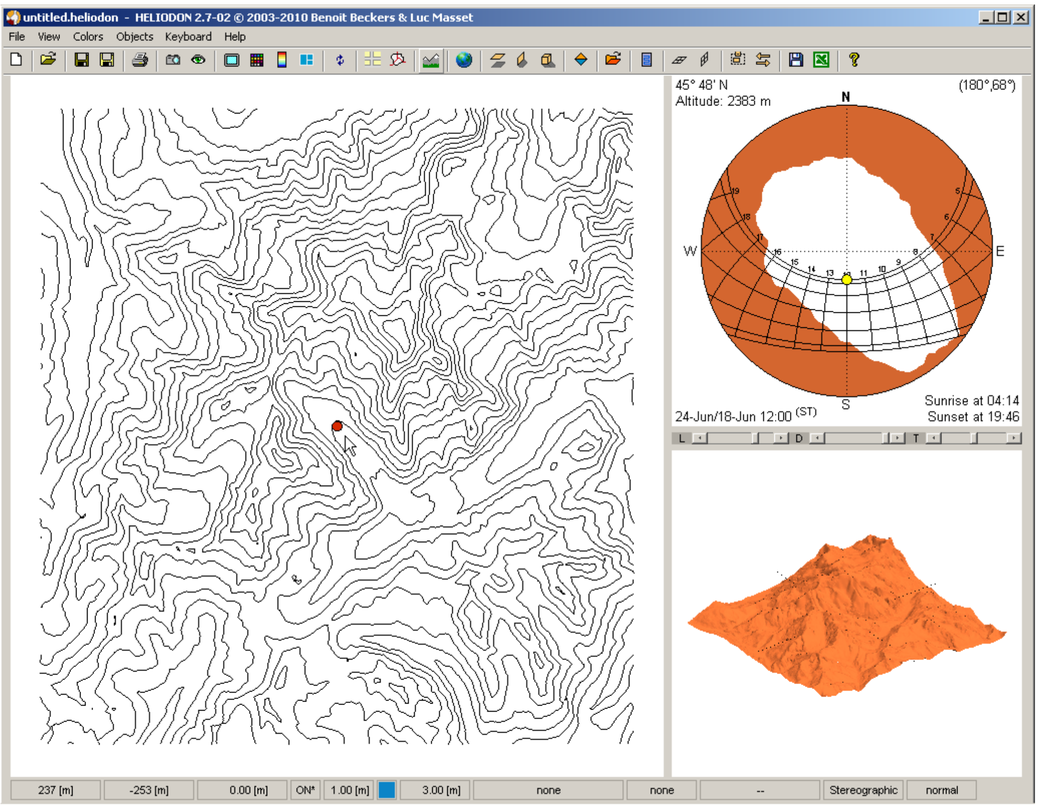
The third field indicates the size of the map. Either enter the desired size or use the menu (right-click on the field). In the example below, we have chosen an area of 20 kilometers wide.



Note that the zone size must be in the range of [2000-50000]. If you set a value outside that range, the closest allowable value is chosen. Also note that, if you select a large zone, the corresponding area may lie on more than a single DEM patch (up to four actually). In this case, Heliodon will have to download the additional patches before displaying the map. The "Download" button appears again. Just click it to proceed.

Import

Click the "Import" button to return to main Heliodon window. The terrain appears in the 3D view (with a uniform color) as well as in the 2D view (in the form of contours). The projection of the terrain is also computed and you may see that, on this glacier, the sun is often masked during the year. On Winter solstice, the daylight is only three hours and a half (from 8:00 to 11:30 approximatively).



Now that you have imported a terrain in Heliodon, you may proceed as usual. The main difference is that the view point always lies on the terrain or at a given altitude. In addition, when you create an object, you can set its vertical position so it lies onto the terrain (see xxx).

Manage views

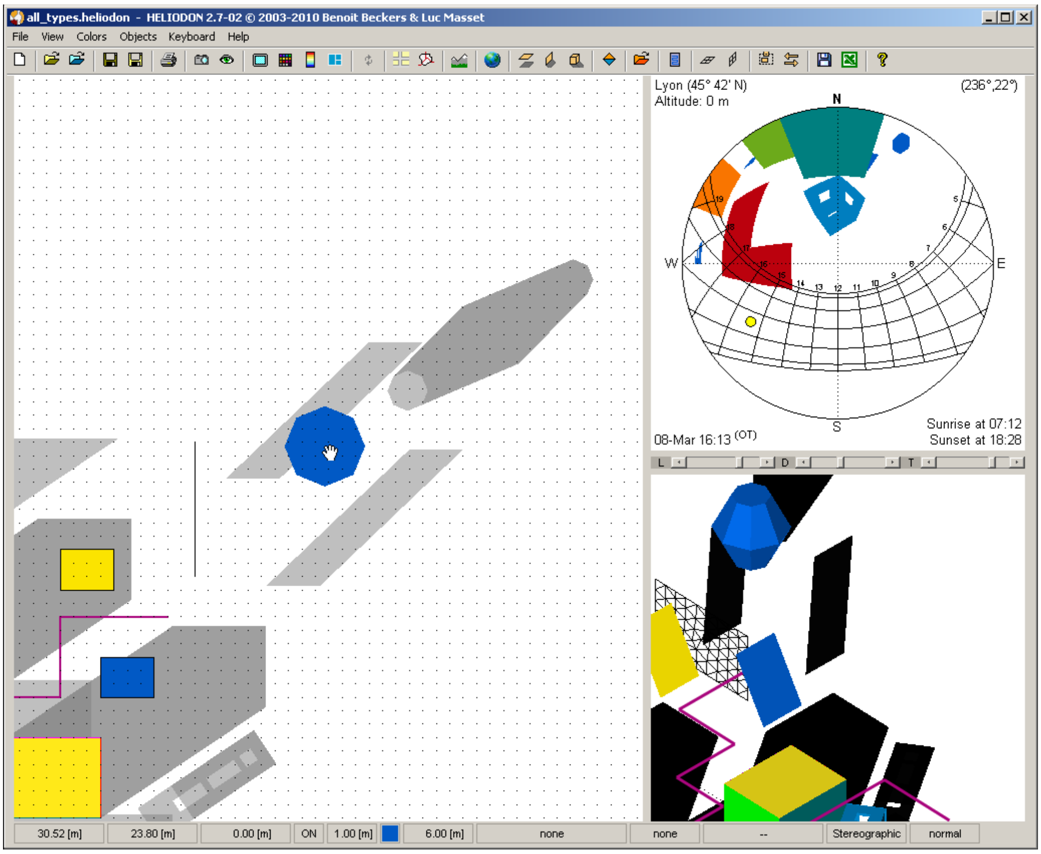
Summary

Key/mouse	Action
Left button	Look at a given point (2D and 3D views)
Middle button	Zoom level (2D and 3D views)
Wheel	Zoom level (2D and 3D views)
Right button	Rotate scene (2D and 3D views)
F1	Load a saved 3D view
F2	Save current 3D view
F3	Load a saved 2D view
F4	Save current 2D view

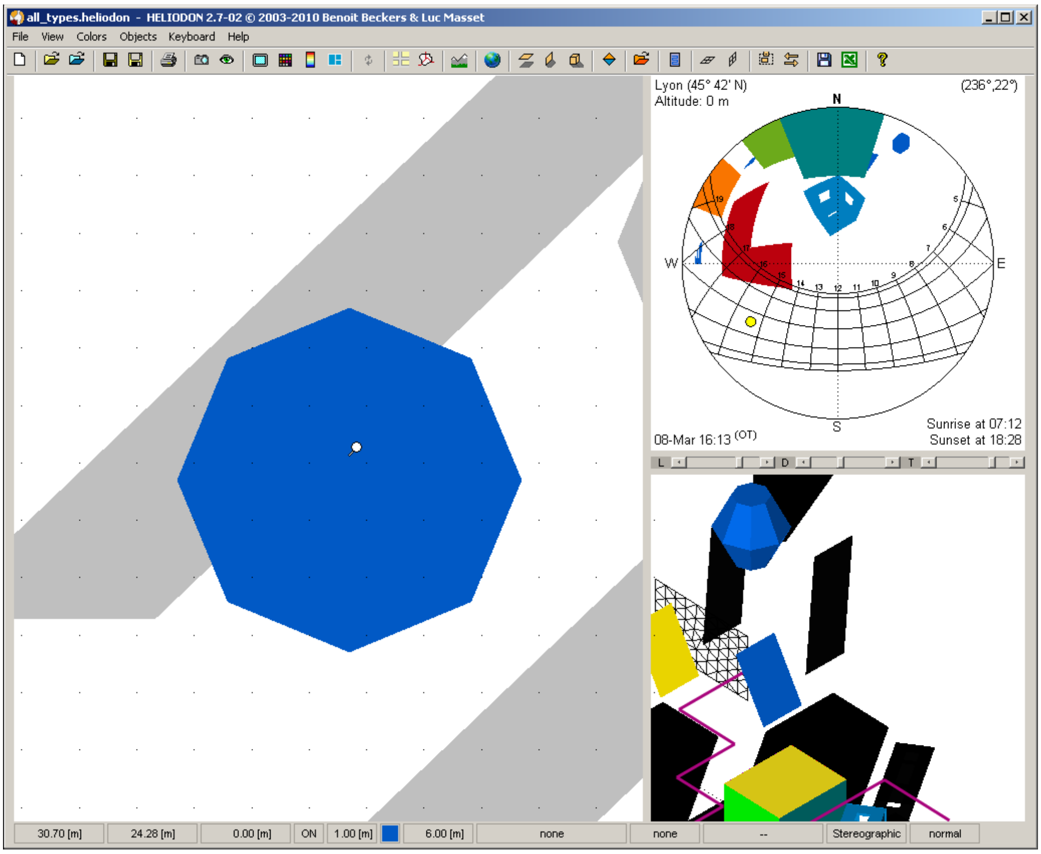
2D view

Adjust the view

The 2D view is a plan view of the scene. The camera always looks downwards. You may only change the camera target, i.e. the point you are looking at, that lies at the center of the 2D view, and the camera zoom level, that controls the portion of the scene you can see. Use the left mouse button to center the view on the desired part of the scene (the blue object in the scene below). Click on the 2D view with the left button, keep it pressed, drag the scene then release the button.



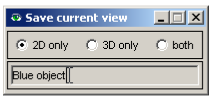
The zoom level is set with the middle button. Again, click on the 2D view with the middle button, keep it pressed, go up to zoom in and down to zoom out then release the button.



You may also set the zoom level with *the mouse wheel*. Roll the wheel towards the screen to zoom in and towards yourself to zoom out. Finally, you may reset the view so that you see all the scene with the "6" key.

Save the view

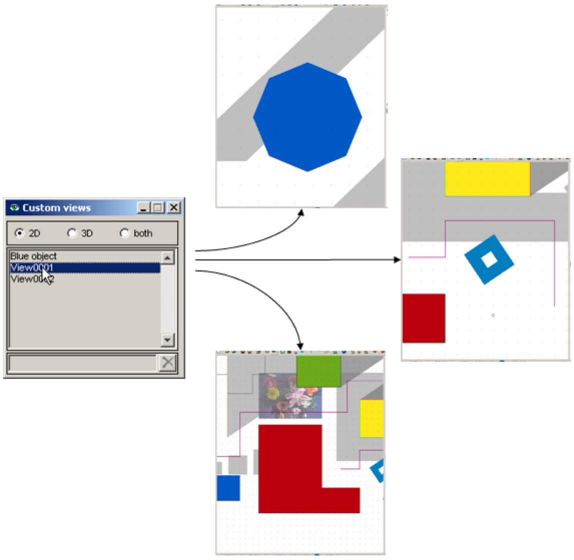
Once the view is set according to your needs, you may save this particular view. The easiest way consists in pressing the F4 key. The view is saved under a generic name (View0001, View0002, ...). Otherwise, you may click on the button. The following dialog box appears.



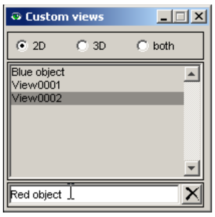
Check "2D only" then enter the name you want to give to this view ("Blue object" in this example) and press Return. Now this particular view is saved. You may save as many views as you want, either with the F4 key or by naming the saved view.

Load a view

The same way you have saved a view, you have two ways for loading one. Either click on the button. The following dialog box appears. Here, we have saved three views ("Blue object", "View0001" and "View0002"). First check "2D" then select one view by clicking its name in the menu.



Note that, if you double click, the name is written in the bottom text field so that you may rename the view as illustrated below. Once you have double clicked, you may also delete the selected view by clicking on the × button.

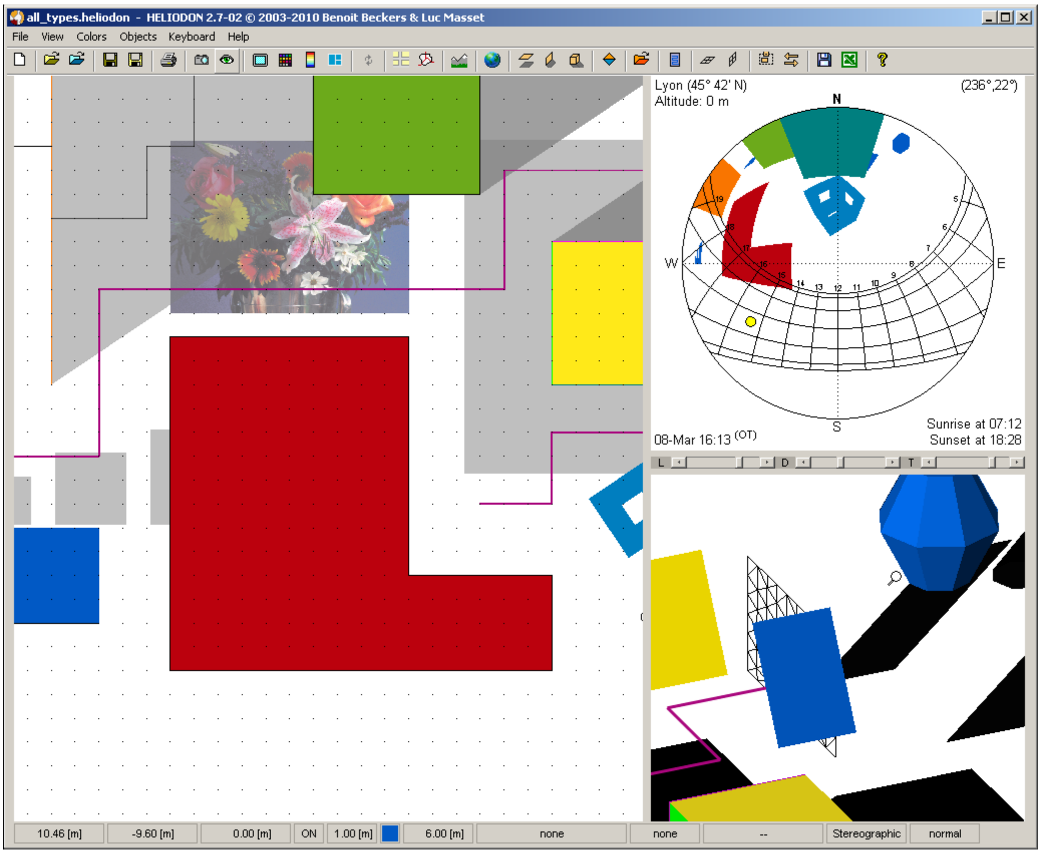


The second and fastest way to change view is to use *the F3 key*. Pressing successively on F3 will load the saved 2D views, one at a time.

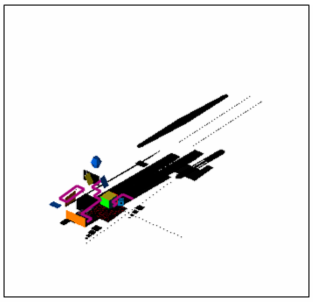
3D view

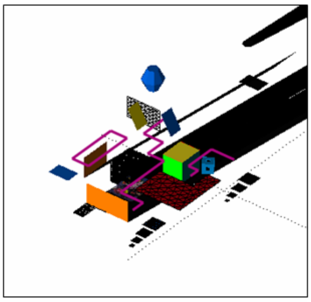
Adjust the view

The 3D view allows you to view the scene from any side. Again, you may set the camera target (the point you are looking at) and the zoom level. In addition, you may rotate the scene (change the camera position) with the right button. Click on the 3D view with the right button, keep it pressed, rotate the scene then release the button. As for the 2D view, the zoom level is set with the middle button or the mouse wheel and the camera target is set with the left button.



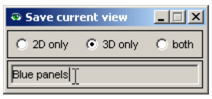
You may reset the 3D view by pressing the "4" or "5" keys, respectively you see the whole scene (with the shadows) or you zoom only on the objetcs as illustrated below.





Save the view

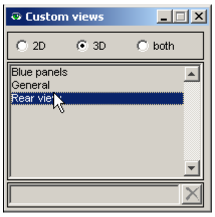
Once the view is set, you may save this particular view. The easiest way consists in pressing the F2 key. The view is saved under a generic name (View0001, View0002, ...). Otherwise, you may click on the button. The following dialog box appears.



Check "3D only" then enter the name you want to give to this view ("Blue panels" in this example) and press Return. Now this particular view is saved. You may save as many views as you want, either with the F2 key or by naming the saved view.

Load a view

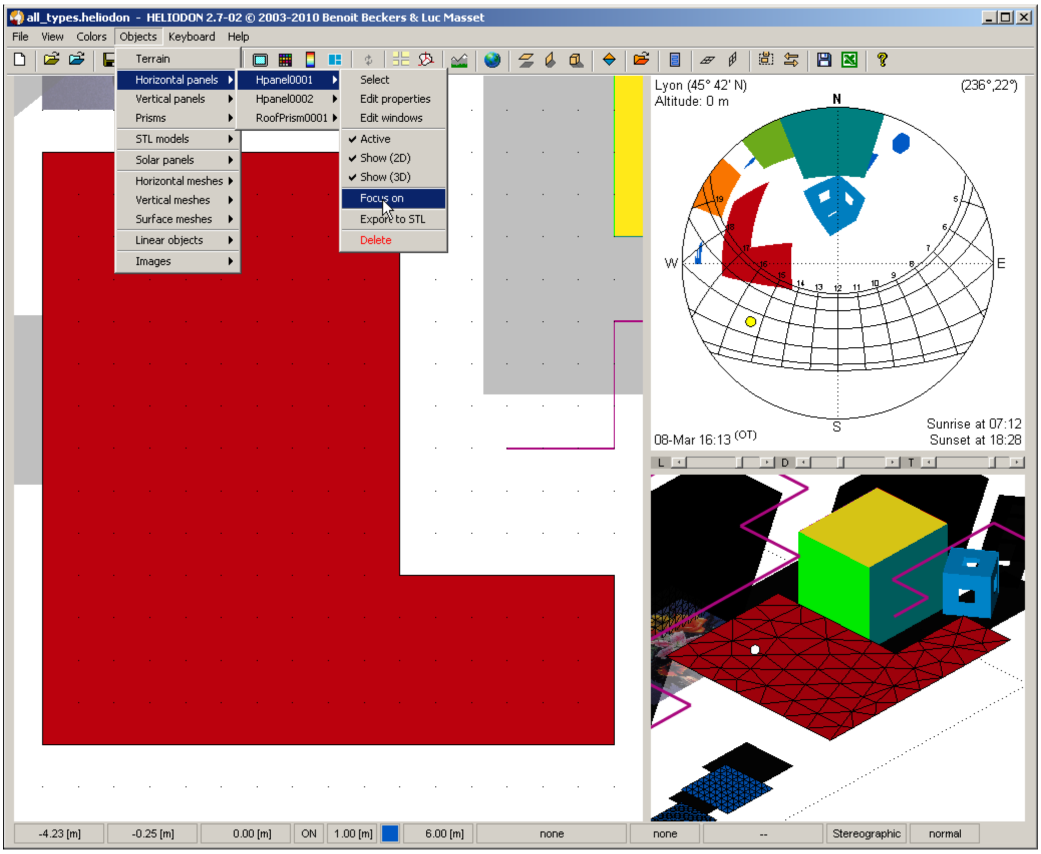
You have two ways for loading a saved view. Use the *the F1 key*. Pressing successively on F1 will load the saved 3D views, one at a time. Otherwise, you may click on the button. The following dialog box appears. Here, we have saved three views ("Blue panels", "General" and "Rear view"). First check "3D" then select one view by clicking its name in the menu.



If you double click, the name is written in the bottom text field so that you may rename the view. Once you have double clicked, you may also delete the selected view by clicking on the × button.

Remarks

- When you save a view, you can save both 2D and 3D view at the same time. A 2D/3D view only appears in the "both" category but enters in the list when you use the keys F1 or F3 to cycle through the saved views.
- You may also use the saved views in the separate 2D and 3D windows though only the keys are availlable. In the 3D window, use F1 to cycle through the saved 3D views and F2 to save a particular view. Also use F1 and F2 in the 2D window (respectively to load and save views) since keys F3 and F4 have another purpose in the separate windows.
- An easy way to adjust the view (both 2D and 3D) is to use the "Focus on" entry in the objects menu. When you use this feature, the camera target and the zoom level are adjusted to see the given object (horizontal panel "Hpanel0001" as illustrated below). Note that, if one or more objects lie between the camera and the given object, you won't see through them. You will have to move the camera to actually see the object.

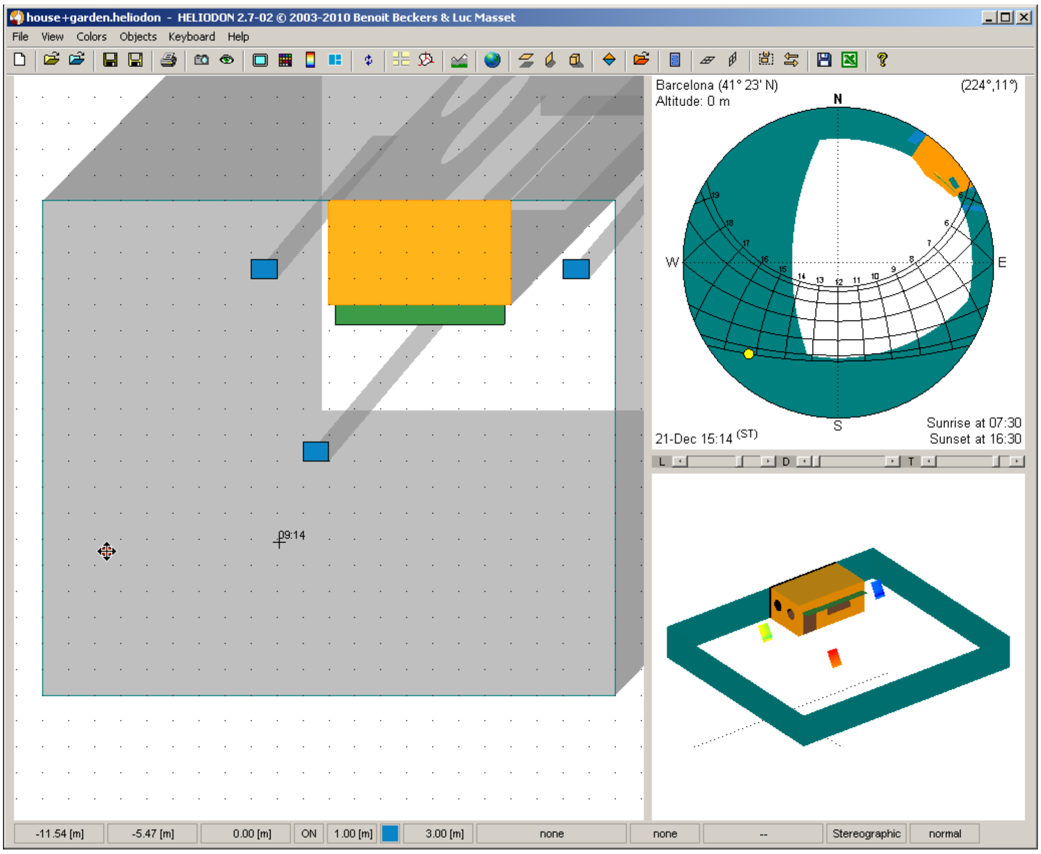


- You may find predefined 3D views in the "View" menu of the main Heliodon window: views from top of the scene, views from cardinal points, isometric views (at 45°) and finally a focus on the view point (the observer, the small circle in the 2D view or the cross in the 3D view).
- In the 3D separate window, you may use the double right-click on an object to focus on this object. After that, when you rotate the scene, you move around this point.

Sensors

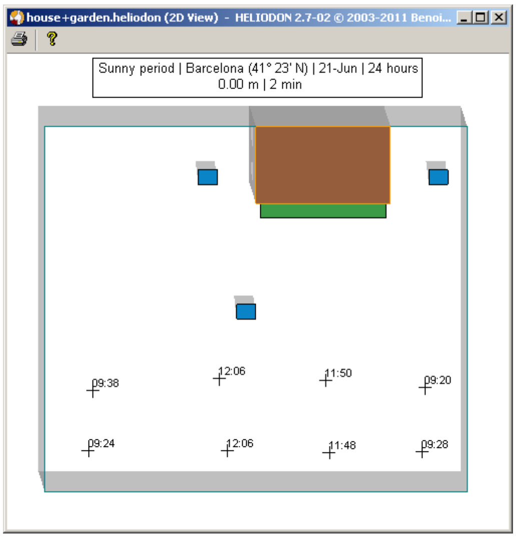
Create sensors

Sensors are punctual receivers that you may place within the scene to measure various quantities such as solar energy or sunlight time. Create a sensor is really easy: move the view point to the desired location in the 2D view then press the key "v". A small cross is placed at this point, the quantity is immediately computed and the result is placed near the sensor in the 2D view (the sunlight time in the example below). Move the view point again and press "v" to create a second sensor and so on ...



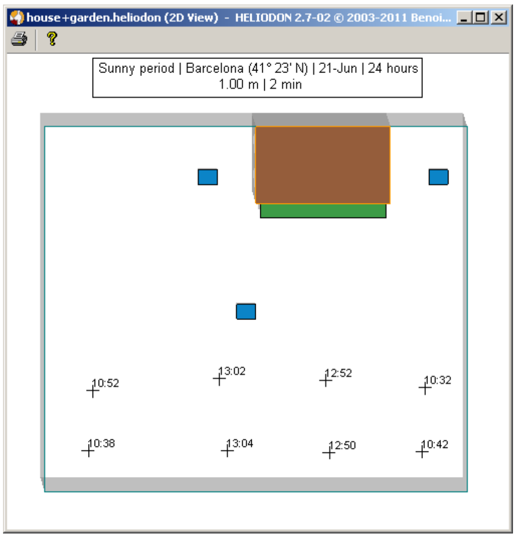
Compared to colored maps, sensors are more convenient because it takes less time to calculate the results (in fact, a map is equivalent to a great number of sensors). On the other hand, sensors only give you numerical results instead of graphical ones for the colored maps (see Colored maps).

Press the "V" key to delete the last sensor then again to delete the last but one and so on. Press F8 to update the results of all the sensors. F7 will bring up the dialog box with the calculation parameters (see Calculation parameters). Note that results of sensors are reset when you change the calculation parameters, the projection or the view point altitude (see below).

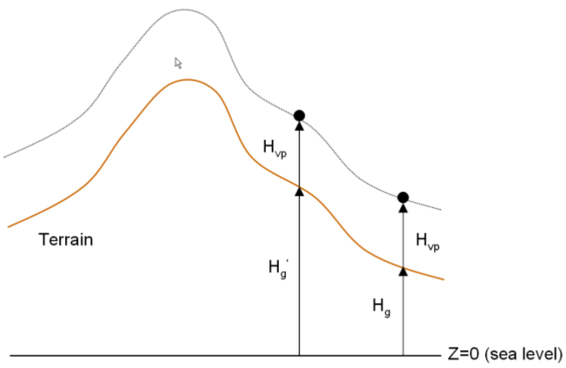


Sensors altitude

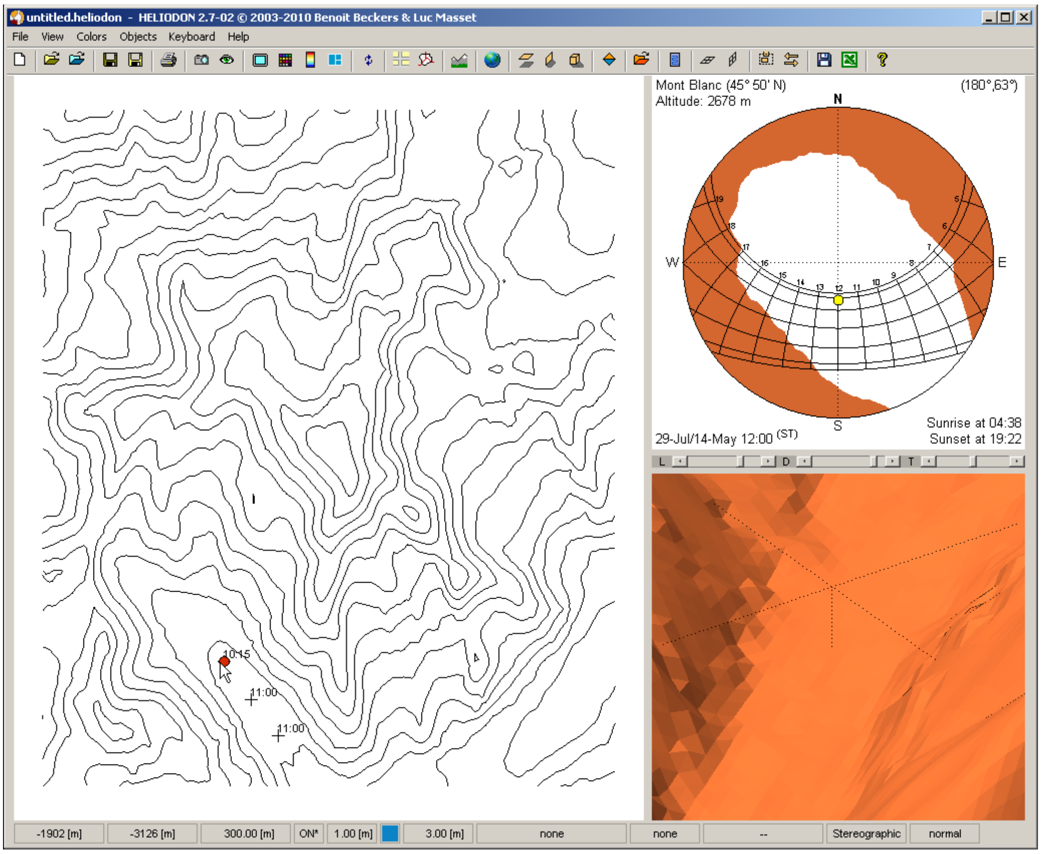
Sensors are created at the altitude of the view point. When you change the view point altitude, results of the sensors are reset. Use F8 to calculate results again. The figure below illustrates the same case as above with sensors located at an altitude of one meter (instead of zero). The sunlight time is higher.



In case the scene includes a terrain model, the altitude of sensors are set with respect to the true terrain altitude. On figure below, if the altitude of the ground is H_g at the horizonatal location of the view point (x_s,x_s) and if the altitude of the view point is set to H_{vp}, the actual sensor altitude is equal to $H_g + H_{vp}$.



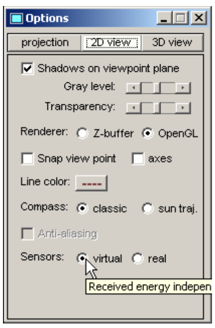
For a given atltitude of the view point, all the sensors will be placed on a surface corresponding to the translated terrain (the dotted line on the above figure). On the example below, the three sensors are located at 300 meters from the actual ground since the view point is set to be at 300 meters from the ground. The overall altitude of the view point is indicated on the projection (2678 meters AMSL, the ground being at 2378 meters at this location).



Real or virtual sensors

In Heliodon, you have real and virtual meshes depending if you take into account the surface normal or not (see Colored maps). It is the same for the sensors. *A real sensor does take into account the perpendicular direction to the surface it lies on.* This means that the amount of energy absorbed by the sensor depends on the inclination of the ray with respect to the surface normal direction. The more the ray is inclined, the less the energy is absorbed. At contrary, *a virtual sensor absorbs the energy of the sun ray equally, whatever the direction of the ray.* Real sensors have a directional response and they are used to measure the sun irradiance. Common real sensors are pyranometers (see here for more details).

You may choose between real and virtual sensors in the options dialog box. Go to the 2D tab and check virtual or real.



For real sensors, we distinguish two situations: a scene with or without terrain.

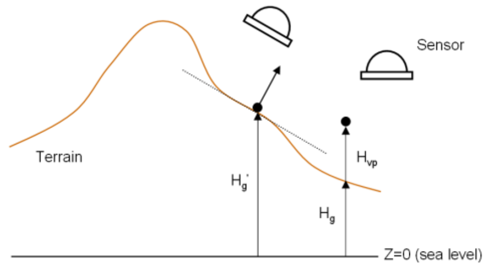
Scene without terrain

When there is no terrain, a real sensor is always supposed to lie horizontally. This corresponds to the most common use of the pyranometers, either fixed horizontally or carried out in hand. Sometimes, they are fixed on an inclined surface (such as a roof). This case is not yet taken into account by the sensors in Heliodon.

Scene with terrain

When the scene includes a terrain,

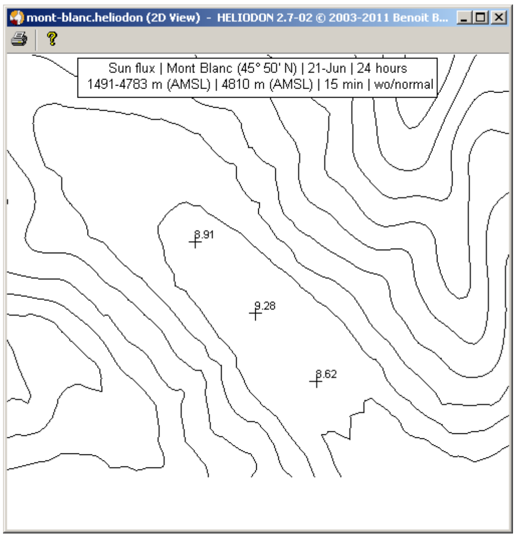
- either the sensor is placed on the ground (altitude of the view point set to zero) and the orientation of the sensor is the orientation of the terrain; this case corresponds to the measurement of the irradiance of the terrain itself, thus accounting its own orientation;
- or the sensor is placed at a given height with respect to the ground and the sensor has an horizontal orientation.



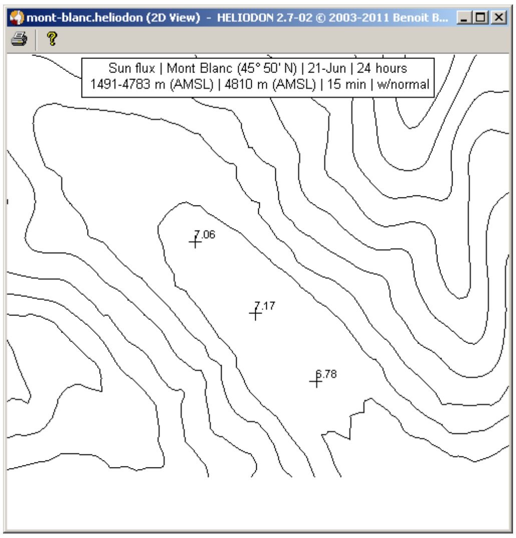
The two situations are illustrated above. On the left, the sensor is placed on the ground so that its orientation is equal to the orientation of the ground at this location (the dotted line). The irradiance is maximum in the perpendicular direction to the ground. On the right, the sensor lies at a height H_{vp} so it has an horizontal orientation. The figure below illustrates the solar energy received by virtual sensors.

Example

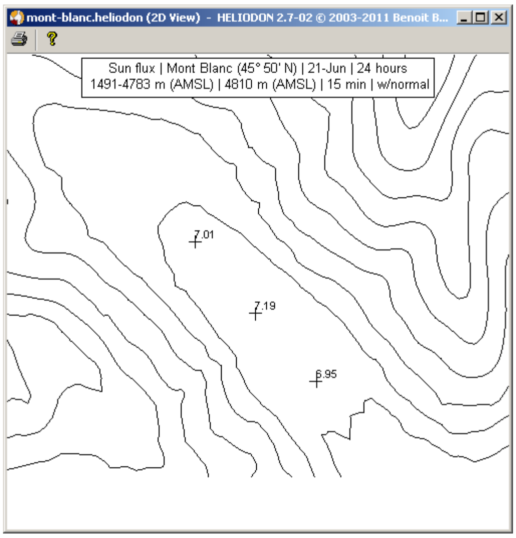
The figure below illustrates the solar energy received by virtual sensors placed on the ground. Note that a flag "wo/normal" is added in the title, indicating that you have chosen virtual sensors.



Now, if we use real sensors, the energy received is lower. Note the flag "w/normal" in the title.



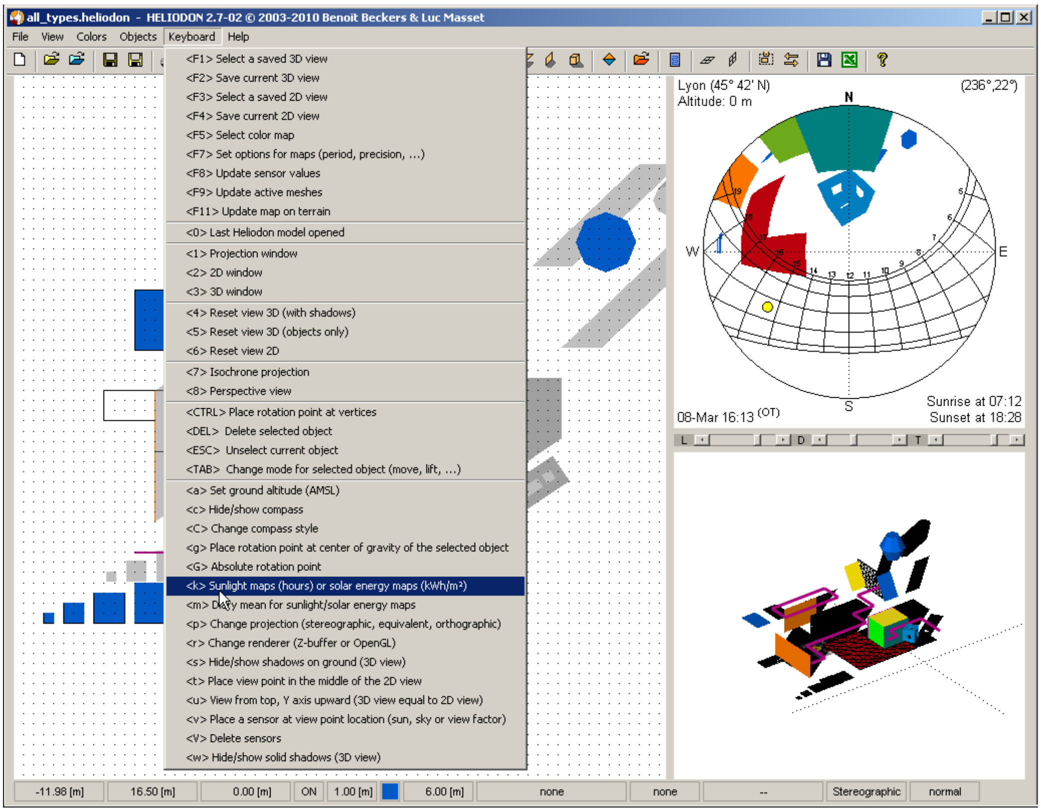
Finally, if we lift up the real sensors one meter from the ground, the computed energy is slightly different.



Keyboard shortcuts

Main window

Shortcuts help you perform several tasks in Heliodon without the need to use a given menu. They are very useful for repeated tasks (for example open a 3D view, update the shadows or compute the colored maps) and you really are able to speed up the use of Heliodon. You can access the shortcuts only if the window is active, i.e. above the other windows (Heliodon windows as well as other programs of Windows) and selected (the title bar should be in blue for the classic Windows color scheme).



The shortcuts of the main Heliodon window are also accessible through the "Keyboard" menu. The tables below give a brief description of the shortcuts and a link to a more comprehensive page.

Function keys (F1, F2, ...)

Shortcut	Description	Link
F1	Load a saved 3D view (camera position, camera target and zoom level)	Manage views
F2	Save current 3D view (camera position, camera target and zoom level)	Manage views
F3	Load a saved 2D view (camera target and zoom level)	Manage views
F4	Save current 2D view (camera target and zoom level)	Manage views
F5	Select colormaps; results are displayed on meshes colored with colors picked whithin a given colormap; you may chose among predefined colormaps (gray, blue to red, Itten, ...) or create your own.	Colormaps
F7	Set options for maps; you may set several parameters for the calculation of colored maps such as period duration, step size, solar flux constants, ...	Calculation parameters
F8	Update sensor values; sensors are created at view point location with the "v" key; they are shown as small crosses in the 2D view; use this key to	Sensors

	calculate the values at sensors (solar energy, daylight, ...)	
F9	Update active meshes; calculate the results (solar energy, daylight, ...) on active meshes and display the mesh as a colored map	Colored maps
F11	Update terrain map; calculate the results (solar energy, daylight, ...) on the terrain model (or part of the terrain model); display terrain as a colored map	Colored terrain

Numeric keys (0, 1, 2, ...)

Shortcut	Description	Link
0	Last Heliodon model opened; open the model you were working on when you last left Heliodon	
1	Projection window; creates a separate window with the projection (stereographic, equivalent or orthographic)	Projection window
2	2D window; creates a separate window with the 2D view	2D window
3	3D window; creates a separate window with the 3D view	3D window
4	Reset 3D view (with shadows); adjust the camera target and zoom level in order to view all the scene in the 3D view, including the shadows	Manage views
5	Reset 3D view (only objects); adjust the camera target and zoom level in order to view all the objects of the scene in the 3D view (excluding the shadows)	Manage views
6	Reset 2D view; adjust the camera target and zoom level in order to view all the objects of the scene in the 2D view	Manage views
7	Isochrone projection; see the isochrone projection of the scene and display the evolution of the solar flux along the year	Isochrone projection
8	Perspective view; see the scene in perspective and walk inside the scene	Perspective

Character keys (a, b, c, ...)

Shortcut	Description	Link
a	Set altitude AMSL (Above Mean Sea Level)	Calculation parameters
c	Hide/show compass; the compass is displayed within the 2D view; you may see and change North direction	Objects of 2D view
C	Compass style; the compass may be displayed with classic style (a needle oriented towards North) or as the stereographic sun paths so that you can visualize the daylight at the compass position	Objects of 2D view
g	Place rotation point at center of gravity; when a object is selected, one of its possible transformations is to rotate the object around a center of rotation; this key places the rotation center at the gravity center of the selected object	Objects transformation
k	Sunlight time or solar energy; toggle the results to display on colored maps between sunlight time (duration of direct sunlight) and solar energy	Colored maps
m	Diary means; display aggregate results (for example total sunlight time over a period) or diary means (mean sunlight time for the period)	Colored maps
p	Change projection; you may choose between stereographic projection (for the study of sunlight or solar energy), equivalent projection (sky factor for buildings or open urban spaces) or orthogonal projection (diffuse solar energy or sky view factor)	Colored maps
r	Change renderer; the renderer is the graphic engine of Heliodon; it displays all the graphics (windows, buttons, drawings, ...) on the screen; the default renderer is the OpenGL renderer (it is the fastest one); in	

	some situations, you may need to change to the Z-buffer renderer (for example if your graphic card does not support OpenGL)	
s	Hide/show shadows on ground (3D view)	3D view
t	Place view point in the middle of 2D view	2D view
u	View from top, Y axis upward	3D view
v	Sensor at view point location; create a sensor where the view point is located; the sensor can measure sun light time, solar energy, sky or view factors	Sensors
V	Delete sensors; delete last created sensor	Sensors
w	Hide/show solid shadows; solid shadows represent the volume that is not reached by direct sun light	3D view

Special keys

Shortcut	Description	Link
CTRL	Place rotation point at vertices; when you want to rotate an object, you can place the rotation center at the vertices of the object	Objects transformation
DEL	Delete selected object; when an object is selected (displayed with thick lines in the 2D view), you can delete it with the DEL key	Objects transformation
ESC	Unselect current object; escape from transformation mode for the selected object	Objects transformation
TAB	Change mode for selected object; toggle between available transformation modes for the selected object (move, rotate, lift, ...)	Objects transformation

3D window

In the 3D window, you also have shortcuts, some are equal to the shortcuts of the main window, some are specific to the 3D window.

Function keys (F1, F2, ...)

Shortcut	Description	Link
F1	Load a saved 3D view (camera position, camera target and zoom level)	Manage views
F2	Save current 3D view (camera position, camera target and zoom level)	Manage views
F3	Save current graphic settings (colormap, camera) in the main Heliodon window	
F4	Apply the same settings (camera, colormap, color scale) to all 3D windows	
F5	Select colormaps; results are displayed on meshes colored with colors picked whithin a given colormap; you may chose among predefined colormaps (gray, blue to red, Itten, ...) or create your own.	Colormaps

Numeric keys (0, 1, 2, ...)

Shortcut	Description	Link
4	Reset 3D view (with shadows); adjust the camera target and zoom level in order to view all the scene in the 3D view, including the shadows	Manage views
5	Reset 3D view (only objects); adjust the camera target and zoom level in order to view all the objects of the scene in the 3D view (excluding the shadows)	Manage views

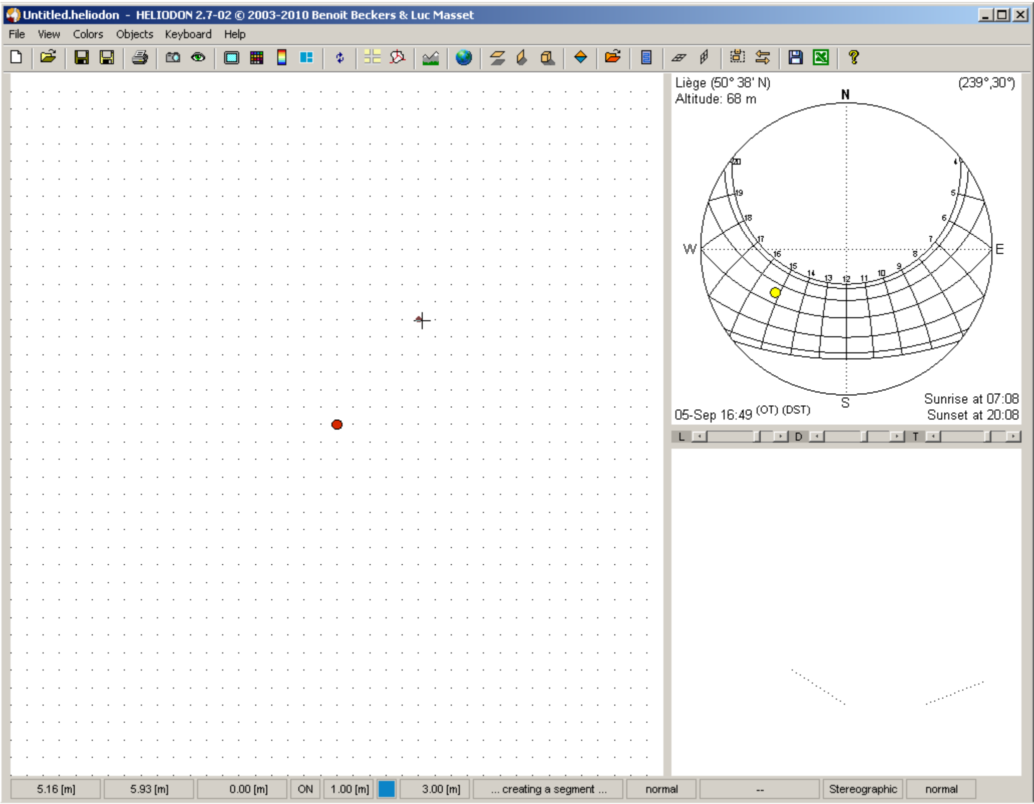
Character keys (a, b, c, ...)

Shortcut	Description	Link
b	Set background color to black/white	
B	Select background color	
C	Color terrain model (altitude, South/North orientation, East/West orientation or terrain slope); press key to toggle between choices	
d	Show labels on colored maps showing numerical values (energy, factor or sunlight)	
D	Hide labels on colored maps	
f	Use a fringed colormap (as many colors as labels) or a continuous colormap	
k	Sunlight time or solar energy; toggle the results to display on colored maps between sunlight time (duration of direct sunlight) and solar energy	Colored maps
l	Switch on/off lighting of the scene	
m	Diary means; display aggregate results (for example total sunlight time over a period) or diary means (mean sunlight time for the period)	Colored maps
p	Show/hide view point	
r	Change renderer; the renderer is the graphic engine of Heliodon; it displays all the graphics (windows, buttons, drawings, ...) on the screen; the default renderer is the OpenGL renderer (it is the fastest one); in some situations, you may need to change to the Z-buffer renderer (for example if your graphic card does not support OpenGL)	
s	Hide/show shadows on ground	
S	Hide/show sensors location	
t	Hide/show title	
T	Hide/show terrain model	
u	View from top, Y axis upward	
v	Hide/show uncolored maps	
w	Hide/show solid shadows; solid shadows represent the volume that is not reached by direct sun light	3D view
$	Create a link to be included in MS PowerPoint document	

Add a solar panel

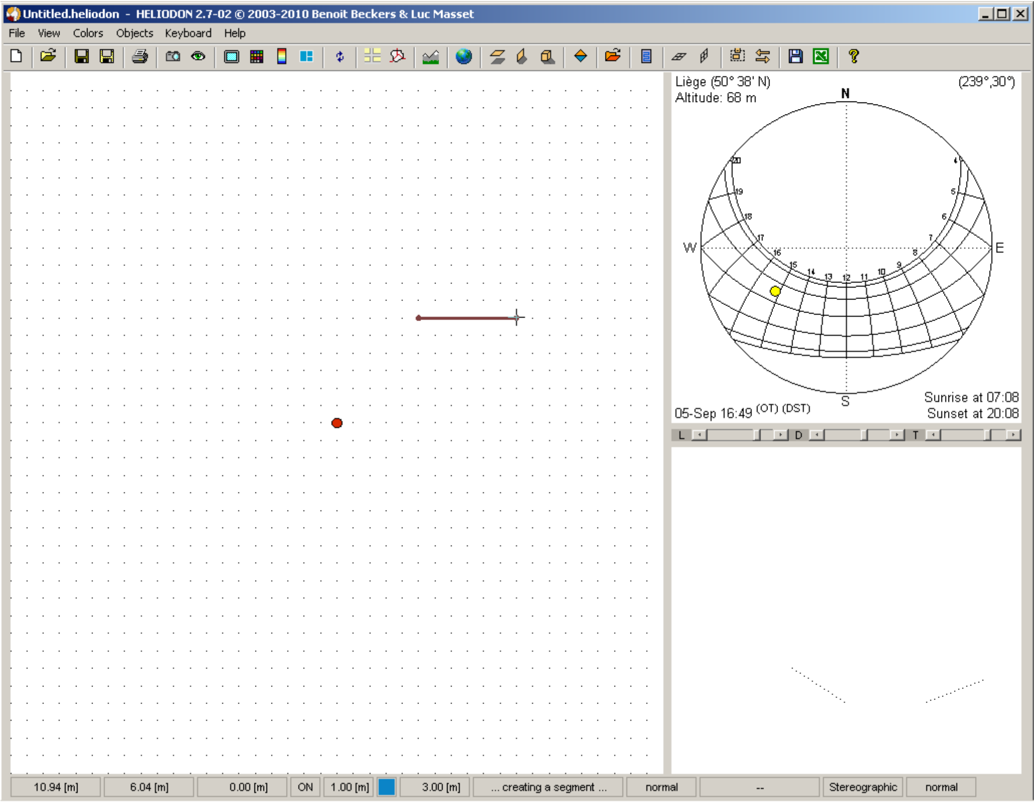
Create the panel

In Heliodon, click on the button to start creating a solar panel. Left click in the 2D view to create the first point.

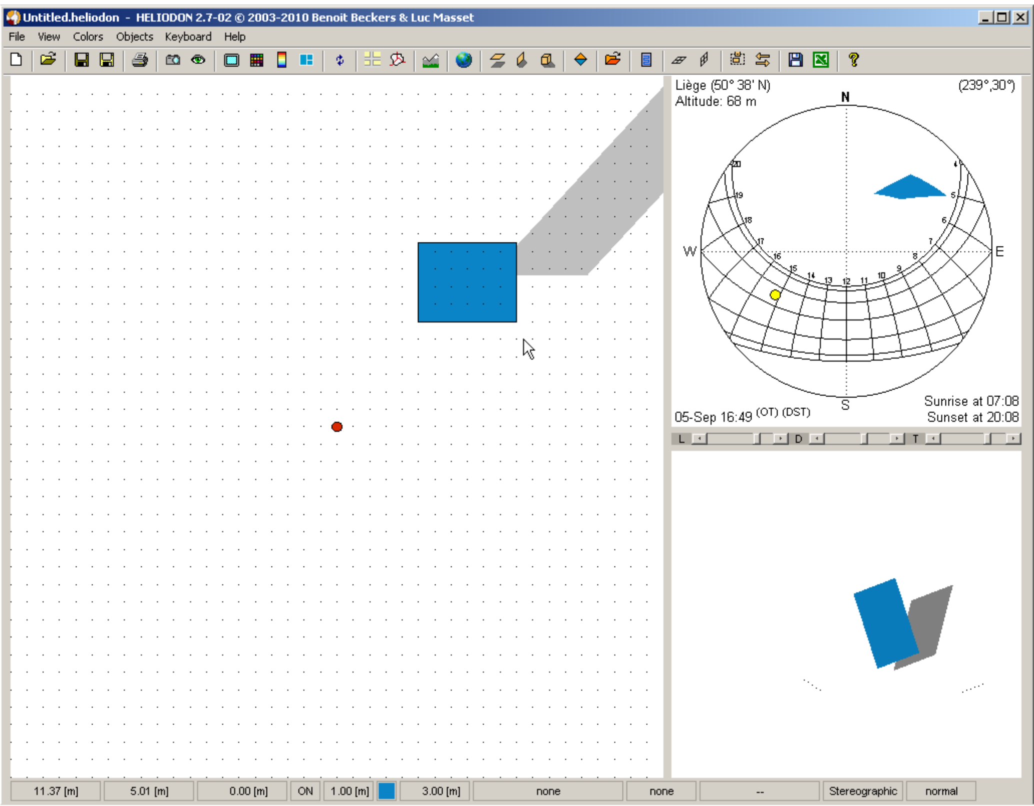


Left click again to create the second point. Use right button to remove points.

Add a solar panel

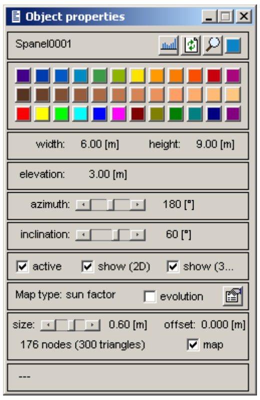


The segment joining the two points is the base of the solar panel. Use middle button to create the solar panel. The panel is always oriented versus South (even in the southern hemisphere). Its vertical inclination is 60°.



Edit panel properties

Select the panel with a double left-click on the panel in the 2D view followed by a right-click. You may also use the Object menu or right-click the panel in the 3D view. The solar panel properties dialog appears.



A solar panel is both a panel object (as horizontal and vertical panels) and a receiver such as a mesh. You find back a mix of the properties of both kinds of objects.

Name

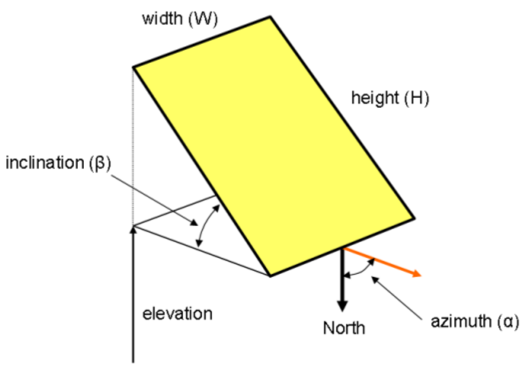
The solar panel is given an automatic name (Spanelxxxx). Right-click on panel name if you want to rename it.

Color

Since the solar panel is also a receiver, it is usually filled with a colored mesh showing the solar energy received. But you may give it a color as all other true objects (opposed to virtual objects such as receivers, horizontal or vertical meshes). Push the color button to select the panel color or select a predefined one.

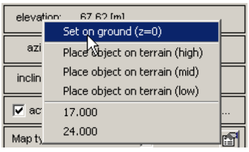
Width and height

The solar panel has a rectangle shape. Its width W and height H are measured in its plane as described in the figure below. It has an area of W.H m^2.



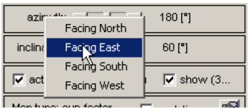
Elevation

The solar panel is placed at a given elevation. Right-click on the elevation value to edit. Use the menu (right-click on the elevation label) to select an existing elevation if any (here we have 17m or 24m available). These values correspond to the elevation of axisting objects. You may also place the panel on the ground (z=0). In case you have imported a terrain, you may also place the panel on the terrain (see xxx for more information).



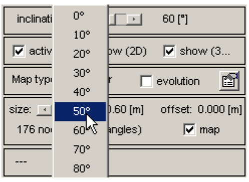
Azimuth

The azimuth angle gives the orientation of the solar panel against North. 180° is a panel facing South, 90° facing East and 270° facing West. Use the menu (right-click on the azimuth label) to access predefined values or use the slider control to select a given angle.



Inclination

The solar panel is inclined along an horizontal axis with an angle ° from horizontal position (90° would be a vertical panel; 89° being the maximum inclination). Use the menu (right-click on the inclination label) to access predefined values or use the slider control to select a given angle.



Active

If unchecked, the solar panel is not active, i.e. it is not a mask any more though. Note that it does not remain a receiver neither (the mesh is not created on the panel). If inactive, the panel borders are displayed with dashed lines.

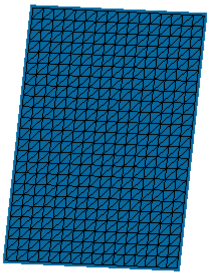
View 2D/3D

As for any object, you may hide/show the solar panel in the 2D or 3D view.

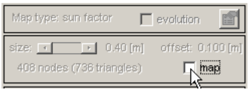
Map

The solar panel is a receiver. You may compute and display a map on it representing the daylight duration or the received solar energy (see example below). If you check "evolution", the overall quantities (daylight and energy) on the panel are computed and stored for each day of the period. The button allows you to edit the computation parameters such as time step, first day, last day, etc (see example below and xxx).

The other parameters are typical of receivers. It is the precision of the mesh, i.e. the size of the triangles composing the panel mesh. The offset is the distance from the panel border to the actual receiving surface (photovoltaic or thermal panels). The figure below shows a panel of 6x9 with a mesh size of 0.4 meter and an offset of 10 centimeters (see xxx).

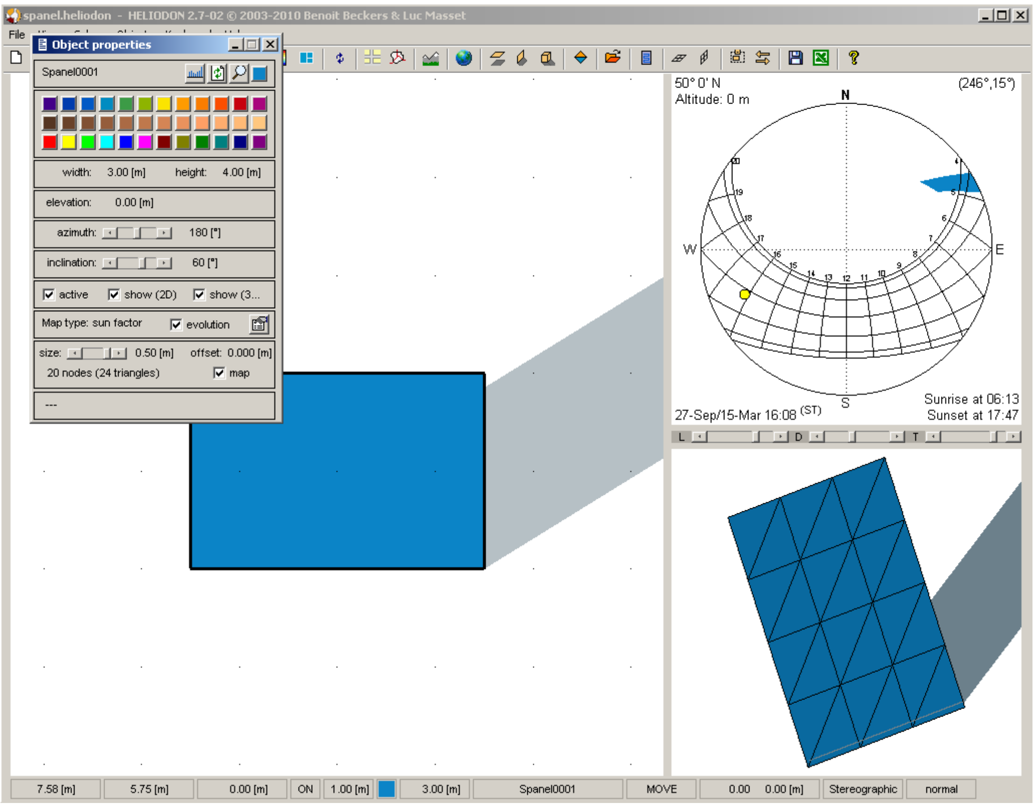


If you uncheck the "map" button, the panel does not contain a map any more. It becomes a single rectangular inclined panel. Use this feature if you don't need to compute daylighting on the panel.

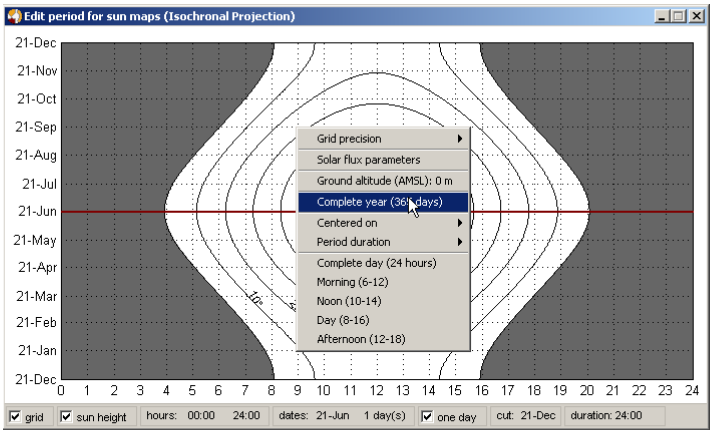


Example

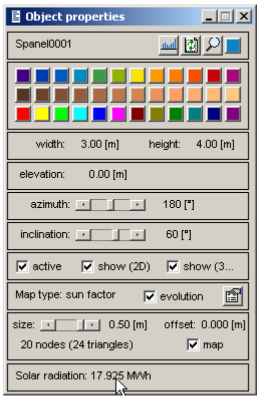
First, let us begin with a solar panel of 3x4 oriented towards South and inclined with a 60° angle. Let us set the mesh size to the lowest value (we don't need a reffined mesh when there is no mask for the sun). Let us suppose we are in a country located under 50° of latitude.



In order to compute the yearly received solar energy, we select the complete year as the study period. Click on the button to launch the simulation parameters window. Right-click on the image and select "Complete year" in the menu then quit the window.



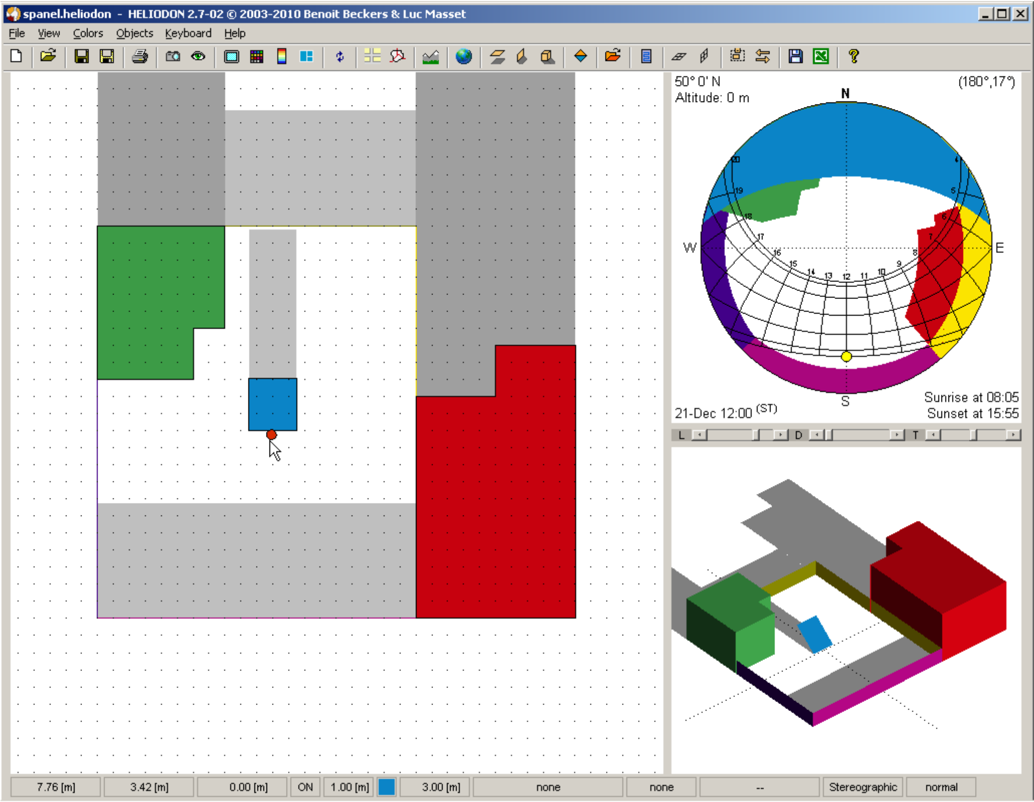
In the object properties window, click the update button to compute the results on the solar panel. After a few seconds, the result appears in the bottom of the dialog box.



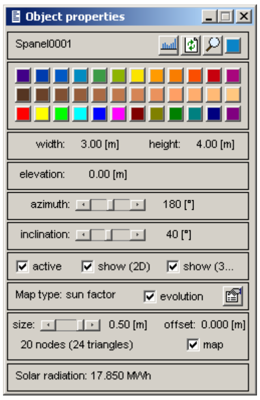
We obtain a solar energy of 17.925 MWh for the whole year. Now let us search the best inclination of the panel. Let us try 70°. Clicking the update button again gives us 16.522 MWh. The table below gives the received energy for different inclination angles. The best inclination is close to 40°. This corresponds to the the colatitude, the complementary angle (90°-) of the latitude. The optimal angle is usually a little bit lower than the colatitude because the solar panel receives sunlight during a longer period although the energy is lower (due to the cosine ot the incident angle).

Inclination (°)	**Energy (MWh)**
30	18.873
35	19.068
40	19.121
45	19.031
50	18.801
55	18.430
60	17.925

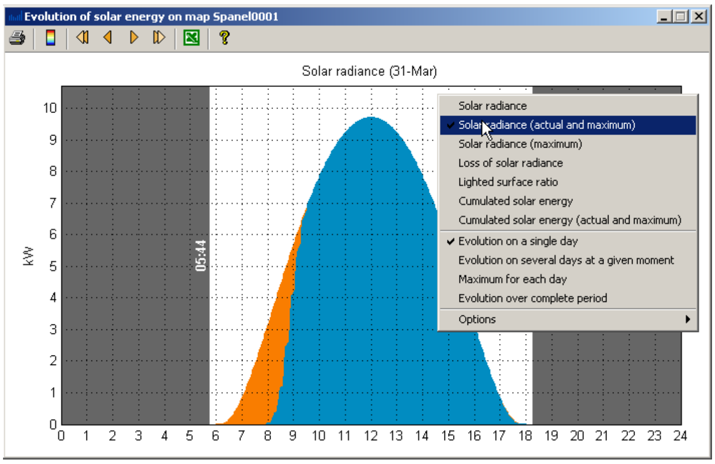
Now we can add buildings around the solar panel and see what we lose in daylight duration and energy. Let us create some prismatic objects representing for example neighbour houses and some vertical panels for fences. Setting the point of view just in front of the solar panel, we can observe in the stereographic projection that the sun is masked several hours along the year, especially by the red building.



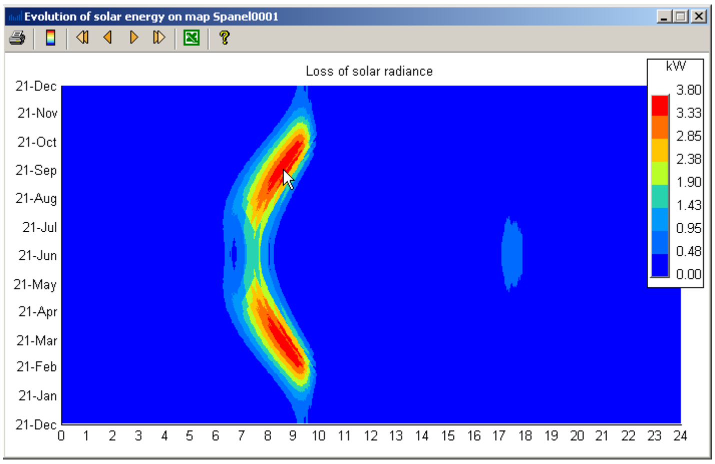
For a 50° inclination, the solar energy received during the whole year is now lower (17.850 MWh instead of 19.121).



If the field "evolution" is checked, you may see the evolution of energy and daylight along the year using button . Use the menu (right-click on the graphic) to select the required visualisation and the options. We may observe here the solar radiance on March 31st. The main loss occurs during the morning (the orange color indicates the actual radiance and the blue one the theoretical one, i.e. without any maks).



We can also see the results for the whole year such as the loss of solar radiance (select "Evolution over complete period"). It mainly occurs during the morning and around the equinoxes (March 21st and September 21st).

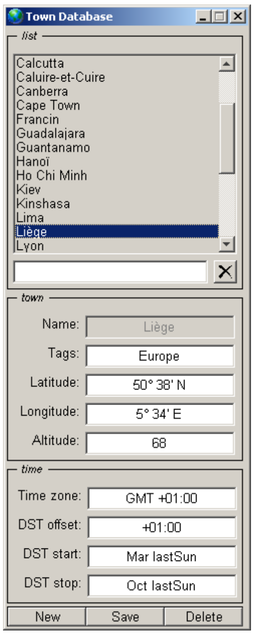


Town database

Data

The town database (use button) contains the data specific to particular locations on earth: town, village, moutain, etc. In first releases of Heliodon, only the solar time was shown. Therefore, the latitude was the only parameter required as illustrated below by Cape Town.

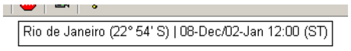
Now that Heliodon has become more and more complex, several additional parameters are needed for example to compute the official time or to define precisely a point on the earth surface. The case of Liège is illustrated below.



You may leave a field empty if you don't need a given parameter. Only the latitude is mandatory. All the parameters are described below.

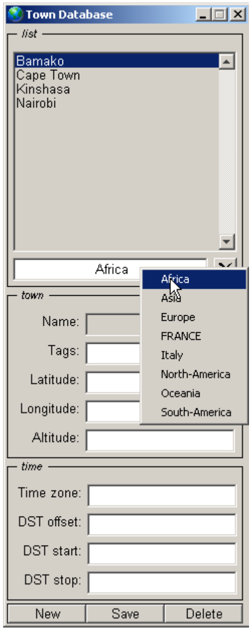
Name

Name parameter may be composed of several words (blank characters ar allowed). There is no limit on the number of characters but be aware that the name could be partially displayed in case it is too long. Also note that the name appears as well in the various windows of Heliodon such as in the title boxes.



Tags

Use the menu (right click) to add an existing tag. You may also add tags of your own (they will be added in the list of tags). Tags are useful to search the database. In the example below, we seek a town in the african continent. Add a tag in the search field (under the list of towns) or right-click on the field to access the tag list. Only the towns corresponding to the tag(s) will be displayed in the selection list.



Latitude

Enter the latitude either in degrees (45.5) or in degrees and minutes (45° 30' N). Negative values are for the southern hemisphere. Note that values are stored in decimal format, thus keeping the exact given value (no rounding).

Longitude

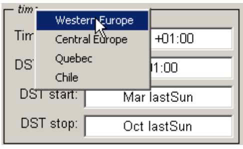
Enter the longitude either in degrees (-5.5) or in degrees and minutes (5° 30' E). Negative values are for east of Greenwich Meridian.

Altitude

Enter the mean altitude (AMSL, Above Mean Sea Level) in meters. This impacts the absorption of the atmosphere (less absorption when altitude increases) and consequently the solar flux computed at the given location. In the case you import a DEM (Digital Elevation Model) in Heliodon (see #REF_terrain), the mean altitude is useless. Instead, the true values of the terrain altitude are taken into account in the simulations.

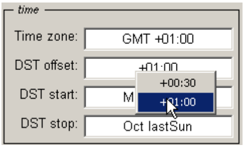
Time zone

Select the time zone with the menu (right click). GMT+x value indicates an x hours advance on Greenwich Meridian Time. Note that predefined time settings are available by right-clicking the "time" label on the time tab. A predefined setting includes time zone and DST parameters.



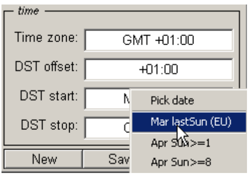
DST offset

DST stands for Daylight Saving Time. In several countries (Europe, Asia and North America), official time is shifted (usually from one hour) from spring to autumn in order to get more daylight during office hours (see here for more informations). Fill the DST offset field with the offset value in hours. Right-click on the offset field for predefined values.



DST start/stop

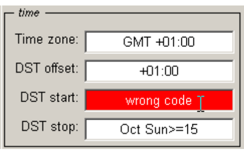
Indicates when the DST period starts and ends. Usually, it takes place the night between a Saturday and a Sunday. Use the menu to select predefined values.



Valid choices are:

- Given date (ex: 28-Apr)
- Special code (ex: Oct Sun>=15, i.e. Sunday directly later than October 15 or equal to)

If the given code or date is not understood, the field background turns to red.



Note that DST start must occurs before DST stop for the northern hemisphere (after in the southern hemisphere).

Select town

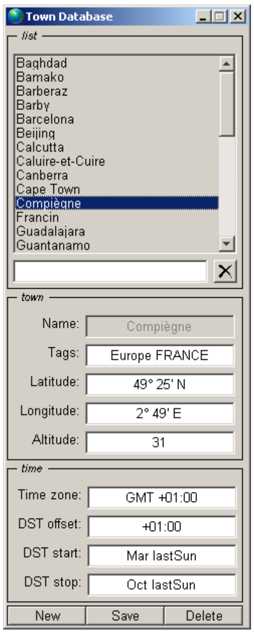
Click on a town in the town list to display its data (longitude, latitude, etc). Double-click this town to select it and return to main Heliodon window. Use tags to limit the number of towns in the list when searching the desired town. While the list is active, push alphabetical keys (abc...xyz) to go to the first town with a name starting with the pushed key. If several towns begins with the same letter, pushing successively on this key will highlight these towns.

New town

Click "New" button to create a new town. Fill in its name in the "Name" field then fill the other fields with the corresponding data. Leave fields empty when you don't know correct values. In case you don't set DST parameters, no DST is taken into account (several countries do not apply DST).

A good hint is to check the Wikipedia page of the desired town. It usually gives latitude and longitude values as well as its altitude.

When all data are set, push "Save" button to add the new town to the database. It appears in the town list.



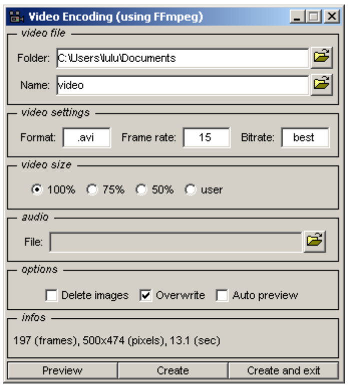
Modify town

Click an existing town to modify it. When modifications are made, click on the "Save" button. Use "Delete" button to remove a town from the database.

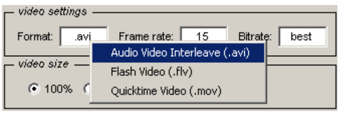
Create a video

Legal notice: this software uses code of FFmpeg licensed under the LGPLv2.1 and its source can be downloaded here.

After viewing an animation (sunrise to sunset, viewpoint path, ...), you may create a video file viewable outside Heliodon (Windows Media Player, Quick Time, ...). Click on the button and the above dialog box will appear.



In the first two fields, you set the output folder and the name of the output video. Then you have to set the video parameters. The first is the type of video file (right-click on the field to access the menu).



Avi files (.avi) should be readable on most systems while Quick time videos (.mov) and Flash videos (.flv) usualy require more specific video reader.

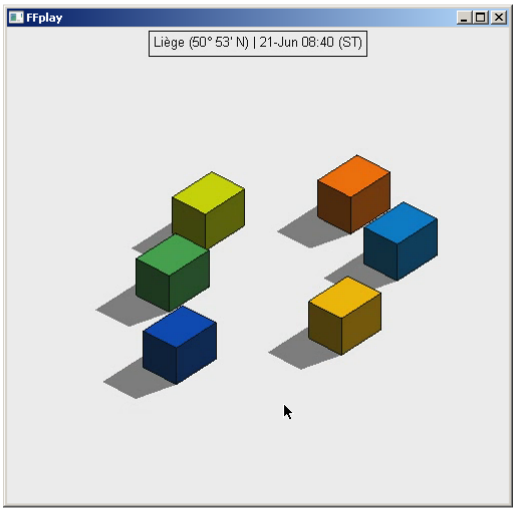
The second field is the frame rate, ie the number of images per second. You may set its value or chose one of the predefined values in the menu (right-click on the field).Note that the number of frames is fixed so that increasing the frame rate reduces the video duration.

In the last field, you may set the quality of the video. By default, the best quality is chosen. If you want to reduce the size of the video file, you may type in the bitrate (kB/sec), ie the size of one second of video. Use right button for a list of predefined values.

The dimensions of the video (width and height) are the dimensions of the window in which the animation was created. You may reduce its size (75%, 50% or type in a single value) keeping the original image aspect ratio or set a video size (ie "400x300", "150x100", ...). Note that if you increase the image size, the quality will decrease (pixelization). Instead, if you want to increase the image size, increase the size of the window where the animation is created.

Optionaly, you may add an audio channel to the video. Note that, if the audio duration is shorter than the video, there will be a blank at the end. If the audio duration is greater than the video, the audio will be cut abruptly at the end of the video.

Use the "Create" button to produce the video and the "Preview" button to check the video. Note that the previewer (FFplay) gives only a fast preview of the final video. Especially colors may change. Use the default video viewer (Windows Media Player, Quick Time, ...) to check the actual video.


FFplay
Liège (50° 53' N) | 21-Jun 08:40 (ST)

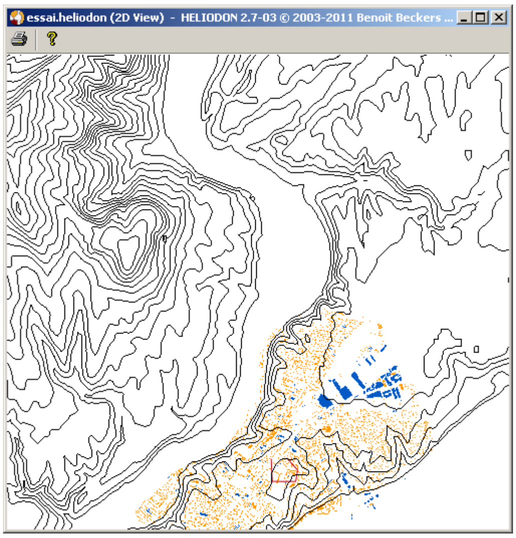
2D window

Plan view

Separate 2D window may be obtained by pressing the "2" key in the main Heliodon window. The 2D window shows the plan view of the scene (view point on top of the scene). Note that the view does not correspond to the true plan view: objects are just displayed in the same order as they were created.

Level curves

In case the scene includes a terrain model, the level curves are displayed.



Shortcuts

Function keys (F1, F2, ...)

Shortcut	Description	Link
F1	Load a saved 2D view (camera position, camera target and zoom level)	Manage views
F2	Save current 2D view (camera position, camera target and zoom level)	Manage views

Numeric keys (0, 1, 2, ...)

Shortcut	Description	Link
6	Reset 2D view; adjust the camera target and zoom level in order to view all the scene	Manage views

Character keys (a, b, c, ...)

Shortcut	Description	Link
b	Set background color to black/white	
B	Select background color	
c	Hide/show compass; the compass is displayed within the 2D view; you may see and change North direction	
C	Compass style; the compass may be displayed with classic style (a needle oriented towards North) or as the stereographic sun paths so that you can visualize the daylight at the compass position	

d	Show labels on colored maps showing numerical values (energy, factor or sunlight)	
D	Hide labels on colored maps	
f	Use a fringed colormap (as many colors as labels) or a continuous colormap	
k	Sunlight time or solar energy; toggle the results to display on colored maps between sunlight time (duration of direct sunlight) and solar energy	Colored maps
l	Switch on/off lighting of the scene	
m	Diary means; display aggregate results (for example total sunlight time over a period) or diary means (mean sunlight time for the period)	Colored maps
p	Show/hide view point	
r	Change renderer; the renderer is the graphic engine of Heliodon; it displays all the graphics (windows, buttons, drawings, ...) on the screen; the default renderer is the OpenGL renderer (it is the fastest one); in some situations, you may need to change to the Z-buffer renderer (for example if your graphic card does not support OpenGL)	
s	Hide/show shadows on ground	
S	Hide/show sensors location	
t	Hide/show title	
T	Hide/show terrain model	
u	View from top, Y axis upward	
v	Hide/show uncolored maps	
w	Hide/show solid shadows; solid shadows represent the volume that is not reached by direct sun light	3D view
$	Create a link to be included in MS PowerPoint document	

Import Google Sketchup models

Google Sketchup

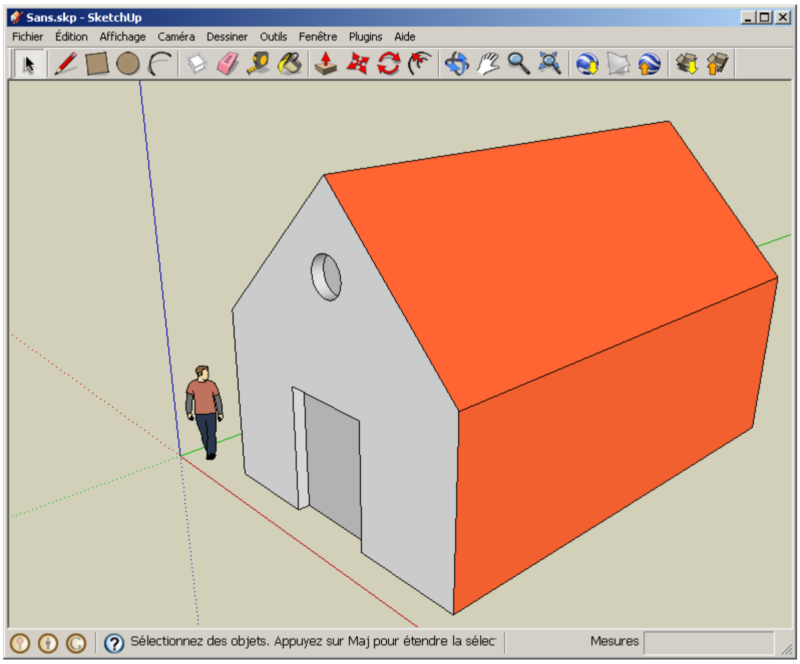
Google Sketchup is a design tool widely used in the field of architecture. It allows you to easily create 3D models. With the free version of Google Sketchup, you cannot export the model in common exchange file formats (.obj, .step, ...) but there is a free plugin (su2stl.rb, see below) that allows you to export your sketchup model in STL format. STL models may be imported in Heliodon2 so that you can design your own 3D models in Sketchup (or import ready-made models in Google 3D Warehouse) and use them in Heliodon2. The steps are described below.

STL plugin for Google Sketchup

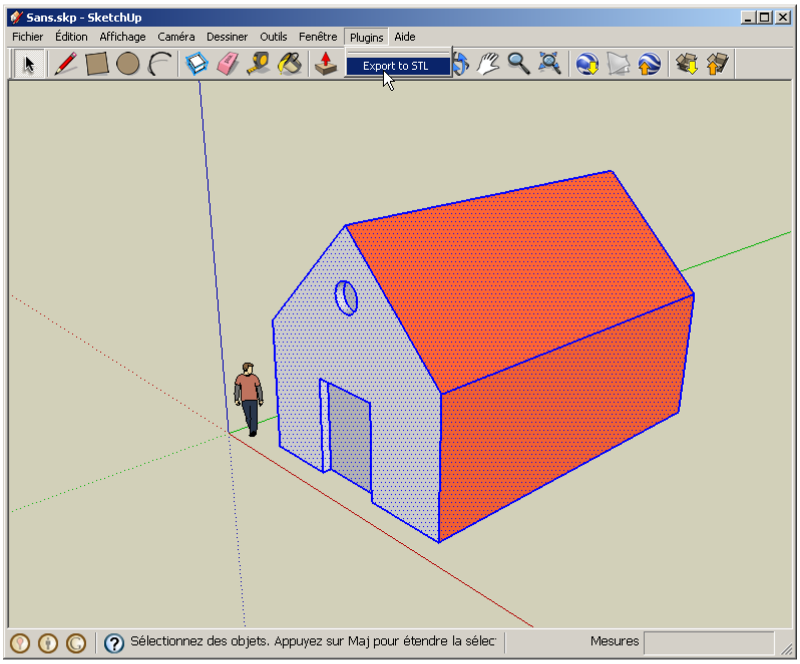
Didier Bur (CRAI, Centre de Recherche en Architecture et Ingénierie) has written a plugin for Google Sketchup that allows to export the Sketchup model into an STL model (made only with triangles). You may search in the Ruby Library Depot the plugin named su2stl.rb. Download the file into the Google Sketchup plugin folder (Usually C:\Program Files\Google\Google SketchUp 7\Plugins\). Whithin Google Sketchup, you should have a new plugin named "Export to STL".

Example

Download here a small Sketchup model, a simple house.

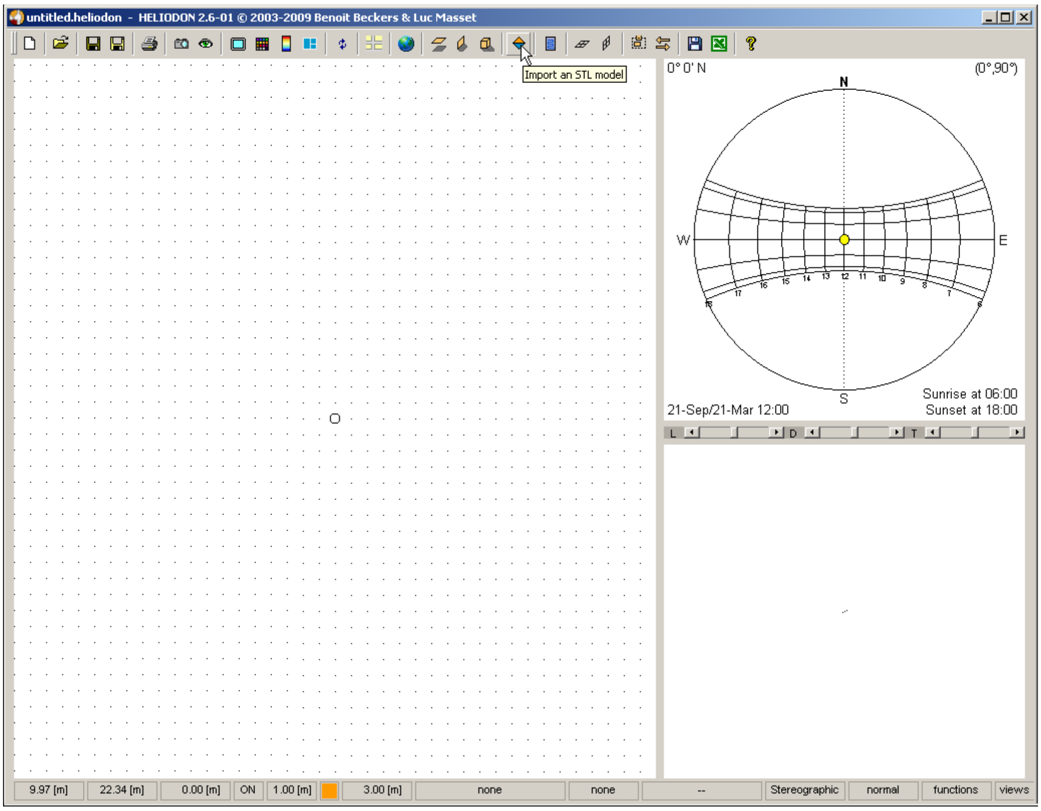


First select the house parts (walls, roof, ...) then run the plugin.

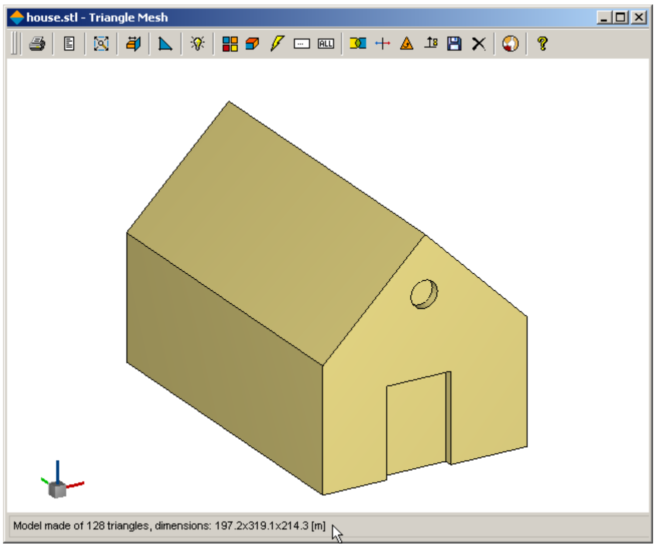


Choose the name for the STL model and the folder then save. A small message indicates the operation status (number of created triangles).

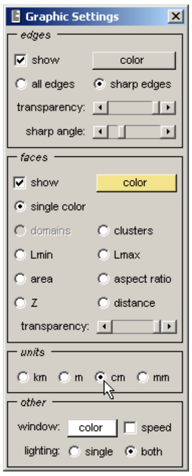
Open Heliodon2 and select "Import an STL model".



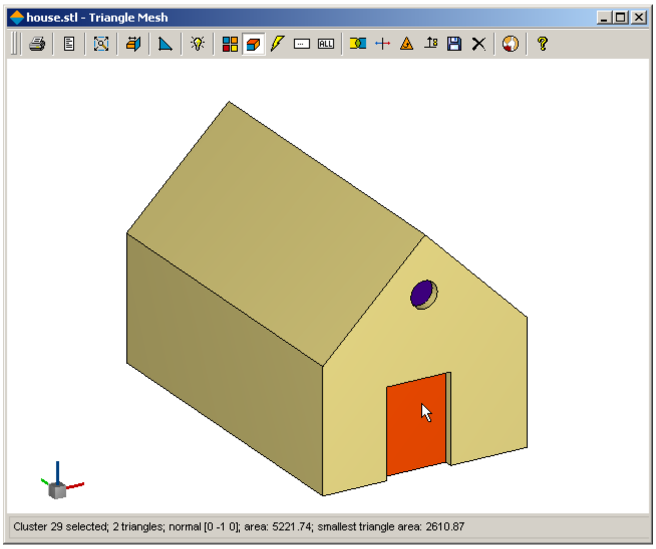
Select the STL model you have created in Google Sketchup. The STL Import window of Heliodon2 brings up. Rotate the model to see its different faces. Notice the model size in the status bar (bottom of the window). By defaut, the lengths are in meters. Here the house was obviously created in centimeters or in inches.



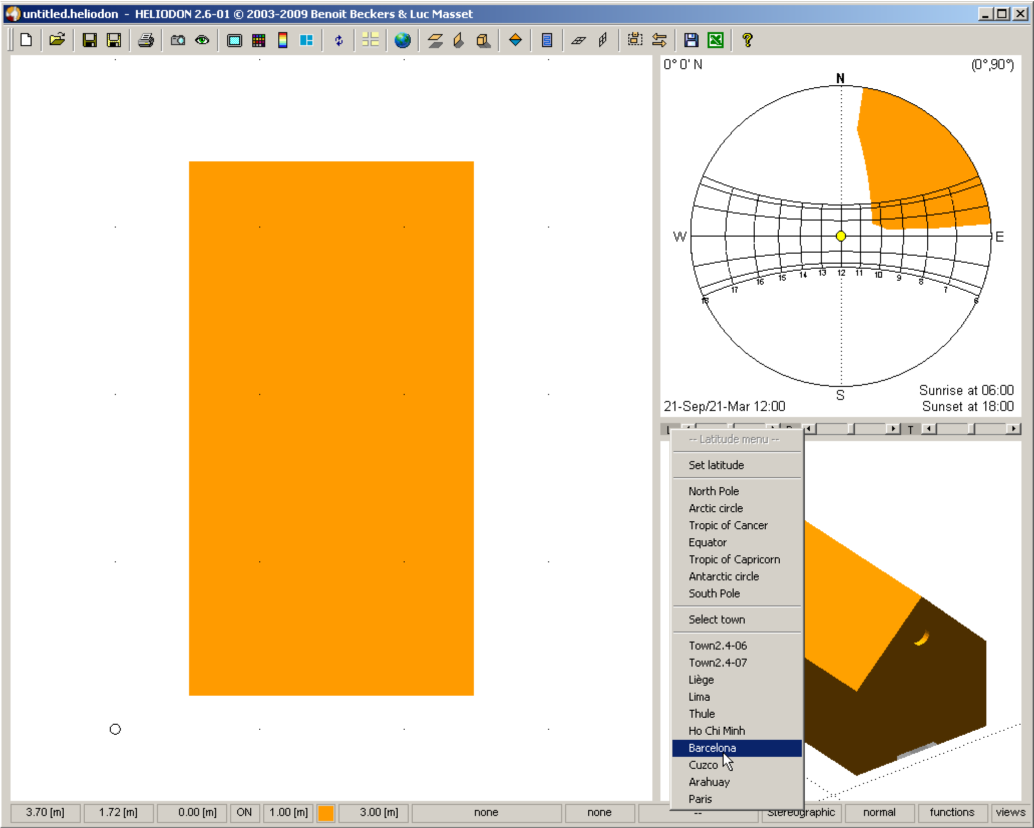
Go in the Graphic Settings dialog and choose "centimeters".



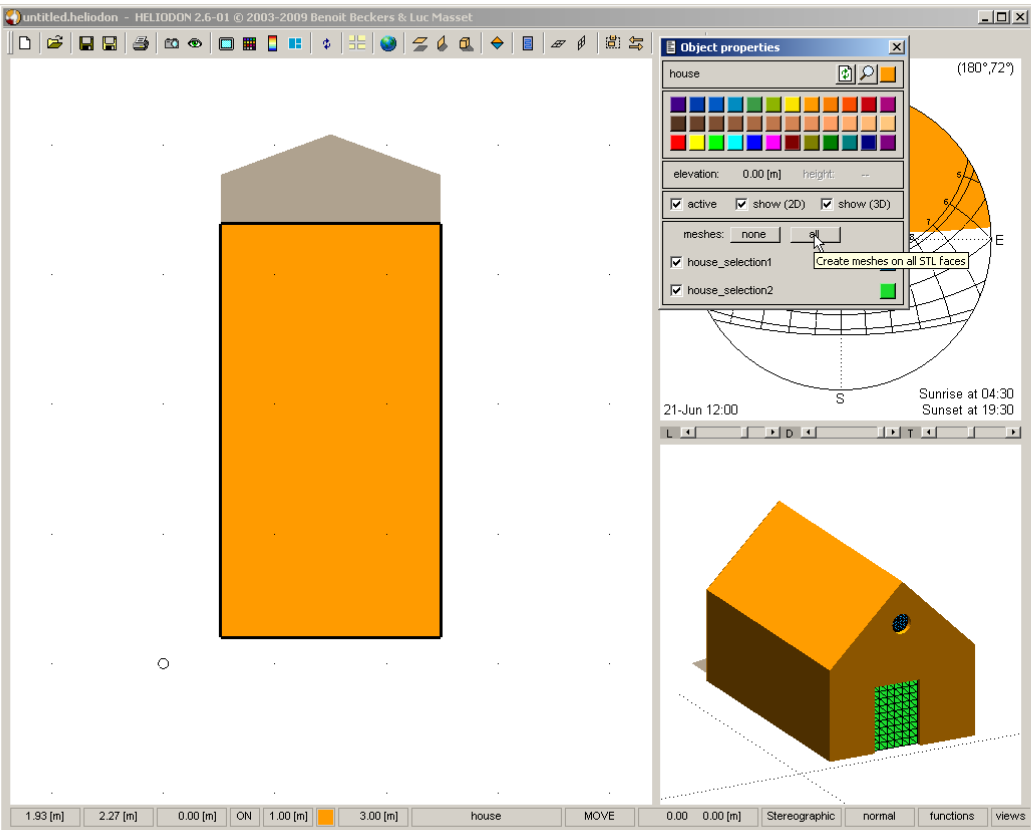
Before returning to Heliodon main window, select two surfaces of the house model - the door and the window. Select the cluster selection tool then double-click on the two surfaces.



Import the STL model in Heliodon (use button) and return back into main window. First select a town (Barcelona here).

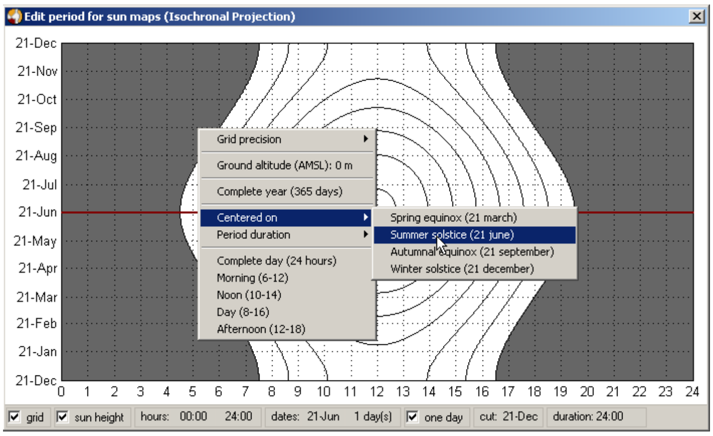


Select the model (named "house" here) and edit its properties. Create meshes for all STL faces (defined previously).

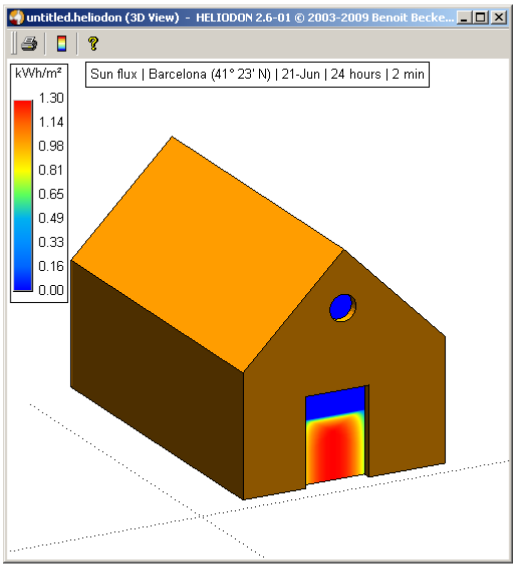


Press F9 key. Set mesh size to a smaller value (0.01) to refine meshes.

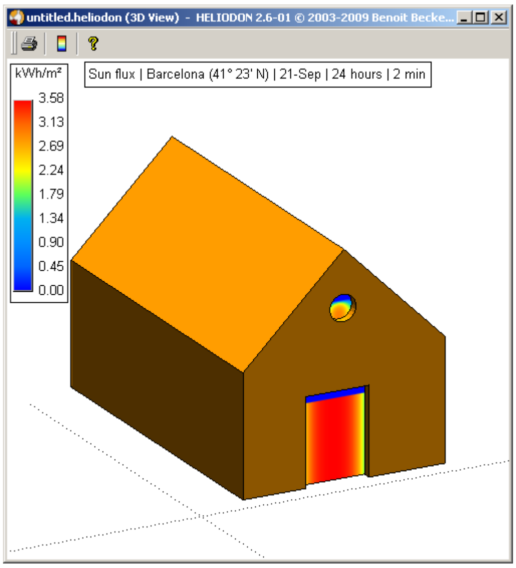
Edit the options for map computation. With the menu, set a smaller grid step (2 min) and select a date (centered on summer solstice, June 21st).



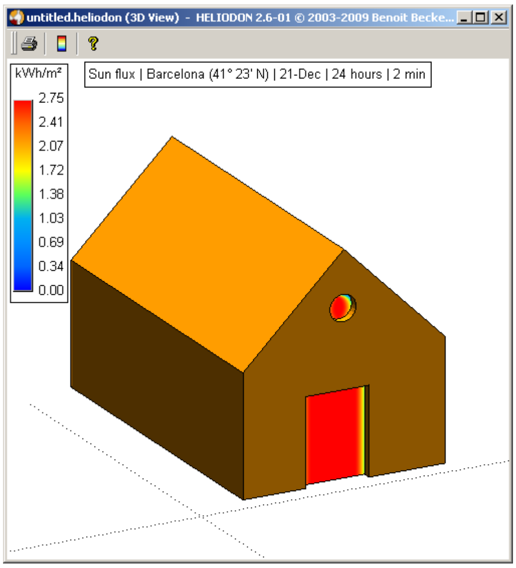
Press the "update" button and you obtain two colored meshes (door and window). Press key to draw the 3D view in a separate window. The solar radiative energy arriving on both surfaces are displayed. Notice that the circle window does not receive any solar radiation since the sun is too high in the sky during all the day on June 21st.



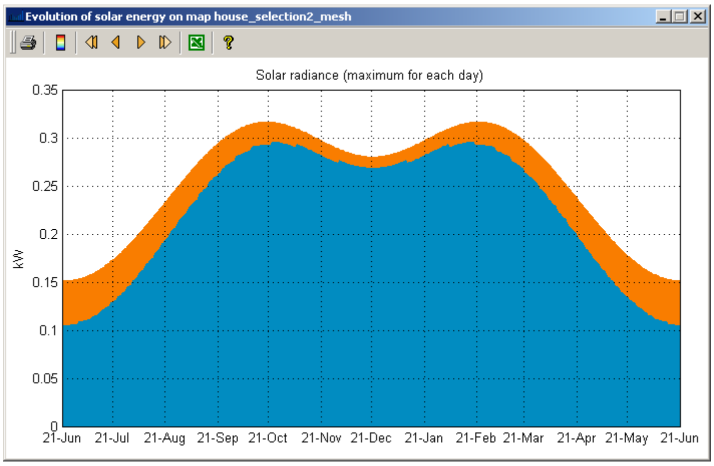
Now change the date to autumnal equinox (September 21st) and launch the computation again. Now the window receives a small amount of solar radiation.



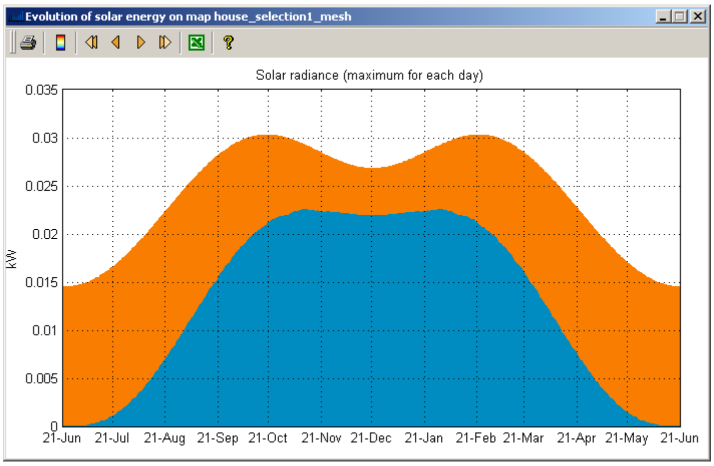
Finally, set the date to winter solstice (December 21st) and launch the computation again. Now the window receives yet more solar radiation.



If you check the "evolution" in the mesh properties and select the date to "Complete year", you may obtain the following curves (*note that this computation may take several minutes*). They represent the evolution of solar radiation during the year. The blue one corresponds to the actual radiation and the orange one to the theoretical one (ie without any other objects). This is for the door.



And this is for the window. Near the summer solstice, during almost a month, the window does not receive any solar radiation.



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