ECOTECT TUTORIAL

1 – Getting Started

1.1 – Installing the necessary software:

Installing Ecotect:
You can install Ecotect from CRON by following the instructions here: http://crn.mit.edu/p.lasso?t=8:5:3 Note that these licenses will only work on campus in buildings 3, 5, 7, 9, and 10.

Installing Radiance for Use with Ecotect:
Go to http://radsite.lbl.gov/deskrad/ and click on "Download". Click on "Download Desktop Radiance 1.02". Read the license agreement and click "Yes, I do agree..." at the bottom of the page. Click on Desktop Radiance Version 1.02 (54.7 MB Self Extracting Archive) – HTTP and save to disk. Run the downloaded install file. NOTE: At some point it will ask you to indicate whether you have AutoCad 2000 or AutoCad R14. Click on either one to fool the install. When it asks what directory AutoCad is in, give it any directory. Basically, we are pretending to have an old version of AutoCad, whereas we'll actually be using Radiance from Ecotect. Accept the default folder destinations. It will make life easier for you. The third one should install the Radiance run files in C:/Radiance.

Running Radiance from Ecotect:
The first time you export to Radiance, it will, during that process, ask you to locate the file "rad.exe". If you have installed the Radiance run files in C:/Radiance, it should be in the folder C:/Radiance/bin/. Don't forget, if you are running DF analysis to make the sky overcast on the last page of the wizard. The folder that you store your own Radiance material files in is C:/Program Files/Square One/Materials. Don't forget to name your material ID the same materialname you called it in Ecotect. And the file must be named materialname.rad, and can be made in notepad if you save it as "all files", not txt, then write the extension .rad yourself. The link which will help you to write material files is http://radsite.lbl.gov/radiance/refer/ray.html#Materials.

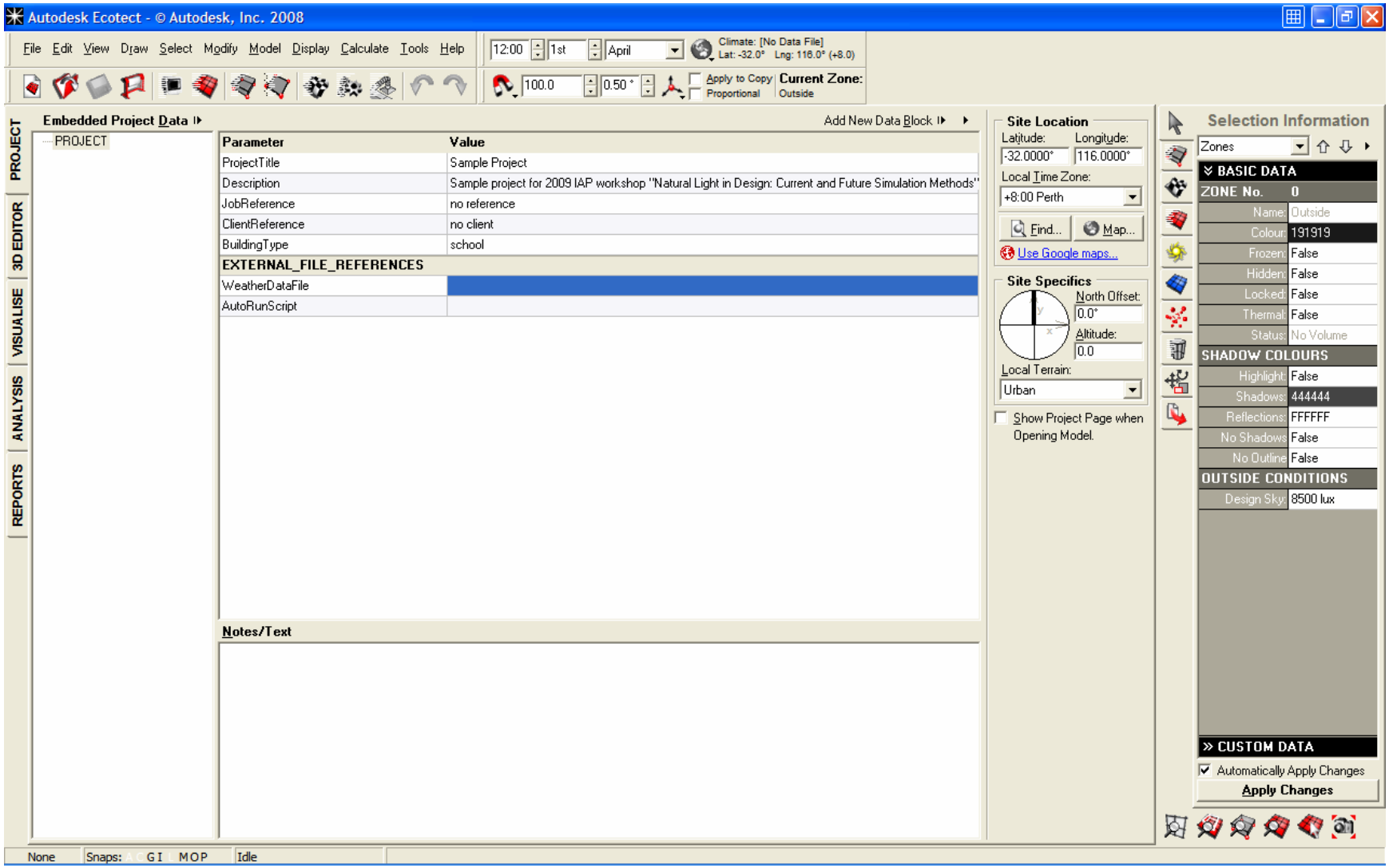
Installing Daysim:
Go to **http://www.nrc-cnrc.gc.ca/eng/projects/irc/daysim/download.html** and fill out the form. Click "Submit" at the bottom of the page. Read the License agreement and click "I agree". Click on the windows download version and save file. Run the install file. Install both Daysim and the Java apps. Accept the Defaults of installing Daysim in the C drive (C:/DAYSIM) Go to **http://www.nrc-cnrc.gc.ca/eng/projects/irc/daysim.html** for tutorials, publications, case studies. The Daysim Tutorial is very useful and includes a section on exporting from Ecotect (Sect 5.2).

Running Daysim from Ecotect:
Use the export manager and chose Radiance/Daysim. Go through the wizard. Make sure to save the .rad file in the folder C:/DAYSIM/projects/projname/projname.rad. On the last page of the wizard, you MUST choose "Daysim Header" from the Output options list, and you MUST click the box that says "Autorun Daysim" right next to it. Daysim should launch and fill out the first three pages for you. (Header, Site, Building import)

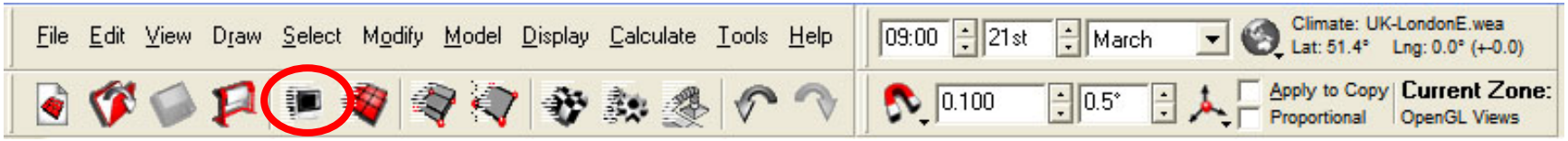
1.2 – The Project Page

On the upper-most tab on the left side of your screen, you may enter any project information and notes for your own records. (See next page.) You can also set the longitude, latitude, and time zone on this page if you wish, but we will do that later in the tutorial. One other very useful function located on this page is the north offset function. If the walls of your building do not face due north, south, east, and west – or if you'd like to try out different building orientations – it's often easier to change the north angle than to change the angle of the walls.

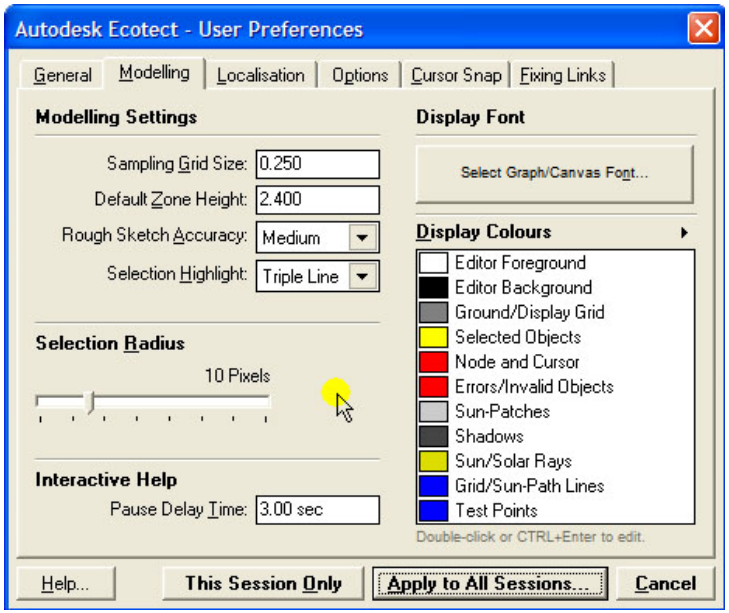
The **altitude** and **local terrain** fields are not used in the lighting analysis portion of Ecotect.

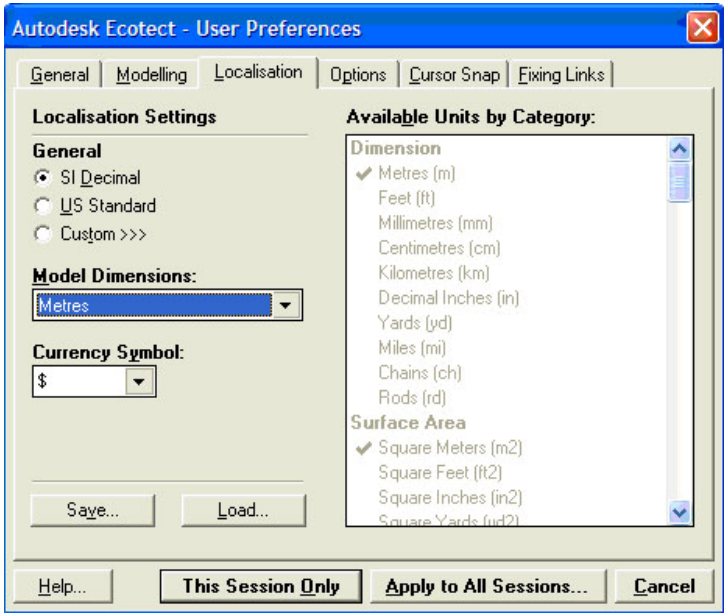

Autodesk Ecotect - © Autodesk, Inc. 2008
File Edit View Draw Select Modify Model Display Calculate Tools Help
Embedded Project Data
Add New Data Block
PROJECT
Parameter
Value
ProjectTitle
Sample Project
Description
Sample project for 2009 IAP workshop "Natural Light in Design: Current and Future Simulation Methods"
JobReference
no reference
ClientReference
no client
BuildingType
school
EXTERNAL_FILE_REFERENCES
WeatherDataFile
AutoRunScript
Notes/Text
Site Location
Latitude:
Longitude:
-32.0000°
116.0000°
Local Time Zone:
+8:00 Perth
Find...
Map...
Use Google maps...
Site Specifics
North Offset:
0.0°
Altitude:
0.0
Local Terrain:
Urban
Show Project Page when Opening Model.
Selection Information
Zones
BASIC DATA
ZONE No. 0
Name: Outside
Colour: 191919
Frozen: False
Hidden: False
Locked: False
Thermal: False
Status: No Volume
SHADOW COLOURS
Highlight: False
Shadows: 444444
Reflections: FFFFFF
No Shadows: False
No Outline: False
OUTSIDE CONDITIONS
Design Sky: 8500 lux
CUSTOM DATA
Automatically Apply Changes
Apply Changes
None
Snaps: GI MOP
Idle

1.3 – User Preferences



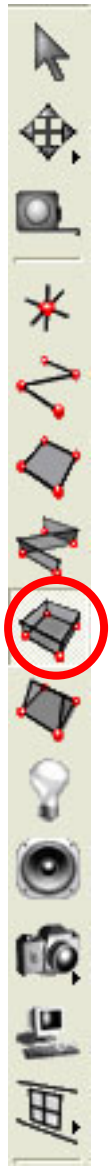
On the top toolbar, there is a little black box through which you can change the user preferences. On these tabs are included the file paths of all important and install files, various user defaults, curser "snap", object linking, and background color options. The two most important tabs are these:





On the **Localization** tab, you set the units in which the model will be built. The Ecotect default is millimeters.

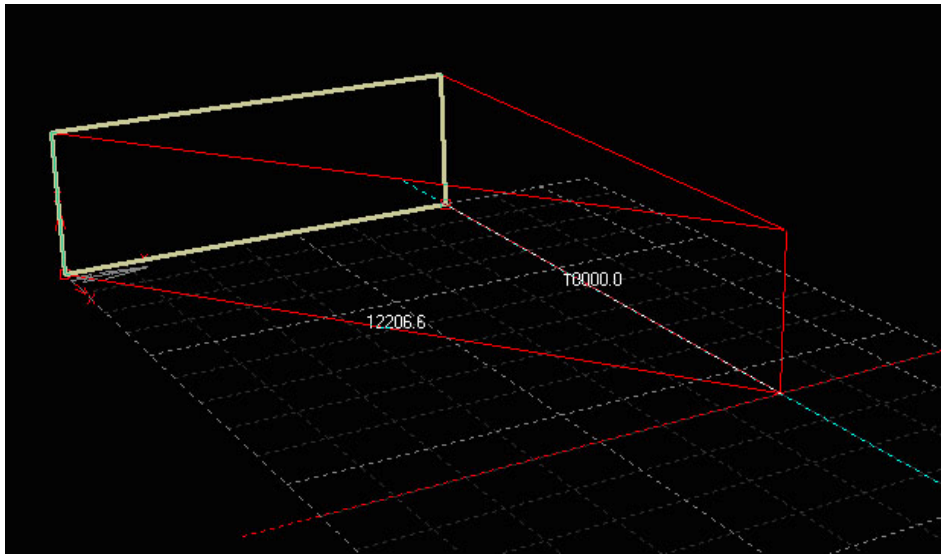
On the **Modeling** tab, the most important thing is to set the **Default Zone Height** to whatever ceiling height you will want. You will have to change this default every time you want to make a space or group of spaces with a new ceiling height.



2 – Basic CAD

2.1 – Making a Room

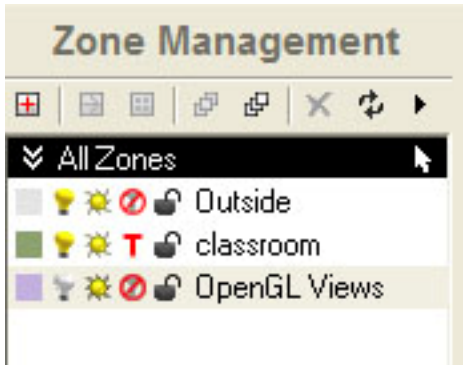
On the side toolbar is the icon for creating a **zone**, which you make by tracing its footprint on the ground plane. (Click on the ground to place each corner, and press **ESC** to close the figure.) The height of the zone is determined by the **Default Zone Height** mentioned in Section 1.3. Unlike points, lines, and planes, a zone is created with every normal facing outwards by default, and appropriate materials are applied to the walls, ceiling, and floor respectively.

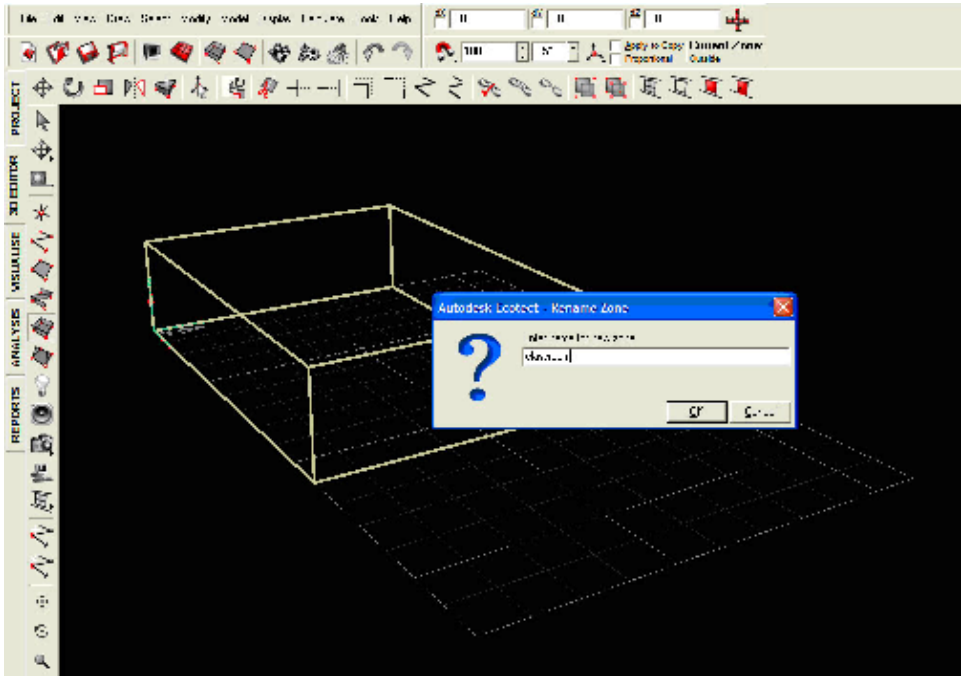


When you press ESC to close your zone, a box will pop up asking what you want to name your zone. Everything you model after this will be placed in this zone until you model a new zone or create one in the zone manager tab to the right of the screen.

The tab with this icon –

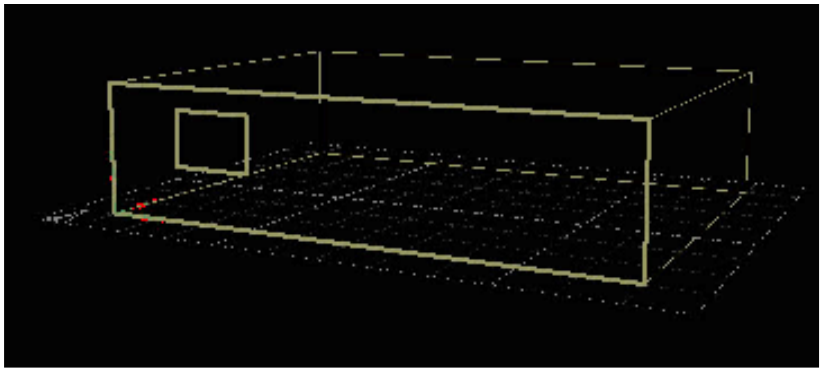
– is for zone management, and in this tab you can select or move objects on a zone, hide zones, etc.

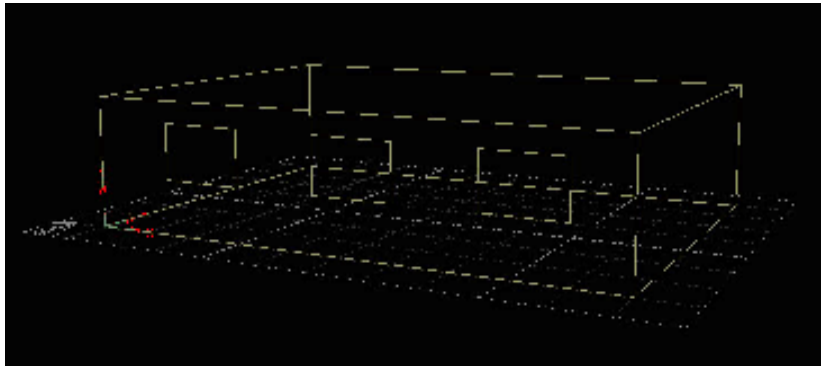




After having made the basic form of my model, I prefer to center the ground-plane grid around my model. You can do this by clicking on **View** in the top menu, then clicking on **Fit Grid to Model** in the drop-down menu. This just makes it easier to orbit and zoom in on your model.

We will now add some windows to our model. First, it is very important to *select the face that the window will be on*. Not only does this assist you in drawing straight lines, but it links the window to that face. Otherwise, you will have a piece of glass floating in front of a wall, not a hole in the wall filled by glass. When your wall is selected, click the window icon on the left side tool bar. It may ask you to chose between several options... just pick the one that looks like a window. (The others are panel, void, and door.)

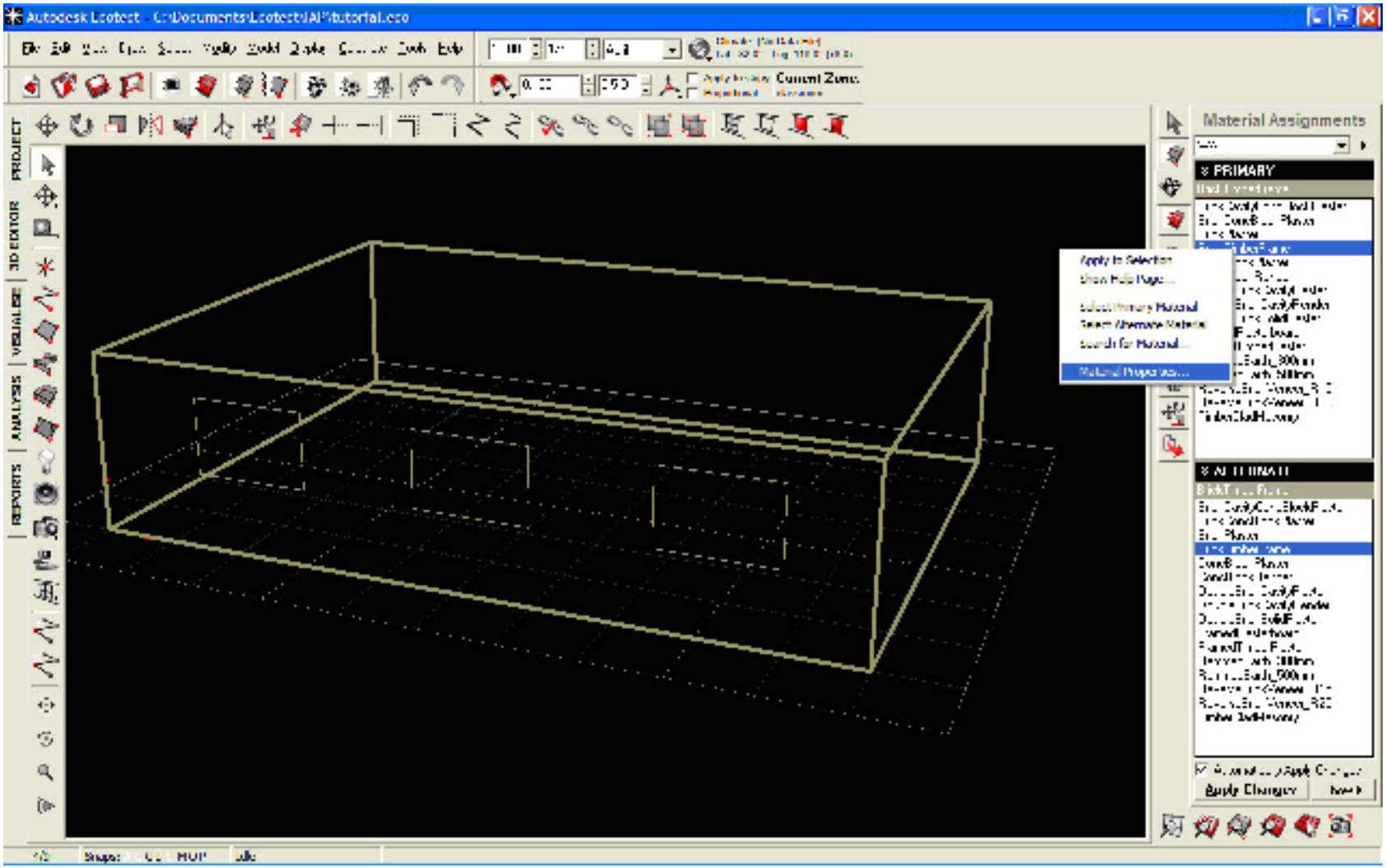




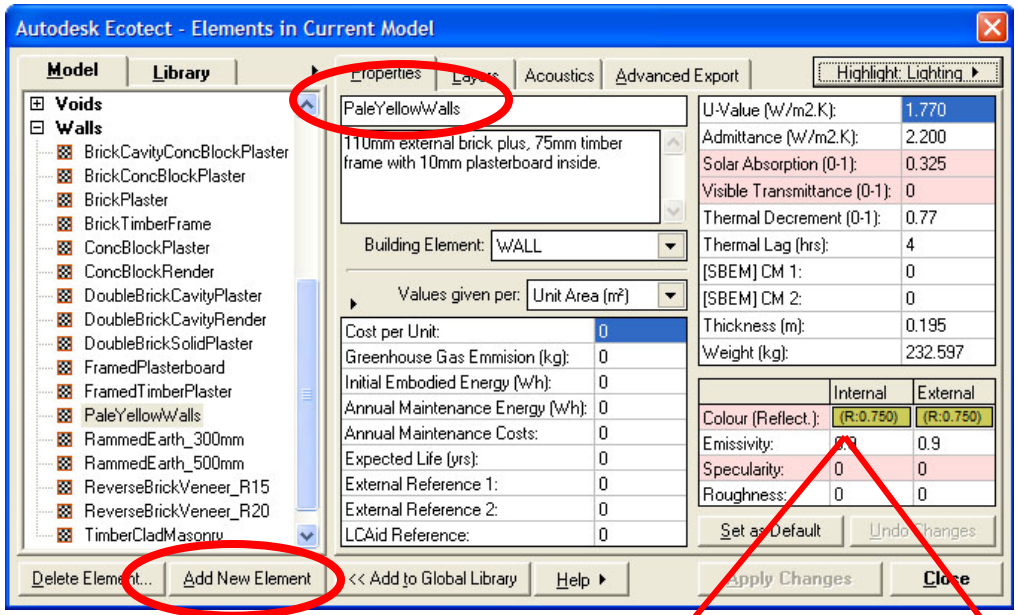
Draw the window on the face, using **ESC** to close the shape. If you want your windows to be exact copies of each other, you can press **Ctrl + C** to copy when the window is highlighted, then **Ctrl + V** to paste (it pastes to the same spot as the first window), and use the move icon (just under the pointer on the left side tool bar) to grab a corner and drag.

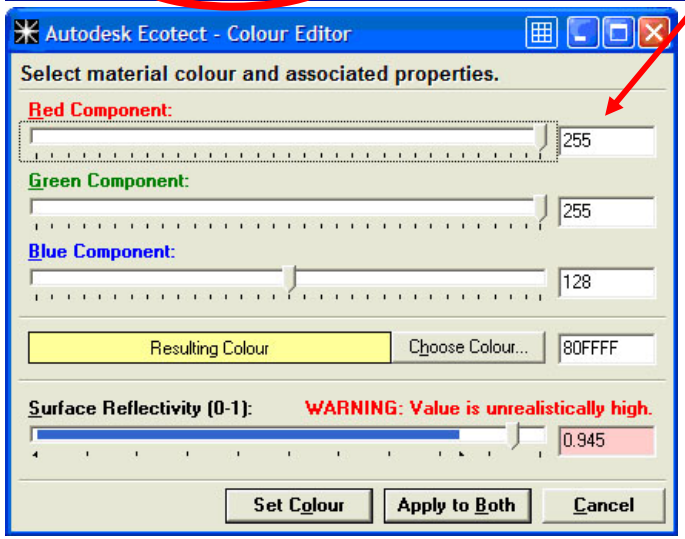
2.2 – Materials

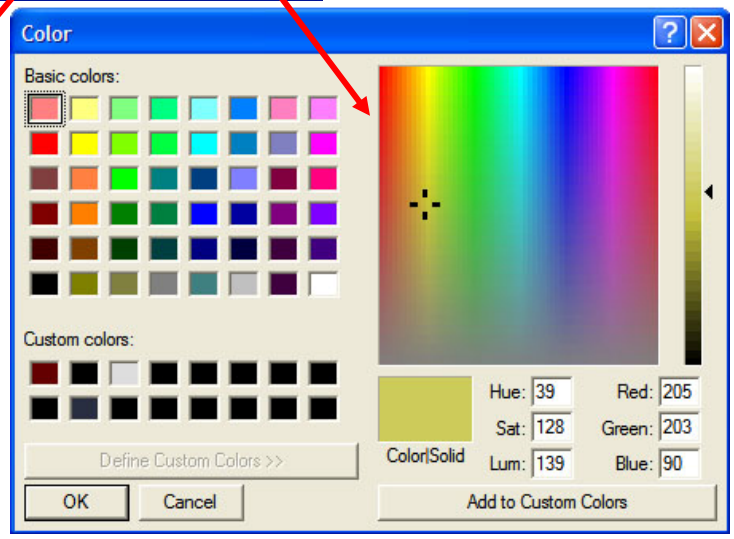
The right side tab with this icon: is the materials library. With this tab open, click on any surface, and the assigned material will be highlighted. Right-click on any material, click **Select Primary Material**, and every object with this material will be slected. Right-click again on any material, click **Material Properties...** and a window will open up that allows you to see and define the properties of that material.



The most important properties to lighting analysis are highlighted in pink below: color, reflectivity, and transmittance. Right-click on the swatches next to the words **Colour (Reflect):** to change the color, and left click to change the overall reflectivity.







You can also change the name of the existing material (no spaces!) and click **Add New Element** to add the new material to the library (the other material will still exist also). This will be useful to us later.

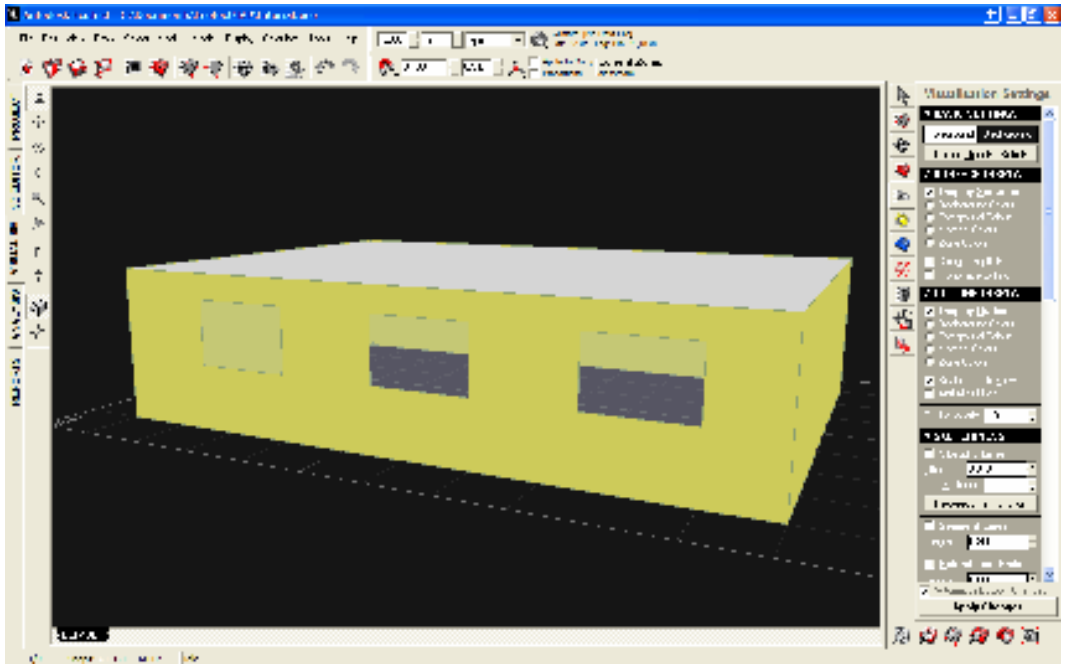
Notice also that if you describe a material that has an unrealistic reflectance, such as the one on the bottom left, Ecotect will warn you, and you can manually change it to something more reasonable.

Keep in mind that when you add a new material to the library, you still need to apply it to the objects in your model. Some ballpark reflectance ranges to keep in mind are 50% – 83% for walls and ceilings, and 10%-50% for floors. White paint has a reflectance of 83%.

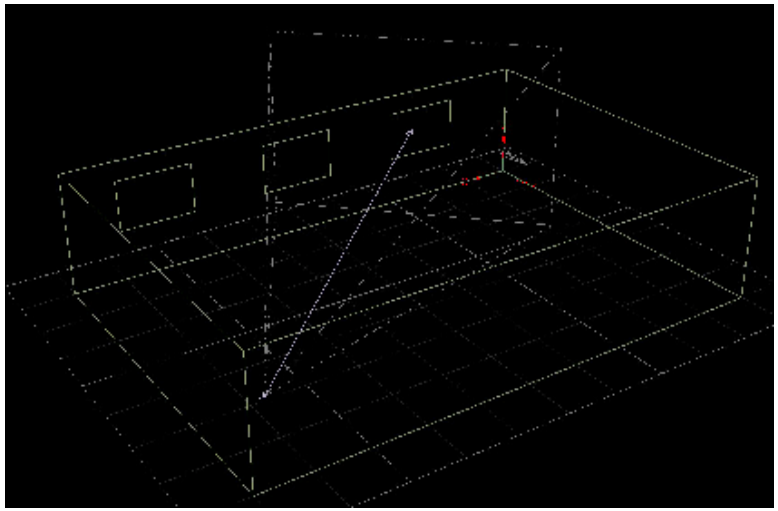
Glass transmittance is around 92% by default in Ecotect. This is very high, so you may want to reduce it manually.

2.3 – Visualizing and Setting Cameras

At any time in the previous process, we could have looked our model in the **Visualise** tab, which shows a filled-in rather than a wireframe model. In this tab, we will notice if our geometry has gone wrong, if we've assigned materials in the wrong places, or if the windows did not become attached to the walls.



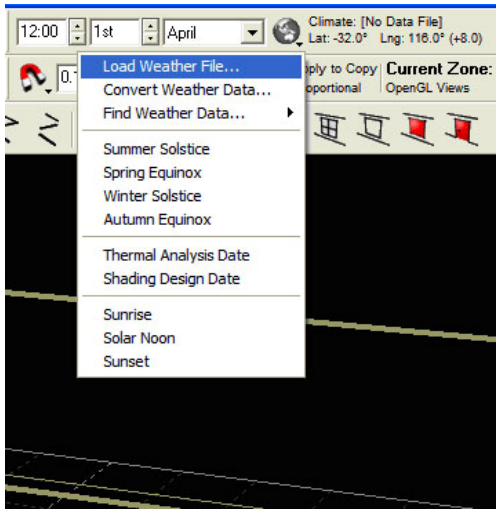
The eye icon on the right side is the **Visualisation Settings** tab. Here you can assign cutting planes, cull the front-faces, so that you can see inside, and more importantly, you can set camera views. To set a camera view, rotate the model to the view position you desire, scroll down the **Visualisation Settings** menu until you find **Camera Views** and click the button marked **New...** That particular view will now be saved in a tab at the bottom of the screen, and that view will be exported for rendering.

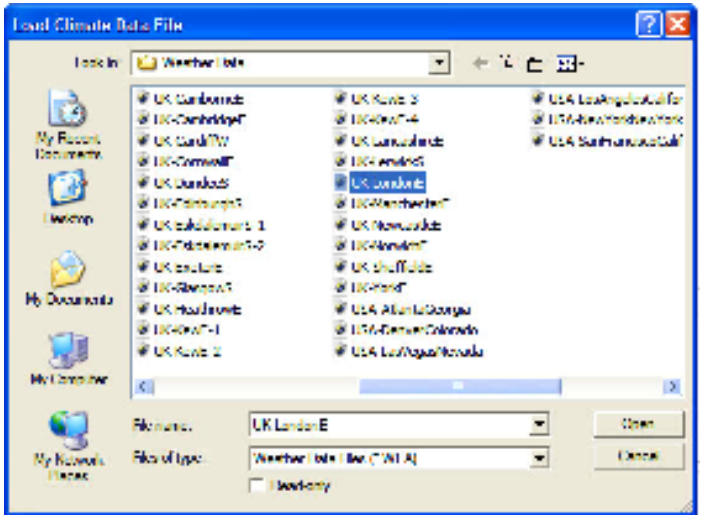


You will notice when you go back to the wireframe model that your camera views have formed a new zone called **OpenGL Views** and are graphically represented by a camera point, a view vector, and a view aperture and plane. If you had a hard time getting the correct spot for your camera in the visualize mode, you can physically move the camera point in the wireframe model.

3 – Sun Path and Climate Data

3.1 – Setting a Weather File



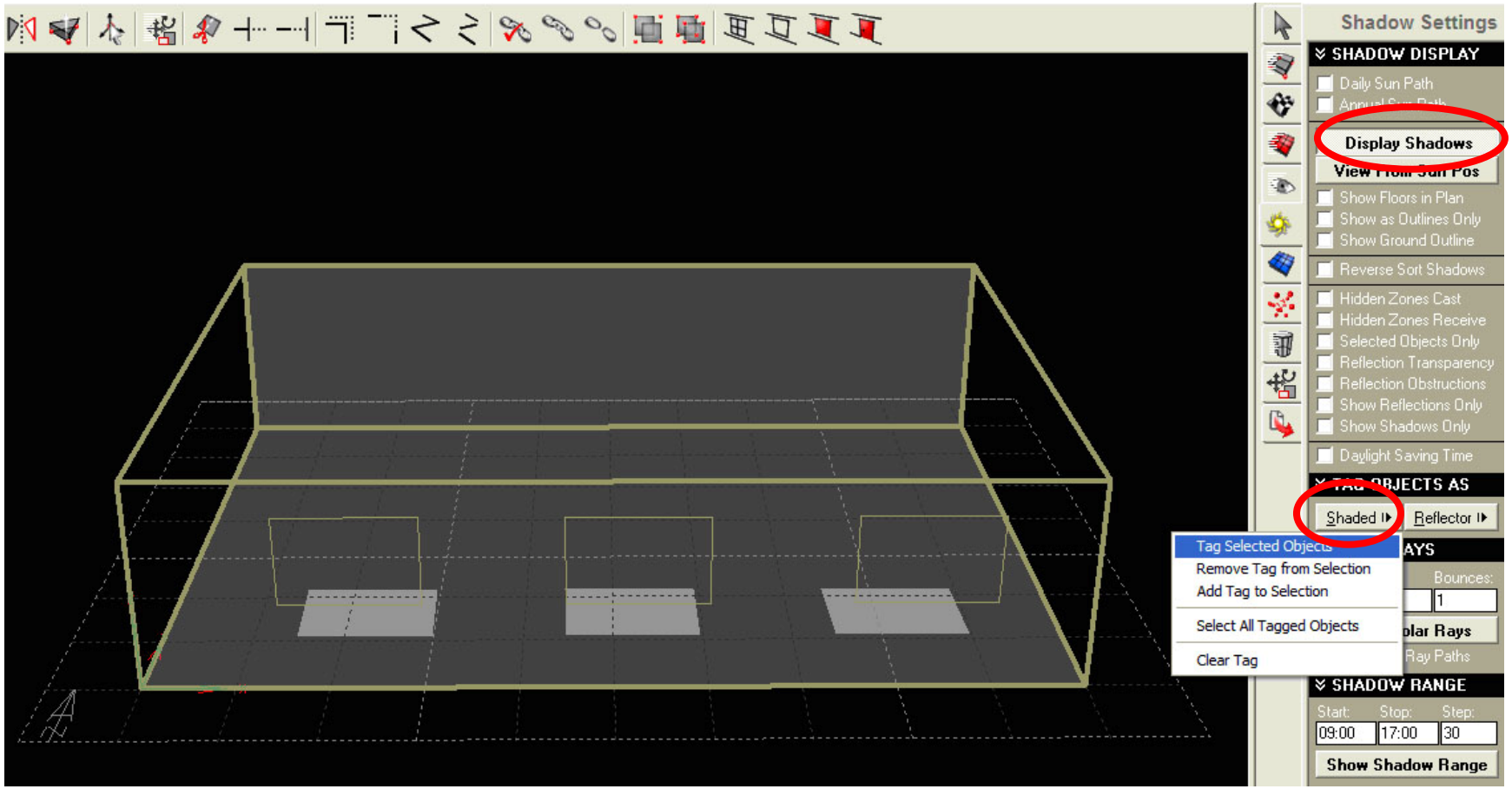


Before we can do any analysis, we must locate our model on the earth. In the top toolbar, next to a group of time and date dropdown menus, is an earth icon. Click on this icon and choose **Load Weather File...** from the menu. This will open up the **Weather Data** folder in the Ecotect install files and allows you to choose from any of the .wea files that come with Ecotect. If the city you desire is not in this folder, choose **Find Weather Data...** from the earth icon menu and get the data either from Ecotect's own website (Square One, Inc) or from the Energy Plus Weather Data website.

If you need to use the Energy Plus site, download the .epw file for the correct city and save it to the Weather Data folder in the Ecotect install files. In Ecotect's top toolbar, click on **Tools** then **Convert Weather Data...** Ecotect's **Weather Tool** will open automatically. Go to **File** and **Open...** in the Weather Tool menu and open the file you just downloaded. An import screen will pop up. Press the button that says **Import...** and the data will be loaded into the Weather Tool. Save the loaded data as a .wea file in the same folder, and you will then be able to load it into Ecotect as described above.

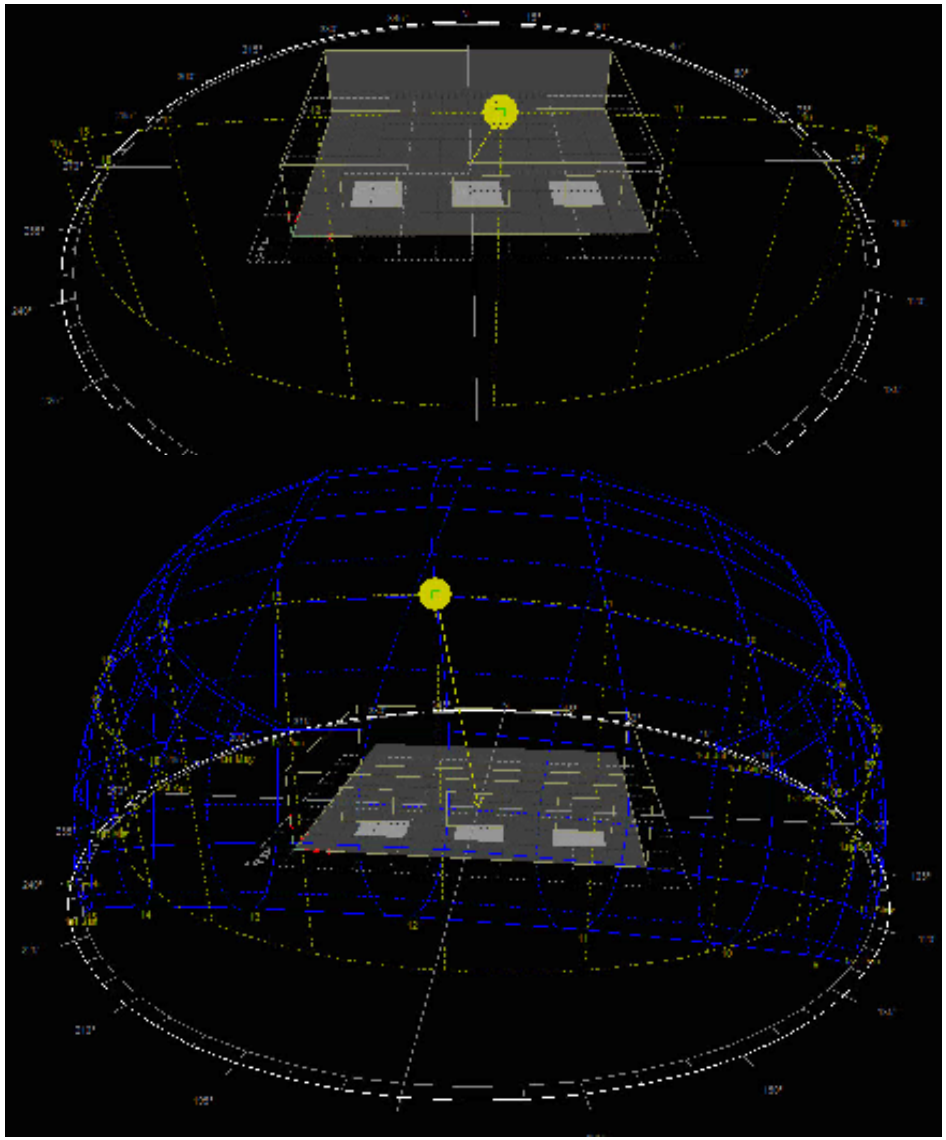
3.2 – Visualizing the Sun Path and Shadows

The ability to visualize the sun path in 3-D is one of the most powerful and useful of Ecotect's abilities. The sun icon on the right side indicates the **Shadow Settings** menu. If you open that menu and click the **Display Shadows** button, a shadow cast by the model (appropriate to the time and date currently listed next to the earth icon) will be displayed on the ground plane. If appropriate, you will also see spots of direct sun penetration through windows in the model.



The ground plane is the default place where shadows will be cast, but you can change that by selecting alternate objects on which shadows (and sun spots) will be cast. One intuitive way to do this is to select the floor and all the walls of the model to "tag as shaded" (see picture above). This will allow you to see how shadows and sun spots are cast inside the model.

The above instructions help visualize shadows and how they move in a space, but Ecotect helps you visualize the sun's path as well. Above the **Display Shadows** button are **Daily Sun Path** and **Annual Sun Path** options. This first will produce a 3-D yellow curve representing the sun's path on the day specified in the top toolbar (with the sun positioned at the specified time), and the second will add a network of blue lines that represent the sun path of the first day of each month. The hourglass figures



spaced along the sun path represent each hour. The path of the hour over the year forms this shape due to the sinusoidal variance (of a few minutes only) between solar time and clock time due nature of earth's rotation and elliptical solar orbit.

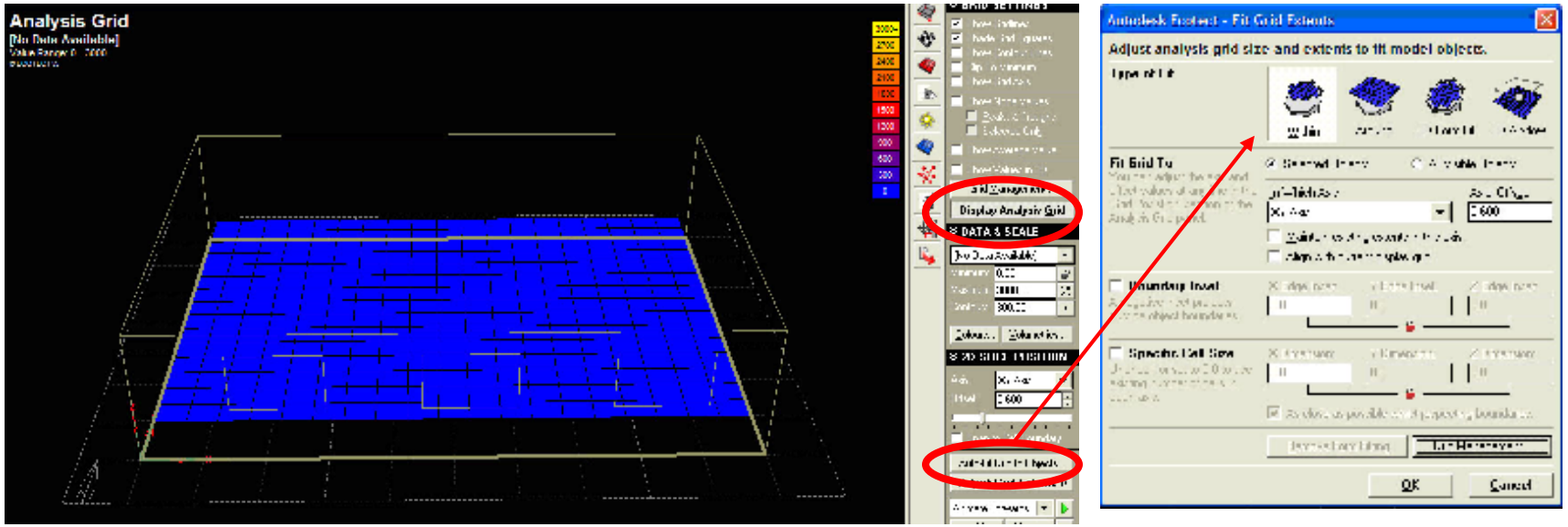
At the bottom of the **Shadow Settings** menu, there are two **Animate Shadows** options; the **Hourly** animation shows the sun (and the resulting shadows) changing from sunrise to sunset on the specified day. The **Annual** animation shows the sun and shadows changing from January through December at the same specified time of day.

These sun path and shadows options give a good visual understanding of geometric sun penetration within the model for the specified climate.

4 – Numerical Analysis

4.1 – Setting the Analysis Grid

Next we will create a work-plane grid for numerical analysis. The **Analysis Grid** menu on the right is indicated by the icon . Click **Display Analysis Grid** to bring up the default grid, and to fit the grid within the model, highlight the floor plane and click **Auto-Fit Grid to Objects**. A menu will pop up offering options for the type of fit. To keep the grid within the floorplan of the model, choose the option **Within** and press **OK**. You can adjust the height of the work-plane grid by adjusting the **Offset** (and change the grid orientation from horizontal to vertical by adjusting the **Axis**) under the subheading **2D Slice Position**. You can also manually adjust the grid cell size and extents by pressing the button **Grid Management...**

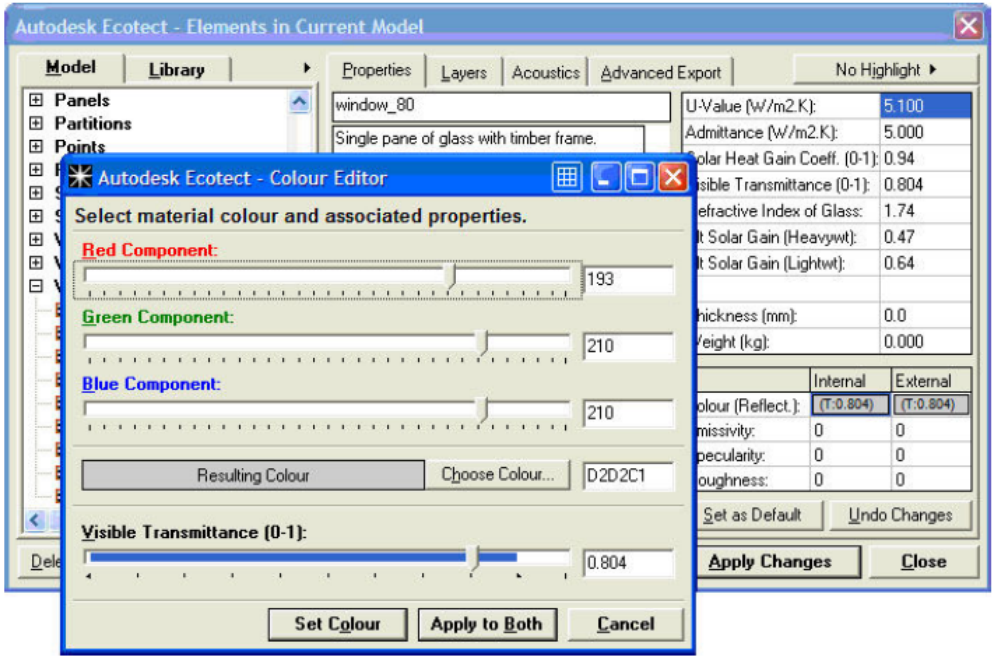


4.2 – Exporting to Radiance

If you have not done so, you should save your model now. Although Ecotect has quite a few internal calculation tools, we will skip over them and export directly to Radiance. The reason for this is that Radiance has been proven one of the most numerically accurate rendering tools in existence, while Ecotect uses quick but much less reliable hand calculations.

One unfortunate thing about the Radiance export function is that it does not always export materials reliably – especially glass and other transparent materials. However, the software allows you to make your own Radiance materials.

For example, to make a Radiance definition for a glass material with 80% transmittance, we must first make a new window material in Ecotect (see section 2.2. This new material is called window_80 and assigned to the model's windows.



The next step is to open Notepad, or some other text editor, and write these lines:

```
void glass window_80
0
0
3   0.84   0.84   0.84
```

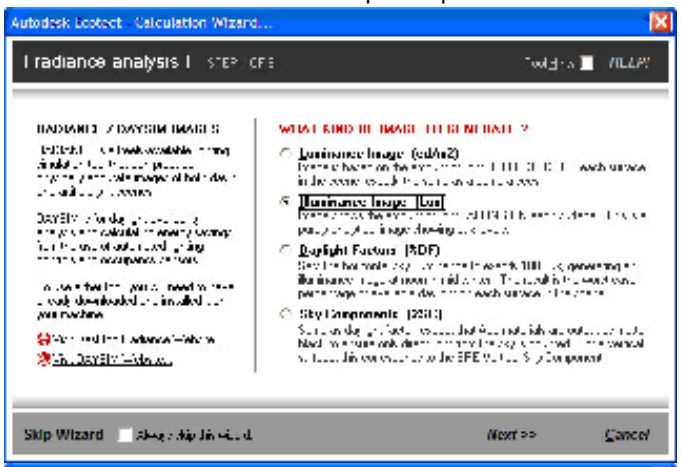
(← Note that the Radiance glass definition requires a slightly higher number than the transmittance.)

The file must then be named "window_80.rad" – it is important to save it as type "All files", so that ".txt" does not get appended to the name. Your new material file needs to then be placed in the Materials folder in the Ecotect install files. On most computers, this will be the folder C:\Program Files\Autodesk\Ecotect\Materials\. Finally, on the last page of the export wizard (see page 19), you must make sure that **Check for Material.rad files...** is checked, or Ecotect will not look for them. When exporting, Ecotect will then replace any materials with a corresponding Radiance material file.

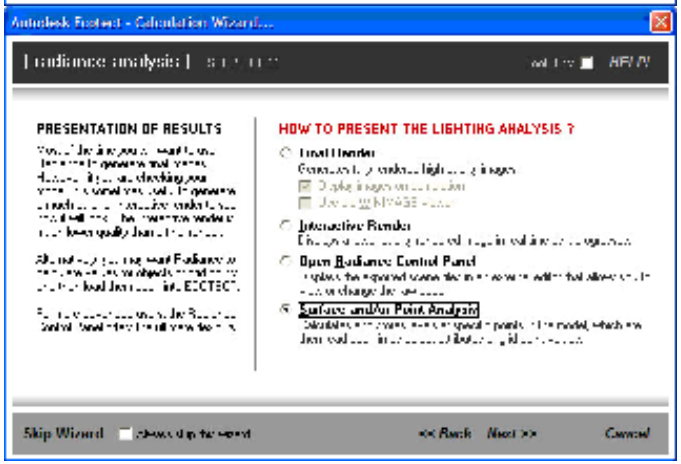
Radiance material definitions can be found at http://radsite.lbl.gov/radiance/refer/ray.html#Materials. Here is an example of a wall material stored as file PaleYellowWalls.rad:

```
void plastic PaleYellowWalls
0
0
5   .804 .796 .353 0 0
```

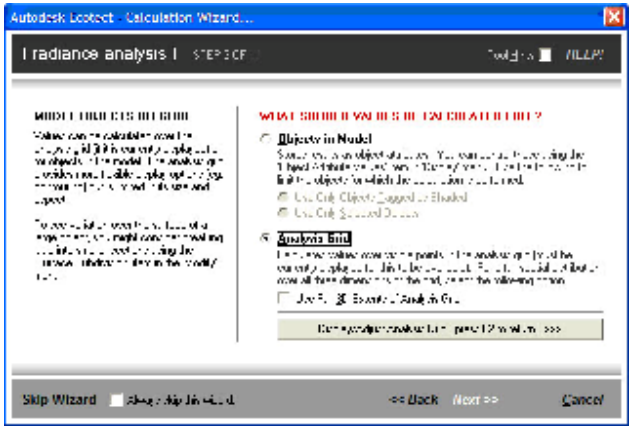
The export menu, indicated by this icon , has buttons for each program that it's possible to export to, although they must be separately installed on your computer beforehand. (Therefore Radiance should already be installed on your computer, preferably in the folder C:\Radiance\.) Click the button **RADIANCE/DAYSIM** and then click **Export Model Data...** The first thing it will ask you to do is to save the model as a .rad file (this is different from saving it as an Ecotect model). You should create a separate folder for this model (there will be several supporting files) in a path with no spaces in it's name. For example, *C:\Ecotect\model1\model.rad* works, but *C:\My Documents\Ecotect\model 1\model.rad* may not work due to the spaces in "My Documents" and "model 1". When your model is saved, a wizard will guide you through the steps of exporting to Radiance. Here is an example export:



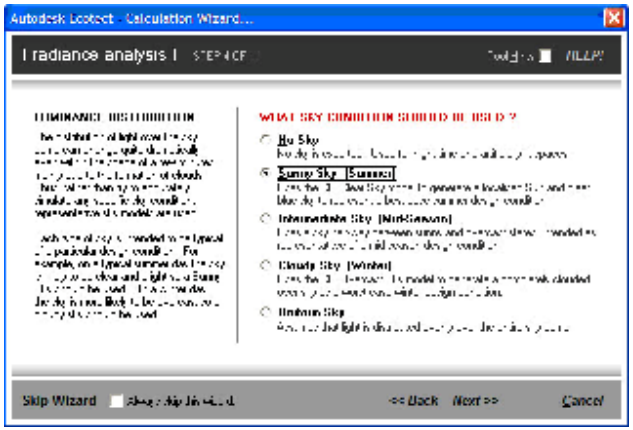
Here, we've chosen to calculate illuminances, in units of lux. Illuminance is the most common metric for architectural lighting codes.



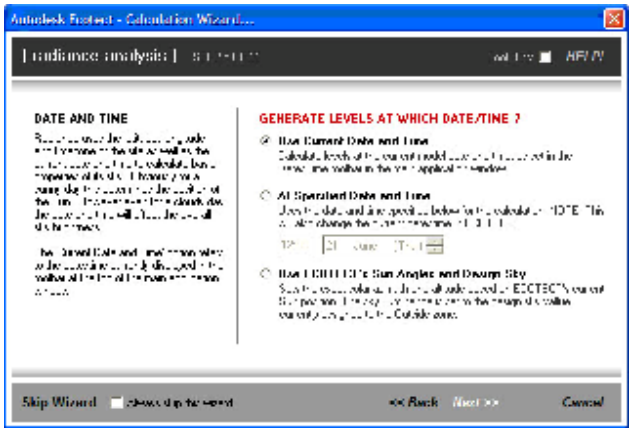
Choosing **Surface and/or Point Analysis** means that numerical illuminances will be calculated as well as pictures rendered.



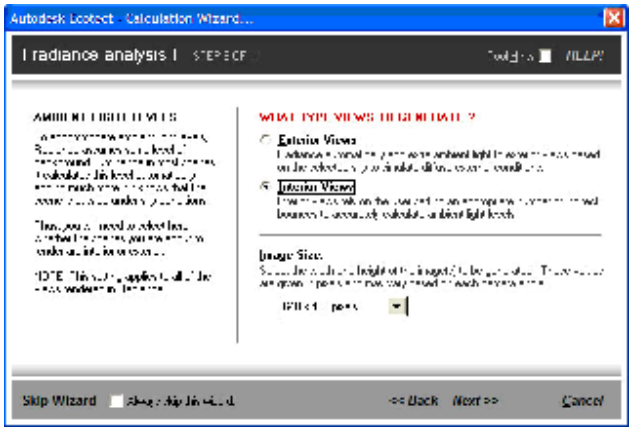
Choose **Analysis Grid** so that illuminance will be calculated at points in the grid we just set up.



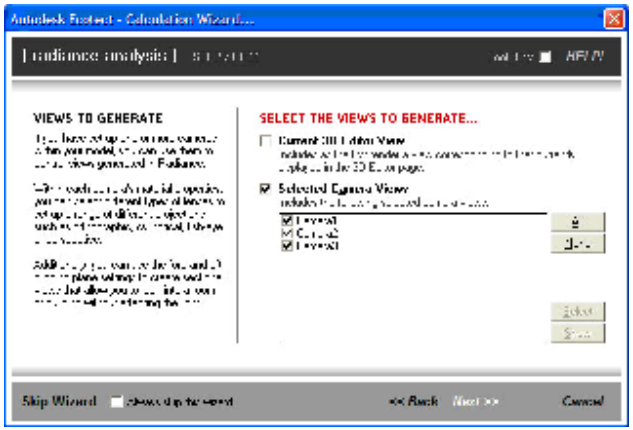
Here we have a choice of sky conditions, and we've chosen **Sunny**.



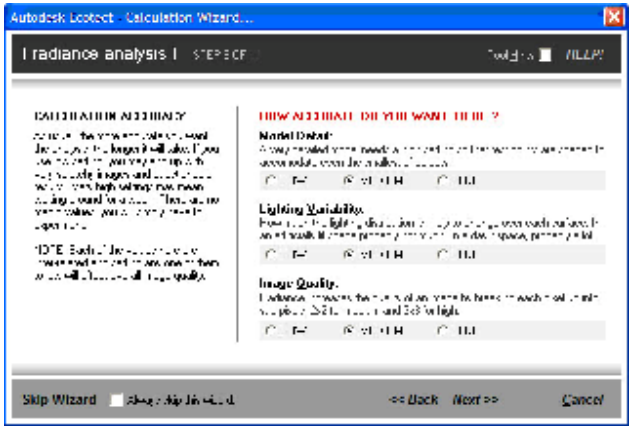
If we pick **Use Current Date and Time**, we will be doing the rendering and calculation for the date and time currently in the top toolbar next to the earth icon.



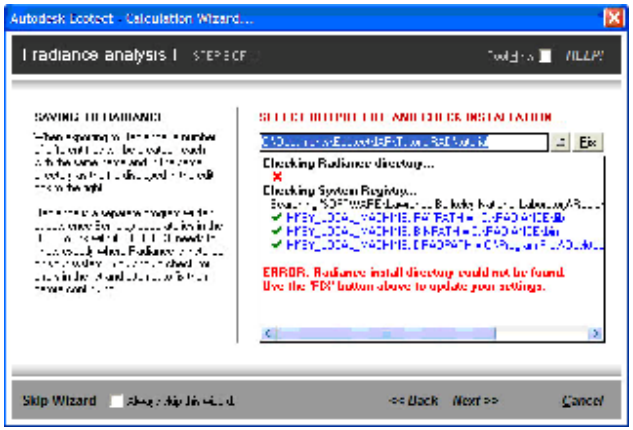
We will probably want to see **Interior Views** of our model, if we have set up the appropriate cameras.



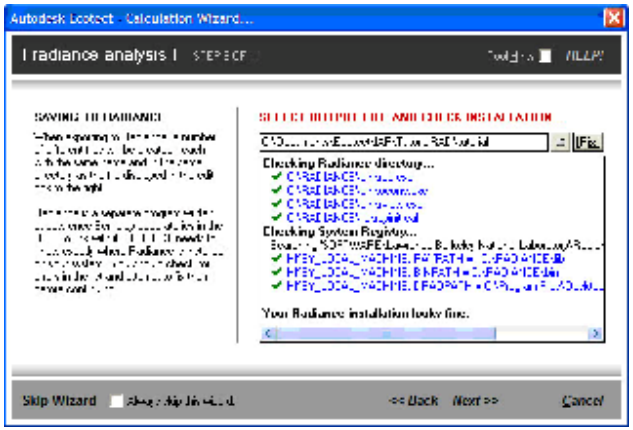
The cameras that you set up will appear in the lower box... select only the ones you wish to render.



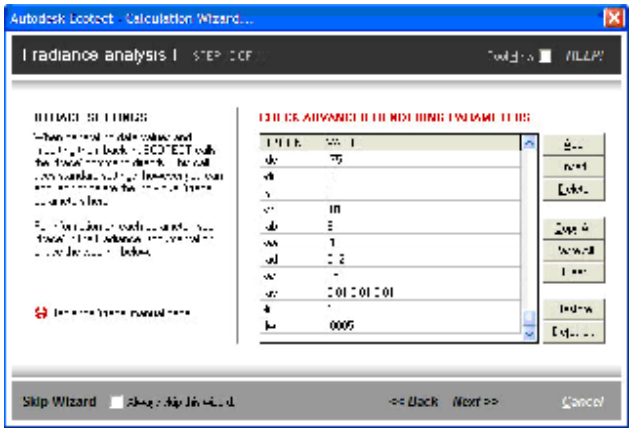
This accuracy effect the suggested Radiance parameters. Obviously a model rendered at high accuracy takes longer. There's no real reason to not use the medium setting.



If this is the first time you've exported to Radiance, you will see an error on this page. What you need to do is locate a file called rad.exe for Ecotect. If you've installed Radiance on the C: drive, rad.exe should be located in C:\Radiance\bin\rad.exe. You should browse and locate this file by clicking the button that says **Fix**.



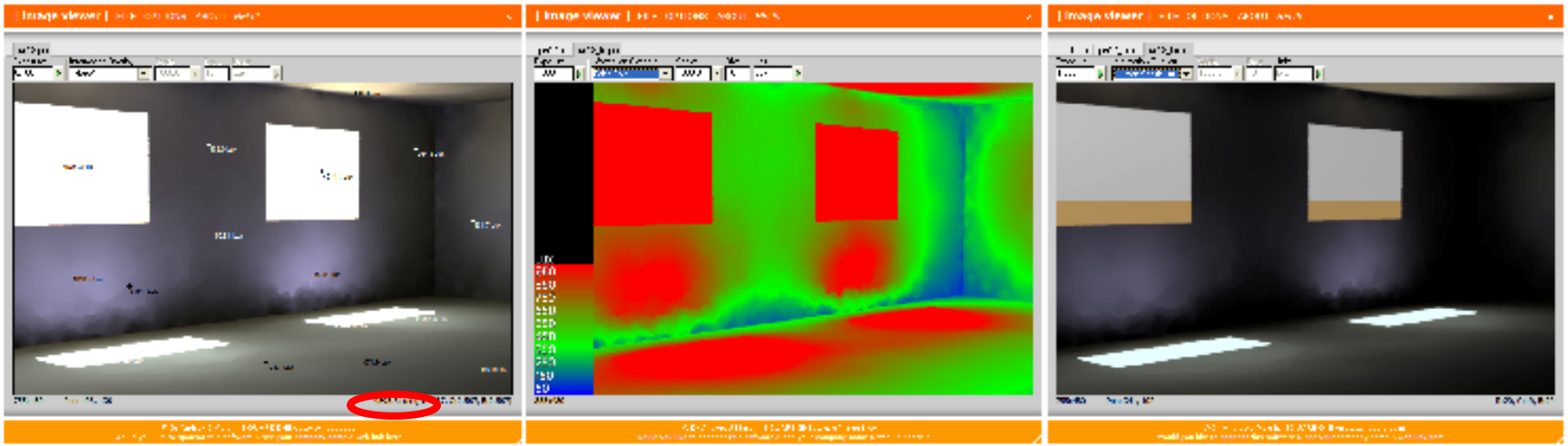
Once Ecotect knows where Radiance is, you need to check the path name for the Radiance output. There should be NO SPACES IN THIS PATH.

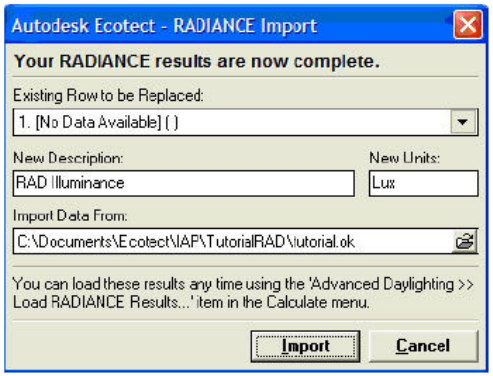


These are the Radiance parameters being used for the calculation and rendering. If you wish to know more about what they mean, there is a link on the left side of the wizard screen to the appropriate Radiance manual page.

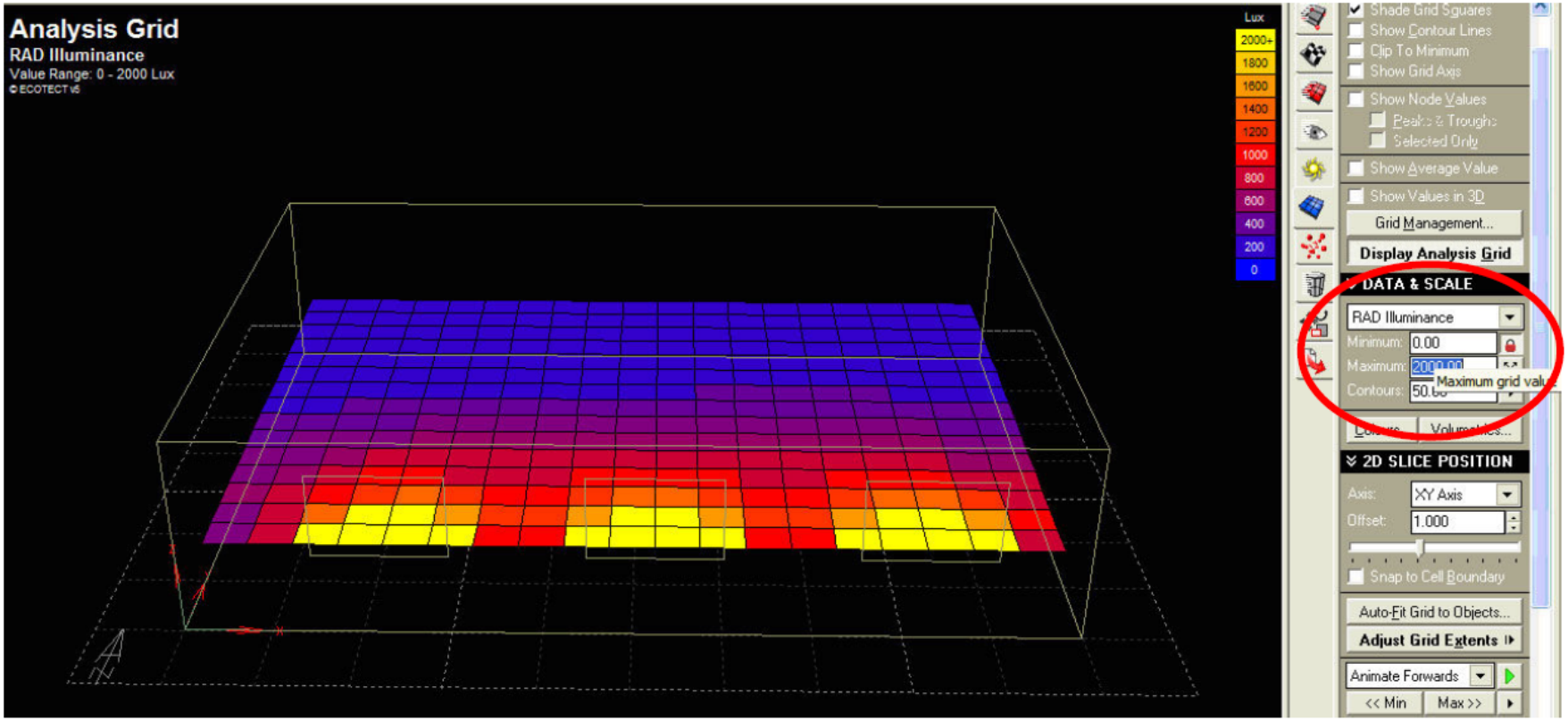
The final page of the export wizard is largely a summary of what the wizard just guided you through. In fact, if you like, you can always skip to this last page to define the export. Make sure the settings are the same as the ones in this picture and click **OK**. The wizard will disappear and a black command screen will open up while Radiance is running.

When Radiance is finished, the renderings will pop up first inside a viewer. You may need to change the size of the window. By running the mouse over the pictures that appear, you can see the illuminance at each pixel (in the bottom right hand corner of viewer). You can also record the illuminance on the picture itself by clicking on different pixels. Different overlays, such as false color (below center) and human sensitivity (below right) are available. Human sensitivity is a setting that tries to take into account the high range of brightness that humans can see at once.



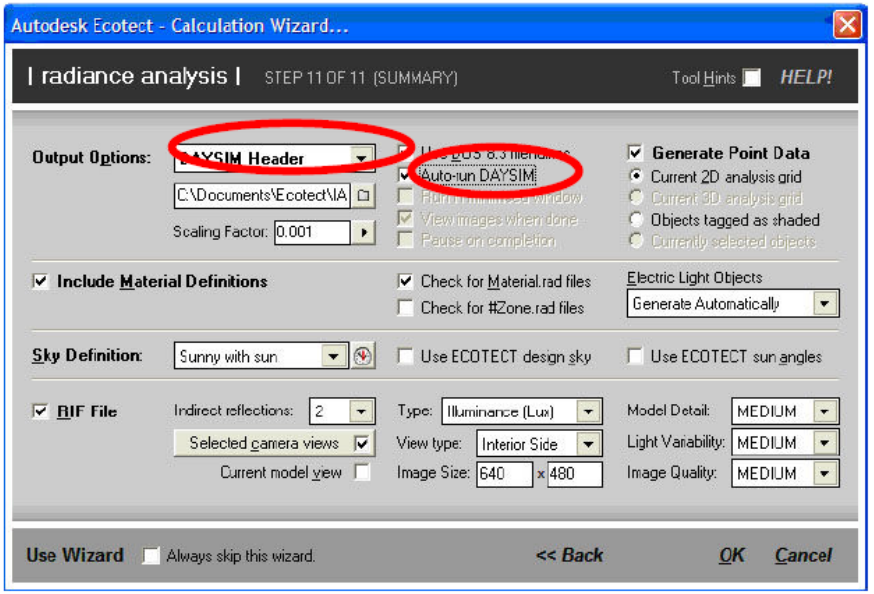


The other output of Radiance is the illuminance data on the work-plane. When you close or minimize the Radiance viewer, you should notice that a little window has popped up on your Ecotect screen detailing the data and what it will replace. Click **Import**. You may need to hide and redisplay the analysis grid, but the Radiance Data should cause the grid to change color. If you do not have a color scale locked in place at this point, it will create its own scale. For readability and for comparison purposes, you will want to create and lock your own scale. Just change the maximum, minimum, and contour range under the subheading **Data & Scale** in the **Analysis Grid** menu, and then click on the small picture of the lock. The analysis grid will stay visible and complete in the visualize mode also.

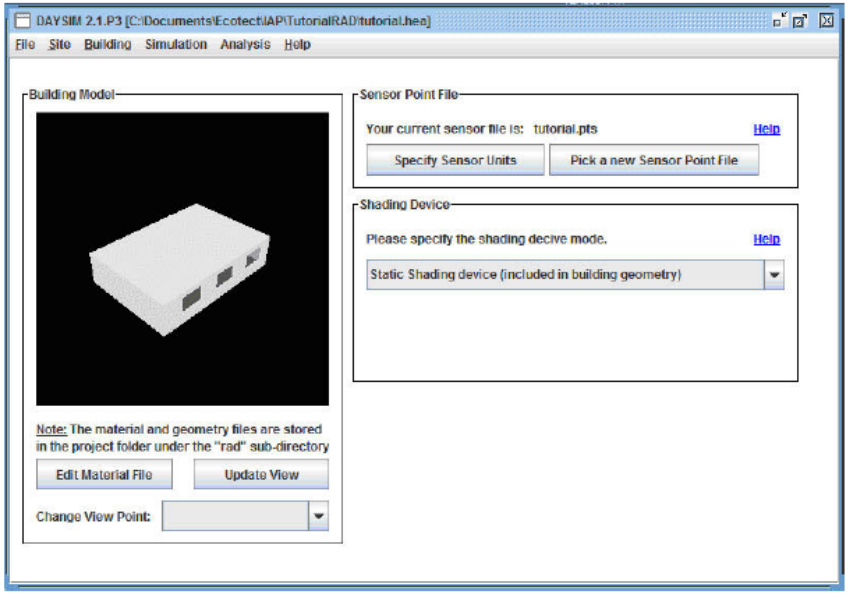


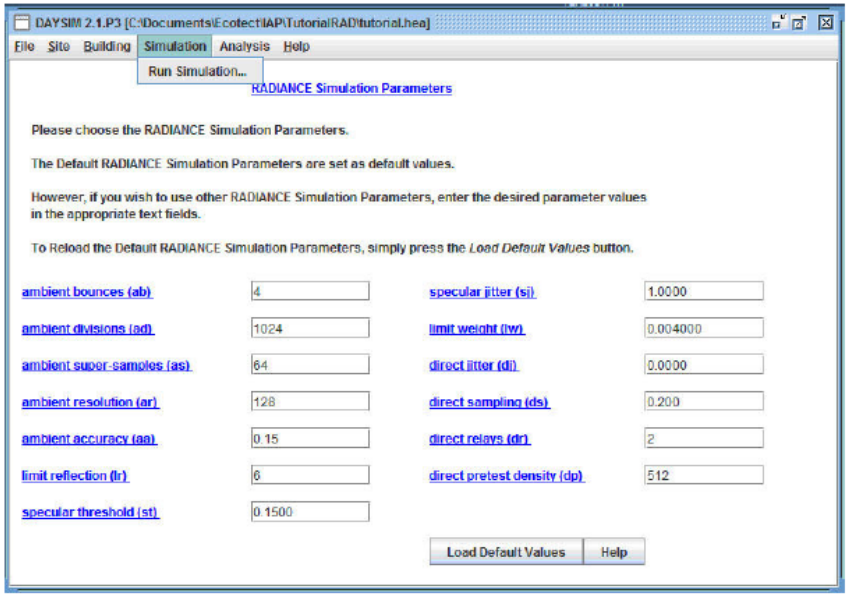
4.3 – Exporting to Daysim

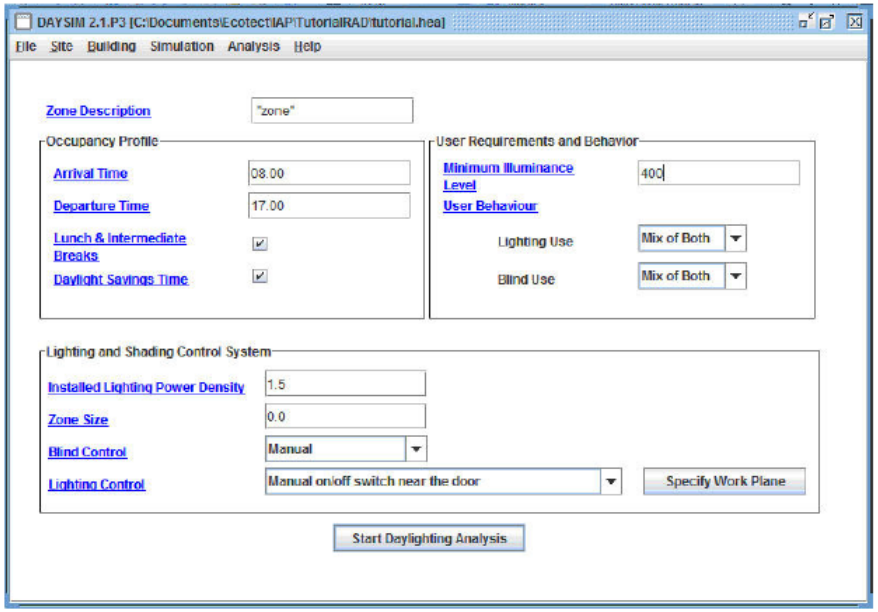
An export to Daysim is the same process as exporting to Radiance (section 4.2) up until the last screen of the wizard. On this page, **Output Options** must now read **DAYSIM Header**, and **Auto-run DAYSIM** should be checked. Everything else can remain the same.



This time, the Daysim java application should open up and fill out the first three pages automatically, ending on the left-hand page below. Click on **Simulation** to reveal the page on the right. These are the Radiance parameters used in simulation, and the defaults are low-accuracy. You can either repeat the parameters used in Radiance by Ecotect (section 4.2), use the ones entered below, which are reasonable for simple models, or research the meaning of the parameters (http://radsite.lbl.gov/radiance/man_html/rtrace.1.html).



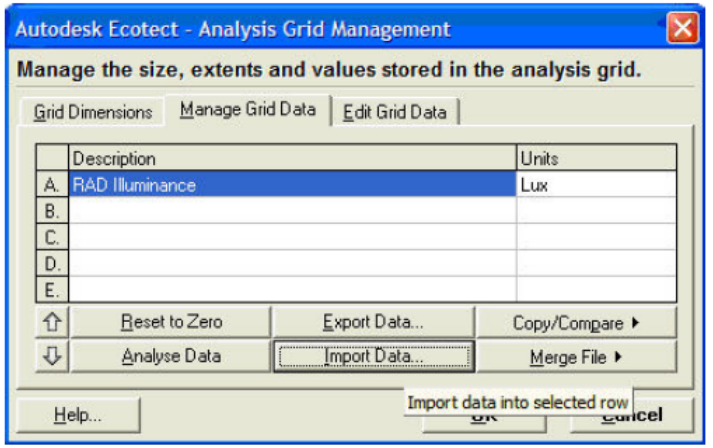


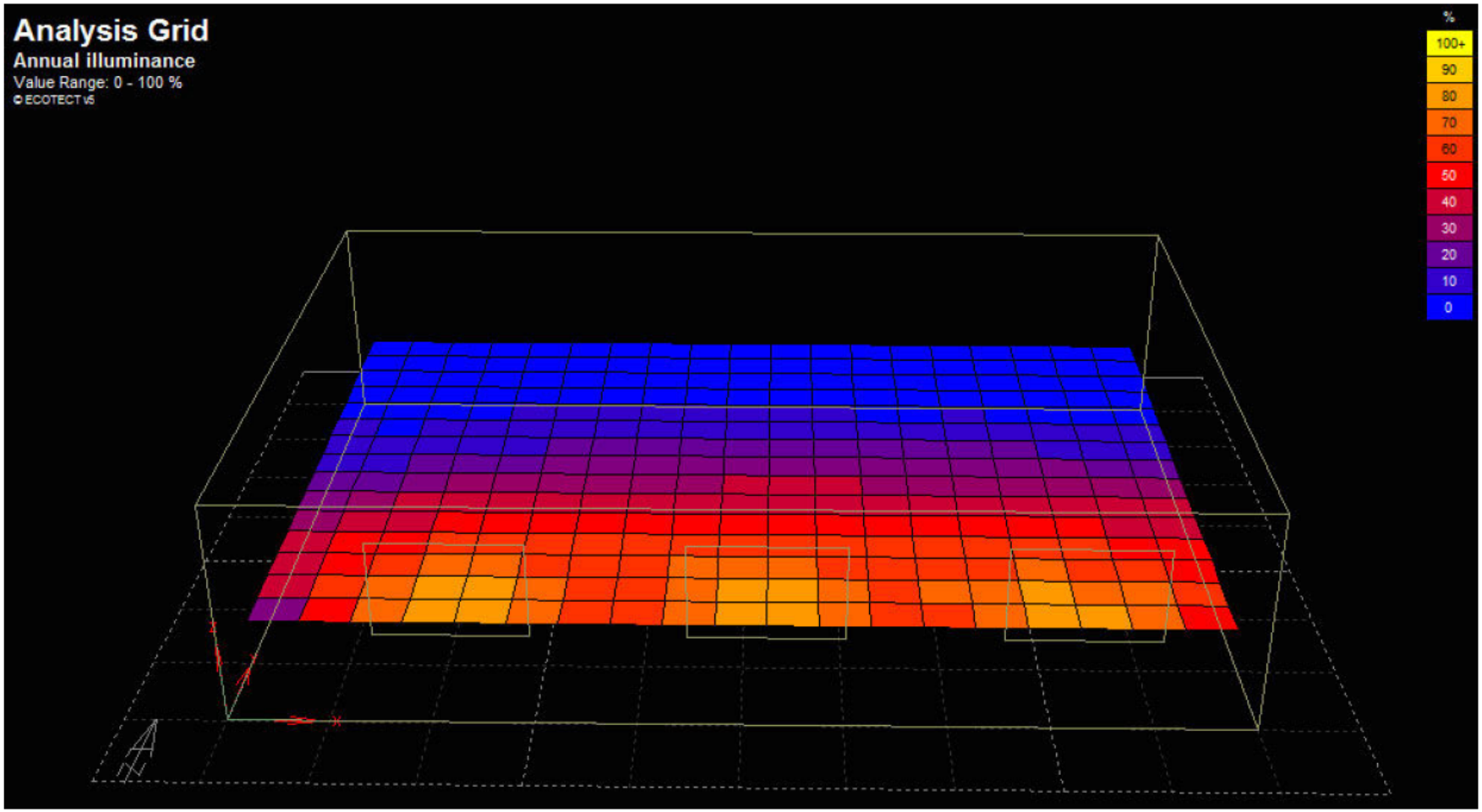


After entering your parameters, click **Run Simulation...**, make sure you are calculating both **daylight coefficients** and **illuminance profiles**, and check **Run a simulation with the Daysim GUI** (do not make a batch file for later). Several black command line screens should pop up one after the other in the course of the calculation, which may take a little while.

When Daysim is finished calculating, it will take you back to the **Simulation** page. Go next to the **Analysis** page to define **occupancy hours** and the **minimum illuminance threshold**. When you click on **Start Daylighting Analysis**, Daysim will look at the illuminance results for your model in 60 minute increments over the year during occupied hours. (You can make it 5 minute increments by replacing the weather file on the **Site** page and re-doing the simulation.) Daysim will then count up the number of hours out of the annual total had an illuminance greater than the minimum threshold. This percentage of hours out of the total is known as Daylight Autonomy. When Daysim is finished calculating Daylight Autonomy, it will open up an html script report in your web browser with the tabulated data and other information.

To import the Daylight Autonomy data onto the work-plane grid in your model, click on the **Grid Management** button in the **Analysis Grid** menu. On the window that pops up, click on the **Manage Grid Data** tab (see right). At the bottom of the window, click on the **Import Data...** button and browse to the folder in which you saved your files before export. Daysim will have generated a group of folders – open the one named **res**. Change the window to look at files of type **DAYSIM Daylight Autonomy (*.DA)**, and open the file with extension ".daylight_autonomy.DA". You may have to hid and re-display the analysis grid, but the daylight autonomy data should now be on the grid. You will probably have to unlock and redefine the scale to go from 0 to 100, since Daylight Autonomy is in units of %.





5 – Closing Comments

This tutorial skipped over many details, but should provide enough information to go from installation to analysis with a simple model. Ecotect includes many other functionalities than are listed here, and I encourage you to spend some time playing with its capabilities, or reading the Ecotect features pages at http://ecotect.com/products/ecotect/features.