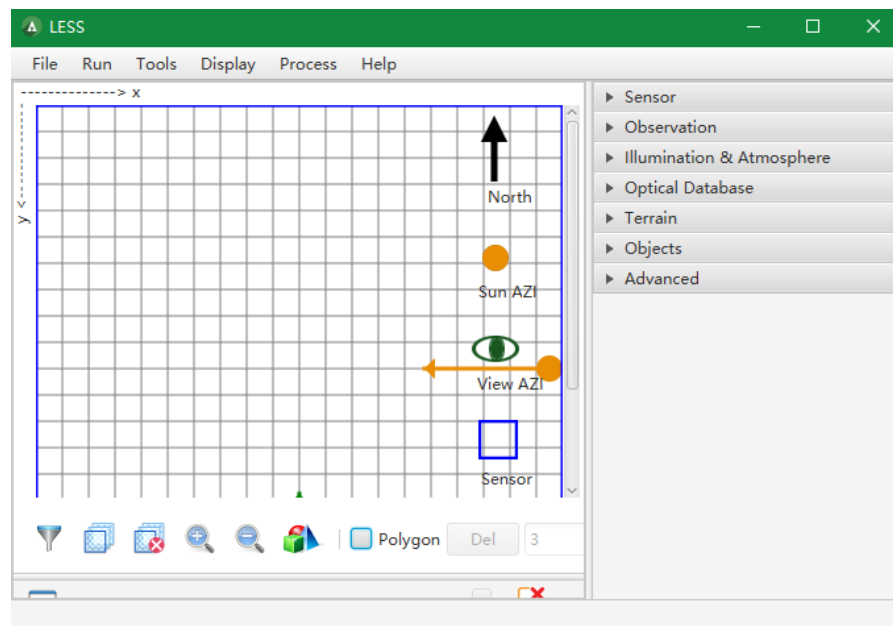


## Example 1. To construct a forest scene

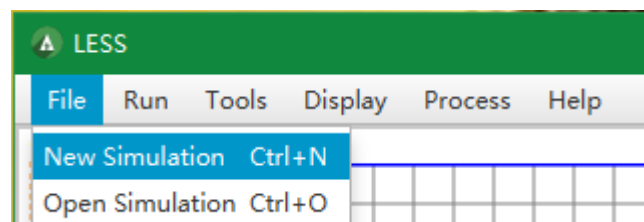
Purpose: Following this manual, you can construct a 3D forest scene based on the given 3D tree model. You can find a file named “birch.obj”, which is a 3D tree model with the “obj” type.

1. Open the LESS, and the main window appears (**Figure 1**).



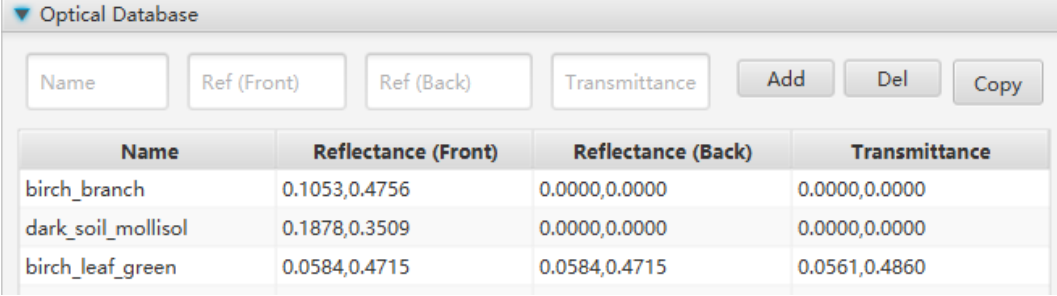
**Figure 1.** Main window

2. Create a new simulation by choosing [File] -> [New Simulation], then create new folder and select it. If create a simulation successfully, you can see “Succeed: ‘save path’” in Progress Panel (**Figure 2**).



**Figure 2.** Create a new simulation

3. Define optical models in [Optical Database] in Parameter Control Panel (Figure 3).

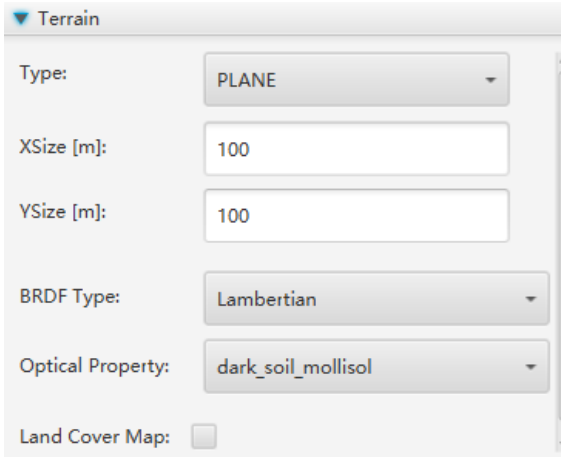


The screenshot shows a window titled 'Optical Database'. At the top, there are input fields for 'Name', 'Ref (Front)', 'Ref (Back)', and 'Transmittance', along with 'Add', 'Del', and 'Copy' buttons. Below these is a table with the following data:

Name	Reflectance (Front)	Reflectance (Back)	Transmittance
birch_branch	0.1053,0.4756	0.0000,0.0000	0.0000,0.0000
dark_soil_mollisol	0.1878,0.3509	0.0000,0.0000	0.0000,0.0000
birch_leaf_green	0.0584,0.4715	0.0584,0.4715	0.0561,0.4860

**Figure 3.** Define optical models

4. Set terrain parameters by default in [Terrain] in Parameter Control Panel (Figure 4).



The screenshot shows the 'Terrain' panel with the following settings:

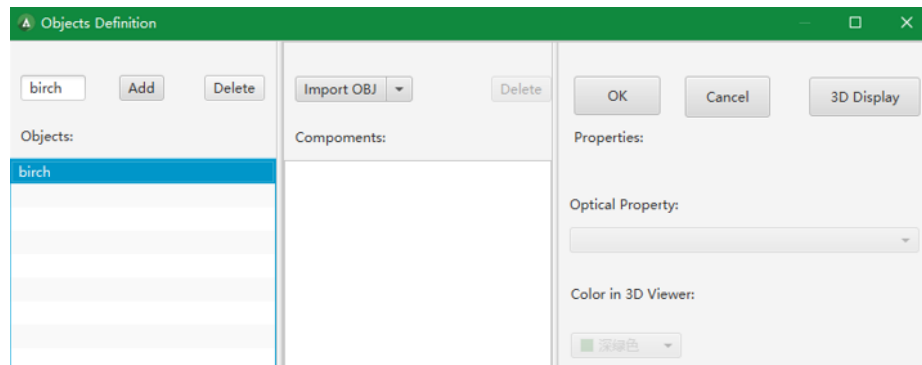
- Type: PLANE
- XSize [m]: 100
- YSize [m]: 100
- BRDF Type: Lambertian
- Optical Property: dark\_soil\_mollisol
- Land Cover Map: ☐

**Figure 4.** Set terrain parameters

5. Input tree models and define their positions in [Objects] in Parameter Control Panel.

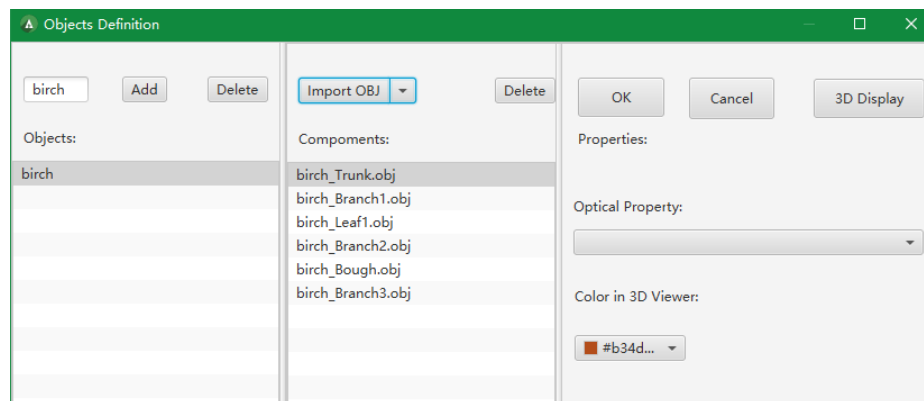
5.1 Input tree models by clicking [Define Object],

- 5.1.1 Enter the name of tree object in the pop-up window, such as “birch”. After clicking [Add] button, “birch” will appear in the Objects list (Figure 5).



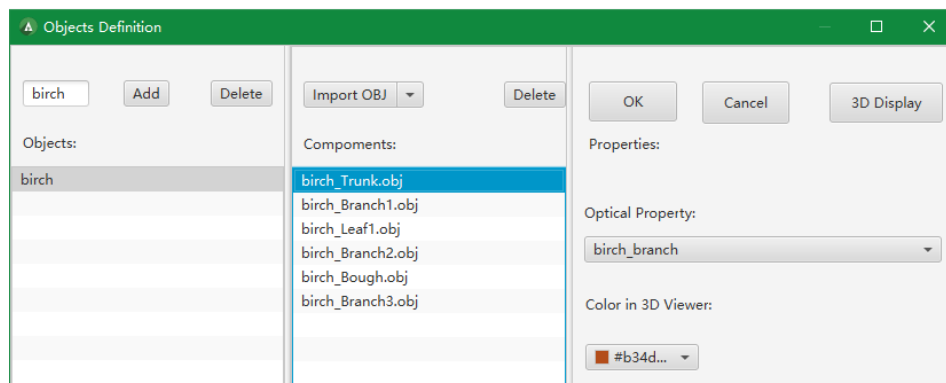
**Figure 5.** Name the obj

5.1.2 Selecting the name we write in “Objects” area, the button [Import OBJ] is activated. Click the [Import OBJ], then choose the obj file in the pop-up window and input it as the object. the units of the model is saved as “m”, so the scale should be 1.00.



**Figure 6.** Input the obj

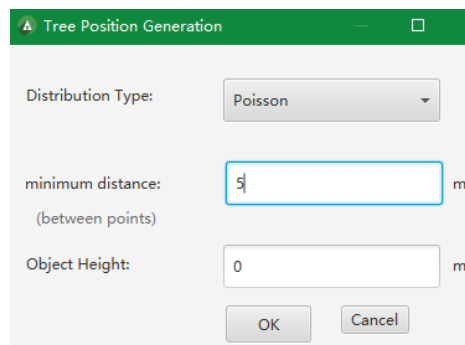
5.1.3 Select one of the components to active [Optical Property], then choose an optical property for the selected component.



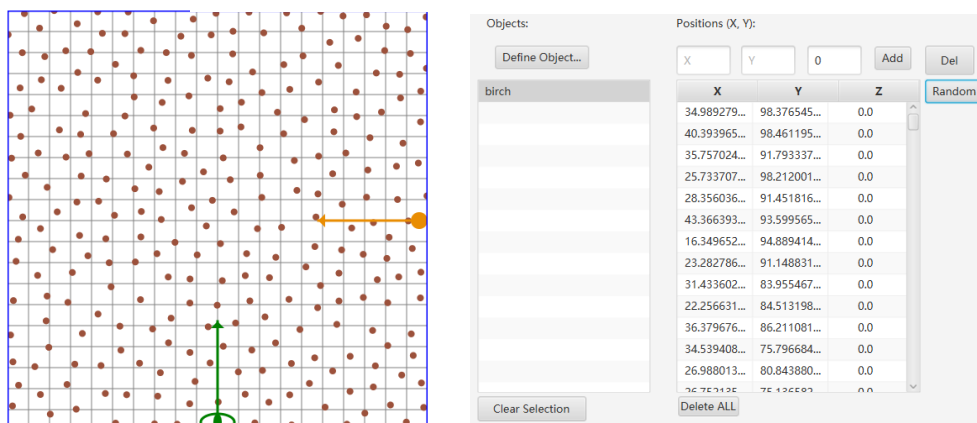
**Figure 7.** Choose optical properties

## 5.2 Define positions of tree model

Choose the tree models, then click [Random]. Enter “5” in [minimum distance], click [OK] (**Figure 8**). The positions of the model will display in Preview Panel (**Figure 9**).

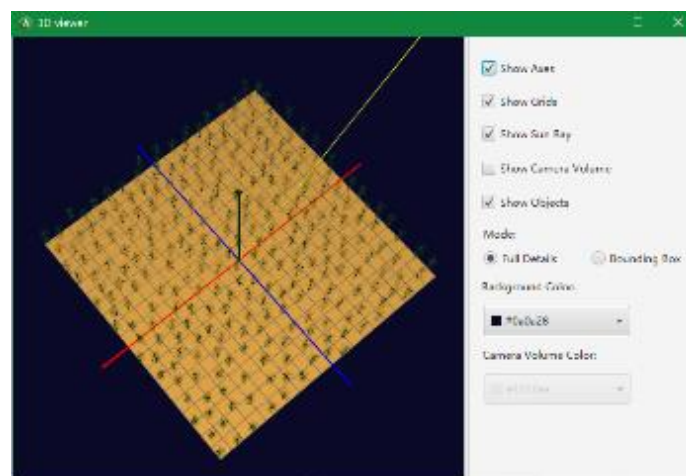


**Figure 8.** Define the position of obj



**Figure 9.** Show the position

6. View and check the 3D scene. Click [  ] in the back of Preview Panel.

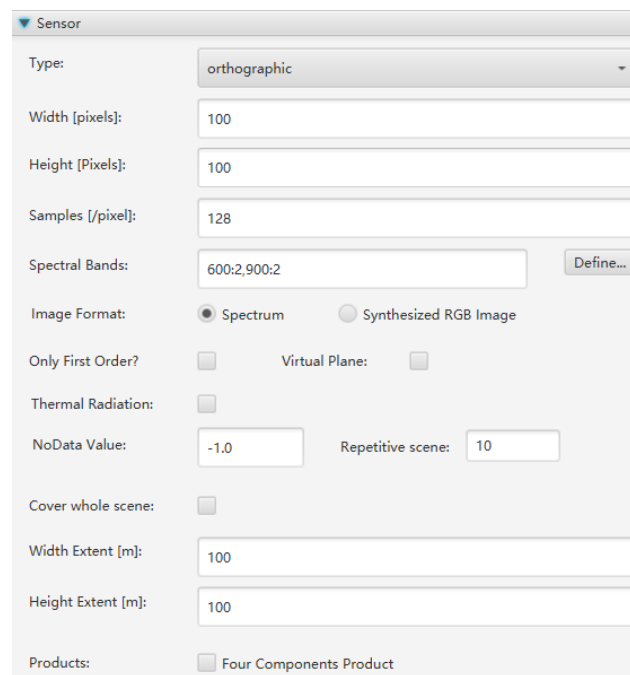


**Figure 10.** 3D scene

## Example 2. To simulate BRF of the scene

Purpose: BRF of the scene can be simulated based on the constructed 3D scene using the LESS

1. Set sensor parameters by default in [Sensor] in Parameter Control Panel.

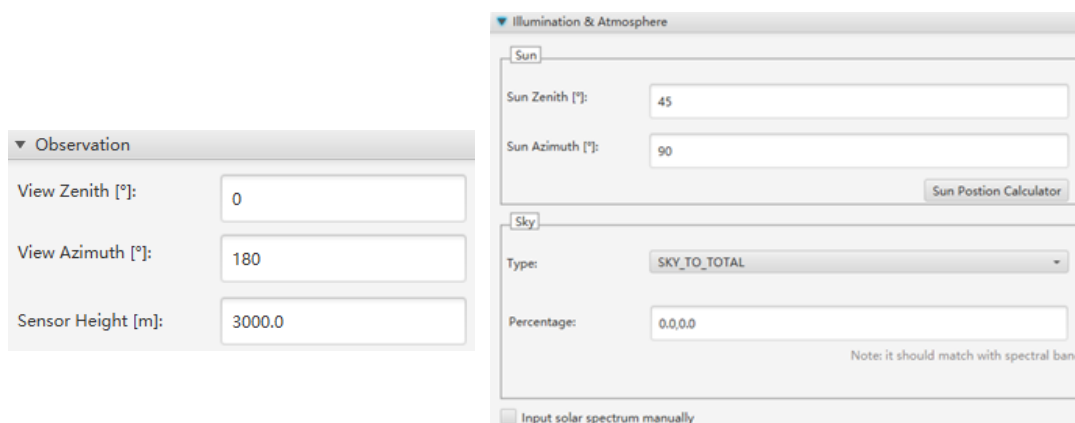


The screenshot shows the 'Sensor' panel with the following settings:

- Type: orthographic
- Width [pixels]: 100
- Height [Pixels]: 100
- Samples [/pixel]: 128
- Spectral Bands: 600:2,900:2 (with a 'Define...' button)
- Image Format: ☒ Spectrum, ☐ Synthesized RGB Image
- Only First Order?: ☐ Virtual Plane: ☐
- Thermal Radiation: ☐
- NoData Value: -1.0 Repetitive scene: 10
- Cover whole scene: ☐
- Width Extent [m]: 100
- Height Extent [m]: 100
- Products: ☐ Four Components Product

**Figure 11.** Sensor parameter

2. [Observation] and [Illumination & Atmosphere] settings remain the default.



The figure shows two panels side-by-side. The left panel is the 'Observation' panel with the following settings:

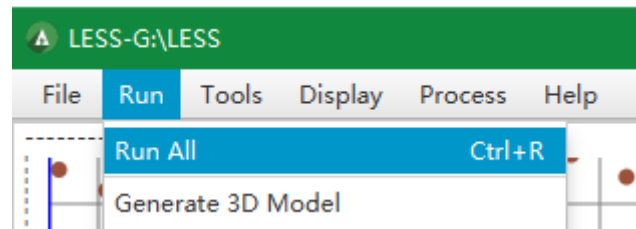
- View Zenith [°]: 0
- View Azimuth [°]: 180
- Sensor Height [m]: 3000.0

The right panel is the 'Illumination & Atmosphere' panel with the following settings:

- Sun** tab: Sun Zenith [°]: 45, Sun Azimuth [°]: 90, and a 'Sun Position Calculator' button.
- Sky** tab: Type: SKY\_TO\_TOTAL, Percentage: 0.0,0.0, and a note: 'Note: it should match with spectral band'.
- At the bottom: ☐ Input solar spectrum manually

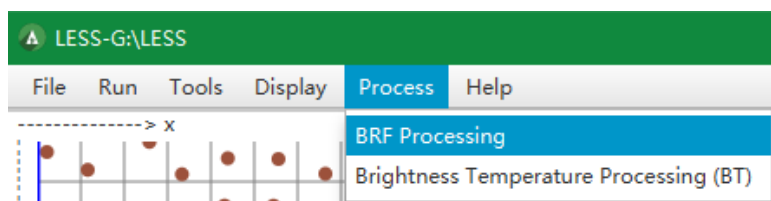
**Figure 12.** Observation and illumination &atmosphere setting

3. Run this program by choosing [Run] -> [Run all]. The result is radiance image.



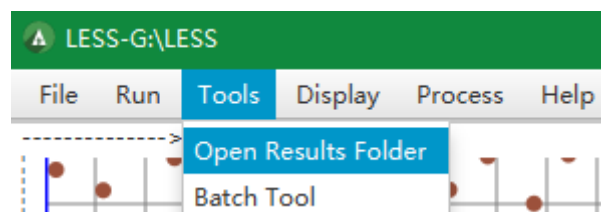
**Figure 13.** Run the program

4. Generate BRF image by choosing [Process] -> [BRF Processing].



**Figure 14.** Generate BRF image

5. View the generated results by choosing [Tools] -> [Open Results Folder] (Figure 14). The file named "spectral\_VZ=0\_VA=180" is the radiance image. And the file named "spectral\_VZ=0\_VA=180\_BRF" is the BRF image. You can open them by ENVI.



**Figure 15.** Open results folder

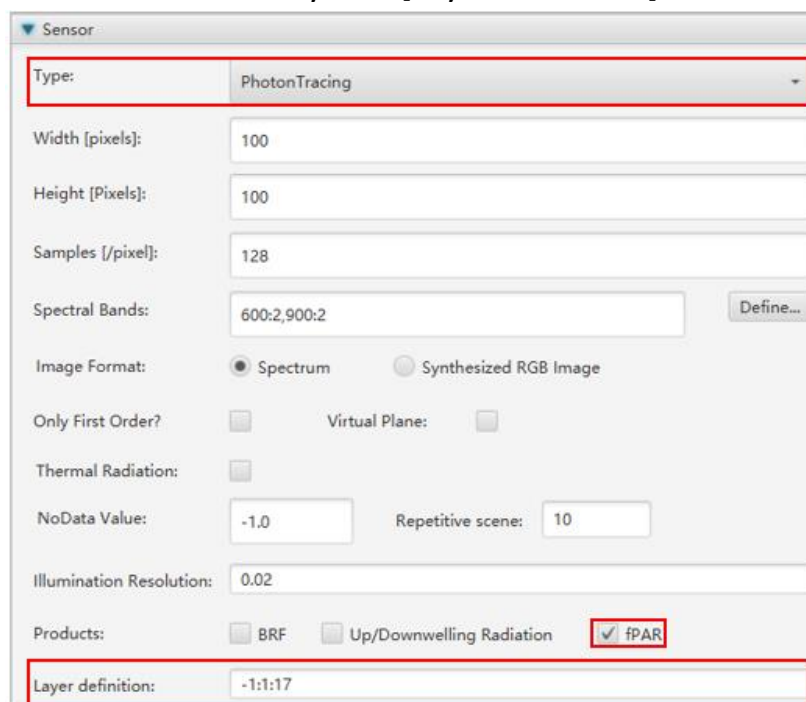
Irradiance.txt	2019/3/12 19:24	文本文档	1 KB
spectral.txt	2019/3/12 19:24	文本文档	1 KB
spectral_BRF.txt	2019/3/12 19:36	文本文档	1 KB
spectral_VZ=0_VA=180	2019/3/12 19:24	文件	79 KB
spectral_VZ=0_VA=180.hdr	2019/3/12 19:24	HDR 文件	1 KB
spectral_VZ=0_VA=180_BRF	2019/3/12 19:36	文件	79 KB
spectral_VZ=0_VA=180_BRF.hdr	2019/3/12 19:36	HDR 文件	1 KB

**Figure 15.** Results

### Example 3. To calculate the layered FPAR

Purpose: the layered FPAR of the forest scene can be calculated based on the constructed 3D forest scene using the LESS.

1. Set sensor parameters. Change [Type] to “PhotonTracing”. Check [Fpar] in [Products]. Input the initial position and end positions of height layers and width of each layer in [Layer definition].

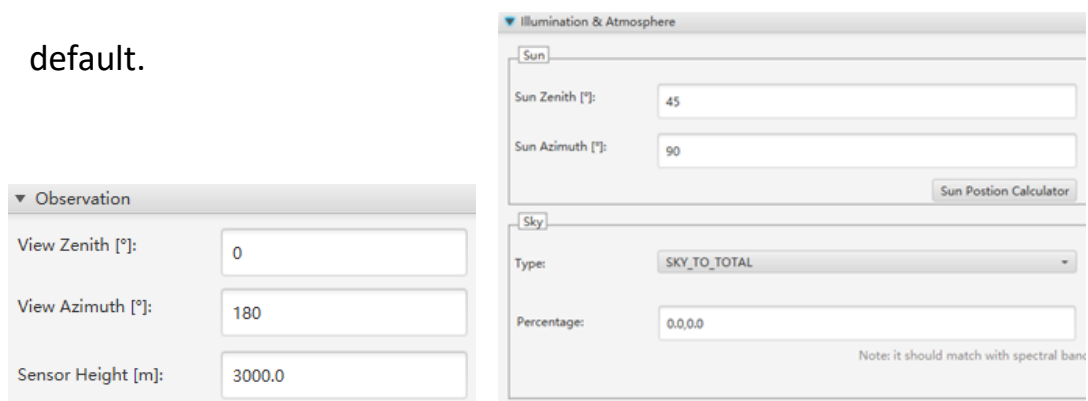


The screenshot shows the 'Sensor' dialog box with the following settings:

- Type: PhotonTracing
- Width [pixels]: 100
- Height [Pixels]: 100
- Samples [/pixel]: 128
- Spectral Bands: 600:2,900:2
- Image Format: Spectrum (selected), Synthesized RGB Image
- Only First Order?: ☐ Virtual Plane: ☐
- Thermal Radiation: ☐
- NoData Value: -1,0 Repetitive scene: 10
- Illumination Resolution: 0.02
- Products: BRF ☐ Up/Downwelling Radiation ☐ fPAR ☒
- Layer definition: -1:1:17

**Figure 16.** Sensor parameter

2. [Observation] and [Illumination & Atmosphere] settings remain the default.



The screenshot shows two dialog boxes side-by-side:

**Observation**

- View Zenith [°]: 0
- View Azimuth [°]: 180
- Sensor Height [m]: 3000.0

**Illumination & Atmosphere**

- Sun Zenith [°]: 45
- Sun Azimuth [°]: 90
- Sky Type: SKY\_TO\_TOTAL
- Percentage: 0,0,0,0

**Figure 17.** Observation and illumination &atmosphere setting

3. Run this program by choosing Run -> Run all.

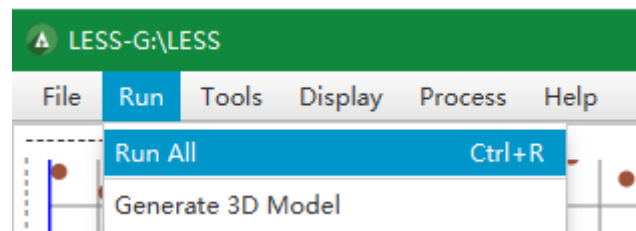


Figure 18. Run the program

4. View the generated results by choosing [Tools] -> [Open Results Folder] (Figure 14). The file named “photontracing\_0\_02\_Layer\_fPAR.txt” is the fPAR in different height layers and component.

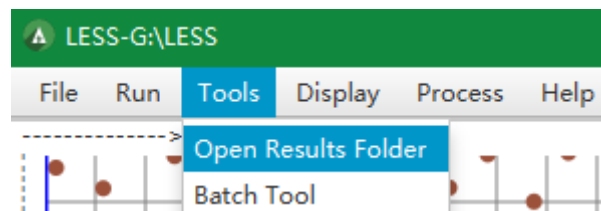


Figure 19. Open results folder

Irradiance.txt	2019/3/12 20:06	文本文档	1 KB
photontracing_0_02.npy	2019/3/12 20:08	NPY 文件	157 KB
photontracing_0_02_Layer_fPAR.txt	2019/3/12 20:08	文本文档	2 KB
spectral.txt	2019/3/12 20:08	文本文档	1 KB

Figure 20. Results

	layer_bottom	layer_upper	TfPAR	terrain	brich_Branch1	brich_Leaf1	brich_Branch2	brich_Bough	brich_Branch3	brich_Trunk
1	-1.0000	0.0000	0.0085	0.0085	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2	0.0000	1.0000	0.6318	0.6307	0.0000	0.0000	0.0000	0.0000	0.0000	0.0011
3	1.0000	2.0000	0.0011	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0011
4	2.0000	3.0000	0.0010	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0010
5	3.0000	4.0000	0.0065	0.0000	0.0002	0.0041	0.0002	0.0008	0.0002	0.0009
6	4.0000	5.0000	0.0087	0.0000	0.0004	0.0050	0.0003	0.0018	0.0003	0.0009
7	5.0000	6.0000	0.0147	0.0000	0.0008	0.0084	0.0005	0.0038	0.0004	0.0008
8	6.0000	7.0000	0.0141	0.0000	0.0010	0.0078	0.0005	0.0039	0.0004	0.0005
9	7.0000	8.0000	0.0153	0.0000	0.0014	0.0084	0.0006	0.0040	0.0004	0.0006
10	8.0000	9.0000	0.0202	0.0000	0.0017	0.0120	0.0009	0.0045	0.0006	0.0005
11	9.0000	10.0000	0.0221	0.0000	0.0021	0.0132	0.0010	0.0047	0.0006	0.0005
12	10.0000	11.0000	0.0234	0.0000	0.0024	0.0144	0.0010	0.0045	0.0007	0.0004
13	11.0000	12.0000	0.0207	0.0000	0.0020	0.0129	0.0009	0.0038	0.0005	0.0005
14	12.0000	13.0000	0.0209	0.0000	0.0016	0.0147	0.0009	0.0029	0.0007	0.0003
15	13.0000	14.0000	0.0095	0.0000	0.0006	0.0073	0.0004	0.0009	0.0004	0.0000
16	14.0000	15.0000	0.0008	0.0000	0.0001	0.0007	0.0000	0.0000	0.0000	0.0000
17	15.0000	16.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
18	16.0000	17.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
19										

Figure 21. photontracing\_0\_02\_Layer\_fPAR.txt