

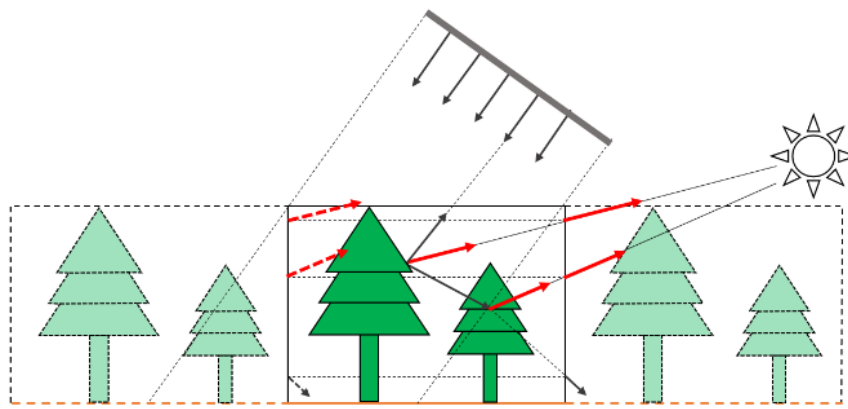


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# LESS Example Document

**Version 1.8.8**

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By Yue Xu, Jianbo Qi, Donghui Xie

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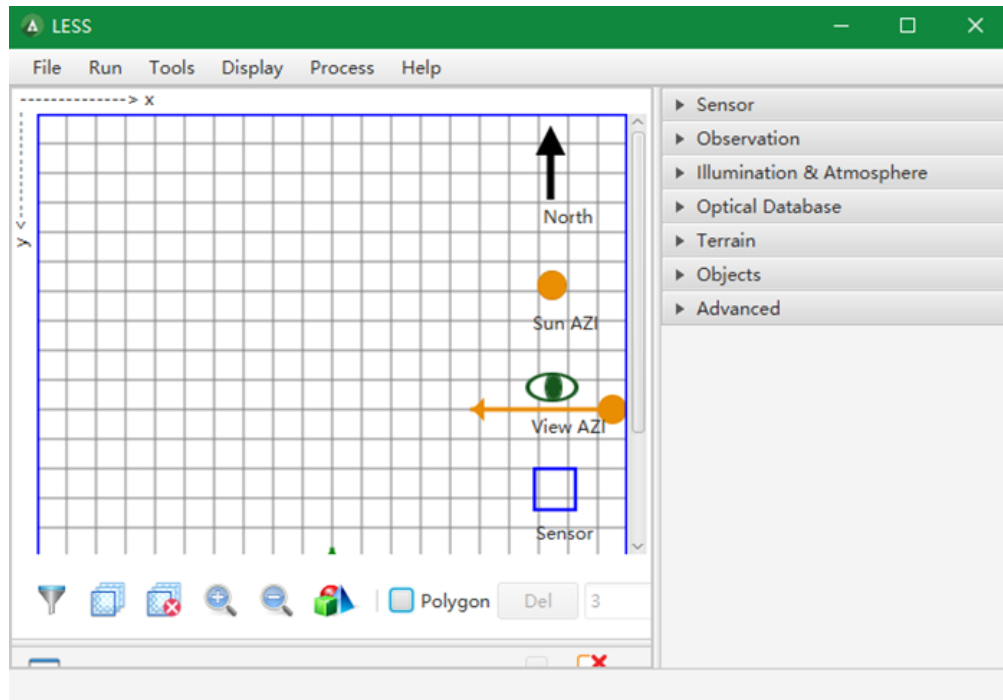
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## Example 0. Forest scene construction

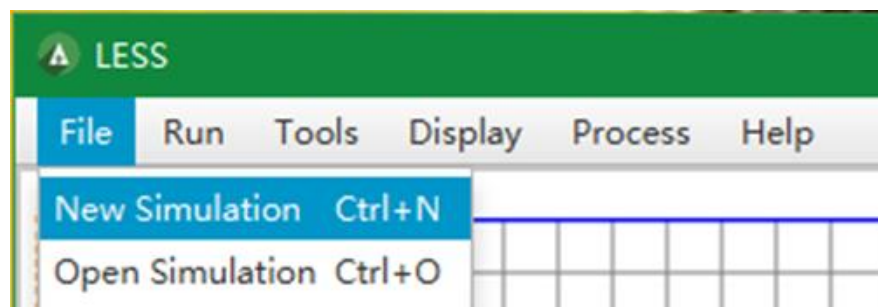
Purpose: Following this manual, you can construct a 3D forest scene based on the given 3D tree model. You can find a file named “birch.obj”, which is a 3D tree model with the “obj” type.

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



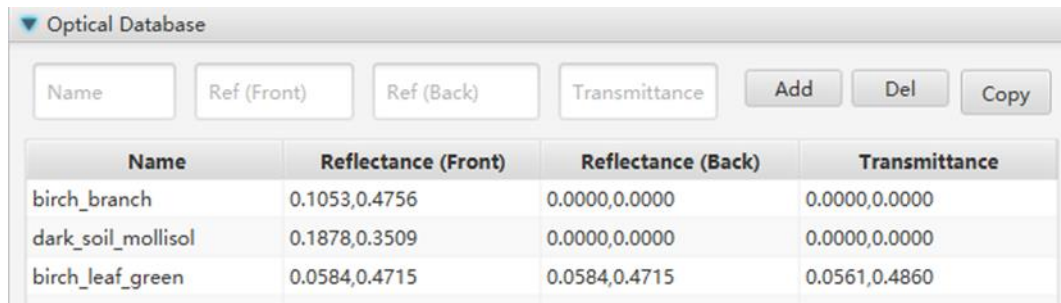
**Figure 1.** Main window

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

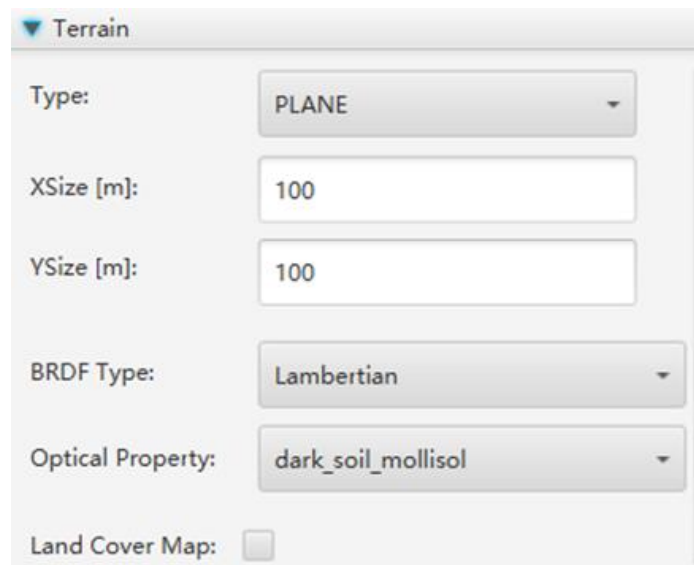
3. Define optical models in [Optical Database] in Parameter Control Panel (**Figure 3**).



Name	Ref (Front)	Ref (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**).



**Terrain**

Type: PLANE

XSize [m]: 100

YSize [m]: 100

BRDF Type: Lambertian

Optical Property: dark\_soil\_mollisol

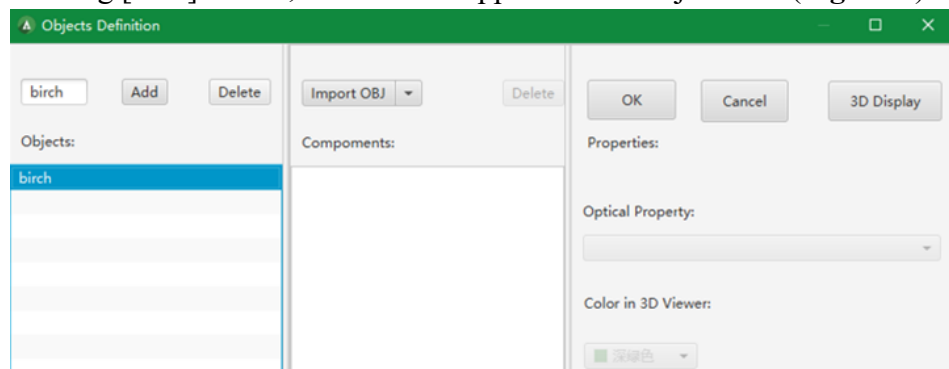
Land Cover Map: ☐

**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**).



**Objects Definition**

birch Add Delete Import OBJ Delete

Objects:

- birch

Compoments:

Properties:

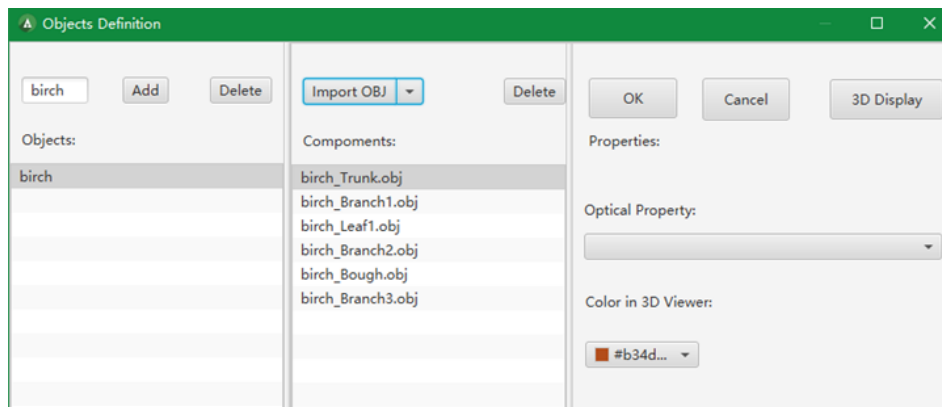
Optical Property:

Color in 3D Viewer:

OK Cancel 3D Display

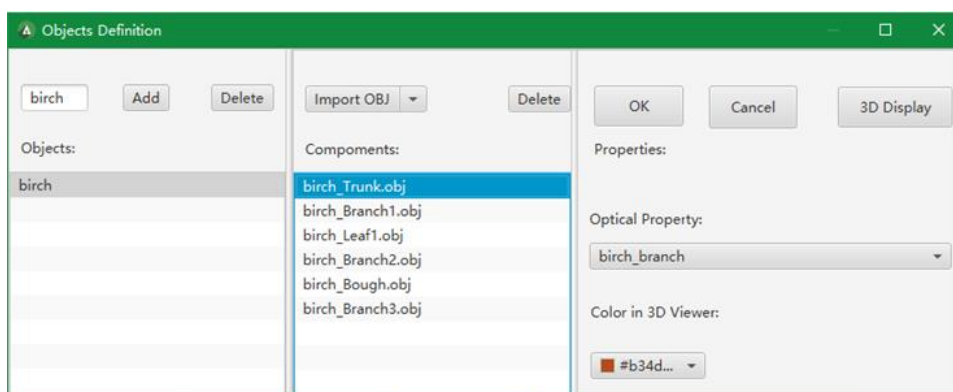
**Figure 5.** Name the obj

- 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 (**Figure 6**). The units of the model is saved as “m”, so the scale should be 1.00.



**Figure 6.** Input the obj

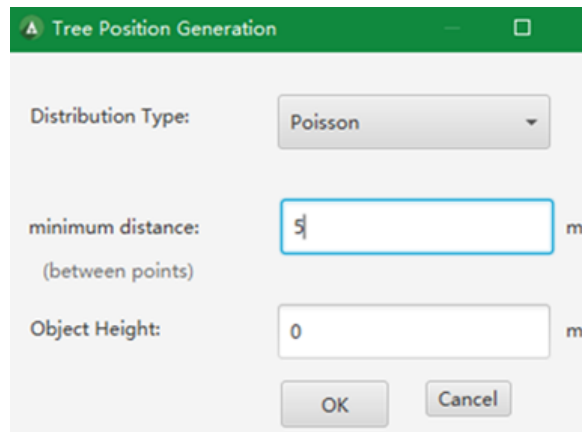
- 5.1.3 Select one of the components to active [Optical Property], then choose an optical property for the selected component (**Figure 7**).



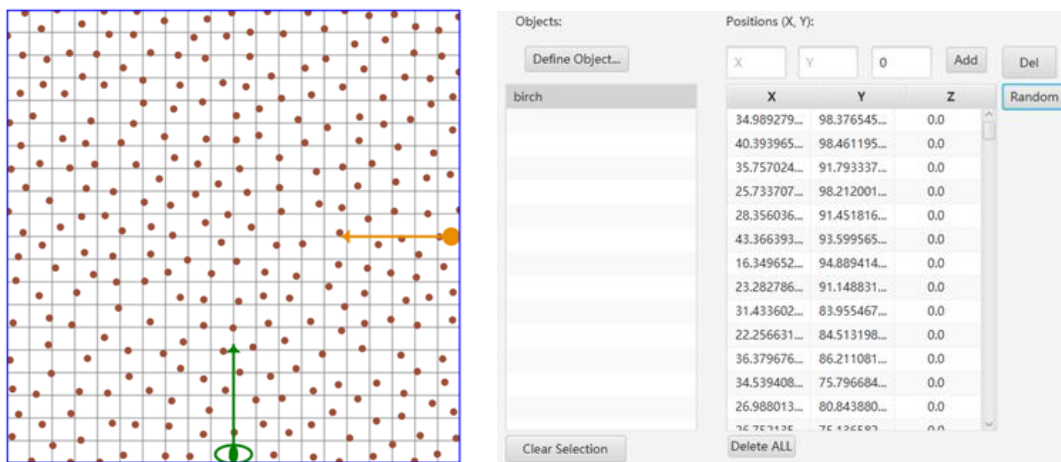
**Figure 7.** Choose optical properties

## 5.2 Define positions of tree model

Choose the tree models, then click [Random]. Enter “5” in [minimum distance], click [OK] (错误!未找到引用源。). The positions of the model will display in Preview Panel (**Figure 9**).

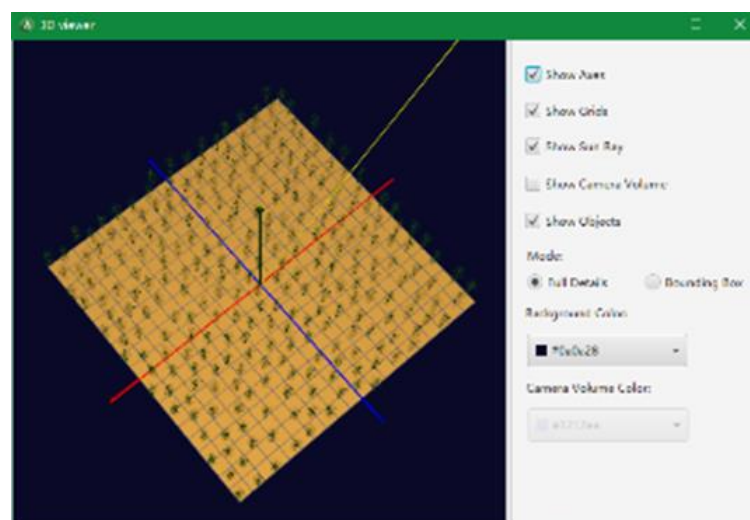


**Figure 8.** Define the position of obj



**Figure 9,** Show the position

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

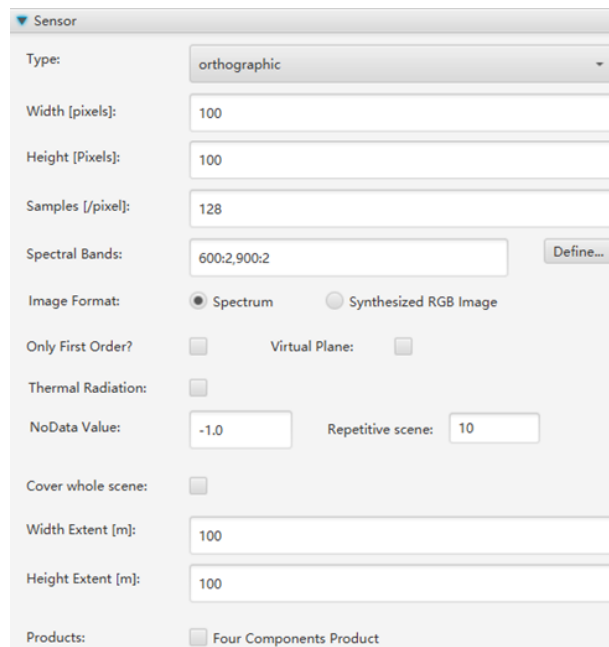


**Figure 10.** 3D scene

### Example 1. To simulate BRF of the scene

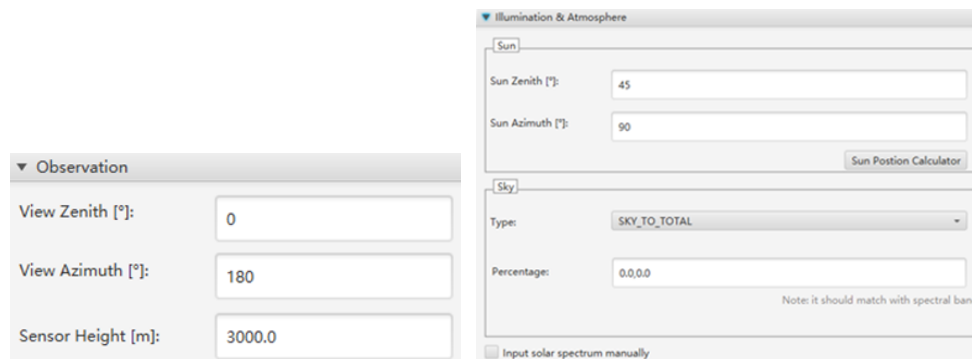
Purpose: BRF of the scene can be simulated based on the constructed 3D scene using the LESS.

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



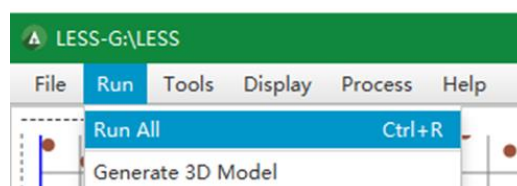
**Figure 11.** Sensor parameter

2. [Observation] and [Illumination & Atmosphere] are set according your requirement.



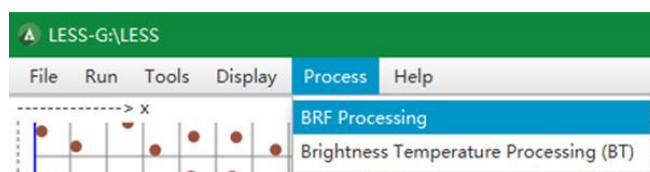
**Figure 12.** Observation and illumination &atmosphere setting

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



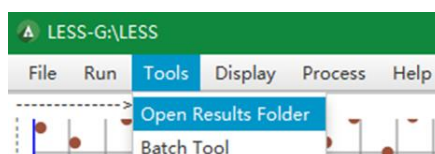
**Figure 13.** Run the program

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 15**). 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 (**Figure 16**). You can open them by ENVI.



**Figure 15.** Find the generated results

 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 16.** Results



## Example 2. 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.

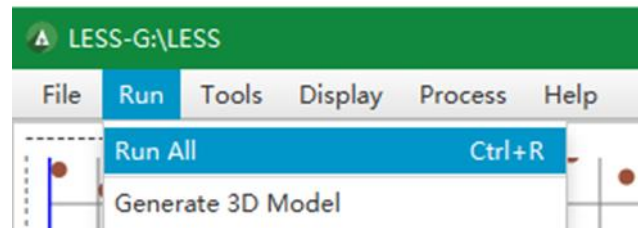
1. Set sensor parameters. Change [Type] to “PhotonTracing”. Check [Fpar] in [Products]. Input the initial position and end positions of height layers and width of each layer in [Layer definition] (**Figure 17**).

**Figure 17.** Sensor parameter

2. [Observation] and [Illumination & Atmosphere] are set according your requirement (**Figure 18**).

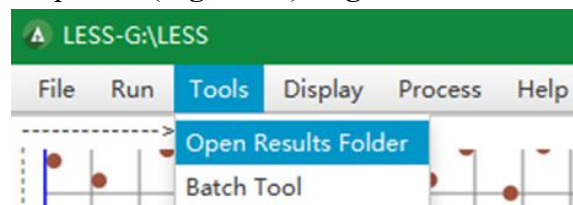
**Figure 18.** Observation and illumination &atmosphere setting

3. Run this program by choosing Run -> Run all (**Figure 19**).



**Figure 19.** Run the program

4. View the generated results by choosing [Tools] -> [Open Results Folder] (**Figure 20**). The file named “photontracing\_0\_02\_Layer\_fPAR.txt” is the fPAR in different height layers and component (**Figure 21**). **Figure 22** shows the result of fPAR..



**Figure 20.** 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 21.** 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

**Figure 22.** The result of fPAR

### Example 3. To calculate the albedo

1. Set sensor parameters. Change [Type] to “PhotonTracing”. Check [BRF] in [Products] (**Figure 23**).

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
- Only First Order?: ☐
- Virtual Plane: ☐
- Thermal Radiation: ☐
- NoData Value: -1.0
- Repetitive scene: 10
- Illumination Resolution: 0.02
- Products: ☒ BRF, ☐ Up/Downwelling Radiation, ☐ fPAR
- Number of Directions: 150
- Virutal Directions [°]: zenith:azimuth;zentih:azimuth or zenith1,zenith2;azimuth1,azimuth2
- Virutal Detectors [°]: centerZenith,centerAzimuth,angleInterval;centerZenith,centerAzimuth,angl

**Figure 23.** Sensor parameter

2. [Observation] and [Illumination & Atmosphere] are set according your requirement (**Figure 24**).

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

**Observation**

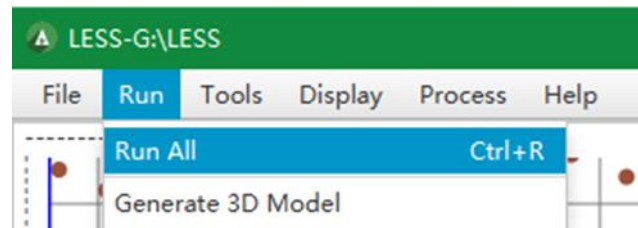
- View Zenith [°]: 0
- View Azimuth [°]: 180
- Sensor Height [m]: 3000.0

**Illumination & Atmosphere**

- Sun Zenith [°]: 45
- Sun Azimuth [°]: 90
- Sky Type: SKY\_TO\_TOTAL
- Percentage: 0.0,0.0
- Input solar spectrum manually: ☐

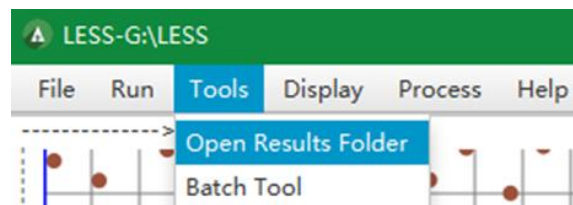
**Figure 24.** Observation and illumination &atmosphere setting

3. Run this program by choosing Run -> Run all (**Figure 25**).








**Figure 25.** Run the program

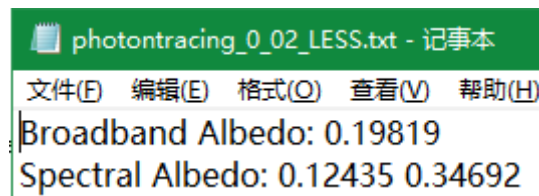
4. View the generated results by choosing [Tools] -> [Open Results Folder] (**Figure 26**). The file named “photontracing\_0\_02\_LESS.txt” is the albedo results (**Figure 27**). **Figure 28** shows the result of albedo.



**Figure 26.** Open results folder

 Irradiance.txt	2019/4/20 20:11	文本文档	1 KB
 photontracing_0_02.npy	2019/4/20 20:12	NPY 文件	157 KB
 photontracing_0_02_BRF.txt	2019/4/20 20:12	文本文档	6 KB
 photontracing_0_02_LESS.txt	2019/4/20 20:12	文本文档	1 KB
 spectral.txt	2019/4/20 20:12	文本文档	1 KB

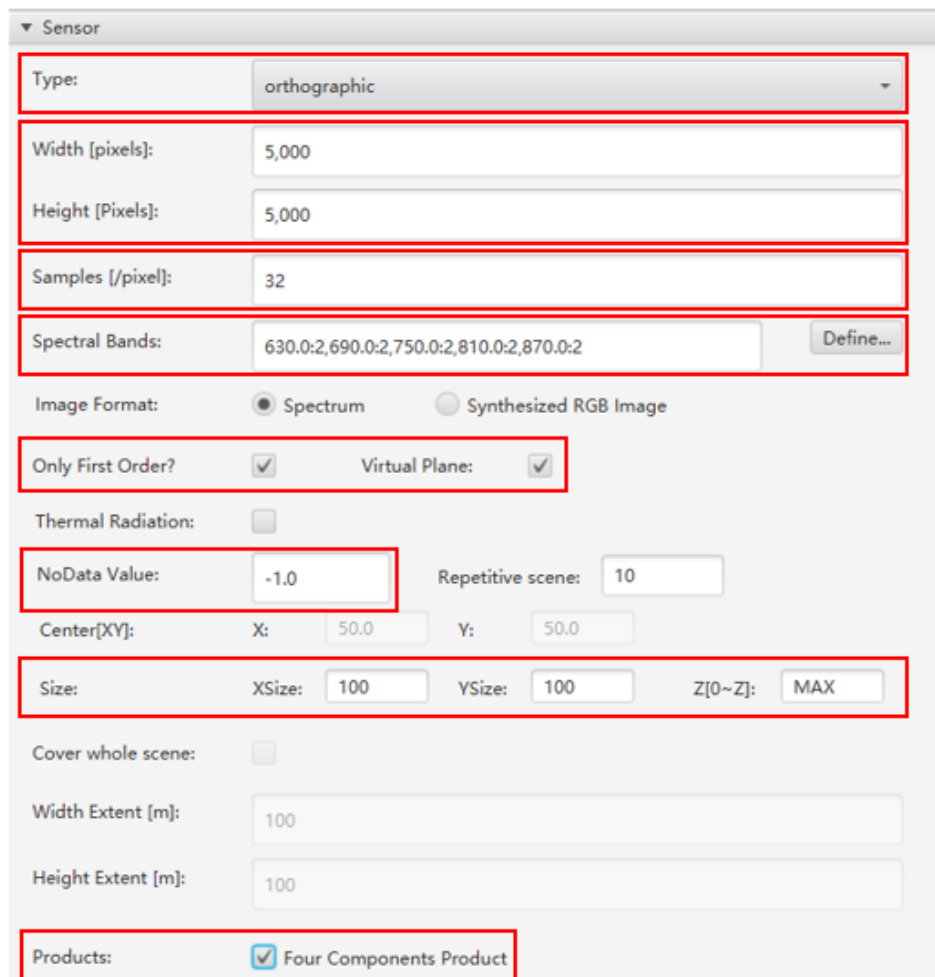
**Figure 27.** Results



**Figure 28.** Albedo results

### Example 4. To calculate the directional gap probability

1. Set sensor parameters. Keep [Type] to “orthographic”. Set [width] and [Height] to make sure that the spatial resolution is higher than 0.05 meters. The value of [Sample] must higher than 32. The number of [Spectral Bands] must more than 5. Check [Only First Order] & [Virtual Plane]. Set [NoData Value] to -1. Set [XSzie] and [YSzie] in [Size] according to the size of scene. Check [Four Components Product] in [Product].

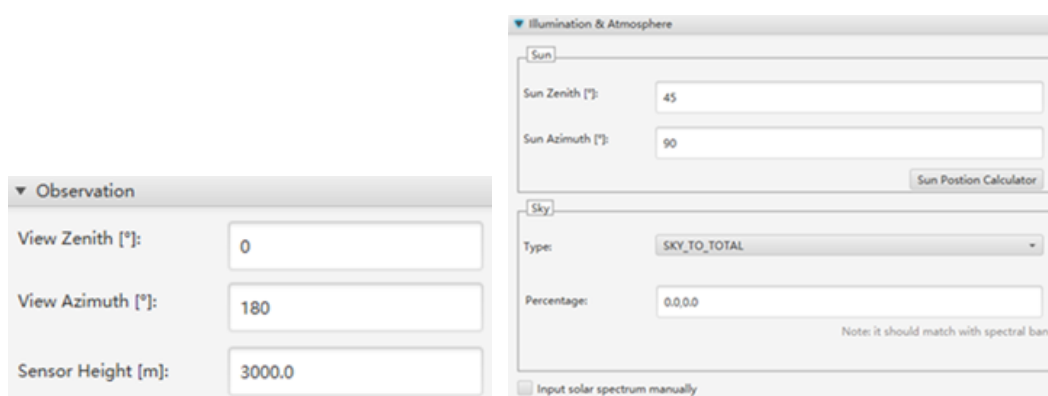


The screenshot shows the 'Sensor' dialog box with the following parameters highlighted by red rectangles:

- Type:** orthographic
- Width [pixels]:** 5,000
- Height [Pixels]:** 5,000
- Samples [/pixel]:** 32
- Spectral Bands:** 630.0:2,690.0:2,750.0:2,810.0:2,870.0:2
- Image Format:** Spectrum (selected)
- Only First Order?:** ☒ Virtual Plane: ☒
- Thermal Radiation:** ☐
- NoData Value:** -1.0
- Repetitive scene:** 10
- Center[X,Y]:** X: 50.0, Y: 50.0
- Size:** XSize: 100, YSize: 100, Z[0~Z]: MAX
- Cover whole scene:** ☐
- Width Extent [m]:** 100
- Height Extent [m]:** 100
- Products:** ☒ Four Components Product

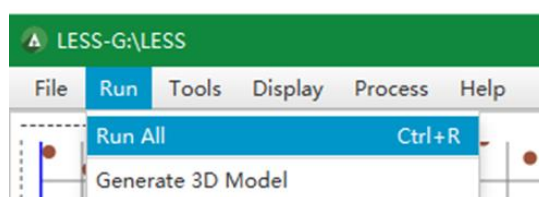
**Figure 29.** Sensor parameter

2. [Observation] and [Illumination & Atmosphere] are set according your requirement.



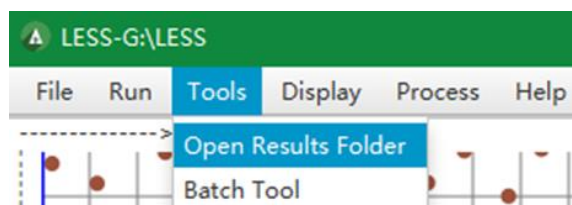
**Figure 30.** Observation and illumination &atmosphere setting

3. Run this program by choosing Run -> Run all (**Figure 31**).



**Figure 31.** Run the program

4. View the generated results by choosing [Tools] -> [Open Results Folder] (**Figure 32**). The file named “spectral\_VZ=0\_VA=180\_4Components” is the results (**Figure 33**).



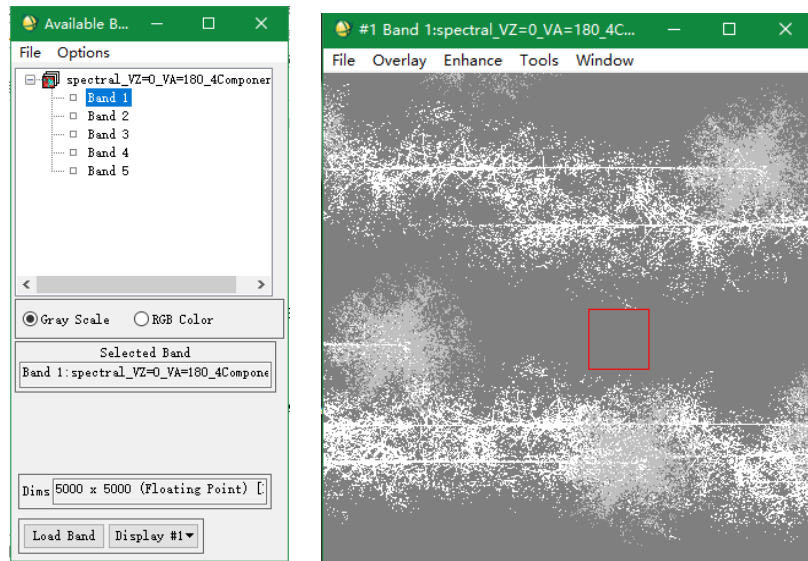
**Figure 32.** Open results folder

spectral_VZ=0_VA=180	2019/4/22 14:17	文件	488,282 KB
spectral_VZ=0_VA=180.hdr	2019/4/22 14:17	HDR 文件	1 KB
spectral_VZ=0_VA=180_4Components	2019/4/22 14:17	文件	488,282 KB
spectral_VZ=0_VA=180_4Components.hdr	2019/4/22 14:17	HDR 文件	1 KB
spectral.txt	2019/4/22 14:16	文本文档	1 KB
Irradiance.txt	2019/4/22 13:43	文本文档	1 KB

**Figure 33.** Results

5. **Figure 34** shows the result opened by ENVI. Band one is the four component result.

The pixel value of band 1 represents the category of pixels (1 means the pixel type is sunlit soil. 2 means the pixel type is sunlit plant. 3 means the pixel type is shaded soil. 4 means the pixel type is shaded plant.). The pixel value of band 2, band 3, band 4, band 5 is the proportion of the corresponding component in the pixel (band 2 is sunlit soil, band 3 is sunlit plant, band 4 is shaded soil, band 5 is shaded plant).

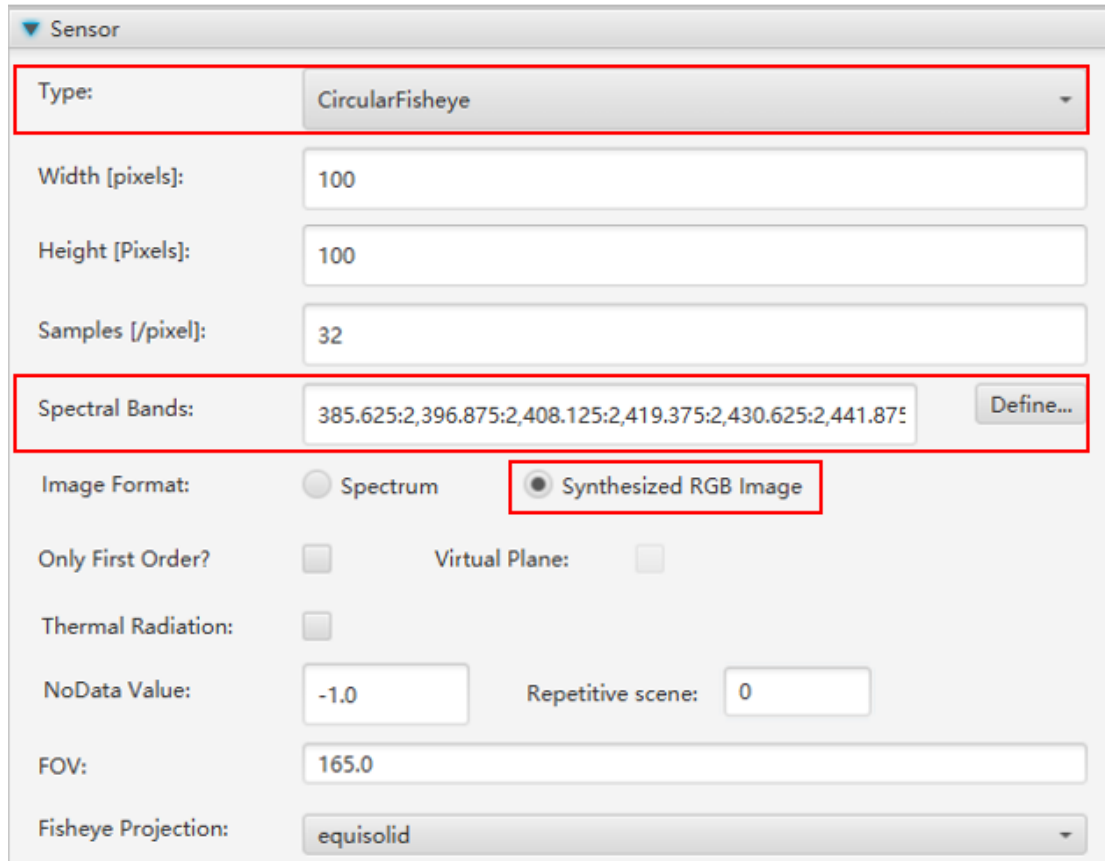
**Figure 34**

6. Calculate the directional gap probability

The directional gap probability can be calculated by:  $\text{mean}(b2+b4)$

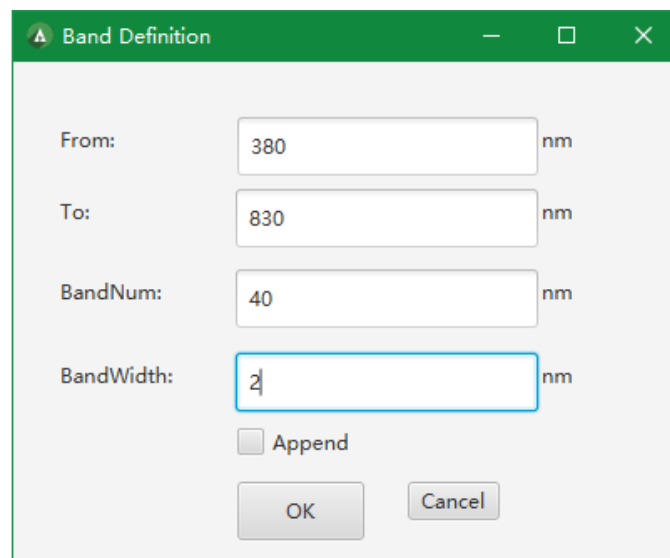
### Example 5. To generate fisheye images

1. Set sensor parameters. Change [Type] to “CircularFisheye”. Set [Spectral Bands] by click [Define] (**Figure 36**). [From] is modified to 380, and [To] is modified to 830, and [BandNum] is modified to 40. Check [Synthesized RGB Image] (**Figure 35**).



The image shows a 'Sensor' dialog box with various parameters. The 'Type' dropdown is set to 'CircularFisheye'. The 'Width [pixels]' is 100, 'Height [Pixels]' is 100, and 'Samples [/pixel]' is 32. The 'Spectral Bands' field contains the text '385.625:2,396.875:2,408.125:2,419.375:2,430.625:2,441.875' and a 'Define...' button. The 'Image Format' section has two radio buttons: 'Spectrum' (unselected) and 'Synthesized RGB Image' (selected). Below this, there are checkboxes for 'Only First Order?' (unchecked), 'Virtual Plane:' (unchecked), and 'Thermal Radiation:' (unchecked). The 'NoData Value:' is set to '-1.0' and 'Repetitive scene:' is set to '0'. The 'FOV:' is set to '165.0' and 'Fisheye Projection:' is set to 'equisolid'.

Figure 35. Sensor parameter



The image shows a 'Band Definition' dialog box with the following fields: 'From:' set to 380 nm, 'To:' set to 830 nm, 'BandNum:' set to 40 nm, and 'BandWidth:' set to 2 nm. There is an 'Append' checkbox which is unchecked. At the bottom are 'OK' and 'Cancel' buttons.

Figure 36. Define spectral bands



- Set the position and direction of camera in [Observation]. The [Camera Position] and [Target] construct a vector of view (**Figure 37**).

▼ Observation

Camera Position:

X

50.0

Y

50.0

Z

0.0

Target:

X

50.0

Y

50.0

Z

1.0

Relative Height:

☐

Show Camera Position:

☒

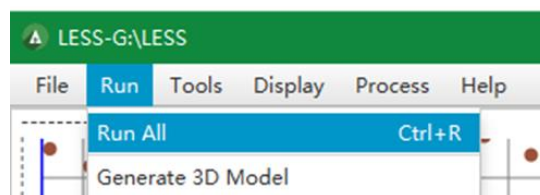
### Figure 37. Set the Observation

3. [Illumination & Atmosphere] are set according your requirement (**Figure 38**).

[illegible]

### Figure 38. Illumination & Atmosphere

- Run this program by choosing Run -> Run all (**Figure 39**).



**Figure 39.** Run the program

- View the generated results by choosing [Tools] -> [Open Results Folder] (**Figure 40**). The file named “spectral\_ox=50\_00\_oy=50\_00\_oz=0\_00\_tx=50\_00\_ty=50\_00\_tz=1\_00.png” is the results (**Figure 41**). **Figure 42** shows the result of fisheye image.

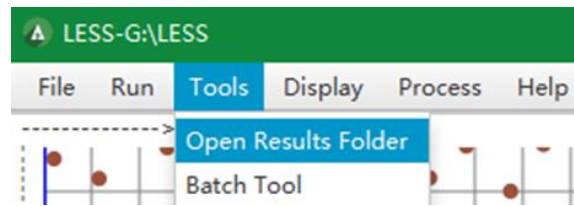


Figure 40. Open results folder



 Irradiance.txt	2019/4/30 21:59	文本文档	1 KB
 spectral.txt	2019/4/30 21:59	文本文档	1 KB
 spectral_ox=50_00_oy=50_00_oz=0_0...	2019/4/30 21:59	PNG 文件	13 KB

Figure 41. Results



Figure 42. Fisheye image