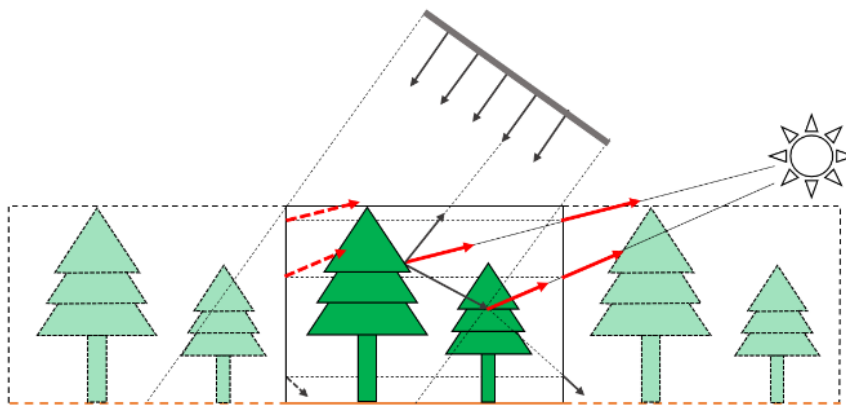




LESS Example Document

Version 1.8.8



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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**).

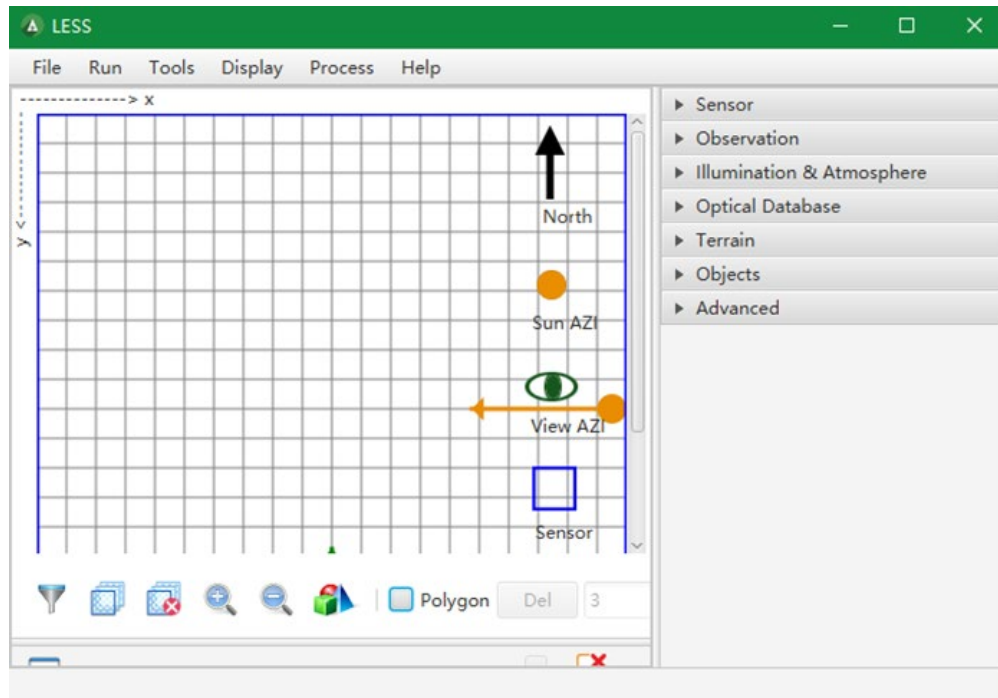


Figure 1. Main window

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**).

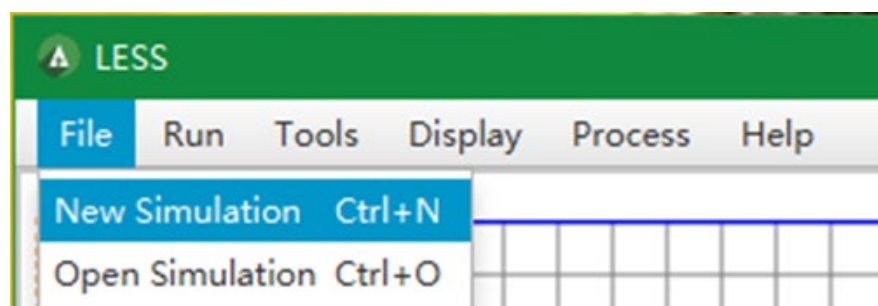
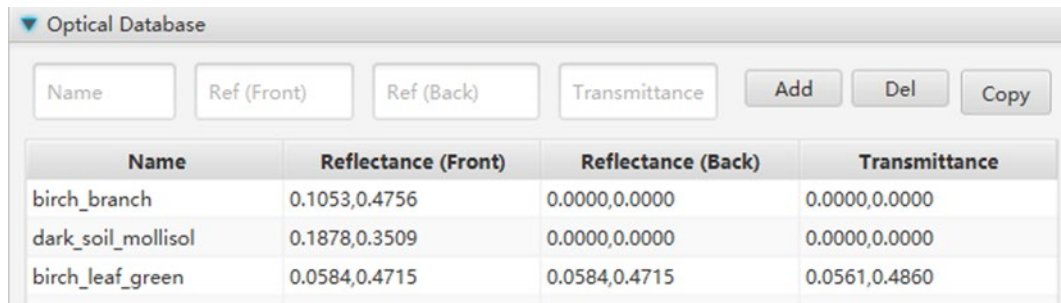


Figure 2. Create a new simulation

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

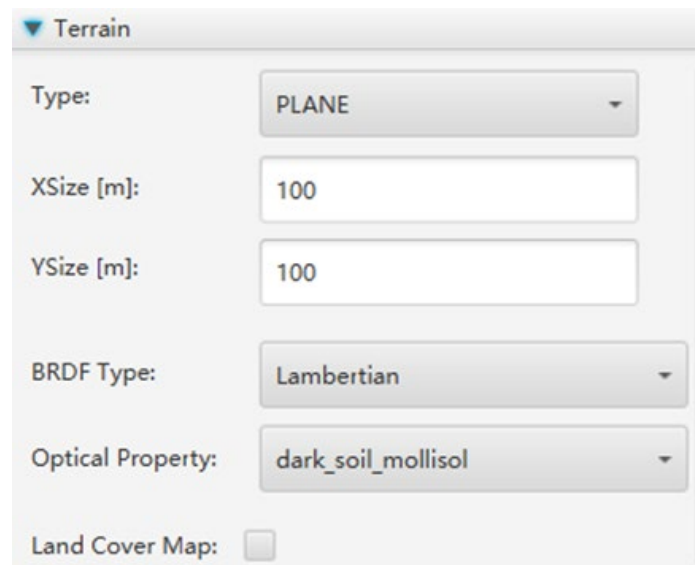


The Optical Database window contains a table with the following data:

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 Terrain window shows the following settings:

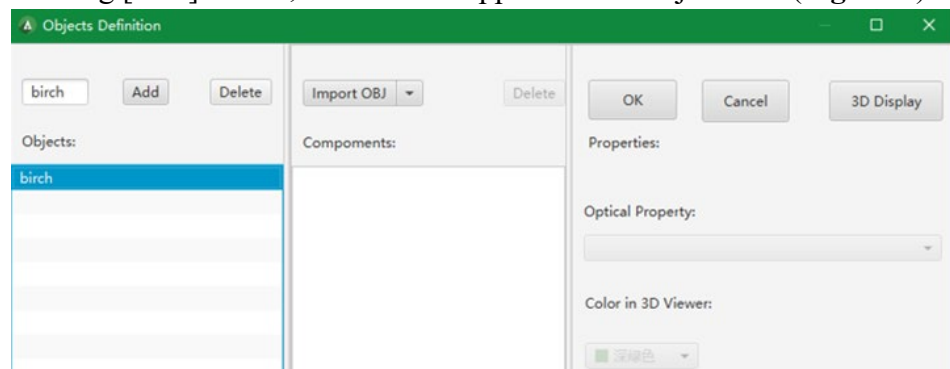
- Type: PLANE
- XSize [m]: 100
- YSize [m]: 100
- BRDF Type: Lambertian
- Optical Property: dark_soil_mollisol
- Land Cover Map: ☐

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**).



The Objects Definition window shows the following state:

- Input field: birch
- Buttons: Add, Delete, Import OBJ, Delete
- Objects list: birch (selected)
- Compoments list: (empty)
- Buttons: OK, Cancel, 3D Display
- Properties section:
 - Optical Property: (empty dropdown)
 - Color in 3D Viewer: (color picker showing green)

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.

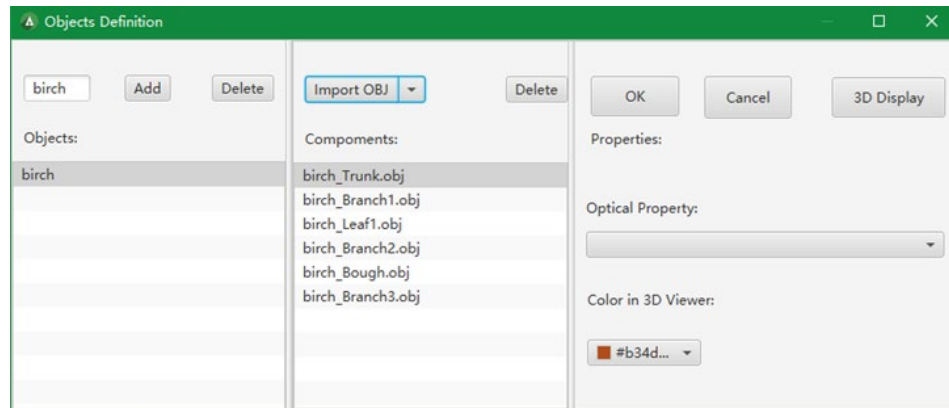


Figure 6. Input the obj

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

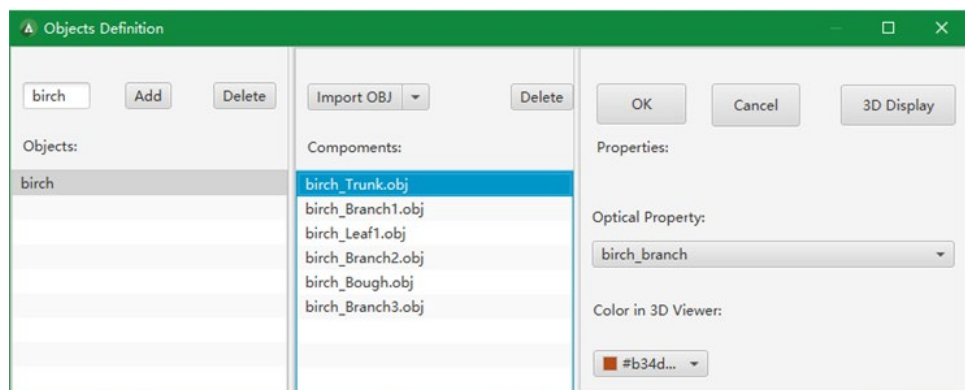


Figure 7. Choose optical properties

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**).

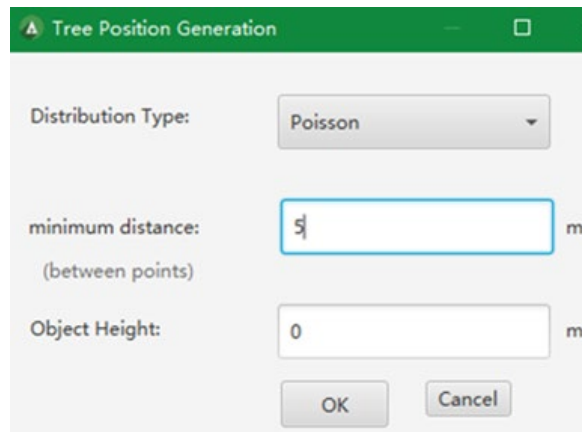


Figure 8. Define the position of obj

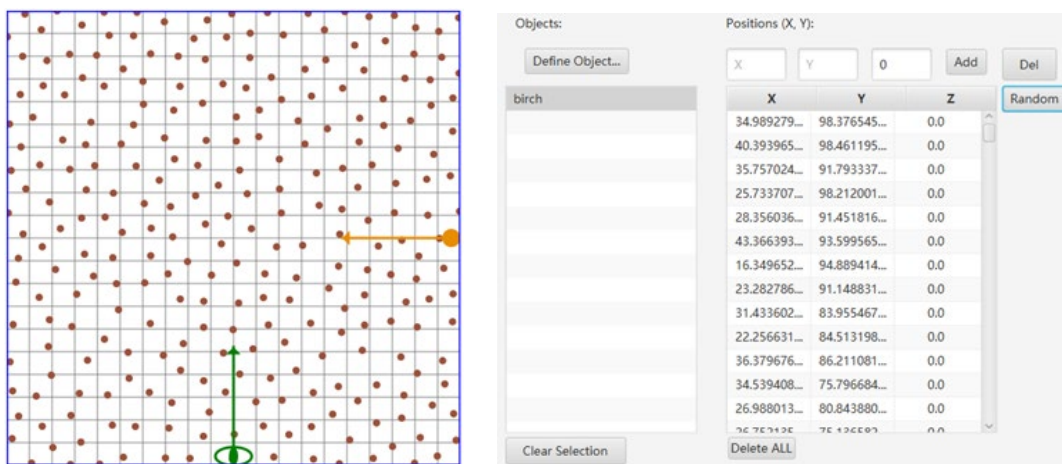


Figure 9, Show the position

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

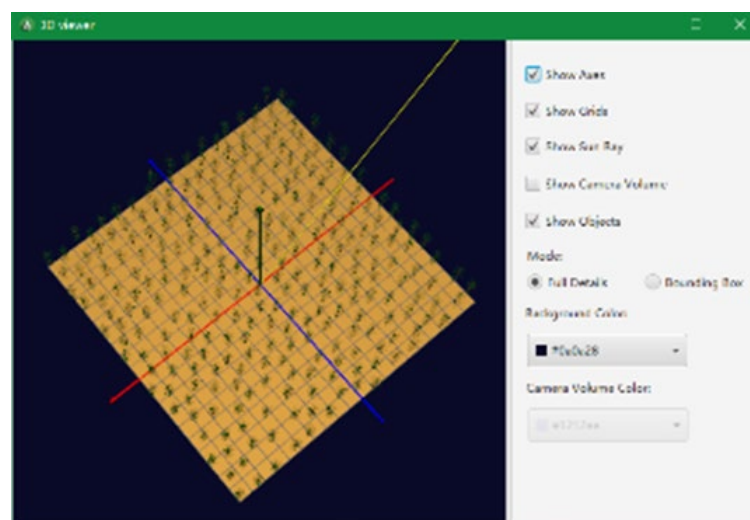


Figure 10. 3D scene

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.

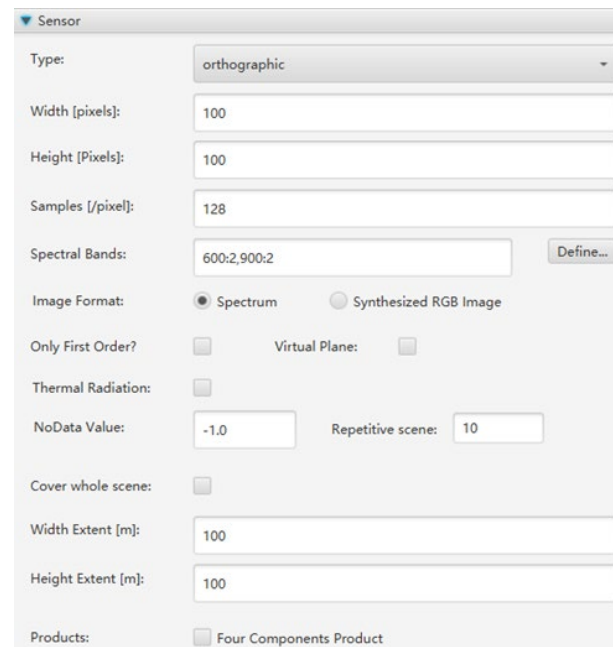


Figure 11. Sensor parameter

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

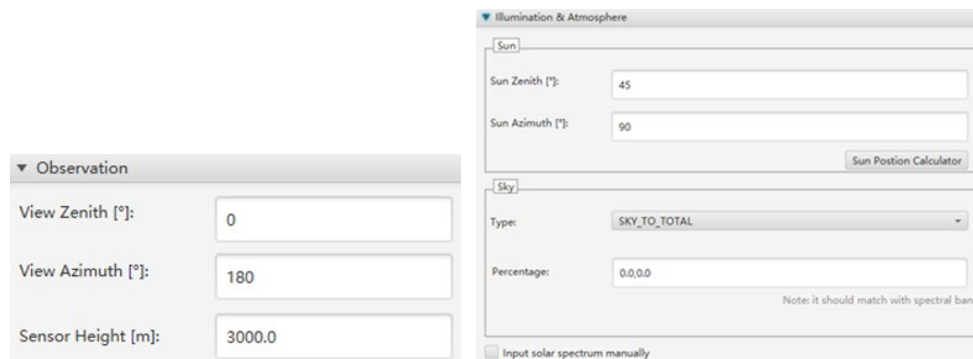


Figure 12. Observation and illumination &atmosphere setting

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

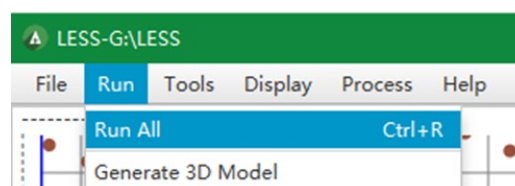


Figure 13. Run the program

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

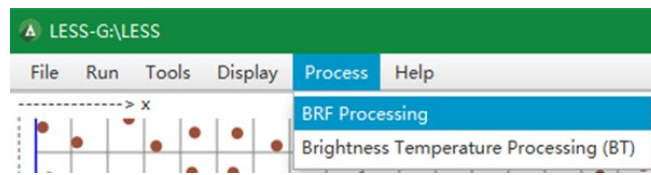


Figure 14. Generate BRF image

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.

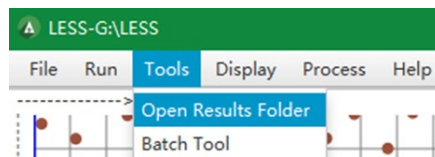


Figure 15. Find the generated results








	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**).

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?: ☐
- 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 17. Sensor parameter

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

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 18. Observation and illumination &atmosphere setting

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

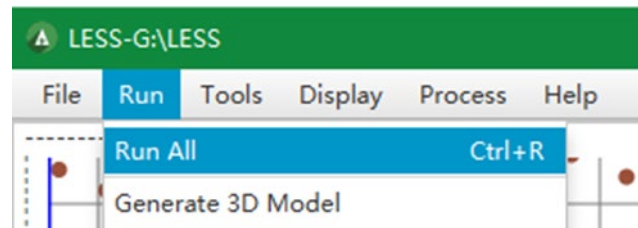


Figure 19. Run the program

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..

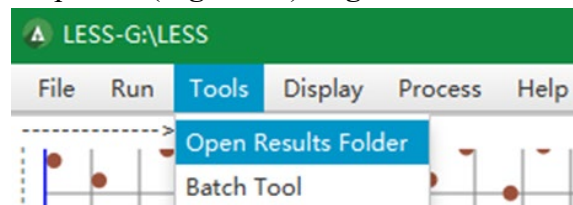


Figure 20. Open results folder

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
- Note: it should match with spectral band
- ☐ Input solar spectrum manually

Figure 24. Observation and illumination &atmosphere setting

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

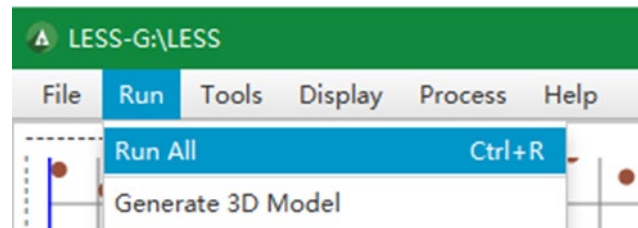


Figure 25. Run the program

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.

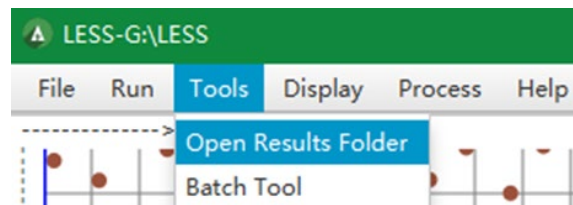


Figure 26. Open results folder

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

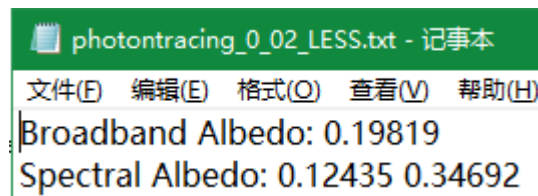
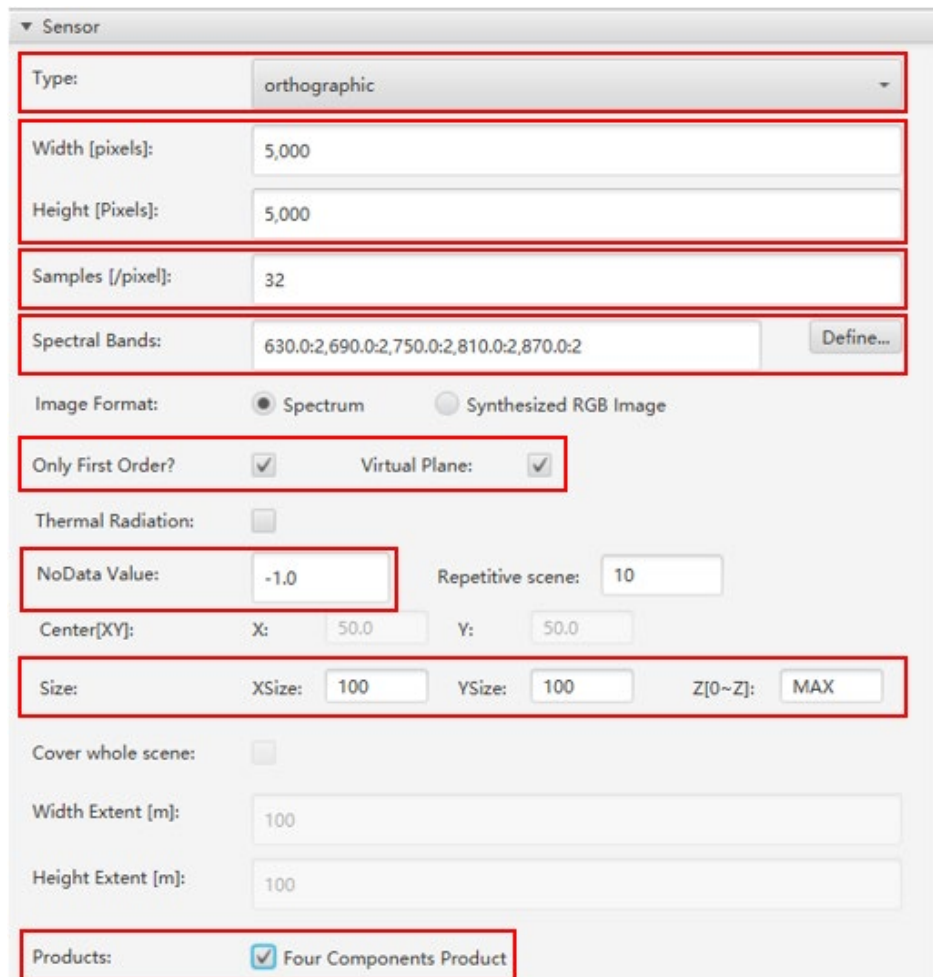


Figure 28. Albedo results

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 and settings:

- 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 ☐ Synthesized RGB Image
- 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.

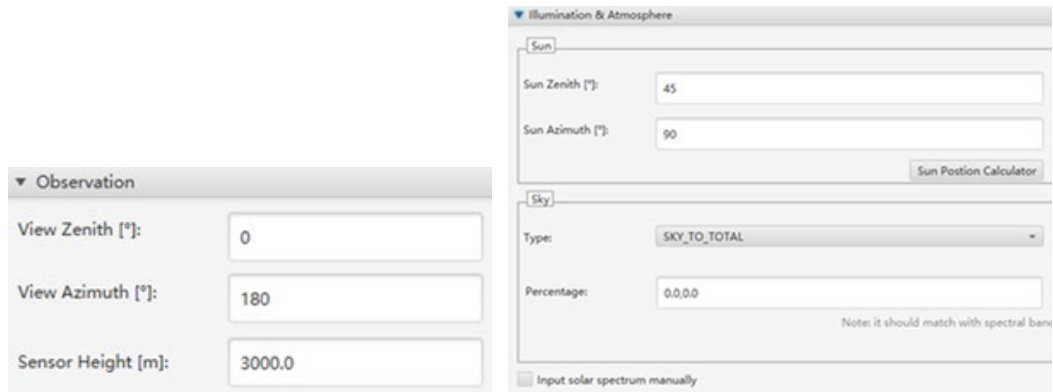


Figure 30. Observation and illumination &atmosphere setting

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

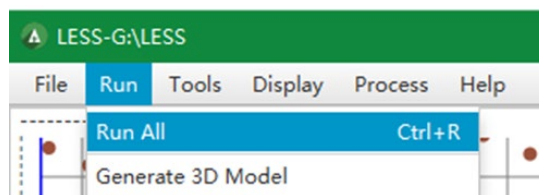


Figure 31. Run the program

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**).

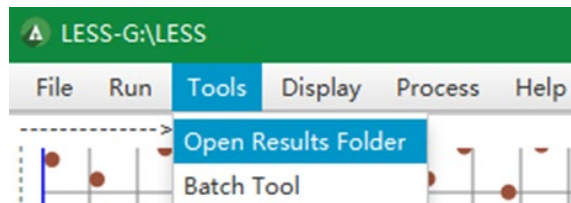


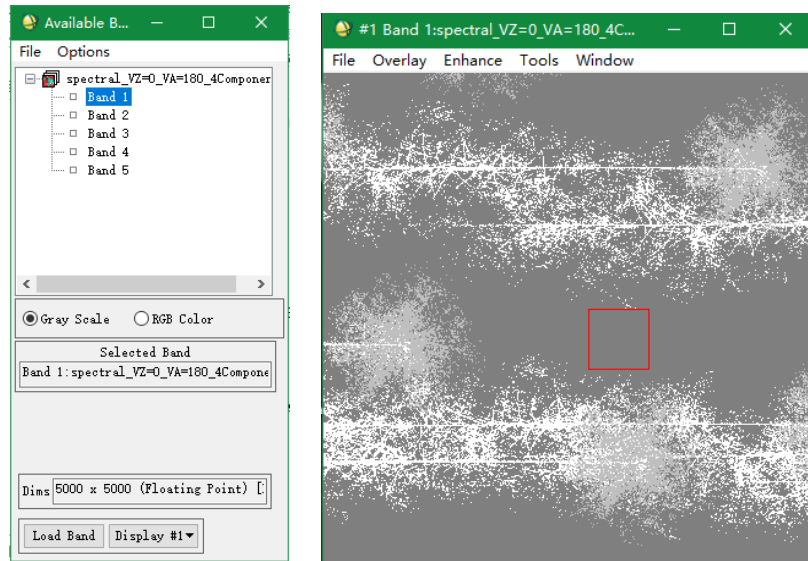
Figure 32. Open results folder

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: $\text{mean}(b2+b4)$