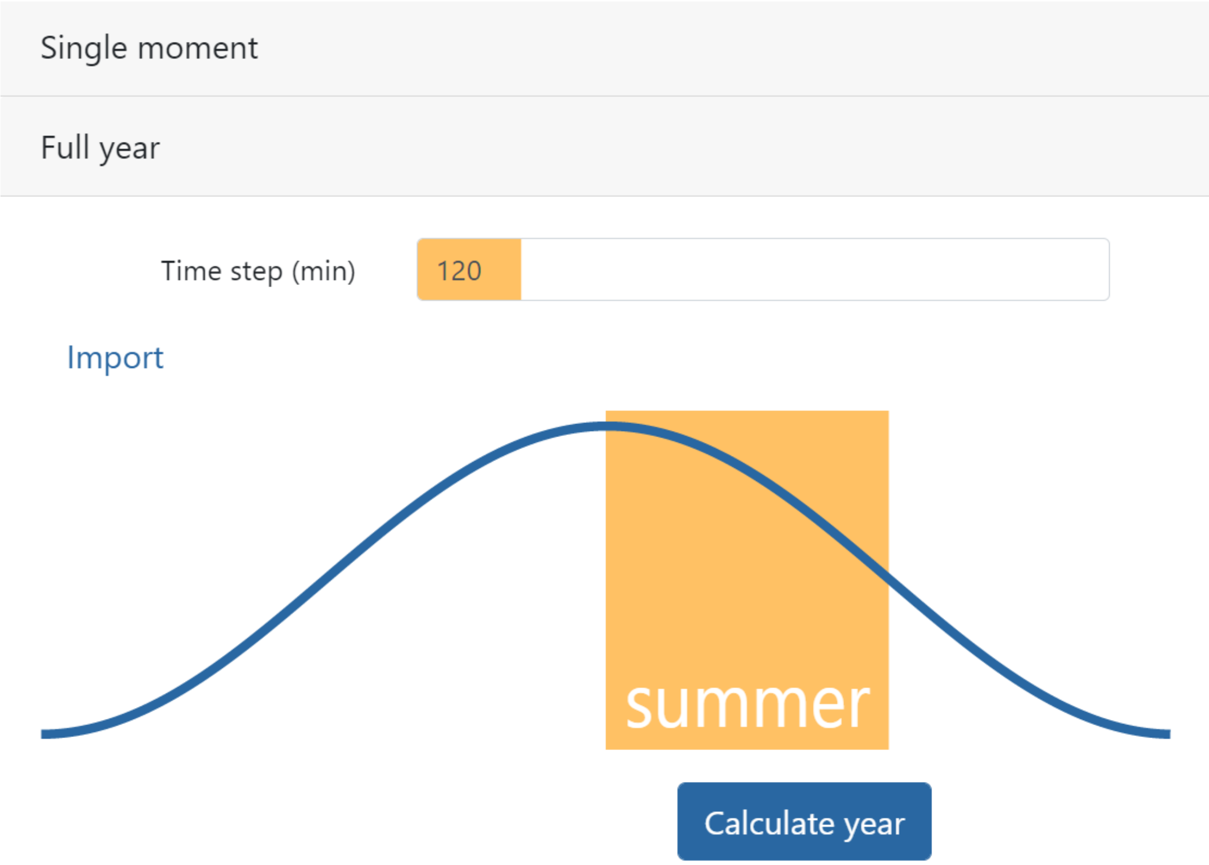
Instruction manual light model

General model description

This version of the light model is recommended to be run in a chrome browser. In this light model, a field is surrounded by different blue tiles, which represent a diffuse light component, this is radiation from the sun which is scattered in the earth's atmosphere and after scattering reaches the earth's surface. Next, a yellow boll is visible with a red arrow pointing towards the field, this represents the direct light component, which is radiation that falls on the earth's surface directly from the sun. Within the dome, consisting of diffuse and direct light sources, a scene can be placed. This scene can be altered to the user's needs and contains a preselected number and size of colored tiles which represent sensors. These sensors can be "seen" by the diffuse and direct light components, and during the simulation, the area which is seen by the direct and diffuse component is exported per sensor and time interval. To account for differences in light intensity in the diffuse light component from different directions from the atmosphere, the diffuse tiles are weighted according to the following function: N(B) = N(90)/3*(1+2*sin(B)) (B=0 for the horizon and B=90 for zenith). The function was derived from grace et al. (1971).

Simulations in this model can be run in different modes, single moment simulations or whole year simulations.

For a whole year, simulations start on the 21st of December, and a time step (in minutes) for which simulations need to be performed can be specified. Next, leaf growth can also be implemented. To implement leaf growth, a file with numbers between 0 and 1 for every day of the year can be imported by clicking on “import”. This represents phenological development of the trees in the scene. 0 means no leafs are present on the trees, 1 means leafs are completely unfolded.



Model parameters

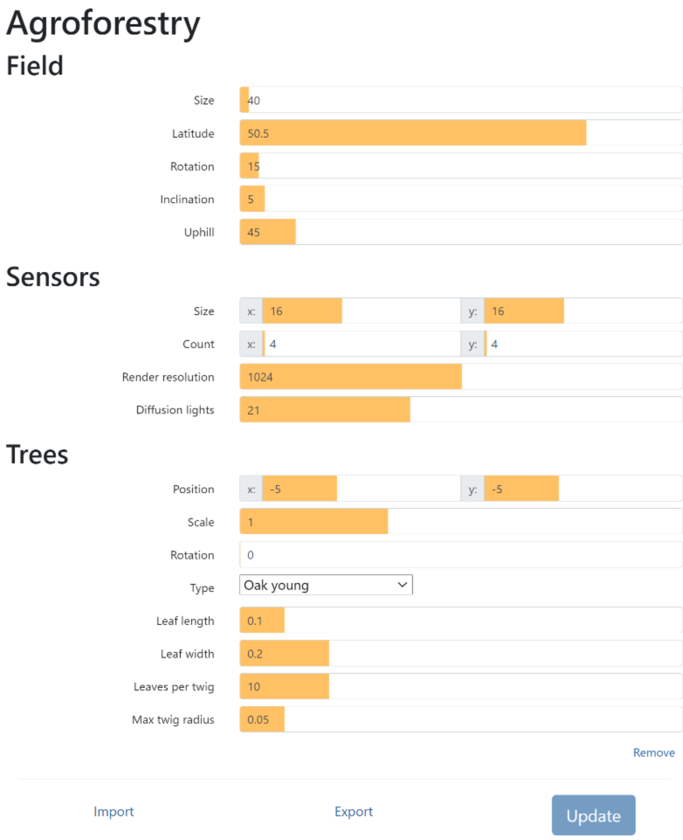
Field

Latitude: Latitude location for which simulations need to be performed.

Rotation: The number of degrees the field needs to be rotated.

Inclination: The number of degrees the field is inclined.

Uphill: The direction in which the field inclines.



Sensors

Size: The size of the sensor field in an x and y direction.

Count: the number of sensors in which the sensor field is divided in an x and y direction.

Render resolution: Resolution in which the scene is rendered.

Time step size: The time step size for which simulations are run (in minutes).

Diffusion lights: The number of diffuse lights panels used for the light simulations, a larger amount means more accurate simulations but longer simulation time.

Trees

Position: The position of the tree in the scene in an x and y coordinate.

Scale: A factor scaling the tree size.

Rotation: Rotation of the tree in the scene.

Type: The tree LIDAR scan implemented in the light model. For now limited to oak, birch and alder trees in 3 age categories.

Leaf length: The length of the triangular leaf shapes.

Leaf width: The width at the base of the triangular leaf shapes.

Leaves per twig: The number of leaves which are placed on a single “twig” represented by cylinders.

Max twig radius: The maximum twig radius on which leafs are placed.

Conversion to light intensity

Since the output of this model is not expressed in a unit of light intensity, but in areas as seen by the diffuse and direct components, output of the model has to be converted after the simulations.

To convert this output multiple steps need to be performed.

1. Partition the amount of diffuse and direct radiation from the total global radiation which falls on the earth's surface at a given moment. The total radiation intensity can be obtained from weather station data and can be partitioned in a direct and a diffuse component based on modules provided by Spitters et al. (1986)
2. Perform simulations for an empty scene with the light model.
3. Derive a conversion factor from the direct and diffuse outputs from the light model (step 2), which are expressed as areas, and the diffuse and direct component which are measured by a weather station and partitioned with the spitters modules, which is expressed in MJ/m2 (step 1).
4. Perform simulations for a scene containing the agroforestry system with the light model.
5. Convert diffuse and direct outputs from the light model (step 4) with the conversion factors derived in step 3 for every hour and day of the year and add the diffuse to direct component per sensor and every time interval.

References

Spitters C.J.T., Toussaint H.A.J.M., Goudriaan J., 1986. Separating the diffuse and direct component of global radiation and its implications for modelling canopy photosynthesis. Part 1: components of incoming radiation. Agricultural and Forest Meteorology, 38, 217-229

Grace J., The directional distribution of light in natural and controlled environment conditions. J. Appl. Ecol., 8 (1971), pp. 155-165