GENDAYLIT 2.3

Presentation of new features

Jan Wienold

Wendelin Sprenger

Fraunhofer Institute for Solar Energy Systems ISE

Golden/Colorado, August 13th, 2013

www.ise.fraunhofer.de

Fraunhofer ISE

AGENDA

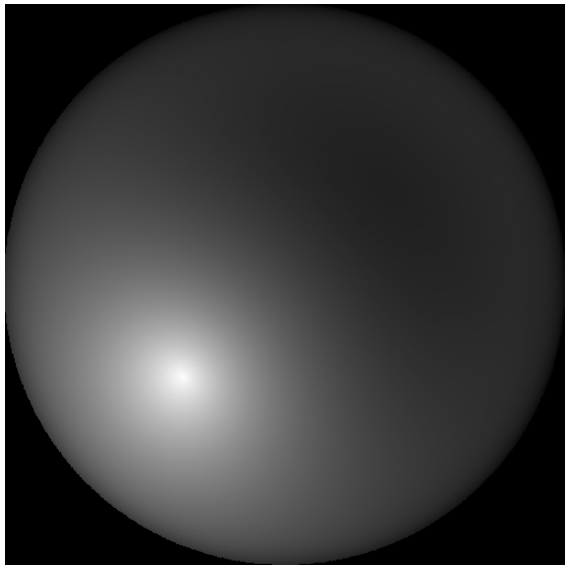
- The Perez sky implementation into RADIANCE: gendaylit
- Status of gendaylit so far
- The reason of too high results for the sky radiance distribution
- The new –i option
- The new –E option
- Conclusions

The program gendaylit (so far)

gendaylit is the Perez sky model implementation for RADIANCE and is of major importance for all ray-tracing simulations that include daylight.

Implementation of

- The all weather model of sky luminance distribution (R. Perez 1993)
- Luminance efficacy model (R. Perez 1990)

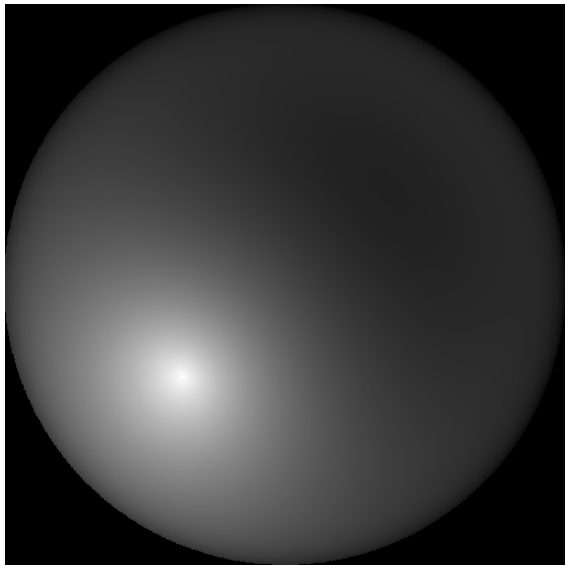


Fisheye view of the sky hemisphere.
Command: gendaylit 9 12 10 -E 400

The program gendaylit (so far)

Input values:

- –W option:
  direct-normal and
  diffuse-horizontal irradiance
- –L option:
  direct-normal illuminance and
  diffuse-horizontal illuminance
- –G option:
  direct-horizontal irradiance and
  diffuse-horizontal irradiance



Fisheye view of the sky hemisphere.
Command: gendaylit 9 12 10 -E 400

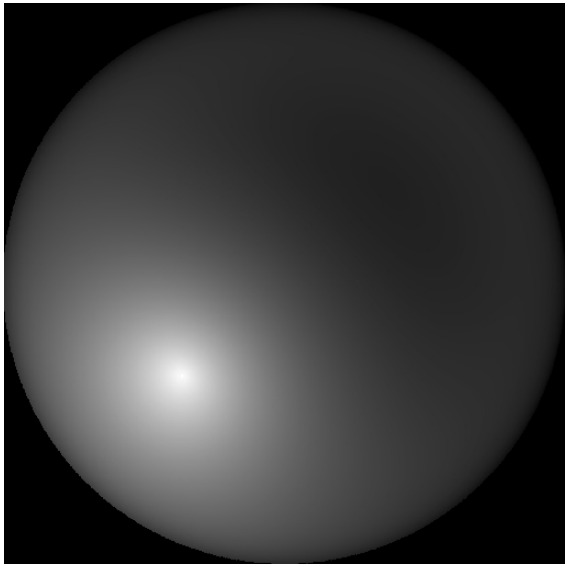
The program gendaylit

gendaylit uses the same format as *gensky* for the definition of time, geographical coordinates and time zone.

Example:

gendaylit 8 13 11 –a 39.741 –o -105.168 –m -105

calculates the sun position at August 13th in Golden / Colorado.



Fisheye view of the sky hemisphere.
Command: gendaylit 9 12 10 -E 400

The program gendaylit (so far)

Problems while using gendaylit:

- Sometimes, the resulting sky has far too high radiance values.
- There are many warning messages, especially during sunrise/sunset

The reason: usage of gendaylit with meteorological data.

Example: (with two arbitrary irradiance values)

08	13	10:00	207	240
08	13	10:30	215	245
08	13	11:00	227	247

The program gendaylit (so far)

Example: (with two arbitrary irradiance values)

08	13	10:00	207	240
08	13	10:30	215	245
08	13	11:00	227	247

What does 10:30 mean?

- Value exactly at 10:30?
- Average in the time period of 10:15 until 10:45?
- Average in the time period of 10:00 to 10:30?
- Average in the time period of 10:30 to 11:00?

gendaylit, up to now, takes you for real (exactly at 10:30) -> same as gensky
→ the sun position is calculated for 10:30.

The program gendaylit (so far)

- The problem is not relevant for points of time during the day.
  At sunrise or sunset, however, the sun might be at a position where the defined amount of direct irradiance is impossible.

  Example: hourly data, real sunrise 6:40
- Data set (direct normal, diffuse):

  Hour 5: 0 0

  Hour 6: 5 30

  Hour 7: 30 80
- The problem is, that at 6 and also at 6:30 the sun is below horizon, the average hourly data between 6 and 7 shows a value, because sun rises at 6:40
- Therefore using 6:00 or 6:30 as “time stamp” is wrong

The program gendaylit (so far)

→ the problem is caused by wrong understanding of what *gendaylit* does, it is not a mistake of *gendaylit* itself. However, it caused much trouble in the past.

New program option in gendaylit 2.3: –i

New features of gendaylit 2.3

New program option in gendaylit 2.3: –i

–i specifies the time interval of the meteorological data set in minutes.
It calculates the times of sunset and sunrise and corrects the solar position if the specified time is near the sunset time or sunrise time. For this cases, it calculates the sun position of the mean value between sunset/sunrise and the specified time.

→ For our example, gendaylit –i 60 would use 6:50 as sun position (because the radiation occurs between 6:40 and 7:00)

→ Besides this new function, overflowing parameters have been limited now in order to have a very stable behavior

→ gendaylit 2.3 has been tested for various weather files and does not produce the error of exploding radiance values anymore.

→ Please tell us if there are still errors!

What to do when only global radiation data are available?

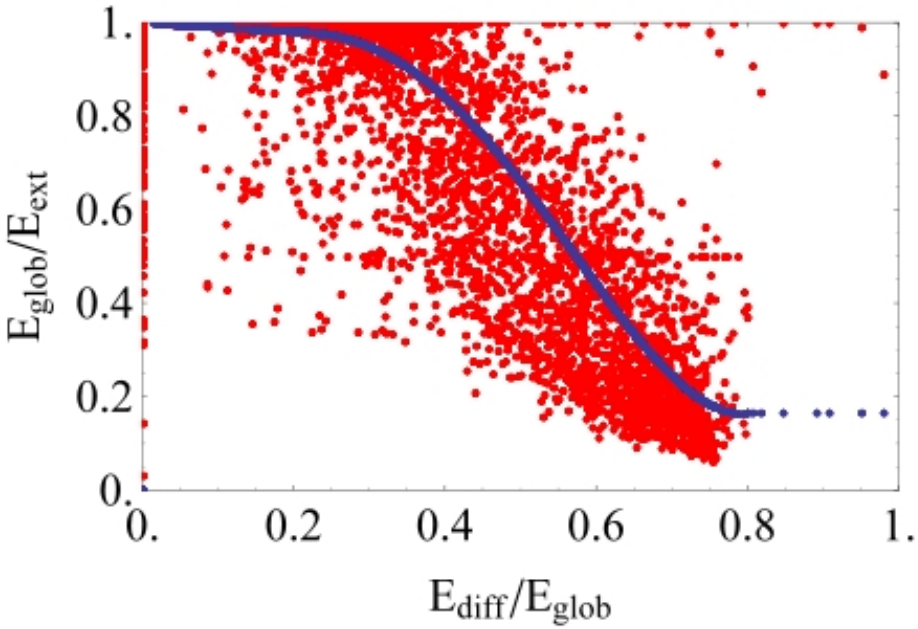
Another new feature: option –E

–E allows running gendaylit with only the global-horizontal irradiance.

The diffuse irradiance fraction is calculated according to the Erbs model.

Idea of the Erbs model:

Plot the fraction of diffuse and global irradiance versus the fraction of global irradiance to extraterrestrial irradiance



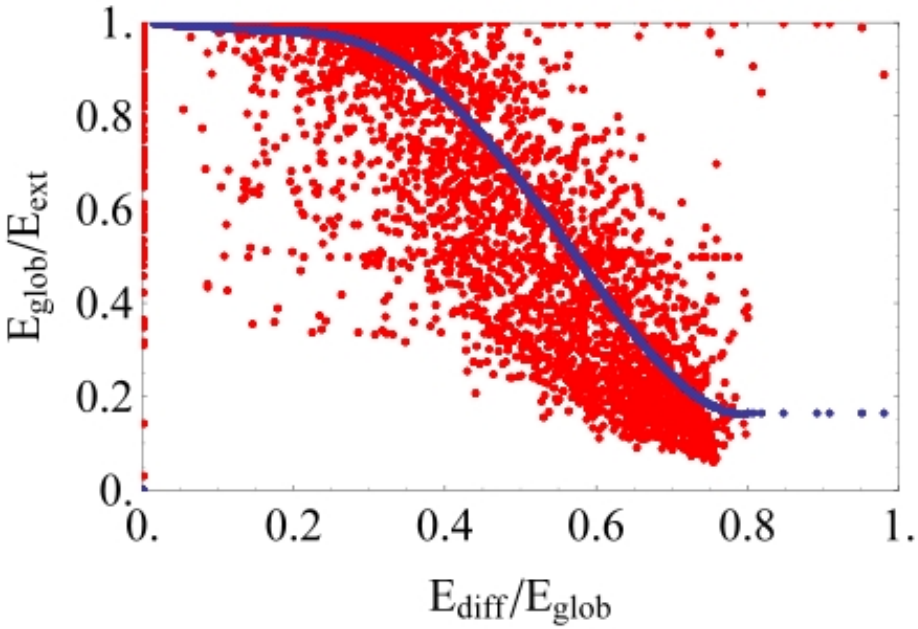
Fraunhofer ISE

New features of gendaylit 2.3

Another new feature: option –E

–E is only recommended if there are no measurements of the diffuse irradiance available.

How “good” are the results of the sky radiance distribution when applying the –E option?



New features of gendaylit 2.3

How “good” are the results of the sky radiance distribution when applying the –E option?

Comparison with the time-dependent, measured irradiance (pyranometer) values on

The horizontal plane (diffuse and global irradiance)

The vertical plane in south, east, north and west orientation (albedo excluded in the measurements by black rings)

New features of gendaylit 2.3

How “good” are the results of the sky radiance distribution when applying the –E option?

Statistical measures: R², RMSE, MBE;
irradiance values under 5 W/m² are neglected

R²: correlation coefficient
(ideal correlation: 100%)

$$R^2 = 1 - \frac{\sum_{i=1}^{N} (x_{meas}^i - x_{sim}^i)^2}{\sum_{i=1}^{N} (x_{meas}^i - \bar{x}_{meas})^2}$$

RMSE: root mean square error
standard deviation of the cumulation function of differences between simulation and measurements

$$RMSE = \sqrt{\frac{1}{N} \sum_{i=1}^{N} (x_{meas}^i - x_{sim}^i)^2}$$

MBE: shift of the cumulation function

$$MBE = \frac{1}{N} * \sum_{i=1}^{N} (x_{sim}^i - x_{meas}^i)$$

New features of gendaylit 2.3

How “good” are the results of the sky radiance distribution when applying the –E option?

Agreement of the time-dependent diffuse-horizontal irradiance values:

	R^2	RMSE	MBE	$\overline{SIM}$	$\overline{MEAS}$	$\Delta\%$
E_{diff}	77.75	52.99	−16.94	121.45	138.39	−12.24

… not really good.

New features of gendaylit 2.3

Results for the Erbs model:

Global irradiance data:

	R^2	RMSE	MBE	$\overline{SIM}$	$\overline{MEAS}$	$\Delta\%$
hor	99.97	4.16	−2.36	245.19	247.55	−0.95
east	91.37	46.87	9.72	119.07	109.35	8.89
south	87.16	64.64	21.08	164.98	143.90	14.65
west	91.01	46.99	0.44	113.64	113.20	0.39
north	76.15	20.03	−5.67	48.55	54.22	−10.46

New features of gendaylit 2.3

For comparison: Statistical results for the simulation with measured diffuse-horizontal and global-horizontal irradiance values.

Global irradiance data:

	R^2	RMSE	MBE	$\overline{SIM}$	$\overline{MEAS}$	$\Delta\%$
hor	99.98	3.19	−2.29	245.25	247.55	−0.93
east	98.13	22.02	5.34	118.07	112.72	4.74
south	98.51	22.12	9.08	158.07	148.98	6.10
west	99.15	14.56	−0.91	115.59	116.51	−0.79
north	94.21	9.77	−2.14	53.42	55.55	−3.85

New features of gendaylit 2.3

→ We decided to implement a warning message every time the Erbs model is applied. However, the model is useful for cases where only a global-horizontal irradiance measurement is available.

The program gendaylit 2.3

Available in the HEAD release!

Thank you very much for your attention.