Extraterrestrial Solar Radiation: Daily Ho and Hourly Io

Extraterrestrial normal irradiance, the day's extraterrestrial radiation Ho on a horizontal surface and the radiation between two solar times at any latitude.

Input parameters

Unit system: SI

Parameter	Value	Unit
Latitude (north positive, south negative)	0	°
Day of the year (1 = 1 January, 365 = 31 December)	80.000	
Period start (solar time)	0	h
Period end (solar time)	24.000	h
Declination formula	Cooper (1969), as in the textbook examples	

Calculated results

Parameter	Value	Unit
Extraterrestrial radiation normal to the beam	1,375.7	W/m²
Declination	-0.40365	°
Sunset hour angle	90.000	°
Day's extraterrestrial radiation on a horizontal surface	37.833	MJ/m²
Extraterrestrial radiation between the two times	37.833	MJ/m²
Extraterrestrial irradiance at the period midpoint	1,375.6	W/m²

Notes for this case

• Solar constant 1,367 W/m² in common practice; satellite measurements since 2011 give about 1,361 W/m², 0.4 % less. The period is clipped to sunrise and sunset.

Formula and method

$$G_{on} = G_{sc}\left(1 + 0.033\cos\frac{360n}{365}\right)$$

$$H_o = \frac{24 \times 3600\, G_{on}}{\pi}\left(\cos\phi\cos\delta\sin\omega_s + \frac{\pi\omega_s}{180}\sin\phi\sin\delta\right)$$

$$I_o = \frac{12 \times 3600\, G_{on}}{\pi}\left[\cos\phi\cos\delta(\sin\omega_2 - \sin\omega_1) + \frac{\pi(\omega_2 - \omega_1)}{180}\sin\phi\sin\delta\right]$$

Variables

ϕ	Latitude (north positive, south negative)	rad
n	Day of the year (1 = 1 January, 365 = 31 December)	-
t_1	Period start (solar time)	s
t_2	Period end (solar time)	s
δ formula	Declination formula	-
G_{on}	Extraterrestrial radiation normal to the beam	W/m²
δ	Declination	rad
ω_s	Sunset hour angle	rad
H_o	Day's extraterrestrial radiation on a horizontal surface	J/m²

I_o	Extraterrestrial radiation between the two times	J/m²
G_o	Extraterrestrial irradiance at the period midpoint	W/m²

Method and standards

Integration of the extraterrestrial irradiance on a horizontal plane over the day or the hour.

Assumptions and limits

- Outside the atmosphere only; no atmospheric attenuation.

Report details

Report reference	FCC-WGAF-8JWB (the same inputs always give the same reference)
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Calculator	Extraterrestrial Solar Radiation: Daily Ho and Hourly Io
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Release checks	4 reference cases of this calculator, computed independently, are checked on every release

Results are for engineering estimation. Verify critical designs against the referenced standards and your own data.

This calculator online

https://calc.firecad.com/environmental/solar-thermal/extraterrestrial-solar-radiation

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Reopens the calculator with the inputs of this report.