## Package 'solrad'

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**Title** Calculating solar radiation and related variables based on location, time and topographical conditions

**Description** The 'solrad' R package is to be used in surface energy models and estimation of solar positions and components with varying topography, time and locations. The functions calculate solar top-of-atmosphere, open, diffuse and direct components, atmospheric transmittance and diffuse factors, day length, sunrise and sunset, solar azimuth, zenith, altitude, incidence, and hour angles, earth declination angle, equation of time, and solar constant.

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## R topics documented:

Altitude
AST
Azimuth
DayLength
DayOfYear
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2 Altitude

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## Description

This function solar altitude angle (in degrees) for a given day of year and location.

#### Usage

```
Altitude(DOY, Lat, Lon, SLon, DS)
```

## Arguments

DOY	Day of year
Lat	Latitude in degrees
Lon	Longitude in degrees
SLon	Standard longitude (based on time zone) in degrees
DS	Daylight saving in minutes

```
#Calculating solar altitude angle for two consecutive days

DOY <- seq(0, 2, .05)

alpha <- Altitude(DOY, Lat = 45, Lon=0, SLon=0, DS=60)
#Note: only the difference between Lon and SLon matters not each value
plot(DOY, alpha)</pre>
```

AST 3

|--|

#### **Description**

This function returns the apparent solar time (in minutes) for a given day of year and location.

#### Usage

```
AST(DOY, Lon, SLon, DS)
```

#### **Arguments**

DOY	Day of year
Lon	Longitude in degrees
SLon	Standard longitude (based on time zone) in degrees
DS	Daylight saving in minutes

## **Examples**

```
#Calculating apparent solar time for two consecutive days

DOY <- seq(0, 2, .05)

ast <- AST(DOY, Lon=0, SLon=0, DS=60)
#Note: only the difference between Lon and SLon matters not each value
plot(DOY, ast)</pre>
```

Azimuth	Solar Azimuth Angle

## Description

This function returns solar azimuth angle (in degrees) for a given day of year and location. The solar azimuth angle is the angle of sun's ray measured in the horizental plane from due south

#### Usage

```
Azimuth(DOY, Lat, Lon, SLon, DS)
```

DayLength

## **Arguments**

DOY	Day of year
Lat	Latitude (in degrees)
Lon	Longitude in degrees
SLon	Standard longitude (based on time zone) in degrees
DS	Daylight saving in minutes

## **Examples**

```
#Calculating solar azimuth angle for two consecutive days on 45 degree lat and 10 degree lon DOY <- seq(0, 2, .05)

Az <- Azimuth(DOY, Lat = 45, Lon=10, SLon=10, DS=0)

#Note: only the difference between Lon and SLon matters not each value plot(DOY, Az)
```

DayLength

Day Length

#### **Description**

This function estimates day length (in hours) for a given day of year and latitude.

#### Usage

```
DayLength(DOY, Lat)
```

#### **Arguments**

DOY Day of year

Lat Latitude (in degrees)

```
#Calculating day length for 365 day of the year for 45 degree latitude
DOY <- 1:365
Lat = 45
dl <- DayLength(DOY, Lat)
plot(DOY, dl)</pre>
```

DayOfYear 5

Day of year Day of year

## Description

This function returns a continuous the day of year value (as integer value 1:365) for a given date-time in "POSIXIt" "POSIXct" format.

## Usage

```
DayOfYear(DateTime)
```

## Arguments

DateTime

DateTime object

## **Examples**

```
#Calculating day of year for now
DayOfYear(Sys.time())
```

Declination

Declination Angle

## Description

This function calculates solar declination angle for a given day of year.

## Usage

Declination(DOY)

## Arguments

DOY

Day of year

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#### **Examples**

```
#Calculating solar declination angle for 365 day of the year
DOY <- 1:365
delta <- Declination(DOY)
plot(DOY, delta)</pre>
```

DiffuseRadiation

Solar Diffuse Radiation on a Surface

## Description

This function returns solar diffuse dadiation (in W/m2) for a given day of year, location and topography.

#### Usage

```
DiffuseRadiation(DOY, Lat, Lon, SLon, DS, Elevation, Slope)
```

#### **Arguments**

DOY	Day of year
-----	-------------

Lat Latitude (in degrees)
Lon Longitude in degrees

SLon Standard longitude (based on time zone) in degrees

DS Daylight saving in minutes
Elevation Elevation of the site in meters

Slope Site slope in degrees

## Examples

#Calculating atmospheric transmittance coefficient for two consecutive days on 45 degree # latitude and 10 degree longitude and at 100 m altitude.

```
DOY <- seq(0, 2, .05)
```

Sdifopen <- DiffuseRadiation(DOY, Lat = 45, Lon=10, SLon=10, DS=0, Elevation = 100, Slope = 0) #Note: only the difference between Lon and SLon matters not each value

```
plot(DOY, Sdifopen)
```

DiffusionFactor 7

#### **Description**

This function returns atmospheric diffusion factor for a given day of year, location and topography.

#### Usage

```
DiffusionFactor(DOY, Lat, Lon, SLon, DS, Elevation)
```

#### **Arguments**

DOY	Day of year
Lat	Latitude (in degrees)
Lon	Longitude in degrees
SLon	Standard longitude (based on time zone) in degrees
DS	Daylight saving in minutes
Elevation	Elevation of the site in meters

#### **Examples**

```
#Calculating atmospheric diffusion factor for two consecutive days on 45 degree
# latitude and 10 degree longitude and at 100 m altitude.

DOY <- seq(0, 2, .05)

td <- DiffusionFactor(DOY, Lat = 45, Lon=10, SLon=10, DS=0, Elevation = 100)
#Note: only the difference between Lon and SLon matters not each value
plot(DOY, td)</pre>
```

DirectRadiation	Solar Direct Beam Radiation on Surface	

#### **Description**

This function returns solar open direct beam dadiation (in W/m2) for a given day of year, location and topography.

#### Usage

```
DirectRadiation(DOY, Lat, Lon, SLon, DS, Elevation, Slope, Aspect)
```

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#### **Arguments**

DOY Day of year

Lat Latitude (in degrees)

Lon Longitude in degrees

SLon Standard longitude (based on time zone) in degrees

DS Daylight saving in minutes

Elevation Elevation of the site in meters

Slope Site slope in degrees

Aspect Site aspect with respect to the south in degrees

## Examples

#Calculating atmospheric transmittance coefficient for two consecutive days on 45 degree #latitude and 10 degree longitude and at 100 m altitude.

```
DOY < - seq(0, 2, .05)
```

Sopen <- OpenRadiation(DOY, Lat = 45, Lon=10, SLon=10, DS=0, Elevation = 100) #Note: only the difference between Lon and SLon matters not each value

plot(DOY, Sopen)

EOT Equation of time

## Description

This function approximates the value of equation of time for a given day of year

#### Usage

EOT(DOY)

## Arguments

DOY Day of year

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#### **Examples**

```
#Calculating equaiton of time for 365 day of the year

DOY <- 1:365

eot <- EOT(DOY)

plot(DOY, eot)</pre>
```

Extraterrestrial

Solar Extraterrestrial Radiation

## Description

This function calculates solar extraterrestrial radiation (in W/m2) for a given day of year.

## Usage

```
Extraterrestrial(DOY)
```

#### **Arguments**

DOY

Day of year

#### **Examples**

```
#Calculating solar extraterrestrial radiation for 365 day of the year
DOY <- 1:365
Sextr <- Extraterrestrial(DOY)
plot(DOY, Sextr)</pre>
```

ExtraterrestrialNormal

Normal Extraterrestrial Solar Radiation

#### **Description**

This function calculates extraterrestrial solar radiation normal to surface (in W/m2) for a given day of year, location and topography.

HourAngle

#### Usage

ExtraterrestrialNormal(DOY, Lat, Lon, SLon, DS, Slope, Aspect)

#### **Arguments**

DOY	Day of year
Lat	Latitude (in degrees)
Lon	Longitude in degrees
SLon	Standard longitude (based on time zone) in degrees
DS	Daylight saving in minutes

Slope Site slope in degrees

Aspect Site aspect with respect to the south in degrees

#### **Examples**

```
#Calculating solar incidence angle for two consecutive days on 45 degree latitude and
# 10 degree longitude

DOY <- seq(0, 2, .05)

SextrNormal <- ExtraterrestrialNormal(DOY, Lat = 45, Lon=10, SLon=10, DS=0, Slope = 10, Aspect = 0)
#Note: only the difference between Lon and SLon matters not each value
plot(DOY, SextrNormal)</pre>
```

## Description

This function returns solar hour angle for a given day of year, and location.

#### Usage

```
HourAngle(DOY, Lon, SLon, DS)
```

#### **Arguments**

DOY	Day of year
Lon	Longitude in degrees
SLon	Standard longitude (based on time zone) in degrees
DS	Daylight saving in minutes

Incidence 11

#### **Examples**

Incidence

Solar Incidence Angle

#### **Description**

This function returns solar incidence angle (in degrees) for a given day of year and location and site slope and aspect. The solar incidence angle is the angle between sun's ray and the normal on a surface.

#### Usage

```
Incidence(DOY, Lat, Lon, SLon, DS, Slope, Aspect)
```

#### **Arguments**

DOY	Day of year
Lat	Latitude (in degrees)
Lon	Longitude in degrees
SLon	Standard longitude (based on time zone) in degrees
DS	Daylight saving in minutes
Slope	Site slope in degrees
Aspect	Site aspect with respect to the south in degrees

```
#Calculating solar incidence angle for two consecutive days on 45 degree latitude and # 10 degree longitude
```

```
DOY <- seq(0, 2, .05)
theta <- Incidence(DOY, Lat = 45, Lon=10, SLon=10, DS=0, Slope = 10, Aspect = 0) #Note: only the difference between Lon and SLon matters not each value plot(DOY, theta)
```

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LST

Local Standard Time

#### **Description**

This function returns local standard time (in minutes) given a day of the year value.

## Usage

```
LST(DOY)
```

#### **Arguments**

DOY

Day of year

## **Examples**

```
#Calculating local standard time for two consecutive days
DOY <- seq(0, 2, .05)
lst <- LST(DOY)
plot(DOY, lst)</pre>
```

OpenRadiation

Open Sky Solar Radiation

## Description

This function returns open sky solar radiation (in W/m2) for a given day of year and location.

## Usage

```
OpenRadiation(DOY, Lat, Lon, SLon, DS, Elevation)
```

#### **Arguments**

DOY	Day of year
Lat	Latitude (in degrees)
Lon	Longitude in degrees
SLon	Standard longitude (based on time zone) in degrees
DS	Daylight saving in minutes
Flevation	Elevation of the site in meters

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#### **Examples**

```
#Calculating open sky solar radiation for two consecutive days on 45 degree latitude and # 10 degree longitude and at 100 m altitude.
```

```
DOY <- seq(0, 2, .05)

Sopen <- OpenRadiation(DOY, Lat = 45, Lon=10, SLon=10, DS=0, Elevation = 100)

#Note: only the difference between Lon and SLon matters not each value

plot(DOY, Sopen)
```

Solar

Calculating Solar Variables

#### Description

This function calculates solar variables including radiation components, solar angles and positions and day length.

#### Usage

```
Solar(DOY, Lat, Lon, SLon, DS, Elevation, Slope, Aspect)
```

#### **Arguments**

DOY	Day of year
Lat	Latitude (in degrees)
Lon	Longitude in degrees
SLon	Standard longitude (based on time zone) in degrees
DS	Daylight saving in minutes
Elevation	Elevation of the site in meters
Slope	Site slope in degrees
Aspect	Site aspect with respect to the south in degrees

```
#Calculating solar variables and angles

DOY <- seq(0, 2, .05)

solar <- Solar(DOY, Lat = 45, Lon=10, SLon=10, DS=0, Elevation = 1000, Slope = 10, Aspect = 0)
#Note: only the difference between Lon and SLon matters not each value
par(mfrow=c(3,1))</pre>
```

14 Sunrise

```
plot(DOY, solar$Altitude, ylim = c(-90,90))
plot(DOY, solar$Azimuth, col= 'red')

plot(DOY, solar$Sdiropen)
lines(DOY, solar$Sdifopen, col='red')
```

SolarConstant

Solar Constant

#### Description

This constant value returns solar constant in Watt per meter squared

#### Usage

SolarConstant

#### **Format**

An object of class numeric of length 1.

#### **Examples**

```
#Printing Solar Constant
print(SolarConstant)
```

Sunrise

Sunrise Time

#### **Description**

This function estimates sunrise time (in continuous hour values) for a given day of year and latitude.

## Usage

```
Sunrise(DOY, Lat)
```

#### **Arguments**

DOY	Day	of year
DOY	Dav	of vear
DO 1	Day	or year

Latitude (in degrees)

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#### **Examples**

```
#Calculating sunrise time for 365 day of the year for 45 degree latitude
DOY <- 1:365
Lat = 45
sunrise <- Sunset(DOY, Lat)
plot(DOY, sunrise)</pre>
```

Sunset

Sunset Time

## Description

This function estimates sunset time (in continuous hour values) for a given day of year and latitude.

#### Usage

```
Sunset(DOY, Lat)
```

## Arguments

DOY Day of year

Latitude (in degrees)

```
#Calculating sunset time for 365 day of the year for 45 degree latitude
DOY <- 1:365
Lat = 45
sunset <- Sunset(DOY, Lat)
plot(DOY, sunset)</pre>
```

16 Transmittance

Transmittance Atmospheric Transmittance
---

## Description

This function returns atmospheric transmittance coefficient for a given day of year and location.

## Usage

```
Transmittance(DOY, Lat, Lon, SLon, DS, Elevation)
```

## Arguments

DOY	Day of year
Lat	Latitude (in degrees)
Lon	Longitude in degrees
SLon	Standard longitude (based on time zone) in degrees
DS	Daylight saving in minutes
Elevation	Elevation of the site in meters

```
\#Calculating atmospheric transmittance coefficient for two consecutive days on 45 degree \# latitude and 10 degree longitude and at 100 m altitude.
```

```
DOY <- seq(0, 2, .05)

tb <- Transmittance(DOY, Lat = 45, Lon=10, SLon=10, DS=0, Elevation = 100)

#Note: only the difference between Lon and SLon matters not each value

plot(DOY, tb)
```

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