Package ‘solrad’

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Title Calculating Solar Radiation and Related Variables Based on Location, Time and Topographical Conditions

Description For 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. Details about the methods and equations are explained in Seyednasrollah, Bijan, Mukesh Kumar, and Timothy E. Link. 'On the role of vegetation density on net snow cover radiation at the forest floor.' Journal of Geophysical Research: Atmospheres 118.15 (2013): 8359-8374, <doi:10.1002/jgrd.50575>.

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`Altitude` *Solar Altitude Angle*

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

Examples

```
#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)
```

AST *Apparent Solar Time*

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)
```

`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)
```

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)

Examples

```
#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)
```

`DayOfYear` *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 "POSIXlt" "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

Examples

```
#Calculating solar declination angle for 365 day of the year

DOY <- 1:365

delta <- Declination(DOY)

plot(DOY, delta)
```

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` *Atmospheric Diffusion Factor*

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)
```

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)
```

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

Examples

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

DOY <- 1:365

eot <- EOT(DOY)

plot(DOY, eot)
```

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)
```

`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 topogrpahy.

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)
```

HourAngle *Solar Hour Angle*

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

Examples

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

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

h <- HourAngle(DOY, Lon=0, SLon=0, DS=60)
#Note: only the difference between Lon and SLon matters not each value

plot(DOY, h)
```

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

Examples

```
#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)
```

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)
```

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
`Elevation`	Elevation of the site in meters

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

Examples

```
#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))
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
Lat	Latitude (in degrees)

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)
```

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
Lat	Latitude (in degrees)

Examples

```
#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)
```

`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

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)

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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