etp package

April 8, 2019

`daylight` *Astronomic helper functions*

Description

Some useful calculations of the astronomic configuration of earth in relation to the sun.

sunsetangle

Usage

```
daylight(lat, day)

sunsetangle(lat, day)

declination(day)

rel_dist(day)
```

Arguments

`lat`	latitude
`day`	julian day (day of the year)
`deg`	angle in degrees

Value

`sunsetangle`: sunset angle in degrees.

`declination`: solar declination in degrees.

`rel_dist`: relative distance earth-sun.

Details

`daylight` calculates the duration of the daylight period for a given date and location. It is based purely on geometrical calculation (i.e. does account for dispersion etc.).

`rh2dewpoint` calculates the sunset hour angle for a given latitude and date.

`rh2dewpoint` calculates the solar declination angle in degrees for a given day.

`rel_dist` calculates the relative distance of earth from sun in relation to the mean distance.

Examples

```
sunsetangle(50,1)
sunsetangle(50,1)
rel_dist(50,1)
```

---

etp_estimate — *Estimate potential evapo-transpiration from weather data (1948)*

Description

NOT YET IMPLEMENTED!

...

Estimation method can selected manually or will be chosen automatically based on availability of weather data

...

Usage

```
etp_estimate(...)
```

Arguments

`lat`	latitude (used for calculating daylight hours)
`weather`	weather in a data.frame
`columns`	identification of columns in the weather data.frame
`frequency`	output time unit: daily or monthly

Examples

```
bla()
```

---

etp_hs — *Potential evapo-transpiration sensu Hargreaves-Samani*

Description

Calculates potential evapo-transpiration from air temperature extremes using the approach by Hargreaves&Samani (1985) and popular corrections.

Usage

```
etp_hs(lat, day, tmin, tmax, tmean = (tmax + tmin)/2, alt, ke = 0.0135,
  kt = 0.16, kmethod, ...)
```

Arguments

tmin	minimum air temperature (°C)
tmax	maximum air temperature (°C)
tmean	mean air temperature (°C). Deafults to (tmin+tmax)/2
alt	elevation above sea level (m)
ke	calibration coefficient for Hargreaves' ETP function
kt	calibration coefficient for Hargreaves' irradiance estimation.
kmethod	Method to use for estimating the kt parameter in the Hargreaves equation. One of "anadale", "allen", "samani".

Value

Potential evapo-transpiration in mm per period.

Examples

```
etp_hs(lat=20,day=45,tmin=1,tmax=7)
```

---

etp_pm *Potential evapo-transpiration sensu Penman-Monteith*

Description

Calculates daily potential evapo-transpiration in mm.

Usage

```
etp_pm(rad, shf = 0, temp = 20, vpd, rh, p = 101.3, r_s = rs(...),
  r_a = ra(...), lh = 2.501 - 0.002361 * temp, ...)
```

Arguments

rad	net radiation (MJ/(m2*day))
shf	soil heat flux (MJ/(m2*day))
temp	air temperature (dC)
rh	lative air humidity (%)
p	air pressure (kPa)
r_s	canopy surface resistance (s/m)
r_a	canopy aerodynamic resistance in s/m
lh	latent head of vapourisation
vp	air water vapour pressure (kPa)
lai	leaf area index

Value

ra Potential evapo-transpiration in mm/d

Examples

```
etp_pm(rad=5,shf=0,temp=4,rh=80)
```

etp_pt *Priestley-Taylor*

Description

WARNING: NOT CHECKED.

...

Calculates daily potential evapo-transpiration in using the approach by Priestley-Taylor.

Usage

```
etp_pt(rad, shf = 0, temp = 20, alpha = 1.26, p = 101.3,
  lh = 2.501 - 0.002361 * temp, ...)
```

Arguments

rad	net radiation (MJ/(m^2*day)).
shf	soil heat flux (MJ/(m^2*day)).
temp	air temperature (°C).
p	air pressure (kPa)

Value

ra Potential evapo-transpiration in mm/d.

Examples

```
etp_pt(rad=5,shf=0,temp=20)
```

etp_th *Potential evapo-transpiration sensu Thorntwaite (1948)*

Description

WARNING: IMPLEMENTATION IS PRELIMINARY. RESULTS PROBABLY WRONG. Especially for higher latitudes.

Calculates monthly potential evapo-transpiration in using the approach by Thorntwaite (1948).

Usage

```
etp_th(lat, dates, temp, fillmethod = na.approx)
```

Arguments

`lat`	latitude (used for calculating daylight hours)
`temp`	air temperature (°C) for the given dates.
`fillmethod`	na.approx or na.spline, used inter- and extrapolate insufficient values to the whole year.
`date`	either a vector of dates (class "Date") or a julian day (numeric). Since the Thorntwaite method is based on an annual heat index, dates should cover the whole year.

Value

`ra` Potential evapo-transpiration in mm/d.

Examples

```
etp_th(lat=54,temp=c(1,14,1),dates=c(1,210,365))
```

`magnus` *Thermodynamic helper functions*

Description

Various useful calculations and conversion functions.

Usage

```
magnus(temp)

rh2dewpoint2(temp, rh)

rh2vp(temp, rh)

vp2rh(temp, vp)

dewpoint2rh(temp, dp)

dewpoint2rh(temp, dp)

psychro(p)

satpressslope(temp)

alt_pressure(altitude)

rsurf_(LAIact = 1.44, rstom = 100)

ra_(zom, zoh, d = 2 * h/3, uz = 2.8, h = 0.12, zm = 2, zh = 2)

wind2m(windz, z)
```

Arguments

`temp`	air temperature in °C
`rh`	relative air humidity in %.
`vp`	water vapour partial pressure in kPa
`dp`	dewpoint temperature in °C
`p`	air pressure in kPa
`LAIact`	active LAI in m²/m².
`rstom`	stomatal resistance in s/m.
`zom:`	roughness length for momentum transfer (m)
`zoh:`	roughness length for heat transfer (m)
`d:`	zero plane displacement height (m)
`uz:`	wind measured at zm (m/s)
`h:`	crop height (m)
`zm:`	height of wind measurement (m)
`zh:`	height of humidity measurements (m)

Value

`rh2dewpoint`: returns dewpoint temperature in °C

`rh2vp`: water vapour pressure in kPa.

`vp2rh`: relative humidity in %.

`rh2dewpoint` relative air humidity in %.

`dewpoint2vp` water vapur pressure in kPa.

psychrometric constant in kPa/°C

`satpressslope`: slope of the curve in kPa/°C

`alt_pressure`: air pressure in kPa.

`rsurf`: canopy surface resistance in s/m (=stomatal resistance/active LAI). Default values for FAO grass reference surface.

`ra`: aerodynamic resistance in s/m. Default arguments for canopy represent the FAO grass reference surface.

`wind2m`:

Details

`magnus` calculates the saturation water vapour pressure (over liquid water surfaces) in kPa for a given temperature using the magnus formula.

`rh2dewpoint` calculates the dewpoint temperature for a given relative air humidity and temperature.

`rh2vp` calculates the water vapour pressure from relative air humidity and temperature.

`vp2rh` calculates the relative air humidity from water vapour pressure and temperature.

`rh2dewpoint` calculates the relative air humidity for a given dewpoint and air and temperature.

`dewpoint2vp` calculates the relative air humidity for a given dewpoint and air and temperature.

`psychro` calculates the psychrometre constant (water in air) for a given air pressure.

satpressslope calculates the slope of the water vapour saturation pressure curve in kPa/°C for a given temperature in °C.

alt_pressure calculates the atmospheric air pressure at normal conditions for a given altitude above the sea level.

rsurf

rsurf

wind2m

Examples

```
rh2dewpoint(50,20)
rh2vp(50,20)
rh2vp(50,20)
rh2dewpoint(50,20)
psychro(101.3)
satpressslope(20)
alt_pressure(1000)
rsurf()
ra()
```

---

rad_toa *Radiation balance*

Description

Functions to calculate the radiation balance for a given location.

Usage

```
rad_toa(lat, day)

rad_clearsky(lat, day, angstr_a = 0.25, angstr_b = 0.5, alt = 0)

rad_nsw(albedo = 0.23, rad = NULL, sunshineduration = NULL, ...)

rad_nlw(tmin, tmax, vp, rad, rad_actual, rad_clearsky, rad_rel)

ssd2rad(lat, day, angstr_a = 0.25, angstr_b = 0.5, sunshinehours = 0)
```

Arguments

lat	latitude in degrees
day	julian day (day of the year)
angstr_a	Ångström a coefficient (defaults to .25)
angstr_b	Ångström b coefficient (defaults to .5)
alt	altitude above sea level
vp	atmospheric water vapour pressure (kPa)

Value

Daily sum of incoming solar radiation in MJ/m²

rad_clearsky calculates the daily sum of incoming radiation for a given location under clear sky conditions.

rad_clearsky daily net sum of incoming shortwave radiation (MJ/m²).

rad_lw_em daily sum of emitted longwave radition (MJ/m²).

ssd2rad estimates daily sum of incoming radiation (bottom of atmosphere) from sum of sunshine duration.

Details

rad_toa calculates the daily sum of incoming extraterrestrial (top of atmosphere) radiation.

rad_clearsky calculates the daily sum of incoming radiation (bottom of atmosphere) for a given location under clear sky conditions.

rad_nsw #' calculates the daily net amount of shortwvae radiation. This is simply (1-albedo)*irradiance. If no irradiance measurements are available, it can alternatively be estimated from sunshine duration and Ångström coefficients (calling ssd2rad internally). Future versions will allow estimations based on daily cloud cover values.

rad_lw_em estimates daily sum of emitted longwave radiation.

ssd2rad estimates daily sum of incoming radiation (bottom of atmosphere) from sum of sunshine duration.

Examples

```
rad_boa(50,20)
rad_sw()
ssd2rad(50,20)
ssd2rad(50,20)
```

---

ra *Aerodynamic resistance*

Description

Calculation of the aerodynamic resistance for a given crop surface. Defaults to the FAO grass reference surface.

Usage

```
ra(wz = 2, zrm = NULL, zrh = NULL, d, h = 0.12, zw = 2, zh = 2)
```

Arguments

wz	wind speed at height zw (default 2m/s)
zrm	roughness length governing momentum transfer in m (default 0.123*h)
zrh	roughness length governing heat transfer in m (default 0.1*zrm)
d	zero plane displacement height (default 2/3*h)
h	crop height in m (defaults to 0.12m).

`zw`	height of wind measurements in m (default 2m).
`zh`	height of humidity measurements in m (default 2m).
`lai`	Leaf area index

Value

`ra` returns the aerodynamic resistance

`temp2rad` *Estimation of global radiation based on temperature differences*

Description

Estimate solar radiation from temperature extremes. Implements some popular equations and adjustments.

Usage

```
temp2rad(lat, day, tmin, tmax, kt = 0.162, alt = 0, trmax = 0.75,
  method = c("hargreaves"), kmethod = c("allen"))
```

Arguments

`lat`	latitude in degrees
`day`	julian day (day of the year)
`tmin, tmax`	minimum and maximum temperatures for the period in question.
`kt`	regression parameter for Hargreaves formula. 0.162 (default) for interior, 0.19 for coastal regions.
`alt`	altitude in metres above sea level
`trmax`	maximum atmospheric transmissivity (default .75) used for Bristow method. The default value of .75 is the sum of the default Ångström a (.25) and b (.5) coefficients for the direct and diffuce radiation components.
`method`	Method to use: One of "hargreaves" (default) or "bristow".
`kmethod`	Method to use for estimating the kt parameter in the Hargreaves equation. One of "anadale", "allen", "samani".

Value

Daily sum of incoming solar radiation in MJ/m²

Details

`temp2rad` estimates daily sum of incoming solar radiation (bottom of atmosphere) from air temperature extremes. Available methods are sensu Bristow & Campbell 1984 or sensu Hargreaves & Samani1982. For the Hargreaves method, the calibration parameter kt can be adjusted o altitude according to Allen (1995), Samani (2000), Annandale (2002). In the Bristow 1984 paper, a different method for calculating extraterrestrial radiation is used. This is also applied #' temp2rad

References

Bandyopadhyay, A., Bhadra, A., Raghuwanshi, N. S., & Singh, R. (2008). Estimation of monthly solar radiation from measured air temperature extremes. Agricultural and Forest Meteorology, 148(11), 1707–1718. https://doi.org/10.1016/j.agrformet.2008.06.002 Bristow, K. L., & Campbell, G. S. (1984). On the relationship between incoming solar radiation and daily maximum and minimum temperature. Agricultural and Forest Meteorology, 31(2), 159–166. https://doi.org/10.1016/0168-1923(84)90017-0 H. Hargreaves, G., & Samani, Z. (1985). Reference Crop Evapotranspiration From Temperature. Applied Engineering in Agriculture, 1. https://doi.org/10.13031/2013.26773 Maluta, E. N., Mulaudzi, T. S., & Sankaran, V. (2014). Estimation of the Global Solar Radiation on the Horizontal Surface from Temperature Data for the Vhembe District in the Limpopo Province of South Africa. International Journal of Green Energy, 11(5), 454–464. https://doi.org/10.1080/15435075.2013.772518 Ollila, A. (o. J.). Dynamics between Clear, Cloudy and All-Sky Conditions: Cloud Forcing Effects. 20. Samani, Z. (2000). Estimating Solar Radiation and Evapotranspiration Using Minimum Climatological Data (Hargreaves-Samani equation). 13.

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