# Package 'agriwater'

June 8, 2023
Title Evapotranspiration and Energy Fluxes Spatial Analysis
Version 1.0.2
Description Spatial modeling of energy balance and actual evapotranspiration using satellite images and meteorological data. Options of satellite are: Landsat-8 (with and without thermal bands), Sentinel-2 and MODIS. Respectively spatial resolutions are 30, 100, 10 and 250 meters. User can use data from a single meteorological station or a grid of meteorological stations (using any spatial interpolation method). Silva, Teixeira, and Manzione (2019) <doi:10.1016 j.envsoft.2019.104497="">.</doi:10.1016>
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albedo\_18

Surface Albedo using Landsat-8 images.

# Description

Surface Albedo using Landsat-8 images.

# Usage

albedo\_18(doy)

# Arguments

doy

is the Day of Year (DOY)

#### Value

It returns in raster format (.tif) the Surface Albedo at 24h scale ("Alb\_24").

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albedo\_modis

Surface Albedo using MODIS images.

#### **Description**

Surface Albedo using MODIS images.

#### Usage

```
albedo_modis()
```

#### Value

It returns in raster format (.tif) the Surface Albedo at 24h scale ("Alb\_24").

#### **Examples**

```
library(agriwater)
# dependencies of package 'agriwater'
library(terra)
# Using a temporary folder to run example
wd <- tempdir()</pre>
initial = getwd()
setwd(wd)
# creating raster which simulate Sentinel-2 reflectances - for using
# real data, please download:
# https://drive.google.com/open?id=14E1wHNLxG7_Dh4I-GqNYakj8YJDgKLzk
xy \leftarrow matrix(rnorm(4, mean = 0.05, sd = 0.015), 2, 2)
rast <- rast(xy, crs="+proj=longlat +datum=WGS84")</pre>
ext(rast) <- c(-40.5, -40.45, -9.5, -9.45)
writeRaster(rast, file.path(wd, "B2.tif"),filetype = "GTiff", overwrite=TRUE)
xy \leftarrow matrix(rnorm(4, mean = 0.05, sd = 0.01), 2, 2)
rast <- rast(xy, crs="+proj=longlat +datum=WGS84")</pre>
ext(rast) <- c(-40.5, -40.45, -9.5, -9.45)
writeRaster(rast, file.path(wd, "B1.tif"),filetype = "GTiff", overwrite=TRUE)
# creating mask of study area
mask <- as.polygons(rast)</pre>
writeVector(mask, file.path(getwd(), "mask.shp"), overwrite=TRUE)
# using "agriwater"
albedo_modis()
#Exiting temporary folder and returning to previous workspace
setwd(initial)
```

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albedo\_s2

Surface Albedo using Sentinel-2 images.

#### **Description**

Surface Albedo using Sentinel-2 images.

#### Usage

```
albedo_s2()
```

#### Value

It returns in raster format (.tif) the Surface Albedo at 24h scale ("Alb\_24").

#### **Examples**

```
library(agriwater)
# dependencies of package 'agriwater'
library(terra)
# Using a temporary folder to run example
wd <- tempdir()</pre>
initial = getwd()
setwd(wd)
# creating raster which simulate Sentinel-2 reflectances - for using
# real data, please download:
# https://drive.google.com/open?id=14E1wHNLxG7_Dh4I-GqNYakj8YJDgKLzk
xy < -matrix(rnorm(4, mean = 0.07, sd = 0.01), 2, 2)
rast <- rast(xy, crs="+proj=longlat +datum=WGS84")</pre>
ext(rast) <- c(-40.5, -40.45, -9.5, -9.45)
writeRaster(rast, file.path(wd, "B2.tif"),filetype = "GTiff", overwrite=TRUE)
xy \leftarrow matrix(rnorm(4, mean = 0.05, sd = 0.015), 2, 2)
rast <- rast(xy, crs="+proj=longlat +datum=WGS84")</pre>
ext(rast) < c(-40.5, -40.45, -9.5, -9.45)
writeRaster(rast, file.path(wd, "B3.tif"),filetype = "GTiff", overwrite=TRUE)
xy \leftarrow matrix(rnorm(4, mean = 0.03, sd = 0.018), 2, 2)
rast <- rast(xy, crs="+proj=longlat +datum=WGS84")</pre>
ext(rast) <- c(-40.5, -40.45, -9.5, -9.45)
writeRaster(rast, file.path(wd, "B4.tif"),filetype = "GTiff", overwrite=TRUE)
xy \leftarrow matrix(rnorm(4, mean = 0.05, sd = 0.015), 2, 2)
rast <- rast(xy, crs="+proj=longlat +datum=WGS84")</pre>
ext(rast) <- c(-40.5, -40.45, -9.5, -9.45)
writeRaster(rast, file.path(wd, "B8.tif"),filetype = "GTiff", overwrite=TRUE)
mask <- as.polygons(rast)</pre>
writeVector(mask, file.path(getwd(), "mask.shp"), overwrite=TRUE)
```

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```
# using "agriwater"
albedo_s2()

#Exiting temporary folder and returning to previous workspace
setwd(initial)
```

evapo_18	Actual evapotranspiration (ETa) using Landsat-8 images with single
	agrometeorological data.

# Description

Actual evapotranspiration (ETa) using Landsat-8 images with single agrometeorological data.

#### Usage

```
evapo_18(doy, RG, Ta, ET0, a, b)
```

#### **Arguments**

doy	is the Day of Year (DOY)
RG	is the global solar radiation
Та	is the average air temperature
ET0	is the reference evapotranspiration
а	is one of the regression coefficients of SAFER algorithm
b	is one of the regression coefficients of SAFER algorithm

# Value

It returns in raster format (.tif) the Surface Albedo at 24h scale ("Alb\_24"), NDVI, Surface Temperature ("LST"), net radiation ("Rn\_MJ"), Crop Coefficient ("kc") and Actual Evapotranspiration (evapo).

evapo_18t	Actual evapotranspiration (ETa) using Landsat-8 (including thermal
	bands) images with single agrometeorological data.

#### **Description**

Actual evapotranspiration (ETa) using Landsat-8 (including thermal bands) images with single agrometeorological data.

#### Usage

```
evapo_18t(doy, RG, Ta, ET0, a, b)
```

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# **Arguments**

doy	is the Day of Year (DOY)
RG	is the global solar radiation
Та	is the average air temperature
ET0	is the reference evapotranspiration
a	is one of the regression coefficients of SAFER algorithm
b	is one of the regression coefficients of SAFER algorithm

#### Value

It returns in raster format (.tif) the Surface Albedo at 24h scale ("Alb\_24"), NDVI, Surface Temperature ("LST"), net radiation ("Rn\_MJ"), Crop Coefficient ("kc") and Actual Evapotranspiration (evapo).

evapo_18t_grid	Actual evapotranspiration (ETa) using Landsat-8 (including thermal bands) images with a grid of agrometeorological data.
	buttus) images with a grid of agrometeorological data.

# Description

Actual evapotranspiration (ETa) using Landsat-8 (including thermal bands) images with a grid of agrometeorological data.

#### Usage

```
evapo_l8t_grid(doy, a, b)
```

# Arguments

doy	is the Day of Year (DOY)
a	is one of the regression coefficients of SAFER algorithm
b	is one of the regression coefficients of SAFER algorithm

#### Value

It returns in raster format (.tif) the Surface Albedo at 24h scale ("Alb\_24"), NDVI, Surface Temperature ("LST"), net radiation ("Rn\_MJ"), Crop Coefficient ("kc") and Actual Evapotranspiration (evapo).

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of agrometeorological data.
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# Description

Actual evapotranspiration (ETa) using Landsat-8 images with a grid of agrometeorological data.

#### Usage

```
evapo_18_grid(doy, a, b)
```

# Arguments

doy	is the Day of Year (DOY)
а	is one of the regression coefficients of SAFER algorithm
b	is one of the regression coefficients of SAFER algorithm

#### Value

It returns in raster format (.tif) the Surface Albedo at 24h scale ("Alb\_24"), NDVI, Surface Temperature ("LST"), net radiation ("Rn\_MJ"), Crop Coefficient ("kc") and Actual Evapotranspiration (evapo).

evapo_modis	Actual evapotranspiration (ETa) using MODIS with single agromete-
	orological data.

# Description

Actual evapotranspiration (ETa) using MODIS with single agrometeorological data.

# Usage

```
evapo_modis(doy, RG, Ta, ET0, a, b)
```

doy	is the Day of Year (DOY)
RG	is the global solar radiation
Та	is the average air temperature
ET0	is the reference evapotranspiration
а	is one of the regression coefficients of SAFER algorithm
b	is one of the regression coefficients of SAFER algorithm

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#### Value

It returns in raster format (.tif) the Surface Albedo at 24h scale ("Alb\_24"), NDVI, Surface Temperature ("LST"), net radiation ("Rn\_MJ"), Crop Coefficient ("kc") and Actual Evapotranspiration (evapo).

# **Examples**

```
library(agriwater)
# dependencies of package 'agriwater'
library(terra)
# Using a temporary folder to run example
wd <- tempdir()</pre>
initial = getwd()
setwd(wd)
# creating raster which simulate Sentinel-2 reflectances - for using
# real data, please download:
# https://drive.google.com/open?id=14E1wHNLxG7_Dh4I-GqNYakj8YJDgKLzk
xy \leftarrow matrix(rnorm(4, mean = 0.05, sd = 0.015), 2, 2)
rast <- rast(xy, crs="+proj=longlat +datum=WGS84")</pre>
ext(rast) <- c(-40.5, -40.45, -9.5, -9.45)
writeRaster(rast, file.path(wd, "B2.tif"),filetype = "GTiff", overwrite=TRUE)
xy <- matrix(rnorm(4, mean = 0.05, sd = 0.015), 2, 2)
rast <- rast(xy, crs="+proj=longlat +datum=WGS84")</pre>
ext(rast) <- c(-40.5, -40.45, -9.5, -9.45)
writeRaster(rast, file.path(wd, "B1.tif"),filetype = "GTiff", overwrite=TRUE)
mask <- as.polygons(rast)</pre>
writeVector(mask, file.path(getwd(), "mask.shp"), overwrite=TRUE)
# using "agriwater" - it's the same procedure as the used for
# evapo_18(), evapo_18t(), evapo_modis_grid(), evapo_18_grid(),
# evapo_18t_grid(), evapo_s2() and evapo_s2_grid()
evapo_modis(doy = 134, RG = 17.6, Ta = 27.9, ET0 = 3.8, a = 1.8, b = -0.008)
#Exiting temporary folder and returning to previous workspace
setwd(initial)
```

evapo\_modis\_grid

Actual evapotranspiration (ETa) using MODIS with a grid of agrometeorological data.

# Description

Actual evapotranspiration (ETa) using MODIS with a grid of agrometeorological data.

evapo\_s2

#### Usage

```
evapo_modis_grid(doy, a, b)
```

#### **Arguments**

doy	is the Day of Year (DOY)
а	is one of the regression coefficients of SAFER algorithm
b	is one of the regression coefficients of SAFER algorithm

#### Value

It returns in raster format (.tif) the Surface Albedo at 24h scale ("Alb\_24"), NDVI, Surface Temperature ("LST"), net radiation ("Rn\_MJ"), Crop Coefficient ("kc") and Actual Evapotranspiration (evapo).

evapo_s2	Actual evapotranspiration (ETa) using Sentinel-2 images with single
	agrometeorological data.

#### **Description**

Actual evapotranspiration (ETa) using Sentinel-2 images with single agrometeorological data.

#### Usage

```
evapo_s2(doy, RG, Ta, ET0, a, b)
```

#### **Arguments**

doy	is the Day of Year (DOY)
RG	is the global solar radiation
Та	is the average air temperature
ET0	is the reference evapotranspiration
а	is one of the regression coefficients of SAFER algorithm
b	is one of the regression coefficients of SAFER algorithm

# Value

It returns in raster format (.tif) the Surface Albedo at 24h scale ("Alb\_24"), NDVI, Surface Temperature ("LST"), net radiation ("Rn\_MJ"), Crop Coefficient ("kc") and Actual Evapotranspiration (evapo).

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#### **Examples**

```
library(agriwater)
# dependencies of package 'agriwater'
library(terra)
# Using a temporary folder to run example
wd <- tempdir()</pre>
initial = getwd()
setwd(wd)
# creating raster which simulate Sentinel-2 reflectances - for using
# real data, please download:
# https://drive.google.com/open?id=14E1wHNLxG7_Dh4I-GqNYakj8YJDgKLzk
xy \leftarrow matrix(rnorm(4, mean = 0.07, sd = 0.01), 2, 2)
rast <- rast(xy, crs="+proj=longlat +datum=WGS84")</pre>
ext(rast) <- c(-40.5, -40.45, -9.5, -9.45)
writeRaster(rast, file.path(wd, "B2.tif"),filetype = "GTiff", overwrite=TRUE)
xy \leftarrow matrix(rnorm(4, mean = 0.05, sd = 0.015), 2, 2)
rast <- rast(xy, crs="+proj=longlat +datum=WGS84")</pre>
ext(rast) <- c(-40.5, -40.45, -9.5, -9.45)
writeRaster(rast, file.path(wd, "B3.tif"),filetype = "GTiff", overwrite=TRUE)
xy \leftarrow matrix(rnorm(4, mean = 0.03, sd = 0.018), 2, 2)
rast <- rast(xy, crs="+proj=longlat +datum=WGS84")</pre>
ext(rast) < c(-40.5, -40.45, -9.5, -9.45)
writeRaster(rast, file.path(wd, "B4.tif"),filetype = "GTiff", overwrite=TRUE)
xy \leftarrow matrix(rnorm(4, mean = 0.05, sd = 0.015), 2, 2)
rast <- rast(xy, crs="+proj=longlat +datum=WGS84")</pre>
ext(rast) <- c(-40.5, -40.45, -9.5, -9.45)
writeRaster(rast, file.path(wd, "B8.tif"),filetype = "GTiff", overwrite=TRUE)
mask <- as.polygons(rast)</pre>
writeVector(mask, file.path(getwd(), "mask.shp"), overwrite=TRUE)
# using "agriwater"
evapo_s2(doy = 134, RG = 17.6, Ta = 27.9, ET0 = 3.8, a = 1.8, b = -0.008)
#Exiting temporary folder and returning to previous workspace
setwd(initial)
```

evapo\_s2\_grid

Actual evapotranspiration (ETa) using Sentinel-2 images with a grid of agrometeorological data.

#### Description

Actual evapotranspiration (ETa) using Sentinel-2 images with a grid of agrometeorological data.

kc\_18

#### Usage

```
evapo_s2_grid(doy, a, b)
```

# Arguments

doy	is the Day of Year (DOY)
а	is one of the regression coefficients of SAFER algorithm
b	is one of the regression coefficients of SAFER algorithm

#### Value

It returns in raster format (.tif) the Surface Albedo at 24h scale ("Alb\_24"), NDVI, Surface Temperature ("LST"), net radiation ("Rn\_MJ"), Crop Coefficient ("kc") and Actual Evapotranspiration (evapo).

kc_18	Crop coefficient (ETa / ET0) using Landsat-8 images with single
	agrometeorological data.

# Description

Crop coefficient (ETa / ET0) using Landsat-8 images with single agrometeorological data.

# Usage

```
kc_18(doy, RG, Ta, a, b)
```

#### **Arguments**

doy	is the Day of Year (DOY)
RG	is the global solar radiation
Та	is the average air temperature
а	is one of the regression coefficients of SAFER algorithm
b	is one of the regression coefficients of SAFER algorithm

#### Value

It returns in raster format (.tif) the Surface Albedo at 24h scale ("Alb\_24"), NDVI, Surface Temperature ("LST"), Crop Coefficient ("kc") and net radiation ("Rn\_MJ").

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kc 18t	Crop coefficient (ETa / ET0) using Landsat-8 images (including ther-
KC_10t	mal bands) with single agrometeorological data.
	mai banas) win single agrometeorological adia.

# **Description**

 $Crop\ coefficient\ (ETa\ /\ ET0)\ using\ Landsat-8\ images\ (including\ thermal\ bands)\ with\ single\ agrometeorological\ data.$ 

# Usage

```
kc_l8t(doy, RG, Ta, a, b)
```

# Arguments

doy	is the Day of Year (DOY)
RG	is the global solar radiation
Та	is the average air temperature
а	is one of the regression coefficients of SAFER algorithm
b	is one of the regression coefficients of SAFER algorithm

#### Value

It returns in raster format (.tif) the Surface Albedo at 24h scale ("Alb\_24"), NDVI, Surface Temperature ("LST"), Crop Coefficient ("kc") and net radiation ("Rn\_MJ").

kc_18t_grid	Crop coefficient (ETa / ET0) using Landsat-8 images (including thermal bands) with a grid of agrometeorological data.
	mai vanas) min a gra of agrometeorological actai

# Description

Crop coefficient (ETa / ET0) using Landsat-8 images (including thermal bands) with a grid of agrometeorological data.

#### Usage

```
kc_18t_grid(doy, a, b)
```

doy	is the Day of Year (DOY)
a	is one of the regression coefficients of SAFER algorithm
b	is one of the regression coefficients of SAFER algorithm

kc\_18\_grid 13

#### Value

It returns in raster format (.tif) the Surface Albedo at 24h scale ("Alb\_24"), NDVI, Surface Temperature ("LST"), Crop Coefficient ("kc") and net radiation ("Rn\_MJ").

kc\_l8\_grid Crop coefficient (ETa / ET0) using Landsat-8 images with a grid of agrometeorological data.

# Description

Crop coefficient (ETa / ET0) using Landsat-8 images with a grid of agrometeorological data.

#### Usage

```
kc_18_grid(doy, a, b)
```

#### **Arguments**

doy is the Day of Year (DOY)

a is one of the regression coefficients of SAFER algorithmb is one of the regression coefficients of SAFER algorithm

#### Value

It returns in raster format (.tif) the Surface Albedo at 24h scale ("Alb\_24"), NDVI, Surface Temperature ("LST"), Crop Coefficient ("kc") and net radiation ("Rn\_MJ").

kc\_modis Crop coefficient (ETa / ET0) using MODIS with single agrometeorological data.

#### **Description**

Crop coefficient (ETa / ET0) using MODIS with single agrometeorological data.

#### Usage

```
kc_modis(doy, RG, Ta, a, b)
```

doy	is the Day of Year (DOY)
RG	is the global solar radiation
Та	is the average air temperature
a	is one of the regression coefficients of SAFER algorithm
b	is one of the regression coefficients of SAFER algorithm

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#### Value

It returns in raster format (.tif) the Surface Albedo at 24h scale ("Alb\_24"), NDVI, Surface Temperature ("LST"), Crop Coefficient ("kc") and net radiation ("Rn\_MJ").

#### **Examples**

```
library(agriwater)
# dependencies of package 'agriwater'
library(terra)
# Using a temporary folder to run example
wd <- tempdir()</pre>
initial = getwd()
setwd(wd)
# creating raster which simulate MODIS reflectances - for using
# real data, please download:
# https://drive.google.com/open?id=14E1wHNLxG7_Dh4I-GqNYakj8YJDgKLzk
xy \leftarrow matrix(rnorm(4, mean = 0.07, sd = 0.01), 2, 2)
rast <- rast(xy, crs="+proj=longlat +datum=WGS84")</pre>
ext(rast) <- c(-40.5, -40.45, -9.5, -9.45)
writeRaster(rast, file.path(wd, "B2.tif"), filetype = "GTiff", overwrite=TRUE)
xy < -matrix(rnorm(4, mean = 0.05, sd = 0.015), 2, 2)
rast <- rast(xy, crs="+proj=longlat +datum=WGS84")</pre>
ext(rast) <- c(-40.5, -40.45, -9.5, -9.45)
writeRaster(rast, file.path(wd, "B1.tif"), filetype = "GTiff", overwrite=TRUE)
mask <- as.polygons(rast)</pre>
writeVector(mask, file.path(getwd(), "mask.shp"), overwrite=TRUE)
# using "agriwater"
kc_{modis}(doy = 134, RG = 17.6, Ta = 27.9, a = 1.8, b = -0.008)
#Exiting temporary folder and returning to previous workspace
setwd(initial)
```

kc\_modis\_grid

Crop coefficient (ETa / ET0) using MODIS with a grid of agrometeo-rological data.

#### Description

Crop coefficient (ETa / ET0) using MODIS with a grid of agrometeorological data.

#### Usage

```
kc_modis_grid(doy, a, b)
```

kc\_s2

# **Arguments**

doy	is the Day of Year (DOY)
а	is one of the regression coefficients of SAFER algorithm
b	is one of the regression coefficients of SAFER algorithm

#### Value

It returns in raster format (.tif) the Surface Albedo at 24h scale ("Alb\_24"), NDVI, Surface Temperature ("LST"), Crop Coefficient ("kc") and net radiation ("Rn\_MJ").

kc_s2	Crop coefficient (ETa / ET0) using Sentinel-2 images with single
	agrometeorological data.

# Description

Crop coefficient (ETa / ET0) using Sentinel-2 images with single agrometeorological data.

#### Usage

```
kc_s2(doy, RG, Ta, a, b)
```

#### **Arguments**

doy	is the Day of Year (DOY)
RG	is the global solar radiation
Та	is the average air temperature
а	is one of the regression coefficients of SAFER algorithm
b	is one of the regression coefficients of SAFER algorithm

#### Value

It returns in raster format (.tif) the Surface Albedo at 24h scale ("Alb\_24"), NDVI, Surface Temperature ("LST"), Crop Coefficient ("kc") and net radiation ("Rn\_MJ").

# **Examples**

```
library(agriwater)

# dependencies of package 'agriwater'
library(terra)

# Using a temporary folder to run example
wd <- tempdir()
initial = getwd()
setwd(wd)</pre>
```

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```
# creating raster which simulate Sentinel-2 reflectances - for using
# real data, please download:
# https://drive.google.com/open?id=14E1wHNLxG7_Dh4I-GqNYakj8YJDgKLzk
xy \leftarrow matrix(rnorm(4, mean = 0.07, sd = 0.01), 2, 2)
rast <- rast(xy, crs="+proj=longlat +datum=WGS84")</pre>
ext(rast) <- c(-40.5, -40.45, -9.5, -9.45)
writeRaster(rast, file.path(wd, "B2.tif"),filetype = "GTiff", overwrite=TRUE)
xy <- matrix(rnorm(4, mean = 0.05, sd = 0.015), 2, 2)
rast <- rast(xy, crs="+proj=longlat +datum=WGS84")</pre>
ext(rast) <- c(-40.5, -40.45, -9.5, -9.45)
writeRaster(rast, file.path(wd, "B3.tif"),filetype = "GTiff", overwrite=TRUE)
xy \leftarrow matrix(rnorm(4, mean = 0.03, sd = 0.018), 2, 2)
rast <- rast(xy, crs="+proj=longlat +datum=WGS84")</pre>
ext(rast) <- c(-40.5, -40.45, -9.5, -9.45)
writeRaster(rast, file.path(wd, "B4.tif"),filetype = "GTiff", overwrite=TRUE)
xy \leftarrow matrix(rnorm(4, mean = 0.05, sd = 0.015), 2, 2)
rast <- rast(xy, crs="+proj=longlat +datum=WGS84")</pre>
ext(rast) <- c(-40.5, -40.45, -9.5, -9.45)
writeRaster(rast, file.path(wd, "B8.tif"),filetype = "GTiff", overwrite=TRUE)
mask <- as.polygons(rast)</pre>
writeVector(mask, file.path(getwd(),"mask.shp"), overwrite=TRUE)
# using "agriwater"
kc_s2(doy = 134, RG = 17.6, Ta = 27.9, a = 1.8, b = -0.008)
#Exiting temporary folder and returning to previous workspace
setwd(initial)
```

kc\_s2\_grid

Crop coefficient (ETa / ET0) using Sentinel-2 images with a grid of agrometeorological data.

#### **Description**

Crop coefficient (ETa / ET0) using Sentinel-2 images with a grid of agrometeorological data.

#### Usage

```
kc_s2_grid(doy, a, b)
```

doy	is the Day of Year (DOY)
a	is one of the regression coefficients of SAFER algorithm
b	is one of the regression coefficients of SAFER algorithm

radiation\_18

#### Value

It returns in raster format (.tif) the Surface Albedo at 24h scale ("Alb\_24"), NDVI, Surface Temperature ("LST"), Crop Coefficient ("kc") and net radiation ("Rn\_MJ").

radiation_18	Energy balance using Landsat-8 images with single agrometeorological data.
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#### **Description**

Energy balance using Landsat-8 images with single agrometeorological data.

#### Usage

```
radiation_18(doy, RG, Ta, ET0, a, b)
```

# Arguments

doy	is the Day of Year (DOY)
RG	is the global solar radiation
Та	is the average air temperature
ET0	is the reference evapotranspiration
a	is one of the regression coefficients of SAFER algorithm
b	is one of the regression coefficients of SAFER algorithm

#### Value

It returns in raster format (.tif) the Surface Albedo at 24h scale ("Alb\_24"), NDVI, Surface Temperature ("LST"), Crop Coefficient ("kc"), Actual Evapotranspiration (evapo), latent heat flux "LE\_MJ"), net radiation ("Rn\_MJ"), ground heat flux ("G\_MJ") and the sensible heat flux ("H\_MJ").

radiation_18t	Energy balance using Landsat-8 images (including thermal bands)
	with single agrometeorological data.

#### **Description**

Energy balance using Landsat-8 images (including thermal bands) with single agrometeorological data.

#### Usage

```
radiation_18t(doy, RG, Ta, ET0, a, b)
```

18 radiation\_18t\_grid

#### **Arguments**

doy	is the Day of Year (DOY)
RG	is the global solar radiation
Та	is the average air temperature
ET0	is the reference evapotranspiration
а	is one of the regression coefficients of SAFER algorithm
b	is one of the regression coefficients of SAFER algorithm

#### Value

It returns in raster format (.tif) the Surface Albedo at 24h scale ("Alb\_24"), NDVI, Surface Temperature ("LST"), Crop Coefficient ("kc"), Actual Evapotranspiration (evapo), latent heat flux "LE\_MJ"), net radiation ("Rn\_MJ"), ground heat flux ("G\_MJ") and the sensible heat flux ("H\_MJ").

radiation_l8t_grid	Energy balance using Landsat-8 images (including thermal bands)
	with a grid of agrometeorological data.

# Description

Energy balance using Landsat-8 images (including thermal bands) with a grid of agrometeorological data.

#### Usage

```
radiation_18t_grid(doy, a, b)
```

# Arguments

doy	is the Day of Year (DOY)
а	is one of the regression coefficients of SAFER algorithm
b	is one of the regression coefficients of SAFER algorithm

#### Value

It returns in raster format (.tif) the Surface Albedo at 24h scale ("Alb\_24"), NDVI, Surface Temperature ("LST"), Crop Coefficient ("kc"), Actual Evapotranspiration (evapo), latent heat flux "LE\_MJ"), net radiation ("Rn\_MJ"), ground heat flux ("G\_MJ") and the sensible heat flux ("H\_MJ").

radiation\_18\_grid

radiation_18_grid Energy balance using Landsat-8 images with a grid of agrometed logical data.	ro-
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# Description

Energy balance using Landsat-8 images with a grid of agrometeorological data.

# Usage

```
radiation_18_grid(doy, a, b)
```

# **Arguments**

doy	is the Day of Year (DOY)
a	is one of the regression coefficients of SAFER algorithm
b	is one of the regression coefficients of SAFER algorithm

#### Value

It returns in raster format (.tif) the Surface Albedo at 24h scale ("Alb\_24"), NDVI, Surface Temperature ("LST"), Crop Coefficient ("kc"), Actual Evapotranspiration (evapo), latent heat flux "LE\_MJ"), net radiation ("Rn\_MJ"), ground heat flux ("G\_MJ") and the sensible heat flux ("H\_MJ").

radiation_modis	Energy balance using Landsat-8 images with single agrometeorological data.

# **Description**

Energy balance using Landsat-8 images with single agrometeorological data.

# Usage

```
radiation_modis(doy, RG, Ta, ET0, a, b)
```

doy	is the Day of Year (DOY)
RG	is the global solar radiation
Та	is the average air temperature
ET0	is the reference evapotranspiration
а	is one of the regression coefficients of SAFER algorithm
b	is one of the regression coefficients of SAFER algorithm

20 radiation\_modis\_grid

#### Value

It returns in raster format (.tif) the Surface Albedo at 24h scale ("Alb\_24"), NDVI, Surface Temperature ("LST"), Crop Coefficient ("kc"), Actual Evapotranspiration (evapo), latent heat flux "LE\_MJ"), net radiation ("Rn\_MJ"), ground heat flux ("G\_MJ") and the sensible heat flux ("H\_MJ").

#### **Examples**

```
library(agriwater)
# dependencies of package 'agriwater'
library(terra)
# Using a temporary folder to run example
wd <- tempdir()</pre>
initial = getwd()
setwd(wd)
# creating raster which simulate Sentinel-2 reflectances - for using
# real data, please download:
# https://drive.google.com/open?id=14E1wHNLxG7_Dh4I-GqNYakj8YJDgKLzk
xy < -matrix(rnorm(4, mean = 0.05, sd = 0.015), 2, 2)
rast <- rast(xy, crs="+proj=longlat +datum=WGS84")</pre>
ext(rast) <- c(-40.5, -40.45, -9.5, -9.45)
writeRaster(rast, file.path(wd, "B2.tif"),filetype = "GTiff", overwrite=TRUE)
xy <- matrix(rnorm(4, mean = 0.05, sd = 0.015), 2, 2)
rast <- rast(xy, crs="+proj=longlat +datum=WGS84")</pre>
ext(rast) <- c(-40.5, -40.45, -9.5, -9.45)
writeRaster(rast, file.path(wd, "B1.tif"),filetype = "GTiff", overwrite=TRUE)
# creating mask of study area
mask <- as.polygons(rast)</pre>
writeVector(mask, file.path(getwd(), "mask.shp"), overwrite=TRUE)
# using "agriwater" - it's the same procedure as the used for
# radiation_18(), radiation_18t(), radiation_s2(),
# radiation_18_grid(), radiation_18t_grid(),
# radiation_s2_grid(), radiation_s2() and radiation_modis_grid()
radiation_modis(doy = 134, RG = 17.6, Ta = 27.9, ET0 = 3.8, a = 1.8, b = -0.008)
#Exiting temporary folder and returning to previous workspace
setwd(initial)
```

radiation\_modis\_grid Energy balance using Landsat-8 images with a grid of agrometeoro-logical data.

#### **Description**

Energy balance using Landsat-8 images with a grid of agrometeorological data.

radiation\_s2 21

#### Usage

```
radiation_modis_grid(doy, a, b)
```

#### **Arguments**

doy	is the Day of Year (DOY)
a	is one of the regression coefficients of SAFER algorithm
b	is one of the regression coefficients of SAFER algorithm

#### Value

It returns in raster format (.tif) the Surface Albedo at 24h scale ("Alb\_24"), NDVI, Surface Temperature ("LST"), Crop Coefficient ("kc"), Actual Evapotranspiration (evapo), latent heat flux "LE\_MJ"), net radiation ("Rn\_MJ"), ground heat flux ("G\_MJ") and the sensible heat flux ("H\_MJ").

radiation_s2	Energy balance using Sentinel-2 images with single agrometeorological data.

# Description

Energy balance using Sentinel-2 images with single agrometeorological data.

# Usage

```
radiation_s2(doy, RG, Ta, ET0, a, b)
```

#### **Arguments**

doy	is the Day of Year (DOY)
RG	is the global solar radiation
Та	is the average air temperature
ET0	is the reference evapotranspiration
a	is one of the regression coefficients of SAFER algorithm
b	is one of the regression coefficients of SAFER algorithm

# Value

It returns in raster format (.tif) the Surface Albedo at 24h scale ("Alb\_24"), NDVI, Surface Temperature ("LST"), Crop Coefficient ("kc"), Actual Evapotranspiration (evapo), latent heat flux "LE\_MJ"), net radiation ("Rn\_MJ"), ground heat flux ("G\_MJ") and the sensible heat flux ("H\_MJ").

22 radiation\_s2\_grid

#### **Examples**

```
library(agriwater)
# dependencies of package 'agriwater'
library(terra)
# Using a temporary folder to run example
wd <- tempdir()</pre>
initial = getwd()
setwd(wd)
# creating raster which simulate Sentinel-2 reflectances - for using
# real data, please download:
# https://drive.google.com/open?id=14E1wHNLxG7_Dh4I-GqNYakj8YJDgKLzk
xy \leftarrow matrix(rnorm(4, mean = 0.07, sd = 0.01), 2, 2)
rast <- rast(xy, crs="+proj=longlat +datum=WGS84")</pre>
ext(rast) <- c(-40.5, -40.45, -9.5, -9.45)
writeRaster(rast, file.path(wd, "B2.tif"),filetype = "GTiff", overwrite=TRUE)
xy \leftarrow matrix(rnorm(4, mean = 0.05, sd = 0.015), 2, 2)
rast <- rast(xy, crs="+proj=longlat +datum=WGS84")</pre>
ext(rast) <- c(-40.5, -40.45, -9.5, -9.45)
writeRaster(rast, file.path(wd, "B3.tif"),filetype = "GTiff", overwrite=TRUE)
xy \leftarrow matrix(rnorm(4, mean = 0.03, sd = 0.018), 2, 2)
rast <- rast(xy, crs="+proj=longlat +datum=WGS84")</pre>
ext(rast) < c(-40.5, -40.45, -9.5, -9.45)
writeRaster(rast, file.path(wd, "B4.tif"),filetype = "GTiff", overwrite=TRUE)
xy \leftarrow matrix(rnorm(4, mean = 0.05, sd = 0.015), 2, 2)
rast <- rast(xy, crs="+proj=longlat +datum=WGS84")</pre>
ext(rast) <- c(-40.5, -40.45, -9.5, -9.45)
writeRaster(rast, file.path(wd, "B8.tif"),filetype = "GTiff", overwrite=TRUE)
mask <- as.polygons(rast)</pre>
writeVector(mask, file.path(getwd(), "mask.shp"), overwrite=TRUE)
# using "agriwater"
radiation_s2(doy = 134, RG = 17.6, Ta = 27.9, ET0 = 3.8, a = 1.8, b = -0.008)
#Exiting temporary folder and returning to previous workspace
setwd(initial)
```

radiation\_s2\_grid

Energy balance using Sentinel-2 images with a grid of agrometeorological data.

#### Description

Energy balance using Sentinel-2 images with a grid of agrometeorological data.

reflectance\_18 23

#### Usage

```
radiation_s2_grid(doy, a, b)
```

#### **Arguments**

doy is the Day of Year (DOY)

a is one of the regression coefficients of SAFER algorithmb is one of the regression coefficients of SAFER algorithm

#### Value

It returns in raster format (.tif) the Surface Albedo at 24h scale ("Alb\_24"), NDVI, Surface Temperature ("LST"), Crop Coefficient ("kc"), Actual Evapotranspiration (evapo), latent heat flux "LE\_MJ"), net radiation ("Rn\_MJ"), ground heat flux ("G\_MJ") and the sensible heat flux ("H\_MJ").

reflectance\_18

Reflectancies from Landsat-8 images.

#### **Description**

Reflectancies from Landsat-8 images.

### Usage

```
reflectance_18(doy)
```

#### **Arguments**

doy is the Day of Year (DOY)

# Value

It returns in raster format (.tif) the Surface Albedo at 24h scale ("Alb\_24").

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