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Revision of the Single-
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Mapping land surface emissivity from NDVI: Application to European, African, and South American areas. Valor E (1996). <doi:10.1016/0034-4257(96)00039-9>.
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TIRS sensor. Land product validation and evolution. Skoković D, Sobrino JA, Jimenez-
Munoz JC, Soria G, Julien Y, Mattar C, Cristóbal J. (2014).

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BT *At-Sensor Temperature or brightness temperature*

Description

This function calculates at-Sensor Temperature or brightness temperature

Usage

```
BT(Landsat_10 = Landsat_10, Landsat_11 = Landsat_10)
```

Arguments

Landsat_10	Raster* object, Landsat band 10
Landsat_11	Raster* object, Landsat band 11

Value

A list containing brightness temperature corresponding to Landsat band 10 and Landsat band 11

Examples

```
a <- raster::raster(ncol=100, nrow=100)
set.seed(2)
raster::values(a) = runif(10000, min=27791, max=30878)

b <- raster::raster(ncol=100, nrow=100)
set.seed(2)
raster::values(b) = runif(10000, min=25686, max=28069)

BT(Landsat_10 = a, Landsat_11 = b)
```

E_Skokovic *Land Surface Emissivity according to Skokovic et al. 2014*

Description

This function calculates Land Surface Emissivity according to Skokovic et al. 2014

Usage

```
E_Skokovic(red = red, NDVI = NDVI, band = band)
```

Arguments

red	Raster* object, red band of remote sensing imagery
NDVI	Raster* object, NDVI calculated from remote sensing imagery
band	A string specifying which Landsat 8 thermal band to use. It can be "band 10" or "band 11"

Value

RasterLayer

Examples

```
red <- raster::raster(ncol=100, nrow=100)
set.seed(2)
raster::values(red) = runif(10000, min=0.1, max=0.4)
NDVI <- raster::raster(ncol=100, nrow=100)
set.seed(2)
raster::values(NDVI) = runif(10000, min=0.02, max=0.8)
E_Skokovic(red = red, NDVI = NDVI, band = "band 11")
```

E_Sobrino *Land Surface Emissivity according to Sobrino et al. 2008*

Description

This function calculates Land Surface Emissivity according to Sobrino et al. 2008

Usage

```
E_Sobrino(red = red, NDVI = NDVI)
```

Arguments

red	Raster* object, red band of remote sensing imagery
NDVI	Raster* object, NDVI calculated from remote sensing imagery

Value

RasterLayer

Examples

```
red <- raster::raster(ncol=100, nrow=100)
set.seed(2)
raster::values(red) = runif(10000, min=0.1, max=0.4)
NDVI <- raster::raster(ncol=100, nrow=100)
set.seed(2)
raster::values(NDVI) = runif(10000, min=0.02, max=0.8)
E_Sobrino(red = red, NDVI = NDVI)
```

E_Valor *Land Surface Emissivity according to Valor and Caselles 1996*

Description

This function calculates Land Surface Emissivity according to Valor and Caselles 1996

Usage

```
E_Valor(NDVI)
```

Arguments

NDVI	Raster* object, NDVI calculated from remote sensing imagery

Value

RasterLayer

Examples

```
NDVI <- raster::raster(ncol=100, nrow=100)
set.seed(2)
raster::values(NDVI) = runif(10000, min=0.02, max=0.8)
E_Valor(NDVI)
```

E_VandeGriend *Land Surface Emissivity according to Van de Griend and Owe 1993*

Description

This function calculates Land Surface Emissivity according to Van de Griend and Owe 1993

Usage

```
E_VandeGriend(NDVI)
```

Arguments

NDVI	Raster* object, NDVI calculated from remote sensing imagery

Value

RasterLayer

Examples

```
NDVI <- raster::raster(ncol=100, nrow=100)
set.seed(2)
raster::values(NDVI) = runif(10000, min=0.02, max=0.8)
E_VandeGriend(NDVI)
```

E_Yu *Land Surface Emissivity according to Yu et al. 2014*

Description

This function calculates Land Surface Emissivity according to Yu et al. 2014

Usage

```
E_Yu(red = red, NDVI = NDVI, band = band)
```

Arguments

red	Raster* object, red band of remote sensing imagery
NDVI	Raster* object, NDVI calculated from remote sensing imagery
band	A string specifying which Landsat 8 thermal band to use. It can be "band 10" or "band 11"

Value

RasterLayer

Examples

```
red <- raster::raster(ncol=100, nrow=100)
set.seed(2)
raster::values(red) = runif(10000, min=0.1, max=0.4)
NDVI <- raster::raster(ncol=100, nrow=100)
set.seed(2)
raster::values(NDVI) = runif(10000, min=0.02, max=0.8)
E_Yu(red = red, NDVI = NDVI, band = "band 11")
```

MWA *Mono window algorithm*

Description

This function calculates Land Surface Temperature using mono window algorithm

Usage

```
MWA(BT = BT, tau = tau, E = E, Ta = Ta)
```

Arguments

BT	Raster* object, brightness temperature
tau	Atmospheric transmittance
E	Raster* object, Land Surface Emissivity calculated according to Van de Griend and Owe 1993 or Valor and Caselles 1996 or Sobrino et al. 2008
Ta	Mean atmospheric temperature (K) of the date when Landsat passed over the study area

Value

RasterLayer

Examples

```
BTemp <- raster::raster(ncol=100, nrow=100)
set.seed(2)
raster::values(BTemp) = runif(10000, min=298, max=305)
E <- raster::raster(ncol=100, nrow=100)
set.seed(2)
raster::values(E) = runif(10000, min=0.96, max=0.99)
MWA(BT = BTemp, tau = 0.86, E = E, Ta = 26)
```

NDVI *NDVI*

Description

Function for NDVI calculation

Usage

```
NDVI(Red, NIR)
```

Arguments

Red	Raster* object, red band of remote sensing imagery
NIR	Raster* object, NIR band of remote sensing imagery

Value

RasterLayer

Examples

```
red <- raster::raster(ncol=100, nrow=100)
set.seed(2)
raster::values(red) = runif(10000, min=0.1, max=0.4)

NIR <- raster::raster(ncol=100, nrow=100)
set.seed(2)
raster::values(NIR) = runif(10000, min=0.1, max=0.6)

NDVI(Red = red, NIR = NIR)
```

Pv *Proportion of vegetation or fractional vegetation cover*

Description

Calculation of the proportion of vegetation or fractional vegetation cover from NDVI

Usage

```
Pv(NDVI, minNDVI, maxNDVI)
```

Arguments

NDVI	Raster* object, NDVI calculated from remote sensing imagery
minNDVI	= 0.2 (Ref. Sobrino et al. 2004)
maxNDVI	= 0.5 (Ref. Sobrino et al. 2004)

Value

RasterLayer

Examples

```
NDVI <- raster::raster(ncol=100, nrow=100)
set.seed(2)
raster::values(NDVI) = runif(10000, min=0.02, max=0.8)
Pv(NDVI = NDVI, minNDVI = 0.2, maxNDVI = 0.5)
```

RTE *Radiative transfer equation method*

Description

This function calculates Land Surface Temperature using radiative transfer equation method

Usage

```
RTE(TIR = TIR, tau = tau, E = E, dlrad = dlrad, ulrad = ulrad, band = band)
```

Arguments

TIR	Raster* object, Landsat band 10 or 11
tau	Atmospheric transmittance
E	Raster* object, Land Surface Emissivity calculated according to Van de Griend and Owe 1993 or Valor and Caselles 1996 or Sobrino et al. 2008
dlrad	Downwelling radiance calculated from https://atmcorr.gsfc.nasa.gov/
ulrad	upwelling radiance calculated from https://atmcorr.gsfc.nasa.gov/
band	A string specifying which Landsat 8 thermal band to use. It can be "band 10" or "band 11"

Value

RasterLayer

Examples

```
TIR <- raster::raster(ncol=100, nrow=100)
set.seed(2)
raster::values(TIR) = runif(10000, min=27791, max=30878)
BT <- raster::raster(ncol=100, nrow=100)
set.seed(2)
raster::values(BT) = runif(10000, min=298, max=305)
E <- raster::raster(ncol=100, nrow=100)
set.seed(2)
raster::values(E) = runif(10000, min=0.96, max=0.99)
Ts_RTE <- RTE(TIR = TIR, tau = 0.86, E = E,
dlrad = 2.17, ulrad = 1.30, band = "band 11")
```

SCA *Single channel algorithm*

Description

This function calculates Land Surface Temperature using single channel algorithm

Usage

```
SCA(
  TIR = TIR,
  BT = BT,
  tau = tau,
  E = E,
  dlrad = dlrad,
  ulrad = ulrad,
  band = band
)
```

Arguments

TIR	Raster* object, Landsat band 10 or 11
BT	Raster* object, brightness temperature
tau	Atmospheric transmittance
E	Raster* object, Land Surface Emissivity calculated according to Van de Griend and Owe 1993 or Valor and Caselles 1996 or Sobrino et al. 2008
dlrad	Downwelling radiance calculated from https://atmcorr.gsfc.nasa.gov/
ulrad	upwelling radiance calculated from https://atmcorr.gsfc.nasa.gov/
band	A string specifying which Landsat 8 thermal band to use. It can be "band 10" or "band 11"

Value

RasterLayer

Examples

```
TIR <- raster::raster(ncol=100, nrow=100)
set.seed(2)
raster::values(TIR) = runif(10000, min=27791, max=30878)
BT <- raster::raster(ncol=100, nrow=100)
set.seed(2)
raster::values(BT) = runif(10000, min=298, max=305)
E <- raster::raster(ncol=100, nrow=100)
set.seed(2)
raster::values(E) = runif(10000, min=0.96, max=0.99)
Ts_SCA <- SCA(TIR = TIR, BT = BT, tau = 0.86, E = E,
dlrad = 2.17, ulrad = 1.30, band = "band 11")
```

SWA *Split-window algorithm*

Description

This function calculates Land Surface Temperature using split-window algorithm

Usage

```
SWA(
  TIR_10 = TIR_10,
  TIR_11 = TIR_11,
  tau_10 = tau_10,
  tau_11 = tau_11,
  E_10 = E_10,
  E_11 = E_11
)
```

Arguments

TIR_10	Raster* object, Landsat band 10
TIR_11	Raster* object, Landsat band 11
tau_10	Atmospheric transmittance for Landsat band 10
tau_11	Atmospheric transmittance for Landsat band 11
E_10	Raster* object, Land Surface Emissivity for Landsat band 10 calculated according to Skokovic et al. 2014 or Yu et al. 2014
E_11	Raster* object, Land Surface Emissivity for Landsat band 11 calculated according to Skokovic et al. 2014 or Yu et al. 2014

Value

RasterLayer

Examples

```
TIR_10 <- raster::raster(ncol=100, nrow=100)
set.seed(2)
raster::values(TIR_10) = runif(10000, min=27791, max=30878)
TIR_11 <- raster::raster(ncol=100, nrow=100)
set.seed(2)
raster::values(TIR_11) = runif(10000, min=25686, max=28069)
E_10 <- raster::raster(ncol=100, nrow=100)
set.seed(1)
raster::values(E_10) = runif(10000, min=0.96, max=0.99)
E_11 <- raster::raster(ncol=100, nrow=100)
set.seed(2)
raster::values(E_11) = runif(10000, min=0.96, max=0.99)
```

```
Ts_SWA <- SWA(TIR_10=TIR_10, TIR_11=TIR_11, tau_10=0.86,
tau_11=0.87, E_10=E_10, E_11=E_11)
```

Ta *Mean atmospheric temperature*

Description

This function calculates mean atmospheric temperature (Ta) using near-surface air temperature (To)

Usage

```
Ta(To = To, mod = mod)
```

Arguments

To	Near-surface air temperature (°C) of the date when Landsat passed over the study area
mod	A string specifying which model to use. It can be anyone of "USA 1976 Standard" or "Tropical Region" or "Mid-latitude Summer Region" or "Mid-latitude Winter Region"

Value

Mean atmospheric temperature (K)

Examples

```
Ta(To = 26, mod = "Mid-latitude Winter Region")
```

---

tau *Atmospheric transmittance calculation*

Description

This function calculates Atmospheric transmittance from near-surface air temperature (To, °C) and relative humidity (RH, %) of the date when Landsat passed over the study area

Usage

```
tau(To = To, RH = To, band = band)
```

Arguments

To	Near-surface air temperature (°C) of the date when Landsat passed over the study area
RH	relative humidity (%) of the date when Landsat passed over the study area
band	A string specifying which Landsat 8 thermal band to use. It can be "band 10" or "band 11"

Value

Atmospheric transmittance

Examples

```
tau(To = 26, RH = 42, band = "band 11")
```

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