Package ‘BGDB’

September 1, 2020

Type Package

Title Create EU critical load background database

Version 0.3

Date 20200828

Author GJ Reinds, Max Posch, jaap slootweg

Maintainer jaap slootweg<jaap.slootweg@rivm.nl>

Description All you need for an European background database of S,N critical loads

License MIT

LazyData TRUE

Imports

RoxygenNote 7.1.0

Suggests knitr, rmarkdown

VignetteBuilder knitr

R topics documented:

`argridd` *argridd*

Description

the area of a 'grid cell' on a sphere of radius R in double precision of 'dlon' degrees east-west extension and 'dlat' degrees north-south extension with its southern border at latitude 'ylat' (in degrees).

Usage

```
argridd(ylat, dlon, dlat = dlon, R = 6371)
```

Arguments

`ylat`	latitude of southern border of grid cell
`dlon`	east-west extension of grid cell (in degrees)
`dlat`	north-south extension of grid cell (in degrees)
`R`	Radius of sphere #Radius of the earth ranges from 6,378 km at the equator to 6,357 km at a pole.

Value

Area

Author(s)

M. Posch, ported to R by jaap slootweg

`claysilt` *claysilt*

Description

Clay and silt content texture class and texture triangle

Usage

```
claysilt(itex)
```

Arguments

`itex`	Texture class

Details

Clay and silt content (gravity in texture triangle. If peat or unknown take c(5,20)

Value

c(clay,silt,sand) in %

Author(s)

GJ Reinds , ported to R by jaap slootweg

`contBcNP` *contBcNP*

Description

contents % of N, Ca, Mg, K and P (in eq/kg)

Usage

```
contBcNP(iopt)
```

Arguments

`iopt`	stems (iopt=1) or stems+branches (iopt=2)

Details

Note: For iopt=2 this is NOT the average content of stems+branches, but the content, when multiplied by stem growth, gives the growth of stems+branches (assuming branches have the same growth rate)! Source: Table 5.8 in MapMan and Jacobsen et al (2002) other_c = mean of pine & spruce other_b = mean of oak & beech & birch

Value

rbind(1=pine, 2=spruce, 3=other_c, 4=beech, 5=oak, 6=birch, 7=other_b)

Author(s)

M. Posch, ported to R by jaap slootweg

`coslin` *coslin*

Description

Function used in PET and AET calculations (IMAGE 2.1) Ref: Federer CA, 1982. Transpirational supply and demand: plant, soil and atmospheric effects evaluated by simulation. Water Resources Research 18(2): 355-362

Usage

```
coslin(u, v)
```

Arguments

`u`	see ref
`v`	see ref

Author(s)

M. Posch, ported to R by jaap slootweg

`Daycosz` *Daycosz*

Description

integral over cos(z), where z is the Sun's zenith angle (integrated over the length of the day)

Usage

```
Daycosz(jul, lambda)
```

Arguments

`jul`	Julian day, or Day Of Year (1..365)
`lambda`	latitude (radian)

Value

maximum (at clear sky) dayly downward solar radiation (and NOT length of half of day 'jul', i.e. the time between true noon and sunset) ! tset ...... hours of daylight till sunset after true noon (i.e. length of day = 2*tset)

Author(s)

M. Posch , ported to R by jaap slootweg

`declinat` *declinat*

Description

Returns the solar declination (i.e. the angle between a line joining the centres of Sun and Earth and the Earth's equatorial plane) in radians as function of the Julian day 'jul' (1-365).

Usage

```
declinat(jul)
```

Arguments

`jul`	julian day (DOY = "day of year")

Details

Ref: Spencer JW, 1971. Fourier series representation of the position of the Sun. Search 2(5): 172 quoted in: Iqbal M, 1983. An Introduction to Radiation in the Atmosphere. Academic Press

Author(s)

M. Posch, ported to R by jaap slootweg

`EfromLog` *EfromLog*

Description

Returns the X-Y Exchange constant KXY from its Log10 'lgK' (in 'mol/L') for the Gaines-Thomas (modExc=1), Gapon (modExc=2) or Kerr (modExc=3) cation exchange model.

Usage

```
EfromLog(modExc = 2, lgK, m, n, lit)
```

Arguments

`modExc`	• 1: Gaines-Thomas • 2: Gapon • 3: Kerr
`lgK`	
`m`	m and n are the charges, see description
`n`	m and n are the charges, see description
`lit`	integer defining the output unit: eq/(10^lit*L), e.g. for lit=3 it is eq/m3

Details

Ref: Common Knowledge; see also App.C of the 2003 CCE Status Report.

- 1: Gaines-Thomas: EX^n / EY^m = KXY * [Xm+]^n / [Yn+]^m
- 2: Gapon: EX / EY = KXY * [Xm+]^1/m / [Yn+]^1/n
- 3: Kerr: EX / EY = KXY * [Xm+] / [Yn+]

Value

The output unit is eq/(10^lit*L), e.g. for lit=3 it is eq/m3.

Author(s)

M. Posch, ported to R by jaap slootweg

`Falbedo` *Falbedo*

Description

Returns 'interpolated' albedo depending on snow cover.

Usage

```
Falbedo(albsno, albveg, snow)
```

Arguments

`albsno`	albedo of snow cover
`albveg`	albedo of vegetation (surface) under snow cover
`snow`	snow cover expressed as mm of water

Author(s)

M. Posch, ported to R by jaap slootweg

fKHCO3 *fKHCO3*

Description

Returns the bicarbonate equilibrium constant in (mol/m3)^2/atm

Usage

```
fKHCO3(temp)
```

Arguments

`temp`	Temperature (oC)

Details

[HCO3] = pCO2*KHCO3/[H], as a function of temperature (in oC), where KHCO3 = KH*K1 ... Henry's law constant * first dissociation constant [= 10^-1.8 = 0.0158489 (mol/m3)^2/atm at 25oC] Ref: Harned and Davis (1943), quoted in Cosby et al. (1985).

Value

KHCO3

Author(s)

M. Posch, ported to R by jaap slootweg

FlgKAlox *FlgKAlox*

Description

Returns log10(KAlox) (Al-H equilibrium constant) as a function of temperature (oC) and the log10 of the ref-value at 10oC.

Usage

```
FlgKAlox(lgKAlox, temp)
```

Arguments

`lgKAlox`

`temp`

Value

log10(KAlox)

Author(s)

M. Posch, ported to R by jaap slootweg

---

fOliver *fOliver*

Description

fOliver

Usage

```
fOliver(cH, mDOC, pKpar)
```

Arguments

cH	[H+] (eq/m3=mol/m3)
mDOC	total concentration of organic acids (m*DOC) (mol/m3)
pkPar	parameter(s) for the equation; can be of length 1 or 3

Details

If length(pKpar)==1: simple mono-protic model with pK = pKpar[1],
else pK = par[1]+par[2]*pH-par[3]*pH^2

Value

concentration of mono-protic organic anions in mol/m3=eq/m3

Author(s)

M. Posch, ported to R by jaap slootweg

F_DOC *F_DOC*

Description

Derived from FIMCI data, not including NL data (8-Oct-03) Confirmed for 0-20 cm and derived for 0-40 cm on 28-Sep-16

Usage

```
F_DOC(pH, itex)
```

Arguments

pH	pH
itex	texture class

Value

DOC in molC/m3.

Author(s)

GJ Reinds , ported to R by jaap slootweg

---

get1BCdep *get1BCdep*

Description

BC & Cl deposition based on function of distance to coast

Usage

```
get1BCdep(xlonylat, d2coast)
```

Arguments

xlonylat	coordinates (vector of length 2, or matrix with 2 columns) for which depositions are required named variables are expected : c(lon,lat)
d2coast	distance to the coast

Details

returns BC & Cl deposition based on distance to coast

Value

Deposition BC and Cl as the Ions "structure"

Author(s)

M. Posch, ported to R by jaap slootweg

---

getKAlox *getKAlox*

Description

Returns log10(KAlox) and expAl as function of:
ialfa =1: variable alfa in [Al]=KAlox*[H]^alfa
ialfa =2: alfa=3 (gibbsite equilibrium)
itex texture class (1,2,[>=]3)

Usage

```
getKAlox(ialfa = 2, itex)
```

Arguments

`ialfa`	see description
`itex`	texture index

Value

Deposition BC and Cl as Ions

Author(s)

M. Posch, ported to R by jaap slootweg

`get_inp` *get_inp*

Description

set input constants, possibly depending on other constants

Usage

```
get_inp(iNopt)
```

Arguments

`iNopt`	see EUpar.R

Details

The following variables are set in the global environment!! notice «- ztop, cont, Alox0, expH, ibc, ialsp, Sadmax, Sadh, modOrg, chdens, KOrgv, KAlOrgv, fdev, cmin, cNaccv This needs improving for readability

Value

Side effects only, but a lot!!

Author(s)

M. Posch, ported to R by jaap slootweg

Intcosz *Intcosz*

Description

Returns for a given Julian day 'jul' the Integral over cos(z), where z is the Sun's zenith angle (integrated over the length of the day) It also returns the length of half of day 'jul', i.e. the time between true noon and sunset (see routine 'sunset')

Usage

```
Intcosz(jul, lambda)
```

Arguments

`jul`	.... number of Julian day (1-366)
`lambda`	.... latitude (radian)

Value

coszint .., integral over cos(z) (hours) AND tset ...... hours of daylight till sunset after true noon

Author(s)

M. Posch, ported to R by jaap slootweg

Ions *Ions*

Description

Initialise an Ions matrix, or vector (if asMatrix == F, see below)

Usage

```
Ions(asMatrix = T, ...)
```

Arguments

`asMatrix`	should the funcion return a matrix [,length(ionNames)] or a vector.
`...`	named numeric (singular or vector), with name one of ioNames

Details

use of Ions in this package

Value

Matrix or vector of Ions 'type'

Author(s)

jaap slootweg

`llemep` *llemep*

Description

This subroutine computes for a point (xlon,ylat), where xlon is the longitude (<0 west of Greenwich) and ylat is the latitude (<0 south of the Equator) in degrees, its EMEP coordinates (emepi,emepj) with parameters given in par().

Usage

```
llemep(xlon, ylat, cellSizeKM = 50, xp = 8, yp = 110)
```

Arguments

`xlon`	(vector of) longitude
`ylat`	(vector of) latitude
`cellSizeKM`	= size of grid cell (km)
`xp`	EMEP coordinates of the North Pole
`yp`	EMEP coordinates of the North Pole

Details

See Appendix a in the 2003 CCE Status Report

Value

matrix[length(xlon),2] of emepi, emepj

Author(s)

M. Posch, ported to R by jaap slootweg

`MualvGen` *MualvGen*

Description

Computes soil water content at saturation and soil water content at the given pressure head from soil properties using the Mualem-vanGenuchten equation. Refs: Van Genuchten MT, 1980. A closed-form equation for predicting the hydraulic conductivity of unsaturated soils. SSSA Journal 44: 892-898 Woesten JHM, Lilly A, Nemes A, Le Bas C, 1999. Development and use of a database of hydraulic properties of European soils. Geoderma 90:169-185 (Table 5)

Usage

```
MualvGen(rhoOMclaysilt, topsoil, head)
```

Arguments

`topsoil`	1=topsoil, 0=subsoil
`head`	pressure head (cm) (can be given as positive or negative value!)
`rho`	bulk density (g/cm3)
`OM`	percent organic matter
`clay`	percent clay
`silt`	percent silt

Value

data.frame with thetas (soil water content at saturation) and theta(soil water content)

Author(s)

M. Posch, ported to R by jaap slootweg

`pedo_rho` *pedo_rho*

Description

Returns soil bulk density (in Mg/m3=g/cm3) as a function of organic C, clay and silt (all in %) for the model chosen by iopt (1-5).

Usage

```
pedo_rho(orgCclaysilt, iopt = NULL)
```

Arguments

`orgCclaysilt` data.frame-ish with orgC clay silt

`iopt`
- 1: Manrique & Jones (1991)
- 2: Kaur et al. (2002)
- 3: Adams (1973)
- 4: Harrison & Bocock (1981)
- 5: Jeffrey (1970)

Details

For an overview see: De Vos B, Van Meirvenne M, Quataert P, Deckers J, Muys B, 2005. Predictive quality of pedotransfer functions for estimating bulk density of forest soils. Soil Science Society of America Journal 69: 500-510
If iopt is not set (NULL), which is the default, than iopt = 2 if clay is present, else iopt = 1 if OrgC is present, otherwise the value is returned.

Value

soil bulk density (in Mg/m3=g/cm3)

Author(s)

M. Posch, ported to R by jaap slootweg

`petaet` *petaet*

Description

Returns daily PET, AET, soil moisture, percolation and quickflow, using daily input data for one year (365 days)

Usage

```
petaet(
  ylat,
  SolConstv,
  declicosv,
  declisinv,
  tset,
  coszintv,
  temp,
  prec,
  rads,
  fsun,
  albveg,
  swwilt,
  swfcap,
  swsat,
  snow,
  smold
)
```

Arguments

`ylat`	latitude
`SolConstv`	solar constant (W/m2) for Julian days 1-365
`declisinv`	sine of solar declination for Julian days 1-365
`tset`	hours of daylight till sunset after true noon (i.e. length of day = 2*tset)
`coszintv`	integral over cos(z) (z=Sun's zenith angle) (hours) for Julian days 1-365
`temp`	mean temperature on day j (oC)
`rads`	daily downward short-wave radiation (W/m2)
`fsun`	sunshine fraction on day j (0-1)
`albveg`	albedo of vegetation
`swwilt`	soil water at wilting point (mm)
`swfcap`	soil water at field capacity (mm)
`swsat`	soil water at saturation (mm)
`snow`	depth of snow in water equivalents (mm) and watin; is now data.frame; watin = prec+-snow
`smold`	initial soil moisture (mm)

Details

Refs: Prentice IC, Sykes MT, Cramer W (1993) A simulation model for the transient effects of climate change on forest landscapes. Ecological Modelling 65: 51-70 Federer CA (1982) Transpirational supply and demand: Plant, soil, and atmospheric effects evaluated by simulation. Water Resources Research 18(2): 355-362

Value

a data.frame of pet potential evapotranspiration (ET) on day j (mm/day), aet actual ET (mm/day), soilm soil moisture on day j (mm), perc percolation on day j (mm), qickf

Author(s)

M. Posch, ported to R by jaap slootweg

`petuv` *petuv*

Description

daily potential evapotranspiration (PET in mm/day) as calculated in the IMAGE 2.1 model. However, 'rads' is now an input! Ref: Prentice IC, Sykes MT, Cramer W, 1993. A simulation model for the transient effects of climate change on forest landscapes. Ecological Modelling 65: 51-70

Usage

```
petuv(SolConst0, declicos, declisin, coszint, ylat, temp, rads, fsun, albedo)
```

Arguments

`SolConst0`	solar constant (W/m2) for today
`declicos`	cosine of solar declination for today
`declisin`	sine of solar declination for today
`coszint`	integral over cos(z) (z=Sun's zenith angle) for today (hours)
`ylat`	latitude (degrees)
`temp`	daily mean temperature (oC)
`rads`	daily downward short-wave radiation (W/m2)
`fsun`	sunshine fraction (0-1)
`albedo`	(average) albedo (0-1)

Value

potential evapotranspiration (mm/day) and
u,v u = a-c; c = constant instantaneous upward flux (mm)

Author(s)

M. Posch, ported to R by jaap slootweg

`RegGrow` *RegGrow*

Description

reading RegGrow data

Usage

```
RegGrow(icol)
```

Value

data.frame with RegGrow data (_RegGrow.Tab)

Author(s)

M. Posch, ported to R by jaap slootweg

`RegGrown` *RegGrown*

Description

read EFIscen data

Usage

```
RegGrown(KnownSpecies, efiFile = "PreData/_EFIscen.csv")
```

Arguments

`KnownSpecies`	of trees
`efiFile`	input csv-file with efiscen data

Value

data.frame with RegGrown data (_EFIscen.csv)

Author(s)

M. Posch, ported to R by jaap slootweg

`SeaSalts` *SeaSalts*

Description

fractions of relevant Ions corrected for sea-salt

Usage

```
SeaSalts(iopt, Dep)
```

Arguments

`iopt`	option for selection of the tracer element (with only sea as origen)
`Dep`	vector of Ions (= matrix)

Details

For base cation and Cl depositions (given in eq in Dep), this subroutine returns their sea-salt fractions, assuming – for iopt=1,2,3,4,5 – that all Cl(iopt=1),Na,Mg,Ca,K(iopt=5) is sea-salt derived. [Seasalt-corrected depositions can then be computed as Dep* = Dep-Depss.] Also returned is an estimate of the sulfate originating from seasalts.

Value

matrix with same dimension as input Dep

Author(s)

M. Posch, ported to R by jaap slootweg

SMB	*SMB*

Description

Computes critical loads (CLF) of acidity for selected criteria with the SMB model.

Usage

```
SMB(
  iAci = 1,
  critAci = 1,
  KAlox,
  expAl = 3,
  thick,
  modExc = 2L,
  KAlBc,
  KHBc,
  fde,
  KHCO3,
  pCO2,
  ps,
  coacid,
  pKpar,
  cmin,
  Nimacc,
  Wea,
  Upt,
  Dep
)
```

Arguments

`iAci` option for computing CLmaxS, CLminN and CLmaxN:

- 1: critAci = molar [Al]:[Bc]
- 2: critAci = [Al] (eq/m3)
- 3: critAci = EBc (base saturation) (**fraction**, NOT %)
  Note: Only for Gapon exchange (modExc=2) and, in this case, expAl=3 (gibbsite)
- 4: critAci = pH
- 5: critAci = [ANC] (eq/m3)
- 6: critAci = molar [Bc]:[H] ([Al]=0 => not compatible with VSD!)
- 7: critAci = Alw ! no Al depletion
- 8: critAci = molar [Al]:[Ca]

`critAci` limit value, see iAci

`KAlox` Al equilibrium constant (mol/l)^(1-expAl)

`expAl`	exponent in [Al] = KAlox*[H]^expAl (>0); (3=gibbsite equilibrium)
`thick`	soil thickness (m)
`modExc`	cation exchange model option: 1=Gaines-Thomas, 2=Gapon
`KAlBc`	selectivity constant for Al-Bc exchange
`KHBc`	selectivity constant for H-Bc exchange
`fde`	denitrification factor (0<=fde<1); If fde<0, -fde is a denitrification flux Nde (eq/m2/a)
`KHCO3`	bicarbonate equilibrium constant in [HCO3] = pCO2*KHCO3/[H] ((mol/m3)^2/atm)
`pCO2`	CO2 pressure in soil solution (atm)
`ps`	precipitation surplus (m/a)
`coacid`	total concentration of organic acids (m*DOC) (mol/m3)
`cmin`	minimum[X] in soil leacheate (X=Ca,Mg,K) (eq/m3); see ionNames
`Nimacc`	.... acceptable N immobilisation (eq/m2/a)
`Wea`	weathering rate of X (X=Ca,Mg,K,Na) (eq/m3/a)
`Upt`	net uptake of X (X=Ca,Mg,K,NO3) (eq/m2/a)
`Dep`	deposition of X (X=Ca,Mg,K,Na,Cl) (eq/m2/a)
`pKpar()`	... 1-3 parameters of (Oliver-type) mono-protic organics model: $pK = pKpar(1) + pKpar(2) * pH - pKpar(3) * pH^2$

Value

c(ANCle, CLmaxS, CLminN, CLmaxN)

- ANCle critical ANC leaching (eq/m2/a)
- CLmaxS maximum critical load of S (eq/m2/a)
- CLminN minimum critical load of N (eq/m2/a)
- CLmaxN maximum critical load of N (eq/m2/a)

Author(s)

M. Posch, ported to R by jaap slootweg

`snowam` *snowam*

Description

Computes snow accumulation and melting Ref: Rekolainen S, Posch M, 1993. Adapting the CREAMS model for Finnish conditions. Nordic Hydrology 24: 309-322

Usage

```
snowam(prec, temp, snow_i)
```

Arguments

`prec`	daily precipitation (mm/day)
`temp`	daily mean temperature (oC)
`snow_i`	initial (and iterative) depth of snow in water equivalents (mm)

Value

watin water arriving at the soil (mm/day)

Author(s)

M. Posch, ported to R by jaap slootweg

`soilchar` *soilchar*

Description

read, slightly curate and save SoilChar in data

Usage

```
soilchar()
```

Value

data.frame with slightly curated SoilChar data (_SoilChar.Tab)

Author(s)

M. Posch, ported to R by jaap slootweg

`SolConst` *SolConst*

Description

Returns value of Solar Constant (W/m2) for Julian day 'jul' taking into account Earth's orbital eccentricity.

Usage

```
SolConst(jul)
```

Arguments

`jul`	julian day

Details

Ref. for eccentricity correction factor (eccofa): Spencer JW (1971) Fourier series representation of the position of the Sun. Search 2(5): 172 Ref. for recent' Solar Constant: Kopp, G, Lean JL (2011) A new, lower value of total solar irradiance: Evidence and climate significance. Geophysical Research Letters 38: L01706, doi:10.1029/2010GL045777

Author(s)

M. Posch, ported to R by jaap slootweg

`sunset` *sunset*

Description

Computes the length of half of day, i.e. the time between true noon and sunset (in the northern hemisphere).

Usage

```
sunset(jul, lambda)
```

Arguments

`jul`	Julian day, or Day Of Year (1..365)
`lambda`	latitude (radian)

Details

Ref.: Iqbal, M. (1983) "An Introduction to Radiation in the Atmosphere", Academic Press

Value

hours of daylight till sunset after true noon (i.e. length of day = 2*tset)

Author(s)

M. Posch , ported to R by jaap slootweg

trunclin *trunclin*

Description

Returns the value of the following truncated linear interpolation function (xleft<xrite):

- yleft for x < xleft
- linear for xleft <= x < xrite
- yrite for x >= xrite

Usage

```
trunclin(x, xleft, xrite, yleft, yrite)
```

Arguments

x	see description
xleft	see description
xrite	see description
yleft	see description
yrite	see description

Value

y with x

Author(s)

M. Posch, ported to R by jaap slootweg

uptake *uptake*

Description

calculate (Ions) uptake

Usage

```
uptake(growth, Q, thick, cont, cmin, Dep, Wea)
```

Arguments

`growth`	annual growth (m3/m2/a)
`Q`	runoff (m/a)
`thick`	soil depth (m)
`cont`	content of Ions in tree (eq/m3)
`cmin`	min concentration of Ions in leaching flux (eq/m3)
`Dep`	deposition of Ions (eq/m2/a)
`Wea`	weathering of Ions (eq/m3/a)

Value

balanced actual Upt

Author(s)

M. Posch, ported to R by jaap slootweg

`weasplit` *weasplit*

Description

Splits a given BC weathering rate into 4 constituents (Ca,Mg,K,Na); Wea

Usage

```
weasplit(BCwe, itex, clay, silt)
```

Arguments

`BCwe`	weathering as sum of Bc
`itex`	texture class
`clay`	percent clay for all sites
`silt`	percent silt for all sites

Details

Note: clay and silt have to lie in the polygon defined by the texture class! loess/silt, C.v.d.Salm et al., Geoderma 85:41-62 (1998) C.v.d.Salm's thesis, chap.3.3 for sand (see W.deVries' thesis, p.305; but also for itex=9 (peat))

Value

Wea (as Ions)

Author(s)

M. Posch, ported to R by jaap slootweg

`wrate` *wrate*

Description

weathering rates in eq/m3

Usage

```
wrate(soil, itex, ipm, clay, silt, temp)
```

Arguments

`soil`	soil type
`itex`	texture class
`ipm`	parent material class
`clay`	percent
`silt`	percent
`temp`	erature [deg.C]

Value

data.frame

Author(s)

M. Posch, ported to R by jaap slootweg

`wratecl` *wratecl*

Description

Assignes a weathering rate class for each soil type depending on parent material class and texture.

Usage

```
wratecl(soil, itex, ipm)
```

Arguments

`soil`	soil type
`itex`	texture
`ipm`	parent mat.

Value

vector of weathering class with the same length as soil, itex and ipm

Author(s)

M. Posch, ported to R by jaap slootweg

Index