Package ‘EmissV’

October 8, 2020

Title Vehicular Emissions by Top-Down Methods

Date 2020-09-28

Version 0.665.3.0

Maintainer Daniel Schuch <schuch@usp.br>

Description Creates emissions for use in air quality models. Vehicular emissions are estimated by a top-down approach, total emissions are calculated using the statistical description of the fleet of vehicles, the emission is spatially distributed according to satellite images or openstreetmap data <https://www.openstreetmap.org> and then distributed temporarily (Vara-Vela et al., 2016, <doi:10.5194/acp-16-777-2016>).

Depends R (>= 3.4)

Imports ncdf4, units(>= 0.5-1), raster, sp, sf, methods, data.table

Suggests testthat (>= 2.1.0), covr, osmar, rgdal, eixport, lwgeom

License MIT + file LICENSE

Encoding UTF-8

LazyData true

RoxygenNote 7.1.1

URL https://atmoschem.github.io/EmissV/

BugReports https://github.com/atmoschem/EmissV/issues

NeedsCompilation no

Author Daniel Schuch [aut, cre] (<https://orcid.org/0000-0001-5977-4519>), Sergio Ibarra-Espinosa [aut] (<https://orcid.org/0000-0002-3162-1905>)

Repository CRAN

Date/Publication 2020-10-08 08:00:03 UTC

R topics documented:

`areaSource` *Distribution of emissions by area*

Description

Calculate the spatial distribution by a raster kasked by shape/model grid information.

Usage

```
areaSource(s, r, grid = NA, name = "", as_frac = F, verbose = T)
```

Arguments

`s`	input shape object
`r`	input raster object
`grid`	grid with the output format
`name`	area name
`as_frac`	return a fraction instead of a raster
`verbose`	display additional data

Format

a raster

Details

About the DMSP and example data https://en.wikipedia.org/wiki/Defense_Meteorological_Satellite_Program

Source

Data avaliable https://www.ospo.noaa.gov/Operations/DMSP/index.html

Examples

```
shape  <- raster::shapefile(paste(system.file("extdata", package = "EmissV"),
                            "/BR.shp",sep=""),verbose = FALSE)
shape  <- shape[22,1] # subset for Sao Paulo - BR
raster <- raster::raster(paste(system.file("extdata", package = "EmissV"),
                         "/dmsp.tiff",sep=""))
grid  <- gridInfo(paste(system.file("extdata", package = "EmissV"),"/wrfinput_d02",sep=""))
SP     <- areaSource(shape,raster,grid,name = "SPMA")

sp::spplot(SP,scales = list(draw=TRUE),ylab="Lat",xlab="Lon",
           main=list(label="Spatial Distribution by Lights for Sao Paulo - Brazil"),
           col.regions = c("#031638","#001E48","#002756","#003062",
                           "#003A6E","#004579","#005084","#005C8E",
                           "#006897","#0074A1","#0081AA","#008FB3",
                           "#009EBD","#00AFC8","#00C2D6","#00E3F0"))
```

`emission` *Emissions in the format for atmospheric models*

Description

Combine area sources and total emissions to model output

Usage

```
emission(
  total,
  pol,
  area,
  grid,
  inventory = NULL,
  mm = 1,
  aerosol = F,
  plot = F,
  positive = T,
  verbose = T
)
```

Arguments

total	list of total emission
pol	pollutant name

area	list of area sources or matrix with a spatial distribution
grid	grid information
inventory	a inventory raster from read
mm	pollutant molar mass
aerosol	TRUE for aerosols and FALSE (defoult) for gazes
plot	TRUE for plot the final emissions
positive	TRUE (defoult) to check negative values and replace for zero
verbose	display additional information

Format

matrix of emission

Note

if Inventory is provided, the firsts tree arguments are not be used by the funciton.

Is a good practice use the set_units(fe,your_unity), where fe is your emission factory and your_unity is usually g/km on your emission factory

the list of area must be in the same order as defined in vehicles and total emission.

just WRF-Chem is suported by now

See Also

totalEmission and areaSource

Examples

```
fleet  <- vehicles(example = TRUE)

EmissionFactors <- emissionFactor(example = TRUE)

TOTAL  <- totalEmission(fleet,EmissionFactors,pol = c("CO"),verbose = TRUE)

grid   <- gridInfo(paste0(system.file("extdata", package = "EmissV"),"/wrfinput_d01"))
shape  <- raster::shapefile(paste0(system.file("extdata", package = "EmissV"),"/BR.shp"))
raster <- raster::raster(paste0(system.file("extdata", package = "EmissV"),"/dmsp.tiff"))

SP     <- areaSource(shape[22,1],raster,grid,name = "SP")
RJ     <- areaSource(shape[17,1],raster,grid,name = "RJ")

e_CO   <- emission(TOTAL,"CO",list(SP = SP, RJ = RJ),grid,mm=28)
```

emissionFactor *Tool to set-up emission factors*

Description

Return a data frame with vehicle information. Types argument defines the diary use:

Usage

```
emissionFactor(
  ef,
  poluttant = names(ef),
  vnames = NA,
  unit = "g/km",
  example = F,
  verbose = T
)
```

Arguments

ef	list with emission factors
poluttant	poluttant names
vnames	name of each vehicle categoy (optional)
unit	tring with unit from unit package, for default is "g/km"
example	TRUE to diaplay a simple example
verbose	display additional information

Format

data frame

See Also

areaSource and totalEmission

Examples

```
EF <- emissionFactor(example = TRUE)

# or the code for the same result
EF <- emissionFactor(ef = list(CO = c(1.75,10.04,0.39,0.45,0.77,1.48,1.61,0.75),
                               PM = c(0.0013,0.0,0.0010,0.0612,0.1052,0.1693,0.0,0.0)),
                  vnames = c("Light Duty Vehicles Gasohol","Light Duty Vehicles Ethanol",
                        "Light Duty Vehicles Flex","Diesel Trucks","Diesel Urban Busses",
                                "Diesel Intercity Busses","Gasohol Motorcycles",
                                "Flex Motorcycles"))
```

gridInfo *Read grid information from a NetCDF file*

Description

Return a list containing information of a regular grid / domain

Usage

```
gridInfo(file = file.choose(), z = F, geo = F, verbose = T)
```

Arguments

file	file name/path to a wrfinput, wrfchemi or geog_em file
z	TRUE for read wrfinput vertical coordinades
geo	True for use geog_em files
verbose	display additional information

Note

just WRF-Chem is suported by now

Examples

```
grid_d1 <- gridInfo(paste(system.file("extdata", package = "EmissV"),"/wrfinput_d01",sep=""))

grid_d2 <- gridInfo(paste(system.file("extdata", package = "EmissV"),"/wrfinput_d02",sep=""))
grid_d3 <- gridInfo(paste(system.file("extdata", package = "EmissV"),"/wrfinput_d03",sep=""))
names(grid_d1)
# for plot the shapes
library(sp)
shape  <- raster::shapefile(paste0(system.file("extdata", package = "EmissV"),"/BR.shp"))
plot(shape,xlim = c(-55,-40),ylim = c(-30,-15), main="3 nested domains")
axis(1); axis(2); box(); grid()
lines(grid_d1$Box, col = "red")
text(grid_d1$xlim[2],grid_d1$Ylim[1],"d1",pos=4, offset = 0.5)
lines(grid_d2$Box, col = "red")
text(grid_d2$xlim[2],grid_d2$Ylim[1],"d2",pos=4, offset = 0.5)
lines(grid_d3$Box, col = "red")
text(grid_d3$xlim[1],grid_d3$Ylim[2],"d3",pos=2, offset = 0.0)
```

`lineSource` *Distribution of emissions by lines*

Description

Create a emission distribution from 'sp' or 'sf' spatial lines data.frame or spatial lines.

There 3 modes available to create the emission grid: - using gridInfo function output (defoult) - using the patch to "wrfinput" (output from real.exe) file or "geo" for (output from geog.exe) - "sf" (and "sp") uses a grid in SpatialPolygons format

The variable is the column of the data.frame with contains the variable to be used as emissions, by defoult the idstribution taken into acount the lench distribution of lines into each grid cell and the output is normalized.

Usage

```
lineSource(
  s,
  grid,
  as_raster = F,
  verbose = T,
  type = "info",
  gcol = 100,
  grow = 100,
  variable = "length"
)
```

Arguments

s	SpatialLinesDataFrame of SpatialLines object
grid	grid object with the grid information or filename
as_raster	output format, TRUE for raster, FALSE for matrix
verbose	display additional information
type	"info" (default), "wrfinput", "geo", "sp" or "sf" for grid type
gcol	grid points for a "sp" or "sf" type
grow	grid points for a "sp" or "sf" type
variable	variable to use, default is line length

Source

OpenstreetMap data avaliable https://www.openstreetmap.org/ and https://download.geofabrik.de/

See Also

gridInfo and rasterSource

Examples

```
roads <- osmar::get_osm(osmar::complete_file(),
                        source = osmar::osmsource_file(paste(system.file("extdata",
                        package="EmissV"),"/streets.osm.xz",sep="")))
road_lines <- osmar::as_sp(roads,what = "lines")
roads <- sf::st_as_sf(road_lines)

d3    <- gridInfo(paste0(system.file("extdata", package = "EmissV"),"/wrfinput_d03"))

roadLength <- lineSource(roads,d3,as_raster=TRUE)
sp::spplot(roadLength, scales = list(draw=TRUE), ylab="Lat", xlab="Lon",main="Length of roads",
           sp.layout=list("sp.lines", road_lines))
```

perfil *Temporal profile for emissions*

Description

Set of hourly profiles that represents the mean activity for each hour (local time) of the week.

LDV Light Duty vehicles

HDV Heavy Duty vehicles

PC_JUNE_2012 passenger cars counted in June 2012

PC_JUNE_2013 passenger cars counted in June 2013

PC_JUNE_2014 passenger cars counted in June 2014

LCV_JUNE_2012 light comercial vehicles counted in June 2012

LCV_JUNE_2013 light comercial vehicles counted in June 2013

LCV_JUNE_2014 light comercial vehicles counted in June 2014

MC_JUNE_2012 motorcycles counted in June 2012

MC_JUNE_2013 motorcycles counted in June 2013

MC_JUNE_2014 motorcycles counted in June 2014

HGV_JUNE_2012 Heavy good vehicles counted in June 2012

HGV_JUNE_2013 Heavy good vehicles counted in June 2013

HGV_JUNE_2014 Heavy good vehicles counted in June 2014

PC_JANUARY_2012 passenger cars counted in january 2012

PC_JANUARY_2013 passenger cars counted in january 2013

PC_JANUARY_2014 passenger cars counted in january 2014

LCV_JANUARY_2012 light comercial vehicles counted in january 2012

LCV_JANUARY_2013 light comercial vehicles counted in january 2013

LCV_JANUARY_2014 light comercial vehicles counted in january 2014

MC_JANUARY_2012 Motorcycles counted in january 2012

MC_JANUARY_2014 Motorcycles counted in january 2014

HGV_JANUARY_2012 Heavy good vehicles counted in january 2012

HGV_JANUARY_2013 Heavy good vehicles counted in january 2013

HGV_JANUARY_2014 Heavy good vehicles counted in january 2014

POW Power generation emission profile

IND Industrial emission profile

RES Residencial emission profile

TRA Transport emission profile

AGR Agriculture emission profile

SHP Emission profile for ships

SLV Solvent use emission constant profile

WBD Waste burning emisssion constant profile

PC_nov_2018 passenger cars at Janio Quadros on November 2018

HGV_nov_2018 heavy good vehicles at Janio Quadros on November 2018

TOTAL_nov_2018 total vehicle at Janio Quadros on November 2018

PC_out_2018 passenger cars at Anhanguera-Castello Branco on October 2018

MC_out_2018 Motorcycles cars at Anhanguera-Castello Branco on October 2018

Usage

```
data(perfil)
```

Format

A list of data frames with activity by hour and weekday.

Details

- Profiles 1 to 2 are from traffic count at São Paulo city from Perez Martínez et al (2014).

- Profiles 3 to 25 comes from traffic counted of toll stations located in São Paulo city, for summer and winters of 2012, 2013 and 2014.

- Profiles 26 to 33 are for different sectors from Oliver et al (2003).

- Profiles 34 to 36 are for volumetric mechanized traffic count at Janio Quadros tunnel on November 2018.

- Profiles 37 to 38 are for volumetric mechanized traffic count at Anhanguera-Castello Branco on October 2018.

Note

The profile is normalized by days (but is balanced for a complete week) it means diary_emission x profile = hourly_emission.

References

Pérez-Martínez, P. J., Miranda, R. M., Nogueira, T., Guardani, M. L., Fornaro, A., Ynoue, R., & Andrade, M. F. (2014). Emission factors of air pollutants from vehicles measured inside road tunnels in São Paulo: case study comparison. International Journal of Environmental Science and Technology, 11(8), 2155-2168.

Olivier, J., J. Peters, C. Granier, G. Pétron, J.F. Müller, and S. Wallens, Present and future surface emissions of atmospheric compounds, POET Report #2, EU project EVK2-1999-00011, 2003.

Examples

```
# load the data
data(perfil)

# function to simple view
plot.perfil <- function(per = perfil$LDV, text="", color = "#0000FFBB"){
  plot(per[,1],ty = "l", ylim = range(per),axe = FALSE,
       xlab = "hour",ylab = "Intensity",main = text,col=color)
  for(i in 2:7){
    lines(per[,i],col = color)
  }
  for(i in 1:7){
    points(per[,i],col = "black", pch = 20)
  }
  axis(1,at=0.5+c(0,6,12,18,24),labels = c("00:00","06:00","12:00","18:00","00:00"))
  axis(2)
  box()
}

# view all profiles in perfil data
for(i in 1:length(names(perfil))){
  cat(paste("profile",i,names(perfil)[i],"\n"))
  plot.perfil(perfil[[i]],names(perfil)[i])
}
```

---

plumeRise *Calculate plume rise height.*

Description

Calculate the maximum height of rise based on Brigs (1975), the height is calculated using different formulations depending on stability and wind conditions.

Usage

```
plumeRise(df, imax = 10, ermax = 1/100, Hmax = T, verbose = T)
```

Arguments

`df`	data.frame with micrometeorological and emission data
`imax`	maximum number of iteractions
`ermax`	maximum error
`Hmax`	use weil limit for plume rise, see details
`verbose`	display additional information

Format

data.frame with the input, rise (m) and effective higt (m)

Details

The input data.frame must contains the folloging colluns:

- z: height of the emission (m)
- r: source raius (m)
- Ve: emission velocity (m/s)
- Te: emission temperature (K)
- ws: wind speed (m/s)
- Temp: ambient temperature (K)
- h: height of the Atmospheric Boundary Layer-ABL (m)
- L: Monin-Obuhkov Lench (m)
- dtdz: lapse ration of potential temperature, used only for stable ABL (K/m)
- Ustar: atriction velocity, used only for neutral ABL (m/s)
- Wstar: scale of convectie velocity, used only for convective ABL (m/s)

Addcitionaly some combination of ws, Wstar and Ustar can produce inacurate results, Weil (1979) propose a geometric limit of 0.62 * (h - Hs) for the rise value.

References

The plume rise formulas are from Brigs (1975):"Brigs, G. A. Plume rise predictions, Lectures on Air Pollution and Environmental Impact Analyses. Amer. Meteor. Soc. p. 59-111, 1975." and Arya 1999: "Arya, S.P., 1999, Air Pollution Meteorology and Dispersion, Oxford University Press, New York, 310 p."

The limits are from Weil (1979): "WEIL, J.C. Assessmet of plume rise and dispersion models using LIDAR data, PPSP-MP-24. Prepared by Environmental Center, Martin Marietta Corporation, for Maryland Department of Natural Resources. 1979."

The example is data from a chimney of the Candiota thermoelectric powerplant from Arabage et al (2006) "Arabage, M. C.; Degrazia, G. A.; Moraes O. L. Simulação euleriana da dispersão local da pluma de poluente atmosférico de Candiota-RS. Revista Brasileira de Meteorologia, v.21, n.2, p. 153-160, 2006."

Examples

```
candiota <- matrix(c(150,1,20,420,3.11,273.15 + 3.16,200,-34.86,3.11,0.33,
                     150,1,20,420,3.81,273.15 + 4.69,300,-34.83,3.81,0.40,
                     150,1,20,420,3.23,273.15 + 5.53,400,-24.43,3.23,0.48,
                     150,1,20,420,3.47,273.15 + 6.41,500,-15.15,3.48,0.52,
                     150,1,20,420,3.37,273.15 + 6.35,600, -8.85,3.37,2.30,
                     150,1,20,420,3.69,273.15 + 5.93,800,-10.08,3.69,2.80,
                     150,1,20,420,3.59,273.15 + 6.08,800, -7.23,3.49,1.57,
                     150,1,20,420,4.14,273.15 + 6.53,900,-28.12,4.14,0.97),
                     ncol = 10, byrow = TRUE)
candiota <- data.frame(candiota)
names(candiota) <- c("z","r","Ve","Te","ws","Temp","h","L","Ustar","Wstar")
row.names(candiota) <- c("08:00","09:00",paste(10:15,":00",sep=""))
candiota <- plumeRise(candiota,Hmax = TRUE)
print(candiota)
```

`pointSource` *Emissions from point sources*

Description

Transform a set of points into a grinded output

Usage

```
pointSource(emissions, grid, verbose = T)
```

Arguments

`emissions`	list of points
`grid`	grid object with the grid information
`verbose`	display additional information

Value

a raster

See Also

`gridInfo` and `rasterSource`

Examples

```
d1 <- gridInfo(paste(system.file("extdata", package = "EmissV"),"/wrfinput_d01",sep=""))

p = data.frame(lat      = c(-22,-22,-23.5),
               lon      = c(-46,-48,-47  ),
               z        = c(0   ,   0,   0  ),
               emission = c(666,444,111  ) )

p_emissions <- pointSource(emissions = p, grid = d1)

sp::spplot(p_emissions,scales = list(draw=TRUE), ylab="Lat", xlab="Lon",
           main = "3 point sources for domain d1")
```

`rasterSource` *Distribution of emissions by a georeferenced image*

Description

Calculate the spatial distribution by a raster

Usage

```
rasterSource(r, grid, nlevels = "all", conservative = T, verbose = T)
```

Arguments

`r`	input raster object
`grid`	grid object with the grid information
`nlevels`	number of vertical levels off the emission array
`conservative`	TRUE (default) to conserve total mass, FALSE to conserve flux
`verbose`	display additional information

Details

About the DMSP and example data https://en.wikipedia.org/wiki/Defense_Meteorological_Satellite_Program

Value

Returns a matrix

Source

Exemple data is a low resolution cutting from image of persistent lights of the Defense Meteorological Satellite Program (DMSP) https://pt.wikipedia.org/wiki/Defense_Meteorological_Satellite_Program

Data avaliable https://www.ospo.noaa.gov/Operations/DMSP/index.html

See Also

gridInfo and lineSource

Examples

```
grid  <- gridInfo(paste(system.file("extdata", package = "EmissV"),"/wrfinput_d01",sep=""))
x    <- raster::raster(paste(system.file("extdata", package = "EmissV"),"/dmsp.tiff",sep=""))
test  <- rasterSource(x,grid)
image(test, axe = FALSE, main = "Spatial distribution by Persistent Nocturnal Lights from DMSP")
```

---

read *Read NetCDF data from global inventaries*

Description

Read data from global inventories, can read several files and merge into one emission and/or split into several species (speciation process)

Usage

```
read(
  file = file.choose(),
  coef = rep(1, length(file)),
  spec = NULL,
  version = "EDGAR_v432",
  month = 1,
  year = 1,
  categories,
  as_raster = T,
  skip_missing = F,
  verbose = T
)
```

Arguments

file	file name or names (variables are summed)
coef	coef to merge different sources (file) into one emission
spec	numeric speciation vector to split emission into different species
version	inventory name 'EDGAR_v432','EDGAR_v432','MACCITY' or 'GAINS'
month	the desired month of the inventary (MACCITY)
year	scenario index (GAINS)
categories	considered categories (MACCITY, GAINS variable names), empty for all
as_raster	return a raster (defoult) or matrix (with units)
skip_missing	return a zero emission for missing variables and a warning
verbose	display additional information

Value

Matrix or raster

Note

for 'GAINS' version, please use flux (kg m-2 s-1) NetCDF file from https://eccad3.sedoo.fr

Source

Read abbout EDGAR at http://edgar.jrc.ec.europa.eu and MACCITY at http://accent.aero.jussieu.fr/MACC_metadata.php

References

Janssens-Maenhout, G., Dentener, F., Van Aardenne, J., Monni, S., Pagliari, V., Orlandini, L., ... & Wankmüller, R. (2012). EDGAR-HTAP: a harmonized gridded air pollution emission dataset based on national inventories. European Commission Joint Research Centre Institute for Environment and Sustainability. JRC 68434 UR 25229 EUR 25229, ISBN 978-92-79-23123-0.

Lamarque, J.-F., Bond, T. C., Eyring, V., Granier, C., Heil, A., Klimont, Z., Lee, D., Liousse, C., Mieville, A., Owen, B., Schultz, M. G., Shindell, D., Smith, S. J., Stehfest, E., Van Aardenne, J., Cooper, O. R., Kainuma, M., Mahowald, N., McConnell, J. R., Naik, V., Riahi, K., and van Vuuren, D. P.: Historical (1850-2000) gridded anthropogenic and biomass burning emissions of reactive gases and aerosols: methodology and application, Atmos. Chem. Phys., 10, 7017-7039, doi:10.5194/acp-10-7017-2010, 2010.

Z Klimont, S. J. Smith and J Cofala The last decade of global anthropogenic sulfur dioxide: 2000–2011 emissions Environmental Research Letters 8, 014003, 2013

See Also

rasterSource and gridInfo

species

Examples

```
dir.create(file.path(tempdir(), "EDGARv432"))
folder <- setwd(file.path(tempdir(), "EDGARv432"))

url <- "http://jeodpp.jrc.ec.europa.eu/ftp/jrc-opendata/EDGAR/datasets/v432_AP/NOx"
file1 <- 'v432_NOx_2012_IPCC_1A1a.0.1x0.1.zip'
file2 <- 'v432_NOx_2012_IPCC_1A2.0.1x0.1.zip'
file3 <- 'v432_NOx_2012_IPCC_1A3b.0.1x0.1.zip'

download.file(paste0(url,'/ENE/',file1), file1)
download.file(paste0(url,'/IND/',file2), file2)
download.file(paste0(url,'/TRO/',file3), file3)

unzip('v432_NOx_2012_IPCC_1A1a.0.1x0.1.zip')
unzip('v432_NOx_2012_IPCC_1A2.0.1x0.1.zip')
unzip('v432_NOx_2012_IPCC_1A3b.0.1x0.1.zip')
```

```
nox    <- read(file = dir(pattern = '.nc'),version = 'EDGAR_v432')
setwd(folder)

sp::spplot(nox, scales = list(draw=TRUE), xlab="Lat", ylab="Lon",main="NOx emissions from EDGAR")

d1   <- gridInfo(paste(system.file("extdata", package = "EmissV"),"/wrfinput_d01",sep=""))
d2   <- gridInfo(paste(system.file("extdata", package = "EmissV"),"/wrfinput_d02",sep=""))
nox_d1 <- rasterSource(nox,d1)
nox_d2 <- rasterSource(nox,d2)
image(nox_d1, axe = FALSE, main = "NOx emissions from transport-energy-industry for d1 (2012)")
image(nox_d2, axe = FALSE, main = "NOx emissions from transport-energy-industry for d2 (2012)")
```

`speciation` *Speciation of emissions in different compounds*

Description

Distribute the total mass of estimated emissions into model species.

Usage

```
speciation(total, spec = NULL, verbose = T)
```

Arguments

`total`	emissions from totalEmissions
`spec`	numeric speciation vector of species
`verbose`	display additional information

See Also

species

Examples

```
veic <- vehicles(example = TRUE)
EmissionFactors <- emissionFactor(example = TRUE)
TOTAL <- totalEmission(veic,EmissionFactors,pol = "PM")
pm_iag <- c(E_PM25I = 0.0509200,
            E_PM25J = 0.1527600,
            E_ECI   = 0.1196620,
            E_ECJ   = 0.0076380,
            E_ORGI  = 0.0534660,
            E_ORGJ  = 0.2279340,
            E_SO4I  = 0.0063784,
            E_SO4J  = 0.0405216,
            E_NO3J  = 0.0024656,
```

```
            E_NO3I  = 0.0082544,
            E_PM10  = 0.3300000)
PM <- speciation(TOTAL,pm_iag)
```

---

species *Species mapping tables*

Description

Set of tables for speciation:

voc_radm2_mic Volatile organic compounds for RADM2

voc_cbmz_mic Volatile organic compounds for CBMZ

voc_moz_mic Volatile organic compounds for MOZART

voc_saprc99_mic volatile organic compounds for SAPRC99

veicularvoc_radm2_iag Vehicular volatile organic compounds for RADM2 (MOL)

veicularvoc_cbmz_iag Vehicular volatile organic compounds for CBMZ (MOL)

veicularvoc_moz_iag Vehicular volatile organic compounds for MOZART (MOL)

veicularvoc_saprc99_iag Vehicular volatile organic compounds for SAPRC99 (MOL)

pm_madesorgan_iag Particulate matter for made/sorgan

pm25_madesorgan_iag Fine particulate matter for made/sorgan

nox_iag Nox split Perez Martínez et al (2014)

nox_bcom Nox split usin Ntziachristos and Zamaras (2016)

voc_radm2_edgar432 Volatile organic compounds species from EDGAR 4.3.2 for RADM2 (MOL)

voc_moz_edgar432 Volatile organic compounds species from EDGAR 4.3.2 for MOZART (MOL)

- Volatile organic compounds species map from 1 to 4 are from Li et al (2014) taken into account several sources of pollutants.

- Volatile organic compounds from vehicular activity species map 5 to 8 is a by fuel and emission process from USP-IAG tunel experiments (Rafee et al., 2017) emited by the process of exhaust (through the exhaust pipe), liquid (carter and evaporative) and vapor (fuel transfer operations).

- Particulate matter speciesmap for made/sorgan emissions 9 and 10.

- Nox split using Perez Martínez et al (2014) data (11).

- Nox split using mean of Ntziachristos and Zamaras (2016) data (12).

- Volatile organic compounds species map 13 and 14 are the corespondence from EDGAR 4.3.2 VOC specialization to RADM2 and MOZART.

Usage

```
data(species)
```

Format

List of numeric vectors with the 'names()' of the species and the values of each species.

Details

iag-voc: After estimating all the emissions of NMHC, it was used the speciation presented in (RAFEE et al., 2017). This speciation is based on tunnel measurements in São Paulo, depends on the type of fuel (E25, E100 and B5) and provides the mass of each chemical compound as mol/g. This speciation splits the NMHC from evaporative, liquid and exhaust emissions of E25, E100 and B5, into minimum compounds required for the Carbon Bond Mechanism (CBMZ) (ZAVERI; PETERS, 1999). Atmospheric simulations using the same pollutants in Brazil have resulted in good agreement with observations (ANDRADE et al., 2015).

iag-pm: data tunnel experiments at São Paulo in Perez Martínez et al (2014)

iag-nox: common NOx split for São Paulo Metropolitan area.

bcom-nox: mean of Ntziachristos and Zamaras (2016) data.

mic: from Li et al (2014).

edgar: Edgar 4.3.2 emissions Crippa et al. (2018).

Note

The units are mass ratio (mass/mass) or MOL (MOL), this last case do not change the default 'mm' into 'emission()' function.

References

Li, M., Zhang, Q., Streets, D. G., He, K. B., Cheng, Y. F., Emmons, L. K., ... & Su, H. (2014). Mapping Asian anthropogenic emissions of non-methane volatile organic compounds to multiple chemical mechanisms. Atmos. Chem. Phys, 14(11), 5617-5638.

Huang, G., Brook, R., Crippa, M., Janssens-Maenhout, G., Schieberle, C., Dore, C., ... & Friedrich, R. (2017). Speciation of anthropogenic emissions of non-methane volatile organic compounds: a global gridded data set for 1970–2012. Atmospheric Chemistry and Physics, 17(12), 7683.

Abou Rafee, S. A., Martins, L. D., Kawashima, A. B., Almeida, D. S., Morais, M. V. B., Souza, R. V. A., Oliveira, M. B. L., Souza, R. A. F., Medeiros, A. S. S., Urbina, V., Freitas, E. D., Martin, S. T., and Martins, J. A.: Contributions of mobile, stationary and biogenic sources to air pollution in the Amazon rainforest: a numerical study with the WRF-Chem model, Atmos. Chem. Phys., 17, 7977-7995, https://doi.org/10.5194/acp-17-7977-2017, 2017.

Martins, L. D., Andrade, M. F. D., Freitas, E., Pretto, A., Gatti, L. V., Junior, O. M. A., et al. (2006). Emission factors for gas-powered vehicles traveling through road tunnels in Sao Paulo, Brazil. Environ. Sci. Technol. 40, 6722–6729. doi: 10.1021/es052441u

Pérez-Martínez, P. J., Miranda, R. M., Nogueira, T., Guardani, M. L., Fornaro, A., Ynoue, R., & Andrade, M. F. (2014). Emission factors of air pollutants from vehicles measured inside road tunnels in São Paulo: case study comparison. International Journal of Environmental Science and Technology, 11(8), 2155-2168.

ANDRADE, M. d. F. et al. Air quality forecasting system for southeastern brazil. Frontiers in Environmental Science, Frontiers, v. 3, p. 1–12, 2015.

Crippa, M., Guizzardi, D., Muntean, M., Schaaf, E., Dentener, F., Aardenne, J. A. V., ... & Janssens-Maenhout, G. (2018). Gridded emissions of air pollutants for the period 1970–2012 within EDGAR v4.3.2. Earth System Science Data, 10(4), 1987-2013.

See Also

`speciation` and `read`

Examples

```
# load the mapping tables
data(species)
# names of eath mapping tables
for(i in 1:length(names(species)))
    cat(paste0("specie map ",i," ",names(species)[i],"\n"))
# names of species contained in the (first) mapping table
names(species[[1]])
# The first mapping table / species and values
species[1]
```

---

streetDist *Distribution by OpenStreetnMap street*

Description

Distribute emissions by streets of OpenStreetMap

Usage

```
streetDist(
  emission = 1,
  dist = c(1, 0, 0, 0, 0),
  grid = NULL,
  osm = NULL,
  epsg = 31983,
  warnings = FALSE
)
```

Arguments

`emission`	Numeric; emissions.
`dist`	Numeric; vector with length 5. The order represents motorway, trunk, primary, secondary and tertiary
`grid`	'sf' POLYGON; grid of polygons class sf.
`osm`	streets of OpenStreetMaps class sf
`epsg`	Numeric; spatial code for projecting spatial data
`warnings`	Logical; to show warnings.

Value

grid of polygon

Examples

```
## Not run:
# Do not run
library(sf)
# Download OSM streets
streets <- st_read("path")
streets <- streets[streets$highway != "residential", ]
# Grid
grid <- gridInfo(paste(system.file("extdata", package = "EmissV"),"/wrfinput_d02",sep=""))
names(grid)
d3 <- data.frame(x = as.numeric(grid$Lon),
                 y = as.numeric(grid$Lat))
d3 <- st_as_sf(d3, coords = c("x","y"))
st_crs(d3) <- st_crs(4326)
library(vein)
g <- st_transform(st_as_sf(vein::make_grid(as(st_transform(d3, 31983),
                  "Spatial"),
               grid$DX*1000, grid$DX*1000, T)), 4326)
streets$id <- NULL
per <- c(1, 0, 0, 0, 0)
teste <- streetDist(emission = 1000000, dist = per, grid = g,
                    osm = streets, epsg = 31983)
# Another example:
library (EmissV)
library (osmdata)
library (sf)
city <- "accra"
bb <- getbb (city)
dat <- opq (bbox = city) %>%
  add_osm_feature (key = "highway") %>%
  osmdata_sf (quiet = FALSE) %>%
  osmdata::osm_poly2line () %>%
  magrittr::extract2 ("osm_lines")
#saveRDS (dat, file = "accra-hw.Rds")
utm <- 32630 # for Accra

# Get a raster grid of population density to use for the emission distribution:
url <- paste0 ("https://github.com/ATFutures/who-data/releases/download/",
               "v0.0.2-worldpop-tif-gha-npl/accra.2fpopdens.2fGHA15adj_040213.tif")
download.file (url, "accra-pop.tif", mode = "wb")
ras <- raster::raster ("accra-pop.tif") %>%
  raster::crop (raster::extent (bb)) %>%
  as ("SpatialPolygons") %>%
  st_as_sf ()

#dat <- readRDS (file = "accra-hw.Rds")
dat <- dat[dat$highway %in% c ("motorway", "trunk", "primary",
                                "secondary", "teritary"), ]
```

```
s <- streetDist (emission = 1, dist = c (1, 0, 0, 0, 0), grid = ras,
                 osm = dat, epsg = utm)

## End(Not run)
```

---

totalEmission *Calculate total emissions*

Description

Caculate the total emission with:

Emission(pollutant) = sum(Vehicles(n) * Km_day_use(n) * Emission_Factor(n,pollutant))

where n is the type of the veicle

Usage

```
totalEmission(v, ef, pol, verbose = T)
```

Arguments

v	dataframe with the vehicle data
ef	emission factor
pol	pollutant name in ef
verbose	display additional information

Format

Return a list with the daily total emission by interest area (cityes, states, countries, etc).

Note

the units (set_units("value",unit) where the recomended unit is g/d) must be used to make the ef data.frame

See Also

rasterSource, lineSource and emission

Examples

```
veic <- vehicles(example = TRUE)

EmissionFactors <- emissionFactor(example = TRUE)

TOTAL <- totalEmission(veic,EmissionFactors,pol = c("CO","PM"))
```

totalVOC *Calculate Total VOCs emissions (depreciated)*

Description

Calculates Volatile Organic Compounds (COVs) emited by the process of exhaust (through the exhaust pipe), liquid (carter and evaporative) and vapor (fuel transfer operations).

This function calculates the total emission using emission factors and then speciate into one of the available species. A better approach is to use 'speciate()' function and 'species' dataset.

Avaliable COVs are: eth, hc3, hc5, hc8, ol2, olt, oli, iso, tol, xyl, ket, ch3oh and ald

Usage

```
totalVOC(v, ef, pol, verbose = T)
```

Arguments

v	data frame with the vehicle data
ef	emission factors
pol	pollutant name in ef
verbose	display additional information

Format

Return a list with the daily total emission by territory.

Note

The same ef can be used to totalEmission and voc

See Also

speciation and species

Examples

```
veic <- vehicles(example = TRUE)

COV = c("eth","hc3","hc5","hc8","ol2","olt","oli","iso","tol","xyl","ket","ch3oh","ald")
EF_COV <- as.data.frame(matrix(NA,ncol = 9,nrow = 8,byrow = TRUE),
                        row.names = row.names(veic))
names(EF_COV) <-  c("vap_g","vap_e","vap_d",
                    "liq_g","liq_e","liq_d",
                    "exa_g","exa_e","exa_d")

EF_COV["vap_g"]  <- c(0.230,0.00,0.120,0.00,0.00,0.00,0.00,0.00)
EF_COV["vap_e"]  <- c(0.000,0.25,0.120,0.00,0.00,0.00,0.00,0.00)
```

```
EF_COV["vap_d"]  <- c(0.000,0.00,0.000,0.00,0.00,0.00,0.00,0.00)
EF_COV["liq_g"]  <- c(2.000,0.00,0.875,0.00,0.00,0.00,1.20,0.00)
EF_COV["liq_e"]  <- c(0.000,1.50,0.875,0.00,0.00,0.00,0.00,1.20)
EF_COV["liq_d"]  <- c(0.000,0.00,0.000,0.00,0.00,0.00,0.00,0.00)
EF_COV["exa_g"]  <- c(0.425,0.00,0.217,0.00,0.00,0.00,1.08,0.00)
EF_COV["exa_e"]  <- c(0.000,1.30,0.217,0.00,0.00,0.00,0.00,1.08)
EF_COV["exa_d"]  <- c(0.000,0.00,0.000,2.05,0.00,0.00,0.00,0.00)

print(EF_COV)

COV_total <- totalVOC(veic,EF_COV,pol = COV[10])
```

`vehicles` *Tool to set-up vehicle data table*

Description

Return a data frame with 4 columns (vehicle category, type, fuel and avarage kilometers driven) and an aditional column with the number of vehicles for each interest area (cityes, states, countries, etc).

Average daily kilometres driven are defined by vehicle type:

- LDV (Light duty Vehicles) 41 km / day

- TRUCKS (Trucks) 110 km / day

- BUS (Busses) 165 km / day

- MOTO (motorcycles and other vehicles) 140 km / day

The number of vehicles are defined by the distribution of vehicles by vehicle classs and the total number of vehicles by area.

Usage

```
vehicles(
  total_v,
  area_name = names(total_v),
  distribution,
  type,
  category = NA,
  fuel = NA,
  vnames = NA,
  example = F,
  verbose = T
)
```

Arguments

`total_v`	total of vehicles by area (area length)
`area_name`	area names (area length)
`distribution`	distribution of vehicles by vehicle class
`type`	type of vehicle by vehicle class (distribution length)
`category`	category name (distribution length / NA)
`fuel`	fuel type by vehicle class (distribution length / NA)
`vnames`	name of each vehicle class (distribution length / NA)
`example`	a simple example
`verbose`	display additional information

Note

total_v and area_name must have the same length.

distribution, type, category (if used), fuel (if used) and vnames (if used) must have the same length.

See Also

`areaSource` and `totalEmission`

Examples

```
fleet <- vehicles(example = TRUE)

# or the code bellow for the same result
# DETRAN 2016 data for total number of vehicles for 5 Brazilian states (Sao Paulo,
# Rio de Janeiro, Minas Gerais, Parana and Santa Catarina)
# vahicle distribution of Sao Paulo

fleet <- vehicles(total_v = c(27332101, 6377484, 10277988, 7140439, 4772160),
                  area_name = c("SP", "RJ", "MG", "PR", "SC"),
                  distribution = c( 0.4253, 0.0320, 0.3602, 0.0260,
                                    0.0290, 0.0008, 0.1181, 0.0086),
                  category =  c("LDV_E25","LDV_E100","LDV_F","TRUCKS_B5",
                                "CBUS_B5","MBUS_B5","MOTO_E25","MOTO_F"),
                  type = c("LDV", "LDV", "LDV","TRUCKS",
                          "BUS","BUS","MOTO", "MOTO"),
                  fuel = c("E25", "E100", "FLEX","B5",
                           "B5","B5","E25", "FLEX"),
                 vnames = c("Light duty Vehicles Gasohol","Light Duty Vehicles Ethanol",
                        "Light Duty Vehicles Flex","Diesel trucks","Diesel urban busses",
                             "Diesel intercity busses","Gasohol motorcycles",
                             "Flex motorcycles"))
```

Index