Package 'ISRaD'

September 24, 2019

Title Tools and Data for the International Soil Radiocarbon Database

Version 1.0.0

Description This is the central location for data and tools for the development, maintenance, analysis, and deployment of the International Soil Radiocarbon Database. This database and package have been developed in collaboration between the U.S. Geological Survey Powell Center and the Max Planck Institute.

Depends R (>= 3.3.0)

Imports openxlsx, devtools, raster, dplyr, plyr, tidyr, RCurl, ggplot2, ggmap, assertthat, rcrossref, pangaear, tidyverse, usethis, stringr

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Encoding UTF-8

LazyData true

RoxygenNote 6.1.1

Suggests knitr,
   rmarkdown

R topics documented:

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checkTemplateFiles   *Check ISRaD Template/Info files*

Description

Check that the template information file and the template file match appropriately.

Usage

```
checkTemplateFiles(outfile = "", verbose = T)
```

Arguments

outfile   file to dump the output report. Defaults to an empty string that will print to
                 standard output.

verbose   if TRUE (default) will print output to specified outfile

Value

returns NULL

Examples

```
checkTemplateFiles()
```

---

compile   *Compile ISRaD data product*

Description

Construct data products to the International Soil Radiocarbon Database.

Usage

```
compile(dataset_directory, write-report = FALSE, write_out = FALSE,
  return_type = c("none", "list")[2], checkdoi = F, verbose = T)
```

Arguments

dataset_directory

> string defining directory where completed and QC passed soilcarbon datasets are stored

write_report

> boolean flag to write a log file of the compilation. File will be in the specified dataset_directory at "database/ISRaD_log.txt". If there is a file already there of this name it will be overwritten.

write_out

> boolean flag to write the compiled database file as .xlsx in dataset_directory

return_type

> a string that defines return object. Default is "list". Acceptable values are "none" or "list" depending on the format you want to have the database returned in.

checkdoi

> set to F if you do not want the QAQC check to validate doi numbers

verbose

> set to TRUE to print results of function to console

Examples

```
ISRaD.compiled <- compile(tempdir(), write_report = T, write_out = T,
return_type = 'list', checkdoi = F, verbose = T)
```

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graven	*Graven dataset for delta delta calculation*

Description

Data from Graven et al 2017 https://www.geosci-model-dev.net/10/4405/2017/gmd-10-4405-2017.pdf

Usage

```
graven
```

Format

dataframe

ISRaD.build	*ISRaD.build builds the database and updates objects in R package*

Description

Wrapper function that combines tools for rapid deployment of R package data objects. Meant to be used by the maintainers/developers of ISRaD

Usage

```
ISRaD.build(ISRaD_directory, geodata_clim_directory, geodata_pet_directory,
  geodata_soil_directory, citations = T)
```

Arguments

`ISRaD_directory`
  directory where the ISRaD package is found

`geodata_clim_directory`
  directory where geospatial climate datasets are found. Necessary to create IS-RaD_Extra

`geodata_pet_directory`
  directory where geospatial pet dataset is found. Necessary to create ISRaD_Extra

`geodata_soil_directory`
  directory where geospatial soil datasets are found. Necessary to create IS-RaD_Extra

`citations` T or F. Update citations.

Value

runs QAQC on all datafiles, moves files that fail QAQC, updates ISRaD_Data, updates ISRaD_Extra

Examples

```
ISRaD.build(ISRaD_directory="~/ISRaD/", geodata_clim_directory="~/geospatial_clim_datasets",
  geodata_pet_directory="~/geospatial_pet_dataset",
  geodata_soil_directory="~/geospatial_soil_datasets")
```

ISRaD.extra *ISRaD.extra*

Description

Fills in transformed and geospatial data where possible, generating an enhanced version of ISRaD.

Usage

```
ISRaD.extra(database, geodata_clim_directory, geodata_soil_directory,
  geodata_pet_directory)
```

Arguments

`database` soilcarbon dataset object

`geodata_clim_directory`
  directory where geospatial climate data are found

`geodata_soil_directory`
  directory where geospatial soil data are found

`geodata_pet_directory`
  directory where geospatial pet data are found

Details

Fills fraction modern, delta 14C, delta-delta values, profile coordinates, and SOC stocks frmo entered data; fills soil and climatic data from external geospatial data products

Value

returns new ISRaD_extra object with derived, transformed, and filled columns

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ISRaD.extra.Cstocks   *ISRaD.extra.Cstocks*

Description

Calculates soil organic carbon stock

Usage

```
ISRaD.extra.Cstocks(database)
```

Arguments

database   ISRaD dataset object.

Details

Function first fills lyr_bd_samp and lyr_c_org. SOC stocks can only be calculated if organic carbon concentration and bulk density data are available. SOC stocks are then calculated for the fine earth fraction (<2mm).

Value

returns ISRaD_data object with filled columns

Author(s)

J. Beem-Miller

Examples

```
ISRaD_full <- ISRaD.getdata(tempdir())
ISRaD.extra.Cstocks(ISRaD_full)
```

ISRaD.extra.delta_delta

ISRaD.extra.delta_delta

Description

Calculates the difference between sample delta 14C and the atmosphere for the year of collection (delta-delta)

Usage

```
ISRaD.extra.delta_delta(database)
```

Arguments

database   ISRaD dataset object.

Details

Creates new column for delta-delta value. Observation year and profile coordinates must be filled (use ISRaD.extra.fill_dates, and ISRaD.extra.fill_coords fxs). The relevant atmospheric d14C data (northern or southern hemisphere, or tropics) are determined by profile coordinates.

Value

returns ISRaD_data object with new delta delta columns in relevant tables

Author(s)

J. Beem-Miller and C. Hicks-Pries

References

Graven et al. 2017 https://www.geosci-model-dev.net/10/4405/2017/gmd-10-4405-2017.pdf

Examples

```
ISRaD_full <- ISRaD.getdata(tempdir())
ISRaD.extra.delta_delta(ISRaD_full)
```

ISRaD.extra.fill_14c   *ISRaD.extra.fill_14c*

Description

: Fills delta 14C from fraction modern if delta 14C not reported.

Usage

```
ISRaD.extra.fill_14c(database)
```

Arguments

database   ISRaD dataset object.

Details

: Warning: xxx_obs_date_y columns must be filled for this to work!

Value

returns ISRaD_data object with filled delta 14C columns

Author(s)

: J. Beem-Miller & A. Hoyt

References

: Stuiver and Polach, 1977

Examples

```
ISRaD_full <- ISRaD.getdata(tempdir())
ISRaD.extra.fill_14c(ISRaD_full)
```

ISRaD.extra.fill_coords
                    ISRaD.extra.fill_coords

Description

Fills profile coordinates from site coordinates if profile coordinates not reported.

Usage

```
ISRaD.extra.fill_coords(database)
```

Arguments

database   ISRaD dataset object.

Value

returns ISRaD_data object with filled profile coordinates

Author(s)

J. Beem-Miller

Examples

```
ISRaD_full <- ISRaD.getdata(tempdir())
ISRaD.extra.fill_coords(ISRaD_full)
```

ISRaD.extra.fill_dates
                              ISRaD.extra.fill_dates

Description

Fills frc_obs_date_y and inc_obs_date_y columns from lyr_obs_date_y if not reported.

Usage

```
ISRaD.extra.fill_dates(database)
```

Arguments

database   ISRaD dataset object.

Details

This function must be run prior to the ISRaD.extra.fill_14c, ISRaD.extra.fill_fm, and ISRaD.extra.delta_delta for the layer and fraction tables.

Value

returns ISRaD_data object with filled obs_date_y columns

Examples

```
ISRaD_full <- ISRaD.getdata(tempdir())
ISRaD.extra.fill_dates(ISRaD_full)
```

```
ISRaD.extra.fill_expert
```
ISRaD.extra.fill_expert

Description

: Fills in columns of expert-reviewed full data with real data where available, and calculates missing carbon stocks with filled data.

Usage

```
ISRaD.extra.fill_expert(database)
```

Arguments

database   ISRaD dataset object.

Details

:

Value

returns ISRaD_data object with the lyr_xxx_fill_extra columns containing both original and filled data

Author(s)

: Paul A. Levine

References

:

Examples

```
ISRaD_full <- ISRaD.getdata(tempdir())
ISRaD.extra.fill_expert(ISRaD_full)
```

ISRaD.extra.fill_fm   *ISRaD.extra.fill_fm*

Description

Fills fraction modern from delta 14C if fraction modern not reported.

Usage

```
ISRaD.extra.fill_fm(database)
```

Arguments

database   ISRaD dataset object.

Details

: Warning: xxx_obs_date_y columns must be filled for this to work!

Value

returns ISRaD_data object with filled fraction modern columns

Author(s)

: J. Beem-Miller & A. Hoyt

References

: Stuiver and Polach, 1977

Examples

```
ISRaD_full <- ISRaD.getdata(tempdir())
ISRaD.extra.fill_fm(ISRaD_full)
```

ISRaD.extra.fill_soilorders
                         ISRaD.extra.fill_soilorders

Description

Fills pro_usda_soil_order field from pro_soil_taxon field.

Usage

```
ISRaD.extra.fill_soilorders(database)
```

Arguments

database   ISRaD dataset object.

Details

This function is a static conversion script written at the Fall 2018 Powell Center workshop and therefore performance is not guaranteed for new entries.

Back fills pro_usda_soil_order based on USDA classifications

Value

returns ISRaD_data object with filled pro_usda_soil_order column

Examples

```
ISRaD_full <- ISRaD.getdata(tempdir())
ISRaD.extra.fill_soilorders(ISRaD_full)
```

ISRaD.extra.geospatial.climate
ISRaD.extra.geospatial.climate

Description

Extracts values from gridded (2.5' arc) climate data using ISRaD profile coordinates.

Usage

```
ISRaD.extra.geospatial.climate(database, geodata_clim_directory,
  geodata_pet_directory)
```

Arguments

database   ISRaD dataset object.
geodata_clim_directory
     directory where geospatial climate datasets are found.
geodata_pet_directory
     directory where geospatial pet dataset is found.

Details

Note that for this function to work you must have downloaded the climate data to a local directory (sources given in references section, below).

Adds new climate fields BIO1-BIO19, PET

BIO1 = Annual Mean Temperature, BIO2 = Mean Diurnal Range (Mean of monthly (max temp - min temp)), BIO3 = Isothermality (BIO2/BIO7) (* 100), BIO4 = Temperature Seasonality (standard deviation *100), BIO5 = Max Temperature of Warmest Month, BIO6 = Min Temperature of Coldest Month, BIO7 = Temperature Annual Range (BIO5-BIO6), BIO8 = Mean Temperature of Wettest

Quarter, BIO9 = Mean Temperature of Driest Quarter, BIO10 = Mean Temperature of Warmest Quarter, BIO11 = Mean Temperature of Coldest Quarter, BIO12 = Annual Precipitation, BIO13 = Precipitation of Wettest Month, BIO14 = Precipitation of Driest Month, BIO15 = Precipitation Seasonality (Coefficient of Variation), BIO16 = Precipitation of Wettest Quarter, BIO17 = Precipitation of Driest Quarter, BIO18 = Precipitation of Warmest Quarter, BIO19 = Precipitation of Coldest Quarter PET = Potential evapotranspiration, mm/yr (Penman-Monteith method for short-clipped grass w/ worldclim input data)

All BIO## variables are from http://www.worldclim.org/bioclim V1.4 at 2.5 resolution and are based on profile lat and long

Value

An ISRaD_data object with additional rows containing values from geospatial datasets. See description for details.

Author(s)

J. Grey Monroe, Alison Hoyt

References

http://www.worldclim.org/; PET data from: Kramer, M. and O. Chadwick. 2018. Climate-driven thresholds in reactive mineral retention of soil carbon at the global scale. Nature Climate Change 8:1104–1108.

ISRaD.extra.geospatial.soil

ISRaD.extra.geospatial.soil

Description

Extracts modeled soil properties from 250m resolution Soil Grids spatial products

Usage

```
ISRaD.extra.geospatial.soil(database, geodata_soil_directory)
```

Arguments

database   soilcarbon dataset object
geodata_soil_directory
                  directory where geospatial soil data are found

Details

Uses filled geographic coordinates of profiles to extract estimated (observations + machine learning predictions) clay content (kg/kg), organic carbon content (x 5 g/kg), carbon stock (kg/m2), bulk density (kg/m3), and coarse fragments (

Value

returns new ISRaD_extra object with extracted bulk density and clay, carbon, and coarse fragment content up to 200 cm soil depth

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ISRaD.extra.geospatial.Zheng
ISRaD.extra.geospatial.Zheng

Description

Extracts MAT, MAP, MODIS land cover, and soil order from global 0.5 degree gridded data products

Usage

```
ISRaD.extra.geospatial.Zheng(database, geodata_soil_directory)
```

Arguments

database   soilcarbon dataset object

geodata_soil_directory

directory where 0.5 degree geospatial soil and climate data are located

Details

Uses geographic coordinates of profiles (including those filled from site-level coordinates) to extract MAT, MAP, land cover, and soil order at 0.5 degree spatial resolution. These products were derived for global mapping purposes by Yujie He and Zheng Shi. Note: MODIS 0.5 degree land cover (pro_0.5_landCover_MODIS) was reclassified from 16 classes to 10 classes (pro_0.5_landCover) to match observations for He et al. (2016) (doi: 10.1126/science.aad4273)

Value

returns new ISRaD_extra object with extracted 0.5 degree MAT, MAP, land cover, and soil order for every profile

---

ISRaD.flatten   *ISRaD.flatten*

Description

: Joins tables in ISRaD based on linking variables and returns "flat" dataframes

Usage

```
ISRaD.flatten(database, table)
```

Arguments

database   ISRaD dataset object: e.g. ISRaD_data, or ISRaD_extra

table   ISRaD table of interest ("flux", "layer", "interstitial", "fraction", "incubation"). Must be entered with "".

Details

: ISRaD.extra.flatten generates flat files (2 dimensional matrices) for user specified ISRaD tables by joining higher level tables (metadata, site, profile, layer) to lower level tables (layer, fraction, incubation, flux, interstitial).

Value

returns a dataframe with nrow=nrow(table) and ncol=sum(ncol(meta),ncol(site),ncol(profile),...,ncol(table))

Author(s)

: J. Beem-Miller

References

:

Examples

```
ISRaD_full <- ISRaD.getdata(tempdir())
ISRaD_incubation <- ISRaD.flatten(ISRaD_full, "incubation")
```

ISRaD.getdata   *ISRaD.getdata*

Description

ISRaD.getdata

Usage

```
ISRaD.getdata(directory, dataset = "full", extra = F,
  force_download = F)
```

Arguments

directory	location of ISRaD_database_files folder. If not found, it will be created.
dataset	Specify which data you want. Options are c("full", flux","interstitial","incubation","fraction","layer")
extra	T or F. If T, the ISRaD_extra object will be returned. If F, ISRaD_data will be returned. Default is F.
force_download	T or F. If there are already ISRaD_database files in the directory you specify, new data will not be downloaded by default. However, if you set force_downlaod to T, the newest data from github will be downloaded regardless.

Value

ISRaD data object

Examples

```
ISRaD_full <- ISRaD.getdata(tempdir(), dataset = "full", extra = F, force_downlaod = F)
```

ISRaD.save.xlsx   *ISRaD.save.xlsx*

Description

saves data object as xlsx file in ISRaD template format

Usage

```
ISRaD.save.xlsx(database, template_file, outfile)
```

Arguments

database	ISRaD dataset object.
template_file	path and name of template file to use.
outfile	path and name to save the excel file

Author(s)

J Grey Monroe

QAQC   *QAQC*

Description

Check the imported soil carbon dataset for formatting and entry errors

Usage

```
QAQC(file, writeQCreport = F, outfile_QAQC = "", summaryStats = T,
  dataReport = F, checkdoi = T, verbose = T)
```

Arguments

file	directory to data file
writeQCreport	if TRUE, a text report of the QC output will be written to the outfile. Default is FALSE
outfile_QAQC	filename of the output file if writeQCreport==TRUE. Default is NULL, and the outfile will be written to the directory where the dataset is stored, and named by the dataset being checked.
summaryStats	prints summary statistics. Default is TRUE
dataReport	prints list structure of database. Default is FALSE
checkdoi	set to F if you do not want the QAQC check to validate doi numbers
verbose	set to TRUE to print results of function

Details

This function is also called by the online QAQC tool available at the ISRaD website <https://international-soil-radiocarbon-database.ocpu.io/ISRaD/www/>.

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read_Treat2016   *Read in data for Treat 2016.*

Description

Currently doesn't work and is under development

Usage

```
read_Treat2016(download = T, downloadDir = "temp",
  convertedDir = "~/Dropbox/USGS/ISRaD_data/Compilations/Treat/converted/",
  dois_file = "~/Dropbox/USGS/ISRaD_data/Compilations/Treat/dois.csv")
```

Arguments

download	boolean, if T the Treat datasets will be downloaded from pangea. Otherwise, they files in downloadDir will be used.
downloadDir	directory where data files will be downloaded
convertedDir	directory where data files that are converted to ISRaD template will be saved
dois_file	file with doi numbers

Value

writes out files for individual data objects

---

read_YujieHe2016   *Read He 2016*

Description

Read in the data from Yujie He's 2016 Science paper as a raw csv file

Usage

```
read_YujieHe2016(Yujie_file = NULL)
```

Arguments

Yujie_file	The raw csv data

Value

ISRaD compliant file structure with only columns that overlap with original data

---

reports *reports*

Description

generate reports of ISRaD data

Usage

```
reports(database = NULL, report = "count_data")
```

Arguments

database   ISRaD data object

report   Parameter to define which type of report you want. The default is "count_data"
             other options include "entry_stats" and "site_map".

---

rep_count_data *rep_count_data*

Description

generate a count of observations for each level of the database

Usage

```
rep_count_data(database = NULL)
```

Arguments

database   ISRaD data object

---

rep_entry_stats *rep_entry_stats*

Description

generate report of entry statistics

Usage

```
rep_entry_stats(database = NULL)
```

Arguments

database   ISRaD data object

rep_frc_data   *rep_frc_data*

Description

generate a count of fractionation observations including scheme and property

Usage

```
rep_frc_data(database = NULL)
```

Arguments

database   ISRaD data object

rep_site_map   *rep_site_map*

Description

generate a world map with site locations plotted

Usage

```
rep_site_map(database = NULL)
```

Arguments

database   ISRaD data object

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