Package 'MODIS'

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Type Package

Title Acquisition and Processing of MODIS Products

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Description Download and processing functionalities for the Moderate Resolution Imaging Spectroradiometer (MODIS). The package provides automated access to the global online data archives LP DAAC (<https://lpdaac.usgs.gov/>), LAADS (<https://ladsweb.modaps.eosdis.nasa.gov/>) and NSIDC (<https://nsidc.org/>) as well as processing capabilities such as file conversion, mosaicking, subsetting and time series filtering.

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LazyData TRUE

Depends mapdata, R (>= 2.10), raster

Imports bitops, curl, devtools, grDevices, graphics, mapedit, maps, maptools, methods, parallel, ptw, rgdal, rgeos, sf, sp, stats, utils

SystemRequirements GDAL (>= 1.8.0)

ByteCompile TRUE

Encoding UTF-8

RoxygenNote 6.1.1

Suggests testthat

NeedsCompilation no

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MODIS-package *MODIS Acquisition and Processing*

Description

MODIS Acquisition and Processing

Details

Download and processing functionalities for the Moderate Resolution Imaging Spectroradiometer (MODIS). The package provides automated access to the global online data archives (LP DAAC and LAADS) and processing capabilities such as file conversion, mosaicking, subsetting and time series filtering.

Author(s)

Matteo Mattiuzzi, Jan Verbesselt, Tomislav Hengl, Anja Klisch, Forrest Stevens, Steven Mosher, Bradley Evans, Agustin Lobo, Florian Detsch

Maintainer: Florian Detsch <fdetsch@web.de>

aggInterval *Create Periods for Temporal Composites*

Description

The creation of custom temporal aggregation levels (e.g., half-monthly, monthly) from native 16-day MODIS composites usually requires the definition of date sequences based on which the "composite_day_of_the_year" SDS is further processed. Complementing transDate, which returns the respective start and end date only, this function creates full-year (half-)monthly or annual composite periods from a user-defined temporal range.

Usage

```
aggInterval(x, interval = c("month", "year", "fortnight"))
```

Arguments

x	Date object, see eg default value of 'timeInfo' in temporalComposite.
interval	character. Time period for aggregation. Currently available options are "month" (default), "year" and "fortnight" (i.e., every 1st and 15th day of the month).

Value

A `list` with the following slots:

- `$begin`: The start date(s) of each (half-)monthly timestep as `Date` object.
- `$end`: Same for end date(s).
- `$beginDOY`: Similar to `$begin`, but with `character` objects in MODIS-style date format (i.e., "%Y%j"; see `strptime`).
- `$endDOY`: Same for end date(s).

Author(s)

Florian Detsch

See Also

`transDate`.

Examples

```
dates <- do.call("c", lapply(2015:2016, function(i) {
  start <- as.Date(paste0(i, "-01-01"))
  end <- as.Date(paste0(i, "-12-31"))
  seq(start, end, 16)
}))

intervals <- c("month", "year", "fortnight")
lst <- lapply(intervals, function(i) {
  aggInterval(dates, interval = i)
}); names(lst) <- intervals

print(lst)
```

---

arcStats *Get Summary of Local MODIS Data*

Description

In the same manner as `getHdf`, this function quantifies the availability of local MODIS hdf data and gives you an overview (plot or/and table) of locally available MODIS grid hdf files.

Usage

```
arcStats(product, collection = NULL, extent = "global",
  begin = "2000.01.01", end = format(Sys.time(), "%Y.%m.%d"),
  asMap = TRUE, outName = NULL, ...)
```

Arguments

product	character, see getProduct. MODIS grid product to be checked.
collection	character or integer, see getCollection. MODIS product version.
extent	Extent information, defaults to 'global'. See getTile.
begin	character. Begin date of MODIS time series, see transDate.
end	character. End date, defaults to 'Today' expressed in a function.
asMap	Controls output type. Possible options are TRUE (png), FALSE (csv) or 'both'.
outName	character. Name of output file, defaults to 'product.collection.YYYYMMDDHHMMSS.png' (or *.csv) of the function call or, if applicable, 'product.collection.extent.YYYYMMDDHHMMSS.png' (or *.csv).
...	Arguments passed to MODISoptions, most importantly outProj and outDirPath.

Value

An invisible NULL (provably this will change to a matrix-like object similar to the '*.csv' output). If asMap= TRUE, a 'table.csv' and a 'image.png' file(s) in outDirPath.

Author(s)

Matteo Mattiuzzi

Examples

```
## Not run:
# The following examples are expecting that you have some data stored locally!
############################################################
# generates 2 png's and 2 csv's one for TERRA one for AQUA
arcStats(product="M.D13Q1")

# generates 2 png's and 2 csv's one for TERRA one for AQUA with the specified countries.
arcStats(product="M.D13Q1",extent=c("austria","germany","italy"))

# generates 1 png and 1 csv for AQUA.
arcStats(product="MYD13Q1",begin="2005001",outName="MyDataStart2005")

# generates 1 png for AQUA for the selected area and plots it in 'Sinusoidal'.
arcStats(product="MYD13Q1",begin="2005001",asMap=TRUE, outName="InteractiveSelection2005",
         extent=getTile(), outProj="asIn")

# generates 1 png for AQUA for the selected area and plots it in 'Geographic' Coordinates.
arcStats(product="MYD13Q1",begin="2005001",asMap=TRUE, outName="InteractiveSelection2005",
         extent=getTile(), outProj="GEOGRAPHIC")

## End(Not run)
```

delHdf *Delete Local MODIS Grid Files*

Description

Delete MODIS grid files to reduce the local storage.

Usage

```
delHdf(product, collection = NULL, extent = "global", tileV = NULL,
  tileH = NULL, begin = NULL, end = NULL, ask = TRUE, ...)
```

Arguments

product	character, see getProduct.
collection	character or integer, see getCollection.
extent	Extent information, defaults to 'global'. See getTile.
tileH, tileV	numeric or character. Horizontal and vertical tile number, see getTile.
begin, end	Date or character. Begin and end date of MODIS time series, see transDate.
ask	logical. If TRUE (default), the user is being asked for deletion after checking.
...	Arguments passed to MODISoptions, particularly localArcPath.

Author(s)

Matteo Mattiuzzi

Examples

```
## Not run:
# REMOVE "MYD11A2" from specific date range and area subset:
# delHdf(product="MYD11A2",begin="2010001",end="2010.02.01",extent="austria")
# or
# delHdf(product="MYD11A2",begin="2010001",end="2010.02.01",tileV=18:19,tileH=4)

# REMOVE "MOD11A2" and "MYD11A2" from specific date range but globaly:
# delHdf(product="M.D11A2",begin="2010001",end="2010.02.01")

# REMOVE ALL "MOD11A2" from local archive:
# delHdf(product="MOD11A2")

## End(Not run)
```

detectBitInfo *List MODIS Quality Information*

Description

This function returns MODIS QA information for a specific product. It gets the information from an internal database and not all products are available.

Usage

```
detectBitInfo(product, what = "all", warn = TRUE)
```

Arguments

product	character, see getProduct.
what	character. Parameter name, e.g. 'VI Quality' for all MOD13 products (see MODIS Vegetation Index User's Guide, Table 5, Parameter Name).
warn	logical, whether or not to throw warning messages.

Value

If what = "all" a data.frame, else a list.

Author(s)

Matteo Mattiuzzi

Examples

```
detectBitInfo("MOD13Q1")
detectBitInfo("MOD13Q1", "VI usefulness")

detectBitInfo("MYD17A2")
```

EarthdataLogin *Create File with Earthdata Login Credentials*

Description

Create a hidden .netrc file with Earthdata login credentials in your home directory. The information included therein is used to login to urs.earthdata.nasa.gov which is a mandatory requirement in order to download MODIS data from LP DAAC and NSIDC (see also MODISoptions). If .netrc does exists the function can be used to re-enter credentials.

Usage

```
EarthdataLogin(usr = NULL, pwd = NULL)
```

Arguments

usr, pwd	Login credentials as character. If NULL, username and password are read from the terminal.

Value

The invisible Earthdata login credentials as list.

Author(s)

Matteo Mattiuzzi and Florian Detsch

See Also

- http://docs.opendap.org/index.php/DAP_Clients_-_Authentication#LDAP (section 2.2)
- https://github.com/MatMatt/MODIS/issues/10
- https://wiki.earthdata.nasa.gov/display/EL/How+To+Access+Data+With+cURL+And+Wget

Examples

```
## Not run:
EarthdataLogin()

## End(Not run)
```

---

extractBits *Extract Bit-Encoded Information and create Weights Raster*

Description

This function applies bitAnd and bitShiftR from **bitops** to convert bit-encoded information. It is also possible to convert this information to a scale from 0 to 1 in order to use it as weighting information in functions like whittaker.raster or smooth.spline.raster.

Usage

```
extractBits(x, bitShift = 2, bitMask = 15, filename = "",
  datatype = "INT1U", NAflag = 255, ...)

makeWeights(x, bitShift = 2, bitMask = 15, threshold = NULL,
  decodeOnly = FALSE, filename = "", datatype = "INT1U",
  NAflag = 255, ...)

maskWater(X, bitShift = NULL, bitMask = NULL, keep = NULL,
  datatype = "INT1U", NAflag = 255, ...)
```

Arguments

x	matrix, vector or Raster* object.
bitShift	integer. Bit starting point, see examples and detectBitInfo.
bitMask	integer. Bit mask size, see examples and detectBitInfo.
filename	character passed to writeRaster. If not specified, output is written to a temporary file.
datatype	character. Default INT1U used for x = Raster* object.. Output datatype, see writeRaster.
NAflag	integer. Default 255 used for x = Raster* object. Set specific NA value, see writeRaster.
...	Other arguments passed to writeRaster.
threshold	integer. Threshold for valid quality.
decodeOnly	logical. If FALSE (default), convert bits to weights from 0 (not used) to 1 (best quality). If TRUE, only extract selected bits and convert to decimal system.
X	Raster* object.
keep	If NULL (default), bits are only encoded, else an integer vector of values you want to keep (becomes TRUE), the rest becomes NA. See examples.

Value

A Raster* object.

Functions

- extractBits: Extract bit-encoded information from Raster* file
- maskWater: Masks water (additional information required)

Note

makeWeights and extractBits are identical with the only difference that makeWeights does additionally convert the data into weighting information.

Author(s)

Matteo Mattiuzzi

See Also

detectBitInfo.

Examples

```
## Not run:

# example MOD13Q1 see MODIS Vegetation Index User's Guide (MOD13 Series;
# https://lpdaac.usgs.gov/sites/default/files/public/product_documentation/mod13_user_guide.pdf)
# enter in Layers
# See in TABLE 5: Descriptions of the VI Quality Assessment Science Data Sets (QA SDS).
# column 1 (bit) row 2 VI usefulness
bitShift = 2
bitMask = 15 # ('15' is the decimal of the binary '1111')
# or try to use
detectBitInfo("MOD13Q1") # not all products are available!
viu <- detectBitInfo("MOD13Q1","VI usefulness") # not all products are available!
viu

# simulate bit info
bit <- round(runif(10*10,1,65536))

# extract from vector
makeWeights(bit,bitShift,bitMask,decodeOnly=TRUE)
# the same as
extractBits(bit,bitShift,bitMask)

# create a Raster object
VIqual <- raster(ncol=10,nrow=10)
VIqual[] <- bit

# extract from Raster object
a <- makeWeights(VIqual,bitShift,bitMask,decodeOnly=TRUE)

# linear conversion of 0 (0000) to 15 (1111) to 1 fo 0
b <- makeWeights(VIqual,bitShift,bitMask,decodeOnly=FALSE)

threshold=6 # every thing < threshold becomes a weight = 0
c <- makeWeights(VIqual,bitShift,bitMask,threshold,decodeOnly=FALSE)

res <- round(cbind(a[],b[],c[]),2)
colnames(res) <- c("ORIG","Weight","WeightThreshold")
res

#####
# water mask
tif = runGdal(product="MOD13A2",begin="2009001",end="2009001", extent=extent(c(-9,-3 ,54,58)),
              SDSstring="001",job="delme") # 6.4 MB
```

```
x <- raster(unlist(tif))

res1 <- maskWater(x)
plot(res1)

res2 <- maskWater(x,keep=1) # 1 = Land (nothing else)
x11()
plot(res2)

# Land (Nothing else but land) + Ocean coastlines and lake shorelines + shallow inland Water,
# the rest becomes NA
x11()
res3 <- maskWater(x,keep=c(1,2,3))
plot(res3)

###############

# as on Linux you can read HDF4 directly you can also do:
if(.Platform$OS.type=="unix")
{
  x <- getHdf(HdfName="MOD13A2.A2009001.h17v03.005.2009020044109.hdf", wait=0) # 6.4 MB

  detectBitInfo(x) # just info
  getSds(x) # just info

  x <- getSds(x)$SDS4gdal[3] # you need 'VI Quality'
  x  <- raster(x)
  # plot(x)
  # ex <- drawExtent()
  ex <- extent(c(-580779,-200911,5974929,6529959))
  x  <- crop(x,ex) # just for speed-up

  res1 <- maskWater(x)
  plot(res1)

  res2 <- maskWater(x,keep=1) # 1 = Land (Nothing else but land), the rest becomes NA
  x11()
  plot(res2)

  # Land (Nothing else but land) + Ocean coastlines and lake shorelines + shallow inland Water,
  # the rest becomes NA
  res3 <- maskWater(x,keep=c(1,2,3))
  x11()
  plot(res3)
}

## End(Not run)
```

`extractDate` *Extract Dates from (MODIS) Files*

Description

This function helps to extract dates from a vector of files.

Usage

```
extractDate(files, pos1, pos2, asDate = FALSE, format = "%Y%j")
```

Arguments

files	A character vector of filenames from which to extract dates. Alternatively, a Raster* with date information in its layer names.
pos1, pos2	Start and end of date string in files as integer. If missing, positions are tried to be retrieved from a look-up table provided that 'files' comply with the MODIS standard naming convention.
asDate	logical. If TRUE, the result is converted to a Date object.
format	character, date format. Used only if asDate = TRUE. Defaults to MODIS date style (i.e., "%Y%j" for year and julian day). See strptime for modifications.

Value

A list with the following entries: 'inputLayerDates', 'pos1', 'pos2', 'asDate' and, optionally, 'format'. If asDate = FALSE, 'inputLayerDates' are represented as character, else as Date.

Author(s)

Matteo Mattiuzzi

Examples

```
# example on HDF files
files <- c("MOD13Q1.A2010209.h18v03.005.2010239071130.hdf",
           "MOD13Q1.A2010225.h18v03.005.2010254043849.hdf")
extractDate(files)
extractDate(files, asDate = TRUE)

# on any other file
files <- c("Myfile_20010101.XXX", "Myfile_20010115.XXX", "Myfile_20010204.XXX")
extractDate(files, pos1 = 8, pos2 = 15)
extractDate(files, pos1 = 8, pos2 = 15, asDate = TRUE, format = "%Y%m%d")
```

fileSize *Get Size of File(s)*

Description

Function for getting size of any files.

Usage

```
fileSize(file, units = "B")
```

Arguments

file	character vector of file(s) with path.
units	character, defaults to "B". Currently available options are "B", "KB", "MB", "GB" or "TB" for bites, kilo-, mega-, giga- and terabytes.

Value

numeric vector of the same length as file (in units). Note that directories are excluded.

Author(s)

Matteo Mattiuzzi

Examples

```
## Not run:
fileSize(list.files("./"))

## End(Not run)
```

genTile *Generate Global Tiling System*

Description

This function generates a matrix with bounding box information for a global tiling system (based on Lat/Lon).

Usage

```
genTile(tileSize = 1, offset = 0, StartNameFrom = c(0, 0),
  extent = list(xmin = -180, xmax = 180, ymin = -90, ymax = 90))
```

Arguments

tileSize	numeric, size of a single tile in degrees (EPSG:4326).
offset	numeric, shifts the tiling system in upper-left direction.
StartNameFrom	numeric. c(Lat-Direction,Lon-Direction) start number in the naming of the tiles.
extent	list. Tile system extent information, basically the coverage of the data on server.

Value

A matrix.

Author(s)

Matteo Mattiuzzi

See Also

getTile.

Examples

```
# 1x1 degree tiling system
e1 <- genTile()
head(e1)

# 10x10 degree tiling system with offset to be aligned to Geoland2 Dataset
e2 <- genTile(tileSize = 10, offset = (1/112) / 2)
head(e2)

# Tiling system for SRTMv4 data (CGIAR-CSI)
e3 <- genTile(tileSize = 5, StartNameFrom = c(1, 1),
              extent = list(xmin = -180, xmax = 180, ymin = -60,ymax = 60))
head(e3)
```

---

getCollection *Get Available Collections of MODIS Product(s)*

Description

Checks and retrieves available MODIS collection(s) for a given product.

Usage

```
getCollection(product, collection = NULL, newest = TRUE,
  forceCheck = FALSE, as = "character", ...)
```

Arguments

product	character. MODIS grid product to check for existing collections, see getProduct.
collection	character or integer. If provided, the function only checks if the specified collection exists and returns the collection number formatted based on the as parameter or FALSE if it doesn't exists. The check is performed on LP DAAC as the exclusive source for several products or, for snow cover (MOD/MYD10) and sea ice extent (MOD/MYD29), NSIDC.
newest	logical. If TRUE (default), return only the newest collection, else return all available collections.
forceCheck	logical, defaults to FALSE. If TRUE, connect to the 'LP DAAC' or 'NSIDC' server and get available collections, of which an updated version is permanently stored in MODIS:::combineOptions()$auxPath.
as	character, defaults to 'character' which returns the typical 3-digit collection number (i.e., "005"). as = 'numeric' returns the result as numeric (i.e., 5).
...	Additional arguments passed to MODISoptions. Permanent settings for these arguments are temporarily overridden.

Value

A 3-digit character or numeric object (depending on 'as') or, if length(product) > 1, a list of such objects with each slot corresponding to the collection available for a certain product. Additionally, a text file in a hidden folder located in getOption("MODIS_localArcPath") as database for future calls. If 'collection' is provided, only the (formatted) collection (or FALSE if it could not be found) is returned.

Author(s)

Matteo Mattiuzzi, Florian Detsch

See Also

getProduct.

Examples

```
## Not run:

# update or get collections for MCD12C1 and MCD12Q1
getCollection(product = "MCD12.*")
getCollection(product = "MCD12.*", newest = FALSE)
getCollection(product = "MCD12.*", forceCheck = TRUE)

## End(Not run)
```

getHdf *Create or Update Local Subset of Online MODIS Data Pool*

Description

Create or update a local user-defined subset of the global MODIS grid data archive. Based on user-specific parameters the function checks in the local archive for available data and downloads missing data from the online MODIS data pool. When run in a schedule job, the function manage the continuous update of the local MODIS data archive.

Usage

```
## S4 method for signature 'character'
getHdf(product, HdfName, begin = NULL,
  end = NULL, tileH = NULL, tileV = NULL, extent = NULL,
  collection = NULL, checkIntegrity = TRUE, forceDownload = TRUE,
  ...)

## S4 method for signature 'missing'
getHdf(HdfName, checkIntegrity = TRUE, ...)
```

Arguments

product	character. MODIS grid product to be downloaded, see getProduct. Use dot notation to address Terra and Aqua products (e.g. M.D13Q1).
HdfName	character vector or list. Full HDF file name(s) to download a small set of files. If specified, other file-related parameters (i.e., begin, end, collection, etc.) are ignored.
begin, end	Date or character. Begin and end date of MODIS time series, see transDate.
tileH, tileV	numeric or character. Horizontal and vertical tile number, see getTile.
extent	See Details in getTile.
collection	Desired MODIS product collection as character, integer, or list as returned by getCollection.
checkIntegrity	logical. If TRUE (default), the size of each downloaded file is checked. In case of inconsistencies, the function tries to re-download broken files.
forceDownload	logical. If TRUE (default), try to download data irrespective of whether online information could be retrieved via MODIS:::getStruc or not.
...	Further arguments passed to MODISoptions, eg 'wait'.

Value

An invisible vector of downloaded data and paths.

Author(s)

Matteo Mattiuzzi

References

MODIS data is currently available from the online data pools at

- NASA Land Processes Distributed Active Archive Center (LP DAAC),
- Level-1 and Atmosphere Archive & Distribution System (LAADS), and
- National Snow & Ice Data Center (NSIDC).

Examples

```
## Not run:
# One or more specific file (no regular erpression allowed here)
a <- getHdf(HdfName = c("MYD11A1.A2009001.h18v04.006.2015363221538.hdf",
                        "MYD11A1.A2009009.h18v04.006.2015364055036.hdf",
                        "MYD11A1.A2009017.h18v04.006.2015364115403.hdf"))
a

# Get all MODIS Terra and Aqua M*D11A1 data from 1 December 2016 up to today
# (can be ran in a sceduled job for daily archive update)
b1 <- getHdf(product = "M.D11A1", begin = "2016.12.01",
             tileH = 18:19, tileV = 4)
b1

# Same tiles with a 'list' extent
Austria <- list(xmax = 17.47, xmin = 9.2, ymin = 46.12, ymax = 49.3)
b2 <- getHdf(product = "M.D11A1", begin = "2016336", extent = Austria)
b2

# Using country boarders from 'mapdata' package
c <- getHdf(product = "M.D11A1", begin = "2016306", end = "2016335",
            extent = "Luxembourg")
c

# Interactive selection of spatial extent, see getTile()
d <- getHdf(product = "M.D11A1", begin = "2016306", end = "2016307")
d

## End(Not run)
```

`getProduct` *Check and Create Product-Related Information*

Description

On user side, it is a funtion to find the desidered product. On package site, it generates central internal information to hande files.

Usage

```
getProduct(x = NULL, quiet = FALSE, ...)
```

Arguments

x	character. MODIS filename, product name, regular expression passed to pattern in grep, or missing.
quiet	logical, defaults to FALSE.
...	Additional arguments passed to getCollection.

Value

If 'x' is missing, a data.frame with information about all MODIS products available. In case of character input, an invisible MODISproduct-class or MODISfile-class object depending on the type of input (product/regular expression or filename); the object holds information usable by other functions.

Author(s)

Matteo Mattiuzzi and Florian Detsch

Examples

```
getProduct() # list available products

# or use regular expression style
getProduct("M.D11C3")
getProduct("M*D11C")

# or get information about specific product
internal_info <- getProduct("MOD11C3", quiet = TRUE)
internal_info

# or use a valid filename
fileinfo <- getProduct("MYD11A1.A2009001.h18v04.006.2015363221538.hdf")
fileinfo
```

---

getSds *List SDS Layers in an .HDF File*

Description

This function lists the names of all scientific datasets (SDS) contained in a specified MODIS grid HDF file.

Usage

```
getSds(HdfName, SDSstring = NULL, method = "gdal")
```

Arguments

HdfName	character. (Absolute) filename from which to extract SDS names.
SDSstring	character, see Value.
method	character, defaults to "gdal". Caution: on Windows, the default 'GDAL' installation doesn't support HDF4 files. Install 'FWTools' or use method = "mrt" instead.

Value

A list or character. If SDSstring is provided, the function reports extracted SDS and a formatted SDSsting (e.g., "11101"). If not provided, the SDS names in HdfName are returned. Consult the MRT manual for details.

Author(s)

Matteo Mattiuzzi

Examples

```
## Not run:
getSds(HdfName="XXX.hdf")
getSds(HdfName="/path/XXX.hdf",method="gdal") # require GDAL (FWTools on Windows)
getSds(HdfName="/path/XXX.hdf",method="mrt") # require MRTool

## End(Not run)
```

---

getTile *Get MODIS Tile ID(s)*

Description

Get MODIS tile ID(s) for a specific geographic area.

Usage

```
getTile(x, tileH = NULL, tileV = NULL, mode = c("click", "draw"),
  ...)
```

Arguments

x	Extent information, see Details. Ignored if tileH and tileV are specified.
tileH, tileV	numeric or character. Horizontal and vertical tile number(s) of the MODIS Sinusoidal grid (e.g., tileH = 1:5). If specified, no cropping is performed and the full tile(s) (if more than one then also mosaicked) is (are) processed!

mode	Interactive selection mode as character. Available options are "click" (default) and "draw" that trigger interactive MODIS tile selection and free feature drawing, respectively. Ignored if any of 'x' or 'tileH,tileV' is NOT missing.
...	Additional arguments passed to MODISoptions. Here, only 'outProj' and 'pixelSize' are relevant, and this only if 'x' is an object of class character, map, Extent or bbox.

Details

If x is of class (see Examples for use cases)

missing:
: If 'tileH,tileV' are specified, 'x' will be ignored. If no such tile indices are provided and 'x' is missing, a viev

character:
: Either the country name of a map object (see map) or a valid file path of a raster image or ESRI shapefile (shp

Raster*:
: Spatial extent, resolution, and projection of the specified Raster* are determined automatically. This inform

Extent, bbox:
: Boundary coordinates from Extent and bbox objects are assumed to be in EPSG:4326 as such objects have r

Other:
: Spatial, sf, or map object.

Value

A MODISextent object.

Note

MODIS does no longer support the tile identification and automated download of MERIS and SRTM data. At least as far as the latter is concerned, easy data access is granted through getData.

Author(s)

Matteo Mattiuzzi, Florian Detsch

See Also

extent, st_bbox, map, search4map.

Examples

```
## Not run:
# ex 1 #############
# interactive tile selection
getTile()
```

```
## End(Not run)

# ex 2: Spatial (taken from ?rgdal::readOGR) ############
dsn <- system.file("vectors/Up.tab", package = "rgdal")[1]
Up <- rgdal::readOGR(dsn, "Up")
getTile(Up)

# ex 3: sf ############
ifl <- system.file("shape/nc.shp", package = "sf")
nc <- sf::st_read(ifl, quiet = TRUE)
getTile(nc)

# ex 4: tileH,tileV ############
getTile(tileH = 18:19, tileV = 4)

# ex 5: Raster* with valid CRS ############
rst1 <- raster(xmn = 9.2, xmx = 17.47, ymn = 46.12, ymx = 49.3)
getTile(rst1)

# this also works for projected data
rst3 <- projectExtent(rst1, crs = "+init=epsg:32633")
getTile(rst3)

# ex 6: Raster* without CRS or, alternatively, Extent or bbox --> treated as EPSG:4326 ############
mat2 <- matrix(seq(180 * 360), byrow = TRUE, ncol = 360)
rst2 <- raster(mat2, xmn = -180, xmx = 180, ymn = -90, ymx = 90)
getTile(rst2)
getTile(extent(rst1))
getTile(sf::st_bbox(nc))

# ex 7: map names as returned by search4map() ############
getTile("Austria")
getTile(c("Austria", "Germany"))

# or search for specific map name patterns (use with caution):
m1 <- search4map("Per")
getTile(m1)

# or use 'map' objects directly (remember to use map(..., fill = TRUE)):
m2 <- map("state", region = "new jersey", fill = TRUE)
getTile(m2)
```

`minorFuns` *Minor MODIS Package Functions*

Description

Compendium of minor **MODIS** package-related functions.

Usage

```
search4map(pattern = "", database = "worldHires", plot = FALSE)
```

Arguments

pattern	Regular expression passed to grep.
database	character. Defaults to "worldHires", see map for available options.
plot	logical, defaults to FALSE. If TRUE, search results are displayed.

Value

A list of length 2. The first entry is the call to create the given map, whereas the second entry represents the names of areas within the search.

Functions

- search4map: Simplifies search for **mapdata**-based extents

Author(s)

Matteo Mattiuzzi

See Also

getTile, map, grep.

Examples

```
search4map()

search4map(pattern="USA",plot=TRUE)
search4map(database="state",plot=TRUE)

search4map(database="italy",pattern="Bolz",plot=TRUE)

search4map(pattern="Sicily",plot=TRUE)
```

MODISextent-class *Class MODISextent*

Description

An object of class MODISextent, typically created through getTile.

Slots

tile MODIS tile ID as character.

tileH MODIS horizontal tile ID as integer.

tileV MODIS vertical tile ID as integer.

extent Extent information, see getTile.

system Sensor system as character.

target If applicable, a list with additional target information.

MODISfile-class *Class MODISfile*

Description

An object of class MODISfile, typically created through getProduct when the 'x' input is a MODIS filename.

Slots

request User request as character.

PRODUCT MODIS product identified from 'request' as character.

DATE Acquisition date string in the form "A%Y%j" (see strptime and HDF filename convention).

TILE Tile string in the form "hXXvXX".

CCC MODIS data collection as 3-digit character.

PROCESSINGDATE Processing date string in the form "%Y%j%H%M%S" (see strptime).

FORMAT File format as character.

SENSOR Statically set to "MODIS".

PLATFORM Satellite platform on which MODIS sensor is mounted; one of c("Terra", "Aqua").

PF1,PF2,PF3,PF4 Platform specific path feature for LP DAAC, LAADS, NTSG and NSIDC as character.

TOPIC Product topic as character.

TYPE Product type; one of c("Tile", "CMG", "Swath").

SOURCE Product specific MODIS download server(s) as named list.

POS1,POS2 Default start and end index of date string in MODIS filename, usually c("10", "16").

MODISoptions *Set or Retrieve Permanent MODIS Package Options*

Description

Set or retrieve persistant **MODIS** package options (per user or systemwide). Changes here will persist through sessions and updates.

Usage

```
MODISoptions(localArcPath, outDirPath, pixelSize, outProj, resamplingType,
  dataFormat, gdalPath, MODISserverOrder, dlmethod, stubbornness, wait,
  quiet, cellchunk, systemwide = FALSE, save = TRUE,
  checkTools = TRUE, checkWriteDrivers = TRUE, ask = TRUE)
```

Arguments

localArcPath	character, defaults to file.path(tempdir(), "MODIS_ARC"). Target folder for downloaded MODIS HDF files.
outDirPath	character, defaults to file.path(tempdir(), "MODIS_ARC/PROCESSED"). Target folder for results of runGdal and runMrt.
pixelSize	Output pixel size (in target reference system units) passed to runGdal and runMrt, defaults to "asIn".
outProj	Target reference system passed to runGdal and runMrt. runGdal requires a valid CRS. As for runMrt, please consult the MRT manual. Since the two pocessing methods do not have common methods, it is suggested to stick with the default settings (see Details).
resamplingType	Defaults to "NN" (Nearest Neightbour). MRT and GDAL both support c('NN', 'CC', 'BIL'). In addition, GDAL supports cubicspline and lanczos and, from GDAL >= 1.10.0 onwards, also mode and average.
dataFormat	character, defaults to "GTiff". One of getOption("MODIS_gdalOutDriver") (column 'name').
gdalPath	character. Path to gdal bin directory and more relevant for Windows users. Use MODIS:::checkTools("GDAL") to try to detect it automatically.
MODISserverOrder	character. Possible options are "LAADS" (default) and "LPDAAC" (see 'dlmethod' and 'Details'). If only one server is selected, all efforts to download data from the second server available are inhibited.
dlmethod	character, defaults to auto. See 'method' in download.file. On Unix (also Mac?), it is suggested to use "wget" or, if installed, "aria2" (supports multi source download). In order to download MODIS files from LP DAAC and NSIDC, please note that either wget (default) or curl must be installed and made available through the PATH environmental variable.

stubbornness	numeric. The number of retries after the target server has refused a connection. Higher values increase the chance of getting the file, but also lead to hanging functions if the server is down.
wait	numeric waiting time (in seconds) inserted after each internal online download call via download.file or curl. Reduces the chance of connection errors that frequently occur after many requests.
quiet	logical passed eg to download.file which is called from inside getHdf.
cellchunk	Default 1 (=use raster default), comparable with chunksize in rasterOptions. But as no effect was found in adapting chunksize, MODIS applies its own variant: **minrows <- max(floor(cellchunk/ncol(x)),1) blockSize(x,minrows=minrows)**. On a reasonable working station you can easily increase cellchunk to 500000.
systemwide	A logical determining whether changes made to MODISoptions are to be applied system or user-wide (default), see 'Details'.
save	logical. If TRUE (default), settings are permanent.
checkTools	logical, defaults to TRUE. Check if external tools (i.e., GDAL and MRT) are installed and reachable through R.
checkWriteDrivers	logical. If TRUE (default), find write drivers supported by local GDAL installation.
ask	logical. If TRUE (default) and permanent settings file does not exist (see Details), the user is asked whether to create it.

Details

These settings are easy to change and take effect immediately! However, please mind that the CRAN Repository Policy does not permit automated write access to the user's file system exempt for tempdir. Therefore, changes made to MODISoptions remain temporally limited to the current R session unless write access is explicitly granted by the user in interactive mode, in which case a permanent settings file is created in file.path("~/.MODIS_Opts.R") (user-wide) or file.path(R.home(component = "etc" (system-wide, write access provided).

Due to similar reasons, 'localArcPath' and 'outDirPath' default to R's tempdir and should be changed immediately after loading the package in order to make downloaded files permanently available. You may also specify a shared network drive if you have a central MODIS data server.

If you change default values, consider that your settings have to be valid for any MODIS product, layer and area!

It is not recommended to use

- a coordinate reference system that is not applicable globally as default for 'outProj',
- or a fixed 'pixelSize' for different products,
- or a 'resamplingType' that is not "NN".

On Windows, you have to set 'gdalPath' to the location of GDAL executables (i.e., the '.../GDAL../bin' directory). On Unix-alikes, this should not be required unless you want to specify a non-default GDAL installation.

On an unixoid OS, it is suggested to use dlmethod = 'wget' because it is a reliable tool and, after the change of the 'LP DAAC' datapool from FTP to HTTP (May 2013), dlmethod = 'auto'

seems not to work properly. On Windows, on the other hand, `dlmethod = 'auto'` seems to work fine.

Please note that in order to download MODIS files from LP DAAC and NSIDC, you are required to register for an Earthdata Login Profile (https://urs.earthdata.nasa.gov/users/new) and create a read-only .netrc file in your home directory containing the Earthdata server address as well as your login credentials. An automated solution for the creation of a workable .netrc file is provided through `EarthdataLogin`.

Value

An invisible `list` of **MODIS** options. In addition, the most relevant of these options are printed to the console. Use `capture.output` to prevent this behavior.

Author(s)

Matteo Mattiuzzi, Steven Mosher and Florian Detsch

Examples

```
## Not run:
## get options
MODISoptions()

## set options
lap = "/another/path/to/MODIS_ARC" # 'localArcPath'
odp = file.path(lap, "PROCESSED")  # 'outDirPath'

MODISoptions(localArcPath = lap, outDirPath = odp)

## End(Not run)
```

`MODISproduct-class` *Class MODISproduct*

Description

An object of class `MODISproduct`, typically created through `getProduct` when the 'x' input is a MODIS product or regular expression.

Slots

`request` User request as `character`.

`PF1,PF2,PF3,PF4` Platform specific path feature for LP DAAC, LAADS, NTSG and NSIDC as `character`.

`PD` Product specific code number following the platform specifier, e.g. `"13A1"` for MOD13A1.

`PLATFORM` Satellite platform on which MODIS sensor is mounted; one of `c("Terra", "Aqua")`.

TYPE Product type; one of c("Tile", "CMG", "Swath").

PRODUCT MODIS product identified from 'request' as character.

SENSOR Statically set to "MODIS".

SOURCE Product specific MODIS download server(s) as named list.

CCC Product specific MODIS data collection(s) stored as 3-digit character objects in a named list.

---

orgStruc *Reorganise MODIS Files in Local Data Archive*

Description

Re-organise the storage structure of your MODIS archive according to the settings in options("MODIS_arcStructure"). Depending on the specified 'source' , you can also use this function to gather all MODIS grid files on you computer and reorganise them. The main purpose is to organise the archive, but it is also possible to copy a subset of files to a desidered location!

Usage

```
orgStruc(from, to, structure, pattern, move = FALSE, quiet = FALSE)
```

Arguments

from	character. Local path to look for MODIS files, defaults to options("MODIS_localArcPath") (see MODISoptions).
to	character. Target folder to move (or copy) MODIS files to, defaults to options("MODIS_localArcPath
structure	character. Storage structure, defaults to options("MODIS_arcStructure") (see Examples).
pattern	Regular expression passed to list.files. Insert a pattern if you want to extract specific files from your archiv.
move	logical. If TRUE (default), files are moved and duplicated files are deleted. If FALSE, files are just copied and thus remain in the origin folder. Note that the copying process performs rather slowly when dealing with large files, e.g. 250-m 'MOD13Q1'.
quiet	logical, defaults to FALSE.

Value

If quiet = FALSE, information on how many files have been moved (or copied) and deleted is printed to the console.

Author(s)

Matteo Mattiuzzi

Examples

```
## Not run:
# MOVE all MODIS grid data to the directory and structure as defined in
# options("MODIS_localArcPath", "MODIS_arcStructure")
orgStruc(move = TRUE)

# COPY all MOD13Q1 from 2001 to folder "MyFiles/MOD13Q1.collection/"
orgStruc(pattern="MOD13Q1.A2001*.",to="MyFiles",structure="PRODUCT.CCC")

# COPY all MOD13Q1 to folder "MyFiles/"
orgStruc(pattern="MOD13Q1.*.",to="MyFiles",structure="")

## End(Not run)
```

`orgTime` *Handle Input and Output Dates Used for Filtering*

Description

This function lets you define the period to be filtered, the output temporal resolution, and select the required data from your input 'files'.

Usage

```
## S4 method for signature 'character'
orgTime(files, nDays = "asIn", begin = NULL,
  end = NULL, pillow = 75, pos1, pos2, format = "%Y%j")

## S4 method for signature 'Date'
orgTime(files, nDays = "asIn", begin = NULL,
  end = NULL, pillow = 75)

## S4 method for signature 'Raster'
orgTime(files, nDays = "asIn", begin = NULL,
  end = NULL, pillow = 75, pos1, pos2, format = "%Y%j")
```

Arguments

`files`	A `character`, `Date`, or `Raster*` object. Typically MODIS filenames created e.g. from `runGdal` or `runMrt`, but any other filenames holding date information are supported as well. If a `Raster*` object is supplied, make sure to adjust 'pos1', 'pos2', and 'format' according to its layer `names`.
`nDays`	Time interval for output layers. Defaults to `"asIn"` that includes the exact input dates within the period selected using `begin` and `end`. Can also be `nDays = "1 month"` or `"1 week"`, see `seq.Date` and Examples.
`begin`	`character`. Output begin date, defaults to the earliest input dataset.

end character. Output end date, defaults to the latest input dataset. Note that the exact end date depends on begin and nDays.

pillow integer. Number of days added to the beginning and end of a time series.

pos1, pos2, format
Arguments passed to extractDate.

Value

A list with the following slots (to be completed):

- $inSeq
- $outSeq
- $inDoys
- $inputLayerDates
- $outputLayerDates
- $call

Author(s)

Matteo Mattiuzzi, Florian Detsch

See Also

seq.Date.

Examples

```
# Using MODIS files
files <- c("MOD13A2.A2010353.1_km_16_days_composite_day_of_the_year.tif",
           "MOD13A2.A2011001.1_km_16_days_composite_day_of_the_year.tif",
           "MYD13A2.A2010361.1_km_16_days_composite_day_of_the_year.tif",
           "MYD13A2.A2011009.1_km_16_days_composite_day_of_the_year.tif")

orgTime(files)
orgTime(files,nDays=2,begin="2010350",end="2011015")

# Using other files, e.g. from AVHRR GIMMS NDVI (Jul 1981 to Dec 1982)
## Not run:
library(gimms)

files.v1 <- system.file("extdata/inventory_ecv1.rds", package = "gimms")
files.v1 <- readRDS(files.v1)[1:3]
dates.v1 <- monthlyIndices(files.v1, timestamp = TRUE)

orgTime(dates.v1)

## End(Not run)
```

preStack *Organise (MODIS) Files in Preparation for Stacking*

Description

This function lets you sort a vector of filenames according to date. It is thought to be used on results from `runGdal` or `runMrt`.

Usage

```
preStack(pattern = "*", path = "./", files = NULL, timeInfo = NULL)
```

Arguments

`pattern`	Regular expression passed to `list.files`
`path`	`character`. Location of MODIS files to stack.
`files`	`character` vector of filenames. If provided, arguments `pattern` and `path` are ignored.
`timeInfo`	Ouput from `orgTime`.

Value

A `character` vector of filenames within the query. If `timeInfo` is provided, filenames are sorted and subsetted by date.

Author(s)

Matteo Mattiuzzi

Examples

```
# see Examples in ?smooth.spline.raster
```

reformatDOY *Reformat MODIS "composite_day_of_the_year" SDS*

Description

In order to create custom temporal aggregation levels (e.g., half-monthly, monthly) from native 16-day MODIS composites, a convenient representation of the pixel-wise acquisition date is urgently required. Since the MODIS "composite_day_of_the_year" SDS merely includes the day of the year (DOY), but not the year itself, this function creates complete date information from both the respective MODIS layer name and the pixel-wise DOY information.

Usage

```
reformatDOY(x, cores = 1L, ...)
```

Arguments

x	character or Raster*. MODIS "composite_day_of_the_year" layer(s).
cores	integer. Number of cores for parallel processing.
...	Additional arguments passed to extractDate.

Value

A Raster* object.

Author(s)

Florian Detsch

See Also

repDoy.

Examples

```
## Not run:
tfs = runGdal("MOD13Q1", collection = "006",
              begin = "2000353", end = "2000366", extent = "Luxembourg",
              job = "reformatDOY", SDSstring = "000000000010")

## raw doy
raw <- raster(unlist(tfs))
unique(raw[])

## reformatted dates
rfm <- reformatDOY(raw)
unique(rfm[])

## End(Not run)
```

---

repDoy *Repair MODIS "composite_day_of_the_year" SDS*

Description

Currently works only for MODIS 16 days composites! In MODIS composites, the Julian dates inside the 'composite_day_of_the_year' SDS are referring always to the year they are effectively in. The problem is that the layer/SDS name from the last files from Terra and Aqua within a year can include dates from the following year and so starting again with 1. The problem occurs if you want to sort values of a time series by date (e.g. for precise time series functions). This function generates a sequential vector beginning always with the earliest SDS/layer date and ending with the total sum of days of the time serie length.

Usage

```
repDoy(pixX, layerDate = NULL, bias = 0)
```

Arguments

pixX	matrix of values, usually derived from as.matrix.
layerDate	If NULL (default), try to autodetect layer dates. If you want to be sure, use the result from extractDate or orgTime.
bias	integer. Bias applied to all values in pixX.

Value

A matrix with sequential Julian dates.

Author(s)

Matteo Mattiuzzi

Examples

```
## Not run:
tfs <- runGdal(product="M.D13A2", begin="2010350", end="2011016"
               , extent="Luxembourg", job="deleteme", SDSstring="100000000010")

ndviFiles <- grep("NDVI.tif$", unlist(tfs, use.names = FALSE), value = TRUE)
ndviFiles <- preStack(files = ndviFiles, timeInfo = orgTime(ndviFiles))
ndvi <- stack(ndviFiles)

doyFiles <- grep("composite_day_of_the_year.tif$"
                 , unlist(tfs, use.names = FALSE), value = TRUE)
doyFiles <- preStack(files = doyFiles, timeInfo = orgTime(doyFiles))
doy <- stack(doyFiles)

layerDates <- extractDate(doyFiles)

pixX <- 169

y <- ndvi[pixX]
print(x1 <- doy[pixX])
print(x2 <- repDoy(x1,layerDates))
```

```
# the plotting example is not really good.
# To create a figurative example it would be necessary to dolwnload to much data!
plot("",xlim=c(1,max(x1,x2)),ylim=c(0,2000),xlab="time",ylab="NDVI*10000")
lines(y=y,x=x1,col="red",lwd=3)
lines(y=y,x=x2,col="green",lwd=2)

# repDoy function is thought to be embedded in something like that:
tr <- blockSize(ndvi)

doyOk <- brick(doy)
doyOk <- writeStart(doyOk, filename='test.tif',  overwrite=TRUE)

for (i in 1:tr$n)
{
  pixX  <- getValues(doy,tr$row[i],tr$nrows[i])
  ok    <- repDoy(pixX,layerDates)
  doyOk <- writeValues(x=doyOk,v=ok,start=tr$row[i])
}
doyOk <- writeStop(doyOk)

unlink(filename(doyOk))

## End(Not run)
```

---

runGdal *Process MODIS HDF with GDAL*

Description

Downloads MODIS grid data from archive (HTTP or local) and processes the files.

Usage

```
runGdal(product, collection = NULL, begin = NULL, end = NULL,
  extent = NULL, tileH = NULL, tileV = NULL, SDSstring = NULL,
  job = NULL, checkIntegrity = TRUE, forceDownload = TRUE,
  overwrite = FALSE, maskValue = NULL, ...)
```

Arguments

product	character, see getProduct.
collection	character or integer, see getCollection.
begin, end	Date or character. Begin and end date of MODIS time series, see transDate.
extent	Extent information, defaults to 'global'. See getTile.
tileH, tileV	numeric or character. Horizontal and vertical tile number, see getTile.
SDSstring	character, see getSds.

job	character. Name of the current job for the creation of the output folder. If not specified, it is created in 'PRODUCT.COLLECTION_DATETIME'.
checkIntegrity	logical, see getHdf.
forceDownload	logical, see getHdf.
overwrite	logical, defaults to FALSE. Determines whether or not to overwrite existing SDS output files.
maskValue	numeric. Value to be excluded when resampling (via gdalwarp -srcnodata argument). This allows non-data values, for example water, to be ignored and thus not effect the final data. NOTE: this argument will be ignored if the original SDS has a No Data value defined.
...	Additional arguments passed to MODISoptions, e.g. 'wait'. Permanent settings for these arguments are temporarily overridden.

Details

outProj	CRS/ prj4 or EPSG code of output, any format supported by gdal see examples. Default is 'asIn' (no warping). See ?MODISoptions.
pixelSize	Numeric single value. Output pixel size in target reference system unit. Default is 'asIn'. See ?MODISoptions.
resamplingType	Character. Default is 'near', can be one of: 'bilinear', 'cubic', 'cubicspline', 'lanczos'. See ?MODISoptions.
blockSize	integer. Default NULL that means the stripe size is set by GDAL. Basically it is the "-co BLOCKYSIZE=" parameter. See: http://www.gdal.org/frmt_gtiff.html
compression	logical. Default is TRUE, compress data with the lossless LZW compression with "predictor=2". See: http://www.gdal.org/frmt_gtiff.html
dataFormat	Data output format, see getOption("MODIS_gdalOutDriver") column 'name'.
localArcPath	Character. See ?MODISoptions. Local path to look for and/or to download MODIS files.
outDirPath	Character. See ?MODISoptions. Root directory where to write job folder.

runGdal uses numerous **MODIS** functions under the hood, see the linked functions in 'Arguments' for details and inputs.

If extent is a Raster* object, the output has exactly the same extent, pixel size, and projection.
If extent is a **sp** or **sf** object, the output has exactly the same extent and projection except for point geometries with *length = 1* (ie. a single point) where only the projection is inherited.
If tileH and tileV are used (instead of extent) to define the area of interest, and outProj and pixelSize are 'asIn', the result is only converted from multilayer-HDF to dataFormat, default "GeoTiff" (MODISoptions).

Value

A list of the same length as 'product'. Each product slot either holds a sub-list of processed dates which, for each time step, include the corresponding output files as character objects or, if

no files could be found for the specified time period, a single NA.

Note

You need to have a GDAL installed on your system!
http://www.gdal.org/gdal_utilities.html

On Unix-alikes, install 'gdal-bin' (i.e. Ubuntu: 'sudo apt-get install gdal-bin')
On Windows, you need to install GDAL through OSGeo4W (http://trac.osgeo.org/osgeo4w/) or FWTools (http://fwtools.maptools.org/) since the standard GDAL does not support HDF4 format.

Author(s)

Matteo Mattiuzzi, Florian Detsch

See Also

getHdf, runMrt.

Examples

```
## Not run:
# LST in Austria
runGdal( product="MOD11A1", extent="austria", begin="2010001", end="2010005", SDSstring="101")

# LST with interactiv area selection
runGdal( product="MOD11A1", begin="2010001", end="2010005", SDSstring="101")

### outProj examples
# LST of Austria warped to UTM 34N (the three different possibilites to specify "outProj")
# to find am EPSG or prj4 you may use: prj <- make_EPSG() See
runGdal( job="LSTaustria", product="MOD11A1", extent="Austria", begin="2010001", end="2010005",
         SDSstring="101", outProj="EPSG:32634")

runGdal( job="LSTaustria", product="MOD11A1", extent="Austria", begin="2010001", end="2010005",
         SDSstring="101", outProj="32634")

runGdal( job="LSTaustria", product="MOD11A1", extent="Austria", begin="2010001", end="2010005",
       SDSstring="101", outProj="+proj=utm +zone=34 +ellps=WGS84 +datum=WGS84 +units=m +no_defs")

### resamplingType examples
runGdal( job="LSTaustria", product="MOD11A1", extent="Austria", begin="2010001", end="2010005",
         SDSstring="1", resamplingType="lanczos", outProj="32634", pixelSize=100)

### processing entire tiles and keeping Sinusoidal projection
# This corresponds to a format conversion (eos-hdf04 to Geotiff) and
# layer extraction (multi-layer to single layer)
runGdal( job="LSTaustria", product="MOD11A1", tileH=18:19,tileV=4, begin="2010001", end="2010005",
         SDSstring="1", outProj="asIn")
```

```
## End(Not run)
```

---

runMrt *Run MODIS Reprojection Tool*

Description

Specifying input parameters, this function gets MODIS grid data from the archive (HTTP or local) and processes it with the MODIS Reprojection Tool (MRT). At any point, you are highly encouraged to consult the MRT User's Manual for further information.

Usage

```
runMrt(product, collection = NULL, begin = NULL, end = NULL,
  extent = NULL, tileH = NULL, tileV = NULL, SDSstring = NULL,
  job = NULL, datum = "NODATUM", zone = NULL, projPara = NULL,
  mosaic = TRUE, anonym = TRUE, ...)
```

Arguments

product, collection, begin, end, extent, tileH, tileV, SDSstring, job	See runGdal and functions linked therein.
datum	The output datum used for datum conversion as character, defaults to "NODATUM". Supported datums are "NAD27", "NAD83", "WGS66", "WGS72" and "WGS84", see MRT User's Manual, p. 7-8.
zone	Output zone number as integer, relevant only for UTM projections (i.e., outProj = "UTM". Valid values are 60 to +60.
projPara	Output projection parameters as character string, see 'Details'. Ignored if outProj %in% c("SIN", "GEO"). If not specified and using another target projection, the default settings for "GEO" are assumed.
mosaic	A logical that toggles mosaicking on (default) or off. One example where mosaic = FALSE makes sense is for large spatial extents because maximum supported HDF4 filesize is 2GB; if crossed, mosaicking will fail.
anonym	A logical, defaults to TRUE. If FALSE, the job name is appended to the root filename.
...	Additional arguments passed to MODISoptions, see also 'Details' for some MRT specific settings.

Details

Please note that in contrast to runGdal, MRT's resample function does not offer an 'overwrite' option, and hence, existing files will be overwritten (see also MRT User's Manual, p. 59). Further arguments that require particular attention when operating MRT are summarized in the following list:

dataFormat:

Output file formats include:

- "raw binary" (.hdr and .dat)
- "HDF-EOS" (.hdf)
- "GeoTiff" (.tif; default)

Any other format specified through MODISoptions or 'dataFormat' is ignored and set to "GeoTiff".

outProj:

MRT uses calls to the General Cartographic Transformation Package (GCTP) and as such allows projection to the following mapping grids:

- Albers Equal Area ("AEA")
- Equirectangular ("ER")
- Geographic ("GEO")
- Hammer ("HAM")
- Integerized Sinusoidal ("ISIN")
- Interrupted Goode Homolosine ("IGH")
- Lambert Azimuthal ("LA")
- Lambert Conformal Conic ("LCC")
- Mercator ("MERCAT")
- Molleweide ("MOL")
- Polar Stereographic ("PS")
- Sinusoidal ("SIN")
- Transverse Mercator ("TM")
- Universal Transverse Mercator ("UTM")

See also 'References' and MRT User's Manual, pp. 6 and 29.

projPara:

Output projection parameters are autodetected for outProj %in% c("SIN", "GEO"):

- "SIN": "6371007.18 0.00 0.00 0.00 0.00 0.00 0.00 0.00 86400.00 0.00 0.00 0.00 0.00 0.00 0.00"
- "GEO": "0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0"

For detailed information on defining paramters for other target projections, please refer to 'Appendix C: Projection Parameters' in the MRT User's Manual, p. 65-66.

Value

A list of output filenames summarized by product and date, see also Value in link[MODIS]{runGdal}.

Author(s)

Matteo Mattiuzzi, Forrest Stevens and Florian Detsch

Source

You can obtain the MRT software after registration from LP DAAC.

References

Dwyer J, Schmidt G (2006) The MODIS Reprojection Tool, 162-177, doi:10.1007/978-3-540-37294-3_9. In: Qu JJ, Gao W, Kafatos M, Murphy RE, Salomonson VV (eds) Earth Science Satellite Remote Sensing. Springer: Berlin, Heidelberg.

Elassal AA (1989) General Cartographic Transformation Package (GCTP), Version II. NOAA Technical Report NOS124 CGS9. NOAA: Rockville, MD, USA. Available online here (2018-09-13).

Land Processes DAAC, USGS Earth Resources Observation and Science Center (2011) MODIS Reprojection Tool User's Manual. Release 4.1, April 2011. Available online here.

See Also

MODISoptions, runGdal.

Examples

```
## Not run:
geo = runMrt(product="MOD11A1", extent="austria", begin="2010001", end="2010002", SDSstring="101",
             job="ExampleGEOdelme", outProj="GEO")
sin = runMrt(product="MOD11A1", extent="austria", begin="2010001", end="2010002", SDSstring="101",
             job="ExampleSINdelme", outProj="SIN")
utm = runMrt(product="MOD11A1", extent="austria", begin="2010001", end="2010002", SDSstring="101",
             job="ExampleUTMdelme", outProj="UTM", zone = 33)

## End(Not run)
```

---

smooth.spline.raster *Filter Time Series Imagery with a Cubic Spline*

Description

This function uses the smooth.spline function to filter a vegetation index time serie of satellite data.

Usage

```
smooth.spline.raster(x, w = NULL, t = NULL, groupYears = TRUE,
  timeInfo = orgTime(x), df = 6, outDirPath = "./", ...)
```

Arguments

x	RasterBrick (or RasterStack) or character vector of filenames, sorted 'Vegetation index'.
w	RasterBrick (or RasterStack) with weighting information, e.g. derived from makeWeights.
t	In case of MODIS composite, the corresponding 'composite_day_of_the_year' RasterBrick (or RasterStack).
groupYears	logical. If TRUE, output files are grouped by years.
timeInfo	Result from orgTime.
df	numeric, yearly degree of freedom value passed to smooth.spline. If set as character (i.e., df = "6"), it is not adapted to the time serie length but used as a fixed value (see Details).
outDirPath	Output path, defaults to the current working directory.
...	Arguments passed to writeRaster. Note that filename is created automatically.

Details

numeric values of df (e.g., df = 6) are treated as yearly degrees of freedom. Here, the length of the input time series is not relevant since df is adapted to it with: df*('length of _input_ timeserie in days'/365). The input length can differ from the output because of the pillow argument in orgTime.

character values of df (e.g., df = "6"), on the other hand, are not adopted to the length of the input time series.

Currently tested on MODIS and Landsat data. Using M*D13 data, it is also possible to use the 'composite_day_of_the_year' layer and the 'VI_Quality' layer. This function is currently under heavy development and a lot of changes are expected to come soon.

Value

The filtered data and a text file with the dates of the output layers.

Author(s)

Matteo Mattiuzzi

See Also

whittaker.raster, raster.

Examples

```
## Not run:
# The full capacity of the following functions is currently avaliable only with M*D13 data.
# !! The function is very new, double check the result!!

# You need to extract the: 'vegetation index', 'VI_Quality layer',
# and 'composite day of the year' layer.
```

```
# runGdal(product="MOD13A2",begin="2004340",extent="sicily",end="2006070",
# job="fullCapa",SDSstring="101000000010")
# Afterward extract it to:
options("MODIS_outDirPath")

# the only obligatory dataset is "x" (vegetatino index), get the 'vi' data on the source directory:
path <- paste0(options("MODIS_outDirPath"),"/fullCapa")
vi <- preStack(path=path, pattern="*_NDVI.tif$")

# "orgTime" detects timing information of the input data and generates based on the arguments
# the output date information. For spline functions (in general) the beginning and
# the end of the time series is always problematic.
# So there is the argument "pillow" (default 75 days) that adds
# (if available) some more layers on the two endings.

timeInfo <- orgTime(vi,nDays=16,begin="2005001",end="2005365",pillow=40)

# now re-run "preStack" with two diferences, 'files' (output of the first 'preStack' call)
# and the 'timeInfo'.
# Here only the data needed for the filtering is extractet:
vi <- preStack(files=vi,timeInfo=timeInfo)

smooth.spline.raster(x=vi,timeInfo=timeInfo)

# Filter with weighting and time information:
# if the files are M*D13 you can use also Quality layers and the composite day of the year:
w <- stack(preStack(path=path, pattern="*_VI_Quality.tif$", timeInfo=timeInfo))
w <- makeWeights(w,bitShift=2,bitMask=15,threshold=6)
# you can also pass only the names
t <- preStack(path=path, pattern="*_composite_day_of_the_year.tif$", timeInfo=timeInfo)

smooth.spline.raster(x=vi,w=w,t=t,timeInfo=timeInfo)

## End(Not run)
```

`temporalComposite` *Calculate MODIS Composite Images*

Description

Based on a user-defined function, e.g. `max` for maximum value composites (MVC), aggregate native 16-day MODIS datasets to custom temporal composites.

Usage

```
temporalComposite(x, y, timeInfo = extractDate(x, asDate =
  TRUE)$inputLayerDates, interval = c("month", "year", "fortnight"),
  fun = max, na.rm = TRUE, cores = 1L, filename = "", ...)
```

Arguments

x	Raster* or character. MODIS composite dataset with an associated "composite_day_of_the_year" SDS, e.g. all vegetation indices products (MOD13).
y	Raster* or character. MODIS "composite_day_of_the_year" SDS associated with 'x'.
timeInfo	Date vector corresponding to all input layers. If not further specified, this is tried to be created through invoking extractDate upon 'x', assuming standard MODIS file names.
interval	character. Time period for aggregation, see aggInterval.
fun, na.rm	function. See overlay.
cores	integer. Number of cores for parallel processing.
filename	character. Optional output filename.
...	Additional arguments passed to writeRaster.

Value

A Raster* object.

Author(s)

Florian Detsch

See Also

aggInterval, calc, writeRaster.

Examples

```
## Not run:
library(mapview)
frc <- as(subset(franconia, district == "Mittelfranken"), "Spatial")
tfs <- runGdal("MOD13A1", begin = "2015001", end = "2016366", extent = frc,
            job = "temporalComposite", SDSstring = "100000000010")

ndvi <- sapply(tfs[[1]], "[[", 1)
cdoy <- sapply(tfs[[1]], "[[", 2)

mmvc <- temporalComposite(ndvi, cdoy)
plot(mmvc[[1:4]])

## End(Not run)
```

transDate *MODIS Date Conversion and Testing*

Description

This function converts a sequence of input dates to 'YYYY-MM-DD' and 'YYYYDDD'.

Usage

```
transDate(begin = NULL, end = NULL)
```

Arguments

begin, end	Date or character. Begin and end date of MODIS time series, see Note. If not provided, this defaults to "1972-01-01" (Sys.Date()).

Value

A list of begin and end dates formatted according to 'YYYY-MM-DD' (first two slots; class Date) and 'YYYYDDD' (second two slots; class character).

Note

If input dates are supplied as character, this function either expects 7-digit strings in the MODIS intrinsic form '%Y%j' or, alternatively, 10-digit strings in the form '%Y-%m-%d' where the two field separators need to be uniform (see Examples).

Author(s)

Matteo Mattiuzzi, Florian Detsch

See Also

strptime.

Examples

```
transDate()
transDate(begin = "2009.01.01") # ends with current date
transDate(end = "2009.01.01") # starts with Landsat 1
transDate(begin = c("2009-01-01", "2010-01-01"), end = "2011.03.16")
```

whittaker.raster *Filter Vegetation Index with Modified Whittaker Approach*

Description

Use a modified Whittaker filter function (see References) from package **ptw** to filter a vegetation index (VI) time serie of satellite data.

Usage

```
whittaker.raster(vi, w = NULL, t = NULL, timeInfo = orgTime(vi),
  lambda = 5000, nIter = 3, outputAs = "single", collapse = FALSE,
  prefixSuffix = c("MCD", "ndvi"), outDirPath = ".",
  outlierThreshold = NULL, mergeDoyFun = "max", ...)
```

Arguments

vi	Raster* or character filenames, sorted VI. Use preStack functionality to ensure the right input.
w	Raster* or character filenames. In case of MODIS composite, the sorted 'VI_Quality' layers.
t	Raster* or character filenames. In case of MODIS composite, the sorted 'composite_day_of_the_year' layers. If missing, the date is determined using timeInfo.
timeInfo	Output from orgTime.
lambda	character or integer. Yearly lambda value passed to whit2. If set as character (i.e., lambda = "600"), it is not adapted to the time serie length, but used as a fixed value (see Details). High values = stiff/rigid spline.
nIter	integer. Number of iteration for the upper envelope fitting.
outputAs	character, organisation of output files. "single" (default) means each date one RasterLayer; "yearly" a RasterBrick for each year, and "one" one RasterBrick for the entire time series.
collapse	logical. Collapse input data of multiple years into one single year before filtering.
prefixSuffix	character, file naming. Names are composed dot-separated: paste0(prefixSuffix[1], "YYYDDD", l
outDirPath	character, output path. Defaults to the current working directory.
outlierThreshold	numeric in the same unit as vi, used for outlier removal (see Details).
mergeDoyFun	Especially when using collapse = TRUE, multiple measurements for one day can be present. Here you can choose how those values are merged to one single value: "max" uses the highest value, "mean" or "weighted.mean" use the mean if no weighting "w" is available, and weighted.mean if it is.
...	Arguments passed to writeRaster (except for filename).

Details

The argument `lambda` is passed to `MODIS:::miwhitatzb1`. You can set it as yearly `lambda`, which means that it doesn't matter how long the input time serie is because `lambda` is adapted to it with: `lambda*('length of input timeserie in days'/365)`. The input length can differ from the output because of the `pillow` argument in `orgTime`. But it can also be set as `character` (i.e., `lambda = "1000"`). In this case, the adaption to the time series length is not performed.

Value

A Whittaker-smoothened `RasterStack`.

Note

Currently tested on MODIS and Landsat data. Using M*D13, it is also possible to use the 'composite_day_of_the_year' and the 'VI_Quality' layers. Note that this function is currently under heavy development.

Author(s)

Matteo Mattiuzzi and Agustin Lobo

References

Modified Whittaker smoother, according to Atzberger & Eilers 2011 International Journal of Digital Earth 4(5):365-386.
Implementation in R: Agustin Lobo 2012

See Also

`smooth.spline.raster`, `raster`.

Examples

```
## Not run:
# The following function will download bit more than 1 year of MOD13A1 (~180mB) and therefore
# take while to execute! Data will be downloaded to options("MODIS_localArcPath") and processed
# to 'paste0(options("MODIS_outDirPath"),"fullCapa")'
# You need to extract: 'vegetation index', 'VI_Quality layer', and 'composite day of the year',
# this is expressed by the argument 'SDSstring'
runGdal(product="MOD13A2",begin="2004340",extent="irland",end="2006020", job="fullCapa",
SDSstring="101000000010")
path <- paste0(options("MODIS_outDirPath"),"fullCapa")

# the only obligatory dataset is the vegetatino index
# get the 'vi' data in the source directory:
vi <- preStack(path=path, pattern="*_NDVI.tif$")

# "orgTime" detects timing information of the input data and generates based on the arguments
# the output date information.
# For spline functions (in general) the beginning and the end of the time series
```

```
# is always problematic. So there is the argument "pillow" (default 75 days) that adds
# (if available) some more layers on the two endings.
timeInfo <- orgTime(vi,nDays=16,begin="2005001",end="2005365",pillow=40)

# now re-run "preStack" with two differences, 'files' (output of the first 'preStack' call)
# and the 'timeInfo'
# Here only the data needed for the filtering is extracted:
vi <- preStack(files=vi,timeInfo=timeInfo)

whittaker.raster(vi,timeInfo=timeInfo,lambda=5000)

# if the files are M*D13 you can use also Quality layers and the composite day of the year:
wt <- preStack(path=path, pattern="*_VI_Quality.tif$", timeInfo=timeInfo)
# can also be already stacked:
inT <- preStack(path=path, pattern="*_composite_day_of_the_year.tif$", timeInfo=timeInfo)

whittaker.raster(vi=vi, wt=wt, inT=inT, timeInfo=timeInfo, lambda=5000, overwrite=TRUE)

## End(Not run)
```

Index