

Package ‘Reanalysis’

November 8, 2017

Type Package

Title Reads reanalysis data for CRHM

Version 1.2.4

Date 2017-11-08

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Description Functions to read and process files of reanalysis data from WATCH, ERA and NARR.

Depends R (>= 3.1)

Imports CRHMr (>= 2.5.0), lubridate(>= 1.3), timeDate, stringr(>= 1.0), zoo, proj4, RNetCDF, reshape2, ncdf4, PCICt

License GPL-3

LazyData true

URL www.usask.ca/hydrology

RoxygenNote 6.0.1

NeedsCompilation no

R topics documented:

| | |
|---|----|
| Reanalysis-package | 2 |
| CanRCM4AdjustedCreateHourlyObs | 3 |
| CanRCM4adjustedGetNearestTimeseries | 4 |
| CanRCM4unadjustedGetNearestTimeseries | 6 |
| ERAdailyArealPrecip | 7 |
| ERAdaccum | 8 |
| ERAggetArealPrecip | 9 |
| ERAggetMultipleLocationTimeseries | 10 |
| ERAggetNearestTimeseries | 12 |
| ERAhourlyAirtemp | 13 |
| ERAhourlyLongwave | 14 |
| ERAhourlyPrecip | 16 |
| ERAhourlyShortwave | 17 |

| | |
|-------------------------------------|-----------|
| ERAhourlyVP | 18 |
| ERAhourlyWindspeed | 19 |
| land | 20 |
| NARRdownloadNetCDF | 21 |
| NARRgetNearestTimeseries | 22 |
| WATCHcreateHourlyWFDEIobs | 23 |
| WATCHcreateHourlyWFDobs | 25 |
| WATCHcreateWFDEIobs | 27 |
| WATCHcreateWFDobs | 28 |
| WATCHdailyArealPrecip | 29 |
| WATCHgetWFDarealPrecip | 30 |
| WATCHgroupWFDEIobs | 31 |
| WATCHgroupWFDobs | 33 |
| WATCHhourlyObs | 34 |
| WRFbyloc2obs | 35 |
| WRFnearest2obs | 37 |
| Index | 39 |

| | |
|--------------------|---|
| Reanalysis-package | <i>Contains functions to download and process reanalysis data</i> |
|--------------------|---|

Description

The package contains functions to download and process reanalysis data. Functions are provided for ERA (-Interim and -40), NARR and WATCH datasets. Because there are so many functions and all of the datasets are slightly different, each function name includes the dataset as a prefix.

References

To cite **Reanalysis** in publications, use the command `citation('Reanalysis')` to get the current version of the citation.

The CRHM program is described in:

Pomeroy, John W, D M Gray, T Brown, N Hedstrom, W L Quinton, R J Granger, and S K Carey. 2007. "The Cold Regions Hydrological Model : A Platform for Basing Process Representation and Model Structure on Physical Evidence". *Hydrological Processes* 21 (19): 2650-2567.

The CRHM model may be downloaded from <http://www.usask.ca/hydrology/CRHM.php>.

CanRCM4AdjustedCreateHourlyObs

Extracts all CRHM obs variables for a specified location and duration and constructs an obs file of hourly values.

Description

This function extracts the time series of 3-hourly values from a set of NetCDF files of CanRCM4 data, which has been bias-corrected using the WFDEI 3-hour reanalysis values. The values are stored at a spatial resolution of 0.125 degrees, so the closest point to the specified location will be used. Note that because the reanalysis data omit February 29, the values returned by this function will be interpolated from February 28 and March 1 for leap days, except for precipitation values, which are set to zero. The variables are converted to values, and variable names, appropriate for CRHM when they are extracted. The three-hourly values of temperature, wind speed

Usage

```
CanRCM4AdjustedCreateHourlyObs(startDate = "1979-01-01",
  endDate = "2100-12-01", longitude = 0, latitude = 0,
  sunTimeOffset = 2, locationName = "",
  fileStr = "_CanRCM4_hist+fut_1979_2100", inDir = "./", outDir = "./",
  timezone = "etc/GMT+7", write3hour = FALSE, quiet = FALSE)
```

Arguments

| | |
|---------------|--|
| startDate | Optional. Beginning date of data to be extracted. A string formatted as "yyyy-mm-dd". The default value of '1979-01-01' is the beginning of the data. |
| endDate | Optional. Beginning date of data to be extracted. A string formatted as "yyyy-mm-dd". The default value of '2100-12-01' is the end of the data. |
| longitude | Required. The longitude of the point being sought. Valid values appear to be between -90 and -142, but the input value is <i>not</i> checked for validity, in case the model extent changes. |
| latitude | Required. The latitude of the point being sought. Valid values appear to be between 45 and 75, but the input value is <i>not</i> checked for validity, in case the model extent changes. |
| sunTimeOffset | Optional. The offset (in hours) is added to the solar time to convert it to local time. The default value 2 shifts the daily peak to occur at 2pm. This is required to downscale the Qsi values. |
| locationName | Optional. Name for the location. This value is used to construct the name of the output file. |
| fileStr | Optional. The name for the NetCDF .nc files containing the data, exclusive of their path and variable name. |
| inDir | Optional. The path to the NetCDF .nc files. Default is the current directory. |
| outDir | Optional. The path output file(s). Default is the current directory. |

| | |
|------------|--|
| timezone | Required. The name of the timezone of the data as a character string. This should be the timezone of your data, but omitting daylight savings time. Note that the timezone code is specific to your OS. To avoid problems, you should use a timezone without daylight savings time. Under Linux, you can use 'CST' and 'MST' for Central Standard or Mountain Standard time, respectively. Under Windows or OSX, you can use 'etc/GMT+6' or 'etc/GMT+7' for Central Standard and Mountain Standard time. DO NOT use 'America/Regina' as the time zone, as it includes historical changes between standard and daylight savings time. |
| write3hour | Optional. Should the three-hour values be written to a .obs file? Default is FALSE. |
| quiet | Optional. If TRUE then comments will be written to the screen as the input data is processed. Note that this function may take a long time to execute, so the default is the <i>opposite</i> value used by most functions. |

Value

If successful, writes **CRHM**r obs file(s) and returns TRUE. If unsuccessful, returns FALSE.

See Also

[CanRCM4adjustedGetNearestTimeseries](#)

Examples

```
## Not run: CanRCM4AdjustedCreateHourlyObs(startDate = "1980-01-01",
endDate = "1980-12-31", longitude = -101.704683, latitude = 50.845585,
locationName = "SmithCreek")

## End(Not run)
```

| |
|--|
| CanRCM4adjustedGetNearestTimeseries |
| <i>Reads a time series for the nearest point from adjusted CanRCM4</i> |

Description

This function extracts a time series of 3-hourly values from a NetCDF file of CanRCM4 data, which has been bias-corrected using the WFDEI 3-hour reanalysis values. The values are stored at a spatial resolution of 0.125 degees, so the closest point to the specified location will be used. Note that because the reanalysis data omit February 29, the values returned by this function will have NA values for leap days. You will have to fill these values yourself. Each NetCDF file contains a single variable. Typically the first letters of the file name designate the variable. The variables are converted to values, and variable names, appropriate for CRHM when they are extracted.

| | | | |
|------------------|--------------|---------------|------------|
| NetCDF parameter | netCDF units | CRHM Variable | CRHM units |
|------------------|--------------|---------------|------------|

| | | | |
|------------------------------------|---------------|------|---------------|
| pr - 3hr precip | mm/s | p | mm |
| tas - surface air temp. | K | t | °C |
| huss - specific humidity | dimensionless | qair | dimensionless |
| sfcWind - surface (10m) wind speed | m/s | u10 | m/s |
| ps - surface pressure | Pa | ps | Pa |
| rsds - incoming SW radiation | W/2 | Qsi | W/2 |
| rlds - incoming LW radiation | W/2 | Qli | W/2 |

Usage

```
CanRCM4adjustedGetNearestTimeseries(netCDFfile = "", longitude = 0,
  latitude = 0, startDate = "1979-01-01", endDate = "2100-12-01",
  timezone = "", logfile = "")
```

Arguments

| | |
|------------|--|
| netCDFfile | Required. The name of a NetCDF file containing a single variable. |
| longitude | Required. The longitude of the point being sought. Valid values appear to be between -90 and -142, but the input value is <i>not</i> checked for validity, in case the model extent changes. |
| latitude | Required. The latitude of the point being sought. Valid values appear to be between 45 and 75, but the input value is <i>not</i> checked for validity, in case the model extent changes. |
| startDate | Optional. Beginning date of data to be extracted. A string formatted as "yyyy-mm-dd". The default value of '1979-01-01' is the beginning of the data. |
| endDate | Optional. Ending date of data to be extracted. A string formatted as "yyyy-mm-dd". The default value of '2100-12-01' is the end of the data. |
| timezone | Required. The name of the timezone of the data as a character string. This should be the timezone of your data, but omitting daylight savings time. Note that the timezone code is specific to your OS. To avoid problems, you should use a timezone without daylight savings time. Under Linux, you can use 'CST' and 'MST' for Central Standard or Mountain Standard time, respectively. Under Windows or OSX, you can use 'etc/GMT+6' or 'etc/GMT+7' for Central Standard and Mountain Standard time. DO NOT use 'America/Regina' as the time zone, as it includes historical changes between standard and daylight savings time. |
| logfile | Optional. Name of the file to be used for logging the action. Normally not used. |

Value

If successful, returns a standard **CRHMr** data frame containing the datetime and the variable. If unsuccessful, returns the value FALSE.

Examples

```
## Not run: f <- "ps_CanRCM4_hist+fut_1979_2100.nc4"
```

```
r <- RCM4adjustedGetNearestTimeseries(f, longitude=-115.27,
latitude=52.03, startDate = "1980-01-01", endDate="1980-12-31")

## End(Not run)
```

CanRCM4unadjustedGetNearestTimeseries

Reads a time series for the nearest point from undadjusted CanRCM4

Description

This function extracts a time series of hourly values from a NetCDF file of CanRCM4 data, which has not been bias-corrected. The values are stored at a spatial resolution of 0.125 degrees, so the closest point to the specified location will be used. Each NetCDF file contains a single variable. Typically the first letters of the file name designate the variable. The variables are converted to values, and variable names, appropriate for CRHM when they are extracted.

| NetCDF parameter | netCDF units | CRHM Variable | CRHM units |
|------------------------------------|---------------|---------------|---------------|
| pr - hourly precip | mm/s | p | mm |
| tas - surface air temp. | K | t | °C |
| huss - specific humidity | dimensionless | qair | dimensionless |
| sfcWind - surface (10m) wind speed | m/s | u10 | m/s |
| ps - surface pressure | Pa | ps | Pa |
| rsds - incoming SW radiation | W/2 | Qsi | W/2 |
| rlds - incoming LW radiation | W/2 | Qli | W/2 |

Usage

```
CanRCM4unadjustedGetNearestTimeseries(netCDFfile = "", longitude = 0,
latitude = 0, startDate = "1979-01-01", endDate = "2100-12-01",
timezone = "Etc/GMT+7", logfile = "")
```

Arguments

| | |
|------------|--|
| netCDFfile | Required. The name of a NetCDF file containing a single variable. |
| longitude | Required. The longitude of the point being sought. Valid values appear to be between -90 and -142, but the input value is <i>not</i> checked for validity, in case the model extent changes. |
| latitude | Required. The latitude of the point being sought. Valid values appear to be between 45 and 75, but the input value is <i>not</i> checked for validity, in case the model extent changes. |
| startDate | Optional. Beginning date of data to be extracted. A string formatted as "yyyy-mm-dd". The default value of '1979-01-01' is the beginning of the data. |
| endDate | Optional. Beginning date of data to be extracted. A string formatted as "yyyy-mm-dd". The default value of '2100-12-01' is the end of the data. |

| | |
|----------|--|
| timezone | Required. The name of the timezone of the data as a character string. This should be the timezone of your data, but omitting daylight savings time. Note that the timezone code is specific to your OS. To avoid problems, you should use a timezone without daylight savings time. Under Linux, you can use 'CST' and 'MST' for Central Standard or Mountain Standard time, respectively. Under Windows or OSX, you can use 'etc/GMT+6' or 'etc/GMT+7' for Central Standard and Mountain Standard time. DO NOT use 'America/Regina' as the time zone, as it includes historical changes between standard and daylight savings time. |
| logfile | Optional. Name of the file to be used for logging the action. Normally not used. |

Value

If successful, returns a standard **CRHMR** data frame containing the datetime and the variable. If unsuccessful, returns the value FALSE.

Examples

```
## Not run: f <- "CanRCM4_r8i2p1r1_hist+fut_1979_2100_huss.nc4"
r <- RCM4UnadjustedGetNearestTimeseries(f, longitude=-115.27,
latitude=52.03, startDate = "1980-01-01", endDate="1980-12-31")

## End(Not run)
```

ERAdailyArealPrecip *Calculates daily ERA areal precipitation*

Description

Calculates the daily total ERA precipitation, for all locations.

Usage

```
ERAdailyArealPrecip(ERAarealPrecip)
```

Arguments

ERAarealPrecip Required. The three-hour ERA areal precipitation as returned by ERAgetArealPrecip.

Value

If unsuccessful, returns FALSE. If successful, returns a list containing the following:

| Name | meaning |
|--------------|--|
| daily_precip | 3d array (lon x lat x date) of precip (mm) |
| lonres | longitude resolution (°) |
| latres | latitude resolution (°) |
| minLon | minimum longitude of data(°W) |

| | |
|--------|-------------------------------|
| maxLon | maximum longitude of data(°W) |
| minLat | minimum latitude of data(°) |
| maxLat | maximum latitude of data(°) |
| date | the date of each layer |

Author(s)

Kevin Shook

Examples

```
## Not run: daily_precip <- ERAdailyArealPrecip(threehour_precip)
```

ERAdaccum

*Deaccumulates ERA cumulative time series***Description**

This function is used to deaccumulate variables stored as 12-hour cumulative values by ERA to 3-hour values. It is called by other functions, but may also be useful as a stand-alone functions. Note that this function only works for a single location, i.e. *NOT* areal values.

Usage

```
ERAdaccum(ERAobs, colnum = 1, quiet = TRUE, logfile = "")
```

Arguments

| | |
|---------|--|
| ERAobs | Required. A CRHMr obs dataframe of ERA data, created by ERAgetnearestTimeSeries. |
| colnum | Optional. The column number containing the values to be deaccumulated, not including the datetime. Default is column 1. |
| quiet | Optional. Suppresses display of messages, except for errors. If you are calling this function in an R script, you will usually leave quiet=TRUE (i.e. the default). If you are working interactively, you will probably want to set quiet=FALSE. |
| logfile | Optional. Name of the file to be used for logging the action. Normally not used |

Value

If successful, returns an obs dataframe containing the deaccumulated value. If unsuccessful, returns the value FALSE.

Author(s)

Kevin Shook

Examples

```
## Not run:
deaccum <- ERAdeaccum(ERAobs)
## End(Not run)
```

| | |
|-------------------|------------------------------------|
| ERAgetArealPrecip | <i>Get ERA areal precipitation</i> |
|-------------------|------------------------------------|

Description

Extracts the areal precipitation for all time intervals from the ERA NetCDF file for a region. If the data are 3-hour values accumulated over 12-hour periods, then they will be deaccumulated, and negative precipitation will be set to zero

Usage

```
ERAgetArealPrecip(ncdfFile, timezone = "", quiet = TRUE)
```

Arguments

| | |
|----------|--|
| ncdfFile | Required. Name of the NetCDF file containing ERA data. |
| timezone | Required. The name of the timezone of the data as a character string. This should be the timezone of your data, but omitting daylight savings time. Note that the timezone code is specific to your OS. To avoid problems, you should use a timezone without daylight savings time. Under Linux, you can use 'CST' and 'MST' for Central Standard or Mountain Standard time, respectively. Under Windows or OSX, you can use 'etc/GMT+6' or 'etc/GMT+7' for Central Standard and Mountain Standard time. DO NOT use 'America/Regina' as the time zone, as it includes historical changes between standard and daylight savings time. |
| quiet | Optional. Suppresses display of messages, except for errors. If you are calling this function in an R script, you will usually leave quiet=TRUE (i.e. the default). If you are working interactively, you will probably want to set quiet=FALSE |

Value

If unsuccessful, returns FALSE. If successful, returns a list containing the following:

| Name | meaning |
|----------|--|
| precip | 3d array (lon x lat x time) of precip (mm) |
| lonres | longitude resolution (°) |
| latres | latitude resolution (°) |
| minLon | minimum longitude of data(°W) |
| maxLon | maximum longitude of data(°W) |
| minLat | minimum latitude of data(°) |
| maxLat | maximum latitude of data(°) |
| datetime | the datetime of each time layer |

Examples

```
## Not run: threehour_precip <-
ERAgetArealPrecip('_grib2netcdf-atls17-95e2cf679cd58ee9b4db4dd119a05a8d-szSVRK.nc',
  timezone='CST')

## End(Not run)
```

ERAgetMultipleLocationTimeseries

Extracts timeseries of ERA data nearest to multiple specified locations

Description

Reads a NetCDF file containing ERA reanalysis data and extracts the timeseries of the specified variable for each location. This is faster than calling the function ERAgetNearestTimeseries for each location, as the reanalysis data are only read in once. Some of the commonly-used variables are:

| Parameter | Units | Variable |
|-------------------------------------|------------------|----------|
| 10 m eastward wind component | m/s | u10 |
| 10 m northward wind component | m/s | v10 |
| 2 metre temperature | K | t2m |
| 2 metre dewpoint | K | d2m |
| Downward surface solar radiation* | J/m ² | ssrd |
| Downward surface thermal radiation* | J/m ² | strd |
| Surface net solar radiation* | J/m ² | ssr |
| Surface net thermal radiation* | J/m ² | str |
| Total precipitation* | m of water | tp |

Parameters marked with an asterisk are *cumulative* values, and must be deaccumulated using the deaccumERA function.

Usage

```
ERAgetMultipleLocationTimeseries(ncdfFile, varName, siteNames, outDir = "",
  pointLons, pointLats, projection = "+proj=utm +zone=13 +ellps=WGS84",
  timezones = "", quiet = TRUE, logfile = "")
```

Arguments

| | |
|-----------|--|
| ncdfFile | Required. Name of the NetCDF file containing ERA data. |
| varName | Required. Name of the NetCDF variable to extract. |
| siteNames | Required. A vector containing the names of the sites. The names will be used for the output obs files. |

| | |
|------------|---|
| outDir | Optional. Directory to hold output files. If not specified, the current directory will be used. |
| pointLons | Required. A vector containing decimal longitudes of desired locations. Note that the NetCDF longitude is 0-360°, so add 360 to negative longitudes. |
| pointLats | Required. A vector containing decimal latitudes of desired location. |
| projection | Optional. Projection to be used to convert latitudes and longitudes to locations. Used for finding the nearest ERA gridpoint. The default, '+proj=utm +zone=13 +ellps=WGS84', is <i>only</i> valid for Western Canada. If you are processing data for the whole world, you can use the August Epicycloidal Projection which is '+proj=august +lon_0=90w'. |
| timezones | Required. A vector containing the name of the timezone of the data as a character string. This should be the timezone of your data, but omitting daylight savings time. Note that the timezone code is specific to your OS. To avoid problems, you should use a timezone without daylight savings time. Under Linux, you can use 'CST' and 'MST' for Central Standard or Mountain Standard time, respectively. Under Windows or OSX, you can use 'etc/GMT+6' or 'etc/GMT+7' for Central Standard and Mountain Standard time. DO NOT use 'America/Regina' as the time zone, as it includes historical changes between standard and daylight savings time. If there are fewer timezone values than variable names, the timezone will be recycled. |
| quiet | Optional. Suppresses display of messages, except for errors. If you are calling this function in an R script, you will usually leave quiet=TRUE (i.e. the default). If you are working interactively, you will probably want to set quiet=FALSE, as it will list the actual latitude and longitude of the ERA tile. |
| logfile | Optional. Name of the file to be used for logging the action. Normally not used. |

Value

If unsuccessful, returns FALSE. If successful, returns TRUE and all variables for all locations are written to obs files in the specified directory.

Author(s)

Kevin Shook

See Also

[ERAgetNearestTimeseries](#) [ERAdeaccum](#)

Examples

```
## Not run:
ERAgetMultipleLocationTimeseries('ssrd.nc', 'ssrd', s$`Station Names`,
pointLons = s$Longitude, pointLats = s$Latitude, projection='+proj=august +lon_0=90w',
timezones=s$timezone, quiet=FALSE)
## End(Not run)
```

 ERAgetNearestTimeseries

Finds timeseries of ERA data nearest to specified location

Description

Reads a NetCDF file containing ERA reanalysis data and extracts the timeseries of the specified variable. Some of the the commonly-used variables are:

| Parameter | Units | Variable |
|-------------------------------------|------------------|----------|
| 10 m eastward wind component | m/s | u10 |
| 10 m northward wind component | m/s | v10 |
| 2 metre temperature | K | t2m |
| 2 metre dewpoint | K | d2m |
| Downward surface solar radiation* | J/m ² | ssrd |
| Downward surface thermal radiation* | J/m ² | strd |
| Surface net solar radiation* | J/m ² | ssr |
| Surface net thermal radiation* | J/m ² | str |
| Total precipitation* | m of water | tp |

Parameters marked with an asterisk are *cumulative* values, and must be deaccumulated using the deaccumERA function.

Usage

```
ERAgetNearestTimeseries(ncdfFile, varName, pointLon, pointLat,
    projection = "+proj=utm +zone=13 +ellps=WGS84", timezone = "",
    quiet = TRUE, logfile = "")
```

Arguments

| | |
|------------|---|
| ncdfFile | Required. Name of the NetCDF file containing ERA data. |
| varName | Required. Name of the NetCDF variable to extract. |
| pointLon | Required. Decimal longitude of desired location. Note that the NetCDF longitude is 0-360°, so add 360 to negative longitudes. |
| pointLat | Required. Decimal latitude of desired location. |
| projection | Optional. Projection to be used to convert latitudes and longitudes to locations. Used for finding the nearest ERA gridpoint. The default, '+proj=utm +zone=13 +ellps=WGS84', is <i>only</i> valid for Western Canada. If you are processing data for the whole world, you can use the August Epicycloidal Projection which is '+proj=august +lon_0=90w'. |
| timezone | Required. The name of the timezone of the data as a character string. This should be the timezone of your data, but omitting daylight savings time. Note that the timezone code is specific to your OS. To avoid problems, you should |

use a timezone without daylight savings time. Under Linux, you can use 'CST' and 'MST' for Central Standard or Mountain Standard time, respectively. Under Windows or OSX, you can use 'etc/GMT+6' or 'etc/GMT+7' for Central Standard and Mountain Standard time. DO NOT use 'America/Regina' as the time zone, as it includes historical changes between standard and daylight savings time.

quiet Optional. Suppresses display of messages, except for errors. If you are calling this function in an R script, you will usually leave quiet=TRUE (i.e. the default). If you are working interactively, you will probably want to set quiet=FALSE, as it will list the actual latitude and longitude of the ERA tile.

logfile Optional. Name of the file to be used for logging the action. Normally not used.

Value

If unsuccessful, returns FALSE. If successful, returns a standard **CRHMR** dataframe containing the datetime and the extracted data, which are unpacked (i.e. the NetCDF multiplier and offset have been applied).

Author(s)

Kevin Shook

See Also

[ERAdeaccum](#)

Examples

```
## Not run:
ssrd <- ERAgetNearestTimeseries('ssrd.nc', 'ssrd', 243.5, 51.69, timezone='Etc/GMT+7')
t2m <- ERAgetNearestTimeseries('t2m.nc', 't2m', 243.5, 51.69, timezone='Etc/GMT+7')
tp <- ERAgetNearestTimeseries('tp.nc', 'tp', 243.5, 51.69, timezone='Etc/GMT+7')
strd <- ERAgetNearestTimeseries('strd.nc', 'strd', 243.5, 51.69, timezone='Etc/GMT+7')
u10 <- ERAgetNearestTimeseries('u10v10.nc', 'u10', 243.5, 51.69, timezone='Etc/GMT+7')
v10 <- ERAgetNearestTimeseries('u10v10.nc', 'v10', 243.5, 51.69, timezone='Etc/GMT+7')
d2m <- ERAgetNearestTimeseries('d2m.nc', 'd2m', 243.5, 51.69, timezone='Etc/GMT+7')
## End(Not run)
```

| | |
|------------------|---|
| ERAhourlyAirtemp | <i>Estimates hourly air temperatures from ERA-Interim 3 -hourly or ERA-40 6-hourly values</i> |
|------------------|---|

Description

Interpolates ERA instantaneous air temperatures to hourly values. The ERA air temperatures are first converted from K to °C, if required.

Usage

```
ERAhourlyAirtemp(ERAt2m, t2mColnum = 1, method = "linear", quiet = TRUE,
  logfile = "")
```

Arguments

| | |
|-----------|--|
| ERAt2m | Required. The CRHMr obs dataframe of ERA t2m values. The values must not be deaccumulated, as the deaccumERA function is called by this function. |
| t2mColnum | Optional. The column number containing the t2m values, not including the datetime. Default is column 1. |
| method | Optional. The methods to be used for interpolation of the air temperature. Currently supported methods are 'linear' and 'spline'. The default is to use linear interpolation. |
| quiet | Optional. Suppresses display of messages, except for errors. If you are calling this function in an R script, you will usually leave quiet=TRUE (i.e. the default). If you are working interactively, you will probably want to set quiet=FALSE. |
| logfile | Optional. Name of the file to be used for logging the action. Normally not used. |

Value

If successful, returns an obs dataframe containing the interpolated hourly 2m air temperatures. If unsuccessful, returns the value FALSE.

Author(s)

Kevin Shook

See Also

[ERAggetNearestTimeseries interpolate](#)

Examples

```
## Not run:
hourlyTemps <- ERAhourlyAirtemp(t2m)
## End(Not run)
```

| | |
|-------------------|--|
| ERAhourlyLongwave | <i>Estimates hourly incoming longwave radiation from ERA-Interim 3-hourly values or ERA-40 6-hourly values</i> |
|-------------------|--|

Description

This function is called *after* using the function getNearestERAtimeseries. This function deaccumulates the ERA-Interim 12-hour cumulative values, using the function ERAdeaccum and interpolates the 3-hour values to hourly values, based on the extra-terrestrial hourly radiation. ERA-40 6-hourly instantaneous values are interpolated directly to hourly values.

Usage

```
ERAhourlyLongwave(ERASTrd, strdColnum = 1, ERAt2m, t2mColnum = 1,
  method = "linear", quiet = TRUE, logfile = "")
```

Arguments

| | |
|------------|--|
| ERASTrd | Required. The CRHMr obs dataframe of ERA strd values. The values must not be deaccumulated, as the ERAdeaccum function is called by this function. |
| strdColnum | Optional. The column number containing the strd values, not including the date-time. Default is column 1. |
| ERAt2m | Required. The CRHMr obs dataframe of ERA t2m values. The values must not be deaccumulated, as the deaccumERA function is called by this function. |
| t2mColnum | Optional. The column number containing the t2m values, not including the datetime. Default is column 1. |
| method | Optional. The methods to be used for interpolation of the air temperature. Currently supported methods are 'linear' and 'spline'. The default is to use linear interpolation. |
| quiet | Optional. Suppresses display of messages, except for errors. If you are calling this function in an R script, you will usually leave quiet=TRUE (i.e. the default). If you are working interactively, you will probably want to set quiet=FALSE. |
| logfile | Optional. Name of the file to be used for logging the action. Normally not used |

Value

If successful, returns an obs dataframe containing the interpolated hourly ERA incoming longwave radiation (Qli) in W/m^2 , and the hourly 2m air temperatures (t) in $^{\circ}\text{C}$. If unsuccessful, returns the value FALSE.

Author(s)

Kevin Shook

References

The value of the Stefan-Boltzmann constant was obtained from <http://physics.nist.gov/cgi-bin/cuu/Value?sigma>

See Also

[ERAGetNearestTimeseries](#) [ERAdeaccum](#) [ERAhourlyShortwave](#)

Examples

```
## Not run:
hourlyQli <- ERAhourlyLongwave(ERASTrd=strd, ERAt2m=t2m)
## End(Not run)
```

ERAhourlyPrecip

Estimates hourly precipitation from ERA cumulative 3 hourly values

Description

This function is called *after* using the function `getNearestERAtimeseries`. This function removes negative values, deaccumulates the 12-hour cumulative values to 3-hour values, using the function `deaccumERA`, and divides the results by 3 to give to hourly values.

Usage

```
ERAhourlyPrecip(ERAtp, tpColnum = 1, quiet = TRUE, logfile = "")
```

Arguments

| | |
|----------|---|
| ERAtp | Required. The CRHMr obs dataframe of ERA tp values. The values must not be deaccumulated, as the <code>deaccumERA</code> function is called by this function. |
| tpColnum | Optional. The column number containing the tp values, not including the date-time. Default is column 1. |
| quiet | Optional. Suppresses display of messages, except for errors. If you are calling this function in an R script, you will usually leave <code>quiet=TRUE</code> (i.e. the default). If you are working interactively, you will probably want to set <code>quiet=FALSE</code> . |
| logfile | Optional. Name of the file to be used for logging the action. Normally not used |

Value

If successful, returns an obs dataframe containing the interpolated hourly precipitation (p). If unsuccessful, returns the value `FALSE`.

Author(s)

Kevin Shook

See Also

[ERAGetNearestTimeseries](#)

Examples

```
## Not run:
hourlyP <- ERAhourlyPrecip(tp)
## End(Not run)
```

| | |
|--------------------|---|
| ERAhourlyShortwave | <i>Estimates hourly incoming shortwave radiation from ERA-Interim 3-hourly values or ERA-40 6-hourly values</i> |
|--------------------|---|

Description

This function is called *after* using the function `getNearestERAtimeseries`. This function removes negative values, deaccumulates the ERA-Interim 12-hour cumulative values, using the function `ERAdeaccum` and interpolates the 3-hour values to hourly values, based on the extra-terrestrial hourly radiation. ERA-40 6-hourly instantaneous values are interpolated directly to hourly values.

Usage

```
ERAhourlyShortwave(ERAssrd, ssrdColnum = 1, latitude, sunTimeOffset = 2,
  solarMethod = "simpleMaxSolar", interpolationMethod = "linear",
  quiet = TRUE, logfile = "")
```

Arguments

| | |
|---------------------|---|
| ERAssrd | Required. The CRHMr obs dataframe of ERA ssrd values. The values must not be deaccumulated, as the <code>deaccumERA</code> function is called by this function. |
| ssrdColnum | Optional. The column number containing the ssrd values, not including the datetime. Default is column 1. |
| latitude | Required. The latitude of the point at which the ssrd data is extracted. This value is used to calculate the extra-terrestrial incoming solar radiation. Not used for ERA-40 data. |
| sunTimeOffset | Optional. Number of hours that local noon is offset from solar noon. The default is 2 hours. Not used for ERA-40 data. |
| solarMethod | Optional. The method to be used for calculating the extra-terrestrial radiation for 3-hourly ERA-Interim data. The default is 'simpleMaxSolar'. The other supported method is 'PotSolarInst', which requires the package EcoHydRology to be installed. |
| interpolationMethod | Optional. This is the method to be used for interpolating instantaneous values from ERA-40. The default is 'linear', but 'spline' can also be specified. |
| quiet | Optional. Suppresses display of messages, except for errors. If you are calling this function in an R script, you will usually leave <code>quiet=TRUE</code> (i.e. the default). If you are working interactively, you will probably want to set <code>quiet=FALSE</code> . |
| logfile | Optional. Name of the file to be used for logging the action. Normally not used |

Value

If successful, returns an obs dataframe containing the interpolated hourly ERA incoming shortwave radiation (Qsi). If unsuccessful, returns the value FALSE.

Author(s)

Kevin Shook

See Also

[ERAGetNearestTimeseries ERAhourlyLongwave distributeQsi](#)

Examples

```
## Not run:
hourlyQsi <- ERAhourlyShortwave(ssrd, latitude = 51.69)
## End(Not run)
```

| | |
|-------------|---|
| ERAhourlyVP | <i>Calculates the hourly vapour pressure from the 3-hour ERA-Interim or 6 hour ERA-40 dew point temperature</i> |
|-------------|---|

Description

Interpolates ERA instantaneous dew point temperatures to hourly values. The ERA dew point temperatures are first converted from K to °C, if required.

Usage

```
ERAhourlyVP(ERAd2m, d2mColnum = 1, method = "linear", quiet = TRUE,
  logfile = "")
```

Arguments

| | |
|-----------|--|
| ERAd2m | Required. The CRHMr obs dataframe of ERA d2m values. The values must not be deaccumulated, as the deaccumERA function is called by this function. |
| d2mColnum | Optional. The column number containing the d2m values, not including the datetime. Default is column 1. |
| method | Optional. The methods to be used for interpolation of the dew point temperature. Currently supported methods are ‘linear’ and ‘spline’. The default is to use linear interpolation. |
| quiet | Optional. Suppresses display of messages, except for errors. If you are calling this function in an R script, you will usually leave quiet=TRUE (i.e. the default). If you are working interactively, you will probably want to set quiet=FALSE. |
| logfile | Optional. Name of the file to be used for logging the action. Normally not used. |

Value

If successful, returns an obs dataframe containing the interpolated hourly 2m vapour pressures (ea) in kPA. If unsuccessful, returns the value FALSE.

Author(s)

Kevin Shook

See Also[ERAgatNearestTimeseries interpolate ERAhourlyAirtemp](#)**Examples**

```
## Not run:
hourlyVP <- ERAhourlyVP(d2m)
## End(Not run)
```

| | |
|--------------------|---|
| ERAhourlyWindspeed | <i>Estimates hourly wind speeds from ERA-Interim 3-hourly or ERA-40 6-hourly wind vectors</i> |
|--------------------|---|

Description

Estimates hourly wind speeds from ERA-Interim 3-hourly or ERA-40 6-hourly wind vectors

Usage

```
ERAhourlyWindspeed(ERAU10, u10Colnum = 1, ERAV10, v10Colnum = 1,
  method = "linear", quiet = TRUE, logfile = "")
```

Arguments

| | |
|-----------|--|
| ERAU10 | Required. The CRHMr obs dataframe of ERA u10 wind vector values. The values must not be deaccumulated, as the deaccumERA function is called by this function. |
| u10Colnum | Optional. The column number containing the u10 values, not including the date-time. Default is column 1. |
| ERAV10 | Required. The CRHMr obs dataframe of ERA v10 wind vector values. The values must not be deaccumulated, as the deaccumERA function is vcalled by this function. |
| v10Colnum | Optional. The column number containing the v10 values, not including the date-time. Default is column 1. |
| method | Optional. The methods to be used for interpolation of the wind speeds. Currently supported methods are 'linear' and 'spline'. The default is to use linear interpolation. |
| quiet | Optional. Suppresses display of messages, except for errors. If you are calling this function in an R script, you will usually leave quiet=TRUE (i.e. the default). If you are working interactively, you will probably want to set quiet=FALSE. |
| logfile | Optional. Name of the file to be used for logging the action. Normally not used. |

Value

If successful, returns an obs dataframe containing the interpolated hourly 10m wind speeds (u10) in m/s and directions in degrees. If unsuccessful, returns the value FALSE.

Author(s)

Kevin Shook

See Also

[ERAgetNearestTimeseries interpolate](#)

Examples

```
## Not run:
hourlyU <- ERAhourlyWindspeed(ERAu10=u10, ERAv10=v10)
## End(Not run)
```

land

Land locations

Description

A dataframe containing the information about the locations inside the WFD netCDF files. This data is used by the function [WATCHcreateHourlyWFDobs](#).

Usage

```
land
```

Format

A dataframe with 67420 rows and 6 variables:

Land number of the grid location

Longitude longitude of the centre grid square

Latitude latitude of the centre grid square

Ht.m elevation of the centre grid square

glon x-location of the grid square

glat y-location of the grid square

Source

This data was extracted from a file distributed with the WFD data, which can be downloaded from <http://www.eu-watch.org/>.

| | |
|--------------------|------------------------------------|
| NARRdownloadNetCDF | <i>Downloads NARR NetCDF files</i> |
|--------------------|------------------------------------|

Description

Downloads NARR NetCDF files for a specified variable for a specified time step and range of years.

Usage

```
NARRdownloadNetCDF(interval = "daily", startYear = 1979, endYear = 1979,  
  destination = ".", variable = "precip", quiet = FALSE)
```

Arguments

| | |
|-------------|--|
| interval | Optional. Time interval of NARR data. Can be '3h' or 'daily', which is the default. |
| startYear | Optional. The first year to download. Default is 1979. |
| endYear | Optional. The last year to download. Default is 1979. |
| destination | Optional. The destination directory for the downloaded files. The default is the current directory. |
| variable | Optional. The variable to be downloaded. Acceptable values are 'precip' (the default), 'temp', 'rh', 'wind', 'qli' and 'qli'. |
| quiet | Optional. Suppresses display of messages, except for errors. Because this function can be very slow to execute, the default value is FALSE, to provide information on the downloading. |

Value

Writes the specified files to the destination directory. If successful, returns TRUE. If unsuccessful, returns FALSE.

Examples

```
## Not run:  
NARRdownloadNetCDF('3h', 1979, 2015)  
## End(Not run)
```

NARRgetNearestTimeseries

Finds timeseries of NARR data nearest to specified location

Description

Reads a NARR NetCDF file, which contains all of the 3-hour values of a single variable for a single year, and extracts the values for a single location. Note that the values are *NOT* quality controlled - negative precipitation values are possible.

Usage

```
NARRgetNearestTimeseries(ncdfFile, varName, pointLon, pointLat, timezone = "",
  quiet = TRUE, logfile = "")
```

Arguments

| | |
|----------|--|
| ncdfFile | Name of the NetCDF file containing ERA data. |
| varName | Required. Name of the NetCDF variable to extract. |
| pointLon | Required. Decimal longitude of desired location. Note that the NetCDF longitude is <i>East</i> , your value should be negative. |
| pointLat | Required. Decimal latitude of desired location. |
| timezone | Required. The name of the timezone of the data as a character string. This should be the timezone of your data, but omitting daylight savings time. Note that the timezone code is specific to your OS. To avoid problems, you should use a timezone without daylight savings time. Under Linux, you can use 'CST' and 'MST' for Central Standard or Mountain Standard time, respectively. Under Windows or OSX, you can use 'etc/GMT+6' or 'etc/GMT+7' for Central Standard and Mountain Standard time. DO NOT use 'America/Regina' as the time zone, as it includes historical changes between standard and daylight savings time. |
| quiet | Optional. Suppresses display of messages, except for errors. If you are calling this function in an R script, you will usually leave quiet=TRUE (i.e. the default). If you are working interactively, you will probably want to set quiet=FALSE, as it will list the actual latitude and longitude of the ERA tile. |
| logfile | Optional. Name of the file to be used for logging the action. Normally not used. |

Value

If unsuccessful, returns FALSE. If successful, returns a standard **CRHMr** dataframe containing the datetime and the extracted data, which are unpacked (i.e. the NetCDF multiplier and offset have been applied). If quiet=FALSE, then the NARR location used and its distance to the specified location will be displayed.

If unsuccessful, returns FALSE. If successful, returns a **CRHMr** data frame of the specified variable. Note that no unit conversions are done, so the variable will be in the NARR units.

Examples

```
## Not run:
p1979 <- NARRgetNearestTimeseries('acpcp.1979.nc', varName='acpcp', pointLon = -113,
pointLat = 52, timezone = 'CST', quiet=FALSE)
## End(Not run)
```

WATCHcreateHourlyWFDEIobs

Creates a CRHM .obs file of hourly values from WATCH reanalysis data WFDEI files

Description

Extracts data from WATCH WFDEI netCDF files and builds a CRHM .obs file of hourly values containing t, ea, u10, p Qsi and Qli. All values are interpolated from 3 and 6 hur data. The windspeeds are at 10m, hence they are denoted as u10. Air temperatures are at 2m. The values for ea are computed from the atmospheric pressure (at 10m) and the absolute humidity (at 2m). Because the original NetCDF files are very large, this function typically runs very slowly. Also, because this function assembles and processes all of the data in memory, it can require a lot of RAM to execute.

Usage

```
WATCHcreateHourlyWFDEIobs(nc.location = "", startyear = 1979,
endyear = 2012, lon = 0, lat = 0, precipType = "CRU",
sunTimeOffset = 2, solarMethod = "simpleMaxSolar",
interpolationMethod = "linear", obsFileName = "", timezone = "",
quiet = TRUE, logfile = "")
```

Arguments

| | |
|---------------|--|
| nc.location | Required. A character string of the directory holding the WATCH WFDEI netCDF files. This is a file path WITHOUT a terminal slash, e.g. 'z:\WATCH\WFDEI' |
| startyear | Optional. Year to begin. Must be in the range 1979–2012. Default is 1979. |
| endyear | Optional. Year to end. Must be in the range 1979–2012. Default is 2012. |
| lon | Required. Decimal longitude to extract for. |
| lat | Required. Decimal latitude to extract for. |
| precipType | Optional. The precipitation type used; can be 'CRU' (the default) or 'GPCC'. |
| sunTimeOffset | Optional. Number of hours that local noon is offset from solar noon. The default is 2 hours. This may be incorrect. It seems that WATCH data may not incorporate the temporal offset correctly - zero may work better. |
| solarMethod | The method to be used for calculating the extra-terrestrial radiation. The default method is 'simpleMaxSolar'. Note that this method is only valid for latitudes between 49 and 55°N. The other supported method is 'PotSolarInst', which requires the package EcoHydRology to be installed |

| | |
|---------------------|---|
| interpolationMethod | Optional. A vector containing the methods to be used for interpolation for each of the variables. Currently supported methods are 'linear' and 'spline'. The default is to use linear interpolation. If fewer methods than columns are specified, the methods are recycled. |
| obsFileName | Required. Name of the .obs file to be created. |
| timezone | Required. The name of the timezone of the data as a character string. This should be the timezone of your data, but omitting daylight savings time. Note that the timezone code is specific to your OS. To avoid problems, you should use a timezone without daylight savings time. You can use 'Etc/GMT+6' or 'Etc/GMT+7' for Central Standard and Mountain Standard time. DO NOT use 'America/Regina' as the time zone, as it includes historical changes between standard and daylight savings time. |
| quiet | Optional. Suppresses display of messages, except for errors. If you are calling this function in an R script, you will usually leave quiet=TRUE (i.e. the default). If you are working interactively, you will probably want to set quiet=FALSE. |
| logfile | Optional. Name of the file to be used for logging the action. Normally not used. |

Value

If successful, returns the value TRUE and writes the specified .obs file. If unsuccessful, returns the value FALSE.

Note

Because this function can be slow, and uses a lot of memory, you may wish to run it repeatedly for short intervals. You can then use the function appendObs in **CRHMr** to join the files together. The time shifting results in obs files which do not begin and end on day boundaries, so you should use the function trimObs in **CRHMr** to trim the obs file - *after* the final file has been assembled.

Author(s)

Kevin Shook.

References

R code for conversion of air pressure and absolute humidity was taken from project PEcAn The Predictive Ecosystem Analyzer <http://pecanproject.github.io>. The source code is available at <https://github.com/PecanProject/pecan/blob/master/modules/data.atmosphere/R/metutils.R>.

See Also

[WATCHcreateHourlyWFDobs](#) [trimObs](#) [appendObs](#)

Examples

```
## Not run:
location <- 'z:\data\WATCH\WFDEI'
obsName <- 'VermilionWATCH_WFDEI.obs'
WATCHcreateHourlyWFDobs(nc.location=location,
startyear=1979, endyear=2001, lon=-111.9, lat=53.2, timezone='Etc/GMT+7', obsFileName=obsName)
# read in file and trim it
obs <- CRHMr::readObsFile(obsFile=obsName, timezone='Etc/GMT+7')
trimmedObs <- CRHMr::trimObs(obs)
CRHMr::writeObsFile(trimmedObs, obsFileName)
## End(Not run)
```

WATCHcreateHourlyWFDobs

Creates a CRHM .obs file of hourly values from WATCH reanalysis data WFD files

Description

Extracts data from WATCH WFD netCDF files and builds a CRHM .obs file of hourly values containing t, ea, u10, p Qsi and Qli. All values are interpolated from 3 and 6 hr data. The windspeeds are at 10m, hence they are denoted as u10. Air temperatures are at 2m. The values for ea are computed from the atmospheric pressure (at 10m) and the absolute humidity (at 2m). Because the original NetCDF files are very large, this function typically runs very slowly. Also, because this function assembles and processes all of the data in memory, it can require a lot of RAM to execute.

Usage

```
WATCHcreateHourlyWFDobs(nc.location = "", startyear = 1901,
endyear = 2001, lon = 0, lat = 0, sunTimeOffset = 2,
solarMethod = "simpleMaxSolar", interpolationMethod = "linear",
obsFileName = "", timezone = "", quiet = TRUE, logfile = "")
```

Arguments

| | |
|---------------|--|
| nc.location | Required. A character string of the directory holding the WATCH WFD netCDF files. This is a file path WITHOUT a terminal slash, e.g. 'z:\WATCH\WFD'. |
| startyear | Optional. Year to begin. Must be in the range 1901–2001. Default is 1901. |
| endyear | Optional. Year to end. Must be in the range 1901–2001. Default is 2001. |
| lon | Required. Decimal longitude to extract for. |
| lat | Required. Decimal latitude to extract for. |
| sunTimeOffset | Optional. Number of hours that local noon is offset from solar noon. The default is 2 hours. |

| | |
|---------------------|---|
| solarMethod | The method to be used for calculating the extra-terrestrial radiation. The default method is 'simpleMaxSolar'. Note that this method is only valid for latitudes between 49 and 55°N. The other supported method is 'PotSolarInst', which requires the package EcoHydRology to be installed |
| interpolationMethod | Optional. A vector containing the methods to be used for interpolation for each of the variables. Currently supported methods are 'linear' and 'spline'. The default is to use linear interpolation. If fewer methods than columns are specified, the methods are recycled. |
| obsFileName | Required. Name of the .obs file to be created. |
| timezone | Required. The name of the timezone of the data as a character string. This should be the timezone of your data, but omitting daylight savings time. Note that the timezone code is specific to your OS. To avoid problems, you should use a timezone without daylight savings time. You can use 'Etc/GMT+6' or 'Etc/GMT+7' for Central Standard and Mountain Standard time. DO NOT use 'America/Regina' as the time zone, as it includes historical changes between standard and daylight savings |
| quiet | Optional. Suppresses display of messages, except for errors. If you are calling this function in an R script, you will usually leave quiet=TRUE (i.e. the default). If you are working interactively, you will probably want to set quiet=FALSE. |
| logfile | Optional. Name of the file to be used for logging the action. Normally not used. |

Value

If successful, returns the value TRUE and writes the specified .obs file. Each month's data is written as it is created. If unsuccessful, returns the value FALSE.

Author(s)

Kevin Shook

References

R code for conversion of air pressure and absolute humidity was taken from project PEcAn The Predictive Ecosystem Analyzer <http://pecanproject.github.io>. The source code is available at <https://github.com/PecanProject/pecan/blob/master/modules/data.atmosphere/R/metutils.R>.

Examples

```
## Not run:
location <- 'z:\data\WATCH\WFD'
obsFileName <- 'VermilionWATCH_WFD.obs'
WATCHcreateWFDobs(location, 1979, 2001, -111.9, 53.2, timezone='Etc/GMT+7', obsFileName=obsFileName)
## End(Not run)
```

| | |
|---------------------|---|
| WATCHcreateWFDEIobs | <i>Creates a CRHM .obs file of 3-hourly values from WATCH reanalysis data WFDEI files</i> |
|---------------------|---|

Description

Extracts data from WATCH WFDEI netCDF files and builds a CRHM .obs file of 3-hour data containing t, ea, u10, and p values. The output values can be interpolated to hourly using the function HourlyWATCHobs. The windspeeds are at 10m, hence they are denoted as u10. Air temperatures are at 2m. The values for ea are computed from the atmospheric pressure (at 10m) and the absolute humidity (at 2m).

Usage

```
WATCHcreateWFDEIobs(nc.location = "", startyear = 1979, endyear = 2012,
  lon = 0, lat = 0, houroffset = 0, obsFileName = "", quiet = TRUE,
  logfile = "")
```

Arguments

| | |
|-------------|--|
| nc.location | Required. A character string of the directory holding the WATCH WFDEI netCDF files. This is a file path WITHOUT a terminal slash, e.g. 'z:\WATCH\WFDEI' |
| startyear | Optional. Year to begin. Must be in the range 1979–2012. Default is 1979. |
| endyear | Optional. Year to end. Must be in the range 1979–2012. Default is 2012. |
| lon | Required. Decimal longitude to extract for. |
| lat | Required. Decimal latitude to extract for. |
| houroffset | Required. Number of hours that the local location is offset from UTC (GMT). Must be negative in the western hemisphere. For Mountain Standard Time, the offset is -7 hours. |
| obsFileName | Required. Name of the .obs file to be created. |
| quiet | Optional. Suppresses display of messages, except for errors. If you are calling this function in an R script, you will usually leave quiet=TRUE (i.e. the default). If you are working interactively, you will probably want to set quiet=FALSE. |
| logfile | Optional. Name of the file to be used for logging the action. Normally not used. |

Value

If successful, returns the value TRUE and writes the specified .obs file. Each month's data is written as it is created. If unsuccessful, returns the value FALSE.

Author(s)

Kevin Shook.

References

R code for conversion of air pressure and absolute humidity was taken from project PEcAn The Predictive Ecosystem Analyzer <http://pecanproject.github.io>. The source code is available at <https://github.com/PecanProject/pecan/blob/master/modules/data.atmosphere/R/metutils.R>.

Examples

```
## Not run:
location <- 'z:\data\WATCH\WFDEI'
obsFileName <- 'VermilionWATCH_WFDEI.obs'
WATCHcreateWFDEIobs(location, 1979, 2001, -111.9, 53.2, -7, obsFileName)
## End(Not run)
```

| | |
|-------------------|--|
| WATCHcreateWFDobs | <i>Creates a CRHM .obs file of 3-hourly and 6-hourly values from WATCH reanalysis data WFD files</i> |
|-------------------|--|

Description

Extracts data from WATCH WFD netCDF files and builds a CRHM .obs file of 3-hour data containing t, ea, u10, and p values. The values of t, ea and u are 6-hourly, with NA values inserted. The data are output at MST. The output values can be interpolated to hourly values using the function HourlyWATCHObs. The windspeeds are at 10m, so they are denoted as u10. Air temperatures are at 2m. The values for ea are computed from the atmospheric pressure (at 10m) and the absolute humidity (at 2m).

Usage

```
WATCHcreateWFDobs(nc.location = "", startyear = 1901, endyear = 2001,
  lon = 0, lat = 0, houroffset = 0, obsFileName = "", quiet = TRUE,
  logfile = "")
```

Arguments

| | |
|-------------|---|
| nc.location | Required. A character string of the directory holding the WATCH WFD netCDF files. This is a file path WITHOUT a terminal slash, e.g. 'z:\WATCH\WFD'. |
| startyear | Optional. Year to begin. Must be in the range 1901–2001. Default is 1901. |
| endyear | Optional. Year to end. Must be in the range 1901–2001. Default is 2001. |
| lon | Required. Decimal longitude to extract for. |
| lat | Required. Decimal latitude to extract for. |
| houroffset | Required. Number of hours that the local location is offset from UTC (GMT). Must be negative in the western hemisphere. For Mountain Standard Time, the offset is -7 hours. |
| obsFileName | Required. Name of the .obs file to be created. |

| | |
|---------|--|
| quiet | Optional. Suppresses display of messages, except for errors. If you are calling this function in an R script, you will usually leave quiet=TRUE (i.e. the default). If you are working interactively, you will probably want to set quiet=FALSE. |
| logfile | Optional. Name of the file to be used for logging the action. Normally not used. |

Value

If successful, returns the value TRUE and writes the specified .obs file. Each month's data is written as it is created. If unsuccessful, returns the value FALSE.

Author(s)

Kevin Shook

References

R code for conversion of air pressure and absolute humidity was taken from project PEcAn The Predictive Ecosystem Analyzer <http://pecanproject.github.io>. The source code is available at <https://github.com/PecanProject/pecan/blob/master/modules/data.atmosphere/R/metutils.R>.

Examples

```
## Not run:
location <- 'z:\data\WATCH\WFD'
obsFileName <- 'VermilionWATCH_WFD.obs'
WATCHcreateWFDobs(location, 1979, 2001, -111.9, 53.2, -7, obsFileName)
## End(Not run)
```

WATCHdailyArealPrecip *Calculates daily WATCH areal precipitation*

Description

Calculates daily WATCH areal precipitation

Usage

```
WATCHdailyArealPrecip(monthlyPrecip, timezone)
```

Arguments

| | |
|---------------|--|
| monthlyPrecip | All WATCH precipitation for a month, as returned by WATCHgetWFDarealPrecip. |
| timezone | Required. The name of the timezone of the data as a character string. This should be the timezone of your data, but omitting daylight savings time. Note that the timezone code is specific to your OS. To avoid problems, you should use a timezone without daylight savings time. Under Linux, you can use 'CST' and 'MST' for Central Standard or Mountain Standard time, respectively. Under |

Windows or OSX, you can use 'etc/GMT+6' or 'etc/GMT+7' for Central Standard and Mountain Standard time. DO NOT use 'America/Regina' as the time zone, as it includes historical changes between standard and daylight savings time.

Details

Calculates the daily total WATCH precipitation for all locations in a region.

Value

If successful, returns a data frame consisting of the date, longitude, latitude, and total precipitation (in mm) for each point. If unsuccessful, returns FALSE.

Examples

```
## Not run:
daily_rain <- WATCHdailyArealPrecip(monthly_rain, 'CST')
## End(Not run)
```

WATCHgetWFDarealPrecip

Extracts the WATCH WFD precipitation for a specified domain

Description

Extracts the WATCH WFD precipitation (rainfall or snowfall) from a monthly netCDF file for a specified domain.

Usage

```
WATCHgetWFDarealPrecip(ncdfFile = "", minLon = 0, maxLon = 0,
  minLat = 0, maxLat = 0, logfile = "")
```

Arguments

| | |
|----------|--|
| ncdfFile | Required. NetCDF file containing monthly WATCH WFD precipitation (rainfall or snowfall). The file name must begin with the precipitation type (i.e. 'Rainf' or 'Snowf' and must end with the year and month, as in '190101'. |
| minLon | Required. Minimum longitude for area to be extracted. |
| maxLon | Required. Maximum longitude for area to be extracted. |
| minLat | Required. Minimum latitude for area to be extracted. |
| maxLat | Required. Maximum latitude for area to be extracted. |
| logfile | Optional. Name of the file to be used for logging the action. Normally not used |

Value

If successful, returns a data frame containing all of the precipitation values. The rows contain the values for each location for all time intervals. The first 2 columns contain the Longitude and Latitude, respectively for each location within the domain. The following columns contain the precipitation rate for each time interval. The names of these columns are the time intervals, e.g. '1901-01-01_00:00' (note the underscore) in GMT.

Author(s)

Kevin Shook

Examples

```
## Not run:
monthly_rain <- WATCHgetWFDarealPrecip('Rainf_WFD_CRU_190101.nc',
  minLon=-105, maxLon=-95, minLat = 49, maxLat = 56)
## End(Not run)
```

WATCHgroupWFDEIobs *Create obs files from WATCH WFDEI data for groups of sites*

Description

Extracts all variables from WFDEI NetCDF files and builds obs files for all specified locations

Usage

```
WATCHgroupWFDEIobs(siteFile, ncLocation, outputLocation, startyear = 1979,
  endyear = 2001, solarMethod = "PotSolarInst",
  interpolationMethod = "linear", quiet = TRUE, logfile = "")
```

Arguments

| | |
|------------|--|
| siteFile | Required. A .csv file containing all of the variables required to describe the site locations. These are: Name Name of site Land Land ID number Longitude Site longitude Latitude Site latitude glon Site glon value glat Site glat value timezone Time zone for site. Must be in Etc format, e.g. Etc/GMT+7 SolarOffset Local offset of solar noon in hours |
| ncLocation | Required. Location of all of the WATCH WFD files. Must have a trailing '\' |

| | |
|---------------------|---|
| outputLocation | Required. Location for all of the output files. Must have a trailing '\ ' symbol. |
| startyear | Optional. Year to begin extraction. Default is 1901. |
| endyear | Optional. Year to begin extraction. Default is 2001. |
| solarMethod | The method to be used for calculating the extra-terrestrial radiation. The default method is 'PotSolarInst', which requires the package EcoHydRology to be installed. The other supported method is 'simpleMaxSolar'. Note that this method is only valid for latitudes between 49 and 55°N. |
| interpolationMethod | Optional. A vector containing the methods to be used for interpolation for each of the variables. Currently supported methods are 'linear' and 'spline'. The default is to use linear interpolation. If fewer methods than columns are specified, the methods are recycled. |
| quiet | Optional. Suppresses display of messages, except for errors. If you are calling this function in an R script, you will usually leave quiet=TRUE (i.e. the default). If you are working interactively, you will probably want to set quiet=FALSE. |
| logfile | Optional. Name of the file to be used for logging the action. Normally not used. |

Value

If successful, returns the value TRUE and writes the specified .obs file. Each month's data is written as it is created. If unsuccessful, returns the value FALSE.

Author(s)

Kevin Shook

References

R code for conversion of air pressure and absolute humidity was taken from project PEcAn The Predictive Ecosystem Analyzer <http://pecanproject.github.io>. The source code is available at <https://github.com/PecanProject/pecan/blob/master/modules/data.atmosphere/R/metutils.R>.

Examples

```
## Not run:
points <- './Reanalysis/testdata/WATCH_selected_points.csv'
outputLocation <- './Reanalysis/testdata/'
ncloc <- '//water.usask.ca/Centre/Reanalysis_data/WATCH/WFD'
WATCHgroupWFDEIobs(siteFile = points, ncLocation = ncloc, outputLocation=outputLocation,
startyear = 1962, endyear = 1962))

## End(Not run)
```


WATCHgroupWFDobs

*Create obs files from WATCH WFD data for groups of sites***Description**

Extracts all variables from WFD NetCDF files and builds obs files for all specified locations

Usage

```
WATCHgroupWFDobs(siteFile, ncLocation, outputLocation, startyear = 1901,
  endyear = 2001, solarMethod = "PotSolarInst",
  interpolationMethod = "linear", quiet = TRUE, logfile = "")
```

Arguments

| | |
|---------------------|--|
| siteFile | Required. A .csv file containing all of the variables required to describe the site locations. These are: Name Name of site Land Land ID number Longitude Site longitude Latitude Site latitude glon Site glon value glat Site glat value timezone Time zone for site. Must be in Etc format, e.g. Etc/GMT+7 SolarOffset Local offset of solar noon in hours |
| ncLocation | Required. Location of all of the WATCH WFD files. Must have a trailing '\' |
| outputLocation | Required. Location for all of the output files. Must have a trailing '\' |
| startyear | Optional. Year to begin extraction. Default is 1901. |
| endyear | Optional. Year to begin extraction. Default is 2001. |
| solarMethod | The method to be used for calculating the extra-terrestrial radiation. The default method is 'PotSolarInst', which requires the package EcoHydRology to be installed. The other supported method is 'simpleMaxSolar'. Note that this method is only valid for latitudes between 49 and 55°N. |
| interpolationMethod | Optional. A vector containing the methods to be used for interpolation for each of the variables. Currently supported methods are 'linear' and 'spline'. The default is to use linear interpolation. If fewer methods than columns are specified, the methods are recycled. |
| quiet | Optional. Suppresses display of messages, except for errors. If you are calling this function in an R script, you will usually leave quiet=TRUE (i.e. the default). If you are working interactively, you will probably want to set quiet=FALSE. |
| logfile | Optional. Name of the file to be used for logging the action. Normally not used. |

Value

If successful, returns the value TRUE and writes the specified .obs file. Each month's data is written as it is created. If unsuccessful, returns the value FALSE.

Author(s)

Kevin Shook

References

R code for conversion of air pressure and absolute humidity was taken from project PEcAn The Predictive Ecosystem Analyzer <http://pecanproject.github.io>. The source code is available at <https://github.com/PecanProject/pecan/blob/master/modules/data.atmosphere/R/metutils.R>.

Examples

```
## Not run:
points <- './Reanalysis/testdata/WATCH_selected_points.csv'
outputLocation <- './Reanalysis/testdata/'
ncloc <- '//water.usask.ca/Centre/Reanalysis_data/WATCH/WFD'
WATCHgroupWFDobs(siteFile = points, ncLocation = ncloc, outputLocation=outputLocation,
startyear = 1962, endyear = 1962))

## End(Not run)
```

WATCHhourlyObs

Interpolates 3 and 6 hour WATCH variables to hourly values

Description

Interpolates t, u10, ea, qsi, and qli values (6-hour in WFD, 3-hour in WFDEI) to hourly. The total p values are evenly divided over the hourly intervals. Outputs hourly t, u10, ea, qsi, qli, and p.

Usage

```
WATCHhourlyObs(infile = "", outfile = "", logfile = "")
```

Arguments

| | |
|---------|--|
| infile | Required. Name of file created by CreateWFDobs or CreateWFDobs. |
| outfile | Required. Hourly obs file to be created. |
| logfile | Optional. Name of the file to be used for logging the action. Normally not use |

Value

If successful, returns the value TRUE and writes the specified .obs file of hourly values. If unsuccessful, returns the value FALSE.

Author(s)

Kevin Shook

Examples

```
## Not run:
WATCHhourlyObs('VermilionWATCH_WFD.obs', 'VermilionWFDhourly.obs')
WATCHhourlyObs('VermilionWATCH_WFDEI.obs', 'VermilionWFDEIhourly.obs')
## End(Not run)
```

WRFbyloc2obs

Extracts CRHM obs variables from a WRF NetCDF at a single specified location

Description

This function is intended to work with NetCDF created by the research group of Dr. Yanping Li of Global Water Futures gwf.usask.ca. This function creates a **CRHM** data frame from a WRF NetCDF specified by their location within the file. This function will work even if there are only values for a single location inside the NetCDF.

Usage

```
WRFbyloc2obs(NetCDF = "", obsfile = "",
  startDatetime = "2000-10-01 00:00", endDatetime = "2100-12-01 23:00",
  west_east_loc = 1, south_north_loc = 1, airPressure = 0,
  timezone = "", trim = TRUE, quiet = TRUE, logfile = "")
```

Arguments

| | |
|-----------------|--|
| NetCDF | Required. The name of the NetCDF containing the WRF data. |
| obsfile | Optional. If specified the values are written to the obs file. |
| startDatetime | Optional. Beginning datetime of data to be extracted. A string formatted as "yyyy-mm-dd hh:mm". The default value is '2000-10-01 00:00'. |
| endDatetime | Optional. Ending datetime of data to be extracted. A string formatted as "yyyy-mm-dd hh:mm". The default value is '2100-12-01 23:00'. |
| west_east_loc | Optional. The NetCDF west_east location as an integer. The default value of 1 specifies the westernmost location. |
| south_north_loc | Optional. The NetCDF south_north location as an integer. The default value of 1 specifies the southernmost location. |
| airPressure | Optional. The mean air pressure in Pa. If set to zero (the default) then the air pressure within the NetCDF file will be used for converting the specific humidity to relative humidity. Because the air pressure may be incorrect or missing, you may wish to specify a mean air pressure to be used for the conversion. Note |

that if there is no air pressure within the NetCDF and you do not specify an air pressure value, this will trigger an error message, and the RH cannot be calculated.

| | |
|----------|--|
| timezone | Required. The name of the timezone of the data as a character string. This should be the timezone of your data, but omitting daylight savings time. Note that the timezone code is specific to your OS. To avoid problems, you should use a timezone without daylight savings time. Under Linux, you can use 'CST' and 'MST' for Central Standard or Mountain Standard time, respectively. Under Windows or OSX, you can use 'etc/GMT+6' or 'etc/GMT+7' for Central Standard and Mountain Standard time. DO NOT use 'America/Regina' as the time zone, as it includes historical changes between standard and daylight savings time. |
| trim | Optional. If TRUE (the default) then the final output will be trimmed to CRHM day boundaries. |
| quiet | Optional. Suppresses display of messages, except for errors. If you are calling this function in an R script, you will usually leave quiet=TRUE (i.e. the default). If you are working interactively, you will probably want to set quiet=FALSE. |
| logfile | Optional. Name of the file to be used for logging the action. Normally not used. |

Value

If successful, returns the value TRUE and (optionally) writes the specified .obs file. If unsuccessful, returns the value FALSE.

If successful, returns either TRUE (if an obs file is specified) or a **CRHM** obs data frame (if no obs file is specified). The data frame will contain the standard CRHM variables: t, p, u, either rh or ea, qsi, and qli, depending on their presence in the NetCDF. If unsuccessful, returns FALSE.

Author(s)

Kevin Shook

See Also

[WRFnearest2obs](#)

Examples

```
## Not run: f <- "wrf2d_tquvr.nc"
r <- WRFbyloc2obs(f, startDatetime = "1980-01-01 00:00", endDatetime = "1980-12-31 23:00")
## End(Not run)
```

| | |
|----------------|---|
| WRFnearest2obs | <i>Extracts CRHM obs variables from a WRF NetCDF closest to specified point</i> |
|----------------|---|

Description

This function is intended to work with NetCDF created by the research group of Dr. Yanping Li of Global Water Futures gwf.usask.ca. This function creates a **CRHM** data frame from a WRF NetCDF specified by their longitude and latitude, extracting values from the nearest location.

Usage

```
WRFnearest2obs(NetCDF = "", obsfile = "", longitude = 0, latitude = 0,
  airPressure = 0, startDatetime = "2000-10-01 00:00",
  endDatetime = "2100-12-01 23:00", timezone = "", trim = TRUE,
  quiet = TRUE, logfile = "")
```

Arguments

| | |
|---------------|--|
| NetCDF | Required. The name of the netCDF file containing the WRF data. |
| obsfile | Optional. If specified the values are written to the obs file. |
| longitude | Required. The longitude of the point being sought. The input value is <i>not</i> checked for validity, in case the model extent changes. |
| latitude | Required. The latitude of the point being sought. The input value is <i>not</i> checked for validity, in case the model extent changes. |
| airPressure | Optional. The mean air pressure in Pa. If set to zero (the default) then the air pressure within the NetCDF file will be used for converting the specific humidity to relative humidity. Because the air pressure may be incorrect or missing, you may wish to specify a mean air pressure to be used for the conversion. Note that if there is no air pressure within the NetCDF and you do not specify an air pressure value, this will trigger an error message, and the RH cannot be calculated. |
| startDatetime | Optional. Beginning date of data to be extracted. A string formatted as "yyyy-mm-dd hh:mm". The default value is '2000-10-01 00:00'. |
| endDatetime | Optional. Ending date of data to be extracted. A string formatted as "yyyy-mm-dd hh:mm". The default value is '2100-12-01 23:00'. |
| timezone | Required. The name of the timezone of the data as a character string. This should be the timezone of your data, but omitting daylight savings time. Note that the timezone code is specific to your OS. To avoid problems, you should use a timezone without daylight savings time. Under Linux, you can use 'CST' and 'MST' for Central Standard or Mountain Standard time, respectively. Under Windows or OSX, you can use 'etc/GMT+6' or 'etc/GMT+7' for Central Standard and Mountain Standard time. DO NOT use 'America/Regina' as the time zone, as it includes historical changes between standard and daylight savings time. |

| | |
|---------|--|
| trim | Optional. If TRUE (the default) then the final output will be trimmed to CRHM day boundaries. |
| quiet | Optional. Suppresses display of messages, except for errors. If you are calling this function in an R script, you will usually leave quiet=TRUE (i.e. the default). If you are working interactively, you will probably want to set quiet=FALSE. |
| logfile | Optional. Name of the file to be used for logging the action. Normally not used. |

Value

If successful, returns the value TRUE and (optionally) writes the specified .obs file. If unsuccessful, returns the value FALSE.

Author(s)

Kevin Shook

See Also

[WRFbyloc2obs](#)

Examples

```
## Not run: f <- "wrf2d_tquvr.nc"
r <- WRFnearest2obs(f, longitude=-115.27,
latitude=52.03, startDatetime = "1980-01-01 00:00", endDatetime="1980-12-31 23:00")

## End(Not run)
```

Index

*Topic **datasets**

land, [20](#)

appendObs, [24](#)

CanRCM4AdjustedCreateHourlyObs, [3](#)

CanRCM4adjustedGetNearestTimeseries, [4](#),
[4](#)

CanRCM4unadjustedGetNearestTimeseries,
[6](#)

distributeQsi, [18](#)

ERAdailyArealPrecip, [7](#)

ERAdaccum, [8](#), [11](#), [13](#), [15](#)

ERAgetArealPrecip, [9](#)

ERAgetMultipleLocationTimeseries, [10](#)

ERAgetNearestTimeseries, [11](#), [12](#), [14–16](#),
[18–20](#)

ERAhourlyAirtemp, [13](#), [19](#)

ERAhourlyLongwave, [14](#), [18](#)

ERAhourlyPrecip, [16](#)

ERAhourlyShortwave, [15](#), [17](#)

ERAhourlyVP, [18](#)

ERAhourlyWindspeed, [19](#)

interpolate, [14](#), [19](#), [20](#)

land, [20](#)

NARRdownloadNetCDF, [21](#)

NARRgetNearestTimeseries, [22](#)

Reanalysis-package, [2](#)

trimObs, [24](#)

WATCHcreateHourlyWFDEIobs, [23](#)

WATCHcreateHourlyWFDobs, [20](#), [24](#), [25](#)

WATCHcreateWFDEIobs, [27](#)

WATCHcreateWFDobs, [28](#)

WATCHdailyArealPrecip, [29](#)

WATCHgetWFDarealPrecip, [30](#)

WATCHgroupWFDEIobs, [31](#)

WATCHgroupWFDobs, [33](#)

WATCHhourlyObs, [34](#)

WRFbyloc2obs, [35](#), [38](#)

WRFnearest2obs, [36](#), [37](#)