

Package ‘gmwmx2’

January 8, 2026

Title Estimate Functional and Stochastic Parameters of Linear Models
with Correlated Residuals and Missing Data

Version 0.0.4

Description Implements the Generalized Method of Wavelet Moments with Exogenous Inputs estimator (GMWMX) presented in Voirol, L., Xu, H., Zhang, Y., Insolia, L., Molinari, R. and Guerrier, S. (2024) <[doi:10.48550/arXiv.2409.05160](https://doi.org/10.48550/arXiv.2409.05160)>.

The GMWMX estimator allows to estimate functional and stochastic parameters of linear models with correlated residuals in presence of missing data.

The 'gmwmx2' package provides functions to load and plot Global Navigation Satellite System (GNSS) data from the Nevada Geodetic Laboratory and functions to estimate linear model model with correlated residuals in presence of missing data.

License AGPL-3

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LinkingTo Rcpp, RcppArmadillo

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Suggests knitr, rmarkdown, knitr citations, raster, rnaturalearth,
shape, tibble, tidygeocoder, sf, geodata

URL <https://github.com/SMAC-Group/gmwmx2>

BugReports <https://github.com/SMAC-Group/gmwmx2/issues>

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df_estimated_velocities_gmwmx
<i>Estimated northward and eastward velocity and their standard deviation using the GMWMX estimator</i>

Description

Estimated northward and eastward velocity and standard deviation for a subset of 1202 GNSS station with more than 10 years of daily data.

Usage

df_estimated_velocities_gmwmx

Format

A data frame with 1202 rows and 12 variables:

- station_name** Name of the GNSS station.
- estimated_trend_N** Estimated northward velocity trend (in meters per day).
- std_estimated_trend_N** Standard deviation of the estimated northward velocity trend.
- estimated_trend_E** Estimated eastward velocity trend (in meters per day).
- std_estimated_trend_E** Standard deviation of the estimated eastward velocity trend.
- length_signal** Length of the signal (in days).

estimated_trend_N_scaled Scaled estimated northward velocity trend (multiplying by 365.25 for yearly values).

std_estimated_trend_N_scaled Scaled standard deviation of the estimated northward velocity trend.

estimated_trend_E_scaled Scaled estimated eastward velocity trend (multiplying by 365.25 for yearly values).

std_estimated_trend_E_scaled Scaled standard deviation of the estimated eastward velocity trend.

latitude Latitude of the GNSS station.

longitude Longitude of the GNSS station.

download_all_stations_ngl

Download all stations name and location from the Nevada Geodetic Laboratory

Description

Download all stations name and location from the Nevada Geodetic Laboratory

Usage

```
download_all_stations_ngl(verbose = FALSE)
```

Arguments

verbose	A boolean that controls the level of detail in the output of the wget command used to load data. Default is FALSE.
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Value

Return a `data.frame` with all stations name, latitude, longitude and heights.

Examples

```
df_all_stations <- download_all_stations_ngl()
head(df_all_stations)
```

download_estimated_velocities_ngl

Download estimated velocities provided by the Nevada Geodetic Laboratory for all stations.

Description

Download estimated velocities provided by the Nevada Geodetic Laboratory for all stations.

Usage

```
download_estimated_velocities_ngl(verbose = FALSE)
```

Arguments

verbose	A boolean that controls the level of detail in the output of the wget command used to load data. Default is FALSE.
---------	--

Value

Return a `data.frame` with all stations name, information about the time series for each station, estimated velocities and estimated standard deviation of the estimated velocities.

Examples

```
df_estimated_velocities <- download_estimated_velocities_ngl()
head(df_estimated_velocities)
```

download_station_ngl	<i>Download GNSS position time series and steps reference from the Nevada Geodetic Laboratory with IGS14 or IGS20 reference frame.</i>
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Description

Download GNSS position time series and steps reference from the Nevada Geodetic Laboratory with IGS14 or IGS20 reference frame.

Usage

```
download_station_ngl(station_name, verbose = FALSE, reference_frame = "IGS20")
```

Arguments

`station_name` A string specifying the station name.

`verbose` A boolean that controls the level of detail in the output of the `wget` command used to load data. Default is `FALSE`.

`reference_frame` A string with value either "IGS14" or "IGS20" that specify which reference frame to use. Default is "IGS20".

Value

A list of class `gnss_ts_ngl` that contains three `data.frame`: The `data.frame` `df_position` which contains the position time series extracted from the `.tenv3` file available from the Nevada Geodetic Laboratory, the `data.frame` `df_equipment_software_changes` which specify the equipment or software changes for that stations and the `data.frame` `df_earthquakes` that specify the earthquakes associated with that station.

Examples

```
station_1LSU <- download_station_ngl("1LSU")
attributes(station_1LSU)
```

<code>gmwmx2</code>	<i>Estimate a trajectory model for a <code>gnss_ts_ngl</code> object considering a white noise plus colored noise as the stochastic model for the residuals and model missingness with a Markov process using the GMWMX estimator.</i>
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Description

Estimate a trajectory model for a `gnss_ts_ngl` object considering a white noise plus colored noise as the stochastic model for the residuals and model missingness with a Markov process using the GMWMX estimator.

Usage

```
gmwmx2(
  x,
  n_seasonal = 2,
  vec_earthquakes_relaxation_time = NULL,
  component = "N",
  toeplitz_approx_var_cov_wv = TRUE,
  stochastic_model = "wn + f1"
)
```

Arguments

<code>x</code>	A <code>gnss_ts_ngl</code> object.
<code>n_seasonal</code>	An integer specifying the number of seasonal signals in the time series. "1" specify only one annual periodic signal and "2" specify an annual and a semi-annual periodic signal.
<code>vec_earthquakes_relaxation_time</code>	A vector specifying the relaxation time for each earthquakes indicated for the time series.
<code>component</code>	A string with value either "N", "E" or "V" that specify which component to estimate (Northing, Easting or Vertical).
<code>toeplitz_approx_var_cov_wv</code>	A boolean that specify if the variance of the wavelet variance should be computed based on a toeplitz approximation of the variance covariance matrix of the residuals.
<code>stochastic_model</code>	A string that specify the stochastic model considered for the residuals. Either "wn + fl" for white noise and flicker/pink noise or "wn + pl" for white noise and stationary power-law noise.

Examples

```
x <- download_station_ngl("CHML")
fit <- gmwm2(x, n_seasonal = 2, component = "N")
```

```
plot.fit_gnss_ts_ngl  Plot a fit_gnss_ts_ngl object
```

Description

Plot a `fit_gnss_ts_ngl` object

Usage

```
## S3 method for class 'fit_gnss_ts_ngl'
plot(x, ...)
```

Arguments

<code>x</code>	A <code>fit_gnss_ts_ngl</code> object.
<code>...</code>	Additional graphical parameters.

Value

No return value. Plot a `fit_gnss_ts_ngl` object.

Examples

```
x <- download_station_ngl("0AMB")
fit_N <- gmwm2(x, n_seasonal = 2, component = "N")
plot(fit_N)
```

plot.gnss_ts_ngl	<i>Plot a gnss_ts_ngl object</i>
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Description

Plot a gnss_ts_ngl object

Usage

```
## S3 method for class 'gnss_ts_ngl'
plot(x, component = NULL, ...)
```

Arguments

x	A gnss_ts_ngl object.
component	A string with value either "N", "E" or "V" that specify which component to plot (Northing, Easting or Vertical).
...	Additional graphical parameters.

Value

No return value. Plot a gnss_ts_ngl object.

Examples

```
station_1LSU <- download_station_ngl("1LSU")
plot(station_1LSU)
plot(station_1LSU, component = "N")
plot(station_1LSU, component = "E")
plot(station_1LSU, component = "V")
```

```
summary.fit_gnss_ts_ngl
```

Extract estimated parameters from a fit_gnss_ts_ngl

Description

Extract estimated parameters from a fit_gnss_ts_ngl

Usage

```
## S3 method for class 'fit_gnss_ts_ngl'  
summary(object, scale_parameters = FALSE, ...)
```

Arguments

object	A fit_gnss_ts_ngl object.
scale_parameters	A boolean indicating whether or not to scale estimated parameters so that the returned estimated trend is provided in m/year instead of m/day. Default is FALSE.
...	Additional parameters.

Examples

```
x <- download_station_ngl("P820")  
fit1 <- gmwm2(x, n_seasonal = 2, component = "N", stochastic_model = "wn + pl")  
summary(fit1)  
summary(fit1, scale_parameters = TRUE)  
fit2 <- gmwm2(x, n_seasonal = 2, component = "N", stochastic_model = "wn + fl")  
summary(fit2)
```

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