Package 'earthtide'

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Type Package

Title Parallel Implementation of 'ETERNA 3.40' for Prediction and Analysis of Earth Tides

Version 0.0.14

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Description This is a port of 'Fortran ETERNA 3.4' <http://igets.u-strasbg.fr/soft_and_tool.php> by H.G. Wenzel for calculating synthetic Earth tides using the Hartmann and Wenzel (1994) <doi:10.1029/95GL03324> or Kudryavtsev (2004) <doi:10.1007/s00190-003-0361-2> tidal catalogs.

BugReports https://github.com/jkennel/earthtide/issues

URL https://github.com/jkennel/earthtide

License GPL-3

Depends R (>= 3.4.0)

Imports Rcpp (>= 1.0.0), RcppParallel (>= 4.4.2), R6 (>= 2.3.0)

LinkingTo Rcpp (>= 1.0.0), RcppParallel (>= 4.4.2), RcppArmadillo (>= 0.9.200.7.0), BH (>= 1.69.0-1)

Suggests testthat (>= 2.1.0), knitr, rmarkdown

RoxygenNote 7.2.0

VignetteBuilder knitr

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LazyData TRUE

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SystemRequirements C++11

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Repository CRAN

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R topics documented:

`earthtide-package` *earthtide: R port of the earth tide processing package ETERNA (by Hans-Georg Wenzel) including the Kudryavtsev wave catalog.*

Description

The goal of this package is to generate synthetic earth tides for use in the R programming language and in particular environmental models. Code was parallized and refactored to minimize duplication, and to allow for future improvements.

Details

You can learn about the earthtide package in the vignettes: `browseVignettes(package = "earthtide")`

Author(s)

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- Wenzel Hans-Georg [contributor]

References

Hartmann, T., Wenzel, H.-G., 1995. The HW95 tidal potential catalogue. Geophys. Res. Lett. 22, 3553-3556. doi:10.1029/95GL03324

Kudryavtsev, S.M., 2004. Improved harmonic development of the Earth tide-generating potential. J. Geod. 77, 829-838. doi:10.1007/s0019000303612

Wenzel, H.G., 1996. The nanogal software: Earth tide data processing package ETERNA 3.30. Bull. Inf. Marées Terrestres, 124, pp.9425-9439. https://www.eas.slu.edu/GGP/ETERNA34/MANUAL/ETERNA33.HTM

See Also

Useful links:

- https://github.com/jkennel/earthtide
- Report bugs at https://github.com/jkennel/earthtide/issues

calc_earthtide *earthtide*

Description

This is a wrapper to the Earthtide R6 class for the prediction of Earth tides. This function is provided for users who would prefer a more typical R function.

Usage

```
calc_earthtide(
  utc,
  do_predict = TRUE,
  method = "gravity",
  astro_update = 1,
  latitude = 0,
  longitude = 0,
  elevation = 0,
  azimuth = 0,
  gravity = 0,
  earth_radius = 6378136.3,
  earth_eccen = 0.0066943979514,
  cutoff = 1e-06,
  wave_groups = NULL,
  catalog = "ksm04",
  eop = NULL,
  return_matrix = FALSE,
  scale = TRUE,
  ...
)
```

Arguments

utc	The date-time in UTC (POSIXct vector).
do_predict	run in predict or analyze mode
method	One or more of "gravity", "tidal_potential", "tidal_tilt", "vertical_displacement", "horizontal_displacement", "n_s_displacement", "e_w_displacement", "vertical_strain", "areal_strain", "volume_strain", "horizontal_strain", or "ocean_tides", "pole_tide", "lod_tide". The pole tide and lod_tide are used in predict mode even if do_predict is FALSE. More than one value can only be used if do_predict == TRUE.
astro_update	Integer that determines how often to phases are updated in number of samples. Defaults to 1 (every sample), but speed gains are realized with larger values. Typically updating every hour will have speed gains and keep precision (ie 3600 for one second data, 60 for minute data, 1 for hourly data).
latitude	The station latitude (numeric) defaults to 0.
longitude	The station longitude (numeric) defaults to 0.

elevation	The station elevation (m) (numeric) defaults to 0.
azimuth	Earth azimuth (numeric) defaults to 0.
gravity	Gravity at the station (m/s^2) (numeric) 0 to estimate gravity from elevation and latitude.
earth_radius	Radius of earth (m) (numeric) defaults to 6378136.3
earth_eccen	Eccentricity of earth (numeric) defaults to 6.69439795140e-3
cutoff	Cutoff amplitude for constituents (numeric) defaults to 1e-6.
wave_groups	Two column data.frame having start and end of frequency groups (data.frame). This data.frame must have two columns with the names 'start', and 'end' signifying the start and end of the wave groupings. An optional third column 'multiplier' can be provided to scale the particular wave group. If column names do no match, the inferred column positions are start, end, multiplier.
catalog	Use the "hw95s" catalog or "ksm04" catalog (character).
eop	User defined Earth Orientation Parameter (EOP) data.frame with the following columns: datetime, ddt, ut1_utc, lod, x, y, dx, dy
return_matrix	Return a matrix of tidal values instead of data.frame. The datetime column will not be present in this case (logical).
scale	Scale results when do_predict is FALSE
...	Currently not used.

Value

data.frame of tidal results

Examples

```
tms <- as.POSIXct('1990-01-01', tz = 'UTC') + c(0, 3600)
wave_groups = data.frame(start = 0, end = 8, multiplier = 1.5)

et <- calc_earthtide(utc = tms,
                     do_predict = TRUE,
                     method = c('tidal_potential', 'lod_tide', 'pole_tide'),
                     astro_update = 1,
                     latitude = 52.3868,
                     longitude = 9.7144,
                     elevation = 110,
                     gravity = 9.8127,
                     cutoff = 1.0e-5,
                     catalog = 'ksm04',
                     wave_groups = wave_groups)
```

Earthtide *Earthtide class*

Description

Class to generate synthetic earthtide signals.

Format

An R6Class generator object

Usage

```
et <- Earthtide$new(
  utc = as.POSIXct("2017-01-01", tz = "UTC") + 0:(24 * 7) * 3600,
  latitude = 52.3868,
  longitude = 9.7144,
  catalog = "ksm04",
  wave_groups = data.frame(start = 0.0, end = 6.0))

et$predict(method = "gravity", astro_update = 1)
et$analyze(method = "gravity", astro_update = 1)
et$lod_tide()
et$pole_tide()
et$tide()
et$print()
```

Arguments

Earthtide$new

- et: An Earthtide object.
- utc: The date-time in UTC (POSIXct vector).
- latitude: The station latitude (WGS84) (degree) (numeric) defaults to 0.
- longitude: The station longitude (WGS84) (degree) (numeric) defaults to 0.
- elevation: The station ellipsoidal height (WGS84) (m) (numeric) defaults to 0.
- azimuth: Earth azimuth (numeric) defaults to 0 (degrees)
- gravity: Gravity at the station (m/s^2) (numeric) 0 to estimate gravity from elevation and latitude.
- earth_radius: Radius of earth (m) (numeric) defaults to 6378136.3
- earth_eccen: Eccentricity of earth (numeric) defaults to 6.69439795140e-3
- cutoff: Cutoff amplitude for constituents (numeric) defaults to 1e-6

- wave_groups: Two column data.frame having start and end of frequency groups (data.frame). This data.frame must have two columns with the names 'start', and 'end' signifying the start and end of the wave groupings. An optional third column 'multiplier' can be provided to scale the particular wave group. If column names do no match, the inferred column positions are start, end, multiplier.
- catalog: Use the "hw95s" catalog or "ksm04" catalog (character).
- eop: User defined Earth Orientation Parameter (EOP) data.frame with the following columns: datetime, ddt, ut1_utc, lod, x, y, dx, dy
- ...: Currently not used.

`Earthtide$predict`, `Earthtide$analyze`

- method: For `predict` and `analyze`. One of "gravity", "tidal_potential", "tidal_tilt", "vertical_displacement", "horizontal_displacement", "n_s_displacement", "e_w_displacement", "vertical_strain", "areal_strain", "volume_strain", "horizontal_strain" or "ocean_tides".
- astro_update: For `predict` and `analyze`. Integer that determines how often to phases are updated in number of samples. Defaults to 1 (every sample), but speed gains are realized with larger values. Typically updating every hour will have speed gains and keep precision (ie 3600 for one second data, 60 for minute data, 1 for hourly data).
- return_matrix: For `predict` and `analyze`. Return a matrix of tidal values instead of data.frame. The datetime column will not be present in this case (logical).

Details

`$new(utc, latitude, longitude, elevation, azimuth, gravity, earth_radius, earth_eccen, cutoff, wave_groups, catalog, ...)`
create a new `Earthtide` object and initialize catalog, station and times.

`$predict(method, astro_argument, return_matrix)` generate a combined synthetic Earth tide.

`$analyze(method, astro_argument, return_matrix, scale)` generate components of the Earth tide for analysis.

`$lod_tide()` generate components of the LOD (Length Of Day) tide.

`$pole_tide()` generate components of the pole tide.

`$tide()` get the tide `data.frame`.

`$print()` print the `Earthtide` object.

References

Hartmann, T., Wenzel, H.-G., 1995. The HW95 tidal potential catalogue. Geophys. Res. Lett. 22, 3553-3556. doi:10.1029/95GL03324

Kudryavtsev, S.M., 2004. Improved harmonic development of the Earth tide-generating potential. J. Geod. 77, 829-838. doi:10.1007/s0019000303612

Wenzel, H.G., 1996. The nanogal software: Earth tide data processing package ETERNA 3.30. Bull. Inf. Marées Terrestres, 124, pp.9425-9439. https://www.eas.slu.edu/GGP/ETERNA34/MANUAL/ETERNA33.HTM

Examples

```
et <- Earthtide$new(
  utc = as.POSIXct("2017-01-01", tz = "UTC") + 0:(24 * 7) * 3600,
  latitude = 52.3868,
  longitude = 9.7144,
  catalog = "ksm04",
  wave_groups = data.frame(start = 0.0, end = 6.0))

et$predict(method = "gravity", astro_update = 1)

plot(gravity~datetime, et$tide(), type='l')
```

`eterna_wavegroups` *Hartmann and Wenzel (1995) (ETERNA 3.4) wavegroups*

Description

This data.frame contains wavegroups for different data time spans. The wavegroups should be subset prior to use and the 'time' column provides guidelines based on your input time span.

Usage

```
eterna_wavegroups
```

Format

A `data.frame` The columns are:

`name` wave group name

`start` lowest frequency of the wave group

`end` highest frequency of the wave group

`time` applicable to data of what length

Examples

```
utils::data(eterna_wavegroups)
```

get_iers *get_iers*

Description

get_iers returns a data.frame of earth orientation parameters from (1962-present). This function requires an active internet connection. Bulletins A and B are combined giving precedence to B. Approximately (~ 7 MB) of data are downloaded. This function is brittle and may fail when data sources change.

Usage

```
get_iers(a_path = NULL, b_path = NULL, daily_path = NULL, tai_utc_path = NULL)
```

Arguments

a_path	ftp or http path to download IERS bullitin A
b_path	ftp or http path to download IERS bullitin B
daily_path	ftp or http path to download IERS daily data
tai_utc_path	ftp or http path to tai-utc data

Value

data.frame of earth orientation parameters with the following columns: datetime, ddt, ut1_utc, lod, x, y, dx, dy.

Examples

```
## Not run:
eop <- get_iers()

## End(Not run)
```

get_main_frequency *get_main_frequency*

Description

Get the frequency of the wave with the maximum amplitude in a range.

Usage

```
get_main_frequency(start, end)
```

Arguments

start	the starting frequency in cycles per day (numeric)
end	the ending frequency in cycles per day (numeric)

Value

the main frequency between start and end

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