

# Package ‘iWISA’

October 13, 2022

**Type** Package

**Title** Wavelet-Based Index of Storm Activity

**Version** 1.0-2

**Date** 2015-11-24

**Depends** R (>= 2.10.0), stats

**Imports** waveslim, fda, ggplot2, splines, graphics

**Description** A powerful system for estimating an improved wavelet-based index of magnetic storm activity, storm activity preindex (from individual station) and SQ variations. It also serves as a flexible visualization tool.

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**LazyData** true

**License** GPL-2 | GPL-3

**Repository** CRAN

**RoxygenNote** 5.0.1

**NeedsCompilation** no

**Date/Publication** 2016-03-14 17:58:21

## R topics documented:

datasq . . . . .	2
magnetic.latitude . . . . .	2
preindexplot . . . . .	3
record . . . . .	4
SAIndex . . . . .	5
SIplot . . . . .	6
SQ . . . . .	7
sqplot . . . . .	9

<b>Index</b>	<b>11</b>
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datasq                      *Magnetometer Observations of Station ABG, PHU, TUC and FRD from March to April 2001*

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### Description

The H-component of the Ground-based magnetometer records from four stations, Alibag (ABG), Phuthuy (PHU), Tucson (TUC) and Fredericksburg (FRD), used to estimate Sq variation. This data frame has 87840 rows, corresponding to a two months interval (March-April 2001), and 4 columns corresponding to each station.

### Usage

```
data(datasq)
```

### Format

A data frame containing 87840 observations for each four stations.

### Source

**INTERMAGNET**

### Examples

```
data(datasq)
head(datasq)
# plot of observations in station ABG
plot(datasq[,1])
```

---

magnetic.latitude              *Magnetic latitude*

---

### Description

Returns cos of magnetic latitude used in Dst. This function is used in SAIndex to adjust for the magnetic latitude.

### Usage

```
magnetic.latitude(col = 68.68, lam = 202)
```

### Arguments

col	Colatitude of a station
lam	Longitude of a station

**See Also**[SAIndex](#)

---

`preindexplot`*Plot Estimations of Storm Activity Preindex*

---

**Description**

This function is used to visualize the preindex estimation for each station. Users can specify the number of graphs per page, the default is set to 2 graphs per page.

**Usage**

```
preindexplot(x, Title = NULL, start = NULL, end = NULL,  
             n.station = NULL, graphs.per.page = 2, station.names = NULL, ...)
```

**Arguments**

<code>x</code>	estimation of preindex from SAIndex
<code>Title</code>	title of preindexplot
<code>start</code>	start date of records for magnetic activities. See examples
<code>end</code>	end date of records for magnetic activities. See examples
<code>n.station</code>	number of stations
<code>graphs.per.page</code>	how many graphs combined in one plot page. Default number is 2
<code>station.names</code>	NULL (indicating no station names) or a vector strings for station names
<code>...</code>	additional arguments.

**Details**

This function is used to visualize the preindex. The function plots the preindex estimation from SAIndex. See example below.

**Author(s)**

Inga Maslova, Wen Xiao

**See Also**[SAIndex](#)

**Examples**

```
## Not run:
## data sets.
data(record)
## Colatitude and longitude of geomagnetic observatories.
coord=matrix(c(124.43, 19.23, 53.77,140.18,68.68,202.00,71.89,293.85),nrow=2,ncol=4)

## estimation of one iWISA and one preindex for each stations.
data<- SAIndex(record, coord, wf="la8")

## generate datetime for one week period
start.date="2001-3-1"
end.date="2001-4-30"

preindexplot(data, Title="Preindex of stations", start = start.date,end=end.date,
n.station=4, graphs.per.page=2, station.names=c("HER", "KAK", "HON", "SJG"))

## End(Not run)
```

---

record	<i>Magnetometer Observations of Station HER, KAK, HON and SJG from March to April 2001</i>
--------	--

---

**Description**

The H-component of the Ground-based magnetometer records four stations, Hermanus (HER), Kakioka (KAK), Honolulu (HON) and San Juan (SJG), used to estimate WISA and preindex. This data frame has 87840 rows, corresponding to a two months (March to April 2001) of 1-minute data, and 4 columns corresponding to each station.

**Usage**

```
data(record)
```

**Format**

A data frame containing 87840 observations of H-component for four stations.

**Source**

**INTERMAGNET**

**Examples**

```
data(record)
head(record)

#plot of observations from station HER
plot(record[,1])
```

---

SAIndex

*Estimate Index and Preindex of Storm Activity*

---

### **Description**

Function to estimate index of global storm activity, WISA (wavelet index of storm activity), and values of storm activity preindex of individual stations Hermanus (HER), station KAKioka (KAK), station Honolulu (HON) and station San Juan (SJG). The WISA can be constructed practically over any period of time, but to obtain values similar to the standard Dst, at least 2 months worth of data are needed.

### **Usage**

```
SAIndex(data, coord, wf = "la8")
```

### **Arguments**

data	a matrix or a data frame of H-component values. Each column should contain records from an individual station.
coord	a matrix of colatitude and longitude of each station used in a study
wf	type of wavelet filter used to separate magnetic storm activity from the solar quiet variation. LA(8) filter is the default.

### **Details**

SAIndex is a function for estimating the index of magnetic storm activity. The function returns the index of global storm activity as well as the preindex for each of the individual stations used.

### **Value**

SI the index of global storm activity, WISA

p.SQ the preindex of the storm activity constructed using wavelet-based MRA. It is the contribution of a station to the storm signature.

### **Author(s)**

Inga Maslova

Wen Xiao

### **References**

Jach,A., P.Kokoszka, J.Sojka, and L.Zhu(2006),Wavelet-based index of magnetic storm activity, J. Geophys. Res.,111, A09215, doi:10.1029/2006JA011635.

Maslova, I.,P.Kokoszka, J.Sojka, and L. Zhu(2009),Removal of nonconstant daily variation by means of wavelet and functional data analysis, J. Geophys. Res.,114, A03202, doi:10.1029/2008JA013685.

**See Also**

[magnetic.latitude](#), [SIplot](#), [preindexplot](#)

**Examples**

```
## Not run:
## data sets.
data(record)
## Colatitude and longitude of geomagnetic observatories.
coord=matrix(c(124.43, 19.23, 53.77,140.18,68.68,202.00,71.89,293.85),nrow=2,ncol=4)

## estimate WISA and preindex for each stations.
index.sample<- SAIndex(record, coord, wf="la8")

## plot SI
start.date="2001-3-1"
end.date="2001-4-30"
n.station=4
station.names=c("HER","KAK","HON","SJG")

SIplot(index.sample$SI, type=1,start=start.date, end=end.date,
main="WISA estimation", xlab="Datetime", ylab="iWISA Estimation")

## End(Not run)
```

---

SIplot

*Plot Global Storm Activity Index WISA*


---

**Description**

Plot WISA, wavelet index of storm activity, by using ggplot2

**Usage**

```
SIplot(x, type = NULL, main = NULL, xlab = NULL, ylab = NULL,
start = NULL, end = NULL, n.stations = NULL, ...)
```

**Arguments**

x	estimation of WISA from SAIndex
type	line width (default=1)
main,	xlab, ylab graphical arguments, see <a href="#">par</a>
xlab	x-axis label
ylab	y-axis label

start	start date of records for magnetic activities. See examples.
end	end date of records for magnetic activities. See examples
n.stations	number of stations included in the study
...	additional arguments

### Details

This is an interface for visualizing WISA with ggplot2. SIplot uses as.POSIXct to convert the index object into a data frame with datetime. It essentially uses the mapping geom\_line and adds aes(x, y) to visualize the series.

### See Also

[SAIndex](#), [preindexplot](#)

### Examples

```
## Not run:
## sample records for one week period
data(record)
coord=matrix(c(124.43, 19.23, 53.77,140.18,68.68,202.00,71.89,293.85),nrow=2,ncol=4)

index.sample<- SAIndex(record, coord, wf="1a8")

## example dates
start.date="2001-3-1"
end.date="2001-4-30"
n.station=4
station.names=c("HER", "KAK", "HON", "SJG")

## plot SI
SIplot(index.sample$SI, type=1, start=start.date, end=end.date,
main="WISA estimation", xlab="Datetime", ylab="iWISA Estimation")

## End(Not run)
```

### Description

Estimate a non-constant solar quiet daily variation by using multiresolution analysis (MRA) and functional principal component analysis. The procedure removes the global signature of a ring current to eliminate the effect of the magnetic storm. The wavelet-based filtering and functional data analysis techniques are used to eliminate the daily periodic component. In order to get better Sq estimate it is necessary to use records from at least two stations.

**Usage**

```
SQ(data, si.v = si.v, wf = "la8")
```

**Arguments**

<code>data</code>	a matrix or data frame of records of magnetic storm activity. Each column should contain records from an individual station. For more accurate estimate, at least two stations should be used.
<code>si.v</code>	estimation of WISA from SAIndex function.
<code>wf</code>	the type of the wavelet filter used. LA(8) filter is the default one.

**Details**

SQ is a function for estimating solar quiet daily variation. Stations used in estimation of SQ need to be differ from stations used in estimating WISA. The resulting daily variation is non-constant, and its day-to-day variability is quantified by functional principal component scores. It uses `mra` to obtain MRA from the data after storm activity was removed. We compute the first PC rather than the first PC of the raw magnetometer data with some seasonal adjustments which do not remove the storm activity from the Sq.

**Value**

SQ the estimation of a non-constant solar quiet daily variation.

**References**

Maslova, P. Kokoszka, J. Sojka, L. Zhu (2010), Estimation of Sq variation by means of multiresolution and principal component analyses.

**See Also**

[SAIndex](#)

**Examples**

```
## Not run:
## example data
data(record)
coord=matrix(c(124.43, 19.23, 53.77,140.18,68.68,202.00,71.89,293.85),nrow=2,ncol=4)

## Estimation of SI index
index.sample<- SAIndex(record, coord, wf="la8")
si.v<-index.sample$SI

## example data of stations which are different from the ones that are used to estimate SI
## index.
## estimation of sq
Sq<-SQ (datasq, si.v=si.v, wf = "la8")
start.date="2001-3-1"
end.date="2001-4-30"
```



```
sqplot(Sq, Title="Sq variation", start = start.date, end=end.date, n.station=4,
       graphs.per.page=2, station.names=c("ABG","PHU","TUC","FRD"))

## End(Not run)
```

---

sqplot

*Plot of Non-constant Solar Quiet Daily Variation*


---

### Description

This function visualizes the estimated non-constant solar quiet daily variation of each station. Users would define how many graphs to be put into one page, The default set is 2 graphs per page.

### Usage

```
sqplot(x, start = NULL, end = NULL, n.station = NULL,
       graphs.per.page = 2, station.names = NULL, Title = NULL, ...)
```

### Arguments

x	estimation of solar quite variations from SQ
start	start date of records for magnetic activities. See examples
end	end date of records for magnetic activities. See examples
n.station	number of studied stations
graphs.per.page	how many graphs combined in one plot page. Default number is 2
station.names	NULL (indicating no station names) or a vector strings for station names.
Title	title of sqplot
...	additional arguments

### Details

This function is used to visualize estimated Sq variation. Specifying the names of each stations would add station names at y-axis.

### See Also

[SQ](#)

**Examples**

```
## data sets.

## Colatitude and longitude of geomagnetic observatories.
## Not run:
coord=matrix(c(124.43, 19.23, 53.77,140.18,68.68,202.00,71.89,293.85),nrow=2,ncol=4)

## Estimation of SI index
index.sample<- SAIndex(record, coord, wf="la8")
si.v<-index.sample$SI

## generate datetime for one week period
start.date="2001-3-1"
end.date="2001-4-30"

## estimation of sq
Sq<- SQ (datasq, si.v=si.v, wf = "la8")

sqplot(Sq, Title="Sq variation", start = start.date, end=end.date, n.station=4,
        graphs.per.page=2, station.names=c("ABG","PHU","TUC","FRD"))

## End(Not run)
```

# Index

- \* **Preindexplot**

- preindexplot, 3

- \* **datasets**

- datasq, 2

- record, 4

datasq, 2

magnetic.latitude, 2, 6

par, 6

preindexplot, 3, 6, 7

record, 4

SAIndex, 3, 5, 7, 8

SIplot, 6, 6

SQ, 7, 9

sqplot, 9