Package ‘SpherWave’

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Title Spherical Wavelets and SW-based Spatially Adaptive Methods

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Description This package carries out spherical wavelet transform developed by Li (1999) and Oh (1999), and implements wavelet thresholding approaches proposed by Oh and Li (2004).

URL http://stat.snu.ac.kr/heeseok/SpherWave.html

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`bandwidth` *Calculation of Bandwidth Parameter*

Description

Given the number of observations at a level, this function calculates bandwidth parameter of spherical basis function (SBF).

Usage

```
bandwidth(n)
```

Arguments

`n`	the number of observations at a level

Details

This function is used for obtaining the bandwidth of the coarsest network level L, h_L. From geometry, the surface area covered by surface mass distribution with variance σ^2 over unit sphere Ω is $2\pi(1-\sqrt{1-\sigma^2})$. Since the total surface area of the unit sphere is 4π and the variance of SBF induced from Poisson kernel is $\sigma^2 = \left(\frac{1-h^2}{1+h^2}\right)^2$, the surface covered are is $2\pi\left(1-\sqrt{1-(\frac{1-h^2}{1+h^2})^2}\right)$. Under the assumption that the observations are distributed equally over the sphere, it can be easily known how many observation are needed in order to cover the whole sphere with fixed h, and how large the h is needed to cover the sphere when the number of observations are fixed as follows:

$$\#\text{ of observations} = n = \frac{2}{1-\sqrt{1-(\frac{1-h^2}{1+h^2})^2}} \text{ and } h = \sqrt{\frac{1-a_n}{1+a_n}}$$

where $a_n = \sqrt{1-(1-\frac{2}{n})^2}$.

Value

`h`	bandwidth parameter at a level

References

Oh, H-S. (1999) Spherical wavelets and their statistical analysis with applications to meteorological data. Ph.D. Thesis, Department of Statistics, Texas A&M University, College Station.

See Also

`eta.comp`

Examples

```
bandwidth(20)
```

`centerpoints` *Generation of Center Points*

Description

Given a multi-resolution level, generate center points of each grid box by Göttlemann's method, modified Göttlemann's method or standard method.

Usage

```
modregcenter(l) # for modified G\"{o}ttlemann's regular grid
modredcenter(l) # for modified G\"{o}ttlemann's reduced grid
gotregcenter(l) # for G\"{o}ttlemann's regular grid
gotredcenter(l) # for G\"{o}ttlemann's reduced grid
regcenter(l)    # for standard regular grid
redcenter(l)    # for standard reduced grid
```

Arguments

`l` an integer which denotes the index of multi-resolution level

Details

It is for obtaining the center points of each grid box from the grid according to multi-resolution level. The values will be used for network design.

Value

`center` center points from grid

References

Göttlemann, J. (1996) Locally supported wavelets on the sphere. Preprint, Johannes Gutenberg University, Mainz.

Oh, H-S. (1999) Spherical wavelets and their statistical analysis with applications to meteorological data. Ph.D. Thesis, Department of Statistics, Texas A&M University, College Station.

See Also

network

Examples

```
modregcenter(3)$center
modredcenter(3)$center
gotregcenter(3)$center
gotredcenter(3)$center
regcenter(3)$center
redcenter(3)$center
```

---

coefmatrix *Computation of Coefficients of SBF and SW*

Description

This function generates several coefficients such as coefficients of SBF in spherical wavelets (SW), coefficients of SBF after removing subnet l, and coefficients of SW for subnet l.

Usage

```
coefmatrix(beta1, fullcov, netlab, l)
```

Arguments

`beta1`	coefficients of SBF from previous SBF representation
`fullcov`	covariance matrix of all observation sites
`netlab`	vector of labels representing sub-networks
`l`	resolution level

Details

The multiresolution analysis based on SBF is derived from the problem of characterizing the loss in an SBF representation as the number of observations are more larger. This function provides the coefficients of basis functions of multiresolution levels. For details, see references below.

Value

`wcoef`	coefficients of SBF in SW
`beta2`	coefficients of SBF after removing sub-network l
`gamma1`	coefficients of SW for sub-network l
`alpha1`	detailed coefficients of SBF for sub-network l
`norm`	norms of SW for sub-network l

References

Oh, H-S. (1999) Spherical wavelets and their statistical analysis with applications to meteorological data. Ph.D. Thesis, Department of Statistics, Texas A&M University, College Station.

Li, T-H. (1999) Multiscale representation and analysis of spherical data by spherical wavelets. *SIAM Journal on Scientific Computing*, **21**, 924–953.

Oh, H-S. and Li, T-H. (2004) Estimation of global temperature fields from scattered observations by a spherical-wavelet-based spatially adaptive method. *Journal of the Royal Statistical Society Ser. B*, **66**, 221–238.

See Also

`mracoef.comp`

`cov.comp` *Computation of Covariance Matrix*

Description

This function generates full covariance matrix of data based on SBF.

Usage

```
cov.comp(site1, site2, eta, netlab)
```

Arguments

`site1`	latitudes of observation sites in radian
`site2`	longitudes of observation sites in radian
`netlab`	vector of labels representing sub-networks
`eta`	bandwidth parameters for Poisson kernel

Details

For details, see references below.

Value

`aa`	covariance matrix

References

Oh, H-S. (1999) Spherical wavelets and their statistical analysis with applications to meteorological data. Ph.D. Thesis, Department of Statistics, Texas A&M University, College Station.

Li, T-H. (1999) Multiscale representation and analysis of spherical data by spherical wavelets. *SIAM Journal on Scientific Computing*, **21**, 924–953.

See Also

`mcov.comp`

`eta.comp` *Calculation of Bandwidth Parameters of Poisson Kernel/SBF's*

Description

This function calculates bandwidth parameters of SBF's induced by Poisson Kernel.

Usage

```
eta.comp(netlab)
```

Arguments

`netlab`	the index vector of network level

Details

The bandwidths h_l of SBF's are chosen as follows

$$h_{L-1} = e^{-\rho_l}, \quad l = 1, 2, \ldots, L-1,$$

where $\rho_l = \rho^*/2^l$. The ρ^* is obtained from the bandwidth of the coarsest network level L, h_L, that is

$$\rho^* = -\log h_L.$$

Note that h_L is obtained from the function bandwidth.

Value

`eta`	bandwidth parameters for Poisson kernel/SBF's

References

Oh, H-S. (1999) Spherical wavelets and their statistical analysis with applications to meteorological data. Ph.D. Thesis, Department of Statistics, Texas A&M University, College Station.

See Also

`bandwidth`

Examples

```
eta.comp(5)
```

`gcv.lambda` *Calculation of Generalized Cross-validation*

Description

This function calculates generalized cross-validation for ridge regression.

Usage

```
gcv.lambda(obs, latlon, netlab, eta, approx=FALSE, lambda)
```

Arguments

`obs`	observations
`latlon`	grid points of observation sites in degree
`netlab`	vector of labels representing sub-networks
`eta`	bandwidth parameters for Poisson kernel
`approx`	if TRUE, approximation is used.
`lambda`	smoothing parameter for penalized least squares method

Value

`gcv` generalized cross-validation for ridge regression.

See Also

ridge.diacomp, ridge.comp.

Examples

```
### Observations of year 1967
#data(temperature)
#names(temperature)

# Temperatures on 939 weather stations of year 1967
#temp67 <- temperature$obs[temperature$year == 1967]
# Locations of 939 weather stations
#latlon <- temperature$latlon[temperature$year == 1967, ]

### Network design by BUD
#data(netlab)

### Bandwidth for Poisson kernel
#eta <- c(0.961, 0.923, 0.852, 0.723, 0.506)

### Select smoothing parameter lambda by generalized cross-validation
#lam <- seq(0.1, 0.9, ,9)
#gcv <- NULL
#for(i in 1:length(lam))
#    gcv <- c(gcv, gcv.lambda(obs=temp67, latlon=latlon,
#        netlab=netlab, eta=eta, lambda=lam[i])$gcv)
#lam[gcv == min(gcv)]
```

---

gg.comp — *Computation of Design Matrix induced by Multi-scale SBF's for Ridge Regression*

Description

This function computes design matrix induced by multi-scale SBF's for ridge regression.

Usage

```
gg.comp(site1, site2, ssite1, ssite2, snet, seta, lam)
```

Arguments

`site1`	latitudes of observation sites in radian
`site2`	longitudes of observation sites in radian
`ssite1`	latitudes of observation sites in radian used in least squares method
`ssite2`	longitudes of observation sites in radian used in least squares method
`snet`	vector of labels representing sub-networks
`seta`	bandwidth parameters for Poisson kernel
`lam`	smoothing parameter for ridge regression

Value

`gg`	design matrix induced by multi-scale SBF's for ridge regression.

References

Oh, H-S. (1999) Spherical wavelets and their statistical analysis with applications to meteorological data. Ph.D. Thesis, Department of Statistics, Texas A&M University, College Station.

Li, T-H. (1999) Multiscale representation and analysis of spherical data by spherical wavelets. *SIAM Journal on Scientific Computing*, **21**, 924–953.

See Also

`lscoef.comp`, `gg.comp`, `ridge.comp`.

`grid` *Generation of Grid*

Description

produces grid points by Göttlemann's method, modified Göttlemann's method or standard method.

Usage

```
modreggrid(l)     # for modified G\"{o}ttlemann's regular grid
modredgrid(l)     # for modified G\"{o}ttlemann's reduced grid
gotreggrid(l)     # for G\"{o}ttlemann's regular grid
gotredgrid(l)     # for G\"{o}ttlemann's reduced grid
reggrid(l)        # for standard regular grid
redgrid(l)        # for standard reduced grid
```

Arguments

`l`	levels

Details

This function generates the grid points on globe.

Value

`grid` grid points

References

Oh, H-S. (1999) Spherical wavelets and their statistical analysis with applications to meteorological data. Ph.D. Thesis, Department of Statistics, Texas A&M University, College Station.

Examples

```
rec.reg <- reggrid(3)$grid
rec.red <- redgrid(3)$grid
mod.reg <- modreggrid(3)$grid
mod.red <- modredgrid(3)$grid
got.reg <- gotreggrid(2)$grid
got.red <- gotredgrid(2)$grid

par(mfrow = c(3, 2), mar = c(2.1, 4.1, 4.1, 1.1))
world()
points(rec.reg[, 2], rec.reg[, 1], cex = 0.7)
title(main = "(a)")
world()
points(rec.red[, 2], rec.red[, 1], cex = 0.7)
title(main="(b)")
world()
points(mod.reg[, 2], mod.reg[, 1], cex = 0.7)
title(main = "(c)")
world()
points(mod.red[, 2], mod.red[, 1], cex = 0.7)
title(main = "(d)")
world()
points(got.reg[, 2], got.reg[, 1], cex = 0.7)
title(main = "(e)")
world()
points(got.red[, 2], got.red[, 1], cex = 0.7)
title(main = "(f)")
```

`lambda.global` *Global Thresholding Value*

Description

This function calculates global thresholding value for spherical wavelet estimator.

Usage

```
lambda.global(swd, policy, nthresh, value, Q)
```

Arguments

`swd`	an object of class 'swd'
`policy`	threshold technique. At present the possible policies are '"universal"', '"probability"', '"fdr"', '"Lorentz"' and '"sure"'.
`nthresh`	the number of resolution levels to be thresholded in the decomposition
`value`	the user supplied threshold represented by quantile level of '"probability"' policy.
`Q`	parameter for the false discovery rate of '"fdr"' policy.

Value

`lam`	global thresholding value

References

Donoho, D.~L. and Johnstone, I.~M. (1994) Ideal spatial adaptation by wavelet shrinkage. *Biometrika*, **81**, 425–455.

Oh, H-S. (1999) Spherical wavelets and their statistical analysis with applications to meteorological data. Ph.D. Thesis, Department of Statistics, Texas A&M University, College Station.

Oh, H-S. and Li, T-H. (2004) Estimation of global temperature fields from scattered observations by a spherical-wavelet-based spatially adaptive method. *Journal of the Royal Statistical Society Ser. B*, **66**, 221–238.

See Also

`mrs.comp.thresh.global`

`ls.comp` *Computation of Coefficients of Multi-scale SBF Representation*

Description

This function computes coefficients of multi-scale SBF representation by least squares method.

Usage

```
ls.comp(obs, site, ssite, snet, seta)
```

Arguments

`obs`	observations
`site`	grid points of observation sites in radian for computing coefficients
`ssite`	grid points of observation sites in radian used in least squares method
`snet`	vector of labels representing sub-networks
`seta`	bandwidth parameters for Poisson kernel

Value

An object of class 'lsfit'.

References

Oh, H-S. (1999) Spherical wavelets and their statistical analysis with applications to meteorological data. Ph.D. Thesis, Department of Statistics, Texas A&M University, College Station.

Li, T-H. (1999) Multiscale representation and analysis of spherical data by spherical wavelets. *SIAM Journal on Scientific Computing*, **21**, 924–953.

Oh, H-S. and Li, T-H. (2004) Estimation of global temperature fields from scattered observations by a spherical-wavelet-based spatially adaptive method. *Journal of the Royal Statistical Society Ser. B*, **66**, 221–238.

See Also

`lscoef.comp`, `ridge.comp`

`lscoef.comp` *Computation of Interpolation Coefficients of Multi-scale SBF Representation*

Description

This function computes interpolation coefficients of multi-scale SBF representation.

Usage

```
lscoef.comp(site1, site2, ssite1, ssite2, snet, seta)
```

Arguments

`site1`	latitudes of observation sites in radian for computing coefficients
`site2`	longitudes of observation sites in radian for computing coefficients
`ssite1`	latitudes of observation sites in radian used in least squares method
`ssite2`	longitudes of observation sites in radian used in least squares method
`snet`	vector of labels representing sub-networks
`seta`	bandwidth parameters for Poisson kernel

Value

gg	interpolation coefficients of multi-scale SBF representation

References

Oh, H-S. (1999) Spherical wavelets and their statistical analysis with applications to meteorological data. Ph.D. Thesis, Department of Statistics, Texas A&M University, College Station.

Li, T-H. (1999) Multiscale representation and analysis of spherical data by spherical wavelets. *SIAM Journal on Scientific Computing*, **21**, 924–953.

Oh, H-S. and Li, T-H. (2004) Estimation of global temperature fields from scattered observations by a spherical-wavelet-based spatially adaptive method. *Journal of the Royal Statistical Society Ser. B*, **66**, 221–238.

See Also

`ls.comp`, `ridge.comp`.

---

mcov.comp — *Computation of Covariance Matrix*

Description

This function generates full covariance matrix of data based on SBF.

Usage

```
mcov.comp(site, netlab, eta)
```

Arguments

site	a J x 2 matrix of grid points of observation sites in radian
netlab	vector of labels representing sub-networks
eta	bandwidth parameters for Poisson kernel

Value

cov	covariance matrix

References

Oh, H-S. (1999) Spherical wavelets and their statistical analysis with applications to meteorological data. Ph.D. Thesis, Department of Statistics, Texas A&M University, College Station.

Li, T-H. (1999) Multiscale representation and analysis of spherical data by spherical wavelets. *SIAM Journal on Scientific Computing*, **21**, 924–953.

See Also

`mcov.comp`, `mracoef.comp`

`mesh` *Creation of M by N grid*

Description

This function creates M by N longitude-latitude grid.

Usage

```
mesh(M, N)
```

Arguments

`M`	M longitudes of M by N grid
`N`	N latitudes of M by N grid

Details

This function creates M by N longitude-latitude grid.

Value

`theta`	latitudes in radian of M by N longitude-latitude grid
`phi`	longitudes in radian of M by N longitude-latitude grid

Examples

```
mesh(100, 50)
```

`mracoef.comp` *Computation of Global and Local Coefficients of Multiscale SBF Representation*

Description

This function generates global and local coefficients of multiscale SBF representation.

Usage

```
mracoef.comp(coef, site, netlab, eta)
```

Arguments

`coef`	coefficients of the initial SBF representation
`site`	grid points of observation sites in radian
`netlab`	vector of labels representing sub-networks
`eta`	bandwidth parameters for Poisson kernel

Value

`beta`	global coefficients of multiscale SBF representation
`gamma`	local coefficients of multiscale SBF representation. That is the detailed coefficients of SW
`norm`	norms of SW coefficients for sub-network

References

Oh, H-S. (1999) Spherical wavelets and their statistical analysis with applications to meteorological data. Ph.D. Thesis, Department of Statistics, Texas A&M University, College Station.

Li, T-H. (1999) Multiscale representation and analysis of spherical data by spherical wavelets. *SIAM Journal on Scientific Computing*, **21**, 924–953.

Oh, H-S. and Li, T-H. (2004) Estimation of global temperature fields from scattered observations by a spherical-wavelet-based spatially adaptive method. *Journal of the Royal Statistical Society Ser. B*, **66**, 221–238.

See Also

`mrafield.comp`

`mrafield.comp` *Decomposition of a Field*

Description

This function computes global and local components (fields) on grid from an initial field.

Usage

```
mrafield.comp(grid, coeff, site, netlab, eta, field, density)
```

Arguments

`grid`	grid points of extrapolation sites in radian
`coeff`	coefficients of multi-scale SBF's
`site`	grid points of observation sites in radian
`netlab`	vector of labels representing sub-networks
`eta`	bandwidth parameters for Poisson kernel
`field`	extrapolation on grid
`density`	density of locations induced from an initial field

Details

This function generates decomposition of a field,

$$T_1(x) = T_l(x) + D_{l-1}(x) + \ldots + D_1(x), \qquad l = 2, \ldots, L$$

where a global component $T_{l+1}(x) \in \mathcal{V}_{l+1}$ and a local component $D_l(x) \in \mathcal{W}_l$. The corresponding space are nested as $\mathcal{V}_l \supset \mathcal{V}_{l+1}$, so that $\mathcal{V}_l = \mathcal{V}_{l+1} \oplus \mathcal{W}_l$.

Value

`global`	matrix of successively smoothed data
`local`	matrix of difference of successively smoothed data
`density`	density of locations in global and local fields
`swcoeff`	spherical wavelet coefficients

References

Oh, H-S. (1999) Spherical wavelets and their statistical analysis with applications to meteorological data. Ph.D. Thesis, Department of Statistics, Texas A&M University, College Station.

Li, T-H. (1999) Multiscale representation and analysis of spherical data by spherical wavelets. *SIAM Journal on Scientific Computing*, **21**, 924–953.

Oh, H-S. and Li, T-H. (2004) Estimation of global temperature fields from scattered observations by a spherical-wavelet-based spatially adaptive method. *Journal of the Royal Statistical Society Ser. B*, **66**, 221–238.

See Also

`sbf`, `swd`, `swthresh`, `swr`

`mrs.comp.thresh.global` *Global Thresholding of SW Coefficients*

Description

This function calculates global thresholded SW coefficients.

Usage

```
mrs.comp.thresh.global(coef, site, netlab, eta, K, lam, type)
```

Arguments

`coef`	coefficients of multi-scale SBF's
`site`	grid points of observation sites in radian
`netlab`	vector of labels representing sub-networks
`eta`	bandwidth parameters for Poisson kernel
`K`	the number of resolution levels to be thresholded in the decomposition
`lam`	thresholding value
`type`	the type of thresholding. This can be ‘"universal"’, ‘"probability"’, ‘"fdr"’, ‘"Lorentz"’ and ‘"sure"’.

Details

For selective reconstruction, this function performs thresholding SW coefficients according to several approaches.

Value

`talpha`	global thresholded SW coefficients

References

Donoho, D.~L. and Johnstone, I.~M. (1994) Ideal spatial adaptation by wavelet shrinkage. *Biometrika*, **81**, 425–455.

Oh, H-S. (1999) Spherical wavelets and their statistical analysis with applications to meteorological data. Ph.D. Thesis, Department of Statistics, Texas A&M University, College Station.

Oh, H-S. and Li, T-H. (2004) Estimation of global temperature fields from scattered observations by a spherical-wavelet-based spatially adaptive method. *Journal of the Royal Statistical Society Ser. B*, **66**, 221–238.

See Also

`mrs.comp.thresh.level`, `mrsfield.comp.thresh.global`

`mrs.comp.thresh.level` *Level-dependent Thresholding of SW Coefficients*

Description

This function calculates level-dependent thresholded SW coefficients.

Usage

```
mrs.comp.thresh.level(coef, site, netlab, eta, K, policy, Q, type)
```

Arguments

`coef`	coefficients of multi-scale SBF's
`site`	grid points of observation sites in radian
`netlab`	vector of labels representing sub-networks
`eta`	bandwidth parameters for Poisson kernel
`K`	the number of resolution levels to be thresholded in the decomposition
`policy`	threshold technique. At present the possible policies are '"universal"', '"fdr"' and '"Lorentz"'.
`Q`	parameter for the false discovery rate of '"fdr"' policy.
`type`	the type of thresholding. This can be '"hard"', '"soft"' or '"Lorentz"'.

Details

This function calculates level-dependent thresholded for selective reconstruction of fields.

Value

`talpha`	level-dependent thresholded SW coefficients

References

Donoho, D.~L. and Johnstone, I.~M. (1994) Ideal spatial adaptation by wavelet shrinkage. *Biometrika*, **81**, 425–455.

Oh, H-S. (1999) Spherical wavelets and their statistical analysis with applications to meteorological data. Ph.D. Thesis, Department of Statistics, Texas A&M University, College Station.

Oh, H-S. and Li, T-H. (2004) Estimation of global temperature fields from scattered observations by a spherical-wavelet-based spatially adaptive method. *Journal of the Royal Statistical Society Ser.* B, **66**, 221–238.

See Also

`mrs.comp.thresh.global`, `mrsfield.comp.thresh.level`

`mrsfield.comp.thresh.global` *Generation of Detailed Fields by Global Thresholding*

Description

This function generates detailed fields based on global thresholding of SW coefficients.

Usage

```
mrsfield.comp.thresh.global(grid, coef, site, netlab, eta, lam,
K, type)
```

Arguments

`grid`	grid points of extrapolation sites in radian
`coef`	coefficients of multi-scale SBF's
`site`	grid points of observation sites in radian
`netlab`	vector of labels representing sub-networks
`eta`	bandwidth parameters for Poisson kernel
`lam`	thresholding value
`K`	the number of resolution levels to be thresholded in the decomposition
`type`	the type of thresholding. This can be ‘"universal"’, ‘"probability"’, ‘"fdr"’, ‘"Lorentz"’ and ‘"sure"’.

Value

`dfield`	detailed fields generated by global thresholding

References

Oh, H-S. (1999) Spherical wavelets and their statistical analysis with applications to meteorological data. Ph.D. Thesis, Department of Statistics, Texas A&M University, College Station.

Oh, H-S. and Li, T-H. (2004) Estimation of global temperature fields from scattered observations by a spherical-wavelet-based spatially adaptive method. *Journal of the Royal Statistical Society Ser. B*, **66**, 221–238.

See Also

`sbf`, `swd`, `swthresh`, `swr`

`mrsfield.comp.thresh.level` *Generation of Detailed Fields by Level-dependent Thresholding*

Description

This function generates detailed fields based on level-dependent thresholding of SW coefficients.

Usage

```
mrsfield.comp.thresh.level(grid, coef, site, netlab, eta, K,
policy, Q, type)
```

Arguments

`grid`	grid points of extrapolation sites in radian
`coef`	coefficients of multi-scale SBF's
`site`	grid points of observation sites in radian
`netlab`	vector of labels representing sub-networks
`eta`	bandwidth parameters for Poisson kernel
`K`	the number of resolution levels to be thresholded in the decomposition
`policy`	threshold technique. At present the possible policies are '"universal"', '"fdr"' and '"Lorentz"'.
`Q`	parameter for the false discovery rate of '"fdr"' policy.
`type`	the type of thresholding. This can be '"hard"', '"soft"' or '"Lorentz"'.

Details

This function calculates level-dependent thresholded detailed fields.

Value

`dfield`	level-dependent thresholded detailed fields

References

Oh, H-S. (1999) Spherical wavelets and their statistical analysis with applications to meteorological data. Ph.D. Thesis, Department of Statistics, Texas A&M University, College Station.

Oh, H-S. and Li, T-H. (2004) Estimation of global temperature fields from scattered observations by a spherical-wavelet-based spatially adaptive method. *Journal of the Royal Statistical Society Ser. B*, **66**, 221–238.

See Also

`sbf`, `swd`, `swthresh`, `swr`

`msbf.comp` *Calculation of an Extrapolation Field with Multiscale SBF's*

Description

This function calculates an extrapolation field evaluated on grid with multiscale SBF's. It also provides the density of SBF on grid.

Usage

```
msbf.comp(grid, site, coef, netlab, eta, p0)
```

Arguments

`grid`	grid points of extrapolation sites in radian
`site`	grid points of observation sites in radian
`coef`	coefficients of multi-scale SBF's
`netlab`	vector of labels representing sub-networks
`eta`	bandwidth parameters for Poisson kernel
`p0`	(p0+1) will be starting detailed level to be included

Value

`field`	extrapolation field
`density`	density of SBF

References

Oh, H-S. (1999) Spherical wavelets and their statistical analysis with applications to meteorological data. Ph.D. Thesis, Department of Statistics, Texas A&M University, College Station.

Li, T-H. (1999) Multiscale representation and analysis of spherical data by spherical wavelets. *SIAM Journal on Scientific Computing*, **21**, 924–953.

Oh, H-S. and Li, T-H. (2004) Estimation of global temperature fields from scattered observations by a spherical-wavelet-based spatially adaptive method. *Journal of the Royal Statistical Society Ser. B*, **66**, 221–238.

See Also

`sbf.comp`

`multi-levels` *Deciding the Number of Multi-Resolution Levels*

Description

This function decides the number of multi-resolution levels by Göttlemann's method, modified Göttlemann's method or standard method.

Usage

```
modnetlevel(angle) # for modified G\"{o}ttlemann's grid
gotnetlevel(angle) # for G\"{o}ttlemann's grid
netlevel(angle)    # for standard grid
```

Arguments

`angle`	radius (geodesic distance) from locations of data within a territory to the center point of the territory

Value

`nlevel` the number of multi-resolution levels.

References

Oh, H-S. (1999) Spherical wavelets and their statistical analysis with applications to meteorological data. Ph.D. Thesis, Department of Statistics, Texas A&M University, College Station.

Examples

```
modnetlevel(3 * pi/180) # for modified G\"{o}ttlemann's grid
gotnetlevel(2 * pi/180) # for G\"{o}ttlemann's grid
netlevel(5 * pi/180)    # for standard grid
```

---

netlab *Bottom-Up Network Design*

Description

labels representing sub-networks for the surface air temperature observed by a network of 939 weather stations in 1967.

Usage

```
data(netlab)
```

Format

A vector of labels representing sub-networks

Source

Oh, H-S. and Li, T-H. (2004) Estimation of global temperature fields from scattered observations by a spherical-wavelet-based spatially adaptive method. *Journal of the Royal Statistical Society Ser. B*, **66**, 221–238.

network *Generation of Network Levels*

Description

produces multi-resolution network by Göttlemann's method, modified Göttlemann's method or standard method.

Usage

```
reg.grid(x, latlon)    # for modified G\"{o}ttlemann's regular grid
red.grid(x, latlon)    # for modified G\"{o}ttlemann's reduced grid
gotreg.grid(x, latlon) # for G\"{o}ttlemann's regular grid
gotred.grid(x, latlon) # for G\"{o}ttlemann's reduced grid
hsreg.grid(x, latlon)  # for standard regular grid
hsred.grid(x, latlon)  # for standard reduced grid
```

Arguments

`x`	radius of territory in degree
`latlon`	grid points of observation sites in degree

Details

This function partitions the grid points of observations into networks. Each network corresponds resolution level and level 1 is the most detailed level.

Value

`netlab`	vector of network labels indicating level of multi-resolution.

References

Oh, H-S. (1999) Spherical wavelets and their statistical analysis with applications to meteorological data. Ph.D. Thesis, Department of Statistics, Texas A&M University, College Station.

Examples

```
### Observations of year 1967
#data(temperature)
#names(temperature)

# Locations of 939 weather stations
#latlon <- temperature$latlon[temperature$year == 1967, ]

#netlab <- reg.grid(x=3, latlon)
#netlab <- red.grid(x=3, latlon)
#netlab <- gotreg.grid(x=2, latlon)
```

```
#netlab <- gotred.grid(x=2, latlon)
#netlab <- hsreg.grid(x=5, latlon)
#netlab <- hsred.grid(x=5, latlon)
```

`network.design` *Network Design*

Description

produces multi-resolution network.

Usage

```
network.design(latlon, method = "Oh", type = "reduce", nlevel, x)
```

Arguments

`latlon`	grid points of observation sites in degree
`method`	network design method, "cover", "ModifyGottlemann", "Gottlemann" or "Oh"
`type`	specifies grid type, "regular" or "reduced"
`nlevel`	the number of observations in each resolution when using the method ‘"cover"’
`x`	radius in degree

Details

This function partitions the grid points of observations into networks. Each network corresponds resolution level and level 1 is the most detailed level. Possible methods are

‘"cover"’ for utilizing ‘"cover.design"’ in the package ‘"field"’

‘"ModifyGottlemann"’ for modified Göttlemann’s method

‘"Gottlemann"’ for Göttlemann’s method

‘"Oh"’ for Oh’s method.

For ‘"ModifyGottlemann"’, ‘"Gottlemann"’ and ‘"Oh"’, two types of design, ‘"regular"’ and ‘"reduced"’ are provided.

Value

`netlab`	vector of network labels indicating level of multi-resolution.

References

Oh, H-S. (1999) Spherical wavelets and their statistical analysis with applications to meteorological data. Ph.D. Thesis, Department of Statistics, Texas A&M University, College Station.

Examples

```
### Observations of year 1967
#data(temperature)
#names(temperature)

# Locations of 939 weather stations
#latlon <- temperature$latlon[temperature$year == 1967, ]

#netlab <- network.design(latlon=latlon, method="cover",
#    nlevel=c(507, 244, 117, 49, 22))
#netlab <- network.design(latlon=latlon, method="ModifyGottlemann",
#    type="regular", x=3)
#netlab <- network.design(latlon=latlon, method="Gottlemann",
#    type="regular", x=2)
#netlab <- network.design(latlon=latlon, method="Oh",
#    type="reduce", x=5)
```

---

pk *Calculation of Normalized Poisson Kernel*

Description

This function calculates normalized Poisson kernel as a function of angle.

Usage

```
pk(theta, eta)
```

Arguments

`theta`	angle
`eta`	bandwidth parameter for Poisson kernel

Details

This function calculates normalized Poisson kernel as a function of angle.

Value

vector of normalized Poisson kernel.

Examples

```
theta <- c(-100:100)/100

par(mfrow=c(1,1), pty="m", mar=c(4,4,7,1)+0.1)
plot(theta, pk(theta, 0.9), type="l", xlab="angle (x pi)", ylab="SBF",
    xlim=c(-1, 1), ylim=c(0, 1), lab=c(9, 7, 7), cex=1)
lines(theta, pk(theta, 0.7), lty=2)
```

```
lines(theta, pk(theta, 0.5), lty=4)
legend(0.4, 0.8, legend = c("ETA = 0.9","ETA = 0.7","ETA = 0.5"),
    lty=c(1,2,4), cex=0.7)
```

`ridge.comp` *Computation of Coefficients of Multi-scale SBF's by Ridge Regression*

Description

This function computes coefficients of multi-scale SBF's by ridge regression.

Usage

```
ridge.comp(obs, site, ssite, snet, seta, lam)
```

Arguments

`obs`	observations
`site`	grid points in radian for computing coefficients
`ssite`	grid points of observation sites in radian used in ridge regression
`snet`	vector of labels representing sub-networks
`seta`	bandwidth parameters for Poisson kernel
`lam`	smoothing parameter for ridge regression

Value

An object of class 'lsfit'.

References

Oh, H-S. (1999) Spherical wavelets and their statistical analysis with applications to meteorological data. Ph.D. Thesis, Department of Statistics, Texas A&M University, College Station.

Li, T-H. (1999) Multiscale representation and analysis of spherical data by spherical wavelets. *SIAM Journal on Scientific Computing*, **21**, 924–953.

Oh, H-S. and Li, T-H. (2004) Estimation of global temperature fields from scattered observations by a spherical-wavelet-based spatially adaptive method. *Journal of the Royal Statistical Society Ser. B*, **66**, 221–238.

See Also

`lscoef.comp`, `gg.comp`, `ls.comp`.

`ridge.diacomp` *Calculation of Generalized Cross-validation*

Description

This function calculates generalized cross-validation for ridge regression.

Usage

```
ridge.diacomp(out.ls, obs, lam)
```

Arguments

`out.ls`	an object of class 'lsfit'
`obs`	observations
`lam`	smoothing parameter for penalized least squares method

Details

This function calculates generalized cross-validation for ridge regression.

Value

`rsq`	R-squared
`gcv`	generalized cross-validation for ridge regression.
`df`	degree of freedom

References

Oh, H-S. (1999) Spherical wavelets and their statistical analysis with applications to meteorological data. Ph.D. Thesis, Department of Statistics, Texas A&M University, College Station.

Li, T-H. (1999) Multiscale representation and analysis of spherical data by spherical wavelets. *SIAM Journal on Scientific Computing*, **21**, 924–953.

Oh, H-S. and Li, T-H. (2004) Estimation of global temperature fields from scattered observations by a spherical-wavelet-based spatially adaptive method. *Journal of the Royal Statistical Society Ser. B*, **66**, 221–238.

See Also

`gcv.lambda`, `ridge.comp`.

sbf *Extrapolation with Multi-sale SBF's*

Description

This function performs extrapolation with multi-sale SBF's.

Usage

```
sbf(obs, latlon, netlab, eta, method, approx=FALSE,
    grid.size=c(50, 100), lambda=NULL, p0=0, latlim=NULL,
    lonlim=NULL)
```

Arguments

`obs`	observations
`latlon`	grid points of observation sites in degree. Latitude is the angular distance in degrees of a point north or south of the Equator. North/South are represented by +/- sign. Longitude is the angular distance in degrees of a point east or west of the Prime (Greenwich) Meridian. East/West are represented by +/- sign.
`netlab`	vector of labels representing sub-networks
`eta`	bandwidth parameters for Poisson kernel
`method`	extrapolation methods, '"ls"' or '"pls"'
`approx`	if TRUE, approximation is used.
`grid.size`	grid size (latitude, longitude) of extrapolation site
`lambda`	smoothing parameter for penalized least squares method
`p0`	specifies starting level for extrapolation. Among resolution levels $1, \ldots, L$, resolution levels $p0 + 1, \ldots, L$ will be included for extrapolation.
`latlim`	range of latitudes in degree
`lonlim`	range of longitudes in degree

Details

This function performs extrapolation with multi-sale SBF's.

Value

An object of class 'sbf'. This object is a list with the following components.

`obs`	observations
`latlon`	grid points of observation sites in degree
`netlab`	vector of labels representing sub-networks
`eta`	bandwidth parameters for Poisson kernel

`method`	extrapolation methods, ‘"ls"’ or ‘"pls"’
`approx`	if TRUE, approximation is used.
`grid.size`	grid size (latitude, longitude) of extrapolation site
`lambda`	smoothing parameter for penalized least squares method
`p0`	starting level for extrapolation. Resolution levels $p0 + 1, \ldots, L$ is used for extrapolation.
`gridlon`	longitudes of extrapolation sites in degree
`gridlat`	latitudes of extrapolation sites in degree
`nlevels`	the number of multi-resolution levels
`coeff`	interpolation coefficients
`field`	extrapolation on grid.size
`density`	density on observation's locations
`latlim`	range of latitudes in degree
`lonlim`	range of longitudes in degree

References

Oh, H-S. (1999) Spherical wavelets and their statistical analysis with applications to meteorological data. Ph.D. Thesis, Department of Statistics, Texas A&M University, College Station.

Li, T-H. (1999) Multiscale representation and analysis of spherical data by spherical wavelets. *SIAM Journal on Scientific Computing*, **21**, 924–953.

Oh, H-S. and Li, T-H. (2004) Estimation of global temperature fields from scattered observations by a spherical-wavelet-based spatially adaptive method. *Journal of the Royal Statistical Society Ser. B*, **66**, 221–238.

See Also

`swd`, `swthresh`, `swr`.

Examples

```
### Observations of year 1967
#data(temperature)
#names(temperature)

# Temperatures on 939 weather stations of year 1967
#temp67 <- temperature$obs[temperature$year == 1967]
# Locations of 939 weather stations
#latlon <- temperature$latlon[temperature$year == 1967, ]

### Network design by BUD
#data(netlab)

### Bandwidth for Poisson kernel
#eta <- c(0.961, 0.923, 0.852, 0.723, 0.506)
```

```
### SBF representation of the observations by pls
#out.pls <- sbf(obs=temp67, latlon=latlon, netlab=netlab, eta=eta,
#    method="pls", grid.size=c(50, 100), lambda=0.89)
```

`sbf.comp` *Calculation of Field and Density with Multi-sale SBF's*

Description

This function calculates field and density with Multi-sale SBF's.

Usage

```
sbf.comp(point1, point2, site1, site2, coef, netlab, eta, p0)
```

Arguments

`point1`	latitude of extrapolation sites in radian
`point2`	longitude of extrapolation sites in radian
`site1`	latitude of observation sites in radian
`site2`	longitude of observation sites in radian
`coef`	coefficients of multi-scale SBF's
`netlab`	vector of labels representing sub-networks
`eta`	bandwidth parameters for Poisson kernel
`p0`	specifies starting level for extrapolation. Among resolution levels $1, \ldots, L$, resolution levels $p0+1, \ldots, L$ will be included for extrapolation.

Details

For a given field, this function provides a multiscale SBF representation

$$T(x) = \sum_l \sum_j \beta_{l,j} G_l(x \cdot x_j),$$

where $G_l(\cdot)$ denotes a SBF with bandwidth h_l at multiresolution level l.

Value

`aa`	a multiscale SBF field on observation's locations
`bb`	density on observation's locations

References

Oh, H-S. (1999) Spherical wavelets and their statistical analysis with applications to meteorological data. Ph.D. Thesis, Department of Statistics, Texas A&M University, College Station.

Li, T-H. (1999) Multiscale representation and analysis of spherical data by spherical wavelets. *SIAM Journal on Scientific Computing*, **21**, 924–953.

Oh, H-S. and Li, T-H. (2004) Estimation of global temperature fields from scattered observations by a spherical-wavelet-based spatially adaptive method. *Journal of the Royal Statistical Society Ser. B*, **66**, 221–238.

See Also

`msbf.comp`.

`SpherWave` — *Spherical Wavelets and SW-based spatially adaptive methods*

Description

This package carries out spherical wavelet transform developed by Li (1999) and Oh (1999), and implements wavelet thresholding approaches proposed by Oh and Li (2004).

`sw.plot` — *Plot of Observation, Network Design, Field, SW Coefficient, Decomposition or Reconstruction Result*

Description

This function performs plotting of observation, network design, field, SW coefficients, decomposition or reconstruction result.

Usage

```
sw.plot(sw = NULL, z = NULL, latlon = NULL, latlim = NULL,
    lonlim = NULL, type = "field", nlevel = 256, pch = NULL,
    cex = NULL, ...)
```

Arguments

`sw`	`sbf` or `swd` object
`z`	observations, network design labels or reconstruction
`latlon`	grid points of observation sites in degree
`latlim`	range of latitudes in degree
`lonlim`	range of longitudes in degree

`type`	specifies the type "obs", "network", "field", "swcoeff", "decom" or "recon"
`nlevel`	number of color levels used in legend strip
`pch`	either an integer specifying a symbol or a single character to be used as the default in plotting points
`cex`	a numerical value giving the amount by which plotting text and symbols should be scaled relative to the default
`...`	the usual arguments to the image function or plot function

Details

This function plots spherical wavelet results. Possible types are

‘"obs"’ for observations

‘"network"’ for network design

‘"field"’ for field

‘"swcoeff"’ for spherical wavelet coefficients

‘"decom"’ for decomposition results

‘"recon"’ for reconstruction result.

For ‘sw’, `sbf` or `swd` object must be provided. For `sbf` object, type ‘"obs"’, ‘"network"’, ‘"field"’ are possible whereas all types are possible for `swd` object. Or specify ‘z’ and ‘latlon’ without ‘sw’.

Examples

```
### Observations of year 1967
data(temperature)
names(temperature)

# Temperatures on 939 weather stations of year 1967
temp67 <- temperature$obs[temperature$year == 1967]
# Locations of 939 weather stations
latlon <- temperature$latlon[temperature$year == 1967, ]

### Draw the temperature data
sw.plot(z=temp67, latlon=latlon, type="obs")

### Network design by BUD
data(netlab)
sw.plot(z=netlab, latlon=latlon, type="network")

### SBF representation of the observations
#eta <- c(0.961,0.923,0.852,0.723,0.506)
#out.pls <- sbf(obs=temp67, latlon=latlon, netlab=netlab, eta=eta,
#    method="pls", grid.size=c(50, 100), lambda=0.89)
# observation
#sw.plot(out.pls, type="obs")
# network design
#sw.plot(out.pls, type="network")
# field
#sw.plot(out.pls, type="field")
```

```
### Decomposition
#out.dpls <- swd(out.pls)
# observation
#sw.plot(out.dpls, type="obs")
# network design
#sw.plot(out.dpls, type="network")
# SBF representation of the observations
#sw.plot(out.dpls, type="field")
# sw coefficient
#sw.plot(out.dpls, type="swcoeff")
# decomposition result
#sw.plot(out.dpls, type="decom")

# Thresholding
#out.univ <- swthresh(out.dpls, policy="universal", by.level=TRUE,
#    type="hard", nthresh=4)
#par(oma=c(0,0,3.5,0))
#sw.plot(out.univ, type="decom")
#mtext("Decomposition & Threshold", side = 3, outer = TRUE,
#    cex = 1.2, line = 1)

# Reconstruction
#out.rec <- swr(out.univ)
#sw.plot(z=out.rec, type="recon", xlab="", ylab="")
```

---

swd *Decomposition*

Description

This function performs decomposition with multi-sale SBF's.

Usage

```
swd(sbf)
```

Arguments

`sbf`	an object of class 'sbf'

Details

This function performs decomposition with multi-sale SBF's.

Value

An object of class spherical wavelet decomposition('swd'). This object is a list with the following components.

`obs`	observations
`latlon`	grid points of observation sites in degree
`netlab`	vector of labels representing sub-networks
`eta`	bandwidth parameters for Poisson kernel
`method`	extrapolation methods, '"ls"' or '"pls"'
`approx`	if TRUE, approximation is used.
`grid.size`	grid size (latitude, longitude) of extrapolation site
`lambda`	smoothing parameter for penalized least squares method
`p0`	starting level for extrapolation. Resolution levels $p0 + 1, \ldots, L$ is used for extrapolation.
`gridlon`	longitudes of extrapolation sites in degree
`gridlat`	latitudes of extrapolation sites in degree
`nlevels`	the number of multi-resolution levels
`coeff`	interpolation coefficients
`field`	extrapolation on grid.size
`density1`	density of SBF
`latlim`	range of latitudes in degree
`lonlim`	range of longitudes in degree
`global`	List of successively smoothed data
`density`	density of SW coefficients
`detail`	List of details at different resolution levels
`swcoeff`	SW coefficients
`thresh.info`	'"None"'

References

Oh, H-S. and Li, T-H. (2004) Estimation of global temperature fields from scattered observations by a spherical-wavelet-based spatially adaptive method. *Journal of the Royal Statistical Society Ser. B*, **66**, 221–238.

See Also

`sbf`, `swthresh`, `swr`.

Examples

```
### Observations of year 1967
#data(temperature)
#names(temperature)

# Temperatures on 939 weather stations of year 1967
#temp67 <- temperature$obs[temperature$year == 1967]
# Locations of 939 weather stations
#latlon <- temperature$latlon[temperature$year == 1967, ]

### Network design by BUD
#data(netlab)

### Bandwidth for Poisson kernel
#eta <- c(0.961, 0.923, 0.852, 0.723, 0.506)

### SBF representation of the observations by pls
#out.pls <- sbf(obs=temp67, latlon=latlon, netlab=netlab, eta=eta,
#    method="pls", grid.size=c(50, 100), lambda=0.89)

### Decomposition
#out.dpls <- swd(out.pls)
```

`swr` *Spherical Wavelet Reconstruction of 'swd' Object*

Description

This function performs spherical wavelet reconstruction.

Usage

```
swr(swd)
```

Arguments

`swd`	an object of class 'swd'

Details

This function performs spherical wavelet reconstruction.

Value

`recon`	the spherical wavelet reconstruction

References

Oh, H-S. and Li, T-H. (2004) Estimation of global temperature fields from scattered observations by a spherical-wavelet-based spatially adaptive method. *Journal of the Royal Statistical Society Ser. B*, **66**, 221–238.

See Also

sbf, swd, swthresh

Examples

```
### Observations of year 1967
#data(temperature)
#names(temperature)

# Temperatures on 939 weather stations of year 1967
#temp67 <- temperature$obs[temperature$year == 1967]
# Locations of 939 weather stations
#latlon <- temperature$latlon[temperature$year == 1967, ]

### Network design by BUD
#data(netlab)

### Bandwidth for Poisson kernel
#eta <- c(0.961, 0.923, 0.852, 0.723, 0.506)

### SBF representation of the observations by pls
#out.pls <- sbf(obs=temp67, latlon=latlon, netlab=netlab, eta=eta,
#    method="pls", grid.size=c(50, 100), lambda=0.89)

### Decomposition
#out.dpls <- swd(out.pls)

### Thresholding
#out.univ <- swthresh(out.dpls, policy="universal", by.level=TRUE,
#    type="hard", nthresh=4)

### Reconstruction
#out.rec <- swr(out.univ)
#sw.plot(z=out.rec, type="recon", xlab="", ylab="")
```

---

swthresh *Thresholding of Spherical Wavelet Decomposition ('swd') Object*

Description

This function performs various ways to threshold a 'swd' class object.

Usage

```
swthresh(swd, policy, by.level, type, nthresh, value = 0.1,
Q = 0.05)
```

Arguments

`swd`	an object of class 'swd'
`policy`	threshold technique. At present the possible policies are '"universal"', '"probability"', '"fdr"', '"Lorentz"' and '"sure"'.
`by.level`	If FALSE, then perform a global threshold. If TRUE, a thresholding value is computed and applied separately to each resolution level.
`type`	the type of thresholding. This can be '"hard"', '"soft"' or '"Lorentz"'.
`nthresh`	the number of resolution levels to be thresholded in the decomposition
`value`	the user supplied threshold represented by quantile level for '"probability"' policy
`Q`	parameter for the false discovery rate of '"fdr"' policy

Details

This function thresholds or shrinks details stored in a 'swd' object and returns the thresholded details in a modified 'swd' object. For level-dependent thresholding, '"universal"', '"Lorentz"' and '"fdr"' are provided. Only hard type thresholding is proper for '"probability"' thresholding. Also note that only soft type thresholding is proper for '"sure"' thresholding.

Value

An object of class 'swd'. This object is a list with the following components.

`obs`	observations
`latlon`	grid points of observation sites in degree
`netlab`	vector of labels representing sub-networks
`eta`	bandwidth parameters for Poisson kernel
`method`	extrapolation methods, '"ls"' or '"pls"'
`approx`	if TRUE, approximation is used.
`grid.size`	grid size (latitude, longitude) of extrapolation site
`lambda`	smoothing parameter for penalized least squares method
`p0`	starting level for extrapolation. Resolution levels $p0 + 1, \ldots, L$ is used for extrapolation.
`gridlon`	longitudes of extrapolation sites in degree
`gridlat`	latitudes of extrapolation sites in degree
`nlevels`	the number of multi-resolution levels
`coeff`	interpolation coefficients
`field`	extrapolation on grid.size

density1	density of SBF
latlim	range of latitudes in degree
lonlim	range of longitudes in degree
global	List of successively smoothed data
density	density of SW coefficients
detail	List of details at different resolution levels
swcoeff	spherical wavelet coefficients
thresh.info	thresholding information and ranges of local components before thresholding

References

Oh, H-S. and Li, T-H. (2004) Estimation of global temperature fields from scattered observations by a spherical-wavelet-based spatially adaptive method. *Journal of the Royal Statistical Society Ser. B*, **66**, 221–238.

See Also

sbf, swd, swr.

Examples

```
### Observations of year 1967
#data(temperature)
#names(temperature)

# Temperatures on 939 weather stations of year 1967
#temp67 <- temperature$obs[temperature$year == 1967]
# Locations of 939 weather stations
#latlon <- temperature$latlon[temperature$year == 1967, ]

### Network design by BUD
#data(netlab)

### Bandwidth for Poisson kernel
#eta <- c(0.961, 0.923, 0.852, 0.723, 0.506)

### SBF representation of the observations by pls
#out.pls <- sbf(obs=temp67, latlon=latlon, netlab=netlab, eta=eta,
#    method="pls", grid.size=c(50, 100), lambda=0.89)

### Decomposition
#out.dpls <- swd(out.pls)

### Thresholding
#out.univ <- swthresh(out.dpls, policy="universal", by.level=TRUE,
#    type="hard", nthresh=4)
```

temperature — *The Surface Air Temperature*

Description

the surface air temperature in Celsius observed by a network of weather stations in 1961 through 1990.

Usage

```
data(temperature)
```

Format

A list of year, latlon (global grid point in degree), obs (temperature)

Source

This data set was organized by Jones, Raper, Cherry, Goodess, Wigley, Santer, and Kelly (1991). The primary sources of this data can be obtained from http://cdiac.esd.ornl.gov/ftp.

Examples

```
### Observations of year 1967
data(temperature)
names(temperature)

# Temperatures on 939 weather stations of year 1967
temp67 <- temperature$obs[temperature$year == 1967]
# Locations of 939 weather stations
latlon <- temperature$latlon[temperature$year == 1967, ]

# Plot of the observations
sw.plot(z = temp67, latlon=latlon, type="obs", xlab="", ylab="")
```

thresh.global — *Global Thresholding of SW Coefficients*

Description

This function calculates global thresholded SW coefficients.

Usage

```
thresh.global(x, lam, type)
```

Arguments

x	coefficients of multiscale SBF's
lam	thresholding value
type	the type of thresholding. This can be '"hard"', '"soft"' or '"Lorentz"'.

Value

tgamma	global thresholded SW coefficients

References

Donoho, D.~L. and Johnstone, I.~M. (1994) Ideal spatial adaptation by wavelet shrinkage. *Biometrika*, **81**, 425–455.

Oh, H-S. (1999) Spherical wavelets and their statistical analysis with applications to meteorological data. Ph.D. Thesis, Department of Statistics, Texas A&M University, College Station.

Oh, H-S. and Li, T-H. (2004) Estimation of global temperature fields from scattered observations by a spherical-wavelet-based spatially adaptive method. *Journal of the Royal Statistical Society Ser.* B, **66**, 221–238.

See Also

mrs.comp.thresh.global.

---

thresh.level *Level-dependent Thresholding of SW Coefficients*

Description

This function calculates level-dependent thresholded SW coefficients.

Usage

```
thresh.level(x, norm, policy, Q, type)
```

Arguments

x	coefficients of multiscale SBF's
norm	norm of multiscale SBF's (SW)
policy	threshold technique. At present the possible policies are '"universal"', '"fdr"' and '"Lorentz"'.
Q	parameter for the false discovery rate of '"fdr"' policy.
type	the type of thresholding. This can be '"hard"', '"soft"' or '"Lorentz"'.

Value

`tgamma`	level-dependent thresholded SW coefficients

References

Donoho, D.~L. and Johnstone, I.~M. (1994) Ideal spatial adaptation by wavelet shrinkage. *Biometrika*, **81**, 425–455.

Oh, H-S. (1999) Spherical wavelets and their statistical analysis with applications to meteorological data. Ph.D. Thesis, Department of Statistics, Texas A&M University, College Station.

Oh, H-S. and Li, T-H. (2004) Estimation of global temperature fields from scattered observations by a spherical-wavelet-based spatially adaptive method. *Journal of the Royal Statistical Society Ser.* B, **66**, 221–238.

See Also

`mrs.comp.thresh.level`

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