

# Package ‘commonDiagnostics’

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**Type** Package

**Title** Set of common tools for model diagnostics.

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**Author** Virginie Guemas <virginie.guemas@ic3.cat>, Isabel Andreu-Burillo <isabel.andreu-burillo@ic3.cat>, Fabian Lienert <fabian.lienert@ic3.cat>, Javier Garcia-Serrano <jgarcia@ic3.cat>, Luis Rodriguez <lrodriguez@ic3.cat>, Caio A. S. Coelho <caio.coelho@cpotec.inpe.br>, Chris Ferro <c.a.t.ferro@reading.ac.uk>, David Stephenson <d.b.stephenson@reading.ac.uk>, Christoph Frei <Christoph.Frei@meteoswiss.ch>, Nicolau Manubens Gil <nicolau.manubens@ic3.cat>

**Maintainer** Virginie Guemas <virginie.guemas@ic3.cat>

**Description** Set of tools to score a model basing on one or more observational datasets and the experimental dataset obtained from the model simulation.

**License** Unlimited

**Depends** R (>= 2.15.3), ncdf, GEOMap, geomapdata, maps, evd, ismev, mapproj

**Encoding** UTF-8

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commonDiagnostics-package
<i>Prediction Model Score</i>

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**Description**

This package contains a set of tools to score prediction models by comparing experimental data with observational data.

**Details**

Package: commonDiagnostics  
Type: Package  
Version: 2.0  
Date: 2013-08-21  
License: Unlimited

First, data has to be loaded from the repository with the function `Load()`. It is needed to specify a variable to load, names for the experimental and observational datasets to load the data from and the starting dates, among other arguments. This will automatically provide two matrices with the observational and experimental data. From then on, you can compute the anomalies, climatologies, etc.

### Author(s)

Virginie Guemas <virginie.guemas@ic3.cat>, Isabel Andreu-Burillo <isabel.andreu-burillo@ic3.cat>, Fabian Lienert <fabian.lienert@ic3.cat>, Javier Garcia-Serrano <jgarcia@ic3.cat>, Luis Rodrigues <lrodrigues@ic3.cat>, Caio A. S. Coelho <caio.coelho@cptec.inpe.br>, Chris Ferro <c.a.t.ferro@reading.ac.uk>, Dag Johan Steinskog <dag.johan.steinskog@nersc.no>, David Stephenson <d.b.stephenson@reading.ac.uk>, Christoph Frei <Christoph.Frei@meteoswiss.ch>, Nicolau Manubens Gil <nicolau.manubens@ic3.cat>

### References

Please, for more information load the package and check the help for each function, or check the wiki page on common diagnostics.

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ACC

*Compute Anomaly Correlation Coefficient*

---

### Description

Matrix `var_exp` & `var_obs` should have dimensions (nexp/nobs, nsdates, nltimes, nlat, nlon). `ACC` computes the Anomaly Correlation Coefficient for each `jexp` in `1:nexp` and each `jobs` in `1:nobs` which gives `nexp x nobs` ACC for each `startdate` and each `leadtime`. The confidence interval is computed by a Fisher transformation. The significance level relies on a one-sided student-T distribution. A domain can be selected by providing the list of longitudes/latitudes (`lon/lat`) of the grid together with the corner of the domain: `lonlatbox = c(lonmin, lonmax, latmin, latmax)`

### Usage

```
ACC(var_exp, var_obs, lon = NULL, lat = NULL, lonlatbox = NULL)
```

### Arguments

<code>var_exp</code>	Matrix of experimental data.
<code>var_obs</code>	Matrix of observational data, same dimensions as <code>var_exp</code> except along the first dimension.
<code>lon</code>	Array of longitudes of the <code>var_exp/var_obs</code> grids, optional.
<code>lat</code>	Array of latitudes of the <code>var_exp/var_obs</code> grids, optional.
<code>lonlatbox</code>	Domain to select <code>c(lonmin, lonmax, latmin, latmax)</code> , optional.

**Value**

ACC	Matrix with c(nexp, nobs, nsdates, nleadtimes, 4) dimensions. The fourth dimension of length 4 corresponds to the lower limit of the 95 confidence interval, the computed ACC, the upper limit of the 95 confidence interval and the 95 T-test.
MACC	Mean Anomaly Correlation Coefficient with c(nexp, nobs, nleadtimes) dimensions.

**Author(s)**

History: 1.0 - 2013-08 (V. Guemas, <vguemas@ic3.cat>) - Original code

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AnimVsLTime

*Animate Variable Values Over Forecast Time*

---

**Description**

Create animations showing the anomalies, the climatologies, the mean InterQuartile Range, Maximum-Minimum, Standard Deviation, Median Absolute Deviation, the trends, the RMSE or correlation between modelled and observed data along the forecast time (versus the lead-times) for all input experiments and input observational datasets.

**Usage**

```
AnimVsLTime(var, lat, lon, toptitle = c("", "", "", "", "", "", "", "", "", "",
"", "" ), units = "", monini = 1, freq = 12, msk95lev = FALSE, brk = NULL,
col = NULL, lonmin = 0, lonmax = 360, latmin = -90, latmax = 90,
center = NULL, equi = TRUE, fileout = c("output1_animvsltime",
"output2_animvsltime", "output3_animvsltime"))
```

**Arguments**

var	Matrix of dimensions (nlttime, nlat, nlon) or (nexp/nmod, nlttime, nlat, nlon) or (nexp/nmod, 3, nlttime, nlat, nlon) or (nexp/nmod, nobs, 3, nlttime, nlat, nlon)
lat	Vector containing latitudes (°)
lon	Vector containing longitudes (°)
toptitle	c(";", ...) array of main title for each animation, optional. If RMS or correlations: first exp with successive obs, then second exp with successive obs, etc ...
units	Units, optional
monini	Starting month between 1 and 12. Default = 1
freq	1 = yearly, 12 = monthly, 4 = seasonal ...
msk95lev	T/F grid points masked if 95 Default = F
brk	Limits of colour levels, optional. For example: seq(min(var), max(var), (max(var) - min(var)) / 10)

col	Vector of colours of length(brk) - 1, optional.
lonmin	Westward limit of the domain to plot ( $> 0$ or $< 0$ ). Default : $0^\circ$
lonmax	Eastward limit of the domain to plot ( $> 0$ or $< 0$ ). lonmax $>$ lonmin. Default : $360^\circ$
latmin	Southward limit of the domain to plot. Default : $-90^\circ$
latmax	Northward limit of the domain to plot. Default : $90^\circ$
center	(latitude, longitude, angle) for stereographic projection
equi	TRUE/FALSE == cylindrical equidistant/stereographic projection. Default: TRUE
fileout	c(" ", ...) array of output file name for each animation without extension. If RMS or correlations : first exp with successive obs, then second exp with successive obs, etc ...

### Details

Examples of input: \_\_\_\_\_

- 1- Outputs from clim (exp, obs, memb=F): (nmod, ntime, nlat, nlon) or (nobs, ntime, nlat, nlon)
- 2- Model output from load/ano/smoothing: (nmod, nmemb, sdate, ntime, nlat, nlon) then passed through spread(var, posdim = 2, narm = T) & mean1dim(var, posdim = 3, narm = T) or through trend(mean1dim(var, 2), posTR = 2): (nmod, 3, ntime, nlat, nlon) animates average along start dates of IQR/MaxMin/SD/MAD across members or trends of the ensemble-mean computed across the start dates.
- 3- model and observed output from load/ano/smoothing: (nmod, nmemb, sdate, ntime, nlat, nlon) & (nobs, nmemb, sdate, ntime, nlat, nlon) then averaged along members mean1dim(var\_exp/var\_obs, posdim = 2): (nmod, sdate, ntime, nlat, nlon) (nobs, sdate, ntime, nlat, nlon) then passed through corr(exp, obs, posloop = 1, poscor = 2) or RMS(exp, obs, posloop = 1, posRMS = 2): (nmod, nobs, 3, ntime, nlat, nlon) animates correlations or RMS between each exp & each obs against leadtime.

### Author(s)

History: 1.0 - 2012-04 (V. Guemas, <vguemas@ic3.cat>) - Original code

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Ano

*Compute Raw Anomalies*

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### Description

This function computes raw anomalies from experimental or observational matrix output from load() and their climatologies output from clim().

### Usage

Ano(var, clim)

**Arguments**

<code>var</code>	Model or observational data: <code>c(nmod/nexp/nobs, nmemb/nparam, nsdates, nlttime)</code> up to <code>c(nmod/nexp/nobs, nmemb/nparam, nsdates, nlttime, nlevel, nlat, nlon)</code>
<code>clim</code>	Climatologies from <code>clim</code> : <code>c(nmod/nexp/nobs, nmemb/nparam, nlttime)</code> up to <code>c(nmod/nexp/nobs, nmemb/nparam, nlttime, nlevel, nlat, nlon)</code> or <code>c(nmod/nexp/nobs, nlttime)</code> up to <code>c(nmod/nexp/nobs, nlttime, nlevel, nlat, nlon)</code>

**Value**

Matrix with same dimensions as `var`

**Author(s)**

History: 1.0 - 2012-03 (V. Guemas, <vguemas@ic3.cat>) - Original code

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Ano_CrossValid	<i>Compute Raw Anomalies From Experimental And Observational Data</i>
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**Description**

This function computes raw anomalies from experimental and observational matrix output from `load()` by subtracting the climatologies computed in a cross-validation mode and with a per-pair method.

**Usage**

```
Ano_CrossValid(var_exp, var_obs, memb = T)
```

**Arguments**

<code>var_exp</code>	Model data: <code>c(nmod/nexp, nmemb/nparam, nsdates, nlttime)</code> up to <code>c(nmod/nexp, nmemb/nparam, nsdates, nlttime, nlevel, nlat, nlon)</code>
<code>var_obs</code>	Observational data: <code>c(nobs, nmemb, nsdates, nlttime)</code> up to <code>c(nobs, nmemb, nsdates, nlttime, nlevel, nlat, nlon)</code>
<code>memb</code>	<code>memb</code> : T/F (1 climatology for each member). Default = T.

**Value**

<code>\$ano_exp</code>	Matrix with same dimensions as <code>var_exp</code>
<code>\$ano_obs</code>	Matrix with same dimensions as <code>var_obs</code>

**Author(s)**

History: 1.0 - 2011-12 (V. Guemas, <vguemas@ic3.cat>) - Original code

Clim

*Comput Per-pair Climatologies***Description**

This function computes per-pair climatologies from experimental and observational matrix output from load.

**Usage**

```
Clim(var_exp, var_obs, memb = T, kharin = F, NDV = F)
```

**Arguments**

var_exp	Model data: c(nmod/nexp, nmemb/nparam, nsdates, nlttime) up to c(nmod/nexp, nmemb/nparam, nsdates, nlttime, nlevel, nlat, nlon)
var_obs	Observational data: c(nobs, nmemb, nsdates, nlttime) up to c(nobs, nmemb, nsdates, nlttime, nlevel, nlat, nlon)
memb	memb: T/F (1 climatology for each member). Default = T.
kharin	T/F (if Kharin method is applied or not). Default = F.
NDV	

**Value**

clim_exp	Matrix with same dimensions as var_exp
clim_obs	Matrix with same dimensions as var_obs

**Author(s)**

History: 1.0 - 2011-03 (V. Guemas, <vguemas@ic3.cat>) - Original code

ColorBar

*Draw Color Bar***Description**

Creates a horizontal or vertical colorbar to introduce in multipanels.

**Usage**

```
ColorBar(brks, cols = NULL, vert = TRUE, subsampleg = 1)
```

**Arguments**

brks	Levels.
cols	List of colours, optional.
vert	TRUE/FALSE for vertical/horizontal colorbar.
subsampleg	Supsampling factor of the interval between ticks on colorbar. Default: 1 = every level

**Author(s)**

History: 1.0 - 2012-04 (V. Guemas, <vguemas@ic3.cat>) - Original code

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Consist\_Trend

---

*Compute Trends*


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**Description**

Compute trends by least square fitting and the associated error interval for both the observational and model data. Provide also the detrended observational and modelled data. The trend is computed along the start date dimension.

**Usage**

```
Consist_Trend(var_exp, var_obs, interval = 1)
```

**Arguments**

var_exp	Ensemble mean of model hindcasts with dimensions: c(nmod/nexp, nsdates, ntime) up to c(nmod/nexp, nsdates, ntime, nlevel, nlat, nlon)
var_obs	Ensemble mean of observational data with dimensions: c(nobs, nsdates, ntime) up to c(nobs, nsdates, ntime, nlevel, nlat, nlon)
interval	Number of months between 2 start dates. Default = 1.

**Value**

\$trend	Trends of model and observational data same dimensions with dimensions: c(nmod/nexp + nobs, 3, ntime) up to c(nmod/nexp + nobs, 3, ntime, nlevel, nlat, nlon) The length 3 dimension corresponds to the lower limit of the 95 interval, the computed trends and the upper limit of the 95 interval.
\$detrendedmod	Same dimensions as var_exp with linearly detrended var along the start date dimension.
\$detrendedobs	Same dimensions as var_exp with linearly detrended var along the start date dimension.

**Author(s)**

History: 1.0 - 2011-11 (V. Guemas, <vguemas@ic3.cat>) - Original code



**Description**

Matrix `var_exp` & `var_obs` should have the same dimensions except along `posloop` where the length can be different (`nexp` & `nobs`). `Corr` computes correlation for each `jexp` in `1:nexp` and each `jobs` in `1:nobs` which gives `nexp` x `nobs` correlation for each other grid point of the matrix. The correlations are computed along the `poscor` dimension. If `compROW` is given, the correlations are computed only if rows along the (`compROW`)th dimension are complete between `limits[1]` and `limits[2]`, that mean with no NA between `limits[1]` and `limits[2]`. Default: `limits[1] = 1` and `limits[2] = length(compROW dimension)`. The confidence interval is computed by a Fisher transformation. The significance level relies on a one-sided student-T distribution.

**Usage**

```
Corr(var_exp, var_obs, posloop = 1, poscor = 2, compROW = NULL, limits = NULL)
```

**Arguments**

<code>var_exp</code>	Matrix of experimental data.
<code>var_obs</code>	Matrix of observational data, same dimensions as <code>var_exp</code> except along <code>posloop</code> .
<code>posloop</code>	Dimension <code>nobs</code> and <code>nexp</code> .
<code>poscor</code>	Dimension along which correlation are to be computed.
<code>compROW</code>	Data taken into account only if ( <code>compROW</code> )th row is complete. Default = <code>NULL</code> .
<code>limits</code>	Complete between <code>limits[1]</code> & <code>limits[2]</code> . Default = <code>NULL</code> .

**Value**

Matrix with `c(length(posloop) in var_exp, length(posloop) in var_obs, 4, all other dimensions of var_exp & var_obs except poscor)`. The third dimension of length 4 corresponds to the lower limit of the 95 confidence interval, the computed correlation, the upper limit of the 95 confidence interval and the 95 T-test.

**Author(s)**

History: 1.0 - 2011-04 (V. Guemas, <vguemas@ic3.cat>) - Original code

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Enlarge	<i>Extend Number Of Dimensions</i>
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**Description**

Extends the number of dimensions of var to numdims (the added dimensions have length 1).

**Usage**

```
Enlarge(var, numdims)
```

**Arguments**

var	Array to extend.
numdims	Desired number of dimensions.

**Value**

Extended array.

**Author(s)**

History: 1.0 - 2011-03 (V. Guemas, <vguemas@ic3.cat>) - Original code

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Eno	<i>Compute Effective Number Of Independant Observations</i>
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**Description**

Compute the effective number of independant observations along the (posdim)th dimension of an observational matrix. This effective number of independant observations may be required to perform statistical tests. Based on eno function from Caio Coelho.

**Usage**

```
Eno(obs, posdim)
```

**Arguments**

obs	Observational matrix of any number of dimensions up to 10.
posdim	Position along which to compute the effective number of observations.

**Value**

Same dimensions as var except without posdim dimension.

**Author(s)**

History: 1.0 - 2011-05 (V. Guemas, <vguemas@ic3.cat>) - Original code

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Histo2Hindcast

*Chunk Long Simulations*

---

**Description**

This function reorganizes a long run (historical typically) with only one start date into chunks corresponding to a set of start dates. The expected input structure is the one output from load with 4 to 7 dimensions.

**Usage**

```
Histo2Hindcast(varin, sdatesin, sdatesout, nleadtimesout)
```

**Arguments**

varin	Input model or observational data: c(nmod/nexp/nobs, nmemb/nparam, nsdates, nlttime) up to c(nmod/nexp/nobs, nmemb/nparam, nsdates, nlttime, nlevel, nlat, nlon)
sdatesin	Start date of the input matrix 'YYYYMMDD'.
sdatesout	List of start dates of the output matrix c('YYYYMMDD', 'YYYYMMDD', ...).
nleadtimesout	Number of leadtimes in the output matrix.

**Value**

A matrix with the same number of dimensions as the input one, the same dimensions 1 and 2 and potentially the same dimensions 5 to 7. Dimensions 3 and 4 are set by the arguments sdatesout and nleadtimesout.

**Author(s)**

History: 1.0 - 2012-11 (V. Guemas, <vguemas@ic3.cat>) - Original code

---

**IniListDims***Create A List Of Integer Ranges*

---

**Description**

This function generates a list of arrays where those arrays contain integers from 1 to various numbers. This list of arrays is used in the other functions as a list of indices of the elements of the matrices.

**Usage**

```
IniListDims(dims, lenlist)
```

**Arguments**

dims	The dimensions of a matrix the elements of which we want to generate the indices to. For example, if the dimensions sent are c(3,2,5), the following list of arrays will be generated: list(c(1:3), c(1:2), c(1:5))
lenlist	lenlist is the length of the list because the list will be complemented above length(dims) by arrays of length 1. For example, if lenlist is set to 7, the previous list of arrays will be extended to: list(c(1:3), c(1:2), c(1:5), 1, 1, 1, 1)

**Value**

A list with lenlist elements, each with arrays with integers from 1 to the corresponding number in dims array.

**Author(s)**

History: 1.0 - 2011-04 (V. Guemas, <vguemas@ic3.cat>) - Original code

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**InsertDim***Add A Dimension To A Matrix*

---

**Description**

Add one dimension to matrix var in position posdim with length lendim and which correspond to (lendim x var matrix).

**Usage**

```
InsertDim(var, posdim, lendim)
```

**Arguments**

var	Matrix to be add a dimension to.
posdim	Position of the new dimension.
lendim	Length of the new dimension.

**Value**

Matrix with the added dimension.

**Author(s)**

History: 1.0 - 2011-03 (V. Guemas, <vguemas@ic3.cat>) - Original code

---

LeapYear

*Check Whether A Year Is Leap Year*

---

**Description**

This function tells whether a year is leap year or not.

**Usage**

LeapYear(year)

**Arguments**

year	The year to tell whether is leap year or not.
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**Value**

Boolean telling whether the year is a leap year or not.

**Author(s)**

History: 1.0 - 2011-03 (V. Guemas, <vguemas@ic3.cat>) - Original code

## Load

*Load Experimental And Observational Data***Description**

This function loads experimental data and corresponding observational data from the specified experimental and observational datasets into two matrices with similar structures. Only data of a specified variable and set of starting dates is loaded. Once the two matrices are filled by calling this function, other functions of the Common Diagnostics package that require this data structure can be executed (e.g: Ano() to compute anomalies, Clim() to compute climatologies).

**Usage**

```
Load(var, exp, obs = NULL, sdates, lonmin = 0, lonmax = 360, latmin = -90,
latmax = 90, nleadtime = NULL, nmember = NULL, leadtimemin = 1,
leadtimemax = NULL, storefreq = "monthly", sampleperiod = 1,
output = "areave", method = "conservative", grid = NULL, maskmod = list(NULL,
NULL, NULL, NULL, NULL, NULL, NULL, NULL, NULL, NULL, NULL, NULL, NULL, NULL,
NULL), maskobs = list(NULL, NULL, NULL, NULL, NULL, NULL, NULL, NULL, NULL,
NULL, NULL, NULL, NULL, NULL, NULL))
```

**Arguments**

var	One of the following: 'tas', 'prlr', 'tos', 'g500', 'g200', 'ta50', 'psl', 'hflsd', 'hfssd', 'rls', 'rss', 'rsds', 'uas', 'vas', 'siaN', 'sieN', 'sivN', 'siaS', 'sieS', 'sivS', 'moc_40N55N_1-2km', 'moc_30N40N_1-2km', 'max_moc_38N50N_500m-2km', 'max_moc_40N', 'heatc', '0-315_heatc', '373-657_heatc', '800-5350_heatc', 'mxl_heatc', 'NAtl_10N65N_heatc', 'NAtl_10N65N_0-315_heatc', 'NAtl_10N65N_373-657_heatc', 'NAtl_10N65N_800-5350_heatc', 'mxl_NAtl_10N65N_heatc', 'TAtl_30S30N_heatc', 'TAtl_30S30N_0-315_heatc', 'TAtl_30S30N_373-657_heatc', 'TAtl_30S30N_800-5350_heatc', 'mxl_TAtl_30S30N_heatc', 'NPac_10N70N_heatc', 'NPac_10N70N_0-315_heatc', 'NPac_10N70N_373-657_heatc', 'NPac_10N70N_800-5350_heatc', 'mxl_NPac_10N70N_heatc', 'TPac_30S30N_heatc', 'TPac_30S30N_0-315_heatc', 'TPac_30S30N_373-657_heatc', 'TPac_30S30N_800-5350_heatc', 'mxl_TPac_30S30N_heatc', 'Arc_65N90N_heatc', 'Arc_65N90N_0-315_heatc', 'Arc_65N90N_373-657_heatc', 'Arc_65N90N_800-5350_heatc', 'mxl_Arc_65N90N_heatc', 'Ant_90S60S_heatc', 'Ant_90S60S_0-315_heatc', 'Ant_90S60S_373-657_heatc', 'Ant_90S60S_800-5350_heatc', 'mxl_Ant_90S60S_heatc', 'TInd_30S30N_heatc', 'TInd_30S30N_0-315_heatc', 'TInd_30S30N_373-657_heatc', 'TInd_30S30N_800-5350_heatc', 'mxl_TInd_30S30N_heatc'.
exp	IMPORTANT: Place first the experiment with the largest number of members and, if possible, with the largest number of leadtimes. If not possible, it is mandatory to specify the argument nleadtime. c('EnsEcmwfDec', 'EnsUkmoDec', 'EnsCerfacsDec', 'EnsIfmDec', 'EnsEcmwfSeas', 'EnsCmccSeas', 'EnsIfmSeas', 'EnsMetfrSeas', 'EnsUkmoSeas', 'DePreSysAsimDec', 'DePreSysNoAsimDec', 'DePreSysAsimSeas', 'ECMWF_S3Seas', 'ECMWF_S4_sea', 'ECMWF_S4_ann', 'hadcm3dec', 'miroc4dec', 'miroc5dec', 'mri-cgcm3dec', 'canm4dec1', 'canm4dec2',

	'cnrm-cm5dec', 'knmidec', 'smhidec', 'mpimdec', 'gfdldec', 'cmcc-cmdec', 'ipsldec', 'bccdec', 'gfdlhis', 'ipslhis', 'cmcc-cmhis', 'bcchis', 'i00k', 'b013', 'b014', 'yve2', ...)
obs	c('ERA40', 'NCEP', 'ERAint', '20thCv2', 'GHCN', 'GHCNERSSTGISS', 'ERSST', 'HadISST', 'GPCP', 'GPCC', 'CRU', 'HadSLP', 'NSIDC', 'PIOMAS', 'UCL', 'DS94', 'OAFlux', 'DFS4.3', 'NCDCglo', 'NCDCland', 'NCDCoc', 'GISSglo', 'GISSland', 'GISSoc', 'HadCRUT3glo', 'HadCRUT4', 'HadSST2oc', 'CRUTEM3land')
sdates	c('ERA40', 'NCEP', 'ERAint', 'GHCN', 'GHCNERSSTGISS', 'ERSST', 'HadISST', 'GPCP', 'GPCC', 'CRU', 'HadSLP', 'NSIDC', 'PIOMAS', 'UCL', 'DS94', 'OAFlux', 'DFS4.3', 'NCDCglo', 'NCDCland', 'NCDCoc', 'GISSglo', 'GISSland', 'GISSoc', 'HadCRUT3glo', 'HadSST2oc', 'CRUTEM3land')
lonmin	>= 0, default: 0
lonmax	<= 360, default: 360
latmin	>= -90, default: -90
latmax	<= 90, default: 90
nleadtime	Optional argument needed only if the first experiment in the parameter exp does not have the largest number of leadtimes. Default: number of leadtimes of the first experiment.
nmember	Some experiments have more members in starting dates other than the first. If it is the case in the first experiment specified, fill nmember with the largest number of members.
leadtimemin	Load into the matrices only the leadtimes from leadtimemin. Default: 1.
leadtimemax	Load into the matrices only the leadtimes before leadtimemax. Default: nleadtime.
storefreq	Frequency at which the data to be loaded are stored in the repository. Can take values 'monthly' or 'daily'. Default: 'monthly'.
sampleperiod	To load only a subset between leadtimemin and leadtimemax with a specified period of subsampling. Default: 1 (all leadtimes are loaded).
output	'areave' / 'lon' / 'lat' / 'lonlat'. 1) Time series of area-averaged variables over the specified domain. 2) Time series of meridional averages as a function of longitudes. 3) Time series of zonal averages as a function of latitudes. 4) Time series of 2d fields. Default: 'areave'
method	'bilinear' / 'bicubic' / 'conservative' / 'distance-weighted' Method of interpolation for 'lon' / 'lat' / 'lonlat' output options. Default: 'conservative'.
grid	To choose the output grid. Possible options: rNXxNY or tTRgrid, ex: r96x72, t106grid. Default: model grid, argument need to be filled if various exp on various grids.
maskmod	list(mask[lon,lat]) = 1/0: kept/removed grid cell over the entire model domains. Warning: list() compulsory even if 1 model!!! Default: 1 everywhere.
maskobs	list(mask[lon,lat]) = 1/0: kept/removed grid cell over the entire observed domains, only necessary for 'areave' output option. Warning: list() compulsory even if 1 dataset !!! Default: 1 everywhere.

## Details

The two output data matrices are similar and have 7 dimensions each with the following lengths: 1) Number of experimental/observational datasets. 2) Number of members. 3) Number of starting dates. 4) Number of lead-times. 5) Number of latitudes (optional). 6) Number of longitudes (optional).

For a detailed explanation of the process read the documentation attached to the package or check the comments in the code.

## Value

\$mod	Model outputs. If output = 'areave', matrix with dimensions c(nmod/nexp or nobs, nmemb/nparam, nsdates, ntime) If output = 'lat', matrix with dimensions c(nmod/nexp or nobs, nmemb/nparam, nsdates, ntime, nlat) If output = 'lon', matrix with dimensions c(nmod/nexp or nobs, nmemb/nparam, nsdates, ntime, nlon) If output = 'lonlat', matrix with dimensions c(nmod/nexp or nobs, nmemb/nparam, nsdates, ntime, nlat, nlon)
\$obs	Observations. Matrix with same dimensions as '\$mod'.
\$lat	Latitudes of the model grid.
\$lon	Longitudes of the model grid.

## Author(s)

History: 1.0 - 2011-03 (V. Guemas, <vguemas@ic3.cat>) - Original code

---

Mean1Dim

---

*Compute Matrix Mean Along A Dimension*


---

## Description

Averages the matrix var along the posdim dimension between limits [1] and limits [2] if limits argument is given.

## Usage

```
Mean1Dim(var, posdim, narm = T, limits = NULL)
```

## Arguments

var	Matrix to average.
posdim	Position of the dimension to average along.
narm	Ignore NA values or not.
limits	Limits to average between.

## Value

Matrix with one dimension less containing the average.



**Author(s)**

History: 1.0 - 2011-04 (V. Guemas, <vguemas@ic3.cat>) - Original code

---

MeanListDim

*Average Matrix Along Various Dimensions*


---

**Description**

Averages the matrix var along a set of dimensions given as argument dims.

**Usage**

```
MeanListDim(var, dims, narm = T)
```

**Arguments**

var	Matrix to average.
dims	List of dimensions to average along.
narm	Ignore NA values or not.

**Value**

Matrix with the averages applied.

**Author(s)**

History: 1.0 - 2011-04 (V. Guemas, <vguemas@ic3.cat>) - Original code

---

Plot2VarsVsLTime

*Plot Two Variables In A Common Plot*


---

**Description**

Plots two input variables havind the same dimensions in a common plot. One plot for all experiments. Input variables should have dimensions (nexp/nmod, ntime).

**Usage**

```
Plot2VarsVsLTime(var1, var2, toptitle = "", ytitle = "", monini = 1,
  freq = 12, nticks = NULL, limits = NULL,
  listexp = c("exp1", "exp2", "exp3"),
  listvars = c("var1", "var2"), biglab = F, hlines = NULL,
  leg = T, siglev = F, sizetit = 1,
  fileout = "output_plot2varsvsltime.eps", show_conf = T)
```

**Arguments**

var1	Matrix of dimensions (nexp/nmod, nlttime).
var2	Matrix of dimensions (nexp/nmod, nlttime).
toptitle	Main title, optional.
ytitle	Title of Y-axis, optional.
monini	Starting month between 1 and 12. Default = 1.
freq	1 = yearly, 12 = monthly, 4 = seasonal, ... Default = 12.
nticks	Number of ticks and labels on the x-axis, optional.
limits	c(lower limit, upper limit): limits of the Y-axis, optional.
listexp	List of experiment names, up to three, optional.
listvars	List of names of input variables, optional.
biglab	T/F for presentation/paper plot. Default = F.
hlines	c(a, b, ...) Add horizontal black lines at Y-positions a, b, ... Default: NULL.
leg	T/F if legend should be added or not to the plot. Default = T.
siglev	T/F if significance level should replace confidence interval. Default = F.
sizetit	Multiplicative factor to change title size, optional.
fileout	Name of output ps file.
show_conf	T/F to show/not confidence intervals for input variables.

**Details**

Examples of input: \_\_\_\_\_

RMSE error for a number of experiments and along lead-time: (nexp, nlttime)

**Author(s)**

History: 1.0 - 2013-03 (I. Andreu-Burillo, <isabel.andreu-burillo@ic3.cat>) - Original code

---

PlotACC

---

*Plot Time-Series Of Anomaly Correlation Coefficient*


---

**Description**

Plots time-series of ACC in matrix with dimensions: c(nexp, nobs, nsdates, nlttime, 4) with the fourth dimension of length 4 containing the lower limit of the 95 confidence interval, the computed ACC, the upper limit of the 95 interval and the 95

**Usage**

```
PlotACC(ACC, sdates, toptitle = "", sizetit = 1, ytitle = "", limits = NULL,
        legends = NULL, freq = 12, biglab = F, fill = F, linezero = F,
        points = T, vl原因es = NULL, fileout = "output_PlotACC.eps")
```



**Arguments**

exp_ano	Matrix with experimental data: c(nmod/nexp, nmemb/nparam, nsdates, nlttime).
obs_ano	Optional matrix with observational data: c(nobs, nmemb, nsdates, nlttime)
sdates	List of starting dates: c('YYYYMMDD','YYYYMMDD').
toptitle	Main title for each experiment: c(""), optional.
ytitle	Title of Y-axis for each experiment: c(""), optional.
limits	c(lower limit, upper limit): limits of the Y-axis, optional.
legends	List of observational dataset names, optional.
freq	1 = yearly, 12 = monthly, 4 = seasonal, ... Default: 12.
biglab	T/F for presentation/paper plot. Default = F.
fill	T/F if filled spread between members. Default = T.
memb	T/F if all members/ensemble-mean only should be plotted. Default = T.
ensmean	T/F if the ensemble-mean should be plotted. Default = T.
linezero	T/F if a line at y=0 should be added. Default = F.
points	T/F if points instead of lines. Default = F.
vlines	List of x location where to add vertical black lines, optional.
fileout	Name of output ps file for each experiment: c("").
sizetit	Multiplicative factor to scale title size, optional.

**Author(s)**

History: 1.0 - 2011-03 (V. Guemas, <vguemas@ic3.cat>) - Original code

---

PlotClim

---

*Plot Climatologies*


---

**Description**

Plots time-series of climatologies of any index output from clim and organized in matrix with dimensions: c(nmod/nexp, nmemb/nparam, nlttime) c(nobs, nmemb, nlttime)

**Usage**

```
PlotClim(exp_clim, obs_clim = NULL, toptitle = "", ytitle = "", monini = 1,
         freq = 12, limits = NULL, listexp = c("exp1", "exp2", "exp3"),
         listobs = c("obs1", "obs2", "obs3"), biglab = F, leg = T,
         fileout = "output_plotclim.eps", sizetit = 1)
```

**Arguments**

exp_clim	Matrix with experimental data: c(nmod/nexp, nmemb/nparam, ntime)
obs_clim	Matrix with observational data, optional: c(nobs, nmemb, ntime)
toptitle	Main title, optional
ytitle	Title of Y-axis, optional.
monini	Starting month between 1 and 12. Default = 1.
freq	1 = yearly, 12 = monthly, 4 = seasonal, ... Default = 12.
limits	c(lower limit, upper limit): limits of the Y-axis, optional.
listexp	List of experiment names, optional.
listobs	List of observational dataset names, optional.
biglab	T/F for presentation/paper plot. Default = F.
leg	Whether to plot legend or not.
fileout	Name of output ps file.
sizetit	Multiplicative factor to scale title size, optional.

**Author(s)**

History: 1.0 - 2011-03 (V. Guemas, <vguemas@ic3.cat>) - Original code

---

PlotEquiMap	<i>Map Two-Dimensional Variable On A Cylindrical Equidistant Projection</i>
-------------	---

---

**Description**

Map two dimensional matrix with (longitude, latitude) dimensions in cylindrical equidistant latitude and longitude projection.

**Usage**

```
PlotEquiMap(var, lon, lat, toptitle = "", sizetit = 1, units = "",
            brks = NULL, cols = NULL, square = TRUE,
            filled.continents = TRUE, contours = NULL, brks2 = NULL,
            dots = NULL, axelab = T, labW = F, intylat = 20, intxlon = 20,
            drawleg = T, subsampleg = 1, numbfig = 1, colNA = "white")
```

**Arguments**

var	Matrix to plot with (longitude, latitude) dimensions.
lon	Array of longitudes.
lat	Array of latitudes.
toptitle	Title, optional.

sizetit	Multiplicative factor to increase title size, optional.
units	Units, optional.
brks	Colour levels, optional.
cols	List of colours, optional.
square	Map with squares (TRUE) for each grid points or smoothing (FALSE). Default: TRUE.
filled.continents	Continents filled in grey (TRUE) or represented by a black line (FALSE). Default = TRUE. Filling unavailable if crossing Greenwich. Filling unavailable if square.
contours	Matrix to add to the plot with contours. Default = NULL.
brks2	Contour levels, optional.
dots	Matrix with TRUE / FALSE flags to add black dots option only available if square = TRUE.
axelab	TRUE/FALSE, label the axis. Default = TRUE.
labW	
intylat	Interval between latitude ticks on y-axis. Default: 20deg.
intxlon	Interval between longitude ticks on x-axis. Default: 20deg.
drawleg	Draw colorbar. Can be FALSE only if square = FALSE. Must be FALSE if numbfig > 1. Default: T.
subsampleg	Supersampling factor of the interval between ticks on colorbar. Default: 1 = every colour level.
numbfig	Number of figures in the final multipanel.
colNA	

**Author(s)**

History: 1.0 - 2011-11 (V. Guemas, <vguemas@ic3.cat>) - Original code

---

PlotSection

---

*Plot A Section*


---

**Description**

Plot a (longitude,depth) or (latitude,depth) section.

**Usage**

```
PlotSection(var, horiz, depth, toptitle = "", sizetit = 1, units = "",
            brks = NULL, cols = NULL, axelab = T, intydep = 200,
            intxhoriz = 20, drawleg = T)
```

**Arguments**

var	Matrix to plot with (longitude/latitude, depth) dimensions.
horiz	Array of longitudes/latitudes.
depth	Array of depths.
toptitle	Title, optional.
sizetit	Multiplicative factor to increase title size, optional.
units	Units, optional.
brks	Colour levels, optional.
cols	List of colours, optional.
axelab	TRUE/FALSE, label the axis. Default = TRUE.
intydep	Interval between depth ticks on y-axis. Default: 200m.
intxhoriz	Interval between longitude/latitude ticks on x-axis. Default: 20deg.
drawleg	Draw colorbar. Default: TRUE.

**Author(s)**

History: 1.0 - 2012-09 (V. Guemas, <vguemas@ic3.cat>) - Original code

---

PlotVsLTime

---

*Plot Data Along Forecast Time*


---

**Description**

Plots mean InterQuartile Range, Maximum-Minimum, Standard Deviation, Median Absolute Deviation, the trends, the RMS and correlation between modelled and observed data against the forecast time for all input experiments.

**Usage**

```
PlotVsLTime(var, toptitle = "", ytitle = "", monini = 1, freq = 12,
nticks = NULL, limits = NULL, listexp = c("exp1", "exp2", "exp3"),
listobs = c("obs1", "obs2", "obs3"), biglab = F, hlines = NULL, leg = T,
siglev = F, fileout = "output_plotvsltime.eps", sizetit = 1)
```

**Arguments**

var	Matrix of dimensions: (nexp/nmod, 3 ,nltime) or (nexp/nmod, nob, 3 ,nltime)
toptitle	Main title, optional.
ytitle	Title of Y-axis, optional.
monini	Starting month between 1 and 12. Default = 1.
freq	1 = yearly, 12 = monthly, 4 = seasonal, ... Default = 12.
nticks	Number of ticks and labels on the x-axis, optional.

limits	c(lower limit, upper limit): limits of the Y-axis, optional.
listexp	List of experiment names, optional.
listobs	List of observation names, optional.
biglab	T/F for presentation/paper plot. Default = F.
hlines	c(a,b, ...) Add horizontal black lines at Y-positions a,b, ... Default = NULL.
leg	T/F if legend should be added or not to the plot. Default = T.
siglev	T/F if significance level should replace confidence interval. Default = F.
fileout	Name of output ps file.
sizetit	Multiplicative factor to change title size, optional.

### Details

Examples of input: \_\_\_\_\_

- 1- Model output from load/ano/smoothing: (nmod, nmemb, sdate, ntime) then passed through spread(var, posdim = 2, narm = T) and mean1dim(var, posdim = 3, narm=T) or through trend(mean1dim(var, 2), posTR = 2): (nmod, 3, ntime) plots average along start dates of IQR/MaxMin/SD/MAD across members or trends of the ensemble-mean computed accross the start dates
- 2- Model and observed output from load/ano/smoothing: (nmod, nmemb, sdate, ntime) and (nobs, nmemb, sdate, ntime) then averaged along members mean1dim(var\_exp/var\_obs, posdim = 2): (nmod, sdate, ntime) and (nobs, sdate, ntime) then passed through corr(exp, obs, posloop = 1, poscor = 2) or RMS(exp, obs, posloop = 1, posRMS = 2): (nmod, nobs, 3, ntime) plots correlations or RMS between each exp & each obs against lead-time.

### Author(s)

History: 1.0 - 2011-03 (V. Guemas, <vguemas@ic3.cat>) - Original code - 2013-03 (I. Andreu-Burillo, - Introduced parameter - <isabel.andreu-burillo@ic3.cat>) - sizetit

---

RatioRMS

*Compute Ratio Between Two RMSs.*

---

### Description

Matrix var\_exp1 / var\_exp2 / var\_obs should have the same dimensions. The ratio RMSE(var\_exp1, var\_obs) / RMSE(var\_exp2, var\_obs) is output. The p-value is provided by a two-sided Fischer test.

### Usage

```
RatioRMS(var_exp1, var_exp2, var_obs, posRMS = 1)
```

### Arguments

var_exp1	Matrix of experimental data 1.
var_exp2	Matrix of experimental data 2, same dimensions as var_exp1.
var_obs	Matrix of observational data, same dimensions as var_exp1.
posRMS	Dimension along which RMS are to be computed.



**Value**

Matrix with the same dimensions than var\_exp1/var\_exp2/var\_obs except along posRMS where the dimension has length 2. The dimension 2 corresponds to the ratio between the computed RMSE (RMSE1/RMSE2) and the p.value of the two-sided Fisher test with  $H_0: \text{RMSE1/RMSE2} = 1$ .

**Author(s)**

History: 1.0 - 2011-11 (V. Guemas, <vguemas@ic3.cat>) - Original code

---

RatioSDRMS

---

*Compute Ratio Between Standard Deviations*


---

**Description**

Matrix var\_exp & var\_obs should have the common diagnostic structure: between c(nmod/nexp, nmemb/nparam, nsdates, nlttime) and c(nmod/nexp, nmemb/nparam, nsdates, nlttime, nlevel, nlat, nlon) The ratio between the standard deviation of the members around the ensemble mean in var\_exp and the RMSE between var\_exp and var\_obs is output for each experiment and each observational dataset. The p-value is provided by a one-sided Fischer test.

**Usage**

```
RatioSDRMS(var_exp, var_obs)
```

**Arguments**

var_exp	Model data: c(nmod/nexp, nmemb/nparam, nsdates, nlttime) up to c(nmod/nexp, nmemb/nparam, nsdates, nlttime, nlevel, nlat, nlon)
var_obs	Observational data: c(nobs, nmemb, nsdates, nlttime) up to c(nobs, nmemb, nsdates, nlttime, nlevel, nlat, nlon)

**Value**

Matrix with c(nexp/nmod, nobs, 2, nlttime) up to c(nexp/nmod, nobs, 2, nlttime, nlevel, nlat, nlon) dimensions. The dimension 2 corresponds to the ratio (SD/RMSE) and the p.value of the one-sided Fisher test with  $H_0: \text{SD/RMSE} = 1$ .

**Author(s)**

History: 1.0 - 2011-12 (V. Guemas, <vguemas@ic3.cat>) - Original code

## Regression

*Compute The Regression Of A Matrix On Another Along A Dimension***Description**

Compute the regression of matrice vary on matrice varx along the (posREG)th dimension by least square fitting. Provides the slope of the regression, the associated confidence interval, and the intercept. Provide also the vary data filtered out from the regression onto varx. The confidence interval relies on a student-T distribution.

**Usage**

```
Regression(vary, varx, posREG = 2)
```

**Arguments**

vary	Matrix of any number of dimensions up to 10.
varx	Matrix of any number of dimensions up to 10.
posREG	Position along which to compute the regression.

**Value**

\$regression	Matrix with same dimensions as varx and vary except along posREG dimension which is replaced by a length 4 dimension, corresponding to the lower limit of the 95 the 95 along all the other dimensions.
\$filtered	Same dimensions as vary filtered out from the regression onto varx along the posREG dimension.

**Author(s)**

History: 1.0 - 2013-05 (V. Guemas, <vguemas@ic3.cat>) - Original code

## RMS

*Compute Root Mean Square***Description**

Matrix var\_exp & var\_obs should have the same dimensions except along posloop where the length can be different (nexp & nobs). RMS compute for each grid point the Root Mean Square difference along the posRMS dimension between each model data in 1:nexp and each observation in 1:nobs which gives nexp x nobs RMS dif for each other grid point of the matrix. The confidence interval relies on a chi2 distribution.

**Usage**

```
RMS(var_exp, var_obs, posloop = 1, posRMS = 2, compROW = NULL, limits = NULL)
```

**Arguments**

<code>var_exp</code>	Matrix of experimental data.
<code>var_obs</code>	Matrix of observational data, same dimensions as <code>var_exp</code> except along <code>posloop</code> .
<code>posloop</code>	Dimension <code>nobs</code> and <code>nexp</code> .
<code>posRMS</code>	Dimension along which RMSE are to be computed.
<code>compROW</code>	Data taken into account only if ( <code>compROW</code> )th row is complete. Default = <code>NULL</code> .
<code>limits</code>	Complete between <code>limits[1]</code> & <code>limits[2]</code> . Default = <code>NULL</code> .

**Value**

Matrix with `c(length(posloop) in var_exp, length(posloop) in var_obs, 3`, all other dimensions of `var_exp` & `var_obs` except `posRMS`). The dimension 3 corresponds to the lower limit of the 95 interval, the computed RMSE and the upper limit of the 95 interval.

**Author(s)**

History: 1.0 - 2011-05 (V. Guemas, <vguemas@ic3.cat>) - Original code

---

 RMSSS

---

*Compute Root Mean Square Skill Score*


---

**Description**

Matrix `var_exp` & `var_obs` should have the same dimensions except along `posloop` where the length can be different (`nexp` & `nobs`). RMSSS compute for each grid point the Root Mean Square Skill Score along the `posRMS` dimension for each model in `1:nexp` against each observational data in `1:nobs` which gives `nexp x nobs` RMSSS for each other grid point of the matrix. The p-value is provided by a one-sided Fisher test.

**Usage**

```
RMSSS(var_exp, var_obs, posloop = 1, posRMS = 2)
```

**Arguments**

<code>var_exp</code>	Matrix of experimental data.
<code>var_obs</code>	Matrix of observational data, same dimensions as <code>var_exp</code> except along <code>posloop</code> .
<code>posloop</code>	Dimension <code>nobs</code> and <code>nexp</code> .
<code>posRMS</code>	Dimension along which RMSE are to be computed.

**Value**

Matrix with  $c(\text{length}(\text{posloop}) \text{ in } \text{var\_exp}, \text{length}(\text{posloop}) \text{ in } \text{var\_obs}, 2, \text{ all other dimensions of } \text{var\_exp} \text{ \& } \text{var\_obs} \text{ except } \text{posRMS})$ . The dimension 2 corresponds to the RMSSS and the p.value of the one-sided Fisher test with  $H_0: \text{RMSSS} = 0$ .

**Author(s)**

History: 1.0 - 2012-04 (V. Guemas, <vguemas@ic3.cat>) - Original code

---

Season	<i>Compute Seasonal Means</i>
--------	-------------------------------

---

**Description**

Computes seasonal means on time-series organized in a matrix of any number of dimensions up to 10 dimensions.

**Usage**

```
Season(var, posdim = 4, monini, moninf, monsup)
```

**Arguments**

var	Matrix in which are the time-series.
posdim	Rank of the dimension along with to compute seasonal means.
monini	Position in the year of the first month of the time-series: 1 to 12.
moninf	Position in the year of the month when to start the seasonal means: 1 to 12.
monsup	Position in the year of the month when to stop the seasonal means: 1 to 12.

**Value**

Matrix with same dimensions as var except along the (posdim)th dimension which length corresponds to the number of seasons. Partial seasons are not accounted for.

**Author(s)**

History: 1.0 - 2011-03 (V. Guemas, <vguemas@ic3.cat>) - Original code

---

SelIndices

*Slice A Matrix Along A Dimension*


---

**Description**

This function allows to select a subensemble from a matrix of any dimensions, providing the dimension along which the user aims at cutting the matrix and between which indices.

**Usage**

```
SelIndices(var, posdim, limits)
```

**Arguments**

var	A matrix of any rank and any dimensions.
posdim	The dimension along which a submatrice should be selected.
limits	The lower and upper indice of the selection along the (posdim)th dimension.

**Value**

The sliced matrix.

**Author(s)**

History: 1.0 - 2011-04 (V. Guemas, <vguemas@ic3.cat>) - Original code

---

Smoothing

*Smooth Time-Series*


---

**Description**

Smoothes time-series organized in a matrix of any number of dimensions up to 10 dimensions (arbitrary choice, can be enlarged if needed → ask Virginie)

**Usage**

```
Smoothing(var, runmeanlen = 12, numdimt = 4)
```

**Arguments**

var	Matrix in which are the time-series to smooth.
runmeanlen	Running mean length in number of time-steps (typically months).
numdimt	Dimension along with to smooth.

**Value**

Matrix with same dimensions as var and smoothed time-series along the (numdimt)th dimension.

**Author(s)**

History: 1.0 - 2011-03 (V. Guemas, <vguemas@ic3.cat>) - Original code

---

Spread	<i>Compute InterQuartile Range, Maximum-Minimum, Standard Deviation and Median Absolute Deviation</i>
--------	---

---

**Description**

Compute InterQuartile Range, Maximum-Minimum, Standard Deviation and Median Absolute Deviation along the (posdim)th dimension of matrix var. The confidence interval is computed by bootstrapping.

**Usage**

```
Spread(var, posdim = 2, narm = T)
```

**Arguments**

var	Matrix of any number of dimensions up to 10.
posdim	Dimensions along which to compute IQR/MaxMin/SD/MAD.
narm	T/F if NA removed/kept before computation. Default = T.

**Details**

Example: ——— To compute IQR, Max-Min, SD & MAD accross members and start dates of var output from load or ano, call: `spread(var, posdim = c(2, 3), narm = T)`

**Value**

Matrix with same dimensions as var except along the first posdim dimension which is replaced by a length 3 dimension, corresponding to the lower limit of the 95 the upper limit of the 95 along all the other dimensions except for the other posdim dimensions which disappear.

\$iqr	InterQuartile Range.
\$maxmin	Maximum - minimum.
\$sd	Standard deviation.
\$mad	Median value.

**Author(s)**

History: 1.0 - 2011-03 (V. Guemas, <vguemas@ic3.cat>) - Original code

---

Trend

---

*Compute Trends*

---

**Description**

Compute trends along the (posTR)th dimension of matrix var by least square fitting, and the associated an error interval. Provide also the detrended data. The confidence interval relies on a student-T distribution.

**Usage**

```
Trend(var, posTR = 2, interval = 1)
```

**Arguments**

var	Matrix of any number of dimensions up to 10.
posTR	Position along which to compute trends.
interval	Number of months between 2 points along posTR dimension. Default = 1.

**Value**

\$trend	Same dimensions as var except along posTR dimension which is replaced by a length 3 dimension, corresponding to the lower limit of the 95 interval, the computed trends and the upper limit of the 95 interval for each point of the matrix along all the other dimensions.
\$detrended	Same dimensions as var with linearly detrended var along the posTR dimension.

**Author(s)**

History: 1.0 - 2011-05 (V. Guemas, <vguemas@ic3.cat>) - Original code

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