



**Barcelona
Supercomputing
Center**

Centro Nacional de Supercomputación



**EXCELENCIA
SEVERO
OCHOA**

R tools user meeting

An-Chi Ho and Núria Pérez-Zanón

08/01/2021

Icebreaker

Agenda

1. Icebreaker: A little interaction
2. Package update
 - startR
 - CStools release status
 - ClimProjDiags release
3. Package kableExtra (Nicola)
4. Indices in s2dv (Carlos)
5. Q&A

Package update

- The time attribute was corrected for different **calendar** types (e.g., '360_day', '365_day', and 'standard').
Before, Start() only considered the standard (i.e., gregorian) calendar.
- Find the calendar in metadata:
`str(attributes(attr(data, 'Variables'))$common$time)`
- We're working on decadal prediction data retrieval by Start().
 - Different sdate and ftime
 - Different calendar
 - Different file amount
 - etc.

Highlights:

- Data Storage and retrieval **vignette**
- PlotMostLikelyQuantileMap **vignette**
- **CST_MultiMetric** includes 'rpss' metric

Under-review:

- downscaling analog functions using predictors (AEMET) [Fortran]
- ADAMONT downscaling method
- CST_Analogs fixes

Visit NEWS in master branch to see the list of all fixes and new developments:

<https://earth.bsc.es/gitlab/external/cstools/-/blob/master/NEWS.md>

Version 0.1.1 was:

- Submitted to CRAN
- On CRAN: <https://CRAN.R-project.org/package=ClimProjDiags>
- Installed in WS and Nord3

News:

- License Apache 2.0
-

Package kableExtra

ECMWF System 5 (Obs: ERA5 1993-2016)		Mean bias (Unit Niño3.4: K; NAO: hPa) Forecast month						Correlation Forecast month						RMSE Forecast month						Spread/RMSE Ratio Forecast month					
Start date	Teleconnection	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
January	Niño3.4 NAO	...	...	...	...	...	...	...	...	...	...	...	...	0.011	...	0.038	0.091	...	0.533	0.011	...	0.03	0.09	...	0.53
February	Niño3.4 NAO	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
March	Niño3.4 NAO	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
April	Niño3.4 NAO	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
May	Niño3.4 NAO	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
June	Niño3.4 NAO	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
July	Niño3.4 NAO	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
August	Niño3.4 NAO	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
September	Niño3.4 NAO	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
October	Niño3.4 NAO	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
November	Niño3.4 NAO	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
December	Niño3.4 NAO	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...

2m temperature of ECMWF System 5
(Obs: ERA5 1993-2016)

Region	Forecast month	Target month												Target month																																	
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec																						
		Mean Bias (K)																								Correlation																					
Tropics (30S-30N)	1	-0.21	-0.21	-0.17	-0.16	-0.12	-0.17	-0.19	-0.19	-0.17	-0.18	-0.22	-0.24	0.81	0.83	0.87	0.90	0.93	0.93	0.91	0.91	0.91	0.91	0.91	0.91																						
	2	-0.24	-0.25	-0.2	-0.16	-0.1	-0.11	-0.14	-0.15	-0.16	-0.16	-0.2	-0.25	0.51	0.52	0.55	0.54	0.51	0.5	0.52	0.52	0.54	0.54	0.55	0.52																						
	3	-0.23	-0.25	-0.2	-0.18	-0.11	-0.08	-0.1	-0.12	-0.14	-0.19	-0.19	-0.23	0.58	0.61	0.6	0.62	0.57	0.55	0.56	0.56	0.56	0.61	0.56	0.55																						
	4	-0.23	-0.24	-0.22	-0.21	-0.16	-0.09	-0.07	-0.09	-0.12	-0.17	-0.22	-0.24	0.51	0.59	0.56	0.59	0.55	0.55	0.55	0.54	0.54	0.59	0.59	0.54																						
	5	-0.24	-0.24	-0.21	-0.23	-0.19	-0.14	-0.09	-0.07	-0.11	-0.16	-0.21	-0.26	0.53	0.52	0.55	0.54	0.51	0.5	0.52	0.52	0.54	0.55	0.55	0.52																						
	6	-0.25	-0.25	-0.23	-0.23	-0.21	-0.17	-0.13	-0.09	-0.09	-0.15	-0.2	-0.25	0.52	0.54	0.5	0.54	0.47	0.45	0.5	0.5	0.49	0.53	0.54	0.49																						
Extra-tropical NH (30N-90N)	1	-0.36	-0.00	0.16	0.19	0.23	-0.04	-0.18	-0.11	-0.02	0.04	-0.46	-0.40	0.60	0.71	0.77	0.75	0.69	0.67	0.61	0.61	0.62	0.60	0.69	0.69																						
	2	-0.53	-0.25	0.17	0.24	0.25	-0.00	-0.22	-0.21	0.11	0.47	0.21	-0.41	0.37	0.20	0.36	0.36	0.31	0.25	0.34	0.34	0.42	0.35	0.20	0.20																						
	3	-0.46	-0.33	0.07	0.18	0.15	-0.23	-0.53	-0.53	0.09	0.64	0.6	-0.04	0.32	0.3	0.27	0.29	0.25	0.22	0.22	0.36	0.37	0.5	0.22	0.28																						
	4	-0.35	-0.26	0	0.1	0.06	-0.34	-0.46	-0.44	-0.16	0.56	0.66	0.14	0.26	0.27	0.22	0.19	0.23	0.2	0.21	0.22	0.33	0.33	0.27	0.25																						
	5	-0.17	-0.10	-0.07	0.07	0.03	-0.39	-0.35	-0.55	-0.20	0.12	0.5	0.25	0.25	0.23	0.22	0.17	0.19	0.21	0.22	0.14	0.37	0.3	0.22	0.25																						
	6	-0.09	-0.06	0.02	0.02	0.05	-0.42	-0.61	-0.64	-0.41	-0.05	0.09	0.12	0.25	0.26	0.16	0.10	0.17	0.2	0.25	0.21	0.29	0.3	0.10	0.25																						
Extra-tropical SH (30S-90S)	1	-0.02	0.23	0.35	0.20	0.19	-0.01	0.27	0.11	0.15	0.24	-0.06	-0.07	0.60	0.57	0.63	0.60	0.66	0.6	0.61	0.66	0.62	0.64	0.66	0.66																						
	2	0.04	-0.47	0.35	0.50	0.27	-0.02	0.4	0.18	0.10	0.2	-0.16	-0.14	0.37	0.30	0.37	0.32	0.25	0.17	0.27	0.20	0.25	0.5	0.51	0.51																						
	3	-0.03	0.35	0.92	0.63	0.47	0.04	0.19	0.11	0.18	0.35	-0.19	-0.21	0.32	0.32	0.33	0.32	0.23	0.16	0.17	0.22	0.2	0.24	0.32	0.24																						
	4	-0.07	0.1	1.01	0.7	0.71	0.12	0.25	-0.04	0.00	0.00	-0.25	-0.36	0.28	0.20	0.29	0.1	0.2	0.10	0.16	0.13	0.12	0.24	0.20	0.31																						
	5	-0.09	0.49	1.03	0.7	0.96	0.37	0.34	0.03	0	0.06	-0.5	-0.27	0.23	0.23	0.27	0.24	0.19	0.18	0.13	0.21	0.19	0.21	0.27	0.26																						
	6	-0.11	0.47	1.02	0.7	0.96	0.35	0.51	0.05	0.03	0	-0.20	-0.31	0.28	0.17	0.29	0.23	0.16	0.18	0.19	0.19	0.2	0.26	0.23	0.23																						

Type	Sparkline	boxplot	sparkline
bar			
line			
bullet			
pie			
tristate			
discrete			

kableExtra

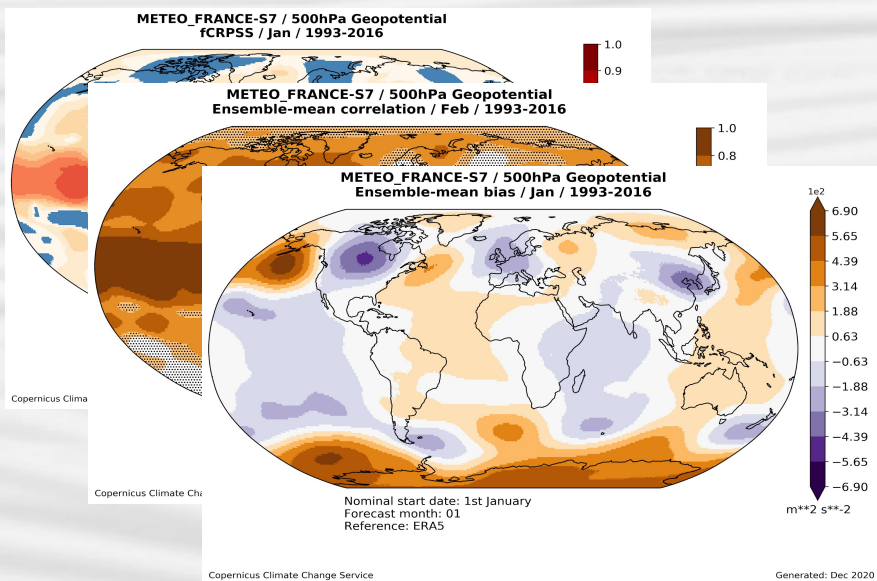
```
table.html <- kbl(table, escape = F, col.names = my.col.names, align = rep("c", n.columns))
```

output figure in HTML or LaTeX

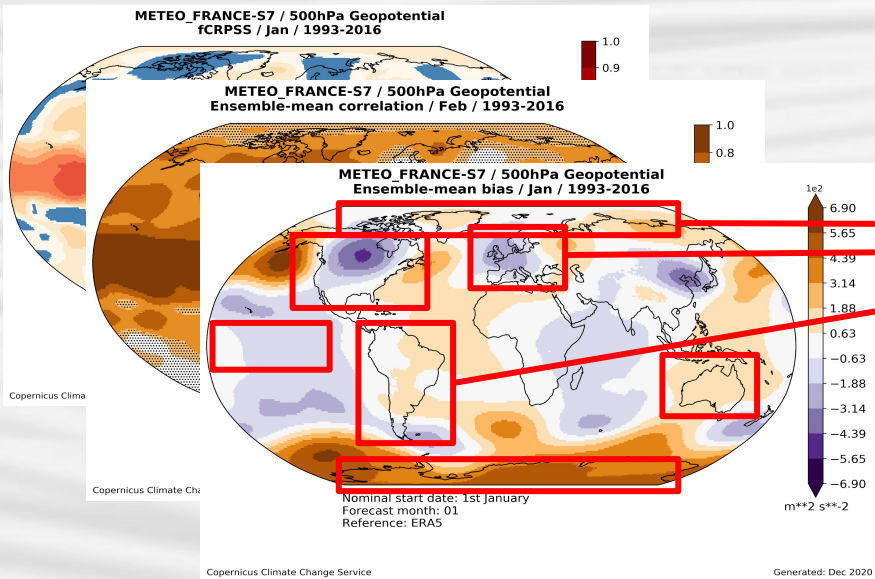
input matrix or data frame

table format

```
save_kable(table.html, file = "~/figure.png")
```

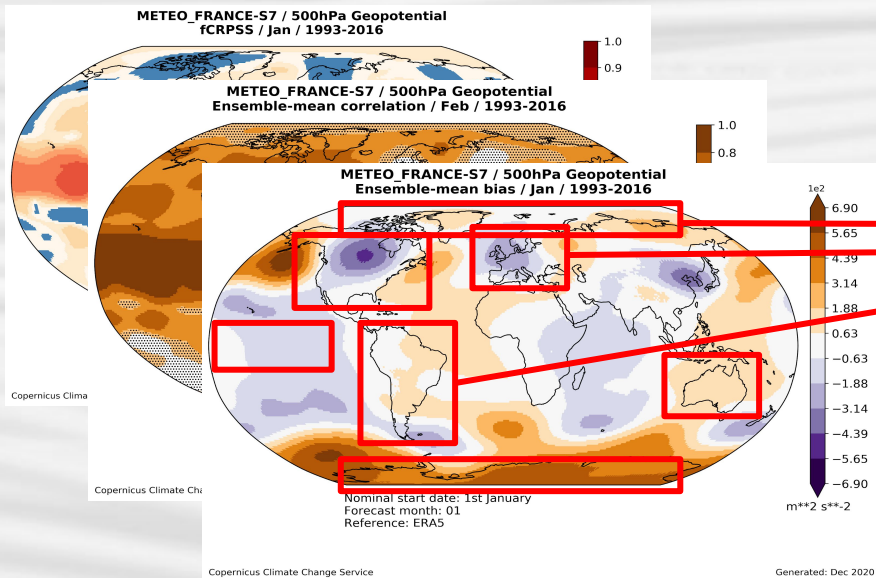


ECMWF System 5		Mean bias					
(Obs: ERA5 1993-2016)		(Unit Niño3.4: K; NAO: hPa)					
		Forecast month					
Start date	Teleconnection	1	2	3	4	5	6
January	Niño3.4	0.27	0.19	0.06	0.27	0.28	0.28
	NAO	0.28	0.19	0.22	0.28	0.28	0.28
February	Niño3.4	0.28	0.19	0.26	0.28	0.28	0.28
	NAO	0.28	0.00	0.29	0.28	0.28	0.28
March	Niño3.4	0.27	0.19	0.26	0.28	0.13	0.28
	NAO	0.28	0.25	0.26	0.28	0.28	0.28
April	Niño3.4	0.28	0.19	0.27	0.28	0.28	0.28
	NAO	0.06	0.02	0.27	0.28	0.28	0.28
May	Niño3.4	0.24	0.01	0.25	0.28	0.19	0.24
	NAO	0.28	0.28	0.22	0.19	0.28	0.03
June	Niño3.4	0.28	0.28	0.28	0.22	0.28	0.28
	NAO	0.24	0.28	0.28	0.28	0.28	0.28
July	Niño3.4	0.28	0.28	0.28	0.14	0.28	0.28
	NAO	0.27	0.28	0.28	0.28	0.28	0.16
August	Niño3.4	0.26	0.19	0.25	0.27	0.28	0.28
	NAO	0.28	0.28	0.29	0.26	0.28	0.23
September	Niño3.4	0.28	0.28	0.28	0.09	0.28	0.28
	NAO	0.24	0.28	0.28	0.28	0.28	0.25
October	Niño3.4	0.28	0.28	0.28	0.28	0.06	0.28
	NAO	0.28	0.26	0.22	0.08	0.28	0.24
November	Niño3.4	0.20	0.01	0.28	0.28	0.28	0.28
	NAO	0.28	0.12	0.28	0.23	0.28	0.28
December	Niño3.4	0.22	0.28	0.22	0.09	0.25	0.26
	NAO	0.28	0.28	0.27	0.28	0.28	0.28



Snow density Meteo-France System 7 (Obs: ERA5 1993-2016)		Mean Bias (Kg m-3)					
Start date	Region	Forecast month					
		1	2	3	4	5	6
January	Tropics (30S-30N)	3.42	3.31	3.39	3.77	10.18	10.24
	Extra-tropical NH (30N-90N)	3.43	3.49	3.34	7.99	110.41	33.08
	Extra-tropical SH (30S-90S)						
February	Tropics (30S-30N)	3.38	3.46	3.83	10.16	10.23	10.24
	Extra-tropical NH (30N-90N)	4.30	2.60	7.69	15.39	33.60	20.61
	Extra-tropical SH (30S-90S)						
March	Tropics (30S-30N)	3.50	3.84	10.15	10.23	10.24	10.24
	Extra-tropical NH (30N-90N)	3.31	6.30	19.84	33.93	20.58	20.24
	Extra-tropical SH (30S-90S)						
April	Tropics (30S-30N)	3.90	10.17	10.23	10.24	10.24	10.20
	Extra-tropical NH (30N-90N)	10.45	22.86	34.09	20.56	20.26	19.44
	Extra-tropical SH (30S-90S)						
May	Tropics (30S-30N)	10.27	10.25	10.25	10.25	10.22	10.05
	Extra-tropical NH (30N-90N)	16.73	33.86	20.31	20.06	18.60	8.99
	Extra-tropical SH (30S-90S)						
June	Tropics (30S-30N)	10.25	10.25	10.25	10.23	10.08	3.71
	Extra-tropical NH (30N-90N)	27.54	19.78	19.56	18.87	12.32	3.18
	Extra-tropical SH (30S-90S)						
July	Tropics (30S-30N)	10.25	10.25	10.23	10.08	3.74	3.38
	Extra-tropical NH (30N-90N)	19.30	19.05	15.50	13.82	3.00	3.51
	Extra-tropical SH (30S-90S)						
August	Tropics (30S-30N)	10.25	10.24	10.13	3.80	3.49	3.34
	Extra-tropical NH (30N-90N)	19.77	15.36	13.33	11.56	1.18	1.79
	Extra-tropical SH (30S-90S)						
September	Tropics (30S-30N)	10.26	10.19	3.90	3.62	3.47	3.38
	Extra-tropical NH (30N-90N)	14.73	13.32	3.69	3.62	3.25	3.61
	Extra-tropical SH (30S-90S)						
October	Tropics (30S-30N)	10.21	3.98	3.73	3.61	3.51	3.56
	Extra-tropical NH (30N-90N)	15.09	10.39	3.96	3.99	3.12	3.45
	Extra-tropical SH (30S-90S)						
November	Tropics (30S-30N)	10.01	3.77	3.62	3.51	3.55	3.87
	Extra-tropical NH (30N-90N)	3.87	3.43	3.98	3.35	3.26	3.91
	Extra-tropical SH (30S-90S)						
December	Tropics (30S-30N)	3.70	3.51	3.38	3.45	3.82	10.23
	Extra-tropical NH (30N-90N)	10.55	3.96	10.36	3.40	4.93	16.95
	Extra-tropical SH (30S-90S)						

kableExtra + formattable



Snow density Meteo-France System 7 (Obs: ERA5 1993-2016)		Mean Bias (Kg m-3)					
Start date	Region	Forecast month					
		1	2	3	4	5	6
January	Tropics (30S-30N)	3.42	3.31	3.39	3.77	10.18	10.24
	Extra-tropical NH (30N-90N)	3.43	3.49	3.34	7.99	110.41	33.08
	Extra-tropical SH (30S-90S)						
February	Tropics (30S-30N)	3.38	3.46	3.83	10.16	10.23	10.24
	Extra-tropical NH (30N-90N)	4.30	2.60	7.69	15.39	33.60	20.61
	Extra-tropical SH (30S-90S)						
March	Tropics (30S-30N)	3.50	3.84	10.15	10.23	10.24	10.24
	Extra-tropical NH (30N-90N)	3.31	6.30	19.84	33.93	20.58	20.24
	Extra-tropical SH (30S-90S)						
April	Tropics (30S-30N)	3.90	10.17	10.23	10.24	10.24	10.20
	Extra-tropical NH (30N-90N)	10.45	22.86	34.09	20.56	20.26	19.44
	Extra-tropical SH (30S-90S)						
May	Tropics (30S-30N)	10.27	10.25	10.25	10.25	10.22	10.05
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	Extra-tropical SH (30S-90S)						
July	Tropics (30S-30N)	10.25	10.25	10.23	10.08	3.74	3.38
	Extra-tropical NH (30N-90N)	19.30	19.05	15.50	13.82	3.00	3.51
	Extra-tropical SH (30S-90S)						
August	Tropics (30S-30N)	10.25	10.24	10.13	3.80	3.49	3.34
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	Extra-tropical SH (30S-90S)						
September	Tropics (30S-30N)	10.26	10.19	3.90	3.62	3.47	3.38
	Extra-tropical NH (30N-90N)	14.73	13.32	3.69	3.62	1.25	3.61
	Extra-tropical SH (30S-90S)						
October	Tropics (30S-30N)	10.21	3.98	3.73	3.61	3.51	3.56
	Extra-tropical NH (30N-90N)	15.09	10.39	3.96	3.99	3.12	3.45
	Extra-tropical SH (30S-90S)						
November	Tropics (30S-30N)	10.01	3.77	3.62	3.51	3.55	3.87
	Extra-tropical NH (30N-90N)	3.87	3.43	3.98	3.35	3.26	3.91
	Extra-tropical SH (30S-90S)						
December	Tropics (30S-30N)	3.70	3.51	3.38	3.45	3.82	10.23
	Extra-tropical NH (30N-90N)	10.55	3.96	10.36	3.40	4.93	16.95
	Extra-tropical SH (30S-90S)						

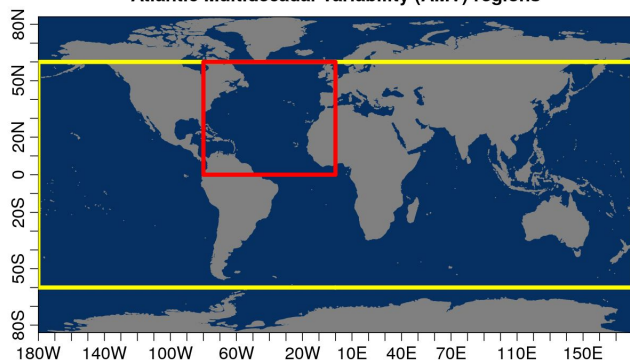
Indices in s2dv

Indices in s2dv

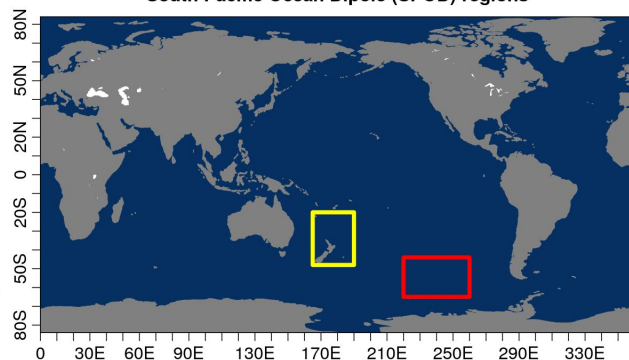
Documentation: <https://cran.r-project.org/web/packages/s2dv/s2dv.pdf>

- **AMV** (Atlantic Multidecadal Variability; Trenberth and Dennis, 2005)
- **SPOD** (South Pacific Ocean Dipole; Saurral et al., 2020) -> related to ENSO and IPO
- **TPI** (Tripole Index for the Interdecadal Pacific Oscillation; Henley et al., 2015)
- **GMST** (Global Mean Surface Temperature) -> tas over land and tos over ocean
- **GSAT** (Global Surface Air Temperature) -> tas over the whole globe

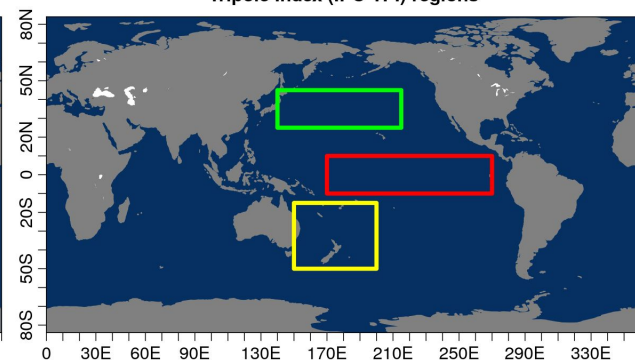
Atlantic Multidecadal Variability (AMV) regions



South Pacific Ocean Dipole (SPOD) regions



Tripole Index (IPO-TPI) regions



Indices in s2dv

Usage: AMV(data, data_lats, data_lons, type, mask = NULL, indices_for_clim = NULL, monini = 11, lat_dim = "lat", lon_dim = "lon", fmonth_dim = "fmonth", sdate_dim = "sdate", year_dim = "year", month_dim = "month", member_dim = "member")

Arguments:

- **data:** A numerical array with data, at least, over the whole region needed to compute the index.
 - type = "dcp" → $\text{dim}(\text{data}) = c(\text{lat_dim}, \text{lon_dim}, \text{fmonth_dim}, \text{member_dim})$
 - type = "hist" → $\text{dim}(\text{data}) = c(\text{lat_dim}, \text{lon_dim}, \text{year_dim}, \text{month_dim}, \text{member_dim})$
 - type = "obs" → $\text{dim}(\text{data}) = c(\text{lat_dim}, \text{lon_dim}, \text{year_dim}, \text{month_dim})$
- **data_lats:** A numeric vector indicating the latitudes of the data.
- **data_lons:** A numeric vector indicating the longitudes of the data.
- **type:** Either "dcp" (decadal predictions), "hist" (historical simulations), or "obs" (observations).
- **mask:** Either an array with $c(\text{lat_dim}, \text{lon_dim})$ dimensions with 0's in the grid points that have to be masked or NULL (no mask is used).
- **indices_for_clim:** Either a numeric vector with the indices to compute the climatology, NULL to use the whole period, or FALSE if data is already anomalies.
- **monini:** An integer indicating the month in which the forecast system is initialised. (11 = November)

Indices in s2dv

Examples:

- type = “obs” (observations or reanalyses)

```
obs <- array(1:100, dim = c(year = 5, lat = 19, lon = 37, month = 12))
```

```
lat <- seq(-90, 90, 10)
```

```
lon <- seq(0, 360, 10)
```

```
index_obs <- AMV(data = obs, data_lats = lat, data_lons = lon, type = 'obs')
```

- type = “hist” (historical simulations)

```
hist <- array(1:100, dim = c(year = 5, lat = 19, lon = 37, month = 12, member = 5))
```

```
index_hist <- AMV(data = hist, data_lats = lat, data_lons = lon, type = 'hist')
```

- type = “dcpp” (decadal predictions)

```
dcpp <- array(1:100, dim = c(sdate = 5, lat = 19, lon = 37, fmonth = 24, member = 5))
```

```
index_dcpp <- AMV(data = dcpp, data_lats = lat, data_lons = lon, type = 'dcpp', monini = 1)
```

Q & A

Next meeting: 5th Feb. 2021 (Friday 4pm)