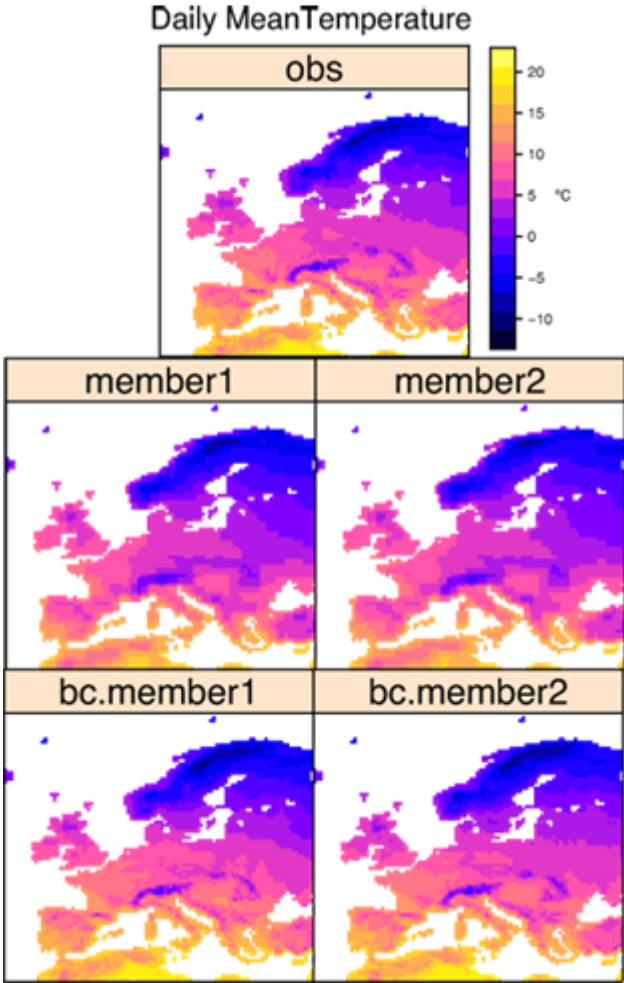


## Bias correction of seasonal forecasting data

The seasonal forecasting data obtained from the `ecomSUDG.Raccess` package can be easily bias corrected (and downscaled) using the [?downscaleR package](#) (see a description of the [?bias correction functions](#)). This package has been developed in the framework of the SPECS and EUPORIAS projects for bias correction and downscaling of daily climate model outputs (with special focus in seasonal forecasting).

The following panels show an illustrative use of `ECOMS-UDG` and `downscaleR` to obtain the bias corrected series of mean temperature for the period DJFMAM (one-month lead time; i.e. with the initializations from November) over Europe. WFDEI is used as reference.

Note that, in order to facilitate the use of the resulting bias corrected data in different impact applications, the resulting bias corrected data can be easily exported to netcdf format.

R code	Output
<pre># Packages and logging library(downscaleR) library(ecomsUDG.Raccess) library(ncdf4) # Only needed to write NetCDF loginECOMS_UDG(username = "username", password = "password")</pre>	
<pre># Loading data (two members) obs &lt;- loadECOMS(dataset = "WFDEI",   var = "tas",   season = c(12,1,2,3,4,5),   lonLim = c(-15,35),   latLim = c(32, 75),   years = c(2001:2010)) prd &lt;- loadECOMS(dataset = "System4_seasonal_15",   var = "tas", time = "DD",   season = c(12,1,2,3,4,5),   members = 1:2,   leadMonth = 1,   lonLim = c(-15,35),   latLim = c(32, 75),   years = c(2001:2010)) prd &lt;- interpGridData(prd, new.grid = getGrid(obs),   method = "nearest");</pre>	
<pre># Bias correction and plotting prd.bc &lt;- biasCorrection(obs, prd, prd,   method = "qqmap",   multi.member = TRUE,   window = 30) plotMeanField(obs) plotMeanField(prd, multi.member = FALSE) plotMeanField(prd.bc, multi.member = FALSE)</pre>	
<pre># Exporting to netcdf4 fileName &lt;- "tas_qqmap_System4_WFDEI_2001_2010.nc4" grid2NetCDF(prd.bc, NetCDFOutFile = fileName,   missval = 1e20,   prec = "float")</pre>	

The `netcdf4` file resulting from this example can be downloaded here:

[http://www.meteo.unican.es/work/datasets/tas\\_qqmap\\_System4\\_WFDEI\\_2001\\_2010.nc4](http://www.meteo.unican.es/work/datasets/tas_qqmap_System4_WFDEI_2001_2010.nc4)

In order to preserve the inter member variability of seasonal forecasts, the bias correction methods should be jointly calibrated using the different ensemble members (considering the CDF of the joined series for the correction). This is the procedure followed by the `biasCorrection` function when using the option `multi.member=TRUE`. Note that `multi.member=FALSE` will independently calibrate each member and, therefore, inter-member variability will be destroyed.

Moreover, in order to take into account the model drift (the change of the model bias as a function of the lead time), the bias correction methods are applied considering the lead month of the predictions as an extra dimension. This is implemented in the `biasCorrection` function by considering a moving time window (one month in the above example: `window = 30`, in days). The default recommended value is one-month (`window=30`), although

some tests are being conducted in order to determine the optimum window to correct the available seasonal forecasts (further information will follow).

## Multi-variable bias correction

Since a number of variables are typically required in impact applications (in particular in EUPORIAS WP23 and WP31; [available variables](#)), we recommend two alternative bias correction methodologies for these tasks: a) the ISI-MIP methodology, b) qqmap bias correction.

In order to facilitate this task (multi-variable bias correction), an script has been prepared to correct the following variables:

ps,wss,huss,tas,tasmax,tasmin,tp,rsds,rlds (the above codes correspond to the standard names used in loadECOMS and downscaleR packages). The example below applies the qqmap technique (considering the WFDEI observations) to the 15 members of the System4 dataset, for the six-month series (DJFMAM) corresponding to the November initialization for the period 2001-2010 in an European domain. The resulting bias corrected series are stored in a separate netcdf file.

```
# Packages and login
library(downscaleR)
library(ecomsUDG.Raccess)
library(ncdf4) # Only needed to write NetCDF
loginECOMS_UDG(username = "username", password = "password")

# Seasonal forecast parameters
dataset <- "System4_seasonal_15"
season <- c(12,1:5)
leadMonth <- 1
members <- 1:15
lonLim <- c(-15,35)
latLim <- c(32, 75)
years <- c(2001:2010)
time <- "DD"

# Bias correction parameters
interpolationMethod <- "nearest" # Both observation and forecast should be define on the same grid. Options: "nearest" and
method <- "qqmap"
multi.member <- FALSE # Should members be adjusted separately (TRUE, default), or jointly (FALSE)?
pr.threshold <- 1 # The minimum value that is considered as a non-zero precipitation.
window <- 30 # Numeric value specifying the time window width used to calibrate. The window is centered on the target day.
```

```
# Script to bias correct and store (as netcdf file) the data
variables <- c("ps","wss","huss","tas","tasmax","tasmin","tp","rsds","rlds")
for (v in 1:length(variables)){
  obs <- NULL
  prd <- NULL
  obs <- loadECOMS(dataset = "WFDEI", var = variables[v],
    lonLim = lonLim, latLim = latLim, season = season, years = years[1])

  prd <- loadECOMS(dataset = dataset, var = variables[v], time = time, members = members,
    lonLim = lonLim, latLim = latLim, season = season, years = years, leadMonth = leadMonth)

  prd <- interpGridData(prd, new.grid = getGrid(obs), method = interpolationMethod);

  if (any(grepl(obs$Variable$varName,c("tp")))){
    prd <- biasCorrection(obs, prd, prd, pr.threshold = pr.threshold,
      method = method, multi.member = multi.member, window = window)
  }else{
    prd <- biasCorrection(obs, prd, prd,
      method = method, multi.member = multi.member, window = window)
  }
}
# Exporting to netcdf4
fileName <- paste(var[v],"System4_WFDEI.nc4",sep = "_")
grid2NetCDF(prd, NetCDFOutFile = fileName,
  missval = 1e20,
```

```
}          prec = "float")
```