

Post-processing of seasonal meteorological forecasts using fuzzy logic. Application to the Jucar River Basin District

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MANAGE EXTREME EVENTS

SEASONAL METEOROLOGICAL FORECASTS

Seasonal meteorological forecasts

Seasonal weather forecast

Month	Precipitation
Jan	4'
Feb	6'
Mar	4'
April	6'
May	5'
Jun	4'
Jul	6'

FLOOD

LEARN WHAT YOU CAN DO TO HELP.

Dariana Avila @Canvas

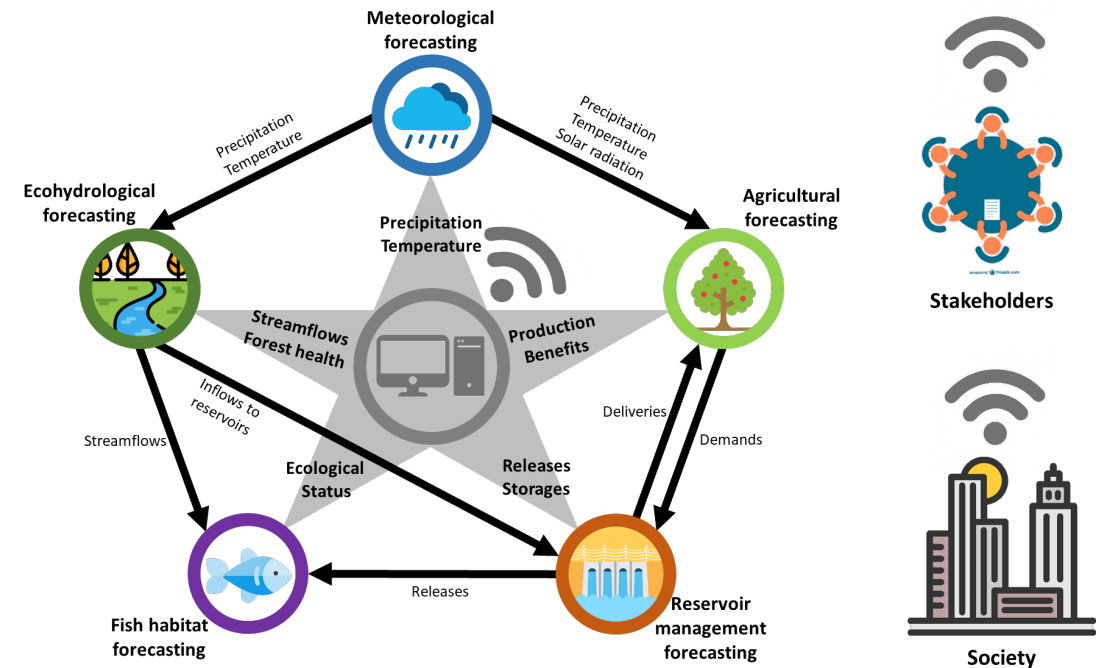
Since these forecasts might have substantial biases for certain areas, post-processing of raw predictions can be crucial to provide adequate meteorological information

```
# Obtain post-processed data using fuzzy logic
def obtain_postprocessed_data_FRB(raw_dataframe, post_processing_dataframe, grid, date, variable, service):
    import numpy as np
    import pandas as pd
```

The objective of the WATER4CAST (Integrated Forecasting System for Water and the Environment) project is to develop an innovative decision support tool for the Jucar system incorporating:

Meteorological, ecohydrological, agronomic, environmental, and water resource management forecasts.

Short-term, sub-seasonal, and seasonal.

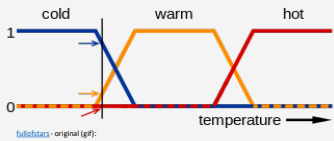


Goal

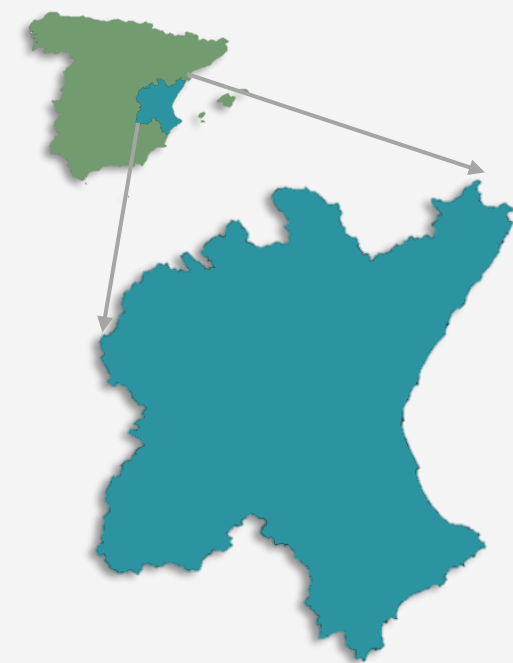
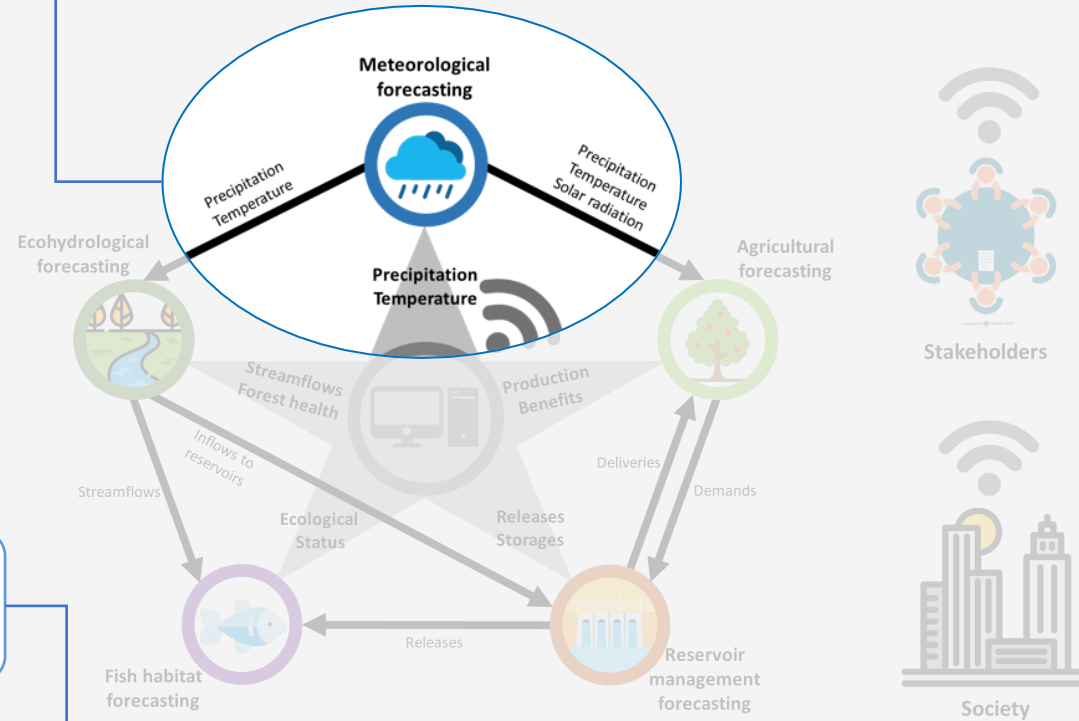
Post-processing methods to improve the quality of local seasonal meteorological forecasts

To achieve this objective

an innovative post-processing method based on Fuzzy logic



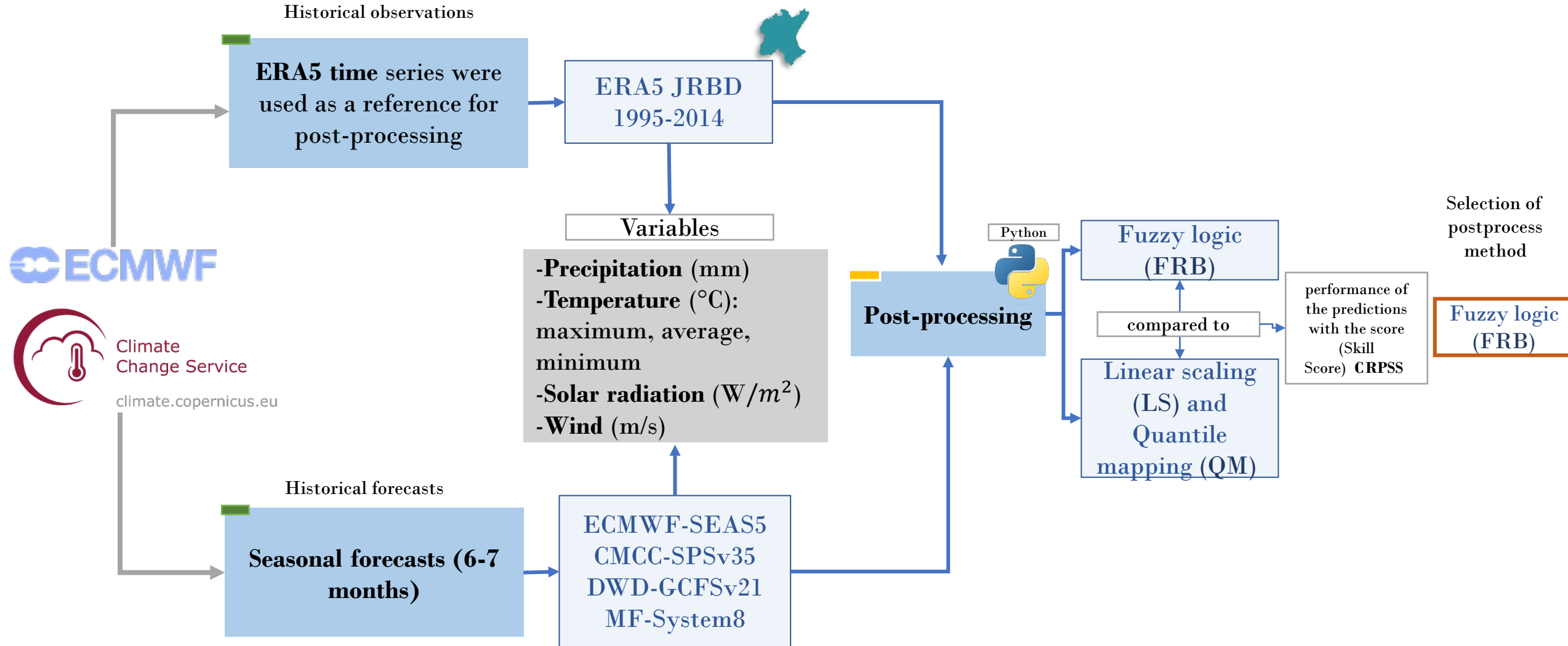
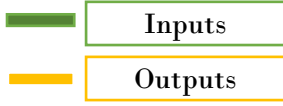
```
# Obtain post-processed data using fuzzy logic
def obtain_postprocessed_data_FRB(raw_dataframe, post_processing_dataframe, grid, date, variable, service):
    import numpy as np
    import pandas as pd
```



Case study: Jucar River Basin District
42735 km²

has been applied and compared with alternative procedures Linear scaling and Quantile mapping

Seasonal meteorological forecasts



Results show how the forecasting skill changes after post-processing for each method, the resulting forecast skills per variable, forecast months and lead month, and how fuzzy logic performs compared to linear scaling and quantile mapping.

- ❑ Forecasts skill metric: Continuous-rank Probability Score (CRPSS)
- ❑ The quality indicator (Skill Score) based on the CRPS is obtained as shown in equation

$$CRPS = \int_{-\infty}^{+\infty} [P(x) - P_a(x)]^2 dx$$

$$CRPSS = \frac{CRPS_{for} - CRPS_{ref}}{CRPS_{perf} - CRPS_{ref}}$$

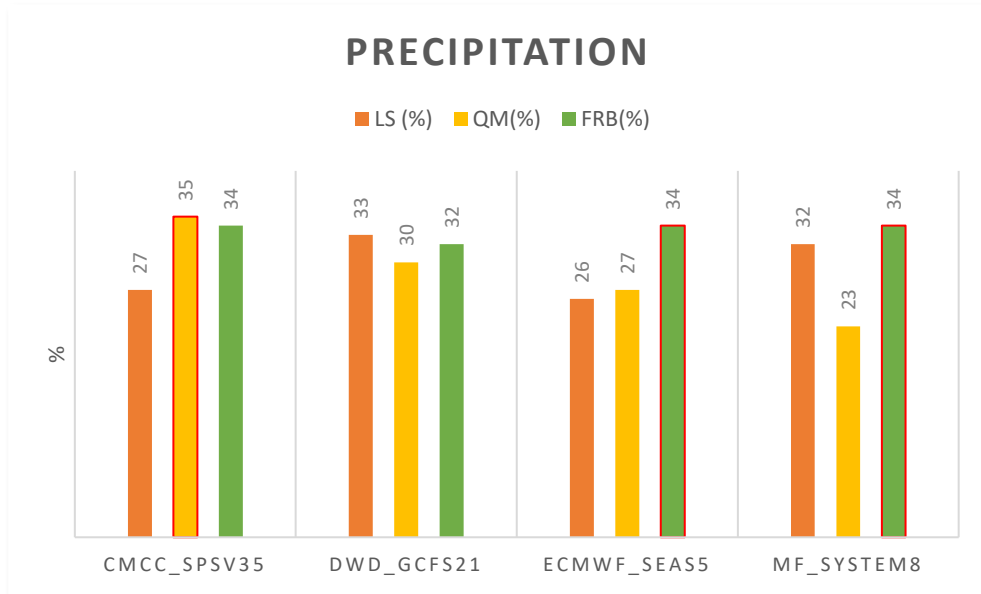
CRPSS can be simplified as shown in equation

$$CRPSS = 1 - \frac{CRPS_{for}}{CRPS_{ref}}$$

Comparison of the corrections

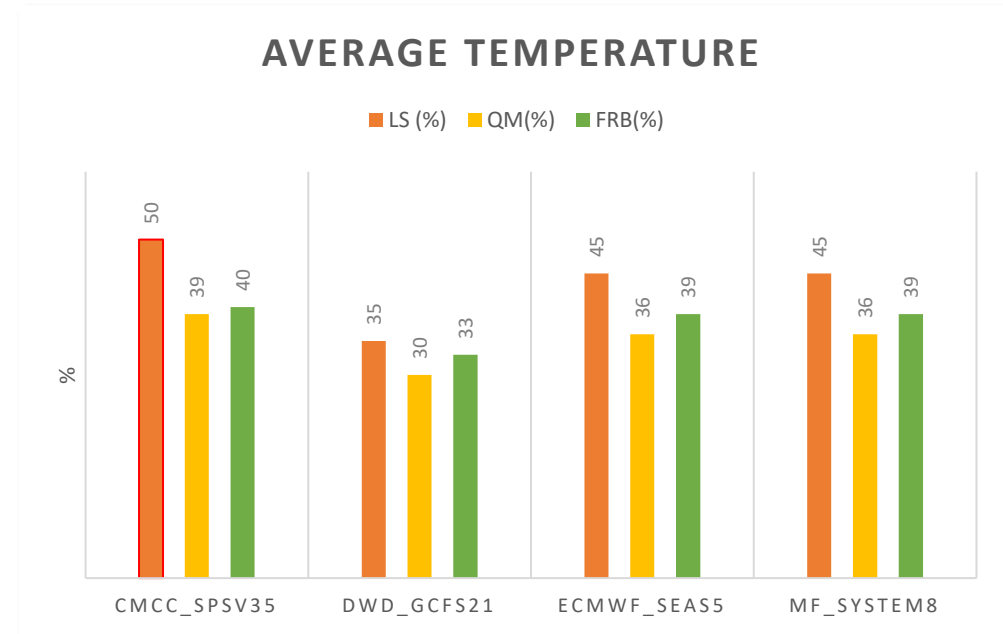
Comparison of the corrections: the 3 corrections (FRB, LS, QM) made for each variable and prediction system are compared according to two criteria: the percentage of times that each correction has the best quality and the percentage of predictions with quality with respect to the total.

CRPSS



QM	1
FRB	2
LS	3

CMCC_SPSV35



LS	1
FRB	2
QM	3

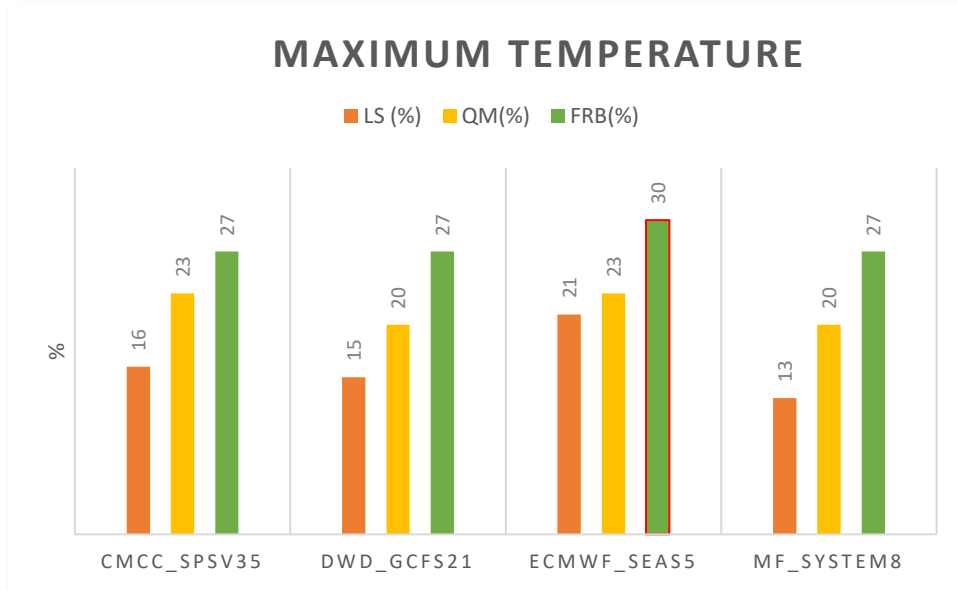
CMCC_SPSV35

The precipitation correction works 1% better with QM (for CMCC) than with FRB for ECMWF and MF.

win

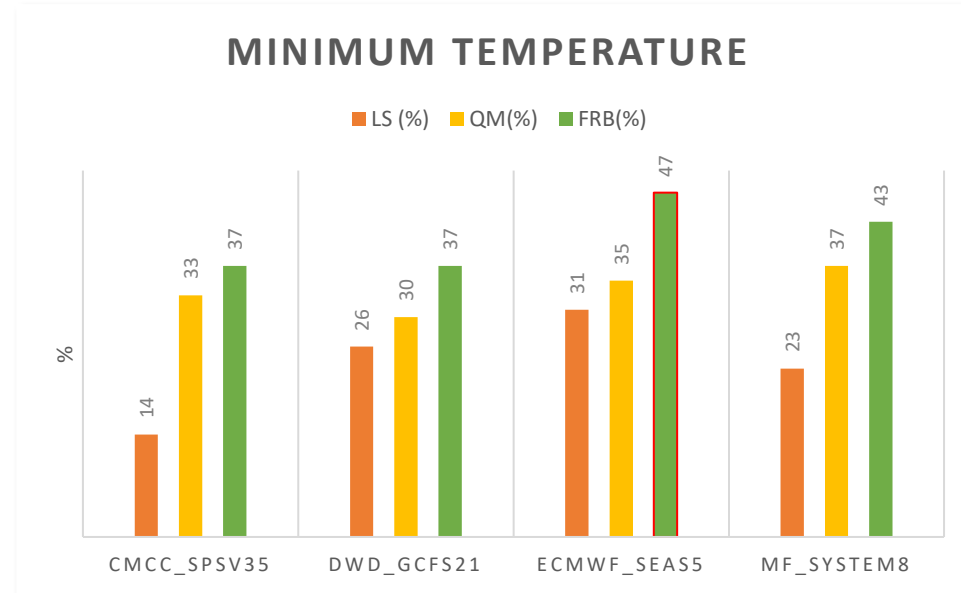
legend

CRPSS



FRB	1
QM	2
LS	3

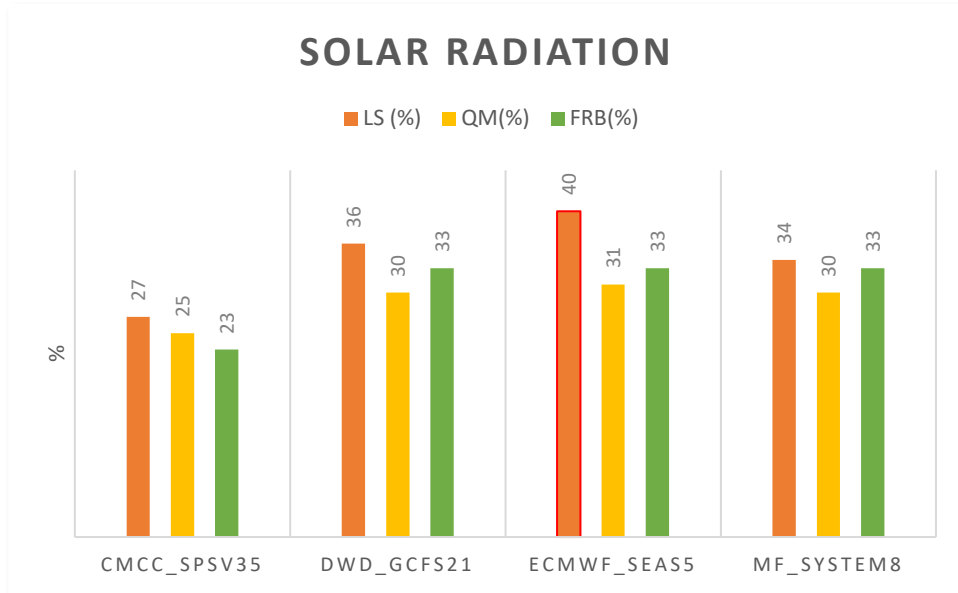
ECMWF_SEAS5



FRB	1
QM	2
LS	3

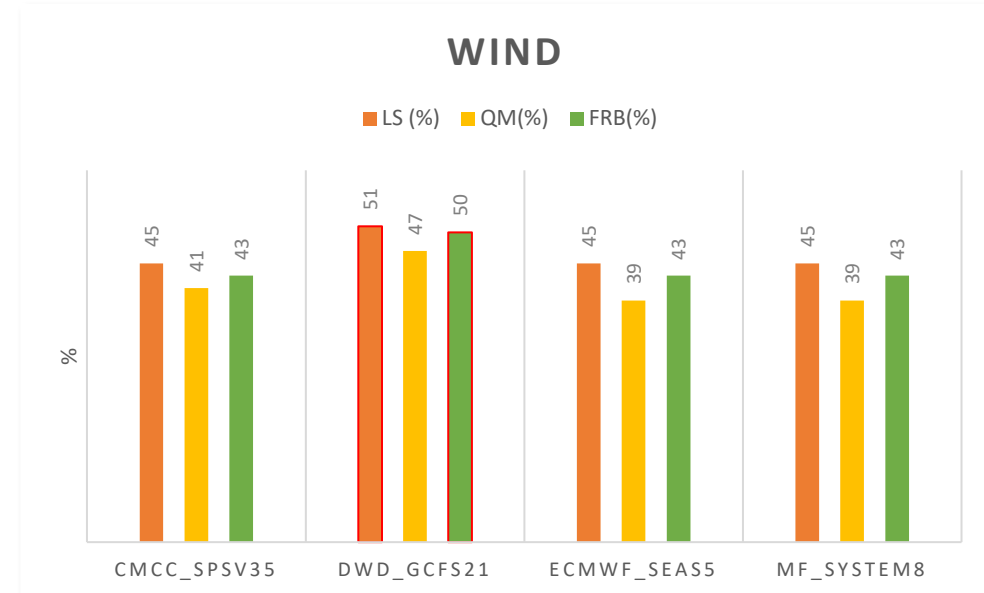
ECMWF_SEAS5

CRPSS



LS	1
FRB	2
QM	3

ECMWF_SEAS5



LS	1
FRB	2
QM	3

DWD_GCFS21

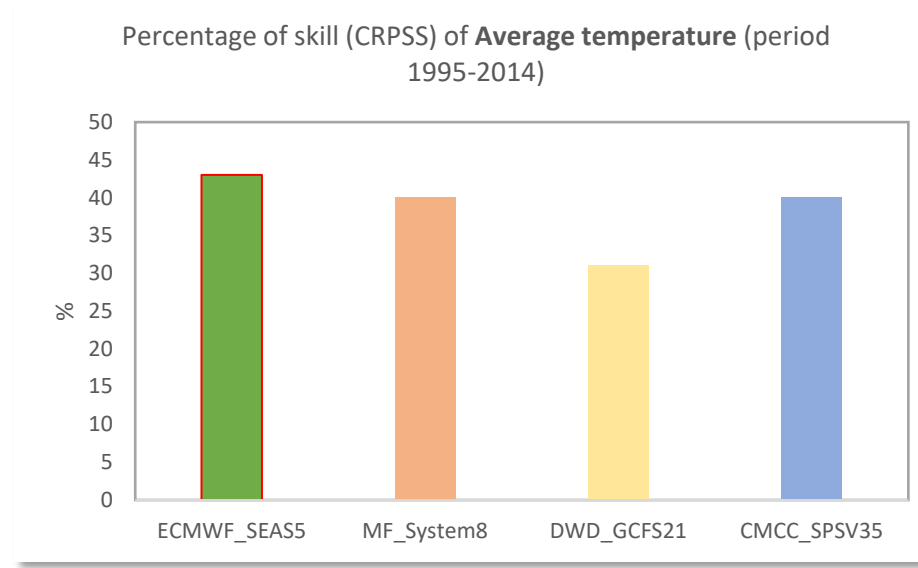
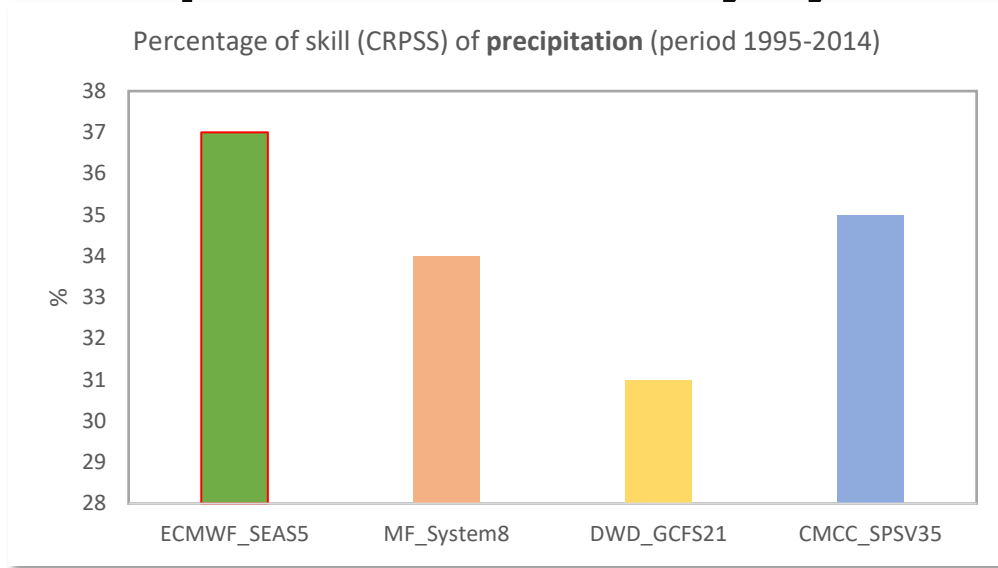
The wind correction works 1% better with LS (for DWD) than with FRB

Comparison of skills by system:

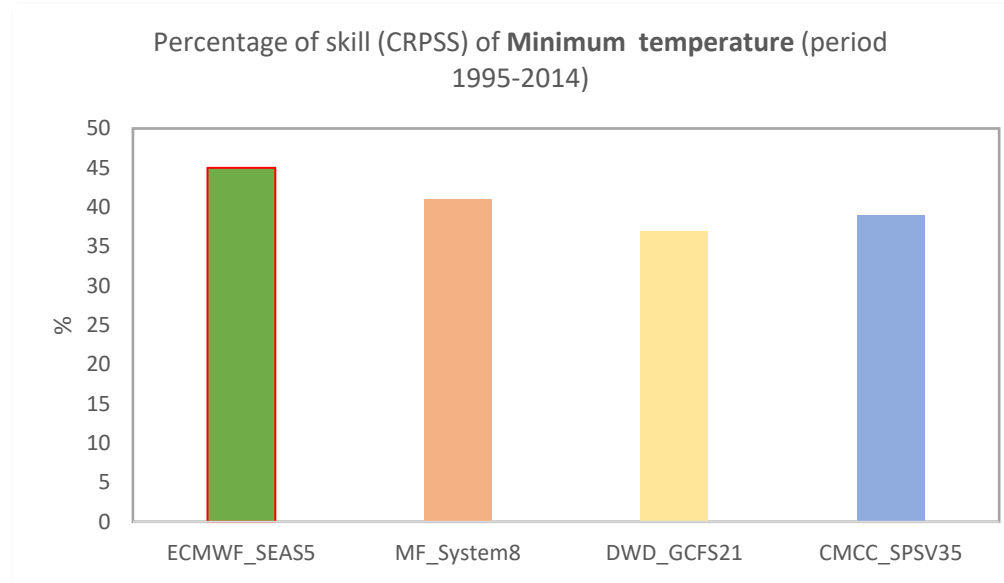
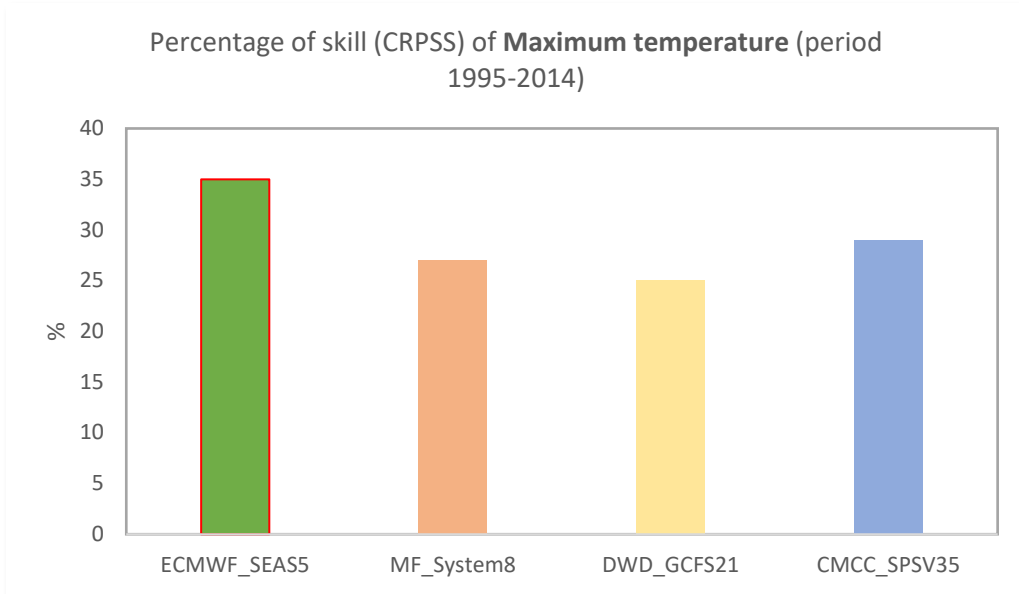
Comparison of skills by system: for each correction method and variable, the quality offered by each prediction system is compared, measured as the percentage of times the prediction has quality concerning the total.

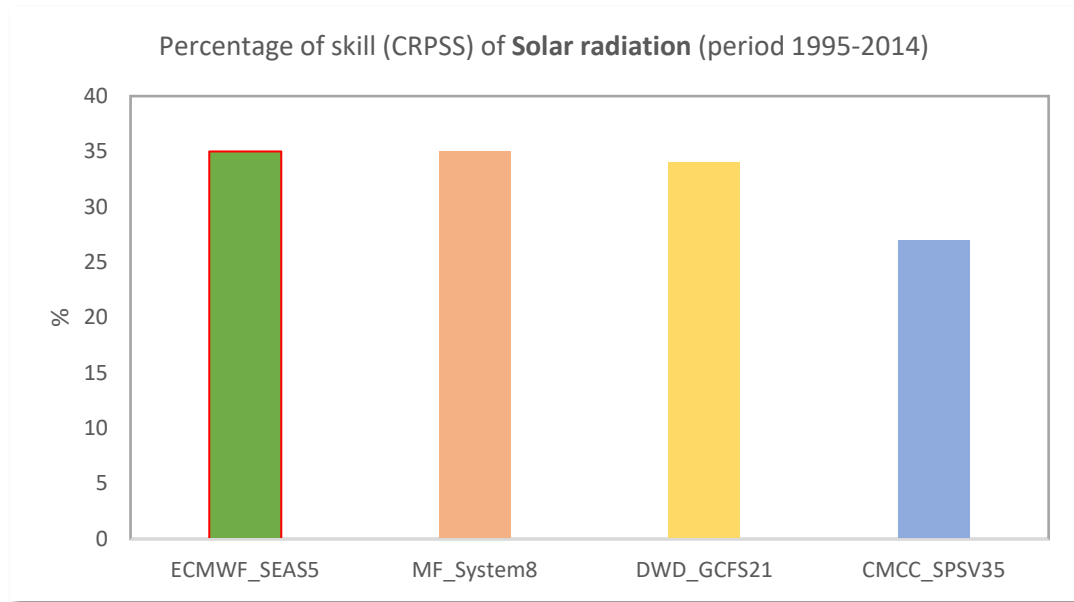
Comparison of skills by system:

Fuzzy logic CRPSS

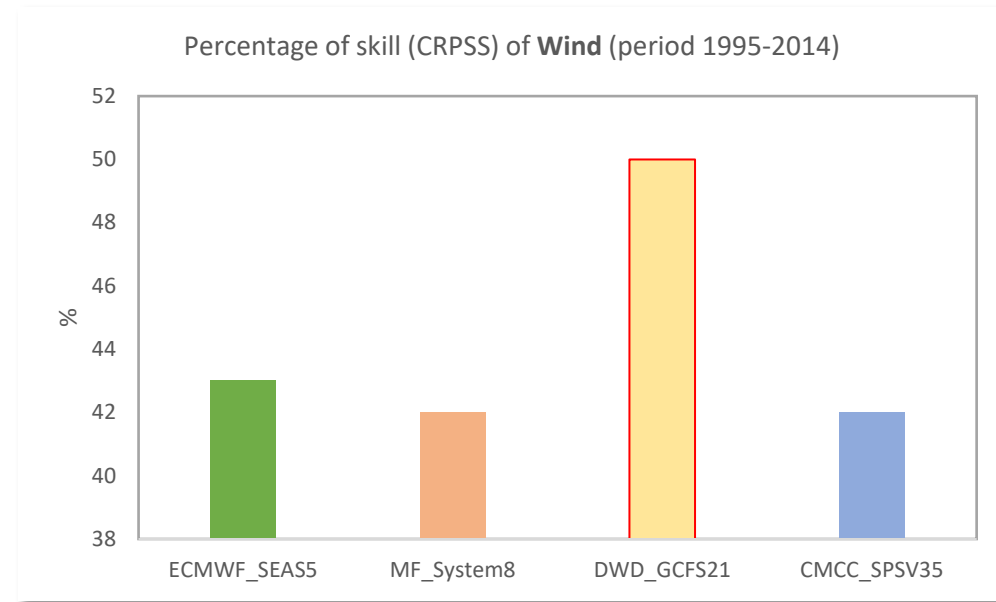


ECMWF_SEAS5





ECMWF_SEAS5

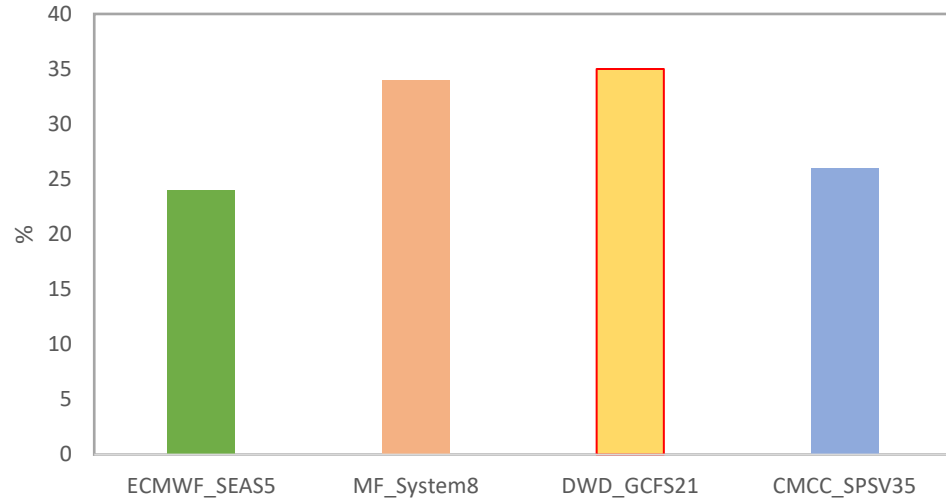


DWD_GCFS21

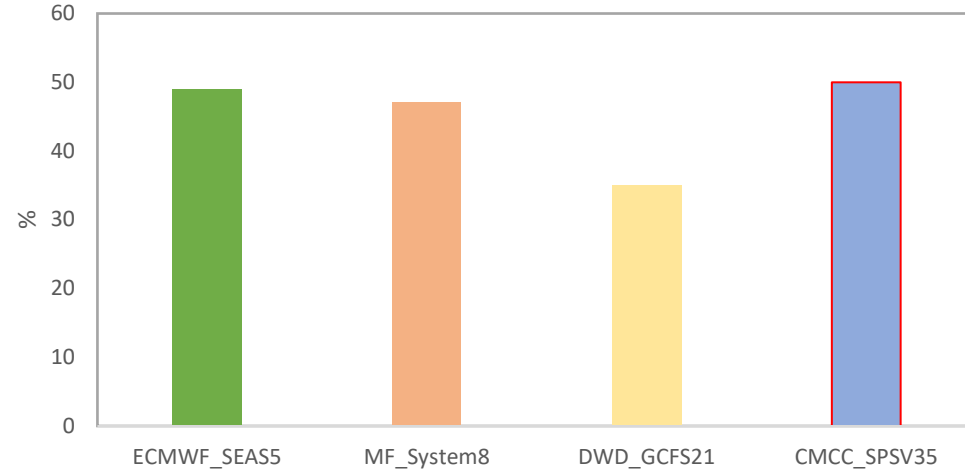
Comparison of skills by system:

Linear Scaling CRPSS

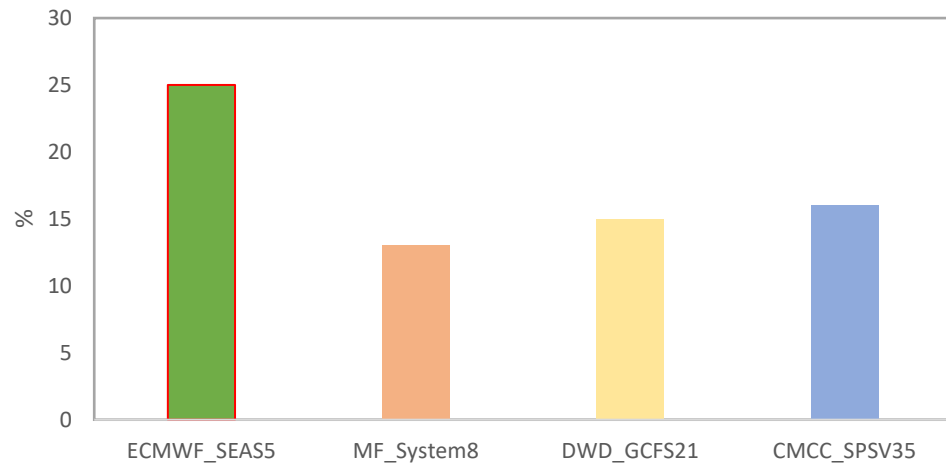
Percentage of skill (CRPSS) of **precipitation** (period 1995-2014)



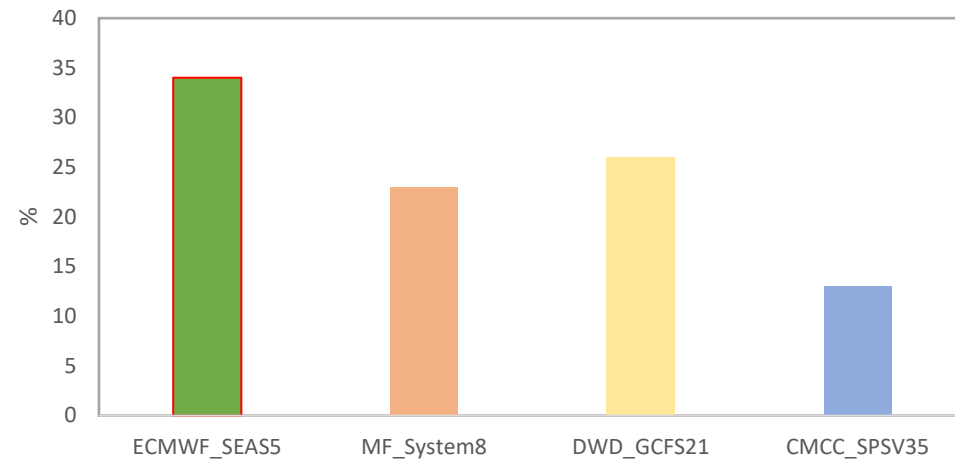
Percentage of skill (CRPSS) of **Average temperature** (period 1995-2014)



Percentage of skill (CRPSS) of **Maximum temperature** (period 1995-2014)



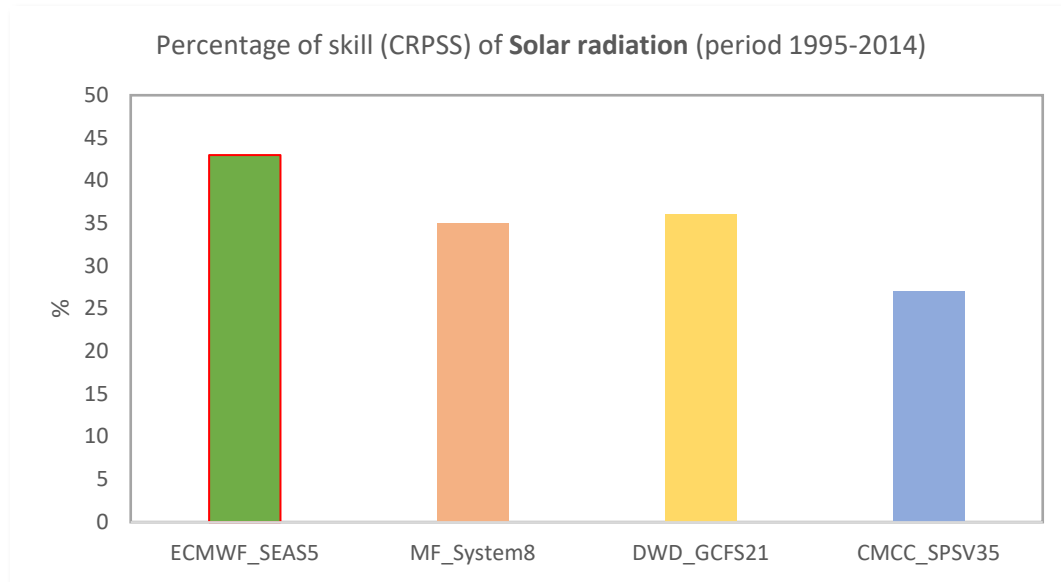
Percentage of skill (CRPSS) of **Minimum temperature** (period 1995-2014)



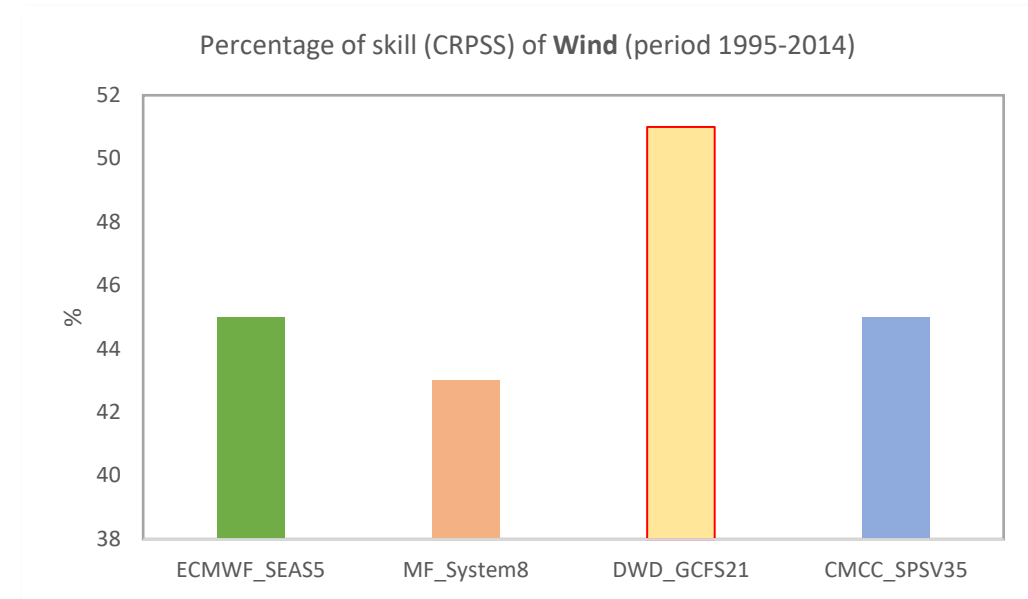
ECMWF_SEAS5

Comparison of skills by system:

Linear Scaling CRPSS



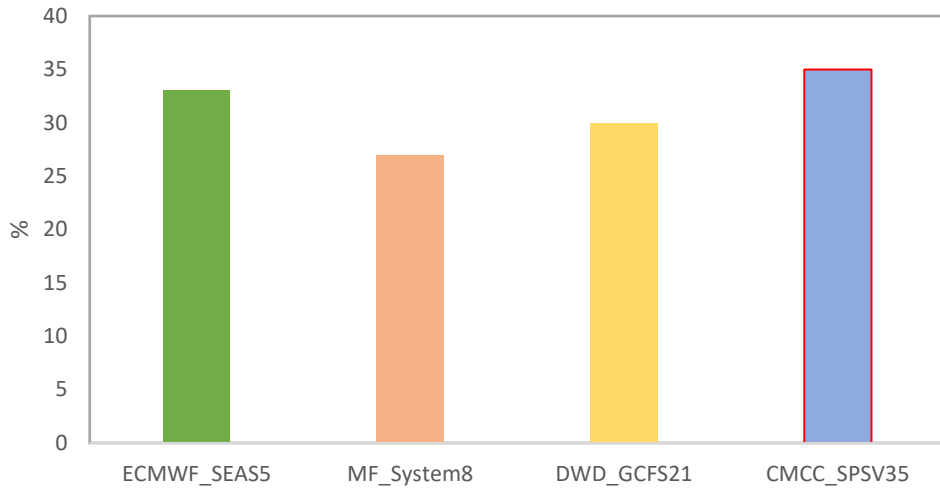
ECMWF_SEAS5



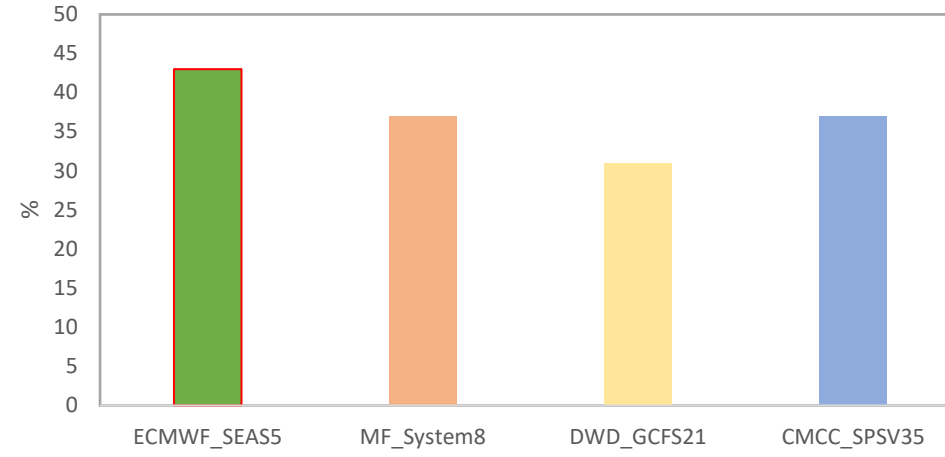
DWD_GCFS21

Comparison of skills by system:

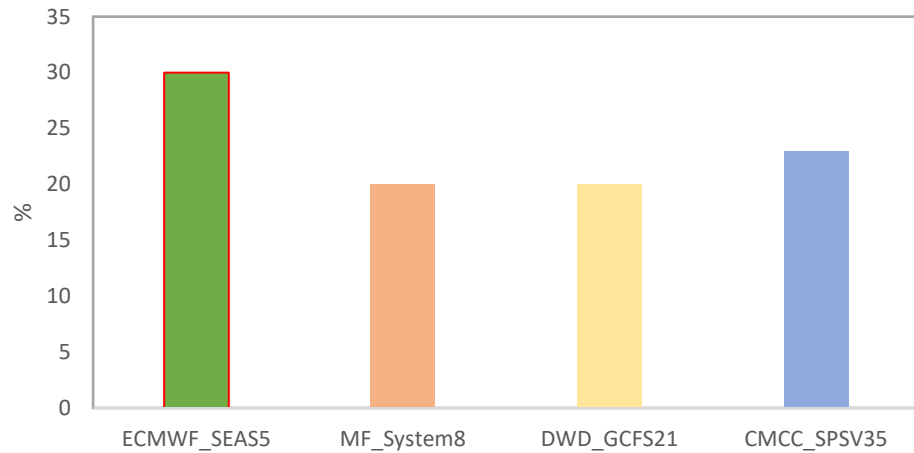
Percentage of skill (CRPSS) of precipitation (period 1995-2014)



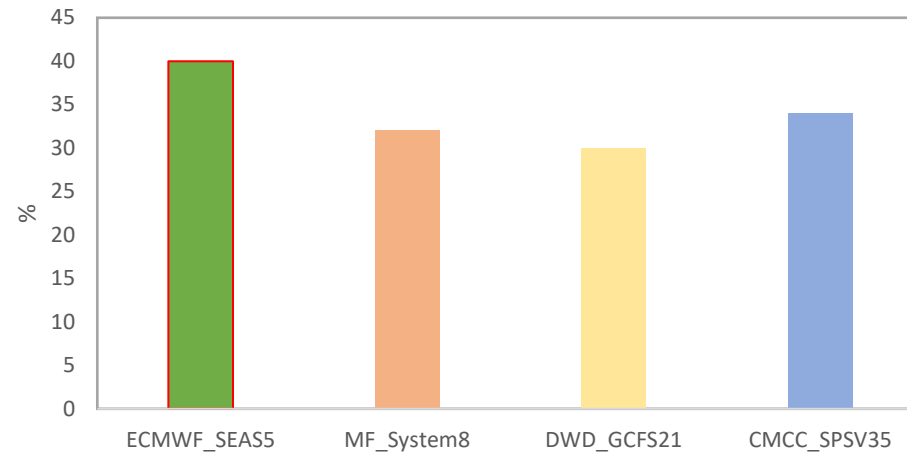
Percentage of skill (CRPSS) of Average temperature (period 1995-2014)



Percentage of skill (CRPSS) of Maximum temperature (period 1995-2014)



Percentage of skill (CRPSS) of Minimum temperature (period 1995-2014)

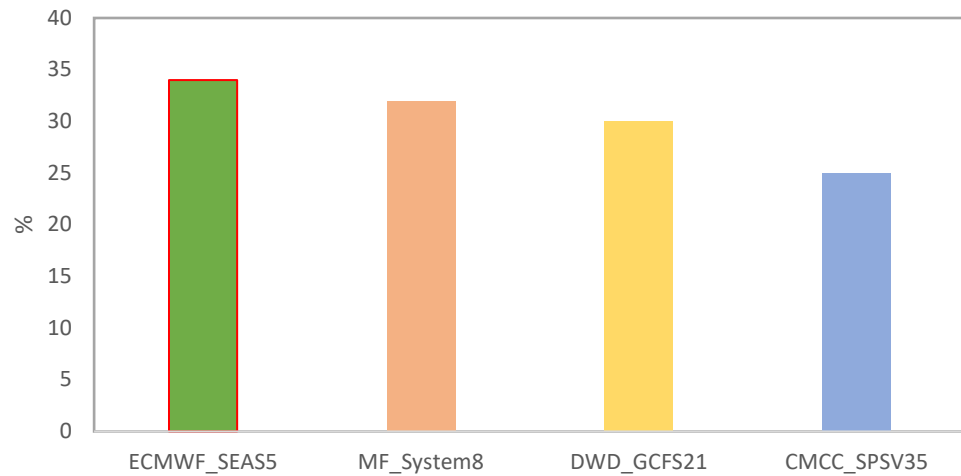


ECMWF_SEAS5

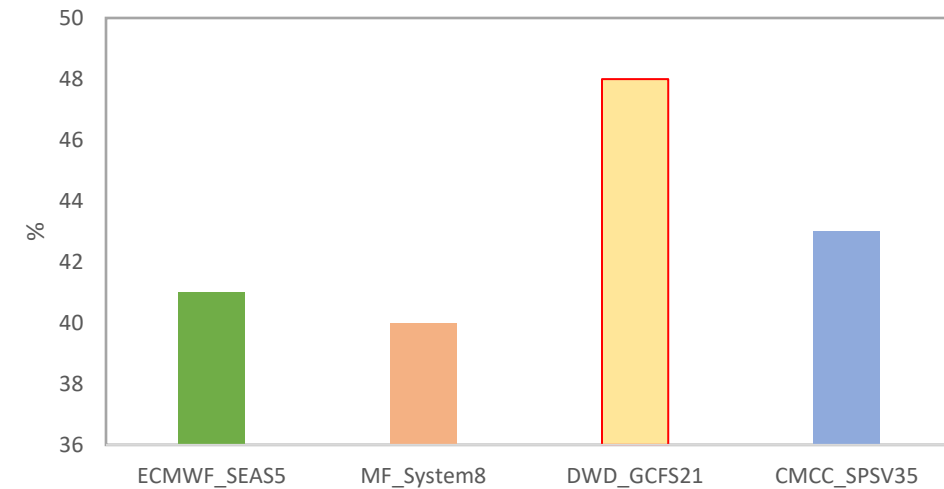
Comparison of skills by system:

Quantile Mapping

CRPSS

Percentage of skill (CRPSS) of **Solar radiation** (period 1995-2014)

ECMWF_SEAS5

Percentage of skill (CRPSS) of **Wind** (period 1995-2014)

DWD_GCFS21

Comparison of skills by system:

FRB	ECMWF_SEAS5	prec, tas, tasmx, tasmin, ssrd
	DWD_GCFS21	Wind

LS	ECMWF_SEAS5	ssrd, tasmx, tasmin,
	DWD_GCFS21	prec, wind
	CMCC_SPSV35	tas

QM	ECMWF_SEAS5	ssrd, tas, tasmx, tasmin,
	DWD_GCFS21	wind
	CMCC_SPSV35	prec

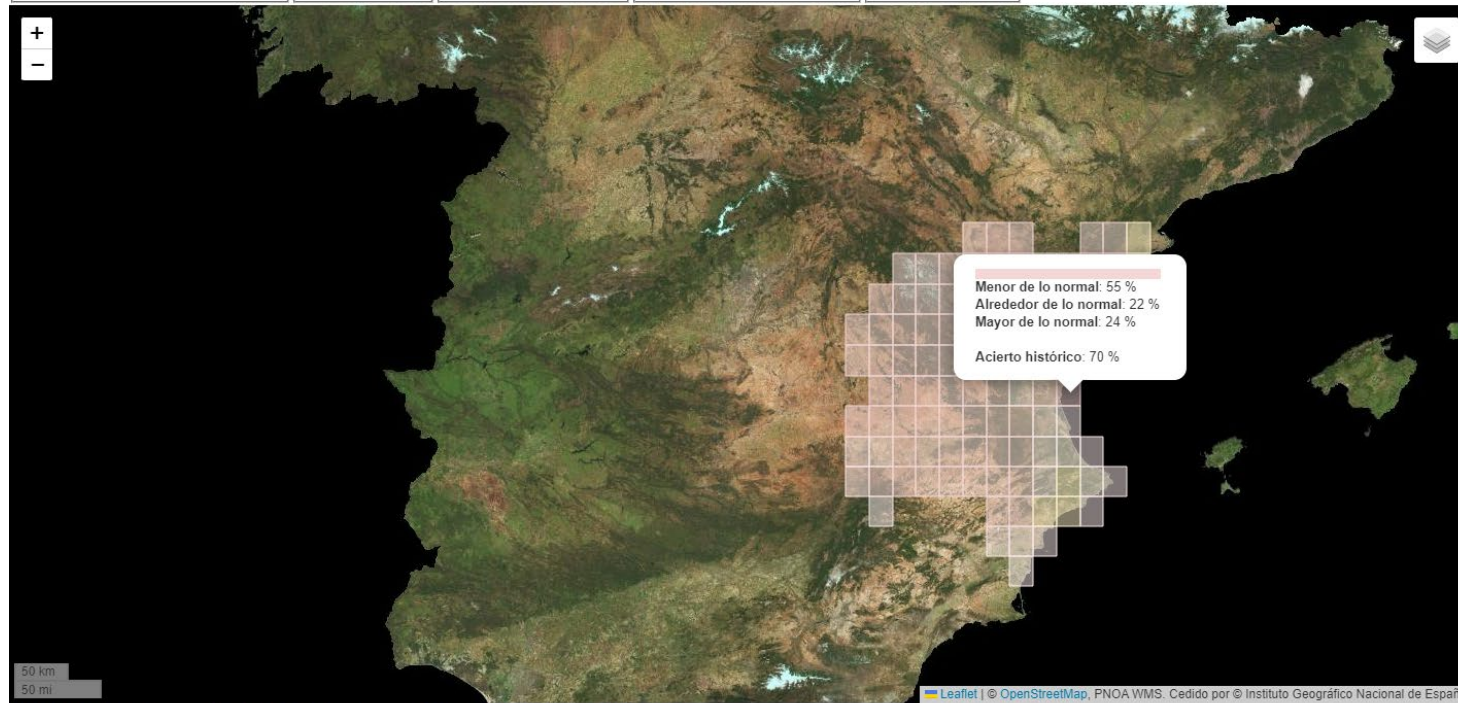
The MF System8 does not win in any of them, but in FRB it behaves almost the same as ECMWF_SEAS5

Visual decision support system



Water4Cast

Variable:
 Predicción:
 Fecha de predicción:
 Periodo predicho:
 Origen:

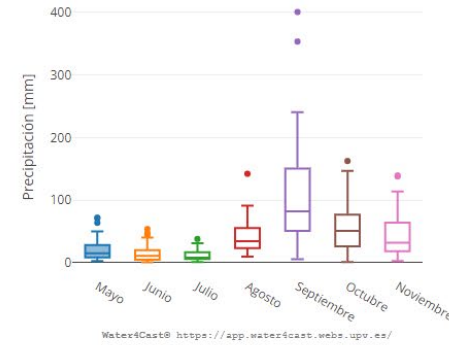


Menor de lo normal	Alrededor de lo normal	Mayor de lo normal	Sin calidad
≥ 75%	≥ 75%	≥ 75%	■
≥ 50%	≥ 50%	≥ 50%	
< 50%	< 50%	< 50%	

@WaterPi - Developer environment



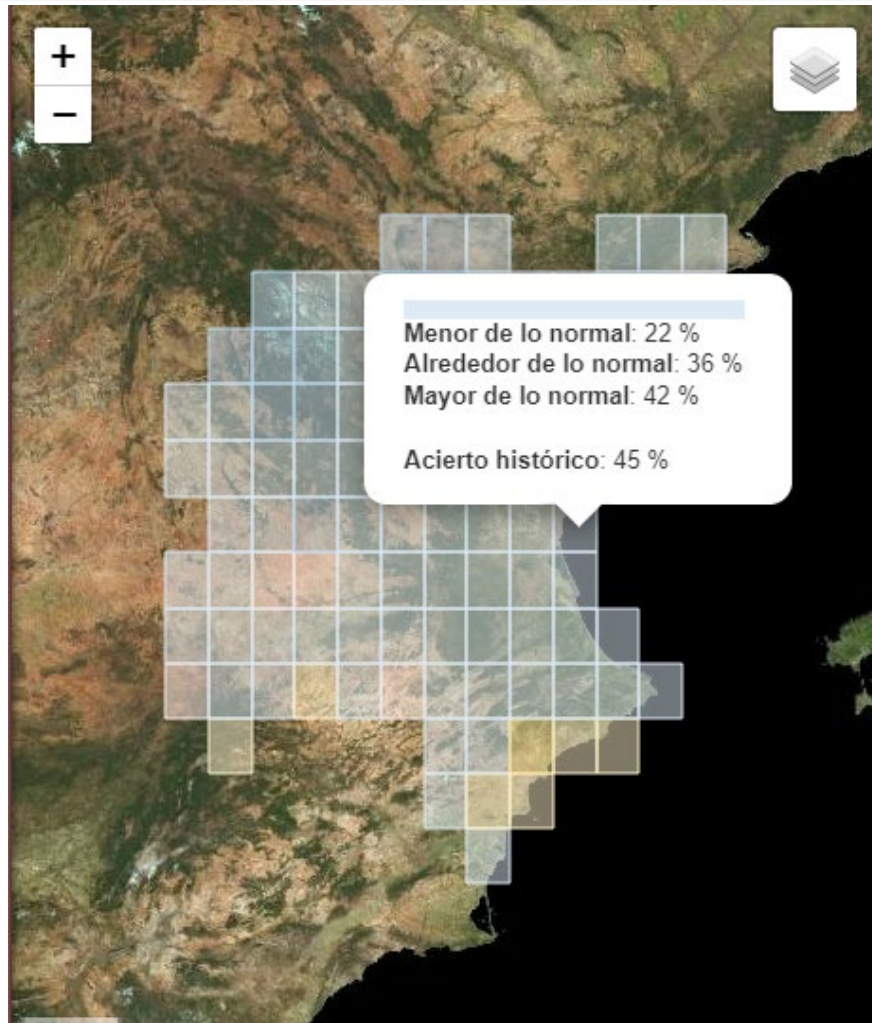
Predicción estacional con el modelo ECMWF_SEAS5
coordenadas (39.5° , -0.25°) - Mayo



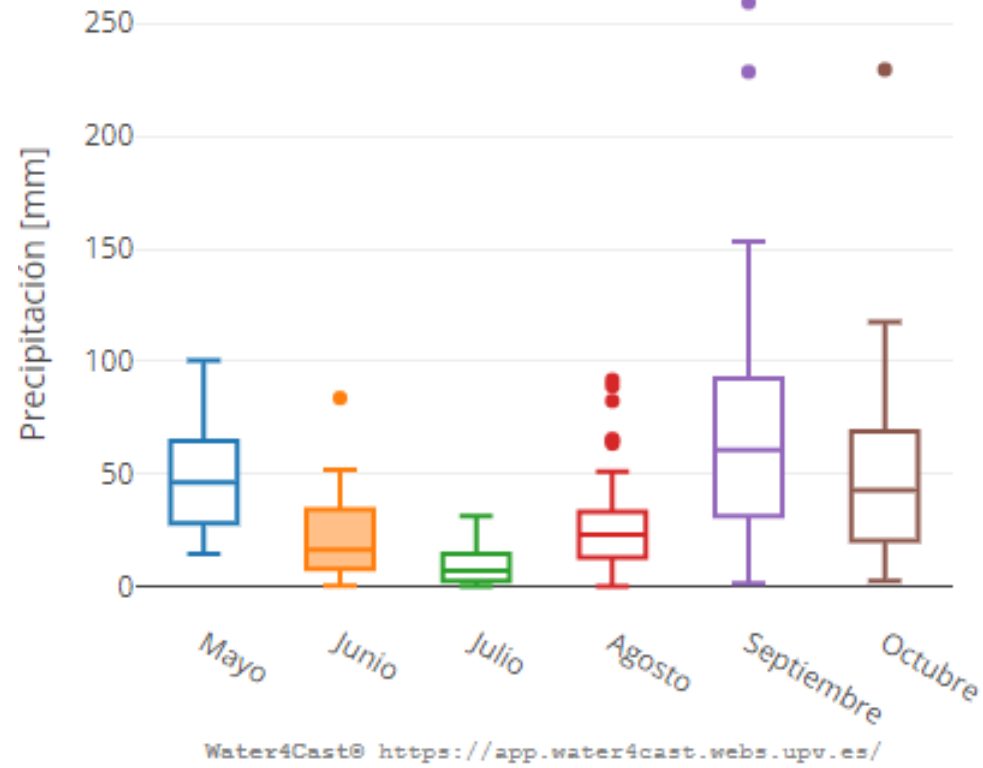
Water4Cast@ <https://app.water4cast.webs.upv.es/>

The platform shows the results of the fuzzy logic post-processing with the four system models

Variable: Precipitación |
 Predicción: Estacional |
 Fecha de predicción: mayo de 2023 |
 Periodo predicho: 1 mes |
 Origen: CMCC-SPSv35



Predicción estacional con el modelo CMCC_SPSv35 coordenadas (39.5° , -0.25°) - Junio



Menor de lo normal	Alrededor de lo normal	Mayor de lo normal	Sin calidad
 ≥75%	 ≥75%	 ≥75%	
 ≥50%	 ≥50%	 ≥50%	
 < 50%	 < 50%	 < 50%	

Fuzzy logic (FRB) wins with higher accuracy percentages for the Jucar basin river district.

For the comparison of the skill by system:

- ECMWF_SEAS5 dominates the other systems in all three correction methods (FRB, LS, QM).
- Only in the wind variable the DWD_GCFS21 system dominates in all three correction methods.
- The CMCC_SPSV35 system in the LS (responds better to the mean temperature variable) and in QM in the precipitation variable.
- The MF System8 does not win in any of them, but in FRB, it behaves almost the same as ECMWF_SEAS5.

*Post-processing of seasonal meteorological forecasts
using fuzzy logic Application to the Júcar River*

THANK YOU!!!

Basin District

FOR YOUR

Dariana Isamel Avila-Velasquez, Hector Macian-Sorribes

and Manuel Ruiz-Velasquez

ATTENTION

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