Subsampling members in a seasonal forecast ensemble

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Introduction

Traditionally, operational seasonal forecasts are issued using a subjective procedure, using expert knowledge to analyse and integrate information from different sources. However, despite its added value, this subjective approach poses several problems, such as the difficulty of reproducing the process and perform an objective verification of the forecasts (WMO, 2020). Additionally, the final products are drafted manually and cannot be used to develop applications in fields like agriculture or the energy sector. Within this context, WMO has commanded RCCs and RCOFs to pursue the development of an objective methodology, using existing knowledge to produce a workflow that automatically combines, selects and weights information from different sources. AEMET coordinates the Mediterranean Climate Outlook Forum, and, hence, is involved in the efforts to develop such a product at a regional level. This work, which focuses on subsampling an ensemble to improve model forecasts in the Mediterranean, is one of several attempts to provide a basis for such transition.

Proposed methodology

We built a seasonal forecast prototype aimed at improving skill in the Mediterranean region, focusing on precipitation during the NH winter season (DJF), which had shown promising potential for improvement. As a baseline, we chose a multi-model ensemble built from those seasonal forecast models available in Copernicus CDS, with the exception of JMA, whose resolution is coarser. We took together all the members from each individual model to build our ensemble, thereby giving more weight to those with bigger populations. The aim of using an ensemble was to reduce the influence of individual model biases. We found that this ensemble showed greater skill for precipitation than most CDS models, including the commonly used ECMWF, although others, such as the NCEP model, showed similar skill to our ensemble.

September and November ensemble runs have comparable skill in winter (DJF), as shown in Figure 2. Moreover, results from empirical models using October information (Sánchez García et al, 2019, Dobrynin, 2018) suggest that some events that take place in that month may have relevant information for the upcoming winter. Having good skill in older model runs opens up the possibility of using observational data to select those ensemble members which had been closer to the actual evolution of the system. First, we performed a K-means cluster analysis of the data and took the cluster whose representative member was closest to the last available monthly observations. Both precipitation and surface pressure fields were selected as the variables to be compared when selecting the members., comparing tertiles in the case of precipitation to prevent giving too much weight to extreme values. Along with clustering, we also tried a simpler subsampling approach to member selection which consisted of taking the 25 closest members to observations instead of one cluster.

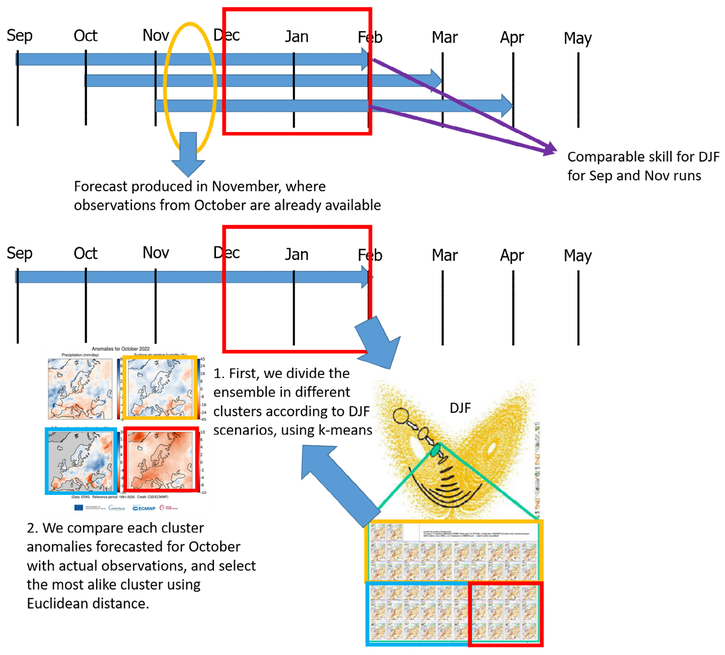


Figure 1. Methodology summary of the clustering approach

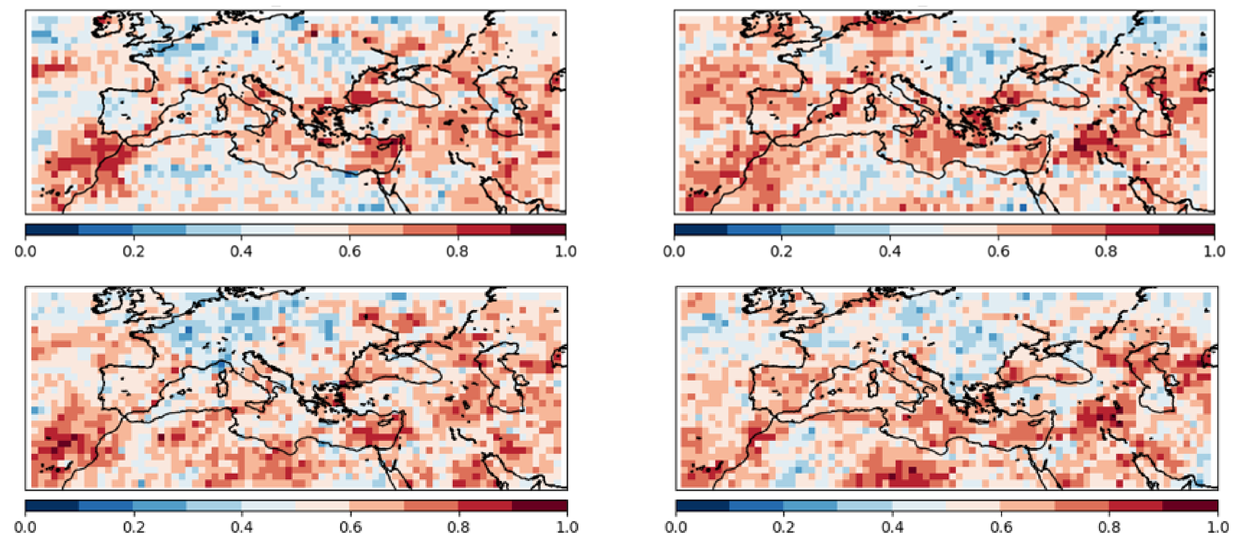
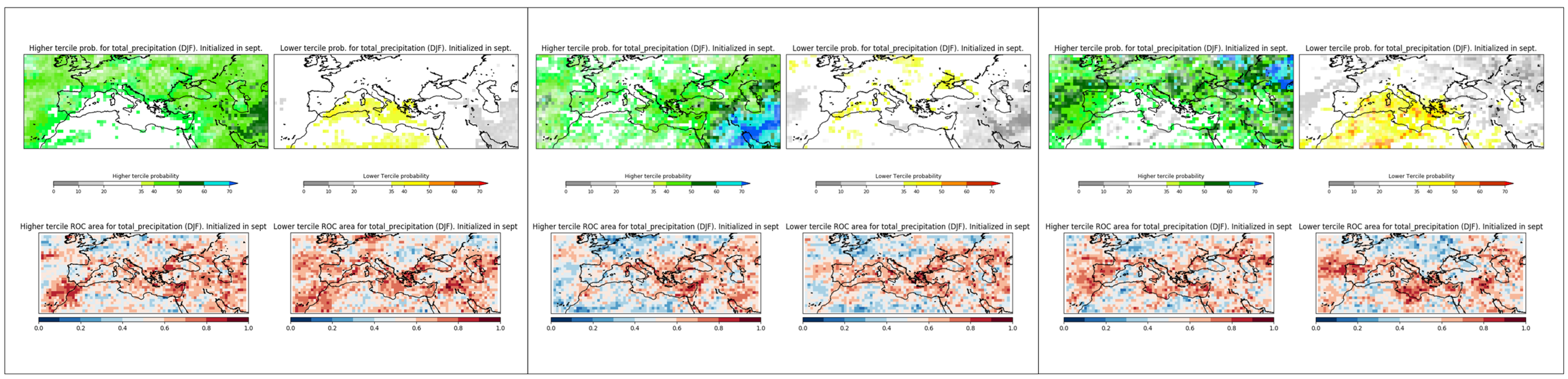


Figure 2. ROC area for the upper (left) and lower (right) precipitation tertiles in winter. Multimodel ensemble, September (up) and November (down) runs.

Results and conclusions

When using October precipitation observations to subsample the September run, we found improvements in skill in several areas of the Mediterranean region, specially around the Iberian Peninsula, as seen in Figures 3, 4 and 5. It is not clear why there is greater skill in those areas when subsampling, although in Iberia the Northern Atlantic Oscillation, which exerts a great influence in winter precipitation there, might be one of the causes.

As the improvements were localized and there were decreases in skill in some areas, this method does not seem to be convenient for an objective seasonal forecast system in the whole Mediterranean region. The clustering approach was less successful, but it achieved small gains of skill in some places. Although the simple subsampling approach seems to be better than clustering, other possible clustering methods could be tried to ensure this is the case. Both selection methods lead to worse results when MSLP observations were used to choose the members.



Figures 3, 4 and 5. Probabilities and ROC area for the upper and lower tertiles in the September run. In the left, for the multimodel ensemble. In the center, for the cluster selected using October precipitation observations. In the right, for the 25 closest members to precipitation observations.

References

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