Comparison of Five Strategies for Seasonal Prediction of Bioclimatic Indicators in the Olive Sector

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Extended Abstract

The forecast quality of five seasonal prediction strategies used to obtain tailored bioclimatic indicators in the olive sector has been assessed over the Iberian Peninsula (IP). In total, five indicators have been selected considering their importance in the management of the olive orchard. As time progresses through the indicator target period, the impact of the increasing share of actual observations included in its computation has been evaluated by examining the variabilities of correlation and fair Rank Probability Skill Score (fair RPSS) in each initialization date.

The results show that blending either seasonal predictions or climatology with observations enhanced the capability of forecasting the tercile category for all the indicators when compared with the use of climatology or seasonal predictions alone. In fact, for Spring Temperature Maximum (SPRTX) and Growing Season Temperature (GST) indicators, the combination of observations and SEAS5 prediction could outperform the other methods for most of the start months. As for those threshold-defined indicators, namely Spring Heat Days (SPR32) and Summer Heat Stress Days (SU36 and SU40), the end-users are highly encouraged to use climatology in the first month and combine it with observations as soon as they become available.

A. Introduction

Olive is one of the key staples in many Mediterranean countries. Approximately 70% of the world's olive oil came from the EU in 2020-2021 (IOC, 2018). Additionally, Mediterranean Spain accounts for more than half of the total cultivation areas in the EU (EPRS, 2017). However, a significantly hotter and drier Mediterranean basin has been projected with regional climate models under varying scenarios by the end of this century (Cos et al., 2022). As such, scientists have warned that an advanced adaptation driven by climatic information is essential to tackle these foreseen threats induced by climate change (Ranasinghe et al., 2021).

Seasonal predictions have been applied to a range of sectors but the forecast skill over non-tropical regions are limited (Doblas-Reyes et al., 2013). This could prevent end-users from using them in their decision making. One of the solutions proposed to solve this problem is the inclusion of observation in the calculation of the bioclimatic indicators (Chou et al., under review). This work aims to understand the transferability of the blending approach (already applied to the wine sector) to five indicators of the olive sector by comparing five seasonal prediction strategies.

B. Data and Spatial Domain

The daily temperature predictions of the ECMWF SEAS5 prediction (S5) in the 1993-2016 period has been used (Johnson et al., 2019). As for the observational data, we have used the ECMWF ERA5 reanalysis (Hersbach et al., 2018) as the reference data over the same hindcast period. The IP has been selected as the spatial domain of interest because it holds more than 50% of the total olive cultivation areas in the EU.

C. Bioclimatic Indicators for the Olive Sector

The five indicators evaluated in this work have been co-defined taking into account the olive grower's perspective.

- SPRTX: mean temperature maximum from April-May
- SPR32: accumulated number of days with the maximum temperature exceeding 32ºC from 21st April to 21st June
- SU36 and SU40: accumulated days with the maximum temperature above 36 and 40ºC, respectively, from 21st June to 21st September
- GST: the mean of daily average temperatures from April to October.

D. Five Strategies to Generate Predictions of Indicators

The acronyms of the five strategies are listed below with the relevant information about the skill metrics calculation followed by the approaches of generating the predictions of indicators.

1. E5: ERA5 climatology (used as a benchmark)
2. S5: bias corrected SEAS5 prediction
3. B-S5: SEAS5 prediction blended with the past observations
4. B-E5: ERA5 climatology blended with the past observations
5. P: persistent prediction

The basic concept of the blending approach is to progressively combine the (passed) observed data with the predicted data. This technique has been applied for B-S5 and B-E5 with the only difference being the predicted data used in each case. The former (B-S5) took SEAS5 prediction while an ensemble of observations was created for the latter (B-E5).

As for the P strategy, the assumption is that tomorrow remains the same as today. Thus, the key step is to decide the month(s) used for each initialization date. To uptake as much information of observations as possible, we have used all the days of the closest month(s) being available. Taking GST as an example, the daily data in March (April) has been taken to compute the indicator for the start month of April (May). Thereafter, from the start month June onwards, the months from April to the month before the present one have been used.

E. Evaluation Methods

Correlation coefficient and fair RPSS have been applied for evaluation. To understand the effect of the increasing share of the observations within the indicator on the skill metrics, they have been computed for each initialization date of each indicator period. It is worth noting that only the highest positive fair RPSS is interesting in the final comparison.

For the P strategy, we assigned 1 to the tercile category in which the prediction belonged due to the lack of ensemble members. As such, the annual fair RPSS would be either one or negative values.

F. Results and Discussions

According to the indicators' features, the results have been grouped into two categories: the threshold-defined indicators including SPR32, SU36 and SU40; and the SPRTX and GST belong to the period-average indicator.

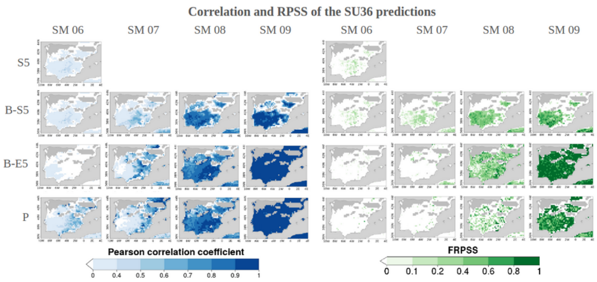

Fig. 1. Correlation and fair RPSS of the SU36 predictions of the four strategies (S5, B-S5, B-E5 and P, top to bottom) for each initialization date (1st June to 1st September, left to right)

Here, the SU36 indicator is used as an example to describe the overall improvement of the verification metrics and the comparison between the different strategies. The increased value in correlation when blending more observations within the season could be seen in most cases as shown in Fig. 1 (left panel). Regarding fair RPSS (the right panel), when comparing B-S5 with B-E5, the former outperformed the latter in July for the southern half of IP (see the SM07 column). After that, the inclusion of July observations substantially enhanced the performance of B-E5 in SM08 as shown in the third column. In SM09, B-E5 performed better than B-S5 throughout the domain when three out of four observations were available. In terms of P, positive fair RPSS started to appear in SM08 when the critical month (July) was uptaken and attained values above 0.6 over a large area in September.

To better understand the spatial and temporal variabilities of the best prediction for each indicator, Fig. 2 depicts the best performer (with the highest fair RPSS) for each pixel and start month for the threshold-defined indicators. To sum up, E5 (Climatology) and B-E5 are recommended for the threshold-defined group (SPR32, SU36 and SU40) while S5 and B-S5 have a better performance for the period-average indicators (SPRTX and GST, not shown here).

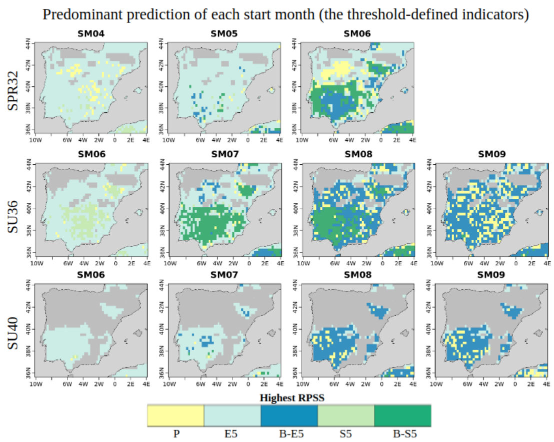

Fig. 2. The best prediction for the threshold-defined indicators (SPR32, SU36 and SU40, top to bottom) in each start month (left to right)

G. Conclusions

It is recommended to uptake the available observations when seasonally predicting bioclimatic indicators for the olive sector. Over the IP, end-users are encouraged to use blending SEAS5 (B-S5) prediction for those period-average indicators while the climatology (E5) and blending past observations with climatology (B-E5) would be a better choice when involving threshold-based indicators.

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Author biography

Chihchung Chou is a postdoctoral researcher of the Climate Services team in the Earth System Services group at BSC. With a background in Environmental Engineering, he studied the land-atmosphere interaction over the South Asia monsoon region in his PhD (University of Melbourne). After that, he participated in preparing a new Catchment Attributes and Meteorological Large Sample dataset for Australia. His research interests include climate services and hydro-meteorology.