Predictability of large-scale atmospheric flow patterns connected to extreme precipitation in the Mediterranean

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MOTIVATION

Previous work[i] demonstrated strong connections between Extreme Precipitation Events (EPEs) in the Mediterranean (Med.) and large-scale atmospheric flow patterns over the domain. Here, we assess the skill of the ECMWF extended-range forecasts in predicting these patterns, and their usefulness for indirectly predicting EPEs.

DATA

ERA5[ii]; 1979–2020; ECMWF reforecasts 0–45 lead days

Selected Variables (at daily temporal scale)	Spatial Resolution
Total Precipitation (*TPr*)	0.25° x 0.25°
Mean Seal Level Pressure (*SLP*)	1.00° x 1.00°
Mean Geopotential Height at 500 hPa (*Z500*)	1.00° x 1.00°

METHODOLOGY

1. Use EOF analysis and K-means clustering of the SLP and Z500 anomalies for deriving the nine (9) Mediterranean patterns (**Fig. 2**).
2. Connect the patterns to P95 EPEs (**Fig. 3**).
3. Calculate Brier (Skill) Score (BSS) when defining EPEs based on the Med. patterns. This is the best improvement from reference score given a perfect forecast (**Fig. 4**). As reference, we considered a 31-day window EPE occurrence climatology.
4. Use Euclidian distance to allocate each forecast to one of the 9 Mediterranean patterns.
5. Use Fair Brier (Skill) Score to assess the performance of the model in allocating the patterns (**Fig. 5**). Reference scores used are i) persistence and ii) 91-day window frequencies.
6. Use conditional probabilities derived from ERA5 (Step 2) to assess with BSS the indirect predictive skill of EPEs forecasts (**Fig. 1**).

REFERENCES

[i]Mastrantonas N, Herrera-Lormendez P, Magnusson L, Pappenberger F, Matschullat J. Extreme precipitation events in the Mediterranean: Spatiotemporal characteristics and connection to large-scale atmospheric flow patterns. Int J Climatol. 2021;. https://doi.org/10.1002/joc.6985 [ii]Copernicus Climate Change Service (C3S) (2017): ERA5: Fifth generation of ECMWF atmospheric reanalyses of the global climate. Copernicus Climate Change Service Climate Data Store (CDS). https://cds.climate.copernicus.eu/cdsapp#!/home

The ECMWF extended-range forecasts provide skilful predictions of Mediterranean patterns up to 3 weeks in advance. Using the forecasted patterns for indirectly predicting extreme precipitation events outperforms reference score up to 1–2 weeks ahead.

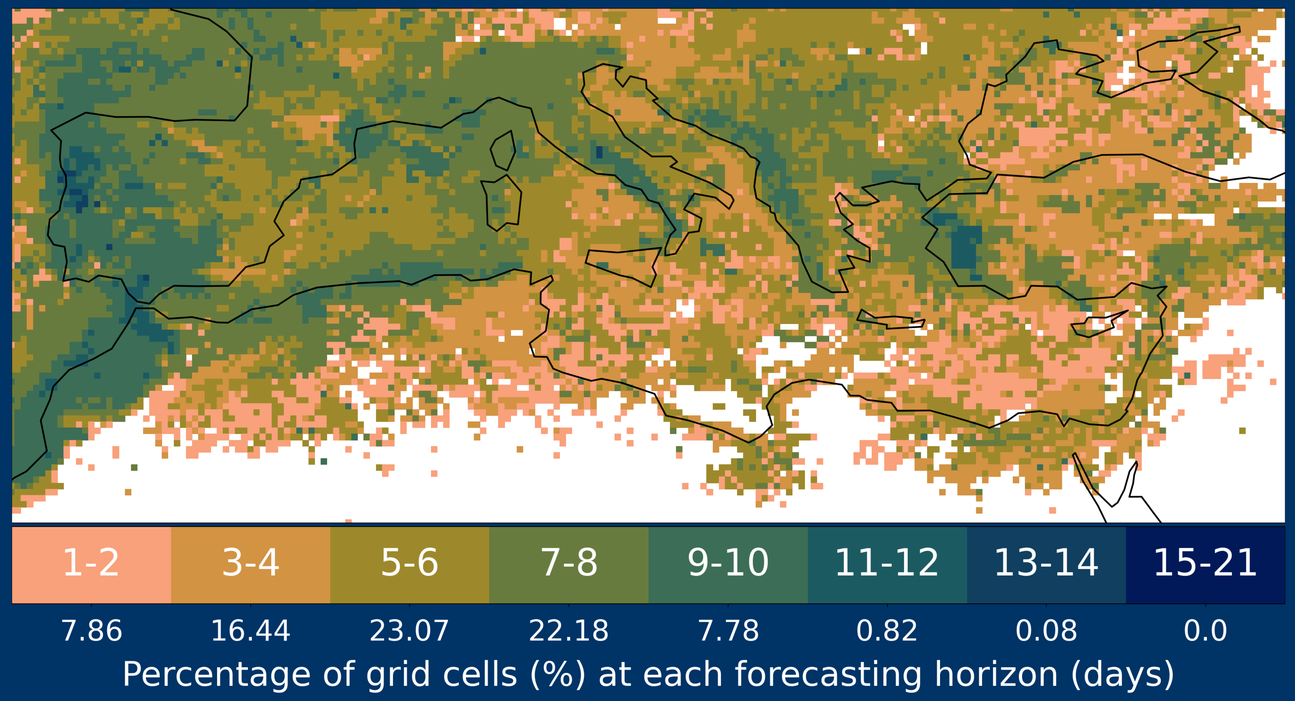

Fig. 1: Forecast limit (in lead-days) up to when ECMWF model outperforms climatology in predicting extreme precipitation, when indirectly predicting extremes with the use of the 9 Mediterranean patterns.

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Find out more
https://youtu.be/W8k5Dy5rlnE

Supportive Information

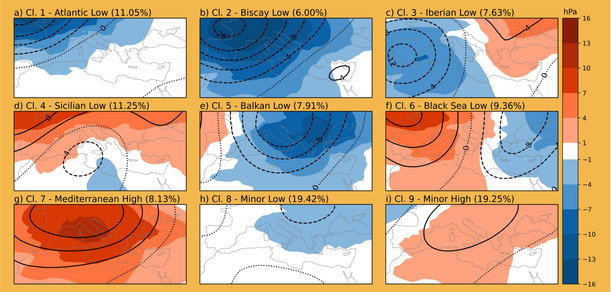

Fig. 2: Composites of weather regimes, derived with K-means clustering on the principal components' projections of SLP and Z500 anomalies. Colour shading refers to SLP anomalies (hPa), and contours to Z500 anomalies (dm). Percentages indicate the occurrence of each cluster to the total days of the analysis (Mastrantonas et al. 2021).

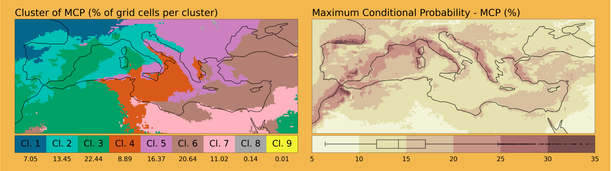

Fig. 3: P95 EPEs: Pattern of Maximum Conditional Probability (MCP) for each grid cell and associated MCP considering the annual statistics.

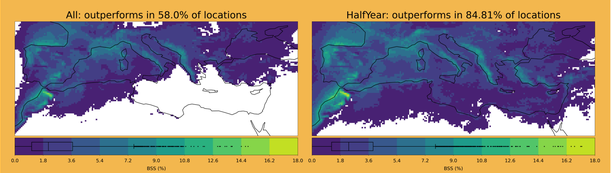

Fig. 4: Brier Skill Score (BSS) for EPEs, based on connection of EPEs and patterns. ***Left***: BSS on annual statistics, ***Right***: BSS considering half-year conditional probabilities of EPEs given the allocated pattern. This figure illustrates the best improvement from reference climatological score when having a perfect forecast of the Mediterranean patterns.

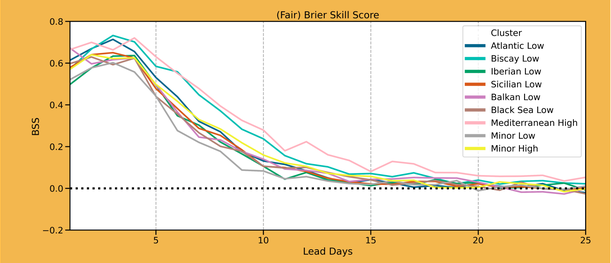

Fig. 5: Brier Skill Score (based on Fair BS) of the Mediterranean patterns. The used reference scores are persistence and climatological frequencies.

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