Effect of ocean-atmosphere interaction in the Mediterranean on sub-seasonal forecasting of precipitation in the Levant

Ofer Cohen[1], Ori Adam[1], Assaf Hochman[1]
[1] Fredy and Nadine Herrmann Institute of Earth Sciences, Hebrew University, Jerusalem, Israel
ofer.cohen5@mail.huji.ac.il

Motivation and Objectives: The Eastern Mediterranean (EM) region is considered a global warming hotspot projected to experience increased temperatures, droughts during summer, as well as high-intensity precipitation and flooding during winter, highlighting the importance of improving the skill of precipitation forecasting on sub-seasonal to seasonal timescales as part of ongoing adaptation efforts. Previous works showed promise in improving the predictability of levant precipitation using EM ocean parameters (Amitai and Gildor 2017). Here we aim to assess the relation of patterns in sea surface temperature (SST) and surface latent heat flux (SLHF) with sub-seasonal to seasonal (S2S) (Vitrat et al. 2017) variability of precipitation in the Levant, with implications for improved forecasting.

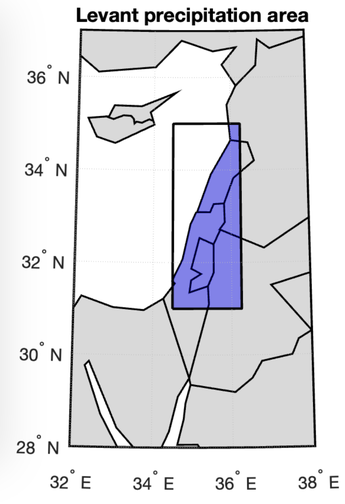
Data and Methods

Data and Preprocessing

- ECMWF ERA5 reanalysis data (Hersbach et al. 2023) is used for SLHF and precipitation, from 1980 to 2020. Only land precipitation data, and only above-sea SLHF data are considered. In accordance with the ERA5 database, up to September 2007, SST is provided from the HadISST2 dataset, and afterward it is provided from the OSTIA dataset.
- For both precipitation and SST, anomaly from climatology is used to remove seasonal effects, and for the SST and SLHF, the data is detrended to remove the effect of global warming.

Self-Organizing Map (SOM) analysis

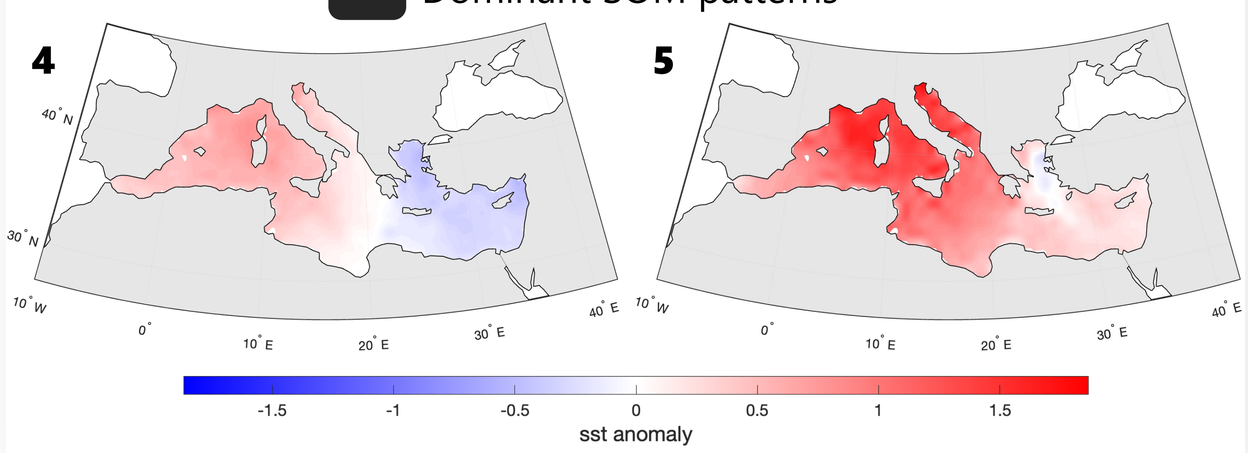
- Unsupervised Self Organizing Map (SOM) analysis (Kohonen et al. 1990) is performed for both SST and SLHF reanalysis data (6X1 maps).
- The similarity between the SOM patterns is assessed and their correlations to the monthly data are calculated.
- The correlation of each of these SOM patterns to the winter (December to February) precipitation at the center of the levant is calculated.
- Two distinct patterns with high statistically significant correlations to Levant winter precipitation are shown and assessed below.



Initial Results

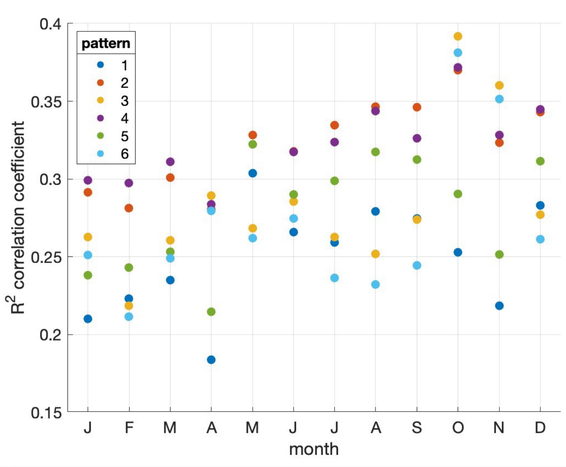
SST

1 Dominant SOM patterns



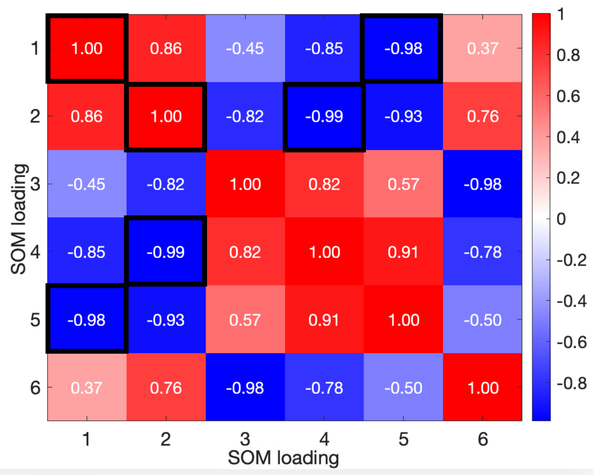
2 SOM Seasonal Dominance

Correlation to monthly data

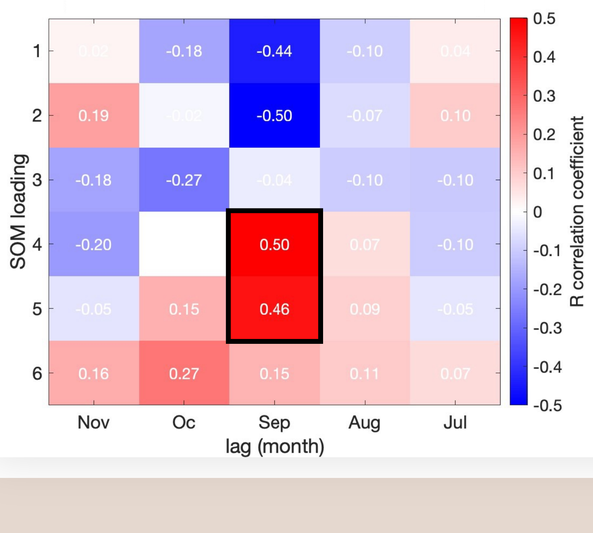


3 Pattern Similarity

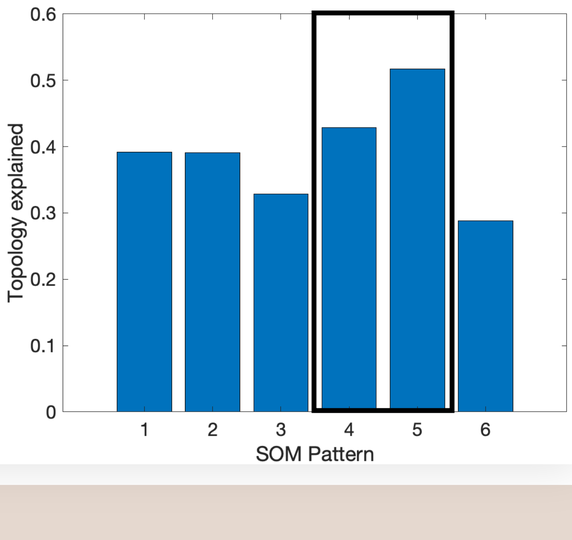
Correlation matrix between patterns



4 Winter Precipitation Correlation

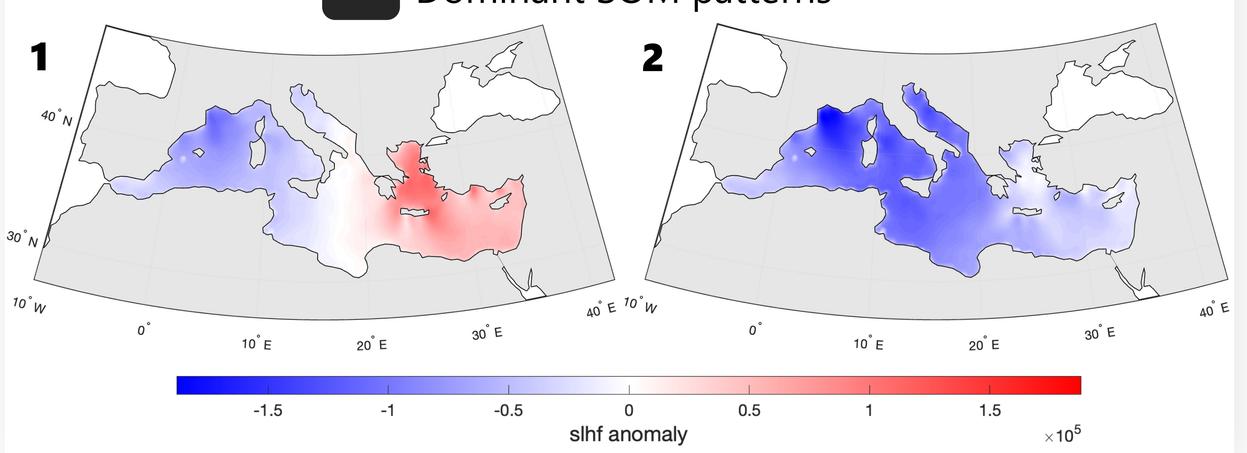


5 Topology Explained



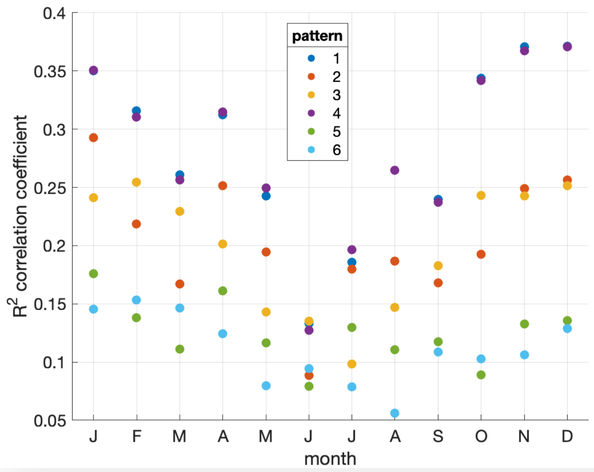
SLHF

1 Dominant SOM patterns



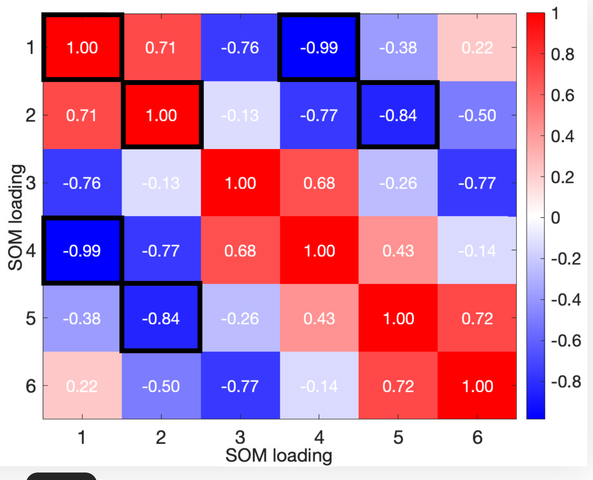
2 SOM Seasonal Dominance

Correlation to monthly data

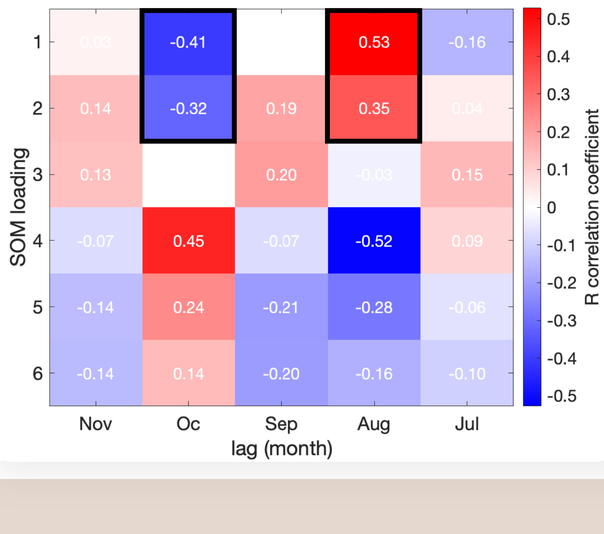


3 Pattern Similarity

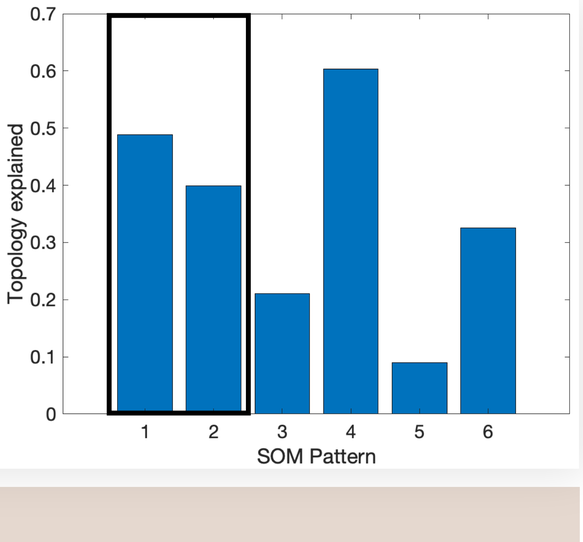
Correlation matrix between patterns



4 Winter Precipitation Correlation



5 Topology Explained



Conclusions and Future Steps: We find two distinct SOM patterns of SST and SLHF in the Mediterranean that are highly correlated to winter precipitation in the central Levant. These patterns highlight the influence of the difference between the eastern and western Mediterranean conditions during summer and fall on Levant winter precipitation and may be applicable to improve sub-seasonal precipitation prediction skills in the region. In future work we will further investigate these connections using regional model simulations, decomposing the response to thermodynamic and dynamic processes (Seager et al. 2010), and examining ocean processes related to relevant SOM patterns, using ocean Reanalysis data.

References: [1]Amitai, Y. and Gildor, H., 2017. Can precipitation over Israel be predicted from Eastern Mediterranean heat content?. *International Journal of Climatology*, *37*(5), pp.2492-2501; [2]Vitart, F., Ardilouze, C., Bonet, A., Brookshaw, A., Chen, M., Codorean, C., Déqué, M., Ferranti, L., Fucile, E., Fuentes, M. and Hendon, H., 2017. The subseasonal to seasonal (S2S) prediction project database. *Bulletin of the American Meteorological Society*, *98*(1), pp.163-173; [3]Hersbach, H., Bell, B., Berrisford, P., Dahlgren, P., Horányi, A., Munoz-Sebater, J., Nicolas, J., Radu, R., Schepers, D., Simmons, A. and Soci, C., 2020. The ERA5 Global Reanalysis: achieving a detailed record of the climate and weather for the past 70 years. *European geophysical union general assembly*, pp.3-8; [4]T. Kohonen, "The self-organizing map," in *Proceedings of the IEEE*, vol. 78, no. 9, pp. 1464-1480, Sept. 1990, doi: 10.1109/5.58325.