



On the link of the Madden Julian Oscillation, Euro-Mediterranean weather regimes and rainfall patterns in Morocco

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Abstract

K-means cluster analysis of wintertime 500-hPa geopotential height anomalies allowed identifying seven weather regimes describing the atmospheric variability over the Euro-Mediterranean domain. The study of transitions between those weather regimes provided consistent results with the westward displacement of the blocking nearby northern Europe before the onset of the negative phase of the North Atlantic Oscillation (NAO-). Furthermore, the examination of the relationship between weather regimes and precipitation over Morocco showed that the NAO- (NAO+) regime is accompanied with more (less) rainy episodes. The exploration of the impact of the Madden Julian Oscillation (MJO) over Morocco showed that phases 7-8-1-2 (phases 4-5-6) are often associated with wetter (drier) conditions. The investigation of the lagged relationships between the MJO and the seven weather regimes depicted a strong delayed response of the NAO+ (NAO-) regime to the MJO phase 3 (phase 6). This study highlighted an evident statistically link between the MJO, weather regimes and rainfall patterns over Morocco, which constitutes an important source of predictability at the medium and the extended-range time scales.

Data and Methods

The relationship between the MJO and the Euro-Mediterranean weather regimes (WRs) was examined with a time lag up to 15 days. The impact of the MJO and WRs on rainfall patterns over Morocco was examined using a weekly running mean of the daily winter precipitation (DJF).

- Data:
- Era-interim 500hpa height: <http://www.ecmwf.int>
 - MJO (Wheeler and Hendon 2004): <http://www.bom.gov.au>
 - Observed rainfall data: Daily precipitation (DJF, 1985-2014) of 28 meteorological stations: Moroccan Meteorological Office (DMN).

Results

In addition to the Classifiability index (CI), the Weighted Information Criterion (WIC) was defined in order to decide for the optimal number of clusters produced by K-means cluster analysis of wintertime 500-hPa. $WIC = \sum_{i=1}^k \left| \frac{n_{i,r}}{n_i} - p_r \right| * 100 = \sum_{i=1}^k \left| \frac{n_{i,r} - p_r * n_i}{n_i} \right| * 100$
 $n_{i,r}$: Number of days with WR(i) and Rainfall >= r mm; n_i : total of days with rainfall >= r; p_r : probability of having rainfall >= r.

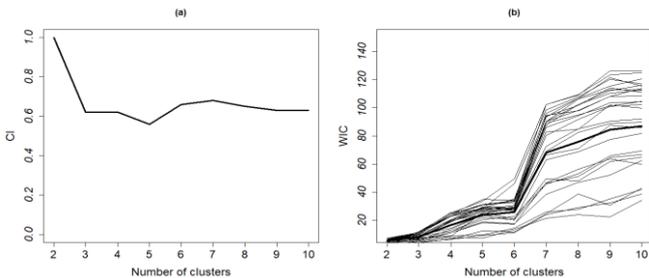


Figure 1 (a) The classifiability index (CI); (b) The weighted Information criterion (WIC)

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Euro-Mediterranean weather regimes (WRs)

K-means cluster analysis of wintertime 500-hPa geopotential height anomalies allowed identifying seven weather regimes describing the atmospheric variability over the Euro-Mediterranean domain.

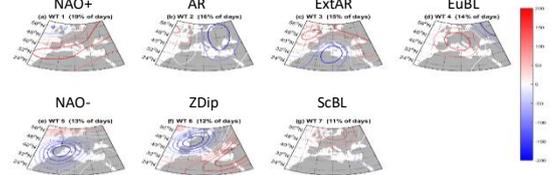
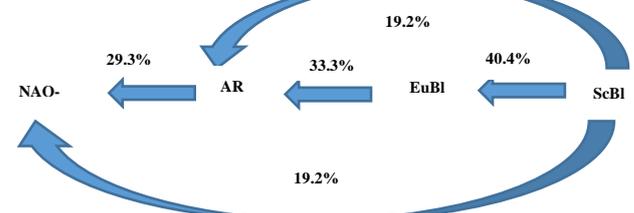


Figure 2 Wintertime Euro-Mediterranean weather regimes (WRs)

Preferred transitions



Euro-Mediterranean weather regimes and rainfall in Morocco

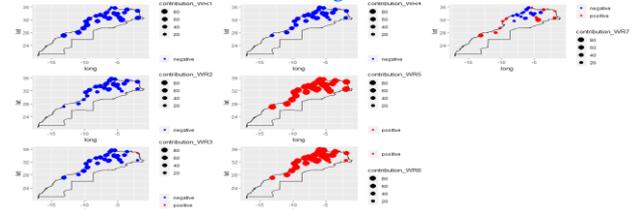


Figure 3 Wintertime Euro-Mediterranean weather regimes (WRs)

NAO- (NAO+) regime favors more (less) rainfall occurrences.

Impact of MJO on rainfall in Morocco

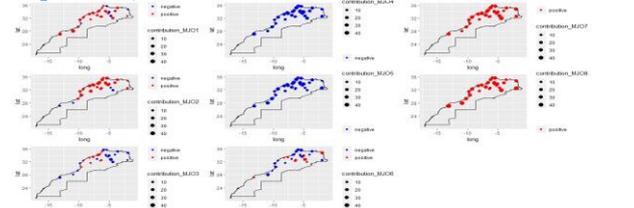


Figure 4 Wintertime Euro-Mediterranean weather regimes (WRs)

MJO phases 7-8 and 1-2 are associated to more wetter conditions.

Lagged impact of MJO on WRs

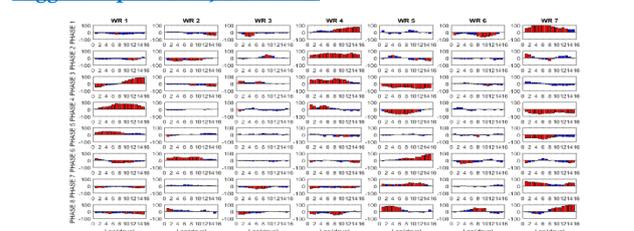


Figure 5: Lagged percentage contribution (%) of MJO in the occurrence of WRs. Strong delayed response of NAO+ (NAO-) regime to the MJO phase 3 (phase 6)

Conclusion:

- Wetter conditions in Morocco are mainly favored during MJO phases 7-8 and 1-2. The latter are mostly in phase either with NAO- or with the Scandinavian blocking.
- The observed lagged linkage between the weather regimes and the MJO is promising the opportunity to improve the weather forecast at the subseasonal scale.