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THE MEDITERRANEAN OSCILLATION IN WINTER

Abstract: A Mediterranean Oscillation (MO) has been assessed in the pressure at the sea level (SLP) and at the 500 hPa geopotential height at the seasonal time-scale. Winter only is studied here. When the SLP (respectively the 500 hPa height) is higher (respectively lower) than the series average in the north and the west of the Mediterranean, it is close to the average in the east and the south-east. The MO corresponds to the first winter unrotated component of Principal Component Analyses on SLP and 500 hPa height. Its pattern has a single pole. Composites show the oscillation in the pressure and at the geopotential height previously mentioned. The component scores can be used as two MO indices which are well correlated between each other and with the NAO (North Atlantic Oscillation).

Key words: Mediterranean Oscillation (MO), SLP, 500 hPa, NAO.

1. Introduction

Conte et al. (1989) are the first researchers to mention a „Mediterranean Oscillation” (MO) between west and east of the Basin at the 500 hPa level with an index calculated as the level difference between Algiers and Cairo. The term was used by Douguédroit (1995) for the pressure at the sea level and defined as SLP oscillation between the north-west and the south-east of the Mediterranean. There we shall focused the presentation on the MO as a phenomenon concerning the whole low and middle atmosphere. It will be studied during winter (from November to January), at the sea level and at 500 hPa height. And relationship between them will be shown.

2. Data

Two datasets are used here: monthly SLP and 500 hPa height (NPEC, USA). They are given at grid-points, every five degrees latitude, from 30°N to 45°N in

latitude and from 45° east to 30° west in longitude. They cover the Mediterranean and the near Atlantic at the same latitudes, from winter 1915-16 for SLP and winter of 1946-47 for the geopotential height to winter 1987-88.

The MO is represented by a low frequency anomaly pattern which can be determined by Principal Component Analyses with Rotation Varimax or RPCA (Richman 1986). It corresponds to the first unrotated component of the RPCA on winter SLP and 500 hPa height in the R mode, with grid-points as variables from 1915-16 or 1946-47 to 1987-88. Its pattern is obtained with the component loadings transferred on the grid-point map. It is interpreted by composites which are formed by the mean SLP or 500 hPa height of the five winters with the highest or the lowest scores of the component. Its index is formed by the successive temporal scores of the component at each atmosphere level.

3. The Winter SLP MED Pattern

The winter SLP MO is represented by the first unrotated component of the RPCA on mean winter SLP. It has a single pole pattern centred on the sea between Sardinia and Spain. Loadings higher than 0.80 cover western and central Mediterranean. It represents 54% of the total variance. This pattern has not been described before in the studies on the low frequency patterns of the Northern Hemisphere or Europe. It somewhat looks like the primary centre of the SENA pattern described by Rogers (1990) from December to June. It has been named MED (for Mediterranean).

Two composites have been computed, one representing the mean SLP of the five winters with the highest scores of the pattern, the second the case of the five others with the lowest scores (not represented). The first map has pressure increasing from the south-east, where they are lower than the average, towards the north-west. On the second one, the pressure which remains around the average all over the Mediterranean is only higher on the near Atlantic.

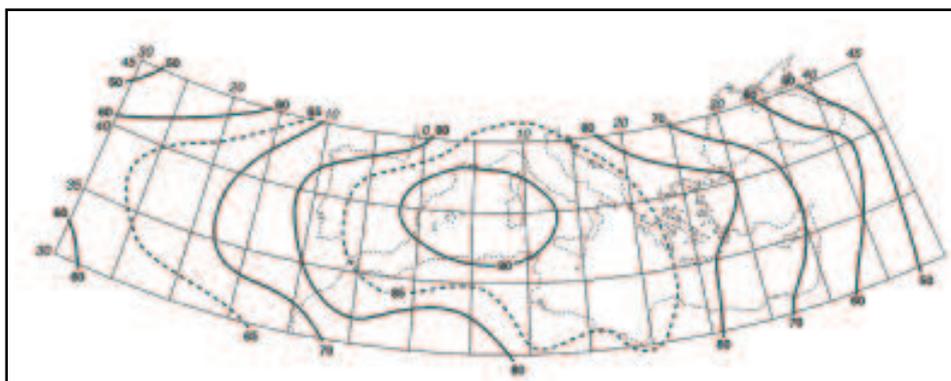


Fig. 1. SLP low frequency MED pattern in winter.

They have been compared with the average pressure of the whole winter SLP series (not represented) and anomalies between the composites and the average pattern has been estimated. The pressure anomalies of the first composite (with the highest scores) are all negative and decrease from the south-east to the north-west. They all are positive on the second composite but the closest to the average on the south-east. Low pressures cover the whole Mediterranean in the first case and high pressures in the second one. The cumulated anomalies of the two composites give Figure 2; they increase from the south-east to the north-west.

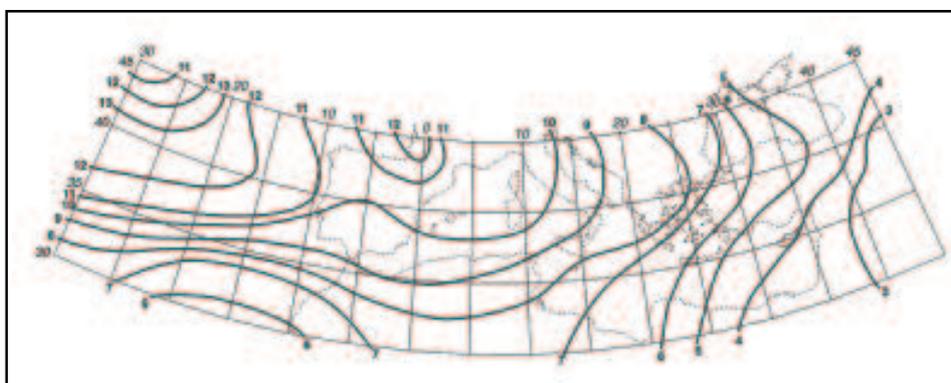


Fig. 2. Differences (in hPa) between two composite SLP patterns: mean pressure of the five winters with the highest scores of the SLP MED pattern and mean pressure of the five winters with the lowest scores of the same pattern.

So when the SLP are higher (respectively lower) than the average in the north-west of the Mediterranean, they are close to the average in the south-east. They represent an oscillation between the two extreme areas of the basin.

4. The Winter 500 hPa ATL-MED Pattern

The winter 500 hPa MO is represented by the first unrotated component of the RPCA on mean winter 500 hPa heights (Fig. 3). It is a single pole pattern with loadings higher than 0.70 over the western Mediterranean. But its center is located west of the straits of Gibraltar, in the Atlantic. It represents 55% of the total variance. It does not correspond to any pattern previously described at the geopotential 500 hPa height field. It is east of the usual southern pole of the NAO, even if it is located at the same latitude and south of the East Atlantic one (Wallace, Guntzler 1981). The name of ATL-MED (Atlantic-Mediterranean) has been given to it.

This pattern has been interpreted with the help of two composite maps which have been realized as for the SLPX. They consist in the average height of the five winters with the highest or the lowest scores of the component (not represented). On

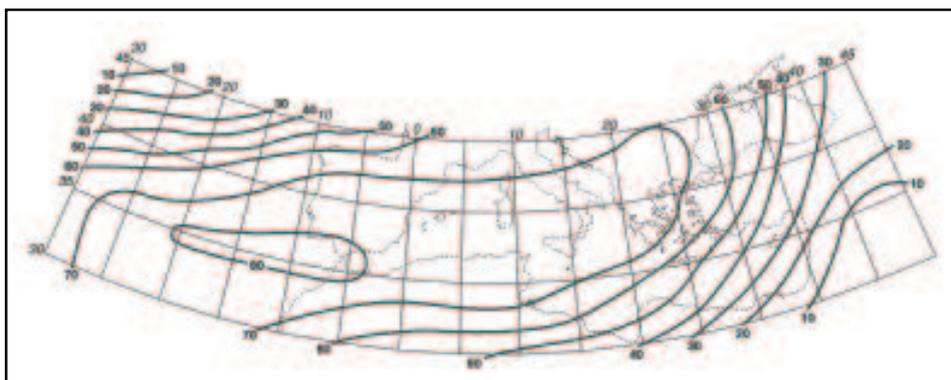


Fig. 3. 500 hPa low frequency MED pattern in winter.

the first one, the mean height increases from 5,520 m on the south-east to 5,760 m north-west of Spain. On the second one, it is lower but also increases in the same direction from 5,540 m to 5,700.

The two composites have been compared with the mean height field of the whole series from 1946-47 to 1987-88. And the level differences between the two composites have been calculated (Fig. 4). They increase from the south-east to the north of the western Mediterranean. When the geopotential 500 hPa height is higher (respectively lower) of the average height of the whole series from 1946-47 to 1987-88 in the north-west of the Mediterranean, it is close to the same average in the south-east. It represents an oscillation between the two extreme areas of the Mediterranean as it has been noticed at the sea-level.

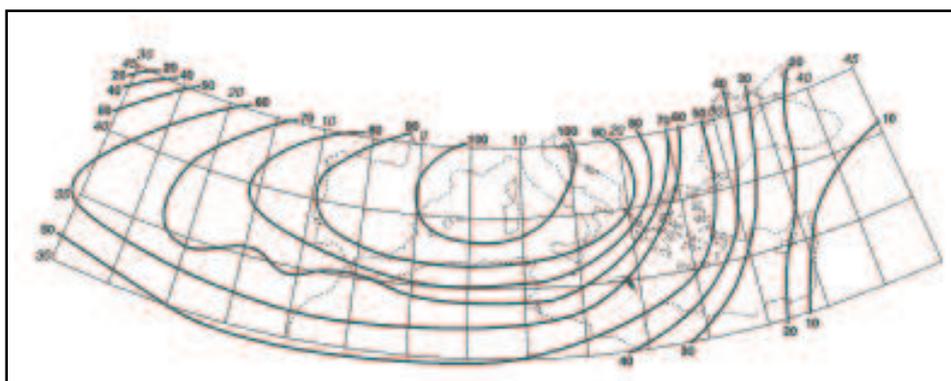


Fig. 4. The same as Fig. 2 but for the 500 hPa MED pattern.

5. The MO Indices

The scores of each first unrotated component which compose a temporal series can be considered as MO indices at the sea-level and the 500 hPa height. They are highly correlated (0.63) for the common period from 1946-47. The MO has an influence in the low and middle atmosphere with differences between the two levels. The scores of the SLP component have been compared with the usual NAO index (pressure difference between the Azores and the Island). They are also highly correlated (0.73). We suppose that the MED pattern can be considered in winter at the sea-level as an extension of the Azores high but not as the Azores high itself. It is due to the location of the MED pattern at the same latitude as the high but eastward. In the absence of NAO index at the 500 hPa height, no comparison could be done with the MO index at that height.

6. Conclusion

The first unrotated component of RPCA on winter SLP and 500 hPa geopotential height represents a Mediterranean Oscillation (MO). At the sea-level, it is a MED (Mediterranean) pattern centred over the west basin of the sea. At the 500 hPa height, the pattern is larger and a little shifted westward over the near Atlantic. Their scores reveal an oscillation of the pressure between the north-west and the south-east of the Mediterranean. When the pressure (the geopotential height) is higher (respectively lower) than the whole series average, it is close to the average in the south-east. The scores can be considered as MO indices. They are highly correlated. And, at the sea level, the MO index is highly correlated with the NAO index computed by the pressure difference between the Azores and the Island.

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