CLIMATE VARIABILITY OF THE MED REGION DETECTED BY ERA-40 SURFACE WATER VAPOUR DATA

M.E. Schiano [1], S. Sparnocchia [2], C. Cappa [3], R. Bozzano [4*], P. Picco [5]

[1] CNR ISMAR-SP, Forte di Santa Teresa, 19036 Pozzuolo di Lerici (SP), Italy - elisabetta.schiano@sp.ismar.cnr.it
[2] CNR ISMAR-TS, Viale Romolo Gessi, 2 - 34123 Trieste, Italy - s.sparnocchia@ts.ismar.cnr.it
[3] CNR ISAC-TO, Corso Fiume 4, 10133 Torino, Italy - c.cappa@isac.cnr.it
[4] CNR ISSIA, Via de Marini 6 - 14149 Genova, Italy - *boz@ge.issia.cnr.it
[5] ENEA-CRAM, Forte di Santa Teresa, 19036 Pozzuolo di Lerici (SP), Italy - picco@santateresa.enea.it

Abstract

An analysis of the climate variability of the Mediterranean region is performed by using ERA-40 surface water vapour data. Previous studies show that this parameter may be used as an index for detecting the prevalence of weather condition more related to the tropical aspects of the Mediterranean area. The ECMWF project ERA-40 provides the long time series of values used in this investigation. The results are examined according to some climate indices and to the main pattern of variability observed in the circulation of the Mediterranean Sea.

Keywords: climate variability, surface water vapour, Mediterranean Sea

The Mediterranean basin shows a "twofold climate regime", i.e. both tropical and mid-latitude aspects are playing a role. Generally, during summer months the tropical features are more appreciable giving raise to a well-marked division between winter and summer conditions. Many signals suggest that the climate regime of this region is varying; and it would seem that the tropical features are prevailing all the year round. In order to analyse the signals of this supposed climate change, the surface water vapour density over the sea may be a good index.

The results of previous studies (1,2) show that the distribution of many quantities, strongly related to climate, versus the surface water vapour density reveals a discontinuity for values of about 15-16 gm^{-3}. This threshold does not separate winter from summer since the water vapour density may be lower than 15 gm^{-3} also during the summer months, but it evidences warm and wet weather condition, more related to the tropical aspects of the Mediterranean area.

We investigate some aspects of the interannual variability of the Mediterranean climate using the surface water vapour density over the sea as a discriminant between the different conditions. In order to perform this analysis we need a long time series of surface values with a good spatial and temporal resolution over the whole basin. At the present, only surface meteorological data from numerical models are able to satisfy this requirement. Particularly, the values obtained from re-analysis projects are very useful because they are not affected by changes of the model which introduce long-term trends in the operational analysis products.

In the present study, data from the European Centre for Medium-range Weather Forecast (ECMWF) 40 years reanalysys (ERA-40) covering the period from mid-1957 to 2001 have been used. The data extracted from the ECMWF ERA-40 archive were the 2m air temperature and 2m dew point temperature on a regular latitude-longitude grid of size 0.5°x0.5° covering the whole Mediterranean Sea from January 1 1958 to December 31 2001. The values at the four synoptic hours were used for computing surface water vapour density values, from which calculating the mean daily value. In order to estimate the accuracy of ERA-40 data we compared the data of the ECMWF re-analysis against experimental values obtained from an offshore large spar buoy in the Ligurian Sea (Northern Mediterranean Sea) from February through December 2000. The comparison was performed by using the two grid points closest to the buoy position and the result shows a significant underestimation of the model. This is in agreement with the results of a previous work (3) which indicates the difficulty in modelling the surface vapour over the Mediterranean Sea. However, the need of a continuous long time data set obliges us to accept the lower accuracy.

The Mediterranean basin was divided into four sub-basins: the North-Western area (-6.0 ÷ 9.0 °E 35.5 ÷ 39.5 °N), the South-Western area (0.5 ÷ 9.0 °E 40.0 ÷ 44.0 °N), the Central area (9.5 ÷ 20.0 °E 30.5 ÷ 45.0 °N) and the Eastern area (20.5 ÷ 35.5 °E 31.0 ÷ 40.5 °N) and an average value was calculated for the water vapour density in each region. Furthermore, we computed the water vapour density in 18 selected grid points located in areas where significant oceanographic processes occur.

A first analysis was performed by computing for each year the number of days for which the surface water vapour density overcomes the threshold of 15 gm^{-3}. This number shows a great variability until 1980 when it drops to a minimum over the whole basin. After this drop, a well marked growth begins which is persisting until the end of our time series. The analysis carried out by looking the monthly distribution reveals that this trend is mainly due to an increase of the number of days over the threshold in spring and early autumn. Even the occurrences of very high values increase in the last 15 years. The analysis of the annual averages of water vapour density shows a similar behaviour with a rise in the last 15 years partially due to a reduction of the minimum values also.

In spite of the limited accuracy of the ERA-40 data, this study seems to confirm that the tropical features of the Mediterranean Basin are becoming stronger in the last years.

In order to evidence possible connections with large scale phenomena we perform an analysis with some climate indexes. Furthermore, since we have found a strong correlation between the evolution of the upper thermal gradient in the Mediterranean Sea and the surface water vapour, we look for links with the main pattern of variability in the Mediterranean circulation.

References

1 - Schiano M.E., Borghini M., Castellari S., Luttazzi C., 2000,. Climatic features of the Mediterranean Sea detected by the analysis of the longwave radiative bulk formulae. *Ann. Geophysicae*, 18: 1482-1487.

2 - Schiano M.E., Bozzano R., Vetrano A., Castellari S., Siccardi A., Gervasio L.,. Manzella G.M, Borghini M., Luttazzi C., 2001, Preliminary study on the use of surface water vapour density over the Mediterranean sea as index for analysis of interannual variability, in Abstract of EGS, GA XXVI, Nice 2001.

3 - Bozzano R., Siccardi A, Schiano M.E., Borghini M., Castellari S., 2003, Comparison of ECMWF surface meteorology and buoy observations in the Ligurian Sea. *Annales Geoph.*, in press.