THE SST MULTI-DECADAL VARIABILITY IN THE ATLANTIC-MEDITERRANEAN REGION

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Abstract

The multi-decadal variability of the Mediterranean Sea Surface Temperature (SST) field is analyzed using different datasets. The analysis of the Mediterranean SST revealed the presence of an evident oscillation of about 70 years. The same oscillation was found only in the North Atlantic Ocean and corresponds to Atlantic Multidecadal Oscillation (AMO). Singular Spectral Analysis and MTM applied to Mediterranean and Atlantic quantitatively confirmed the importance of this oscillation. The analysis of the correlation between SST and NAOI (North Atlantic Oscillation Index) suggests the importance of the external atmospheric forcing for most of the last 150 years.

Keywords: Temperature, Surface Waters, Open Sea, Global Change

Data and Methods

In this work we used the Extended Reconstructed SST (ERSST.v3) dataset (1854-present, monthly, 2 deg spatial resolution) [1] and the Hadley Centre Sea Ice and Sea Surface Temperature (HadISST) dataset (1870-present, monthly, 1 deg spatial resolution) [2] and we analyzed the consistency between the two datasets. At global level, when yearly averages are considered, seasonal or spatial discrepancies between ERSST.v3 and HadISST tend to compensate and the two datasets exhibit similar behaviors. The relatively high abundance of data in the Mediterranean Sea, allow us to produce a new estimate (MArtaS) of the mean monthly sea surface temperature of the Mediterranean Sea using only ICOADS (International Comprehensive Ocean-Atmosphere Data Set) SSTs. MArtaS (Marullo-ARTAle-Santoleri) is based on a simple space average of the available monthly data introducing a correction factor F that takes into account the presence of data voids for each specific month of the year. In spite of its crudeness MArtaS, that is not based on interpolated data, follow quite closely the other two series with differences that rarely exceed 0.1°C. The agreement between the two interpolated SST series (ERSST.v3, HadISST) and the non interpolated one (MArtaS) suggests that dumping or other possible distortions due to the interpolation are not dominant in the Mediterranean basin when yearly averages are used. On the contrary, when monthly means are used, the difference between two interpolated data sets became larger exhibiting a marked annual cycle with an amplitude of about 0.8 °C.

Spectral Analysis, Correlations and NAOI

In order to obtain the signal to noise separation we computed the eigenvalues spectrum of the SST time series using Singular Spectral Analysis (SSA). The first two leading EOFs, that explain about 40% of the total variance and capture the low frequency variability of the SST, have approximately the same amplitude (considering the range of error bars) and are in quadrature. This fact could be interpreted as the occurrence of a ghost limit cycle related to a physical oscillation of the dynamical system that has generated the SST time series [3]. The low frequency variability of the Mediterranean was also investigated applying the Multi Taper Method (MTM) to the de-trended yearly SST. The Multitaper method is a technique developed by D.J. Thomson [4] to estimate the power spectrum of a stationary ergodic finite-variance random process. This method provides useful tools for the spectral estimation of a relatively short time series whose spectrum may contain both broadband and line components. The F-test criterion for harmonic signals yields 6 peaks at the 99% confidence level and 10 peaks at the 95% confidence level that can eventually be associated to some harmonic, phase-coherent oscillation. Peaks at 73, 6.3, and 2.8 years exceed the 99% confidence level in the harmonic test and correspond to significant spectral bands in the power spectrum. The higher frequency peaks are very close to the preferred scale of variability of the ENSO's quasi-biennial and low-frequency modes while the lower frequency one is very similar to the AMO (Atlantic Multidecadal Oscillation). Similar peaks are also observed in the North Atlantic ocean. The evidence that both North Atlantic ocean and Mediterranean Sea exhibit the same multi-decadal climate cycle suggests the occurrence of a common external forcing, likely of atmospheric origin, probably coupled with some internal oscillation[5]. Correlation analysis between NAOI [6] and SST in the Mediterranean and Atlantic Ocean reveals that NAOI is significantly (90%) negatively correlated with SST only in the Eastern Mediterranean Sea (only during Winter), and in the two centers of the NAOI (during the four seasons): The tropical Atlantic and the sub-polar gyre area.

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