SEASONAL AND INTERANNUAL VARIABILITY OF THE SEA SURFACE TEMPERATURE FIELD IN THE EAST MEDITERRANEAN SEA FROM AVHRR DATA

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The increased availability of long time series of satellite data makes possible to investigate the seasonal and interannual variability of the sea surface temperature field over many areas of the world oceans. This is particularly true for those mid latitude regions, like the Mediterranean Sea, where the field of view of infrared sensors is not so frequently obscured by clouds as for other areas.

The NODS/MCSST used in the present work are 18 x 18 km weekly averaged SST maps for the period September 1981 - December 1992. Monthly and seasonal SST maps were produced from these data using objective analysis techniques and averaged over 11 years to evidentiate the seasonal behaviour of the SST field.

The analysis of the monthly climatological maps reveals that SST distribution is zonal from November to April and meridional in the period June-September. May and October are the transition months for the two situation.

The winter to summer transition should happen between May and June and is clearly marked by the northward displacement of the isotherms in the gulf of Sirte with the consequent formation of a meridional thermal front at about 210 E.

From October to November, during the summer to winter transition, the Ionian-Levantine front becomes weaker and less meridional. At the same time the Ionian warm meander starts to droop.

The analysis of the averaged months indicates that inflow of surface Atlantic water should be more intense from July to January when isotherms can directly proceed from the West to the East Mediterranean. The exchange of the modified Atlantic water between the Ionian and Levantine basins is inhibit from July to September by the summer growing of the cold core gyre west of Crete and by the formation of the 210E thermal front.

Moreover, the analysis of the monthly SST maps allows us to classify the permanent or semi-permanent thermal structures and study their seasonal characteristics in relation to basin main pattern.

In order to evaluate the interannual variability of the main dynamic structures of the eastern Mediterranean during the period 1982-1992, we constructed seasonal maps for individual years. These seasonal maps enable us to establish the extent of interannual SST pattern variability and how the variability effects the main features of the Eastern Mediterranean Sea. We observed a strong interannual variability in the whole eastern Mediterranean Basis either terms of absolute sea surface temperature or dynamic features intensity and shapes. Moreover this variability also shows differences and peculiarities in each sub-basin.

Empirical orthogonal function analysis (EOF) was applied to the 11-years sequence of AVHRR images to identify the dominant patterns of the SST variability in the eastern Mediterranean Sea. Singular Value Decomposition (SDV) has been used instead of the formal covariance method because computationally more efficient. Seasonal signal (rather than space or time average) was removed from each image before the SVD computation in order to retain interannual variability. The function used to describe the seasonal behaviour of the SST is where t is the time T is one year period and a, b, c, d parameters that have been estimated by non-linear fit using Lavenberg-Marquard method. EOF modes were calculated separately for the Ionian and Levantine Basins. In Both basin the first four EOF mode explain 87-88% of the total variance. The spatial pattern of the first EOF mode (46-50% of the total variance) in the two basins is very similar to the mean temperature field from averaging over all images. The second EOF mode (31 - 27% of the total variance) is similar to the first in the Ionian Sea while evidentiate sub-basin dynamic structures in the Levantine Basin as well as the main jet at middle of the basin. The third EOF mode (6-9% of the total variance) show the summer meridional distribution of the SST filed in the Ionian Basin, while in the Levantine Basin small scale features dominate. In this third EOF mode a large meander appears in the Mersa-Matruh area. The temporal variance EOF mode amplitude functions clearly show seasonality and interannual variability. Seasonality is more evident in modes 1, 3 and 4 while interannual variability clearly appears in mode 2. It is noteworthy that EOF modes interannual variability shows differences from season to season. This is particularly true for the second EOF winter mode. It shows 3 interesting minima in 1983, 1987, 1992 that are all winters that follows a previous El-Nino December. These three minima also correspond to minima in the SST time series, but it is even more interesting to note that they also corresponds to SST fields less rich of sub-basin features and spatial gradients.

MEDITERRANEAN TIDAL CURRENTS : A QUALIFICATION OF CURRENT METERS PERFORMANCES

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Calibrating current sensors in the lab needs sophisticated equipments and a qualified staff. Therefore, nearly all teams use standard calibrations provided by the manufacturer. However, mechanical sensors used on most of the instruments wear from year to year. They can also suffer from damages. Besides, deep measurements in the western Mediterranean Sea have evidenced currents of several tens of cm/s. The occurrence of such large currents at depth overthrows generally accepted ideas. Therefore, an in situ qualification of current measurements is needed. Surprisingly, this is a very easy task which provides an extremely accurate calibration of the sensors.

Tidal currents in the interior of the ocean are mostly barotropic. Therefore, any location is associated with specific values of the amplitude and phase of each tidal component. Harmonic analyses technics have been proved very efficient to compute these values. Nevertheless, in most of the ocean, tidal currents are relatively large. This is especially the case at depth, when they are compared to longer time scale currents as, for instance, those due to the general circulation. Because of the threshold of a mechanical speed sensor, when tidal currents are relatively large, the change in direction they induce will be associated with an overestimated speed value. On the contrary, when tidal currents are relatively low, as in the Mediterranean Sea, they only induce small variations of the speed and direction of the recorded current. In this case, the efficiency of harmonic analysis extends to the utmost.

A lot of mechanical current meters have been moored over the whole western Mediterranean Sea allowing the computation of tidal currents (ALBEROLA *et al.*, 1994). In the interior of the Algerian Basin, relatively long time series have been collected at different depths and locations. This allows a statistical analysis of the amplitude and phase of the M2, S2 and N2 tidal components. It is demonstrated that amplitudes as low as a few mm/s can be accurately computed together with phases which accuracy is a few degrees. This provides a qualification test for current meters and accounts for their generally good performances.

REFERENCES

ALBEROLA C., S. ROUSSEAU, C. MILLOT, M. ASTRALDI, J. FONT, J. GARCIA-LAFUENTE, G.P. GASPARINI, A. VANGRIESHEIM, U. SEND, 1994. Tidal currents in the interior of the western Mediterranean Sea. Submitted to *Oceanol. Acta* for the PRIMO Special Issue.

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