Consiglio Nazionale delle Ricerche

ISMAR - SEZIONE ECOSISTEMI COSTIERI LESINA

COMPARISON OF CLIMATE DATA SETS FOR THE ANALYSIS OF BIOLOGICAL TIME SERIES

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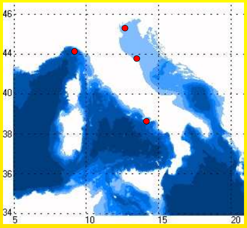
Location of the decadal planktonic series in Italy (the yellow dot shows the series in the Gulf of Trieste)



Bathymetry: courtesy of Andrea Doglioli

INTRODUCTION

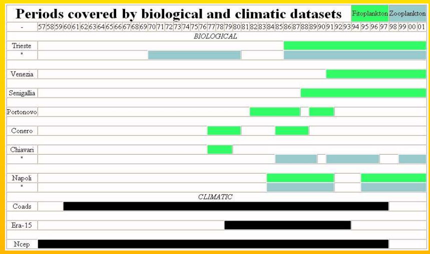
In the last decade, the link between plankton and climate variability has been recognized through several studies in the Atlantic and Pacific Oceans. In the Mediterranean Sea such studies have begun more recently. An important question is which climate data sets and variables should be utilized for this analysis. In the case of the Mediterranean Sea, although connections to the North Atlantic Oscillation and to the monsoon regime have been found, no specific Mediterranean dominant climate modes have been yet identified, thus several climatic variables can be used as proxies for these studies. In this work, which is part of the program SINAPSI, we have approached the problem of the choice of data sets suitable for the analysis of the climate-plankton relationship, reviewing the available climatic data. We have compared the three most complete climate data sets in the Mediterranean: ECMWF and NCEP reanalyses, and COADS (observed data, using the Gridded Data 1x1). We have selected variables (sea level pressure, wind stress, cloud cover, SST) which are: a) either proxies of circulation changes or possibly related to changes in plankton productivity, and b) common to at least two of the three data sets. We have then compared these variables utilizing three different scales: basin, regional and local. The regional (Adriatic Sea) and local (Gulf of Naples and Gulf of Trieste) areas have been chosen around the location of long term (greater than 10 years) planktonic time series in the Italian seas (see map). We have then chosen a dominant species in the Gulf of Trieste, *Acartia clausi,* and have reviewed its interannual variability in comparison to the variability of the climate proxies.

Which climate data sets?

Analysed and Reanalysed DATASETS

(DATA ASSIMILATION PROCESS: combination between model outputs and observed data)

	DATASETS	PERIOD	GRID	FREQUENCY	IMPORTANT FEATURES
ECMWF	Reanalysis ERA-15	1979-1993	1.125° x 1.121°	6 h and monthly	one model; many available variables; centered in Europe
	Operational Analysis	1994-current	Variable	6 h and monthly	different forecast models and many available variables
	Reanalysis ERA-40	1957-1996?	1.125° x 1.121°	6 h and monthly?	not yet available
NCEP	40 year Reanalysis	1958-1998	~1.8° x ~1.9°	6 h and monthly	one model; many available variables; centered in USA
Observed Data collection (only statistics from observed data)					
COADS	Monthly summaries	1960-1997	1° x 1°	only monthly	few available variables; contains missing data



Comparison of climate data sets at different scales: ERA-15, NCEP and COADS, 1979 - 93

Mediterranean Scale

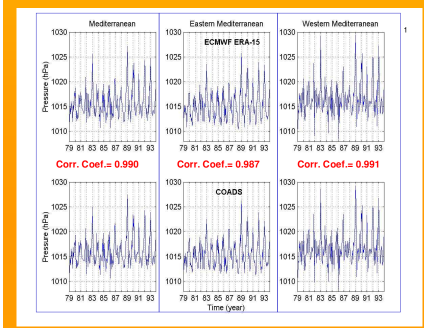


Fig. 1. Monthly mean sea level pressure, ERA-15 and COADS. Both modeled and observed data sets agree quite well at this scale, evidentiating the differences between the two basins, with higher variability in the Western Med. High pressure years were 83 and 89, followed by 90, 92, 93 in both basins, while pressure minima were in 79, 82, 84, 86, 89, in the western Med only.

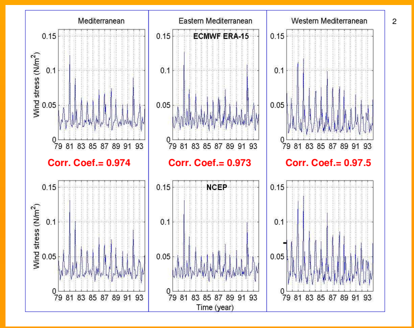


Fig. 2. Surface averaged monthly mean wind stress, ERA-15 and NCEP-40. The data from different assimilation models agree quite well. The seasonal cycle, with winter wind intensification, is stronger in the W. basin. The winter of 81 is characterized by strong winds over the the entire Med, while 82 and 86 winds are mainly present in the western basin and 92 in the eastern basin

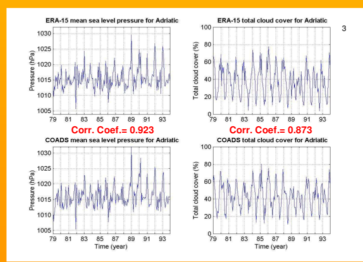
The correspondence between assimilation and observed data sets is very high at the Mediterranean scale, as can be seen by the associated correlation coefficients. The degree of correspondence is related to how the variable field is assimilated in the model: for some variables, such as cloud cover (not shown at Mediterranean scale but shown at regional scale), where the model is not refined enough, patterns and magnitude differ (in particular NCEP underestimates cloud cover with respect to ERA-15 and COADS).

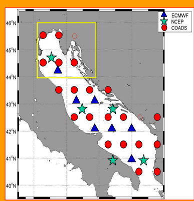
Local Scale – Gulf of Naples and Gulf of Trieste

The two longest plankton time series in Italy are located in the Gulf of Naples and in the Gulf of Trieste. We have thus compared the three climatic data sets at this scale. As the scale becomes smaller, the divergence between the three data sets increases, following the trend seen already in the comparison at regional scale: the NCEP model overestimates wind winter maxima with respect to ERA-15, and underestimates cloud cover with respect to both ERA-15 and COADS. However, the years which are very anomalous (e.g., winter highs in 81, 82, 92 for wind stress, and pressure maxima in 83, 89, 92 and 93) can be seen even at this scale

Regional Scale – Adriatic Sea

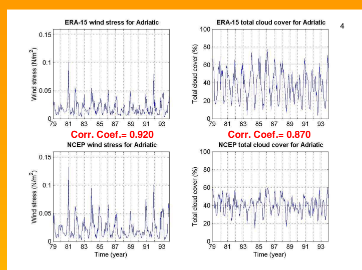
Fig. 3. Monthly mean sea level pressure and total cloud cover, ERA-15 and COADS. The pressure maxima of 83, 89, 92, 93 are visibile at this scale too. The pressure minima of 79, 82 and 86, which were present in the western Med (NOT in the eastern) are also present here





Location of COADS, ERA-15 and NCEP-40 points for the Adriatic Sea region. In the yellow square are shown the COADS points chosen for the Gulf of Trieste

Fig. 4. Surface averaged monthly mean wind stress and total cloud cover, ERA-15 and NCEP-40. The NCEP model overestimates wind seasonal variability and maxima with respect to ERA-15 (or viceversa). The two stronger winters, 81 (for the entire Med) and 92 (in the eastern basin), are in any case seen by both models.



The NCEP model underestimates cloud cover with respect to observed COADS or ECMWF model data. The latter two data sets, although not very similar (years of minima and maxima often do not correspond) still show the same overall interannual patterns.

At the regional scale the differences between the three data sets are larger than at the basin scale. The disagreement is function of the variable chosen: reduced for a 'robust' variable, such as sea level pressure, and very large for cloud cover.

Zooplankton in the Gulf of Trieste

The longest zooplanktonic time series in Italy is located in the Gulf of Trieste. This is an area of high permanent production in the Mediterranean, and is characterized by shallow depth and large river runoff, especially through the Isonzo river. Zooplankton sampling (vertical hauls, 200 μm mesh) started in 1970 with monthly frequency and is still ongoing, but was interrupted in the years 1981-85. In here we show the standardized anomalies of the dominant mesozooplankton species (*Acartia* clausi) and of sea level pressure. The COAD data set (see point locations in the map of the Adriatic above) was chosen because: a) it is longer than the plankton series (as opposed to ERA-15), although it ends earlier (in 1997); b) it contains data for the northern part of the North Adriatic (as opposed to ERA-15 and NCEP).

The coastal copepod *Acartia Clausi* is the dominant species in the Gulf of Trieste, where is found year round. In late spring (Apr-June) its contribution can be 80% of the mesozooplankton biomass

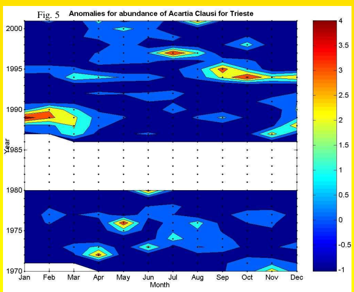


Fig. 5. *Acartia Clausi* generally reaches its maximum in the period Apr-June. In some years there is a secondary peak around November. The plot above shows anomalous months (measured in st. dev.) with respect to the annual cycle. During the years 88-90 the major peak was anticipated to Jan-Feb (no spring peak at all). In the Fall 94 and 95, and in the summer 97, Acartia abundance was greater than usual (but the late spring peak was present)

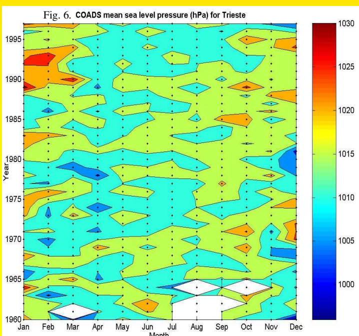


Fig. 6. The pressure maxima in the years 83, 89-94 and the minima in the years 79-80, already seen at basin scale, are present also over a smaller area

Preliminary cross-correlation analyses between the climatic variables of the COADS data set (sea level pressure, wind speed and pseudostress, SST) for the Gulf of Trieste and for the Adriatic region with *Acartia Clausi* abundance indicate no correlation. This can be due to several reasons related to the sample size and structure (besides the obvious possibility of no correlation between populations). A more detailed study on the sample of Acartia (e.g., evaluation of the length of the series in relations to its variance, evaluation of effect of the data gap on the analysis, etc.) needs to be done.

ACKNOWLEDGMENTS:

This work has been partially supported by the Italian program SINAPSI (Seasonal, INterannual and decAdal variability of the atmosPhere, oceanS and related marIne ecosystems)/Ecosistemi Marini. We are thankful to G. Carapella, A. Specchiulli, F. Fiesoletti for their help.

CONCLUSIONS

The choice of the climate data set for the study of biological variability cannot be univocal at this time, but must be made taking into account different issues:

- scale of the processes that one is planning to study
- temporal coverage of the different data sets
- temporal frequency of the data
- spatial coverage of the data
- quality of prediction of the selected variables by the different models

These preliminary analyses show that there is agreement between the three data sets – modeled and observed – according to the quality of the assimilation model for each variable. The level of agreement between data sets decreases, as expected, as the area on which the data are averaged decreases, but major features (anomalous years, interannual patterns) are usually retained. When the ERA-40 data set will be available (shortly), most questions could be answered using that data set.

The evaluation of climate indicators (such as the NAO or the Mediterranean Pressure Index by Raicich et al) for the evaluation of the effects of climate on plankton variability needs still to be done.

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