

## ***Interactive comment on “Long term trends in the sea surface temperature of the Black Sea” by G. I. Shapiro et al.***

**G. I. Shapiro et al.**

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On behalf of all co-authors:

Dear Editor and Reviewers,

We are grateful to the referees for the valuable comments and suggestions to our manuscript “Long term trends in the sea surface temperature of the Black Sea”. In response to the referees’ comments we have made the following amendments

Referee 1. We have corrected the phrase on p.98 as advised by the referee as follows replaced ‘each of the  $12 \times 90 = 1080$  months’

with ‘each of the  $12(\text{months}) \times 90(\text{years}) = 1080$  months’

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Referee 2.

A. The referee points out to a number of additional publications where various aspects of changes in the SST in the Black Sea have been discussed. Most of them are covering a much shorter period (e.g. 1980-2004) than in our manuscript; others are restricted to a specific area. We have extended the introductory and discussion sections of the manuscript to include the most recent/relevant publications suggested by the referee. We have also added comparison of our results with suggested literature where possible (second half/quarter of the century).

### **1 Introduction**

P.93, Line 8 onwards: replaced ‘ In the Black Sea.... the deep sea regions ‘  
with

‘In the Black Sea, studies of inter-annual variability of the physical properties are commonly restricted in their time coverage to the last 20 to 50 years, see e.g. (Kazmin et al., 2009 and references therein). Polonsky and Lovenkova (2004) gave a detailed analysis of SST variability and their possible causes over the period of 1960-1990, however their study was limited to a single transect across the Black Sea. Potential causes of temperature changes and their link with North Atlantic Oscillations were also discussed by Oguz (2005) and by Kazmin et al. (2009). Studies covering longer periods are mostly concerned with changes in the sea as a whole and are based on the analysis of the monthly/yearly mean Sea Surface Temperature (SST) derived from  $1^\circ \times 1^\circ$  gridded data sets (see Oguz, 2005 and references therein), which in turn were obtained by optimal interpolation from  $4^\circ \times 4^\circ$  or  $2^\circ \times 2^\circ$  gridded observations (Rayner et al., 2003 and Stephens et al., 2002). With the exception of recent years when the satellite data become available (see e.g. Ginzburg et al., 2004; Macquatters-Gollop et al., 2008) , historical data sets contain insufficient data to produce charts of monthly SST

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distributions with resolution adequate to separate the shelf and the deep sea regions.'

## 2 Discussion

Page 105, line 7:

added after '... and the deep sea.'

Comparison of presented results with other studies conducted for the second half/last quarter of the 20s century shows both general and quantitative agreement. The cooling trend of Sea Surface Temperature was noticed on a repeated transect taken within a 30-year period (1960-1990) in the western deep Black Sea (Polonsky and Lovenkova, 2004) in agreement with our results showing a cooling phase between 1968 and 1986 after a nearly decade of a warming trend (1960-1968). The warming trend which according to our CUSUM analysis started in the 1990s is in agreement with analysis based on satellite imagery (Ginzburg et al., 2004).

Added references

Ginzburg, A. I., Kostianoy, A. G., Sheremet, N. A.: Seasonal and interannual variability of the Black Sea surface temperature as revealed from satellite data (1982-2000), *J. Mar. Systems*. 52, 33 – 50, 2004.

Kazmin, A. S., Zatsepin, A. G. and Kontoyiannis, H.: Comparative analysis of the long-term variability of winter surface temperature in the Black and Aegean Seas during 1982-2004 associated with the large-scale atmospheric forcing, *Int. J. of Climatol.*, DOI: 10.1002/joc.1985, 2009.

Polonsky, A. B. and Lovenkova E. A.: Temperature and salinity trends in the active layer of the Black Sea in the second half of the 20th century and their possible causes, *Izv. RAN, Fizika atmosfery i okeana*, 40(6), 832–841, 2004.

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B. Suggested analysis of SST trends for individual months for the whole 20s century would carry low statistical significance due to the limited amount of data before 1940, particularly during the stormy winter months. Such analysis can be performed for the 2nd part/end of the century, however such analysis is out of scope of this manuscript and it will be the subject of a separate paper.

With authors' best regards,

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Interactive comment on *Ocean Sci. Discuss.*, 7, 91, 2010.