Long Term Sea Level Changes in the Black Sea

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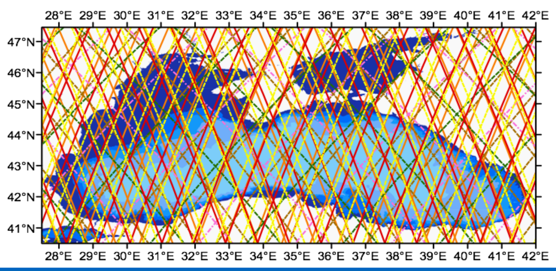
Introduction

Sea level change is an important scientific topic, closely linked to studies of climate change, solid Earth processes and geodetic science. The long term sea level change analysis requires time series of sea level heights over several years. Tide gauge records provide sea level variations relative to the land. In the Black Sea the tide gauge stations on the Northern part have relatively longer records, compared to the southern costs. The data sampling frequency is increased in the recent decades. Satellite altimeter is a remote sensing sensor providing an integrated picture of the oceans over large spatial and temporal extents. It is recognised as the main tool for precisely and continuously monitoring the sea surface height (SSH) with quasi-global coverage and short revisit time.

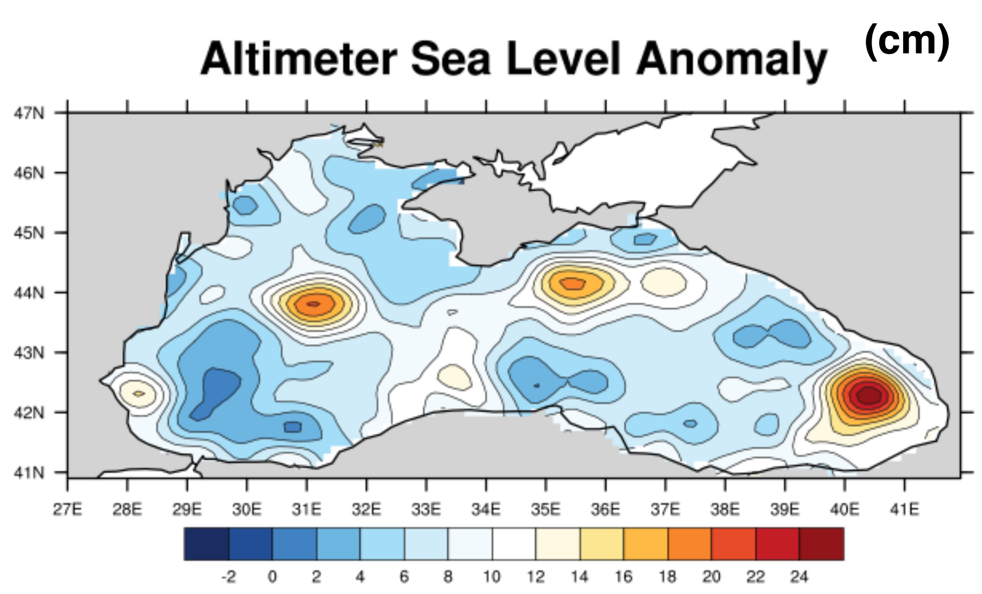
This study provides estimates of long-term sea level change as observed by the three stations the Turkish National Tide Gauge Network (TUDES) and satellite altimeter. The mean satellite altimeter Sea Level Anomaly (SLA) in the Black Sea during 1993-2015 is analysed and compared with tide gauge SLA.

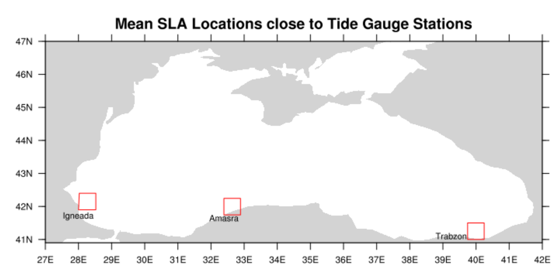
Data and Methodology

The along-track Sea Level Anomaly (SLA) data were obtained from the AVISO web page (http://www.aviso. oceanobs.com/duacs). Ssalto/Duacs multi mission altimeter product on a regular grid of 1/8^{o}x1/8^o used in this study. This product used is MSLA "all-sat-merged" is the mean of available for satellites in given time(TOPEX/Poseidon (T/P), ERS-2,GFO, JASON-1&2, ENVISAT, CROSAT, HY-2, SARAL). The Monomission Envisat product was obtained from the same web page. The time periods and repeat cycle of each satellite mission are summarised in Table 1. The tracks of each satellite are given in the figure.



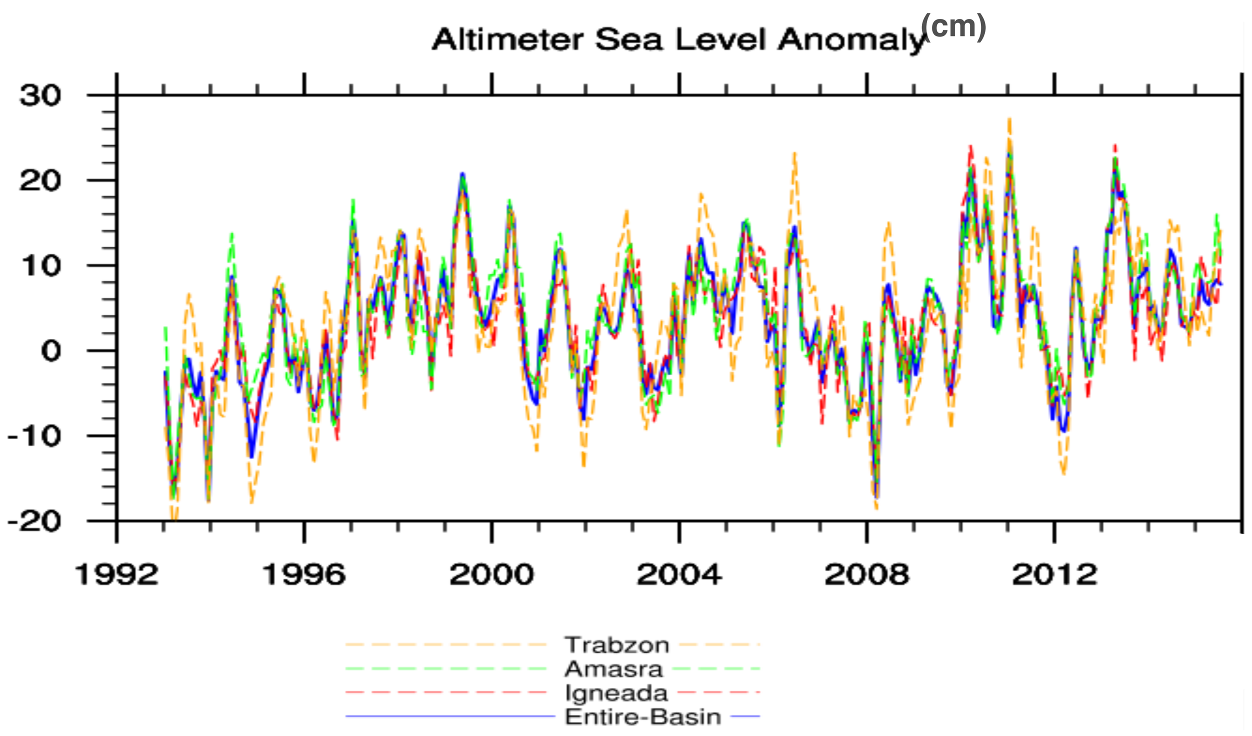
Black Sea Mean (1993-2015) Altimeter and Comparisons of Site locations



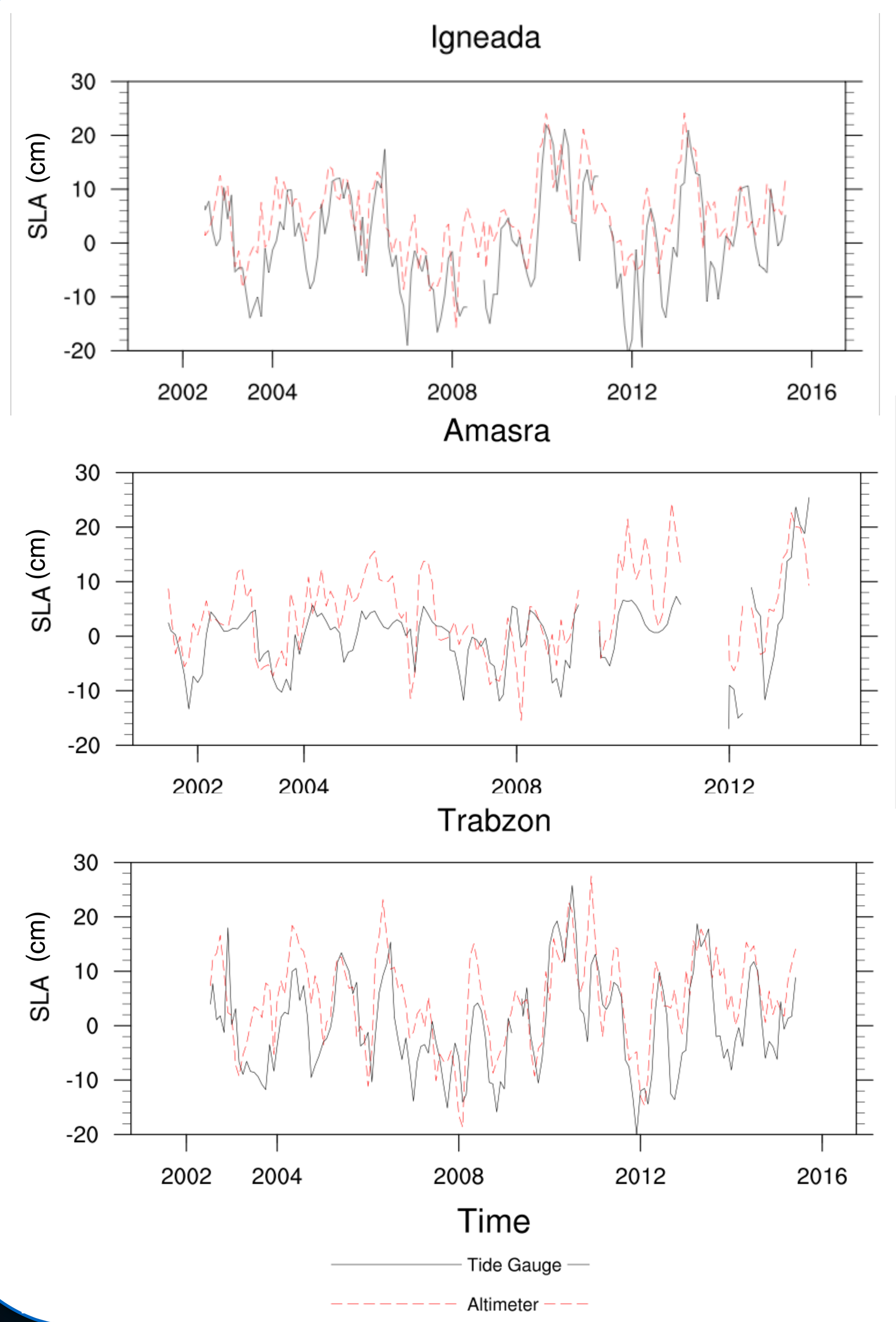


Evaluation of the spatial distributions of SLA shows maximum sea level variability in western and eastern gyres. The highest variability is seen southern east gyre in the Black Sea. Satellite SLA close to tide gauge locations are identified by considering 0.5^{o}x0.5^o rectangular area mean. Then the entire basin satellite SLA averages in monthly interval are compared with the monthly mean satellite SLA at the selected locations. While the stations located in the western part (Igneada and Amasra) correlates well with the basin average, Trabzon station on the east diverges from the basin mean SLA.

The inter-annual variability in the black sea is mainly between -10 and 15. SLA switches to negative in the periods 1993-1997, in some winter periods (2001,2002,2006 and 2012). The teleconnection patterns may explain this cases.



Altimeter and Tide Gauge SLA Comparisons



For the comparison of satellite altimeter SLA with the tide gauge SLA, the mean SLA close to the tide gauge locations calculated in selected rectangular areas. Then the monthly means of the both data sources are calculated.

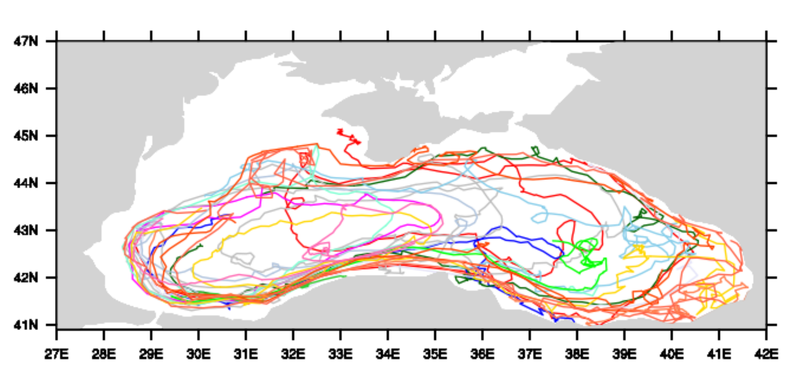
The results shows that the satellite SLA and tide gauge SLA agree in Igneada most of the periods except some short periods of time. The agreement at Amara and Trabzon is also quite convincing.

The difference between the satellite SLA and the tide gauge is calculated for each location. The average discrepancy for the Igneada is 6.5cm, 6.0cm for Amasra and 6.8cm for Trabzon the corresponding standard deviations are 4.9, 4.5 and 4.7.

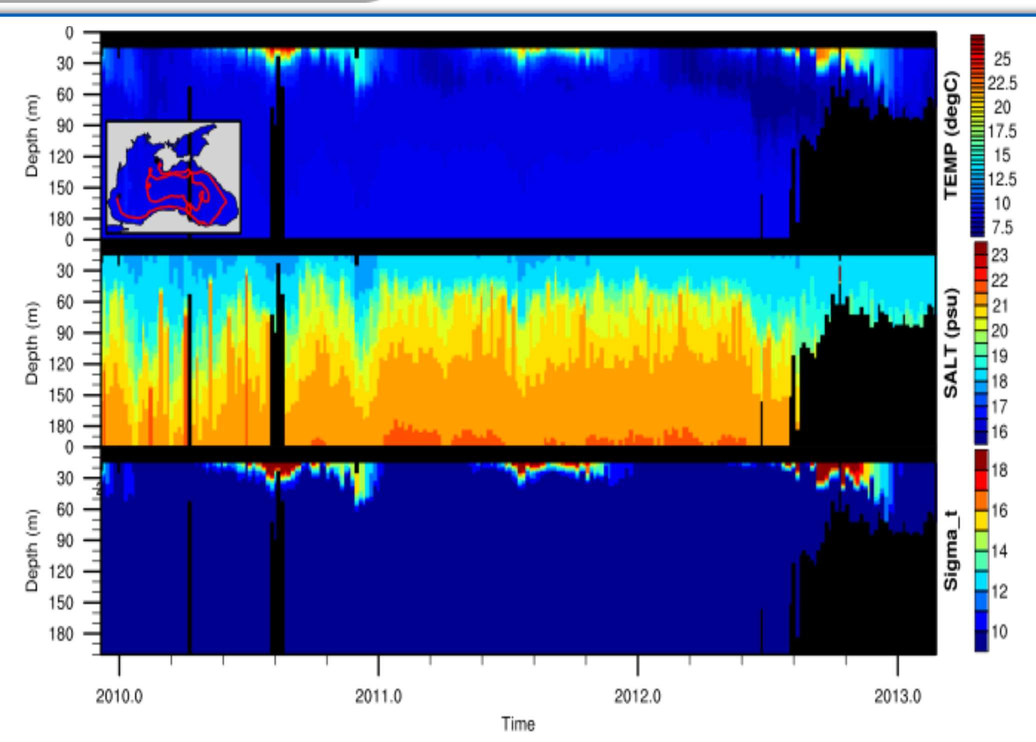
Summary

- The monthly mean distributions of the SLA during 1993-2015 corresponding to each station site locations are similar, but the magnitude of the sea level changes are different. While Igneada and Amasra close to the basin mean magnitudes, Trabzon does not.
- The compatible SLA results from both satellite altimetry and the tide gauge measurements, confirms the reliability of the satellite altimetry in this coastal regions. However discrepancy in terms of magnitude requires further study. As specially, the compatibility at the Trabzon station is important although the large difference from basin mean.

Further Study for DHA by using ARGO Data



The dynamic height anomaly is going to be calculated by using argo data. The irregular space distribution and time considerations are going to be challenging aspects of this study.



Acknowledgments

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The Tide gauge data were obtained from General Command of Mapping - Turkish National Sea Level Monitoring System (TUDES)