Analysis of in-situ temperature and salinity data in the Levantine Sea

Cem Serimozu, Middle East Technical University Institute of Marine Sciences (Turkey),
cem.serimozu@metu.edu.tr

The Levantine Sea (LS), part of the Eastern Mediterranean exposed to rising anthropogenic pressure, and four of its sub-regions: Cilician (CB) and Levantine Basins (LB), Coastal Nile Delta (CND) and Rhodes Gyre (RG) is the focus of this study. On account of the relative scarcity of scientific studies of these regions, the aim is to contribute to the investigation of Sea Water Temperature and Salinity, two critical oceanographic parameters in the context of climate change and to explore the statistical distribution of data for modelling purposes. This work uses the "Mediterranean Sea - Temperature and Salinity Historical Data Collection SeaDataCloud V1" (https://sextant.ifremer.fr/record/2698a37e-c78b-4f78-be0b-ec536c4cb4b3/) aggregated dataset for a descriptive analysis at multiple depth layers and showcases that missing data can be replaced using approximations obtained through chained equation method and gives an overview of the water column in the LS.

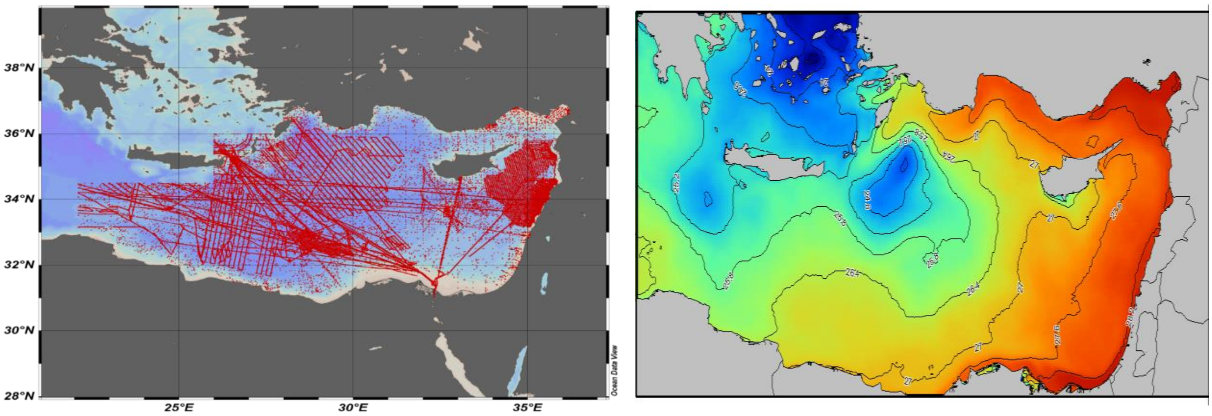

Figure 1: Map of the region showing: Spatial distribution of the data (Left); Isothermal sea surface temperature map in September using WOA18 (Right).

The investigation is on the in-situ data available in LS between 1960 and 2017, for a total number of 81,317 stations and 10,590,891 individual entries. Boundaries of the sub-regions are delimited with climatological maps for SWT and SWS obtained in Ocean Data View (ODV, https://odv.awi.de/) with Data-Interpolating Variational Analysis (DIVA) and supported by isothermal sea surface temperature maps employing World Ocean Atlas 2018 (WOA18, https://www.nodc.noaa.gov/OC5/woa18/) data (Fig. 1). Cluster analysis is applied to identify the existence of distinct regional properties. Missing observations are replaced with approximations computed from chained equations to increase the robustness of the analysis. The descriptive study is conducted for monthly, seasonal and yearly values for both SWT and SWS at the following depth ranges: Surface (0-10m), 25m, 50m, 100m, 200m, 500m, 1000m and 2000m.

The distribution of data shows a significant change in data collection capacity and ratio of absent measurements (Fig. 2). Testing reveals that replacing missing values does not make a significant change in the resulting plots, even in the case of SWS with 27% missing values beside less yearly gaps in sub-regions, presenting an avenue to improve modelling in the area. Comparing the monthly mean SWT and SWS values prior and post 1980 it is discernible that average values are higher in the later period, sometimes as much as 5°C difference in summer maxima SWT in August/September at the surface layer.

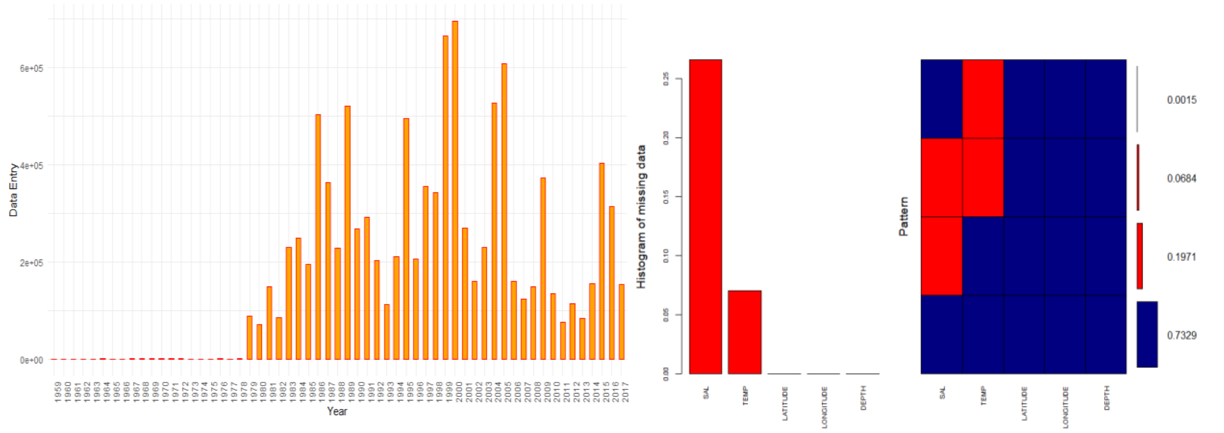

Figure 2: Histogram of data and missing entries per year showing: Increase in data collection capacity in the region after 1980 (Left); 27% SWT and 7% SWS of all entries are absent (Center); Percentage of both SWT and SWS missing entries is 6.8% (Right).

For example, Fig. 3 demonstrates a slow but steady increase in SWS and SWT in LB for the summer months in the surface waters, a process that is mirrored in the area with different degrees of significance per sub-regions. Anomalous events are more prevalent with higher SWT values than the seasonal average, especially in surface to 100m range interacting with the atmosphere.

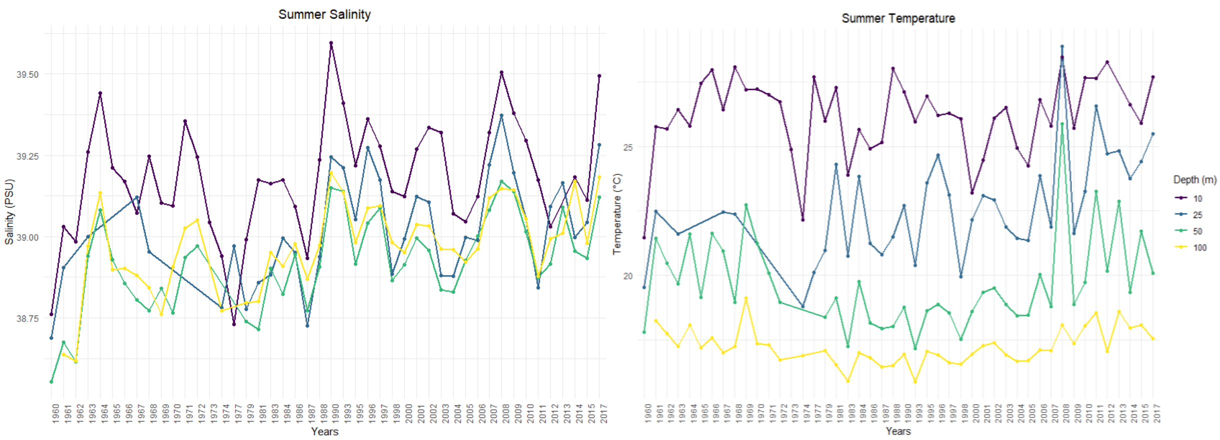

Figure 3: Annual summer mean values in the LB for: Salinity (Left) and Temperature (Right)

The most studied region in the LS is LB, followed by RG. Meanwhile, the least explored areas are the CB and CND. The CB and LB show consistently higher SWT, especially at the surface layers with substantial seasonal variability and overall higher SWS compared to LS. On the other hand, the RG in almost all seasons is considerably colder than LS as a result of the upwelling on the Eastern Mediterranean Deep Waters (EMDW). The study of the data also demonstrates an apparent lack of information in the broader LS contrasting with the rest of the Mediterranean Sea, especially the Western Mediterranean.

SWT normalises between the 200m and 500m layers for all sub-regions and no longer shows any seasonality corresponding with the Levantine Intermediate Water. The distribution pattern of the data for SWT and SWS obtained through density plots is bimodal corresponding to atmospheric temperature differences at the surface before taking a mounded appearance around 200m to 500m indicating the homogeneity of the Levantine Intermediate Water. An interesting find is that SWS becomes bimodal at the 2000m layer which might potentially indicate two slightly different water masses with different SWS properties instead of the traditionally accepted more homogenous distribution of the EMDW in the literature.