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

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INTRODUCTION

This study aims to investigate statistically two critical physical parameters, Sea Water Temperature (SWT) and Salinity (SWS) in the Levantine Sea (LS), the formation area of the Levantine Intermediate Water (LIW), with a focus on its sub-regions (Fig.1): Cilician (CB) and Levantine Basin (LB), Coastal Nile Delta (CND) and Rhodes Gyre (RG). This work uses the SeaDataCloud V1 [1] aggregated dataset containing 81,317 stations and 10,590,891 individual entries (Tbl.1) of multiple depth layers in the LS. Sub-regions are delimited based on maps for SWT and SWS produced in Ocean Data View (ODV) (Fig.2) [2] with Data-Interpolating Variational Analysis (DIVA), climatological sea surface temperature maps from World Ocean Atlas (WOA18) (Fig.3) [3] and Cluster analysis using Clustering Large Application (CLARA) algorithm [4]. Furthermore, the chained equation method was used to fill the gaps in the raw data when one of the two parameters was absent at a station.

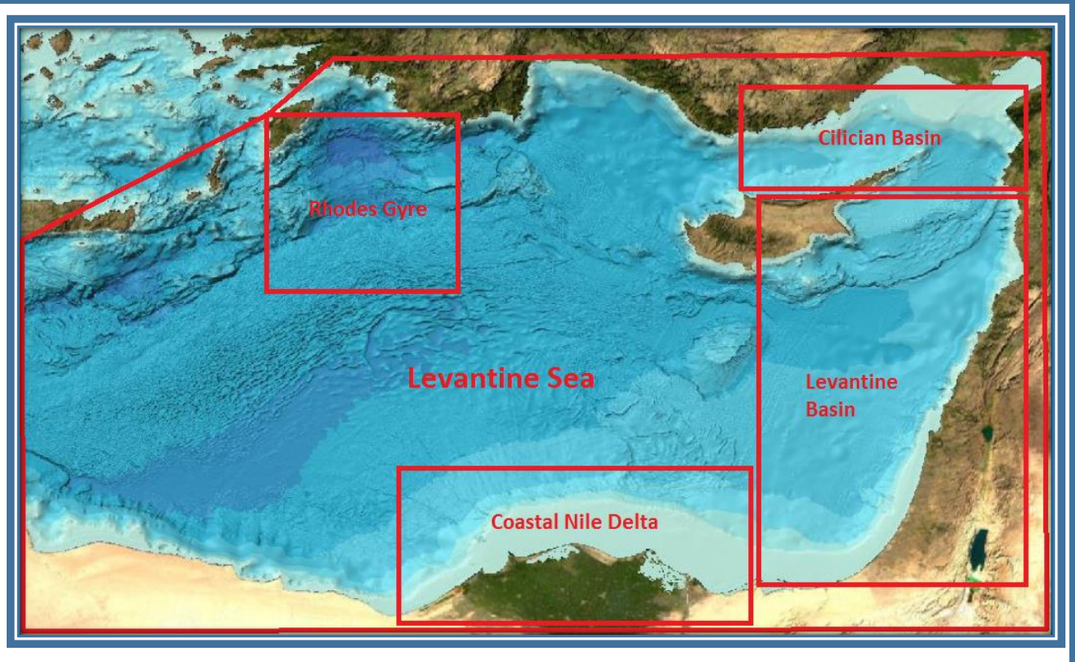
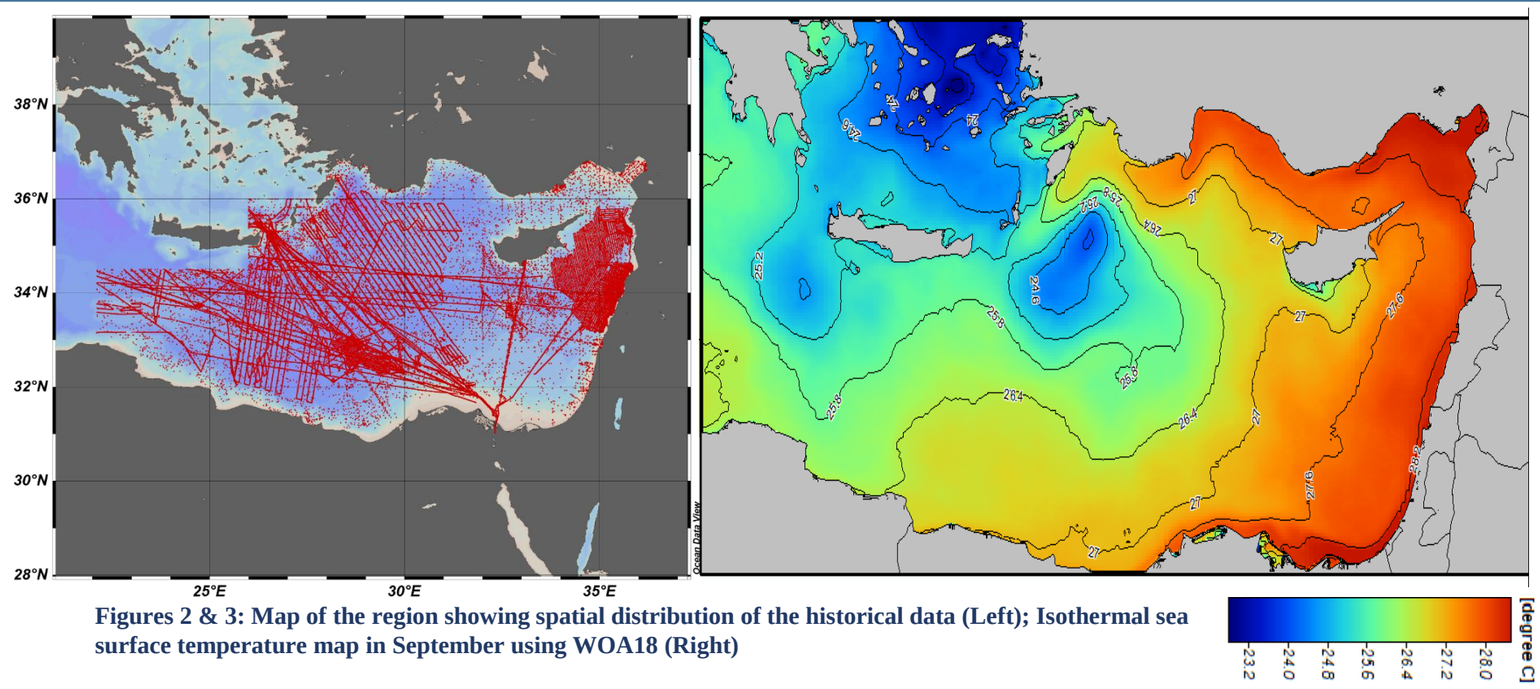


Figure 1: Boundaries of the LS and sub-regions

Region	LS	CB	LB	CND	RG
Stations	81,317	2,690	25,925	9,556	8,401
Data Entries	10,590,891	481,592	2,679,179	787,890	1,686,260

Table 1: Regional Station and Data Entry Numbers in the LS between 1960-2017



Figures 2 & 3: Map of the region showing spatial distribution of the historical data (Left); Isothermal sea surface temperature map in September using WOA18 (Right)

RESULTS

There is a significant change in data availability post-1979 and in the parameter absence ratio (Fig.4-5). The LS's most studied region is LB, followed by RG, while the least explored areas are the CB and CND (Tbl.1). Yearly plots have clear positive trends for SWT and SWS in the LS at the surface and intermediate waters for all sub-regions with a noticeable signature through the LIW (Fig.5-6), particularly in the CB. The data density plots for SWT and SWS are bimodal at the surface in accordance to seasonal atmospheric temperature differences (Fig.7) before taking a mounded appearance around 200m to 500m in the LIW interval (Fig.8). SWS becomes bimodal at 2000m (Fig.9), in the Eastern Mediterranean Deep Water (EMDW) layer.

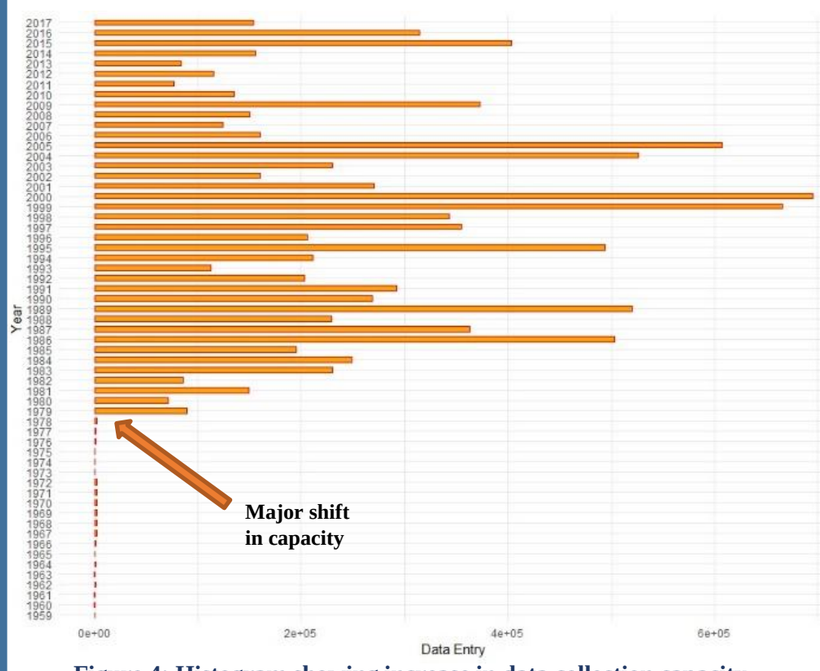


Figure 4: Histogram showing increase in data collection capacity in the region after 1979

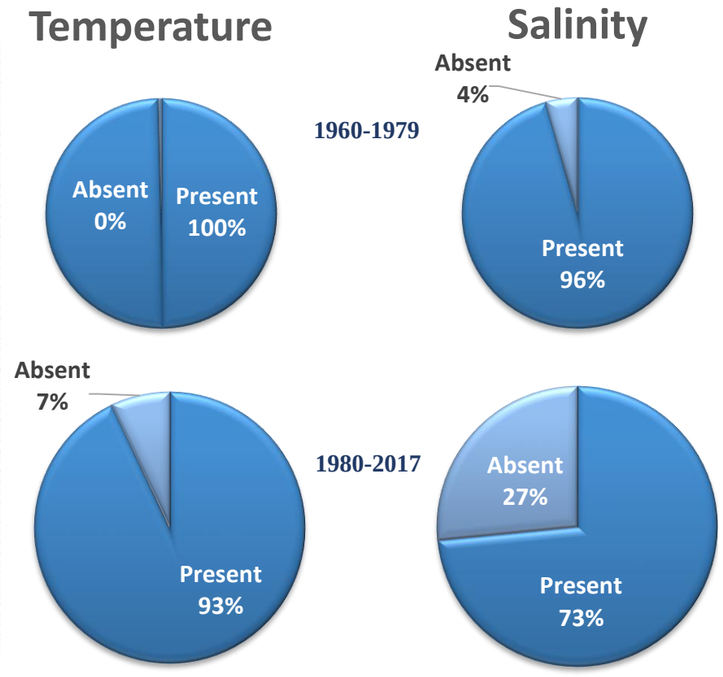
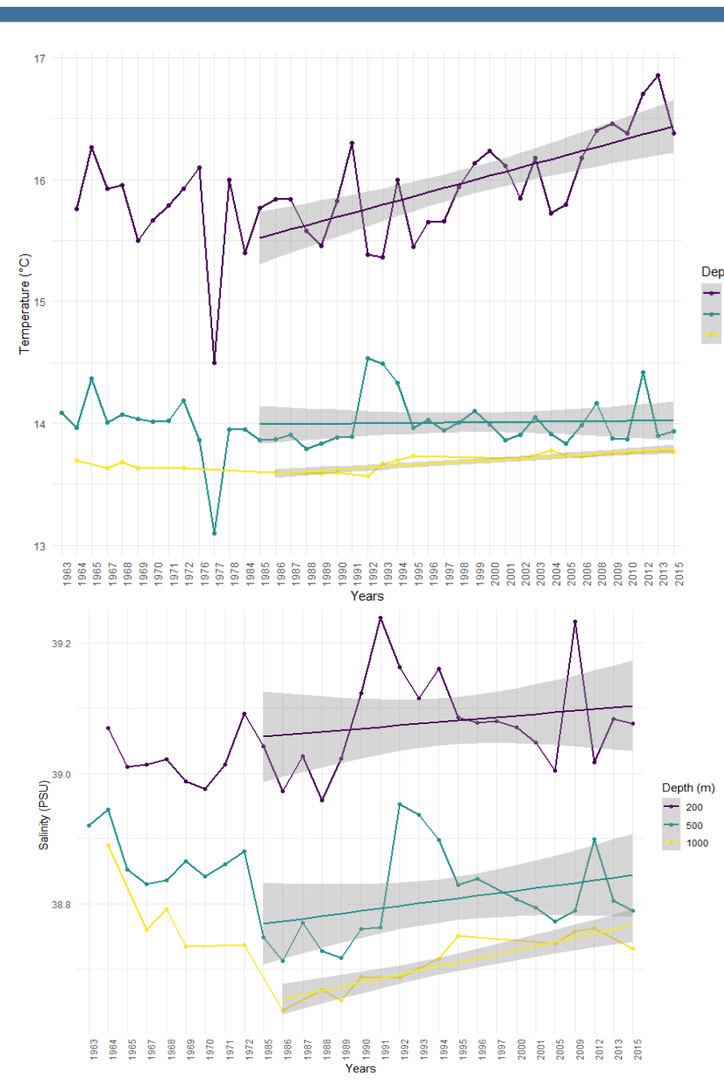


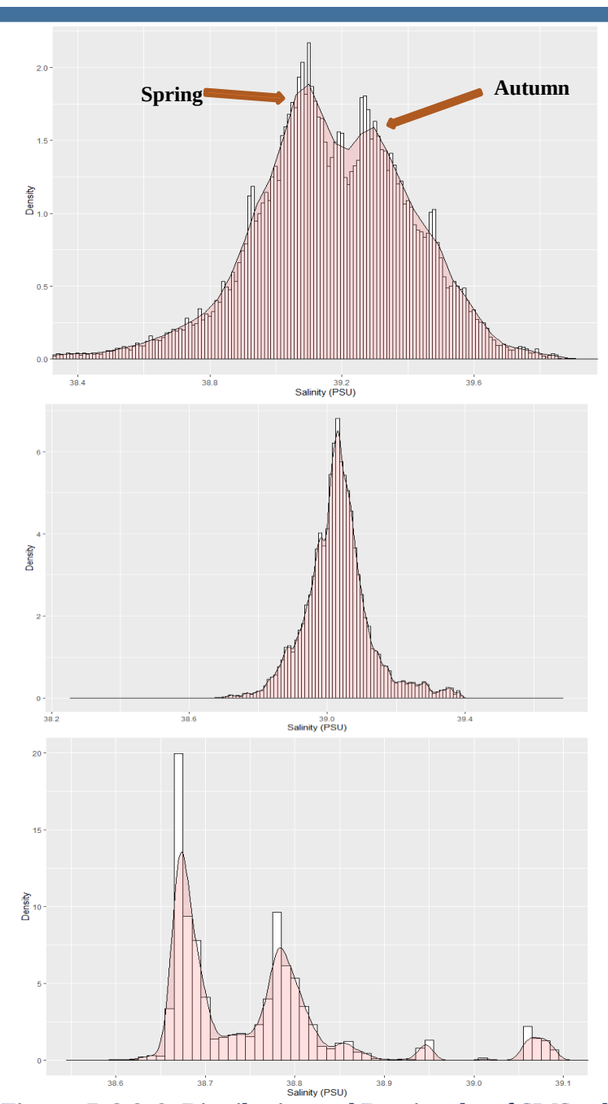
Figure 5: Percentage of absent and present entries of SWT and SWS

CONCLUSIONS

Existing historical data is a precious resource to upcycle for creating new information, while the chained equation method is proven effective in substituting absent values in physical marine datasets even without disturbing patterns and affecting the results. SWT and SWS show a positive trend in the region after 1985 with different magnitudes across the study period. The easternmost areas such as CB and LB have more significant positive trends compared to the whole LS. LIW properties tend to be consistent throughout the LS, although positive changes to the SWT and SWS values in the intermediate layer are perceptible. Density plots of SWS potentially indicate two slightly different water masses displaying different SWS properties instead of the traditionally accepted homogenous distribution of the EMDW in the oceanographic literature.



Figures 5 & 6: SWT (Top) and SWS (Bottom) weighted average plots for the CB 1963-2015 between 200m-1000m



Figures 7, 8 & 9: Distribution and Density plot of SWS values at: 10m (Top); 200m - LIW (Centre) ; 2000m - EMDW(Bottom)

REFERENCES

[1] Mediterranean Sea - Temperature and Salinity Historical Data Collection SeaDataCloud V1 https://sextant.ifremer.fr/record/2698a37e-c78b-4f78-be0b-ec536c4cb4b3/ (Last Accessed 04/03/2021)

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[4] Rousseeuw, P. J., & Kaufman, L. (1990). Finding groups in data. *Hoboken: Wiley Online Library*. DOI: 10.1002/9780470316801