Black Sea
Temperature and Salinity climatologies computed with DIVAnd tool

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General description

The Black Sea (including Sea of Azov) Temperature (T) and Salinity (S) gridded climatologies for the period 1955 – 2017 were created in the framework of the SeaDataCloud (SDC) project. Computing was performed with DIVAnd (Data-Interpolating Variational Analysis - n-dimensional) (Barth et al., 2014) on the following grid: geographical extent 27.5 - 41.875°E, 40.875 - 47.25°N; horizontal resolution: 1/8°; vertical resolution: 67 depth levels from 0 to 2000 m - same as in World Ocean Atlas (WOA, 2018).

The respective data product SDC_BLS_CLIM_TS_V1 (https://doi.org/10.12770/ad2d0efc-7191-4949-8092-796397106290) is published at the SeaDataNet web site along with the Product Information Document (https://doi.org/10.13155/61812). The product contains:

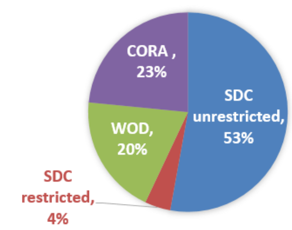
- monthly T and S fields for the periods 1955 – 2017, 1955 – 1994, and 1995 – 2017;
- seasonal fields for 6 decades starting from 1955 and for the same 3 periods as monthly.

Observational data

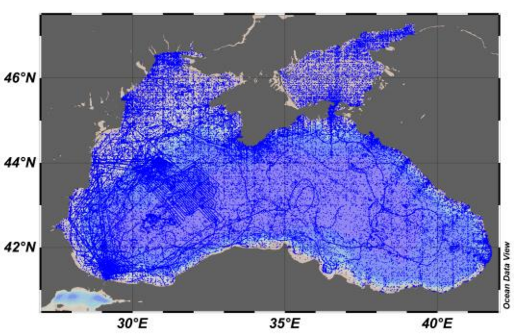
The input dataset for the computation of the Black Sea T and S climatological fields was integrated from two internal SDC datasets and two external datasets:

1. SeaDataCloud Temperature and Salinity Historical Data Collection for the Black Sea V2 (Myroshnychenko et al., 2018).
2. SDC Restricted Temperature and Salinity Historical Data Collection for the Black Sea.
3. Data extracted from the World Ocean Database – WOD (Boyer et al., 2018).
4. Data extracted from the COriolis Ocean Dataset for Reanalysis - CORA 5.1 (Szekely et al., 2016).

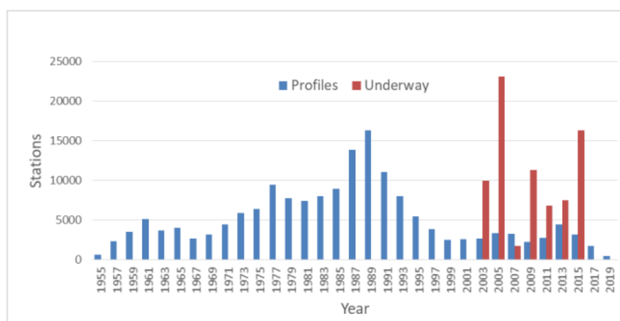
The quality controlled (QC-ed) SDC datasets were taken as primary. Data integration was performed through the following steps: identifying and excluding internal duplicates; identifying and excluding overlapping data; applying QC to non-overlapping data from external datasets; merging non-overlapping data; excluding climatically non-relevant data.



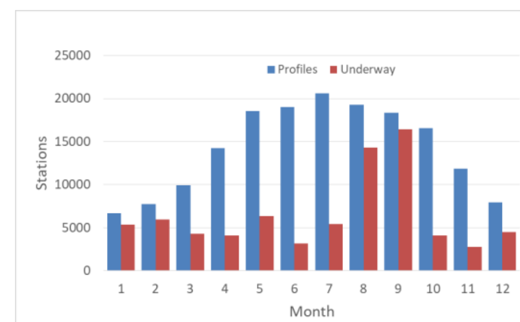
Content of the integrated dataset, total 246825 stations



Spatial distribution of observations



Temporal distribution of observations



Monthly distribution of observations

Methodology

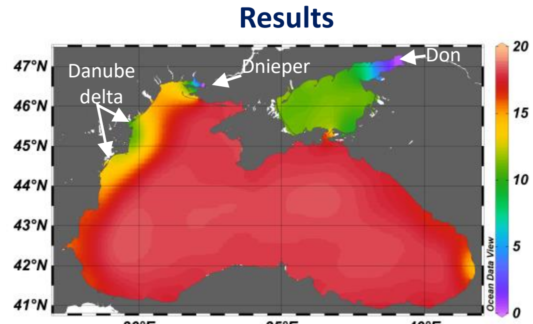
Computation was done with **DIVAnd tool** implemented in the Julia programming language with a Jupyter notebook interface. DIVAnd allows the interpolation of observations onto orthogonal grids in an arbitrary high dimensional space by minimizing a cost function. The fields produced with DIVAnd are the results of 3D (or 4D if time is considered) interpolation and this is the innovation and also the main difference of SDC T-S climatologies from similar products (e.g. WOA), where 3D fields are combined from 2D slices.

Prior calculations the underway data were heavily subsampled to eliminate their "trajectory" effect. In the first iteration, the residuals obtained with DIVAnd for global (1955 – 2017) monthly fields were analysed against 3-Sigma criteria, the outliers were discarded, and the second iteration was run to obtain the final fields.

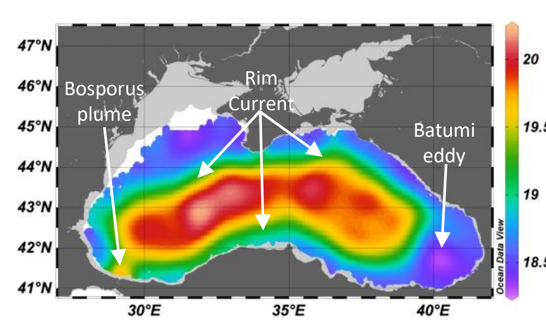
DIVAnd parameter	T	S
Horizontal correlation length (km)	150	150
Vertical correlation length [m]	depth dependent for 67 levels	
epsilon2	0.3	0.1
epsilon2 adjustment	With weights of the observations	

Results

The Black Sea T and S climatological fields well represent Black Sea oceanographic and circulation features (Oguz et al., 1993) as well as their seasonal variability. For example, the inflow of rivers fresh water and its propagation is well visible in the surface salinity field all over the year but mostly in spring months, while the Black Sea Rim Current, Batumi eddy, Bosporus plume are more pronounced in 70-130m layer.



Surface Salinity in May (DIVAnd analysis for 1955-2017)



Salinity at 70m in July (DIVAnd analysis for 1955-2017)

A consistency analysis was performed against WOA18 climatological fields (objectively analysed means) available at a 1/4° resolution. Most of the differences between the two products are observed in the upper 300 m layer. The WOA18 maps are smoother and do not capture some important Black Sea features (e.g. Batumi eddy, Bosporus plume), while SDC maps, even noisy, better represent the Black Sea thermohaline circulation.

Conclusions

The SDC Black Sea Temperature and Salinity climatologies are computed from the most complete dataset combining in-situ data from the tree major data sources – SeaDataNet, WOD, and CORA. Performing real 3-d interpolation with DIVAnd allowed us to obtain realistic climatological fields.

Despite overall good quality of the climatological fields there are known issues such as: anomalies in some decadal fields – mainly due to scarcity of data; anomalies in upper layer (DIVAnd issue that later was resolved in new version of the software); violation of vertical stability in some T-S profiles that are combined from separately calculated fields.

References

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