WEB GIS tools to visualize sea currents data

Elena Zhuk,
Marine Hydrophysical Institute, Russian Academy of Science, Russia

ABSTRACT

The work is dedicated to the development of web GIS tools that provide storage, data access, and visualization of current data. The system was developed using free-access ARGO data from the ARGO portal [1,2] but any other similar data (for example, drifters' data) can be used.
To store data, the Postgresql DBMS was chosen. The database was designed to archive metadata and data separately. The database consists of a metadata table (trajectories) that has key fields connected to the measurement data table (profiles). The tables were automatically filled up by specially developed Python software. Standard Argo files do not have drift information. To calculate it and fill it into the database table, a Python script was developed.
The user interface (UI) was realized using jQuery and MapboxGL as a map service. The UI allows to select the ARGO float trajectories using the ARGO ID from the available relevant list. The trajectory can be displayed as vectors that show the drift's direction and speed, or as points that match observation cycles.
In addition to trajectories, observations points, and profiles plots for every measurement parameter, the user interface (UI) enables the visualization of drift velocity, drift rise, and drift information metadata.
The following criteria can be used to make the queries:
- Selecting an Argo ID.
-Selecting by rectangular area from all of the Argo drift data.
- Selecting based on date intervals, drift depth and combination of these filters
Further, the system will be adapted to archive and visualize current ADCP measurements.

Keywords: GIS, Black Sea, oceanographic database, Postgresql, jQuery, Argo, mapbox gl

1. INTRODUCTIONS

Since 2005, Argo floats have become an important source of observations in the World Ocean and, of course, in the Black Sea. Also, they can be used as Lagrange markers to estimate current speed. [3,4,5] Argo velocity data is only available in netCDF format for all floats on the Argo portal [6] Compared to an online data access and visualization solution, it is less convenient. Therefore, creating a system that allows for data access and current speed visualization is a very real task.

2. METHOD AND TECHNIQUES

The system was developed based on a client-server architecture. jQuery [7] was used to create the user interface, and Plotly was employed to plot profiles and current rose. The Mapbox GL [8] library provides map service functions. The server part includes a currents database and PHP modules that provide data exchange in JSON format.
The Postgresql DBMS [9] was selected to store data. Data and metadata were intended to be kept apart in the database design. The database consists of a metadata table (trajectories) that is connected to the measurement data table (profiles). (Figure 1, Figure 2) The trajectory tables include the Argo profile ID, cycle number, coordinate fields, the depth of the drift for almost each cycle, and velocity information (speed and direction). Drift information is absent from standard Argo files. A Python script was developed in order to calculate it and insert it into the database table.

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The measurement data table includes the argo platform ID, cycle number, which corresponds to the same trajectories' table fields, and observed parameters such as pressure, temperature, and salinity. Additionally, some floats have measures for chlorophyll and oxygen. Specially written Python software filled the tables automatically.

id integer	argo_platform_id integer	cycle integer	date_time timestamp without time zone	latitude double precision	longitude double precision	drift_depth double precision	qc smallint	velocity_pl double precision	velocity_pl_degree double precision	velocity_layer_degree double precision	velocity_layer double precision
1938	1901200	0	2009-12-08 07:07:00	42.917	28.879	219.25	1	0.0251200186064925	221.309299134656	221.309299134656	0.0251200186064925
1939	1901200	1	2009-12-11 00:33:00	42.877	28.831	175.125	1	0.0486606481015092	230.316455399664	230.316455399664	0.0486606481015092
1941	1901200	2	2009-12-16 00:45:00	42.756	28.632	224.571	1	0.0965656475705575	162.592574637488	162.592574637488	0.0965656475705575
1943	1901200	3	2009-12-21 02:21:00	42.393	28.787	208	1	0.0616225980479334	155.446099353723	155.446099353723	0.0616225980479334
1945	1901200	4	2009-12-26 00:45:00	42.178	28.92	191.857	1	0.091507495505909	156.549153914187	156.549153914187	0.091507495505909
1947	1901200	5	2009-12-31 01:21:00	41.85	29.112	222.125	1	0.0766234657448515	118.405619899826	118.405619899826	0.0766234657448515
1949	1901200	6	2010-01-05 00:45:00	41.709	29.462	228.571	1	0.0842037395269948	111.080384955378	111.080384955378	0.0842037395269948
1951	1901200	7	2010-01-10 03:03:00	41.589	29.879	196.125	1	0.179278859804967	95.8721425772018	95.8721425772018	0.179278859804967
1953	1901200	8	2010-01-15 00:51:00	41.519	30.789	223.286	1	0.0660057891286143	92.8894186907982	92.8894186907982	0.0660057891286143
1955	1901200	9	2010-01-20 01:27:00	41.506	31.133	188.5	1	0.1162920106283	72.5362536257137	72.5362536257137	0.1162920106283

Figure 1. Metadata table example

id integer	argo_platform_id integer	cycle integer	pressure double precision	temperature double precision	salinity double precision
47712	1901200	0	25	12.8090006083949	18.2000008644536
47713	1901200	0	45	8.33800039603375	18.3410008711508
47714	1901200	0	65	8.08000038377941	18.5260008799378
47715	1901200	0	85	8.10100038477685	19.3370009184582
47716	1901200	0	105	8.22400039061904	20.0170009507565
47717	1901200	0	115	8.29200039384887	20.3020009642933
47718	1901200	0	125	8.33900039608125	20.4580009717029
47719	1901200	0	135	8.39000039850362	20.6610009813448
47720	1901200	0	145	8.43900040083099	20.8210009889444
47721	1901200	0	155	8.49000040325336	20.9670009958791
47722	1901200	0	165	8.53200040524825	21.0820010013413
47723	1901200	0	175	8.56700040691067	21.174001005711
47724	1901200	0	185	8.59700040833559	21.2470010091783
47725	1901200	0	195	8.62900040985551	21.3210010126932
47726	1901200	0	205	8.65500041109044	21.3800010154955
47727	1901200	0	211	8.67600041208789	21.4310010179179
47728	1901200	1	16	12.7680006064475	18.2120008650236
47729	1901200	1	25	12.7680006064475	18.2030008645961
47730	1901200	1	36	9.40800044685602	18.3300008706283
47731	1901200	1	46	8.26000039232895	19.3880009208806
47732	1901200	1	56	8.11800038558431	20.408000969328

Figure 2. Measurement data table

The floats' station positions were indicated by circles, each of which had a different color. They were plotted on the map using the JSON data.
Visualizing velocity vectors on the interactive map was the other task. Recognize that while the Mapbox GL library does not come with arrow markers by default, you may use it to add custom images and icons to your map. Therefore, it was first required to sketch them and add them to the main JavaScript file. The accompanying arrow images were created for intervals of seven speeds. Next, a step expression was created to illustrate the direction and speed of the velocity arrows.

3. THE USER INTERFACE

You can access the user interface (UI) at http://bod-mhi.ry/ff/.
With the ARGO ID, you can choose the ARGO float trajectories from the appropriate list. The trajectory can be shown as vectors that match the drift speed and direction and can be joined to a line, or as points that match observation cycles.

In addition to trajectories, observations points, profiles plots, and drift velocity at the map, drift rose, and metadata (platform ID, coordinates, date, and time of observations) can all be seen through the user interface. The following criteria can be used to make the queries:
- Selecting on Argo ID. Example is shown at Figure 3 (profile) and Figure 4 (velocity).
- Selecting by rectangular area from all of the Argo drift data. (Figure 5)
- Selecting based on date intervals, drift depth, and combining these filters. (Figure 6)

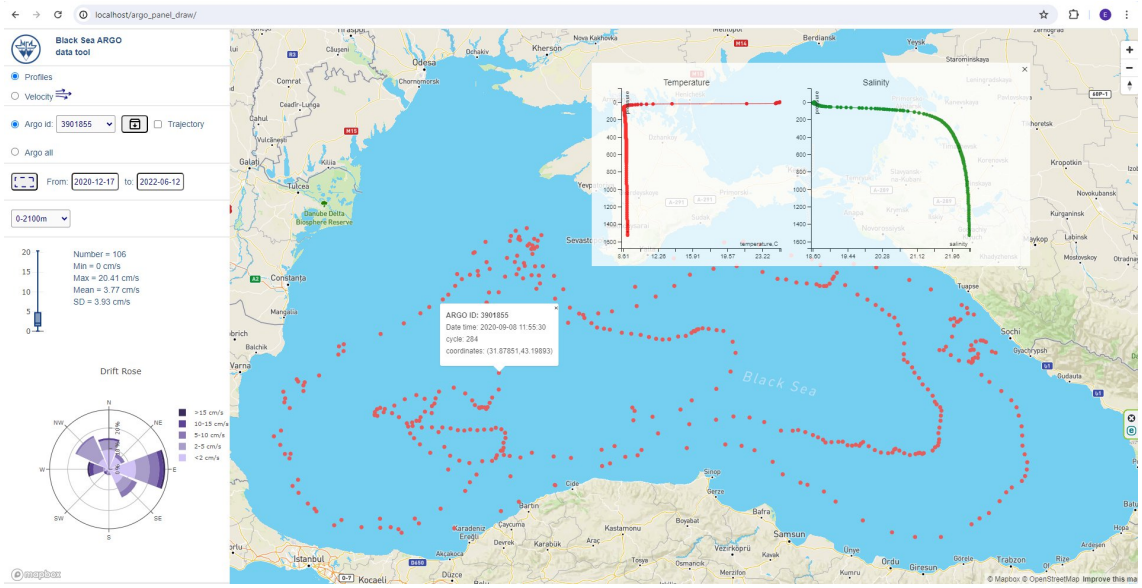

Figure 3. Selection on Argo ID (profiles)

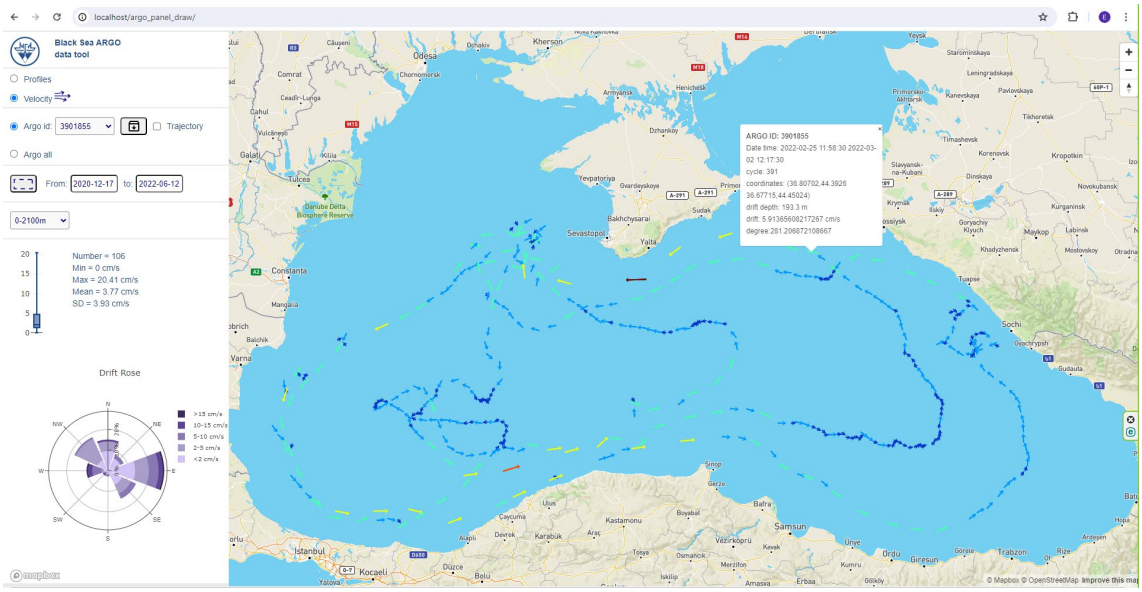

Figure 4. Selection on Argo ID (velocity)

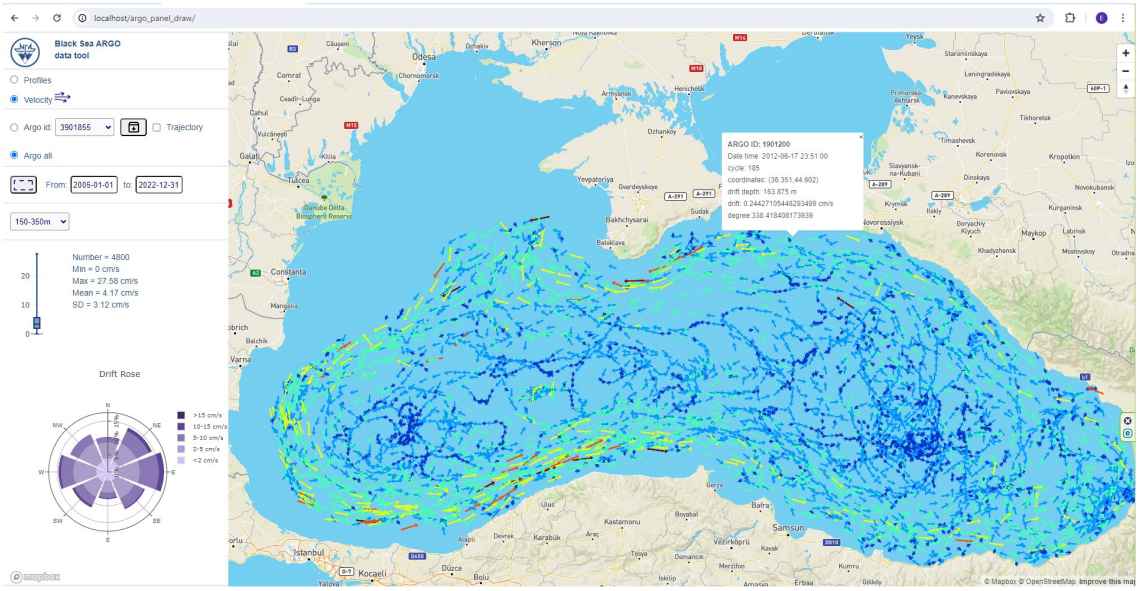

Figure 5. Selection all Argo (velocity)

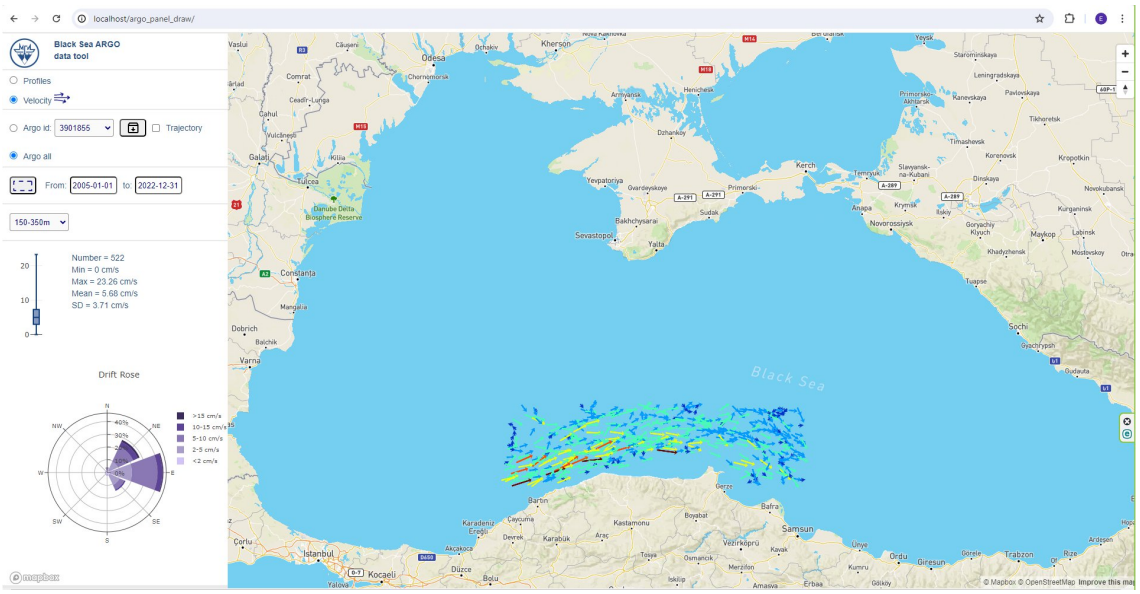

Figure 6. Selection by rectangular area

4. CONCLUSIONS

An online, powerful, and user-friendly instrument for accessing, visualizing, and analyzing currents data—such as Argo float velocity—is made available via WEB GIS tools for visualizing sea current data. Updating data and adding new information is made simple by using Python scripts to automatically fill database tables. In addition to Argo float data, the system can hold other velocity data for the Black Sea and other parts of the World Ocean, such as drifters and ADCP observations.

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