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Visualization and animation trials of 3D geospatial marine oceanographic datasets

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Abstract:

Marine research has gained attention in recent years, partly as a result of the increased interest in global climatic conditions. Discussion about changes in the ocean currents and their effects on the surroundings, among other things, has driven this particular demand. The complex phenomena have also attracted attention of actors outside the academic field. Effective communication and immersive visualizations are essential for marine and oceanographic research and understanding their usefulness is crucial for improving the visual methodology (Evangelidis et al., 2018; Kettunen & Oksanen, 2019).

The ocean is a constantly moving complexity and the phenomena regarding it are ever changing. Waves, currents and surges, as well as their effects on fish stocks or the drift of anthropogenic matter are all highly dynamic factors in the ocean ecosystem. These changes have been typically depicted in static 2D maps and figures. Many of the temporal patterns can become comprehensively presented through dynamic views. In the case of ocean currents, multiple static maps are needed to visualize the change in flow directions and speed. Static visualizations of dynamic phenomena can be used in side-to-side comparison, yet this approach requires deeper understanding and pattern recognition from the viewer. Animated map views are an effective way of communicating complex spatial processes that require presentation of multiple data layers and are also potential for progressive scenes (Kettunen & Oksanen, 2019). One example of visualizing ocean currents is an interactive animated flow field, illustrated in Figure 1, which has been developed using Leafmap tools for NetCDF data.

The third dimension brings additional perspectives for data visualization. Static 2D maps do not always comprehensively communicate reality, as only a small part of the ocean movement occurs on the level of a single depth layer. In addition, ocean currents are strongly influenced by flows between different depth zones, especially on coastal areas, where the rising ocean floor forces up the water flowing towards it. In research sites located on coastal regions, development of 3D views is beneficial. Advances on ocean 3D visualization have been lately attained. For example, ocean flows and salinity levels can be visualized in the ParaView software into an animated 3D view using the newly developed pyParaOcean plugin (Jain et al., 2025). ParaView also supports some 3D animation tools of its own, such as the Stream Tracer filter. It can be used to visualize ocean currents in an animated 3D field, displayed in Figure 2.

The objective of the presented study is to explore visualization methodology of oceanographic datasets and develop workflows for their useful and effective 3D geovisualization. A tool to combine all the elements of an interactive, animated 3D view of GIS data has not been openly available although there have been efforts to develop software applications to tackle this issue (Evangelidis et al., 2018). We aim to compile visualization tools, plugins, libraries and packages that allow for animated 3D visualization, especially for phenomena of the marine water body. These visualization methods are then to be evaluated in the context of depicting oceanic processes, such as currents and particle migration. The conference presentation will present preliminary results and findings within our visualization studies.

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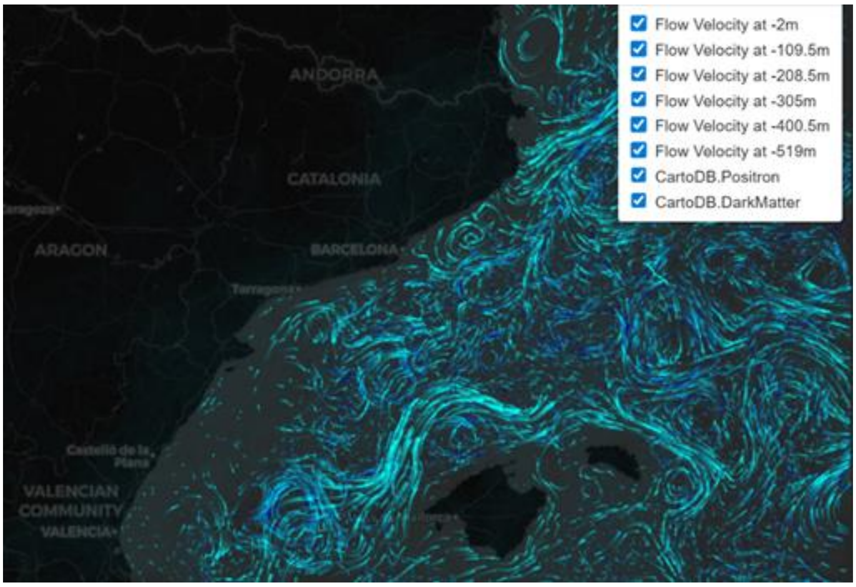

Figure 1. Interactive animation of ocean currents using animated streamlets in Leafmap.

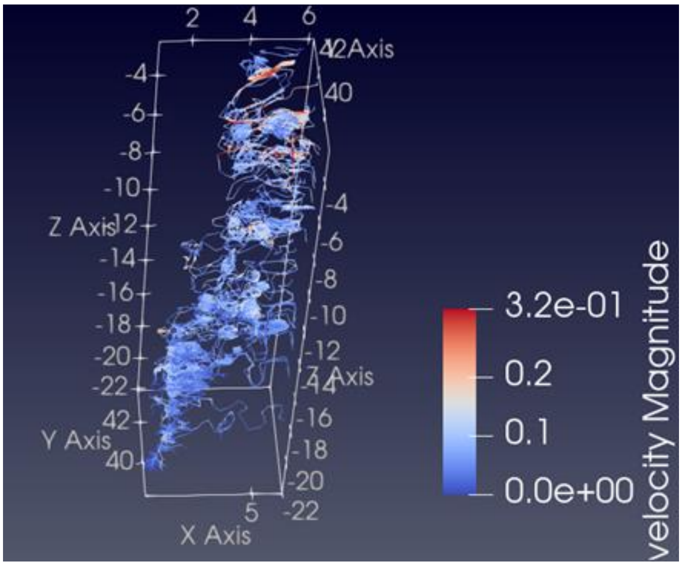

Figure 2. 3D streamlines of ocean currents using ParaView.

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