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Comment on essd-2022-411

Anonymous Referee #2

Referee comment on "A global Lagrangian eddy dataset based on satellite altimetry" by Tongya Liu and Ryan Abernathey, Earth Syst. Sci. Data Discuss., https://doi.org/10.5194/essd-2022-411-RC2, 2023

The Authors present a new global Lagrangian eddy dataset (GLED) containing information about various parameters like size, position, rotation, and lifetime of these coherent structures as well as trajectory data of numerical particles trapped inside these eddies. All quantitative information present in this database comes from massive numerical simulations of Lagrangian trajectories integrated from satellite-derived ocean surface current fields, covering a period of almost three decades.

I appreciate the remarkable effort made by the Authors to carry out a so challenging task although, personally, I have some doubts about the robustness of the results, for the reasons I will try to explain.

The “Lagrangian” eddy database, introduced in this work, is discussed by the Authors in comparison to pre-existing “Eulerian” eddy datasets, and the main differences between the two approaches are described with arguments that I agree with.

-Line 7 (Abstract): “… but also the trajectories of particles…”

Personally, I do not like to consider Lagrangian trajectory simulations a “product” to store in a database as happens for other kinds of data, e.g., real ocean drifter trajectories or ocean current fields. One reason is that Lagrangian trajectories are sensitive to initial conditions and to the resolution of the velocity fields. But we will come back to this point later.

-Lines 112-122 (Particle advection): "The first step… they never move."

Since 2D geostrophic velocity fields are considered, because of the nature of the Eulerian data, all results relate to large scale advection on the ocean surface, and any extrapolation to smaller scales and/or to sub-surface ocean layers must be treated with caution.

A particle spacing of 1/32° is claimed to be necessary for a good resolution of the RCLVs but it should be stressed that this does not mean to improve the resolution of the dynamics but only the definition of the large-scale features of the flow (>> 1/4°).

-Lines 138-184 (Lagrangian eddy identification): "For a coherent eddy … based on satellite observations."

The definition of LAVD fields and RCLV boundaries is supported by common sense arguments, but not much is said about the sensitivity of this eddy identification technique to the resolution of the velocity fields. For example, since the CI coefficient depends on the mean local particle separation, after a given time interval, it must be expected that, if the small scale velocity components, or part of them by means of sub grid parameterization techniques, were included in the trajectory evolution equations, the relative separation speed between particles would increase due to the general growth of the (Lagrangian) Lyapunov exponent with the smallest resolved scale.

Looking at figure 3, I wonder if the Authors have tried to make, at least, a qualitative comparison between a simulated coherent structure evolution and the behavior of a real ocean drifter, initially "trapped" inside the eddy. The Authors do not provide information about the accuracy of their Lagrangian trajectory simulations, but I think this problem should be at least mentioned in the text.

-Lines 219-260 (General features of global coherent eddies) "To assess GLED … along the eastern boundary"

Briefly, I find that all the differences between “Eulerian” and “Lagrangian” approach to eddy detection, here discussed, are plausible. Incidentally, there are many examples of kinematic velocity fields made of quasi stationary eddies advecting chaotic Lagrangian trajectories. So that, if the Eulerian field is analyzed, one finds out the existence of long-living coherent structures (i.e. with infinitely long Eulerian autocorrelation times) but with zero mean transport; on the other hand, the Lagrangian trajectories consist of aperiodic open pathways across the eddies and large-scale particle transport is due to chaotic diffusion.

-Lines 261-288 (Global mass transport by coherent eddies) “One application … live that long.”

Given that the 3D eddy structure is unknown, does it make sense to give quantitative information about the mass transport? Is the depth factor arbitrary or is there an argument to justify its value? Moreover, the eddy lifetime d in formula (4) could be seriously overrated with respect to the real ocean, for the reasons previously mentioned.

-Lines 308-310 “To the best of … from physics to biology”

-Lines 330-333 “Although we have produced … studying mesoscale eddies.”

Personally, I find the presumed impact of this type of databases to the research activity of others is a bit overstated. While the existence of eddies is out of question, it is worth stressing that the assessment of the accuracy of the numerical simulations in reproducing the actual Lagrangian properties of real ocean tracers is a big open issue.

-Lines 334-338 “One limitation … available”

While waiting for the next oceanographic missions, to update the database, I would suggest also to consider a Lagrangian validation of the numerical trajectory dataset (see, for example, Lacorata et al., 2019, FSLE analysis and validation of Lagrangian simulations based on satellite derived GlobCurrent velocity data, Remote Sensing of the Environment). Nobody expects the simulations to perfectly agree with the observations, but it is important to outline the limits of accuracy prior to any kind of application. I think that this could be an interesting information to potential end users of the product.