Review of manuscript egusphere-2024-3730 entitled " Geostrophic circulation and tidal effects in the Gulf of Gabès"

Main comment:

Within the manuscript the authors use a 30-years time series of altimetry data as well as a numerical model (all freely available from CMEMS, Copernicus Marine) to investigate the dynamics in the gulf of Gabès. This region is of particular interest since it is the area of exchange between Western and Eastern Mediterranean Sea water masses. The authors perform a climatological study of the geostrophic circulation and investigate the effect of tides leading to the generation of a cyclonic current. The effect of persistent Lagrangian structures (FTLE) on the phytoplankton bloom occurrence is also discussed.

The paper is detailed, well-written and well structured and I think provide a quite complete overview of the dynamics, as seen by altimetry (or limited only to geostrophic balance) of the area. In its current form the paper is very interesting but I think would benefit from few more information/analysis before it can be published. Therefore I would recommend to publish the manuscript after some major revision. Please find in the following my detailed comments.

Major comments:

1) Even though I am sure that this kind of climatological review is necessary for a good understanding of the studied area, it seems to me that the text lacks from any explanations about what this kind of analysis brings in terms of new knowledges. It stated several times the results agree with previous work but never what we are the additional information. For example in the Introduction and Conclusion, the authors may emphasize more on the novelty of their approach compared to previous studies. I really think this could boost the readers' interest.

2) One point that is not clearly stated in the entire text, although written on line 421, is that FTLEs are dynamical diagnostics allowing to identify frontal/stretching areas it cannot be used as a diagnostic of biogeochemical processes. They can explain the relative 2D horizontal dispersion/distribution of some biological quantities and thus provide some insights on potential vertical processes that may engender phytoplankton blooms (Lévy et al.,). I would like to draw the authors attention on the fact that throughout the text a confusion can arise especially in section 3.2.2 (see detailed comments). Also, the title of section 3.2.2 is a bit confusing tome. I would not talk about turbulence here for several reasons:
   - FTLE are not a diagnostic of turbulence, especially when computed with low-resolution altimetry-derived (geostrophic) surface currents
   - In the present study, the authors got interested in features detected by persistent FTLEs (a mean over a long time period) which means that the features discussed here occur at

temporal scales (years) that are way larger than turbulence (days) or even fine-scales (weeks-months).

I would thus recommend to modify the section title for something like “impact of tides on strain and effect on biogeochemical distribution” or even the authors may consider splitting tides and FTLEs into two different subsections.

3) The authors provide a quite complete overview of the dynamics in the Gulf of Gabès but never discuss the evolution of SSH (surface currents velocity or direction…) as monitored by the altimetry time series between 1993 to 2022. This could provide insights on the evolution of the regional dynamics (any trends ?) in the context of the climate change. In the discussion section these trends (if any?) could be discussed for future years evolution and potential impact on biology.

Detailed minor comments:

L 15: “biogeochemical processes”: I would rather use “biogeochemical dispersion”.

L 24: “richest” for the Mediterranean Sea yes but it is relative for other “rich” places in the world ocean. Maybe the authors can cite some references here.

L 35: “One of them … southward ().” I could not understand this sentence, please rephrase.

L 44: “spatial-temporal” change for “spatio-temporal”

L 53: “exert” not sure if it is correct in English, “act” ?

L 163: You can also cite other types of applications such as: d’Ovidio et al. (2010), Rousselet et al. (2025).

L169-171: I totally agree with these statements, however I don’t see how in this study these gaps are leveraged ? Please maybe add a comment in the text.

L 180: forward in time.

L178-192: I do not understand for how long are the particle trajectories advected to computed FTLE ?

Figure 1: I think only two panels would be sufficient (either 2D or 3D bathymetry).

L 207: Even though I agree with the theory, some subareas are very coastal and we know that altimetry is not really reliable there, so maybe the authors can justify the use of altimetry data in such coastal zones.

L 234-235: This is related to the major comment 2). Mean FTLE averaged over 30-year altimetry cannot be used to investigate chaotic turbulence since it is detecting large scale persistent (permanent) features. However I agree that such diagnostic is comparable to a mean concentration of Chl-a, I am just concerned by the sentence and reference to "chaotic turbulence".

L 259: "several cyclonic eddies". Again here can we rather talk about "permanent/recurrent eddies" or even "gyres" ?

Figure 4: In the caption please specify that the quantities are mean over each boxes.

L 286-287: "the model results" at the surface. No comparison are performed on the vertical. Also is the model assimilating any observations ? Because if the model is assimilating satellite data then the agreement between the model and observations is obvious and I think this part should be removed.

L 389-390: I don't understand how the comparison between Chl-a and FTLE can "provide insights into the time lag" ?

L 391: "biogeochemical processes". I would change processes for "dispersion" since the biogeochemical processes are never really discussed (which one ? How?…)

L 414-415: I am not sure about this statement because many FTLE occurrences are not linked with any phytoplankton bloom (or more specifically high concentration of Chl-a). The authors should clarify or explain.

L 437-439: Here I would lin this to a dynamical process: "FTLE" act as barriers to offshore transport.

L 443-444: This statement is redundant, please remove or move to methods.

References:

d'Ovidio, F., De Monte, S., Alvain, S., Dandonneau, Y. and Lévy, M., 2010. Fluid dynamical niches of phytoplankton types. *Proceedings of the National Academy of Sciences*, *107*(43), pp.18366-18370.

Louise Rousselet, Francesco d'Ovidio, Lloyd Izard, Alice Della Penna, Anne Petrenko, et al.. A Software Package for an Adaptive Satellite-based Sampling for Oceanographic cruises (SPASSOv2.0): tracking fine scale features for physical and biogeochemical studies. 2024. ⟨hal-04705438⟩