Revised version, 12 March, 2021

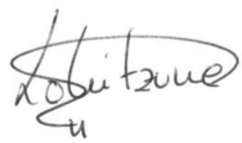
Dear Editor,

We would like to express one more time our sincere appreciation to the reviewers and the Editor for their interest and deep analysis of our manuscript, entitled “A new Lagrangian based short term prediction methodology for HF radar currents”. The paper has been revised and carefully modified following their comments and suggestions. They have undoubtedly helped to improve the quality of this manuscript.

Our response to the revision of Reviewer #2 can be found below.

Hoping the manuscript fulfils now the quality requirements of Ocean Science Journal, I look forward to hearing from you at your earliest convenience.

Sincerely,



Lohitzune Solabarrieta

Reviewer #2

We thank once again, the effort made by the Referee in reviewing our Manuscript (hereinafter Ms.) entitled ***"A new Lagrangian based short term prediction methodology for HF radar currents"***. The paper has been modified, taking into consideration the last advices and comments raised by the reviewer, in particular, improving the Discussion section.

Please find in the following, the answers to the reviewer queries (comments submitted on 26-Feb-2020), as well as the changes performed in the new version.

Reviewer #2 Comments & Replies to the revision submitted on 26 Feb 2021

Reviewer #2 comments

I thank the authors for considering my points in the previous rounds of revisions. I acknowledge their efforts in:

a) inserting a map in Figure 1;
b) remaking Figure 4;
c) removing the Eulerian attempt and
d) better explaining the whole developed methodology in the new Section 2.

The manuscript is strongly improved even though I still believe that the discussion part is poor and remain unconvinced by the arguments provided by the authors in the new response, specifically at point #Q.g. I am getting that, in an abuse of language, predictions made with "persistence" use repeatedly and artificially the velocity measured in the last observation. But it is difficult to me to understand how this repeated and artificial velocity can perform better than the velocity measured by radars, since "they capture well all scales of interest above hours". As suggested earlier, both GDOP maps and a clear example showing the accumulation of small differences using the two methods are really needed.

Typos:
1) L221: correct implementeD
2) L808: correct globaL
3) L845-848 and L852-855: set font to italic for consistency with the rest of the caption

Comments & replies from the authors to reviewer #2:

We agree with the reviewer that the comparison between our prediction system and persistence model may be difficult to interpret. It has also generated several discussions between the coauthors during the analysis and preparation of the manuscripts.

The main idea that we would like to clarify is that the proposed methodology works well, even during the periods when forecast using persistent currents is better. Indeed, the presented methodology is capable to detect those periods when predictions based on persistence perform better than the L-STP and guide the user to use this first solution as the final prediction. We think that this real time capability to detect those periods is a specific skill of the suggested methodology, which improves the final prediction; not the opposite.

Persistence model is referred as when predicting the velocity field at time “t+1” it is simply used the velocity field at time “t” as its prediction. Persistence model is often used as a reference for the assessment of the skill of a prediction system. In our case, we find that the L-STP model performs better than the persistence model, except for a very few and short time periods characterized by persistent dynamical conditions (12%). In these cases, why the persistence model is a better prediction than the “best analogue” of the LSTP model? Why the LSTP model is not able to reproduce (or predict) “persistence” over these time periods when persistent currents control the dynamics?

We would like to clarify this point. The key is that the persistence model prediction is better than the L-STP, during periods of specific persistent dynamics (in both study areas), characterized by intense and shear currents, like the Iberian Poleward Current in the Bay of Biscay area. This is reflected in figure 5 of the Ms. (copied below), where most of the times (black dots over 0 value) occur from November to April, when high persistent currents, linked to the IPC, dominates the dynamics.

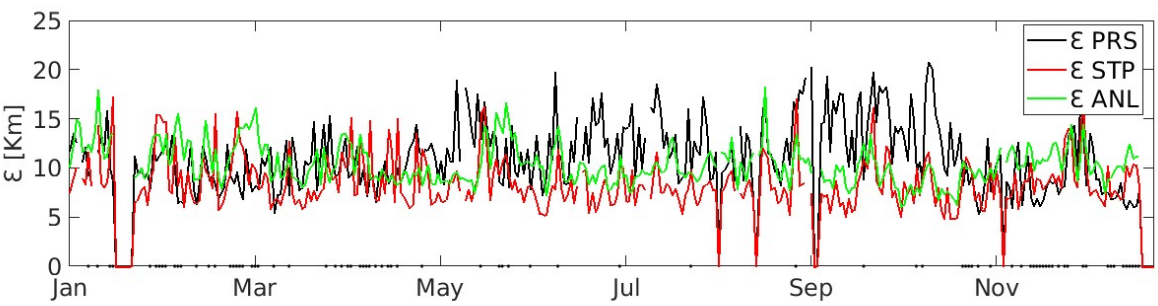
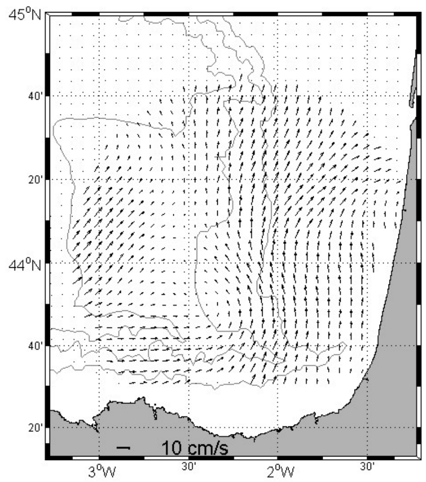


Figure 5: errors of the hourly best analogue for the BoB HFR, for 2015 (ε_{ANL}), together with the ε_{STP} and ε_{PRS}. The black dots over the timeline show the times when ε_{STP} is higher than ε_{PRS}

This dynamical scenario of persistent and intense current periods is recurrent in time, and it mostly occurs in winter. The different events of intense periods share similar characteristics with narrow high-speed jets but slightly different positions, as shown in the next figure:



In this sense, when analogue method finds the most similar Lagrangian field, it will find a similar characteristics pattern period in the Lagranigan catalogue, with the smallest spatial displacement. But those small spatial differences are large enough to generate high errors in the STP method as the separation distances are directed linked to the different speed and direction between the predicted and real currents. However, the repetition of the last hour currents (persistence model prediction) will have lower separation distances as the location of the main jet is more similar.

The predictability, or the growth of a small perturbation in this dynamical system, is given by the growth rate of the separation between two trajectories advected in two different velocity fields (reference and predicted) being higher when the difference between the currents (reference and predicted) are bigger (different direction and speed), that is, as they are more uncorrelated. In our case, under the persistent dynamical conditions governed by the IPC, the currents obtained from the LSTP are slightly shifted, but just enough to advect the particle in a different jet, while the velocity field predicted from persistence advects the particle in the same current.

We have observed that the longer the training periods (as in the BoB system), the better the performance of the STP method. This suggests that longer training periods would improve the capabilities of the STP, increasing the probability to find periods of persistent dynamics which occurred almost in the same spatial area.

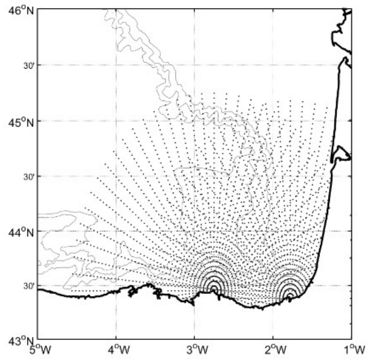
We agree with the reviewer that this was not clearly explained in the Ms. and following his/her advices, the next paragraph has been included in the "Discussion" section of the Ms. We think that clarifying the main reasons of the good behavior of the persistence in some specific cases, greatly improves the discussion about the limitations and advantages of the LSTP method.

> *"…*
>
> *We have compared the capabilities of the L-STP methodology against the forecast based on the persistence of currents. The L-STP method requires long (but not continuous) training periods and improves the results obtained from previously developed HFR forecast system (Solabarrieta et al., 2016) in the same study area (BoB) for the whole year. However, the L-STP still shows some limitations in predicting some specific dynamical scenarios, i.e. the dynamical conditions originated by the persistent IPC (Iberian Poleward Current). We have found that the Lagrangian analogue is not able to properly identify such persistence, it performs relatively better during non-persistent periods. The fact that persistent events in both study areas are characterized by narrow high-speed jets (i.e. IPC in the BoB) small spatial differences in the location of the main circulation could generate high separation distances between the reference and predicted trajectories. While the trajectory computed from the velocity field predicted from the persistence model is advected in the same jet, the currents obtained from the L-STP are slightly shifted, but just enough to advect the particle in a different position within the jet, originating, therefore larger errors (larger* ε_{STP}*). We have observed that the longer the training period (as in the BoB system), the better the performance of the L-STP method. This suggests that longer training periods would increasing the capability to identify periods of persistent dynamics occurring over the same area, and thus improving the performance of the L-STP.*
>
> *As mentioned, previous efforts to forecast surface currents from HFR data have shown similar results compared with the methodology presented in this paper. However, the advantage of the L-STP method is that it can be used in near-real time, with short and non-continuous datasets of around 2-3 years.*
>
> *…"*

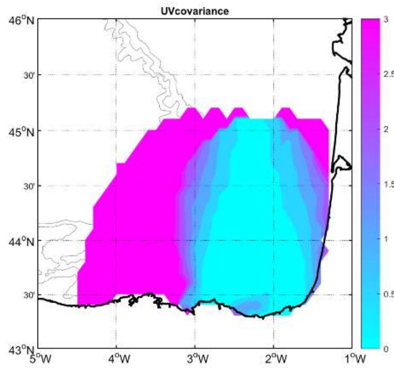
We hope that these new paragraphs clarify all the concerns that the reviewer could have in the previous versions about the performance of the methodology.

Apart from this, and following the recommendation of the reviewer, we have calculated the theoretical GDOP maps for the BoB system, as shown in the next figures:

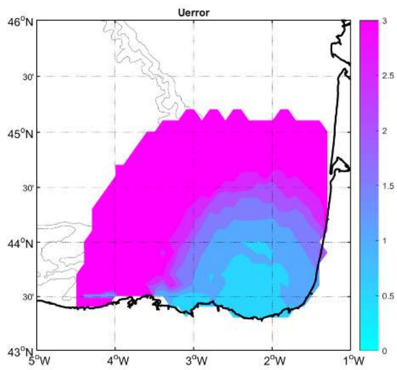
Radial measurement locations (BoB)	

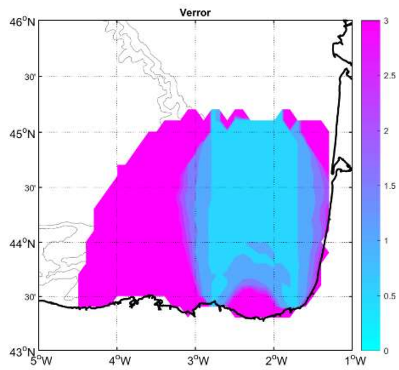


UV covariance	



U error	V error





The reader can think that the GDOP could be related to the “worse” performing of the L-STP methodology vs. persistency, during persistent events. But the area where IPC main jet occurs, is a low GDOP error area (as shown in the previous figures), so GDOP error should not add uncertainty to the L-STP methodology.

We think that these figures could generate more confusion on the final reader than clarification, as it is not the reason of the good performing of the persistency. We also think that the included new explanatory paragraphs at the end of the "Discussion" section, clarify the reasons of the good results of the persistency vs. L-STP during persistent events. Due to all these reasons, we prefer not to include GDOP figures in the Ms, but they could be attached in complementary material, if needed.

Typos:

1) L221: correct implementeD

"D" has been introduced in the Ms.

2) L808: correct globaL

It has been corrected in the Ms.

3) L845-848 and L852-855: set font to italic for consistency with the rest of the caption

It has been changed for consistency in the Ms.