

RESPONSE TO REVIEWER #2

- Title: Coastal HF radars in the Mediterranean: Applications in support of science priorities and societal needs
- Author(s): Emma Reyes et al.
- MS No.: os-2021-115
- MS type: Review article
- Special Issue: Advances in interdisciplinary studies at multiple scales in the Mediterranean Sea

Please, note that all the points raised by the reviewer are in **bold font** below, while the responses to the review are in normal font and the changes made to the revised manuscript are “quoted”.

General comments

This paper presents an extensive review of many different and important applications of HF radar in the Mediterranean. Other reviews of this type have been published, and are referenced in this paper, but I think this is the first one that focusses on this particular region. As a review it is not intending to present new science but it brings together in an interesting way many different scientific contributions and developments, as well as some operational applications, all well-referenced and acknowledged. I did occasionally get lost in some of the detail and felt that there was some unnecessary repetition of key HFR advantages (high temporal and spatial resolution for example) when addressing each of the different applications.

We sincerely appreciate the reviewer’s comments and the time invested on that. Below are all of her/his thoughtful suggestions and concerns followed by our responses.

In short, repetitions have been avoided, unclear concepts and/or paragraphs have been modified, the quality of the figures have been improved and the figure captions further detailed, thus contributing to ensure our joint work is communicated clearly and accurately.

Although I am providing a long list of suggested modifications to the English, on the whole the paper is well-written and will be of interest to many, and not just to those working in the Mediterranean region.

Authors are very grateful to the reviewer for her/his careful, detailed and extensive revision for language that will help to improve the reading and comprehension of the manuscript. Following her/his recommendations, we have polished this manuscript after carefully correcting any errors in spelling, grammar and word choice to guarantee the publication quality.

Specific comments

- 1. To make it easier to navigate through the paper it might be helpful in section 2 to list the subheadings of the three main topics in an introduction to the section. The key features of HFR that support these applications could perhaps be included in this introduction so they do not need to be repeated elsewhere.**

Agreed. Thanks for your comments.

We have listed the subheadings of the three main topics in the introduction in section 2.

“This section presents the existing advanced and emerging scientific and societal applications using HFR data, aiming to address science priorities and societal needs identified in the Mediterranean coastal waters, organized around three main topics: (i) maritime safety; (ii) extreme hazards and (iii) environmental transport processes.”

We have included the key feature of the HFR technology in the Introduction (section 1) to avoid needless repetition along the manuscript.

“The increased capability to address the above-mentioned regional challenges at the required spatio-temporal scales has directly benefited, *inter alia*, from the key features of the High Frequency Radar (HFR hereinafter) technology, i.e. unprecedented high spatio-temporal resolution (i.e. 0.2-6 km and 15-60 min) over wide coastal areas (up to 200 km offshore, depending on the operational frequency).”

- 2. Fig 14 and associated discussion. I couldn't relate what I can see in (a) and (b) to the discussion on page 31. Can the link between them be made more clearly?**

The reviewer is completely right, since an additional step was missing in the discussion on page 31. Thanks for the notice. The paragraph has been revised:

“(i) Reconstruction of the annual and seasonal regimes of HFR currents detected at the LTER-MC site; (ii) Running Lagrangian backtracking simulations advecting virtual phytoplankton patches (VPPs) in the HFR field (Fig. 14, a). VPPs were released at LTER-MC site on the dates of the weekly oceanographic campaigns and tracked backward, allowing thus the estimation of the positions of the VPPs up to 4 days (i.e. 96 h) prior to its arrival at LTER-MC; (iii) Identifying the prevailing directions from which the VPPs arrive at LTER-MC site, as resulting from backtracking simulations (Fig.14, b), also allowing the definition of the spatial distribution of the VPPs origin zones (not shown) in the GoN; “

- 3. I am not sure why the mathematical underpinning of lagrangian transport is included here (equations 1 and 2) when such details for other methods reviewed in the paper are not – and do not need to be.**

Agreed. Thanks for your suggestion. Equations have been removed and the paragraph has been reworded following your recommendation and aligned with the anonymous reviewer #1 comment.

- 4. There is no specific discussion in here about the different types of HFR and their relative merits. Perhaps that is in the companion paper which I haven't seen yet. For most of the applications which involve currents this may not be necessary but when it comes to mapping waves and winds the type of radar is more important so a few words where these measurements are referred to would be useful.**

The reviewer makes an excellent point here about the importance of discussing the type of HFR, particularly in the case of wave and wind monitoring. Authors therefore have included a detailed discussion in this regard in the companion paper, in section 2.1 (entitled "Fundamentals of the HFR technology") and in the SWOT analysis, highlighting the "Non-mature operational stage for waves and winds" as well as the "lack of HFR-derived waves and winds data standards".

The companion paper (Lorente et al., 2021), which has already been accepted, has been cited in L. 566 and in section 4 item b, as follows:

"In addition to that, HFR experts from the Mediterranean institutions are currently and actively contributing in the definition of the European HFR network roadmap detailed in Rubio et al., (2021), leading crucial tasks. One of these tasks aims to define the standard model and to increase the availability and accuracy of the HFR wave parameters, which are weaknesses identified in Lorente et al., (2021). Another important task focuses on reaching a consensus on the methodology for the provision of the HFR data gap-filling products."

Ref:

Lorente, P., Aguiar, E., Bondoni, M., Berta, M., Brandini, C. Cáceres-Euse, A., Capodici, F., Cianelli, D., Ciraolo, G. Corgnati, L., Dadić, V., Doronzo, B., Drago, A., Dumas, D., Falco, P., Fattorini, M., Gauci, A., Gómez, R., Griffa, A., Guérin, C-A., Hernández-Carrasco, I. Hernández-Lasheras, J., Ličer, M., Magaldi, M., Mantovani, C., Mihanović, H., Molcard, A., Mourre, B., Orfila, A., Révelard, A., Reyes, E., Sánchez, J., Saviano, S., Sciascia, R., Taddei, S., Tintoré, J., Toledo, Y., Ursella, L., Uttieri, M., Vilibić, I., Zambianchi, E., Cardin, V. (accepted). Coastal HF radars in the Mediterranean: Status of operations and a framework for future development. *Ocean Sci. Discuss.*, 2021, 1–58, doi:10.5194/os-2021-119, 2021.

- 5. In connection with section 4 item l on funding. If European HFR networks are to be truly sustainable there needs to be long term infrastructure funding at national, regional and European government level with financial input from other operational users through regional consortia. Relying on grant funding, particularly where this is focussed on new science, will not be sufficient.**

We do agree with the reviewer. The following sentence has been included in section 4) :

“In addition to the research/grant funding, long-term infrastructure funding at national, regional and European government level with financial input from other operational users through regional consortia will be needed towards a truly sustainable infrastructure. “

Minor corrections/suggestions

- **Abstract li35-36.** I would suggest a slight rewording for clarity ‘The Mediterranean Sea is a prominent climate change hot spot, with many socio-economically vital coastal areas being the most vulnerable targets for maritime safety, diverse met-ocean hazards and marine pollution.’ Or something like that.

Thank you! Reworded!

- **P2 li 40.** Remove ‘the’ in ‘in the Coastal Ocean’.

Done!

- **P2 li 46.** Remove ‘finally’.

Done!

- **P2 li 47.** Replace ‘societal’ with ‘societally’.

Done!

- **P2 li 56.** Remove ‘the’ after ‘covering’.

Done!

- **P2 li 58.** ‘Both not really needed.

Removed!

- **P4 li 116.** Remove ‘et al’ after Wyatt. Reference lists shows just one author.

Removed!

- **P4 li 124.** Replace ‘It is worth to highlight’ by ‘It is worth highlighting’.

Replaced

- **P4 li 130.** Rearrange ‘providing the first one a’ to ‘the first one providing a’.

Rearranged

- **P4 li 135.** Remove ‘the’ before ‘Sect.4’.

Removed!

- **P5 li 155.** Replace 'highly' with 'greatly'. Replace 'its high' by 'their high' and 'its near' by 'near'.

All replaced

- **P5 li 160.** Replace 'control' by 'controlled'.

Replaced

- **P6 li 170.** Replace 'from which' with 'of which'.

Replaced

- **P6 li 176.** 'accounts with'?? do you mean 'has'

Yes, I do. Replaced

- **P6 li 178.** Replace 'being the 51% from' with 'of which 51% were from'.

Replaced

- **P6 li 179-180.** Rewrite as 'In particular, the number of SAR incidents in the French Mediterranean responsibility area accounts for 23% (3110) of the total number of cases and 32% (7293)'.

Rewritten

- **P6 li 181-182.** Remove 'The' before '94%' and replace 'being more of' with 'with more of'.

Removed and replaced

- **P6 li 186.** Replace 'for 1875' with 'to 1875'.

Replaced

- **P6 li 192.** Replace 'being also' with 'with'.

Replaced

- **P6 li 194.** Remove gap in '267 874' for consistency with large number notation elsewhere (or perhaps include a hyphen if that was missing?).

Gap removed

- **P6 li 195-196.** Rewrite as '...reported as SAR cases occurring within Maltese Territorial Seas'.

Rewritten

- **P6 li 198.** Rewrite end of sentence from 'are served by..' I am not sure what is meant here.

Agreed. We have modified the sentence:

"HFR data are combined with forecast model outputs to get the best representation of the sea state during SAR operations"

- **P7 li 204. Replace 'from' with 'of'.**

Replaced

- **P7 li 205. Rewrite as '(the remaining 12% being in response to ...)'.**

Rewritten

- **P7 li 206. Replace 'From 7 of the HFR' by 'Of the 7 HFR'**

Replaced

- **P7 li 222. Replace 'obtaining' with 'for'**

Replaced

- **P11 li 282. Replace 'issues as' by 'issues such as'.**

Replaced

- **P11 li 283. 'for instance' not really needed.**

Removed

- **P12 Fig 4 caption. Is CC index the same as complex correlation coefficient?**

Yes, it is. A better description has been included in the caption of Figure 4: "Magnitudes of the complex correlation (i.e. CC index) and phase between HFR and model-predicted currents are provided in red font color."

- **P13 li 362. 'only a limited number of studies have been'.**

Replaced

- **P14 Fig 5. I can't see a definition of 'CR'?**

You are completely right. Thanks for the notice. The proper definition of CR (i.e. control run) has been included in the Figure caption.

- **P15 li 408. Insert 'an' between 'using' and 'unsupervised'.**

Inserted

- **P15 li 411. I don't think prerequisite is a verb. Suggest 'requires' or 'assumes' instead.**

'Requires' is used instead.

- **P16 li 420. Replace with 'the HFR systems has had substantial problems since**

2010 and the antennas were eventually removed.'

Replaced

- **P17 li 446-447. Perhaps rewrite as 'The analysis was based on pattern and magnitude estimates of kinematic properties from surface currents'**

Rewritten

- **P17 Fig7. The whole figure should be on one page rather than spilt up. The font size on the maps is too small to read clearly.**

Agreed. We have modified Figure 7 to make the font sizes bigger and to display it on one page.

- **P18 li 469. Replace 'analyzing' with 'analysis of'.**

Replaced

- **P19 ;l 474. Replace 'the flash pressure drops' by the sudden pressure drop'.**

Replaced

- **P19 li 485-486. Unit split across lines.**

Solved

- **P21 li 542. Replace 'damages' with damage'.**

Replaced

- **P22 li 559. Remove 'a' before 'software'.**

Removed

- **P22 li 570. I suggest 'into the ocean, multi-scale coastal ocean dynamics being the key drivers...'**

Suggestion accepted, thanks!

- **P22 li 571. 'HFRs have demonstrated a capacity to provide very'**

Rewritten

- **P23 li 580. Replace 'threat' with 'threats'.**

Replaced

- **P24 li 617. Replace 'state for' with 'are' and define the x' variable at the end of the sentence. Although see also**

This paragraph has been removed following the recommendation from the anonymous Reviewer 1 aiming to avoid the details on how Lagrangian trajectories are computed since it is being considered as part of the methodology.

- **P24 li 630. ‘Moreover’ not needed.**

Removed

- **P25 li 648. ‘Besides’ not needed.**

Removed

- **P29 ;l 743. ‘Furthermore’ not needed.**

Removed

- **P29 li 751. I suggest rewrite as ‘for all seasons except spring, although some were able to’.**

Rewritten

- **P31 li 776. Remove ‘at the’..**

Removed

- **P32 Fig 14. Map font sizes are too small.**

Agreed. We have modified Figure 14 to make the font sizes bigger

- **P32 Fig 14 caption li 797. Delete ‘as’**

Removed. In addition, the date has been modified according to the period of analysis as mentioned in the text.

- **P32 li 808. Replace ‘determinant’ with perhaps ‘important’ or ‘most important’ or ...**

‘Important’ is used instead.

- **P33 li 830-831. Either ‘physically driven’ or ‘physical driving’.**

‘physical driving’ used instead.

- **P34 li 842. Replace ‘along’ with ‘in’.**

Replaced

- **P34 Fig 16. I can’t find a link to Fig 16 in the text although presumably it should be on this page.**

Thanks for the notice. Cross-reference to Fig. 16 has been included three times in this page.

- **P35 li 863. Remove ‘the’ before ‘Fig’.**

Removed

- **P36 li 880-881. Suggest rewriting as ‘...’and making routine maintenance tasks easier under these severe...’**

Suggestion accepted. Thanks a lot!

- **P36 li 881. Rewrite as ‘it is worth highlighting that under...’**

Rewritten

- **P36 li 887. Replace ‘still’ by ‘yet’.**

Replaced

- **P36 li 890. Remove ‘as usual’.**

Removed

- **P36 li 902-903. I wasn’t sure what the phrase beginning ‘ models, being these..’ was getting at. Perhaps replace with ‘models, which in turn will benefit from the future expansion of the HFR network’.**

Replaced

- **P37 Fig 17. The fact that HFR is a surface measurement and many applications require currents at depth (as mentioned in the text) could perhaps be added as a weakness.**

Yes. The fact that the HFR observations are limited to the very near surface has been considered as a weakness in the SWOT analysis of the companion paper (Lorente et al, 2021, accepted). The reference has been added in this manuscript.

And I was not sure what ‘Lock (should this be lack?) of the HFR data potential’ means?

The ‘lock of the HFR data potential’ refers to the limitations in the HFR interoperable data access that do not allow the leverage of the data in a systematic and dynamic way. This restricts the possibilities for delivering greater uptake, use and value from the collected data to its fullest potential. The unlocking data access and potential is aligned with so-called “democratization of data” ([Buck et al., 2019](#)), aiming to turn data into information, facing the further challenge of extending the science-based added-value products into societal relevant downstream services ([Tintoré et al., 2019](#)), impacting in how we use, manage and sustain our coastal oceans.

We have modified the sentence in the Figure 17:

“Lock of the interoperable data access”, followed by:

“Limited data uptake, data use and value”

I'm not sure why 'lower HFR frequencies than is usual in the Med' is a threat. HFRs operating at lower frequencies are available. Perhaps a weakness of the current network?

In order to provide early alerts of plausible tsunamigenic sources in the Mediterranean Sea, the extension of the HFR range is required, which imply operating at lower frequency bands than those usually employed in the Mediterranean. As detailed in the companion paper, the Mediterranean HFR network includes 15 different systems, which cover a small portion of the entire coastal domain (Fig. 1). The limited spatial coverage is not only due to the reduced number of HFR deployed but also to the predominant use of medium (13.5 MHz) and short (above 20 MHz) range systems. While these HFRs present a maximum range of 80 km, long range systems (which operate below 5 MHz and are typically deployed in the Atlantic European waters) can map the surface circulation over broader areas for distances up to 200 km offshore.

Long-range HFR systems are not deployed in the Mediterranean since they present some technical limitations in this semi-enclosed sea that seriously handicap the full coverage of coastal waters. On one hand, they provide surface circulation maps with coarser horizontal grid resolution (above 5 km), which are not convenient to adequately resolve some submesoscale ocean processes (i.e., eddies, instabilities, etc.) that commonly characterize the Mediterranean sea state. On the other hand, they cannot accurately monitor the wave field under low sea states as the second-order spectrum is closer to the noise floor (and more likely to be contaminated with spurious contributions) than in the case of short and medium range HFR systems. As the Mediterranean wave climate is not as intense as the Atlantic one, the use of long-range systems would result in limited precision and reduced temporal continuity in wave measurements (Lipa and Nyden, 2005).

- **P38 li 919. 'Finally' not needed'**

Removed

- **P38 li 935. Remove 'the' at the end of the line.**

Removed

- **P 38 li 943-944. Suggest rewriting as ' Accordingly a review of major scientific and social questions is needed including the environmental....'**

Rewritten

- **P39 li 969. I suggest something like ' held by companies or controlled by arrangements with the private sector'. I'm not sure what 'compromised to' means.**

Suggestion accepted. Many thanks

- **P40 li 986. I am stumped. What does ‘different compartment’ mean?**

Agreed. We have modified the text to make this clearer:

"In this context, it is worth mentioning that the HFRs multi-parameter monitoring of the sea state allows the development of diverse applications to tackle a wide range of coastal threats"

- **P40 li 996. A recent paper on applications to offshore wind power could perhaps be included in this list <http://dx.doi.org/10.21926/jept.2101005>.**

Reference added. Thanks!

- **P40 li 1003. Suggest a full stop after ‘sustainability’ followed by ‘It’.**

Suggestion accepted. Thank you very much

- **P40 li 1011. Suggest moving ‘will offer’ to after 2022.**

Suggestion accepted.

- **P42 li 1071. Replace ‘ones’ by ‘some’.**

Replaced

- **P43 li 1087. Replace ‘increasingly’ with ‘increasing’.**

Replaced