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Interactive comment on "Synergy between in situ and altimetry data to observe and study the Northern Current variations (NW Mediterranean Sea)" *by* Alice Carret et al.

Anonymous Referee #2

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In this manuscript, the authors use 1 Hz along track coastal altimetry from Jason-2/AltiKa in synergy with other data sources (HF radar, gliders, ship-mounted ADCP) to characterize the variability of the Northern Current flowing along Liguria and French coasts, in particular of the mean flow and seasonal cycles. The authors made a comparatively detailed analysis of the various data sets and described agreements/disagreements in the observed variability and the complementary contribution of each data set to advance the understanding at different scales. In addition to a regional view, the authors provide six case-studies at particular dates. This is a potentially worthwhile study to better understand the full capability of coastal altimetry and at what extent it can be used closer to the coast. This study has the potential to make

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a significant contribution, but I have two important remarks:

1) What is the novelty of this paper compared to previous papers that used the same CTOH 1 Hz along track coastal altimetry and focused on the same variability scales (i.e., mean, seasonal and inter-annual flow ?). The paper is not clearly explaining the scientific advance in terms of understanding Northern Current. I have the feeling that the paper describes data very well, but not answering scientific questions related to Northern Current dynamics. My recommendation is to reinforce the discussion (at present it looks like a summary) elaborating major findings in the context of the existing bibliography related to Northern current (from in situ, modelling, altimetry and other remote sensing studies).

2) It is well known that the 1 Hz (7 km) sampling in the coastal zone limits the exploitation. There are many papers that show clearly that longer temporal scales are well reproduced and that the actual challenging in coastal altimetry is to dig the finer ocean scales (along track) and cross-track merging missions (there are actually six missions flying at same time). We have now SAR mode providing improved native along track spatial resolution and better signal to noise ratio. We have retracked data for conventional missions that push resolution at 20 Hz. All these innovations are very promising to study high frequency mesoscale. For example, AltiKA has native resolution at 40 Hz, why reducing to 1 Hz ? I really recommend the authors to investigate data at higher sampling rate as this would be a really step in advance. Therefore, my position is major review as the results are not new, but potentially to become of high interest to the oceanographic community if authors re-focus the analysis on high resolution altimetry

Hereinafter additional comments:

Pg. 3, line 1, “Radar altimeters measure the sea surface height (SSH) variations”: the sentence is uncorrect. The radar altimeter transmit pulses. The system measures the time pulses take to be reflected back satellite. Time is then converted in distance, corrected for various effects and then referred to earth using orbit altitude (this is the

so called SSH). Please be precise

Pg. 3, line 2, “ever more accurate observations”: more accurate than what? Please clarify

Pg. 3, line 9, “the first global synthetic aperture radar (SAR, or Delay-Doppler) technique”: the term “SAR” has to be sued properly to avoid confusion. The reader would understand the first global SAR. SAR, also known as Delay Doppler, is a new coherent processing mode of individual echoes (conventional altimetry uses incoherently processing). Please better clarify

Pg. 3, line 10, “enhanced accuracy and reduced noise”: the use of the term “accuracy is wrong”. Reduced noise means better precision. The other enhancement is increased native along track resolution

Pg. 3, line 13, “the SWOT . . .a new step forward”: reference missing

Pg. 3, lines 14-15, “particularly important to monitor the sea level variations, directly related to our living environments and marine ecosystems”: This sentence is too vague. You have to better explain (in term of processes, e.g. flooding, etc.) why sea level changes are more important in the coastal zone than deep waters.

Pg. 3, line 16, “from these new altimetry techniques”: The statement is vague. Maybe use the term “modern altimetry” to include all technical improvements (Delay Doppler processing, small footprint) as well as reprocessed conventional altimetry (retracking, new/improved corrections, etc.).

Pg. 3, lines 17-18, “The strongest limitation is the modification of the radar echo in the vicinity of land”: here the reader might thing that the problem is only land contamination. Indeed, there are other effects , e.g. inhomogeneity of the water surface (Brown altimetry assumes homogeneous scattering). The authors have to be more rigorous here citing proper literature

Pg. 3, line 27, “new altimetry techniques are intrinsically less sensitive to the land

contamination": The statement is not correct. Again the term "techniques" is not appropriate. Moreover, land contamination cannot be used in general sense., e.g. SAR mode has few effect if the track is parallel to land.

Pg. 1, line 28, "They provide more robust and accurate measurements, ever closer to the coast": The athors have to provide figures about accuracy as function of distance with concrete examples from bibliography

Pg. 3, lines 29-30, "We can easily predict that the use of altimetry in coastal studies": the reader here expects illustrating major findings from these studies (i.e. state-of-the-art)

Pg. 3, lines 32-33, "Coastal observations are mainly based on in situ instruments and satellite imagery (sea surface temperature and ocean color images): I don't understand this sentence. The coastal observing system is multi-sensor, multi-platform. SAR imagery is especially useful in the coastal zone due to its high spatial resolution. The sentence has to be reworded.

Pg. 4, lines 1-2, "in a growing number of regions": Please provide examples

Pg. 4, line 2, "in conjunction": better using in "synergy"

Pg. 4, lines 4-5, "in situ observations cover more limited areas and often provide time series that present large gaps.": please provide examples. What means gaps in time series ? are you referring to tide gauges ? buoys? Please better clarify

Pg. 4, lines 6-7, "satellite imagery is often impacted by clouds and does not provide any direct information on the changes occurring in the water column.": the sentence is confusing the reader. Clouds might be a problem for optical imagery, but not for microwave sensors (e.g. scatterometry, SAR). Moreover, although satellites maps the ocean surface, it si possible to derive info in the water columns (one example is SAR detecting internal waves)

Pg. 4, line 8, "almost-global synoptic observations". Satellite altimetry provide global

coverage. Revisting the same place depends on the mission (e.g. Cryosat is drifting in orbits and revisits the same place in along time). What about “synoptic” ? e.g. Jason takes 10 days to get a global coverage. What do you mean with “almost”? – the sentence in unclear. The reader might be confused, e.g. an optical imagery is synoptic. Infor at all pixels is at same time)

Pg. 4, line 11, “conjunction”: use “synergy”

Pg. 4, line 13, “ideal”: use another word (e.g. laboratory and explain why in detail)

Pg. 4, line 14, “at all time scales”; clarify which scales (i.e. range).

Pg. 4, line 20, mesoscale variability is higher in autumn and winter”: Why higher in these seasons ? please explain

Pg. 4, line 25, “to partially capture”: please explain why “partially”

Pg. 4, line 26, “to provide original aspects of the regional circulation”: please explain “original aspects”

Pg. 4, line 27, “coherent circulation patterns”: please illustrate these patterns

Pg. 4, line 29, “found similarities”: which ones?

Pg. 4, line 33, “compared to the other coastal ocean observing systems”: please specify which coastal observing systems

Pg. 4, line 34, “Ligurian Sea”: better to use Ligurian-Provencal basin, because HF radars are not in the Ligurian Sea (as it is usually defined in term of boundaries)

Pg. 5, line 15, “The performance of SARAL is significantly better than Jason-2”: please provide references stating that with figures

Pg. 5, line 19, “SARAL tracks 302, 343 and 887”: why not using also the other tracks ?

Pg. 5, line 23, “Sea Level Anomalies (SLA) every 6-7 km: I am but surprised authors use this low along track sampling (7 km). As the novel aspect is the finer scale of ocean

circulation, the authors have to use the high res altimetry (350 m) that are reprocessed using re-tracking.

Pg. 6, line 2, “in Morrow et al., 2017, the data located over the continental shelf were discarded”: this is further point that support the need of using high res altimetry

Pg. 6, lines 1-4, “We did ....39 km for the SARAL track 343, 34 km for the SARAL track 887 and 67 km for Jason 2 track 222.. altimetry observations”: I see that Morrow et al., 2017 used these figures come from standard along-track data at 1 Hz (7 km) discarding data in the coastal zone. They found some figures about size of structures and optimal filtering. The authors here use reprocessed along-track data at 1 Hz with no retracking applied, but with more data coverage going to the coast. They found lower figures about size of structures. I am confused as we talk about average values and sampling is not changing. Is signal-to-noise better ? you have to demonstrate, because structures can emerge from background noise only the ratio is higher . I think the scale would only change (become finer) only if authors enhance resolution of their altimeter data. Moreover, the author do not explain why scales vary with close tracks.

Pg. 6, line 8, “35 km for SARAL”: why do you set 35 km if tracks have different scales? Please justify

Pg. 6, line 13, “from (Rio et al.,2014)”: change to “Rio et al., (2014)” Moreover, the authors have to demonstrate that this MDT is accurate going closer to the coast as in open ocean (this product was not generated to be used in the coastal zone)

Pg. 6, lines 29-30 “The ones being too short or moving too far away from an average trajectory”: please be rigorous in stating “too short” and “too far away”

Pg. 7, line 6, “points and the was too”: typo to correct

Pg. 7, lines 12-13, “compare the currents derived from these data with the currents measured or derived from the other instruments”: becareful that altimeter derived currents from altimetry are not equivalent to currents measured e.g. from ADCPs

Pg. 8, line 17, “HF radar is roughly 60x40”: is this the area covered? How much is accuracy of currents? Please discuss bibliography

Pg. 9, lines 4-5, “to altimetry data still remains limited in the 10- 15 km coastal band” The statement is wrong. With reprocessed high res altimetry tat adopts retracking one can go closer to the coast.

Pg. 9, line 19, “HF radars and altimeters observe the ocean surface”: altimetry provides geostrophic currents that are derived from SLA where tides and atmospheric effects (wind and pressure) are removed. HF radar provides the real total current at surface. . Also gliders provide only the baroclinic component of currents. ADCP measure currents at differet layers. Authors have to discuss in detail these differences.

Pg. 9, lines 33-34, “the gliders and altimeters are clearly the closest in terms of current information derived.”. I don’t agree. Gliders miss the barotropic component due to atmospheric effects that in the coastal zone is not negligible.

Pg. 10, line 22, “from March 2013 to October 2014”: I am not sure this is a good approach. Mean flows have sense if you average by month, season or annual.

Pg. 11, lines 1-2, “Fig. 2, where one can notice a very good consistency of the mean currents derived from all the different instruments.”

Pg. 11, lines 32-33, “HF radars ($\sim$-0.44 m/s) than in altimetry ($\sim$-0.29 m/s)”: Why this difference ? please explain.

Pg. 12, line 1, “we observe values of 0.12-0.2 m/s”: Mean values are around 0.3 m/s and variability is of same order of magnitude (more or less). Is this picture confirmed by bibliography ?

Pg. 13, lines 29-30, “The maximum NC current amplitude is defined as the average of the first decile of the velocity values for each transect and time”: please justify this definition

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