Ocean Sci. Discuss., 12, C969–C976, 2015
www.ocean-sci-discuss.net/12/C969/2015/

Ocean Science
Discussions

Interactive comment on "A combined quality-control methodology in Ebro Delta (NE Spain) high frequency radar system" *by* P. Lorente et al.

P. Lorente et al.

plorente@puertos.es

Received and published: 21 October 2015

Many thanks to Dr. Simone Cosoli for taking his time to read the manuscript and also for sharing his experienced point of view in the Open Discussion Forum.

Regarding comment 1: The ms faces an interesting topic - the quality control procedures for HF radars, and the bibliographic references seems to be updated and adequate. It uses some interesting approaches, based on the signal-to-noise ratios and other diagnostic parameters, as provided by the manufacturer monitoring software. However I feel this is also a major limitation and not a novel theme, especially for the SNR values that are used as qc metrics. If I am not mistaken, SNR in the manufacturer

diagnostic files refer to the best-working range cell, and do not provide any significant "fine-scale details" on how these Doppler lines values impact the accuracy of the final radar currents.

The manuscript presents a simplistic, preliminary approach based on additional data quality checks at the post-processing stage and devoted to monitor in real time a variety of nonvelocity-based indicators (shown in Table 1) through a dedicated online website. This web tool has been totally integrated in Puertos del Estado central hub with the aim of transitioning its four individual HF radar systems into a fully operational permanent ocean monitoring network, similar to other instrumental platforms – buoys and tide-gauges networks – implemented to efficiently monitor marine and coastal ecosystems. According to reviewer3's suggestions, in the new version of the manuscript we have provided a diminished focus on quality control and also placed less emphasis on SNR3 as quality indicator.

In this context, the proposed approach does not intend to use SNR3 values as a data quality index on a point-by-point basis but to apply SNR3 values and temporal evolution/changes as an indicator of site status and/or onset of system malfunction. The authors are fully aware of some previous studies have found that SNR3 is not a meaningful quality indicator when values are greater than about 6 - 10 dB, in concordance with Dr. Cosoli's statement (below) that "low SNR constraints are a necessary-but-not-sufficient condition for spikes".

Regarding comment 2: Figure 2 states "...The annual time serie of hourly SNR3 values for VINA site (d) reveals that the imposed thresholds of two standard deviations above/below the mean (bold blue dotted lines) are exceeded several times along June, reaching extremely low values which are related to a lower number of radial vectors provided by VINA site (e)..." this is not the correct interpretation - it should rather be the opposite: low snr values due to either noise, low-signal, interferences or whatever dictate the number of radial velocities - not the opposite. Cosoli et al 2012(b) investigated quite in detail the impact of SNR for the monopole on radar accuracies, suggesting that low snr constraints are a necessary-but-not-sufficient condition for spikes, and also the values of SNR at the two orthogonal loops should be investigated.

We fully agree with Dr. Cosoli that low SNR values dictate the number of radial velocities, as indeed it can be found in the third paragraph in section 4.1:

"The annual time serie of hourly SNR3 values for VINA site (Fig. 2 - d) reveals that the thresholds proposed in the present work (two standard deviations above/below the mean, represented by bold blue dotted lines) were abruptly exceeded several times in June. SNR3 reached extremely low values, leading to a drastic reduction in the radar spatial coverage presumably related to an inherent limitation of MUSIC algorithm. Consequently, the number of radial vectors (NRV) provided by VINA lowered significantly in June (Fig. 2 - e)."

. . . and it also can be found in section 5 (Summary and concluding remarks):

"The abrupt drop in SNR3 values of VINA impacted negatively on the number of radials provided and, subsequently, in the spatiotemporal coverage of total current vectors during June."

In Figure 2 caption, the expression "are related to" underlines the link between "low SNR values" and "low number of radial vectors provided by VINA site" but it does not establish cause-effect relationship where the low number of radial velocities is the triggering factor to cause low SNR values.

Nevermind, the caption of Figure 2 has been shortened (according to reviewer2's request) in order to avoid providing redundant information already presented in the text and also to avoid any kind of potential misunderstanding.

Regarding the SNR at the two orthogonal loops (SNR1 and SNR2), they are also routinely monitored through the online web tool integrated on Puertos del Estado central hub (as shown in Table 1) to evaluate HF radar site status in real time.

Regarding comment 3: Figure 3 and Figure 4 suggest the presence of significant dis-

tortions in the measured patterns, with presumable clustering of radial velocities along preferred directions. This is known to be a serious issue for DF radars and are blamed to introduce errors in the DOA estimates. Effects are not taken into account nor mitigation techniques are described - this should be accounted for somewhere in the text. Figure 4 shows some directional errors, which however appear not to be statistically significant at the typical angular resolution and the comparison range - some discussion should be probably added.

The directional accuracy of Ebro Delta HF radar system was rated at better than 8°. The statistical results obtained (and discussed in detail) are significantly good, within tolerance ranges and in accordance with those previously reported in the literature (Emery et al., 2004; Paduan et al., 2006).

It is also noteworthy that accurate measured antenna beam patterns (APMs) were performed in December 2013 and no relevant changes in the environment were detected during 2014. New validation exercises conducted during 2015 (not shown) have proved a consistent HF radar performance, so no evidences of any pattern distortion have been found up to date.

As far as we know, the clustering of radial velocities along preferred directions is an issue often related to rather complex APMs. According to the 'offline' comments provided by Qualitas Remos staff (partners of CODAR Ocean Sensors), this is not the case of Ebro Delta radar system, where the surrounding terrain is free of obstacles (as the radar sites are deployed in a marine protected area) and the topography is not intricate.

With regards to mitigation techniques, the following sentence can be found at the end of section 4.1: "In this context, the hourly radial vectors provided by VINA site in June that did not satisfy the proposed QC control have been discarded from the analyses performed in the next sections and the associated total vector maps have been accordingly reprocessed offline."

Regarding comment 4: Figure 8 lacks confidence intervals for power spectra, should be added.

As we fully agree with this suggestion, 95% confidence intervals have been added to Figure 8. In addition, a short sentence has been inserted at the end of section 3.2:

“Finally, rotatory spectral analyses (Gonella, 1972) have been performed for HF radar-derived total vectors at HFR1 location and for current data from B1 in order to identify the dominant modes of temporal variability. To ensure the continuity of the data record, small gaps detected (not larger than 6 h) in time series have been linearly interpolated. Spectra have been calculated by dividing time series into successive six day segments, with a 50% overlap and a Hanning window (Emery and Thompson, 2001), and subsequently averaged to provide some smoothing. Confidence levels for spectra densities have been derived assuming a chi-squared distribution for the variance.”

Regarding comment 5: An interesting EOF analysis is presented, with the complex-valued approach, though some authors suggest using the real-valued approach. They are presented as statistically significant- however no information is given on the confidence levels or on the degrees of freedom to support this statement.

Since EOFs are purely statistical, each EOF mode's statistical significance has been evaluated. Several rules of thumb have been previously proposed indicating when an EOF is likely to be subject to large sampling fluctuations. In the present work, error estimates based on temporal decorrelation scales have been calculated according to North et al. (1982):

$\delta(\lambda i) = \lambda i^*(2/N)(1/2)$

Where δi is the eigenvalue for mode i, and N is the number of degrees of freedom determined using a conservative two-day decorrelation time-scale, following Münchow and Chant (2000). If the confidence intervals from the error estimates of any modes overlap, the modes may be non-orthogonal and can not be considered distinct. Such

modes are thus excluded from the EOF analysis and then, the first previous modes can be considered to contain “a significant portion of the total variance”, as stated in the manuscript.

Here, only the first three EOF modes are statistically significant according to the mode selection rule and truncation criterion suggested by North et al. (1982). The first, second and third modes are distinct; however, the fourth mode is not since its error bars overlap with those of mode 5 (not shown). The first three EOF modes cumulatively account for the 46.1% of the variance for the raw (unfiltered) hourly time series of surface currents. Longer convergence rate is observed for higher-order modes since 150 EOF modes are required to reach the 95% cumulative variance threshold. The modes 4 and 5 represent the 3.66% and 3.24% of the variance, respectively. They are so close in terms of explained variance that the respective error bars clearly overlap, and then they must be left out.

To clarify this issue, a small paragraph has been inserted in section 3.3, summarizing the explanation presented above.

Finally, in section 4.3.2 has been also inserted the following explanatory piece of text:

“Since the EOF analysis has been performed on the unfiltered data set containing relevant high-frequency spatiotemporal variability, the first three EOFs cumulatively account only for the 46.1% of the total variance (26.1%, 15.3% and 4.7%, respectively). Only the first three EOF modes are statistically significant according to the mode selection rule and truncation criterion suggested by North et al. (1982). The first, second and third modes are distinct and uncorrelated; however, the fourth mode is not since its error bars overlap with those of mode 5 (not shown). Therefore, higher order modes will not be further addressed here as they represent a combination of unresolved high-frequency motions or noise”

References:

North, G.R., T.L. Bell, R.F. Cahalan and F.J. Moeng: Sampling errors in the estimation of empirical orthogonal functions, Mon. Wea. Rev. 110, pp. 699-706, 1082.

Münchow, A. and R.J. Chant: Kinematics of inner shelf motions during the summer stratified season off New Jersey, J. Phys, Oceanogr., 30, pp. 247-268, 2000.

Interactive comment on Ocean Sci. Discuss., 12, 1913, 2015.

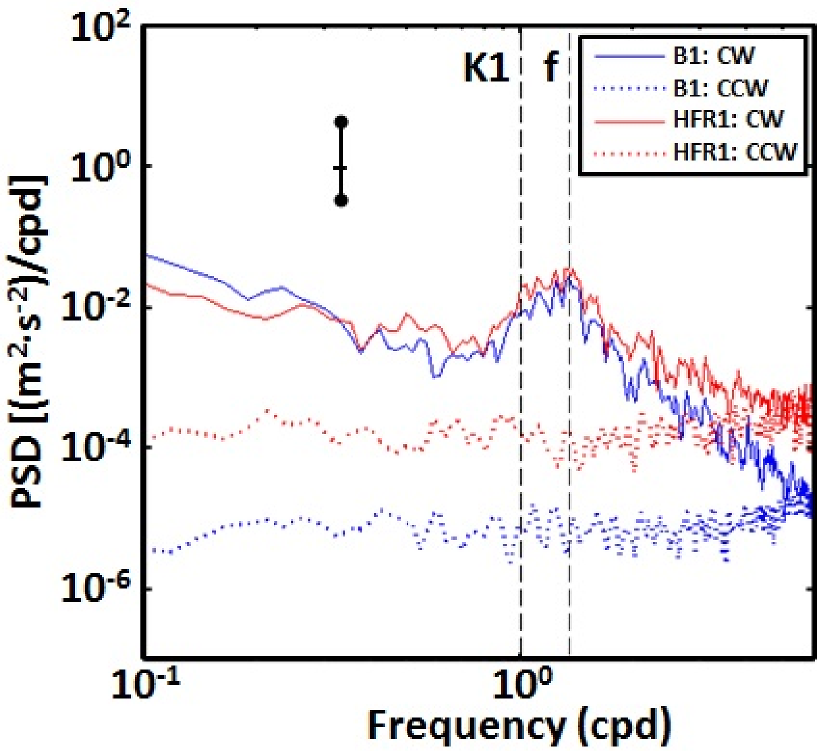

Fig. 1. Spectral density of the rotary auto-spectra of B1 buoy (blue) and HF radar at the closest grid point HFR1 (red), performed for a 6-month period May-October 2014 of concurrent records.