

Interactive comment on “A multi collocation method for coastal zone observations with applications to SENTINEL-3a altimeter wave height data” by Johannes Schulz-Stellenfleth and Joanna Staneva

Anonymous Referee #1

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This paper describes a method to extend the established ‘triple collocation’ technique, used to quantify errors in measurement and forecast datasets, for use in the coastal zone and other regions where correlation lengthscales are short, and/or where observed data are sparse. This represents a significant addition to existing literature on triple collocation with some novel impacts. The paper is well written and clear and, as such, I would recommend it for publication subject to some minor corrections and additional clarifications/discussion points as outlined below.

Clarification / Discussion points:

C1

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The suggested additional discussion points are focused around the description of measured data in section 3 and the results in section 4.

Clarifications required in section 3 are as follows:

- (with reference to previous studies, e.g. Janssen et al., 2007) a choice has been made to use satellite altimeter data in its 1Hz form, whereas these data have previously been super-observed in order to match a representation scale close to that of model or in-situ data. There is no particular issue in using the data this way, but possibly this impacts some of the later results regarding error variability. So could the authors please clarify the representation scales attributed to each of the data sources?
- (as part of the above) the dataset from the JCOMM verification project supplies two versions of in-situ observations; the raw values, and a QC'd value at synoptic hours but derived from a mean of the waves over several hours surrounding this time. It is not entirely clear which of these was used (my impression is the former?) and what QC/super-observing procedures were applied to these and the BSH data.
- in addition to the offshore oil platforms (downward facing lasers/radars) and waveriders, one or two points in the JCOMM dataset are, I believe, measurements at lightvessels. It is worth noting that a known low bias exists in the reports from these locations, due to the hull response of the platform (Anderson, G., Carse, F., Saulter A., and J. Turton, 2016: Quantification of Bias of Wave Measurements from Lightvessels. J Op Oceanography <http://dx.doi.org/10.1080/1755876X.2016.1239242>)

Discussion points in section 4 are:

- the result that the buoys have the smallest errors is different to Janssen et al (2007)'s findings, in which buoy data were found to contain large errors. Caires and Sterl (2003) found something more in line with this study. This raises a question as to how much the results of triple collocation are influenced by the choice of in-situ data and use of super-observation. Janssen et al 'smoothed' their data significantly in attempting to

use a unified representation scale (needed for data assimilation) and then explained the result for in-situ data as due to significant variations in the way in-situ data was processed (subsequent papers, e.g. Durrant et al 2009, seem to confirm this). In this paper the authors appear to have used the data in a more raw form and, although different platforms make up the in-situ dataset, behaviour within a regional observation network may well be more self-consistent than the global dataset used by Janssen et al. For the purposes of this paper, it would therefore be useful for the authors to contextualise the treatment of the study data and results relative to some of these past studies. This is in order that readers can correctly attribute some of the headline results about buoy/altimeter errors to the choice of data processing rather than the updated triple collocation method.

- some expansion on the comments in the paragraph starting at P15-Line7 are, perhaps, warranted. For example, there is significant location to location variability in bias within buoy clusters in open waters (Figure 6), a number of buoys have high relative uncertainties (Figure 7), and one location in the southern North Sea shows similarly high stochastic errors to the two outliers identified in the northern North Sea. Combined with the known bias issues for lightvessels (some of which I think are included in this dataset) I think these results present an opportunity to ask whether in-situ networks, whilst a desirable reference, truly provide the consistency needed in this context?

Suggested minor corrections to text:

P1-Line10: 'presented method allows use of a large variety'

P1-Line12: 'sources is too big to assume that they'

P2-Line12: 'room for improvement, in particular'

P3-Line22: 'an estimation of cross covariance' (delete leading 'to')

P4-Line3: 'the track to assume that all three instruments'

P4-Line9: 'the spatial variation of the "truth" are required'

P4-Line16: 'with a small number of samples'

P4-Line21: 'This includes a new step in the analysis, in which estimation errors are quantified.'

P4-Line22: 'Section 5 describes the combination'

P5-Line6: 'the "truth" cannot, in general, be represented by'

P5-Line9: 'the approach in eq. 4 allows the addition of higher order terms'

Figure 5: 'Bias and calibration errors were corrected for the model and satellite'; I'm not sure I understand this statement in the context of the figure, please clarify or remove.

P15-Line28: 'allows estimation of the errors of all'

P17-Line1: 'allow an estimation of the uncertainties'

P17-Line10: 'allows an estimation of the errors'

P19-Line2: 'In this study we considered only linear models, but this is not a restriction of the method, since more sophisticated functional forms (e.g., bilinear functions) can be easily integrated.'; Is it worth commenting that such forms are likely to be required in near coastal zones, where nonlinear processes are more likely to drive the spatial variations than in the offshore?

P19-Line13: 'allowed a demonstration of the usefulness'

P19-Line16: 'biased high, in particular at higher sea states'

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