REVIEWER #1:

General comments:

In this paper, the authors analyze the spatial distribution of decorrelation ranges on the east coast of Australia using the semivariogram approach. The decorrelation scale analysis at east coast of Australia is relatively new. Over all, the quality of the work done and of the manuscript are adequate. However, more details are needed in order to make the content clearer and more understandable. Below are some comments that I hope can be used to improve the manuscript.

We thank the reviewer for his/her positive comments. We have now enhanced the clarity of the manuscript and provided more details about the method and results. Please find the details below.

Specific comments:

1. More details of the equations are needed in order to let readers understand the method the authors use. For example: 1) Equation (1): what does "variance" rep resent in this equation? Variance of what? Please specify. 2) Equation (2): what the general physical meaning of this equation? Why is equation (2) more robust than equation (1)? What do the number 0.457 and 0.494 represent? Why the 4th square in this equation? The details of this equation is especially important because this is the whole paper based on. 3) Equation (3): The author explain the meaning of sill, nugget and the range in this equation, but what is the meaning of this equation in general? Why do the authors separate it into 3 sections (h=0, 0<h<r. . .. . .)? What are the 3/2 and 3rd square mean? What is the benefits and drawback of this equation?

Equation 1:

Variance of [Z(x)-Z(x+h)] is changed into $\frac{1}{2}\frac{1}{N}\sum(Z(x)-Z(x+h))^2$ *for more clarity.*

Equation 2:

We thank the reviewer for pointing out the need for more details to explain equation 2, which are now included in the manuscript.

"In this equation, the power ½ comes from a fourth-root of $[Z(x)-Z(x+h)]^2$ that reduces the skewness in the distribution, thereby approaching a Gaussian process. The 4^{th} square acts to correct the scale and returns the same units as equation 1, while the denominator adjusts the bias resulting from the whole transformation. This estimate is more robust statistically in the sense that the mean can be applied to the new distribution. Compared to equation 1, the semivariogram is only slightly modified for the highest lags when using equation 2, but the parameters (sill, range and nugget that are investigated in section 3 remain very similar."

Equation 3 is the definition of a classic spherical (or Matheron) model as opposed to other mathematical models such as a linear plateau, Gaussian or exponential models. They can all be fitted to semivariograms in order to extract the parameters of interest (see Biswas and Si, 2013, for a complete description of the different models). Two additional models were tested but were less adequate in terms of sum of squared error (sse) and adjusted R-square statistics for the fit (see last paragraph in section 2.2).

2. Figure 3 lower left panel. Compared with across-shelf Temperature, Salinity, Fluorescence and DO, the across-shelf distance of CDOM extends more than 20 km, while all other variables are limited to less than 20 km (left panel a, b, c, and d). Why is that? I didn't find the explanation in the manuscript. Please explain.

We thank the reviewer for pointing this out. Cross-shelf semivariogram for CDOM was performed for distance lags for which there were more than 5 glider missions as opposed to other variables (10 glider missions) for which the good fit allowed to be more selective and add significance to the statistics. Again, this is because statistics on CDOM appeared to be more challenging than other variables due to the poor quality dataset. The minimum of 30 valid data pairs per lag that was defined by Journel and Huijbregts (1978) is however kept, as in Doney et al. (2003). This is now specified in the manuscript. The extended data (lower threshold on the number of glider missions) required to successfully fit the mathematical model to the across-shelf CDOM semivariogram explains the extended x-axis (to lags up to 25 km) in Fig. 3 lower left panel.

REFERENCE:

Journel, A. G., Huijbregts, C.J., 1978. Mining Geostatistics, Academic Press Inc, London, UK

3. In figure 2, the authors separate the analysis into 12 months. Why not do the same for figure 3? Please explain.

While SST observations are provided every day with a good spatial coverage (except for cloud cover), glider missions are sparse and not numerous enough to break them down into months. As specified in the discussion, we expect that spatial scales may vary seasonally, particularly in the biological parameters. This will be tested when we have sufficient data in each season. We still believe that the monthly information supplied in Fig. 2 on top of the annual mean provides valuable information on how seasons may affect the variance, but barely the range of the SST.

4. Due to the method used here is highly empirical, the authors should discuss the advantages and limitations of the method.

A paragraph discussing the advantages and limitations of the method is now included in the discussion.

"As for all statistics, limitations arise from the amount of data used (especially along the shelf where the data density is smaller) and contamination of the dataset (for instance CDOM). In geostatistics, uneven spatial distribution of the observations over the analyzed area can be a limitation as well but remains difficult to quantify. The major advantage of the semivariogram method used is that it can be applied to sparse dataset like glider observations, as opposed to spatial autocorrelations for instance. It allows to objectively compare interesting parameters (range, sill, nugget) for different variables, directions and depths. In this study, the results compare well when using different statistical fits, and are consistent with expected outcomes based on previous knowledge of local dynamics and related studies in other regions."

5. Decorrelation scale is the analysis variable of this manuscript, and it is also one of the most important parameters in setting up data assimilation procedures. The authors mentioned the observational errors and representation errors in the data assimilation section, but they didn't

mention decorrelation scale at all, which should be the center of this paper. I suggest the authors to add discussion of decorrelation scale in this section. The following paper is an example setting up data assimilation projection space according to decorrelation scales: Pan, C., Yaremchuk, M., Nechaev, D., 2011. Variational assimilation of glider data in the Monterey Bay. Journal of Marine Research 69 (2-3), 331-346.

We thank the reviewer for the relevant reference. A paragraph has been added in the discussion (section 4.4).

"There are a variety of data assimilation systems based upon two broad approaches, ensemble methods (e.g. Oke et al. 2008, Jones et al., 2012) and variational methods, that minimize a cost function (e.g. Moore et al;, 2011). Regardless of the approach used, assumptions are made about the spatial footprint of an observation, for which a key parameter is the decorrelation length scale. Within the ensemble (e.g. Oke 2008) and hybrid (Pan et al., 2011) data assimilation approaches, covariance localization (Sakov and Bertino 2011) is used to increase the rank of the background error covariance matrix. The anisotropic (along-shelf and cross-shelf) ranges presented in this study and method used to derive them, allows for the direct calibration of the decorrelation scales enforced within most data assimilation systems that are currently in use. Additionally, estimates of how these decorrelation scales vary in time is also available (e.g. Figure 2), suggesting that an optimally tuned data assimilation system should allow for temporal variation in the localization or provide an assessment of the temporal variability of the ensemble from an Ensemble Kalman Filter (EnKF) system."

REFERENCES:

Jones, E.M., Oke, P.R., Rizwi, F. and Murray, L.M., 2012. Assimilation of glider and mooring data into a coastal ocean model. Ocean Modelling, 47, pp.1-13.

Moore, A.M., Arango, H.G., Broquet, G., Powell, B.S., Weaver, A.T. and Zavala-Garay, J., 2011. The Regional Ocean Modeling System (ROMS) 4-dimensional variational data assimilation systems: Part I–System overview and formulation. Progress in Oceanography, 91(1), pp.34-49.

Oke, P.R., Brassington, G.B., Griffin, D.A. and Schiller, A., 2008. The Bluelink ocean data assimilation system (BODAS). Ocean Modelling, 21(1), pp.46-70.

Pan, C., Yaremchuk, M., Nechaev, D. and Ngodock, H., 2011. Variational assimilation of glider data in Monterey Bay. Journal of Marine Research,69(2-3), pp.331-346.

Sakov, P. and Bertino, L., 2011. Relation between two common localisation methods for the EnKF. Computational Geosciences, 15(2), pp.225-237.

6. According to figure 1, all glider observations are confined within 200 m isobath. This means the decorrelation scales are all confined within 200 m isobaths. So how does this affect cross-shelf decorrelation scales?

As specified in the title, we only consider shelf dynamics and define the outer end of the continental shelf as the 200 m isobath, consistent with previous studies. The geometry of the shelf ('relatively narrow, between 16 and 70 km (mean of 37 km)' definitely influences the cross-shelf decorrelation scales, as specified in the manuscript. Still, the variability of cross-shelf scales found between different depths and different parameters and the isotropic patterns give new insights into the regional dynamics that are not only related to the geography of the area.

Minor comment:

Figure 1: “Across-shelf” does not seem to be a normal word. “cross-shelf” might be more appropriate.

This has been modified throughout the manuscript.

According to my observation, I believe this paper is well-organized. The method the author used is straightforward, and the figures support the results, although more details are needed to enrich the content. Therefore, I recommend minor revision.

We believe that the new version of the manuscript is now more detailed and improved, and thank the reviewer for his/her contribution.