Responses to Referee # 1:

Accurately forecasting the eddy propagation is a major challenge not only to consider the classes of response to atmospheric forcing but also considering the relative impact of the atmospheric forcing, updated boundary data and different ocean data types. The article of "A simple predictive model for the eddy propagation trajectory in the South China Sea" tries to build a predictive model using the multiple linear regression to predict the positions of the long-lifetime eddy tracks in the SCS.

Response: We greatly appreciate the reviewer for the time spending on providing the valuable comments. We made every effort to clarify our results and improve our manuscript according to the comments. Next our response to each comment will be labeled in blue.

Here, I disagree the reliability of this method applied to forecast the actual eddy track in the SCS because there are two main points:

1) The MCC method although more objective, still includes the assumption that displacements are translational and negate rotational and deformational motions, although Kamachi (1989) modified the MCC to include rotational effects. As they said these eight predictors: those from climatology and persistence and those "synoptic predictors" are geostrophic flows. Just like they found: "The synoptic predictors contribute less to the forecast equations comparing with persistence and climatology.", which means it mostly depends on the persistent inputs. It could be more accurate to regard this model as a diagnosing or corrected persistent forecasting.

Response: Thanks for the comment. During the past 20 years, mesoscale eddies in the South China Sea (SCS) have drawn much attention, and their statistical characteristics, generation mechanisms, and impact on the atmosphere and ocean have been widely studied (e.g., Wang et al., 2003; Chen et al., 2011; Li et al., 2017). However, studies on the forecast of eddies in the SCS are rare because of their complex dynamics and high nonlinearity. Just recently, Xu et al. (2018) used modern ocean dynamical model to predict two eddy cases in the northern SCS, found the eddy propagation paths can be predicted (forecast distance errors are 81-132 km from the third to fifth week) only when the eddy amplitude is larger than 8 cm. To the best of my knowledge, our work is the first attempt at forecasting the eddy propagation trajectories statistically in the SCS. Comparing to the dynamical method, our simple statistical method don't need boundary and forcing conditions and partial differential equation discretization, thus the computation is much faster than ocean models. Also our model is independent of eddy amplitude, and the forecast distance error is comparable with that of the dynamical model. Therefore, although our statistical model can be regarded as a diagnosing or corrected persistent forecasting model, it may provide an alternative and fast means for an operational forecast, which is especially useful to practical applications, such as naval military operation.

2) The currently results miss the independent validation. Page 4 Line 82-84: "To forecast the eddy trajectory 1-4 weeks in advance using the last position of the eddy, only eddies with a lifetime of 5 weeks or longer are retained in this study". It clearly shows the eddy tracks in 2009-2013 used for evaluation here have been artificially filtered, and results the underestimation of the related failure events. Consequently, this model cannot be regarded as a successfully predictive model and it is loss of enough values to be published on OS.

Response: Given the accuracy of satellite altimeter product and to avoid sporadic eddy events, eddy which lifetime is not shorter than 4 weeks is considered in the eddy detection and tracking (e.g., Chelton et al., 2011; Chen et al., 2011; Wang et al., 2003). Thus the 3rd release of the global eddy dataset used in this study discarded the eddies with lifetime shorter than 4 weeks by Chelton et al. (2011). To forecast the eddy trajectory 4 weeks in advance using the last position of the eddy, only eddies with a lifetime of 5 weeks or longer are retained. Table R1 lists the 1-3 week forecast results of the original eddy tracks with lifetime not shorter than 4 weeks and the "filtered" eddy tracks with lifetime not shorter than 5 weeks, which shows the forecast results are comparable and verify our predictive model is stable.

Table R1. Comparison of forecast distance errors (km) between the original eddy tracks with lifetime not shorter than 4 weeks and the filtered eddy tracks with lifetime not shorter than 5 weeks.

Forecast weeks	Original tracks	Filtered tracks
1	38.7	38.1
2	66.9	64.8
3	88.3	86.6

Specific Comments:

1) Before applying the MCC analysis to the images prepared, certain parameters describing the statistical method needed to be set like subwindow size, search window size as well as cross-correlation coefficient. What about their sensibilities? And finally what about the setting?

Response: Thanks for the comment. The MCC method used in this study is the same as that of Fu et al. (2006, 2009), which is a little different with that of Emery et al. (1986). In the method of Emery et al., the correlations of the image **in the subwindow** with all the neighboring ones in the whole window at the next time are computed, and the speed and direction of the maximum correlations can be estimated. While in the method of Fu et al., the correlations of the SLA **at a given location** with all the neighboring SLA at various time lags are computed, and the speed and direction of the maximum correlations can be estimated. The reason of their difference may be due to the low time-space resolution of SLA comparing with other infrared satellite images, such as AVHRR.

In the MCC method of Fu et al. (2009), the size of the time-space window for computing the correlations were determined by the time and space scales of interests. To focus on the global mesoscale eddy, the time lags were limited to less than 70 days and the dimension of the window was less than 400 km. However, the time lags should be limited to less than 42 days in the SCS, since many correlation coefficients are below the 95% confidence level at larger time lags (Zhuang et al., 2010). Besides, Chen et al. (2011) found that eddies propagate with 5.0-9.0 cm/s in the northern SCS. Thus the search radius can be generally limited as 300 km (9.0 cm/s*42 days≈300 km) to reduce incidence of spurious MCC vectors. We add several sentences in the introduction of MCC method to clarity the parameters and their setting.

2) Here all SLA data and eddy dataset have a time resolution of 7 days. In fact, the new version based on the DT-2014 daily "two-sat merged" sea level anomaly (MSLA) fields (formerly referred to as the REF dataset) posted online by AVISO for the 22-year period January 1993–April 2015. So using the daily dataset could be more interesting, and some new knowledge can be expected.

Response: Thanks for the comment. Since the maximum westward propagation speed is about 20 cm/s in the subtropics (Chelton et al., 2011), the maximum propagation distance in one day is about 17.3 km, which is less than one grid dimension (25 km) of AVISO SLA. This may cause some uncertainties in the eddy trajectory forecasting using the daily dataset. Therefore, the weekly SLA data is still used in the eddy forecasting exercises (Oey et al., 2005; Zeng et al., 2015, and Xu et al., 2018).

3) Chen et al. (2011) also find that “Eddy propagation in the western basin to the east of Vietnam is quite random, with no uniform propagate direction”. Are there some effects or comments to that?

Response: The generation mechanism of eddy in the western basin to the east of Vietnam is complicated. Many dynamical factors may contribute, such as the wind jet, the eastward current, the flow instability and the coastal and island topography. It is also found that eddies associated with the eastward current is under the impact of the wind jet, which shows intraseasonal variability (Xie et al., 2007). We suppose these underlying factors may cause eddies in this region propagate with no inform direction.

4) The right panels of Fig. 2 showing the differences which should keep the nan areas as in (a) and (d).

Response: Corrected in the revised manuscript.

5) Page 9, Line 217: "there are a total of 8 regression equations"? Could you provide the related formal or equations to clearly distinguish the explanatory variables, the response variables, and the input regression data sources?

Response: Thanks for the suggestion. The predicted zonal (meridional) displacement *DX* (*DY*) can be estimated using a multiple linear regression approach:

$$DX_j = \sum_{i=1}^{8} a_{i,j} P_{i,} \qquad j = 1, 4 \tag{1}$$

$$DY_j = \sum_{i=1}^{8} b_{i,j} P_{i,} \qquad j = 1, 4 \tag{2}$$

where the subscript j refers to the forecast interval (1-4 weeks), the subscript i refers to the serial number of eight normalized predictors (P), a and b donate normalized regression coefficients of predictors onto *DX* and *DY*, respectively. To distinguish the input predictors, the forecasted variables, and the related regression equations clearly, we revise Table 2 and 3, add a new Table 1, and add Section 3.2 to describe these in the revised manuscript.

6) Figure 5 only shows one trajectory. Could you replaced by all trajectories in the SCS during the same time periods, which could be more objectively to explore the credibility of this method.

Response: Thanks for the suggestion. For the sake of concise layout of the paper, we only selected two cases from all the 74 forecasted results to show the comparison. To verify the credibility of this method, the forecast distance errors of all the predicted eddy trajectories over a 4-week window are shown in Figure R1.

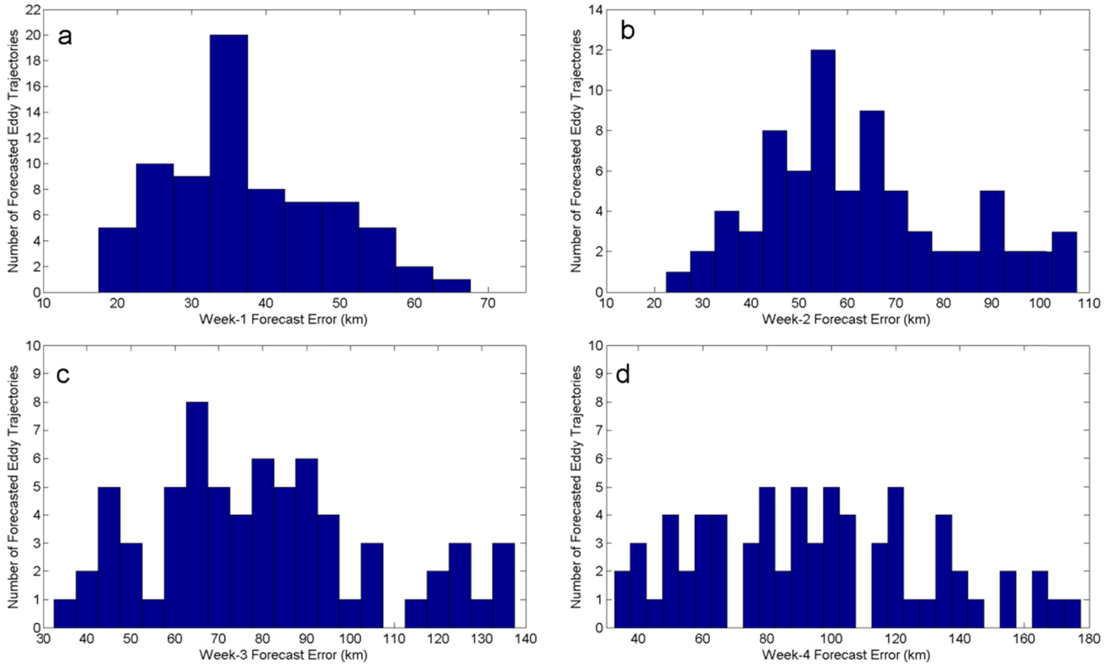

Figure R1. Histogram of the forecast distance errors of all the predicted eddy trajectories at week-1 (a), week-2 (b), week-3 (c) and week-4 (d).

7) The predictive equation should explicitly presented in text. Although the effects of planetary beta and mean flow advection are highlighted many times, the quantitative effect on the inputs or the predictive equations still are not clear.

Response: Thanks for the suggestion. (1) In the revised manuscript, the predictive regression equations have been presented in two equations of Section 2.3, and their coefficients have been shown in Table 3 in the revised version. (2) Actually, the climatological eddy zonal and meridional motions (U_CLIM V_CLIM) derived from the MCC method consist of the effects of beta and the mean flow advection. We have decompose U_CLIM and V_CLIM into these factors and incorporate them into the regression model, but found no improvement of the forecast skill. We add several sentences in Section 3.2 to clarify it.

8) Page 5, Line 99: whether the cross-correlations have been normalized by the variances of the two time series?

Response: Yes, the cross-correlations have been normalized by the variances of the two time series.

9) Page 6, Figure 2 only show at north of 12N. Does it mean this study only investigate the eddy tracks in the northern SCS. If right, the concerned statement and title should be replaced by the northern SCS.

Response: Yes, this study only investigates the eddy tracks in the northern SCS. We have revised the statement and title using the northern SCS (NSCS).

10) Page 9 Line 198: Are the climatological eddy motions divided into 12 months or only annual mean?

Response: The climatological eddy motions are divided into four seasons (winter: 12-2, spring: 3-5, summer: 6-8, autumn: 9-11), since the mean flow and associated eddy propagation in the SCS have seasonal variability. We add several sentences in Section 2.2 to clarity it.

11) Based on the 17 years (1992-2009) of satellite altimeter data, Chen et al. (2011) identified 827 eddy (lifetime >=28 days) tracks in the SCS. However, here uses 1981 eddy trajectories during 1992-2008. Why there are so big gap between them?

Response: Thank you for the comment. 1981 is the number of eddy trajectory segments (a segment refers to the distance between two neighboring eddy center positions at 7-day interval on a single eddy trajectory), not eddy number. We add one sentence in this paragraph to explain this.

12) The eddy forecast error has been discussed by Hurlburt et al. (2008). Related to the previous evaluation, it is valuable to comment.

E. Hurlburt, Harley Chassignet, Eric A. Cummings, James Birol Kara, A Metzger, E F. Shriver, Jay Smedstad, Ole J. Wallcraft, Alan N. Barron, Charlie. (2008). EddyResolving Global Ocean Prediction. Washington DC American Geophysical Union Geophysical Monograph Series. 353-381. 10.1029/177GM21.

Table 2: Eddy center location errors in ocean prediction models compared to ocean color from SeaWiFS in the northwestern Arabian Sea and Gulf of Oman

Response: Thanks for the comment. Because mesoscale eddies are often associated with strong nonlinear processes and their dynamical mechanisms are quite different, the operational forecast of eddies has been a big challenge to ocean numerical model. Much progress has been made in recent years in eddy-resolving ocean prediction. With the data assimilation and the increasing of model resolution, the model increases forecast skill. Eddy center position daily forecast errors in the northwestern Arabian Sea and Gulf of Oman is 44-68 km in $1/12^{o}$ global HYCOM model, and reaches to 22.5-37 km in $1/32^{o}$ NLOM model (Hurlburt et al., 2008). The forecast skill and predictability of dynamical models can only be increased by better assimilation schemes (initialization), sufficient data (especially the subsurface), and improving resolution (physics and computing power). We have added this reference and some sentences in the second paragraph of Section 1 in the revised manuscript.

13) In this study, the distance errors are presented by degree or km only. The relative error considering the eddy radius is more important to directly understanding the uncertainty.

Response: Thanks for the comment. Actually, we once considered the relative errors by normalizing the forecast distance errors with the Rossby radius on each forecast grid. Figure R2 shows the differences and correlation of relative errors between the persistence method and the proposed method over 4-week forecast window. Their correlation decreases from 0.67 at week-1 to 0.38 at week-4. This conclusion based on the relative errors is consistent with that of the comparison of forecast distance errors between the two methods: although the persistence forecast trajectory at week-1 is relatively consistent with the observation, the persistence method cannot forecast the eddy trajectories properly when the forecast horizon increases. Considering the forecast distance errors presented by km have been widely accepted by operational ocean eddy forecasting (e.g., Oey et al., 2005; Zeng et al., 2015) and tropical cyclone track forecasting (e.g., Aberson et al., 2003; Ali et al., 2007), the forecast distance errors by km is still used in the evaluation of forecast performance for the convenience of common readers.

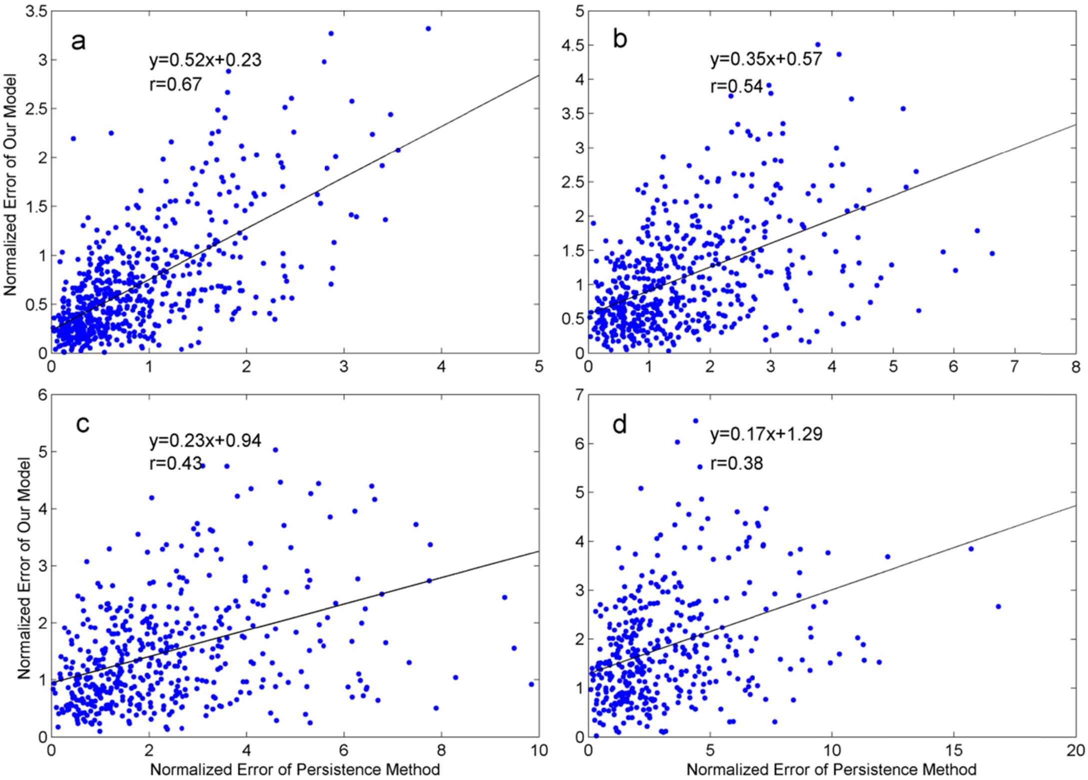

Figure R2. Scatterplot of the normalized forecast distance errors of persistence method vs. the normalized forecast distance errors of out linear regression model with best fit linear regression at week-1 (a), week-2 (b), week-3 (c) and week-4 (d).

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