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Interactive comment on "Could the mesoscale eddies be reproduced and predicted in the northern south China sea: case studies" *by* Dazhi Xu et al.

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General comment: The related studies about the mesoscale eddies in the SCS have amount of achievements, especially owing to the altimeter data widely applied, for understanding the dynamic and the interactions with the environmental current circulations on large scale. The article of "Could the mesoscale eddies be reproduced and predicted in the northern south China sea: case studies" would like focus on two anticyclonic eddies in the northern SCS (NSCS). By helps of a HYCOM-EnOI assimilation system, they found the key of the predictable issues about the eddy generation, evolution and propagation paths can be done well only when the eddy

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Discussion paper

amplitude is larger than 8 cm. Clearly, this topic is interesting for deep understanding the real factors to limit the eddy's forecast performance. The used methods, the related experiments, the main conclusions in this study are creditable. But there are obvious some errors in text and figures/tables, this version needs to be more clear to state the findings and the concerned writings, although don't need to add more experiments. The main comments and some found errors are listed as follow: Ans: We greatly appreciate reviewer for the time and energy spending on reading our manuscript and providing constructive comments and suggestions. We totally agree with the reviewer and we made every effort to clarify our results and improve the manuscript. The revised version reflects these changes. The detailed comments have been replied one by one below. Once again, thank you very much for your significant comments and suggestions, which are valuable in improving the quality of our manuscript. 1) Under the current introduction, the reasons why to choose the two eddies in the north SCS are not clear enough. It means the necessity and the representative still need to be highlight. For example, complement the more details about these two eddies: the lifetime (Section 3.1); all the related references; methods and main points in Wang et al. (2008) and then relate to the aims in this study. Ans: Thank you for these comments. The introduction has been revised, the lifetime, evolution and propagation of these two eddies has been described in the revised versions. (P2 line 31-44). 2) The eddy amplitude of 8 cm is a main finding in this study. For my opinion, it should have a relation with the SLA error in this system. Before the comparison of the eddy paths under different conditions, it is important to evaluate your simulated SLA (like in As_exp) to know how about the uncertainty. So one paragraph should be added. Ans: Thank you! The paragraph which describe the evaluation of the uncertainty of the CSCASS has been added in the revised versions. (P8, line 169-174). 3) It is important to clearly define how to objectively evaluate the eddy reproduction is well. In this study, the compared result is referred to the buoy trajectory and the detected by altimetry. Clearly, the related formula as possible can relate to these two elements. It will be helpful to simple and conclude in Table 2 and 3.

For instance, P6 L230 “From Fig. 4 and Table 2, we can see that the generation and movement of AE1 can be well reproduced by the CSCASS . . .” add the related error statement and then objectively to know reproduced well or not. Ans: Thank you for your constructive advice. In the revised version, we used a dimensionless index called advective nonlinearity parameter (Chelton et al., 2011, Li et al., 2014; 2015; 2016; Wang et al., 2015), which expressed like this the maximum rotational speed U divided by the translation speed c of the eddy, that is U/c (P9, line 176-180). As Fig.5 shows, if the U/c > 2 the CSCASS can well reproduce AE2. 4) P 1 L 51: “. . . high resolution satellite images or numerical model simulations (Yang et al., 2000), . . .” needs to add more reference about the recent key findings about mesoscale eddy both from satellite and modelling like as following: Fu, L.-L., D.B. Chelton, P.-Y. Le Traon, and R. Morrow. 2010. Eddy dynamics from satellite altimetry. Oceanography 23(4):14–25, https://doi.org/10.5670/oceanog.2010.02. Morrow, R. and Le Traon, P.-Y. Recent advances in observing mesoscale ocean dynamics with satellite altimetry. Adv. Spa. Res. 50, 1062–1076 (2012). Frenger, I., Gruber, N., Knutti, R. & Münnich, M. Imprint of southern ocean eddies on winds, clouds and rainfall. Nat. Geosci 6, 608–612 (2013). Ans: Thank you! The references have been added in the revised versions. (P1, line 10-11). 5) L 52: “. . . the operational forecasts of the mesoscale eddy still poses a big challenge because of its complicated dynamical mechanisms and high nonlinearity (Yuan and Wang, 1986; Li et al., 1998).” These references are not suitable because they are not related with ocean operational forecast and were published more than 20 years out of representing the recent knowledge. Some references are recommended as follow: De Vos, M., Backeberg, B. and Counillon, F.: Using an eddy-tracking algorithm to understand the impact of assimilating altimetry data on the eddy characteristics of the Agulhas system. Ocean Dyn., https://doi.org/10.1007/s10236-018-1174-4, 2018. Robert H. Woodham, Oscar Alves, Gary B. Brassington, Robin Robertson & Andrew Kiss (2015) Evaluation of ocean forecast performance for Royal Australian Navy exercise areas in the Tasman Sea, Journal of Operational Oceanography, 8:2, 147-161, DOI: 10.1080/1755876X.2015.1087187 Treguier Anne-Marie,

Chassignet Eric P., Le Boyer Arnaud, Pinardi Nadia (2017). Modeling and forecasting the "weather of the ocean" at the mesoscale. J. Marine Research, 75(3), 301-329. http://doi.org/10.1357/002224017821836842. Ans: Thank you! The references have been added in the revised versions. (P1, line 13) 6) P3 L87: ". . . thus is essential for the prediction of mesoscale eddies (e.g., Xiao et al. 2007; Xie et al., 2011; Xu et al., 2012; Xie et al., 2018)". The concerned assimilation works done in the NSCS needs be commented, and then to be pointed the disadvantages to relate the aims in this study. Xiao, X., Wang, D., Yan, C., and Xu, J.: The assimilation experiment in the southwestern South China Sea in summer 2000, Chinese Sci. Bull., 51, 31–37, 2007. Xie, J., Bertino, L., Cardellach, E., Semmling, M., and Wickert, J.: An OSSE evaluation of the GNSS-R altimetery data for the GEROS-ISS mission as a complement to the existing observational networks, Remote Sens. Environ., 209, 152-165, doi:10.1016/j.rse.2018.02.053, 2018. Xie, J., Counillon, F., Zhu, J., and Bertino, L.: An eddy resolving tidal-driven model of the South China Sea assimilating along-track SLA data using the EnOI, Ocean Sci., 7, 609–627, doi:10.5194/os-7-609-2011, 2011. Ans: Thank you! The references have been added in the revised versions. (P3, line 56) 7) P5 L131: Are there some cases using this detection scheme in the SCS? Yes, give the reference, otherwise provide a simple snapshot to show its ability. Ans: Yes, Cheng et al., (2005) used this detection scheme to study the seasonal and interannual variabilities of mesoscale eddies in South China Sea. (P5, line 90) 8) Table 1 lists the designed experiment time. For instance (my personal point), the experiments designed by the eddy strength should be highlighted using one figure to replace the table. On this figure, the eddy strengths of AE1 and AE2 are curved as a function of the date, and the experimental date at beginning also are marked on by vertical lines. Ans: Thank you! According to your advice, we use Fig.4 to replace table 1. (P24) 9) Table 2: The dates of the first weeks need to be stated. What the differences between "Amplitude" and "Intensity"? As the statement of P4 L127 "the intensity of the mesoscale eddy must be greater than 2 cm;", how the observed amplitudes of AE1/AE2 less than 2 cm? Are they the error or others? And to compare the amplitudes

in the first and the second weeks, can comment the big gap? Ans: Thank you! The dates of the first weeks have been added to table 2 (in the revised version is table1); In the original version, the intensity is the difference between the extremum and the outermost closure of SLA; the amplitude is the difference between the extremum and the zero of SLA. In the revised version, the amplitude is the difference between the extremum and the outermost closure of SLA, and the do not use the intensity. The observed amplitudes of AE1/AE2 less than 2 cm are errors. 10) Use the same color in the panel f of Figure 9-11 as the other panels of Fig. 6-8: the blue (red) is forecast (observation), and using full or empty mark to distinguish AE1 and AE2. Ans: Thank you! The related figures have been revised in the revised versions. 11) There are interested finding in Figure 12: at the first stage of AE1 and AE2 the distance error looks decreasing; at end stages the distance error increasing with time. Can you explain the former? Ans: Thank you! As our results show, at the first stage of AE1 and AE2, they are in strong intensity stage or become more and more strong. The CSCASS, after assimilated SLA, can well reproduce these eddies. But at the end stages, the signals become weak, so the CSCASS can not catch even assimilated the SLA. 12) In Figure12, add another referenced eddy distance line from As_exp. It will be interesting to compare these two lines to show the predictability if without data assimilation. Ans: Thank you! The eddy distance line from As_exp has been added to Fig.12 (in the revised version is Fig.14). 13) Recommend to replace the title by "Could the two anticyclonic eddies during winter 2003/2004 be reproduced and predicted in the northern south China sea?" Ans: Thank you! The title has been revised in the revised versions. Technic comments: Figure 3 is too ambiguous. Ans: Thank you! This figure has been changed in the revised versions. P1, L62: "... (Fig. 1). Forced . . ." the intensity of the mesoscale eddy must be greater than 2 cm; Ans: Thank you! The word 'Forcing' has been changed to 'Forced' in the revised versions. P5: The paragraph introduces the ocean model should be shorten like deleting the lines of 140-150. Ans: Thank you! The sentences have been deleted in the revised versions. P7 L 170: ". . . as a surface forcing from Legates and Willmott (1990)." Legates, D.R., Willmott, C.J.,

1990: Mean seasonal and spatial variability in gauge-corrected, global precipitation. Int. J. Climatology, 10, 111-127. Ans: Thank you! The reference has been corrected in the revised versions. P7, L172: missing the reference of “Han (1984)”. Ans: Thank you! The reference has been added in the revised versions. P7, L 183: EnKF as the first place should give the detailed name. Ans: Thank you! The detailed name of EnKF has been added in the revised versions. P9, Section 3.1: The AE2 lifetime was not clearly stated so the first (last) identified date needs be mentioned. Ans: Thank you! The first (last) identified date of AE2 has been added in the revised versions. (P2, line 38, line 43) Table 3: “. . . distance of eddy centers between the observation SLA’s . . .” are missing on the content. So double cheek the consistence in caption. Ans: Thank you! The distance of eddy centers for forecast experiments have been added in the revised versions. (in the revised version is table 2) Figure 12: The cyan line is hard to see so change it to be black. The histogram should use the rectangle to present well other than circle and triangle. L631:“The red and green histograms indicated the AE1 amplitudes from observation and prediction respectively.” Ans: Thank you! The sentence has been corrected; The circle and triangle have been replaced by the rectangle in the new figure 12 (in the revised version is Fig. 14). Due to the black line has been used to denote AE2, we still use the cyan line denote to AE1 in the revised versions. The wrong order of the references is clear like: P18 L 414 Bleck et al. (2002); P18 L421 Counillon and Bertino (2009); P18 L433 Hamilton et al. (1999); P19 L444 Kara et al. (2002); P20 L475 Rio et al. (2014); P20 L487 Woodruff et al. (1987) Ans: Thank you! The order of the references has been corrected in the revised versions.

Please also note the supplement to this comment:
https://www.ocean-sci-discuss.net/os-2018-74/os-2018-74-AC1-supplement.pdf

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