Review
On the paper
"Application of Hybrid Data Assimilation Methods for Mesoscale Eddy Simulation and Prediction in the South China Sea"

This paper is devoted to the comparison of two data assimilation methods applied together with the Regional ocean model ROMS configured over the South China Sea. Also, this paper contains many interesting results presented in the studied region that appeared after the Data assimilation. My opinion is that this paper has sufficient material to be published however, I would like to see more distinguished presentation of the data assimilation algorithm(s) and their more formalized (mathematically based) basis. More detailed: I would like to see (in the text) the clarity of the following points:
1. The detailed description of the DA algorithm(s) step by step, not only formulas including their parallelization scheme
2. Where are the novelties? More specifically
3. Why is the Gaussian distribution used (formulas 2,3) and how the covariance matrix is found out (estimated?). As I understood the covariance Q is known a priori but Sigma is sought on each assimilation step. It is very expensive as I think, but if I am not right, please explaining.
4. Weight coefficients which are seeking with respect to formulae (5) are not fully clear for me. Please, give at least an idea why? Are they the solution of maximum likelihood equations? This is not obvious at all.
5. The paragraph containing the expressions for IEWVPS algorithm also are not fully clear. I recommend to rewrite it more detailed. This is not only for me but also for readers.
6. Figs 4 and 5 do need more explanations. Prior means forecast? Posterior means analysis? Please use the common terminology.
7. I think the analysis of those figs needs more words and is not enough. For instance, is the shown difference between curves means something? If yes, what namely?

Minor remarks.
Line 12. "particle filter (PF)" –this is not a common term, therefore, please define what you mean
Line 143 and others. Does vertical line in formulas mean the conditional density? Define this for clarity.
Line 173, formula 6. For Jacobian it is better to use its standard notation J
Line 194 and others Why do you use symbol $\propto$ instead of =?
Lines 208-220 What were the lateral boundary conditions for currents?
Line 243, formula (14). Could you justify formula 14 and how the ensemble variable(s) x depend on sigma (numerically, not formally)?

Resume. I recommend this paper for publication after revision which should take into account my remarks.