

## ***Interactive comment on “A pre-operational 3-D variational data assimilation system in the North/Baltic Sea” by S. Y. Zhuang et al.***

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The manuscript presents a study about a 3DVAR assimilation system for the North Sea/Baltic Sea. The system uses core components which can be found in the literature. The methodology is explained and statistical results are given. We appreciate the discussion of coastal zone specific assimilation issues. The paper is relatively well structured and the results look convincing. The presentation of the material could be improved in some places. For example the presentation of the re-cursive filter is hardly understandable for somebody who is not familiar with the subject. More detailed information on the minimisation procedure should be added. What is the termination criteria ? How many iterations are typically required ? How much computer time is needed ? A comparison with observations, which are not used in the analysis would

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have been nice, but due to the realively long correlation length and times one can more or less imagine how those comparison would look like. Did the authors observe any impact of the analysis in the barotropic part ? Discussion of an interesting case (front etc) would have been nice and would also have helped in the explanation of the scheme. The english should be checked by a native speaker. We recommend publication after minor revisions

Reply:

We appreciate the comments of the reviewer. The manuscript presents DMI's efforts in the context of ECOOP towards an operational assimilation system that is able to combine observations from different platforms. The impact of the analysis in the barotropic part is not addressed. At present, the RMSE and biases are calculated to reveal an overall effect of the assimilation system. In follow-up studies, we will present more detailed results in the North/Baltic Sea and examine specific phenomena such as salinity front in the Kattegat. The English is checked and some sentences are rephrased.

In respect to the 3DVAR, minimization is sought by a quasi-newton L-BFGS method (Byrd et al, 1995). The typical number of iterations is about 28 and varying with time. The criterion of termination is set to 50.

Specific Comments:

Q1:Abstract, line 10: please reformulate/correct ".. that no assimilation is done."

Thanks. The sentence is reformulated as 'Effect of the data assimilation scheme is assessed by comparison with observations.'

Q2: page 1133, line 11 : The statement sounds like it is not possible to assimilate 3D observations with a Kalman filter in general - please be more specific.

Thanks. The sentence is revised as 'However, the Kalman filter is heavily reduced to only address the surface SST data. The computational cost is largely reduced accordingly. Practically, it is difficult to adapt the coding for the assimilation of three

dimensional (3-D) observations. In consideration of computational cost and technical maintenance, a 3DVAR scheme is intended for a pre-operational assimilation system. In this implementation, it is capable of assimilating the increasingly expanded ocean measurements from various platforms'

line 21: " .... satellite ... relatively poor ..." This statement is too general - what kind of data are you talking about ?

Thanks. This sentence is revised as 'In addition, quality of satellite observations such as SST and SSH is relatively poor in coastal waters than open seas because the data is more influenced by the cloud cover in the coastal regions.'

Q3: page 1134, line 12 : " ... more efficient approaches .." it is not at all clear what you mean by "efficient"

Thanks for the comment. The sentence is rephrased as 'As compared to 4DVAR and EnKF, 3DVAR or Optimal Interpolation (OI) are more computationally efficient. This is beneficial for an operational forecasting systems.'

Q4: page 1137: line 12 : " ... realively uncorrelated." please reformulate, e.g., " .. the covariance matrix of  $v$  is the identity matrix."

Thanks. This is reformulated as 'when the control variable vector  $v$  is chosen, errors of the variables inside are assumed to be uncorrelated. '

eq. 15: the description of the vertical error covariance is a little bit confusing. Is a parametric form (eq 15) used instead of empirical functions ?

Thanks. A few lines is added to address equation (15) in a more detailed way. In fact, the correlations between different levels in the vertical are calculated by the empirical function. Due to the huge size of the control vector, EOF is used to reduce the computational cost. For our model, there are 50/52 vertical levels for the coarse/fine resolution model, but the number of dominant EOFs (about 10) is less than that.

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Q5: page 1144: line 14: something wrong with observation location The use of relative quantities like, e.g. the forecast skill, to quantify the assimilation performance would have been nice.

Thanks. The longitude/latitude of the location is corrected. More evaluation of the 3DVAR system will be presented in a follow-up study, which involves more quantities such as the forecast skill, standard deviation, variability, etc. Some analysis will also be conducted for specific phenomena like salinity fronts in Kattegat.

Figure 8: units missing

Thanks. Corrected.

Figure 7: units missing

Corrected.

Figure 9: units missing

Corrected.

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