Geosci. Model Dev. Discuss.,
doi:10.5194/gmd-2016-44-RC2, 2016

Geoscientific Model Development Discussions
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EGU

Interactive comment on "East Australian Current region using the Regional Ocean Modelling System (ROMS 3.4) and Incremental Strong-Constraint 4-Dimensional Variational data assimilation (IS4D-Var)" *by* Colette Kerry et al.

Anonymous Referee #2

Received and published: 14 April 2016

Specific Comments: Page 2, Line 18: Sentence beginning with: "Much of the effort . . ." This sentence is awkward to read. But more importantly see: O'Kane, T.J., Oke, P.R. and Sandery, P.A., 2011. Predicting the east Australian current. Ocean Modelling, 38(3), pp.251-266. for additional work in this area.

Page 2, Line 25: You state that a major advantage of the 4D-Var system is the fact that it relies on a linearised version of the governing equations. It could be contested that this is in face a disadvantage in highly non-linear systems and the assimilation window needs to be shortened such the the system behaviour is quasi-linear. I suggest you

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make it clear at this point that there are also some limitations (as all systems have), that need to be accounted for.

Page 5, Line 33: “downward tilt”, this is not a very intuitive description of the thermocline position. e.g. Does this mean the thermocline is uplifted near the shelf break, or depressed near the shelf break?

Page 7, line 4: In this para you give a high level description of the way IS4D-Var work. I suggest you add an additional sentence explaining what the increment is. In the previous para you say the observations are used to constrain the model increments, again without introduce the concept of what an increment is. A sentence such as: “The IS4D-Var system generates a vector (time series) of increments that are added to the initial conditions (and forcing), to minimise the cost function.”

Page 7, line 20: How many inner loops did you run, and what was time series for the “J ratio” or reduction in the cost function?

Page 8, line 16: How is the blended product constructed? Is this done my weighting in the assimilation scheme, or as a post processing step.

Page 8: There is some duplication of material between section 3.2 and section 3.3.

Page 8, line 29: A good discussion of representation error can be found in:

Oke, P.R. and Sakov, P., 2008. Representation error of oceanic observations for data assimilation. Journal of Atmospheric and Oceanic Technology, 25(6), pp.1004-1017.

Section 3.4.1: The AVISO product is a daily gridded product that is derived from along track altimetry. Why not use the raw along track altimetry and use the IS4D-Var system constrain the SSH? By using a daily gridded product, some cells will have a higher error due to the statistical interpolation, while others that lie on the satellite track, will have a low uncertainty, therefore, by assuming a 6cm error, you are degrading the along track product to the error estimate used for the interpolated cells. Why not use the IS4D-Var system to assimilate the along track data, then use the model dynamics

(which should be better than the statistical model) to constrain the unobserved cells? What is the implication of using the interpolated SSH cells with the observed temp and salinity (if/when this occurs), does J fail to converge?

Section 3.4.4: The errors that are assigned to Argo profiles appear very large. How can you justify the error on an Argo float being up to a factor of 3 times larger than an SST observation? Depending on the grid resolution of the model, that cannot just be written off as representation error. Do you need to artificially inflate the prior over the floats to allow J to converge due to the gridded AVISO product?

Page 13, Line 23: Is it usual in 4D-Var system to use a diffusion operator as a prior? Is this not the same as using an isotropic 3D Gaussian function? Is there a reference that can support your use of the diffusion operator?

Section 3.5 What is the implication of choosing sub-optimal de-correlation length scales for the reanalysis system.

Section 4.2 Are the observations used to calculate the RMSD'd in this section withheld from the assimilation system, or are you reporting the forecast error statistics (i.e. before assimilation takes place)? Is the RMSD reduction between the free-run and assimilating run due to a reduction in bias or due to the dynamics features being correctly predicted?

General Comments:

The second half of the introduction reads like a combination of the abstract, methods and results/conclusion section. To avoid replication of information, it would be worthwhile considering moving the material from page 3, line 3 - line 25 into other more appropriate sections.

Can the the inner loops of the assimilation scheme generate unrealistic initial conditions or forcing data?

Is it great to see the Aquarius data being used, can you give any indication as to the

value of this data in the assimilation scheme? i.e. how much does it contribute to the reduction in J?

The authors should be commended in their use of such a wide variety of observational data to constrain the reanalysis. It would be fascinating to know the relative impacts of each of the observation platforms?

This study presents a detailed assessment of the reanalysis skill, but I was left wondering about the following points. These may be outside of the scope of this study, but I thought I'd pass them on as food for thought:

1.) The 10 year control run was assessed against the climatological EAC transports, and shown to give a good statistical representation of the mean transport. What was the difference in transport between the 2 year free run, and the reanalaysis. Is there a substantial difference between the estimated transports? Which observations had the most impact on quantifying the transport (e.g. see the study of Moore et al., 2011)? Such a study may provide insight into how an observing system should be configured to monitor and observe the impacts of Climate change on the EAC strength.

2.) What value does the high resolution reanalysis give compared to BRAN 3p5? Obviously, the high res reanalysis is needed for nesting purposes, but do the error statistics look different between the course global reanalysis and the high resolution regional reanalysis?

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