Geosci. Model Dev. Discuss.,
https://doi.org/10.5194/gmd-2019-203-RC1, 2019

Geoscientific Model Development Discussions

Interactive comment on "Weakly coupled atmospheric-ocean data assimilation in the Canadian global prediction system (v1)" *by* Sergey Skachko et al.

Anonymous Referee #1

Received and published: 13 September 2019

Overview

This paper describes a development to the Canadian global prediction system at ECCC to use weakly coupled ocean atmosphere data assimilation. The impact of this is assessed against a system using the previous uncoupled ocean and atmosphere DA approach. The paper is overall well written and it will be valuable to publish the work. I do have a main comment and some detailed comments which I believe should be addressed first listed below.

Main comment

The are some positive impacts from the coupled DA but I didn't feel I understood why

this was the case. You, the Met Office and ECMWF have somewhat different experiences of the impact of coupled DA. It would be interesting to have a bit more of an idea why this may be. I know you can't explain the results of the other centres, but it would help to explore the mechanisms for the positive impacts you see.

Detailed comments

Page 1 line 12 abstract: "Next steps..." -> "The next steps..."

Page 3 line 5 I was confused by the sentence "The shorter synchronization time ..." It gives the impression the synchronization time is controllable whereas previously it is stated to be different in different parts of the ocean depending on the degree of cross correlation between the ocean and atmosphere. Please clarify the sentence and/or the paragraph. I wonder if changing this sentence to "The shorter synchronization time with strongly coupled DA ..." is correct.

Page 3 line 12. Perhaps: "... coupled reanalysis." -> "... coupled renalysis (described above)." Just to so it is clear for the reader that this is the system you summarised just above.

Page 5 line 2. "global 1/4 deg horizontal grid". Change "horizontal grid" -> "horizontal tripolar grid" or "horizontal ORCA grid" or similar.

Page 5 line 17. Include the name of the MDT. E.g. "The CNES-CLS09 mean dynamic topography is used from Rio et al (2011)".

Page 5 section 2.3. The SST assimilation method (in the ocean) seems less than ideal in that you are creating a gridded SST product with OI using the previous days gridded analysis as the background. This is then assimilated (again) into the ocean model (with the coupled model SST as the background). This means that where there are data gaps in effect the background of the gridded analysis is assimilated as observations in ocean (rather than retaining the ocean model background). Also the SST gridded product has correlations from the SST OI which should be accounted for when

these are assimilated into the ocean (which I don't believe is the case). For the uncoupled system this product is needed to provide the lower boundary condition for the atmosphere. And there is some benefit in the uncoupled framework in using the same SST in the ocean to keep the systems close together. Is this approach then somewhat of legacy and the method of SST assimilation will change in future when coupled DA becomes the standard? Can you add some discussion about these points to the text?

Page 6 line 13. Please expand a little on the practical reasons why the sea ice DA doesn't use a forecast model.

Page 7 section 3.1. I'm not sure I fully grasp how the weekly SAM2 analysis works within the daily cycling system. How are innovations calculated? How are the weekly SAM2 increments applied to the model? Over what time period and when? Presumably you don't rerun the whole week to apply the increments using IAU. How are the weekly increments combined with the increments from daily SST assimilation?

Page 8 lines 10-16. Can you clarify why it is necessary to save the precomputed atmospheric forcing fields in the ocean model? Is it to allow different ocean and atmosphere time windows?

Page 10 line 31. In the uncoupled experiment the same gridded SST is used in the ocean and atmosphere so I wonder why it is necessarily the case there is better accordance between the near-surface atmosphere temperature and the SST in the coupled experiment. Perhaps it is to do short time scale and diurnal variations - if so state that explicitly.

Page 11 line 20. There are quite big differences in the ocean by doing coupled DA. It is not really clear how this is arises since the are not many differences in the ocean DA same observations and SST product. Perhaps it is coming from changes in the atmosphere. I think this is an important result of the work and it merits some exploration of the reasons for the differences.

Page 18. Figure 1. Are the last three forcing states a model forecast or persistance?

Pages 21/22. Figures 4 and 5. What creates the saw tooth structure in the particularly the mean OmA

Pages 21/22. Figures 4 and 5. The caption UNCPL/CPL is hiding some the results. Please widen the time range so this is not the case.

Pages 21/22. Figures 4 and 5. Do you think there is overfitting of the data by the assimilation the Std dev doubles between the analysis and forecast?

Page 23. Figure 6. This plot would look better as a block/binned type plot as the contours are distracting when plotting binned data. (e.g for matplotlib use pcolor with interpolation = nearest).

Page 23. Figure 6. "Numbers show the areas .... statistically significant with confidence level above 90%". This also might work better with a block plot as the numbers could be in the centre of each block. I only see two numbers near the bottom left. Does this mean most of the plot is statistically insignificant? If that is the case is it worth showing?

Page 24. Figure 7. Consider adding a title "air temperatrue at 1000 hPa". You do have this for other figures and it makes it easier for the reader.

Page 24. Figure 7. Consider changing "the change in the " -> "the difference in the "

Page 25. Figure 8. Change the time axis so the dates do not run together (particular for the bottom panels).

Page 25. Figure 8. Change [60degS, 20degS] -> [60degS–20degS] etc. (and also on page 10).

Page 25. Figure 8. I see that the mean OmF is generally lower for UNCPL. You don't really comment on this in the text much. Expand the discussion on this a bit. Is it something to worry about? (The differences are small). And if not why? Also in the text

(page 10) you describe it as a bias (try to be consistent with the terminology used).

Page 25. Figure 9. Change y range for the bias plots. The red line is going off the top of the plot.

Page 25. Figure 9. There seems to a strong daily cycle in some of locations. Can you explain this? It's not discussed when you discuss this figure in the text.

Page 25/26. Figure 10/11. You have swapped the order of the mean and std deviation for these figures compared to the previous figures. Can you keep them in the same order (std dev first and mean/bias second)? It would help the reader also to always use the same linestyles as Fig 7 i.e dot-dashed lines for mean/bias even when they are in a separate panel.

Page 28. Figure 12. Change the colour range. It's a bit hard to see any details in the plot (at least when printed).

Page 28. Figure 12. Typo "W/m2"

Page 29/30. Figures 13/14. The areas described as grey in the caption come out blue in the plot. It would be better to replot so they are grey to distinguish better from the data.

Page 29/30. Figures 13/14/ The "Latitude" label is a bit close to the colour bar below.

Page 29/30. Figures 13/14. The section plots show quite a striking positive result for coupled DA. I would ask that you look a bit closer at the reasons for this good result for the coupled DA as otherwise it is not clear whether this a robust result.

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