Title: Sea Ice Deformation in a Coupled Ocean-Sea Ice Model and in Satellite Remote Sensing Data

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General Comments

This paper provides significant insights on the ability of viscous-plastic (VP) sea ice models to reproduce observed deformation fields. The confirmation of the power law scaling of VP deformation fields is a welcomed clarification to the previous results of Girard et al. 2009. The description of the dependence of the scaling exponent on sea ice thickness and concentration is also a novelty and is highly relevant for future sea ice rheology studies or comparison of deformations from different models.

I find the revised manuscript much easier to read, better structured and with improved grammar/writing. The key findings are now better highlighted, thanks to the improved organization of the paper. I really appreciate the precision on the methods and how the dataset was acquired for the power law scaling section, but I feel there still needs to be some clarification there (see specific comments).

Most of my previous interrogations have been eliminated given the new information that has been added in the manuscript. The authors indeed responded to all my previous comments and questions in a very complete manner. I therefore recommend that this paper be accepted subject to minor revisions (specific comments below).

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Specific comments – Part 1

- Section 2.3: Maybe rename the section to something like *"Common Reference Frame for Model and Observations*", because it is more than just transforming your model output to correspond to simulate RGPS data. You have to make it clear that you are not using the original RGPS Lagrangian grid, but that you also manipulate the RGPS data to form a new dataset (resulting from a triangulation).

- Page 11, Line 10-16: The addition of how the strain rates are obtained for different spatial scales is really helpful to understand the following analysis, but I feel like those steps need to be clarified. Your first point ("Strain rates for the six nominal...") should be incorporated in the text before the steps are given, i.e. something like " Following the procedure described in Stern and Lindsay (2009) strain rates for six nominal length scales L* = 10, 20, 50, 100, 200, 500, and 1000 km are calculated. We obtain those strain rates as follows:" and then continue with the different steps. Also, from what I understood of Stern and Lindsay (2009), the first step should be something like : "- Starting from seeding positions, we aggregate all Lagrangian cells that are at a distance (L*/2) or less from the seeding points (center of the aggregate) within a 5-day window. " See also other specific comments below for more on how to rephrase/clarify the other steps.

- Section 3.2.2: The analysis of PDFs is done only for the absolute divergence. It would be interesting to also show the PDFs of shear rates for comparison with the results presented in Girard et al. (2009) and Girard et al. (2011). The PDF analysis is also done here only for the length scale of 20km. I am curious: Have you checked with other length scales? What do you get?

- Page 13, Line 30: You have many D_i (daily mean deformation rates), but only three L_i (grid spacing). Do you average the D_i's for each grid spacing and then perform the least-square fit on the three points (L_1, <D_1>), (L_2, <D_2>), (L_3, <D_3>)? Please clarify this for the reader.

- Page 14, Line 24: The one *b* you get from section 3.2.1 was obtained by "re-sampling" the same data set at different length scale, while in this section (3.2.3) you compare data sets from runs at different spatial resolutions. My first impression is to think that those two scaling exponent represent two different processes, and I am not sure how they can compare to each other, but maybe they are the same and I am wrong… Can you help me on this?

- Page 16, Line 12: The ice velocity is higher for weaker ice (at least initially before the ice gets stronger), and ice thickness is also higher for weaker ice, yet the export is reduced since the beginning of the experiments…? This is confusing and not intuitive. Added panels with time series of mean sea ice thickness and export would probably help understand this.

- Section 4.2/Figure 12: I find it interesting that ice production in both runs, 0.7P* and 0.3 P*, start decreasing at the same time and become negative at the same time. The argument here for the decrease is that because of the reduced ice strength, there is an initial increase in ice thickness, but after a while, the ice thickness increase will compensate for the low P* and ice will be stronger and deform less, which in turn will decrease the ice production, to the point that it becomes even less than in the control run (negative). I would have thought that the run with 0.3P* would reach that moment earlier than the run with 0.7P* because the drift is much faster and the ice is much weaker, so that the overall ice thickness would increase faster to reach that moment when the ice is strong enough to resist deformation again. Again, it would be interesting to see a time series of the mean ice thickness in figure 12 to understand why/how this happens.

- Figure 12: Panel (c) should be panel (b) and vice versa, since they are discussed in that order.

Specific Comments – Part 2
Here are some typos and other minor comments/suggestions that the authors may want to consider before final submission.

- Figures 1, 5, 8, 9: Please make labels bigger.
- Page 1, Line 2: "deformation strain rates" keep only "deformations" or "strain rates"
- Page 3, Line 13: "In comparison to…" → "As in…" ?
- Page 3, Line 25: "the model results depend on…" → "the modeled sea ice mass balance depends on…" ?
- Section 2.1: Please state somewhere in this section the period for which the model is run (e.g. January 1st 1992 – December 31st 2009) and also state if a spin up is done prior to starting the period analyzed here.
- Page 4, Line 19: "e.g., develops lead patterns." → "e.g. clear lead patterns." ?
- Page 4, Line 29-30: Replace "shows a mode increase…" with "is higher for the 4.5 and 18-km simulations by 24 and 28 cm respectively, compared to the 9-km simulation."
- Page 6, Eqs 2-4: Why partial derivative on top and total derivative on the bottom?
- Page 6, Line 7: Put the comma at the end of Eq. (5) instead.
- Page 6, Line 10-11: Not clear why you have two different conditions on ice area. Why not just use the same condition for all analysis? Please clarify.
- Page 6, Line 21: Add "the" before "triangles" and replace "high deformation rates" with "the deformation rates higher than 1 day^-1".
- Page 6, Line 35: Typo: remove the double coma.
- Page 7, Line 31: "Next we…" → "We now…" ?
- Page 8, Line 12: Replace "the model therefore does depend less on" with "the model is therefore less dependent on"
- Page 8, Line 23: Remove "Anyway"
- Page 8, Line 25: "will become more severe" → "will have an important impact" ?
- Section 3.1.2: Rename to "Deformation Rate Time Series" ?
- Page 8, Line 27: "RGPS observations for 97 months from 20 RGPS …" why not just say "all 20 available periods of RGPS observations (i.e. 97 months, between Nov. 1996 and May 2008) are used (Table 2)."
- Page 8 , Line 29: Remove "(both compared with all 20 RGPS periods available)". This is already said in the previous sentence.
- Page 8, Line 29: Replace "Months" with "The months of"
- Page 8, Line 32: Replace "than the one of" with "than all of the"
- Page 8, Line 33: Replace "The same is the case" with "the same is true for'

- Page 8, Line 34: Replace “higher for” with “lower than”
- Page 9 , Line 19: “amount” → “magnitude” ?
- Page 9, Line 22: “we will look” → “we now look” ?
- Page 9, Line 30-31: “If the deformation…” → Move sentence to next paragraph?
- Page 10, Line 1: “As Q is normalized by the total deformation rate… “ In the equation above, I see that Q is normalized by the total area… not the total deformation rate.
- Page 10, Line 11: “This is confirmed here by…” I don’t understand how the strong localization for the 4.5 km run confirms that the strain rate distributions for the 18 and 9-km runs are similar… Rephrase?
- Page 10, Line 13: Replace “Disregarding” with “Despite”
- Page 10, Line 28: Replace “are, e.g., given in Weiss…” with “given in, e.g., Weiss…”
- Page 10, Line 30: Replace “suitable” with “able”
- Page 10, Line 31: Remove “will”
- Page 11, Line 8: Typo, “special” should be “spatial”
- Page 11, Line 12: Replace “Lagrangian cells” with “individual Lagrangian cells” and “the area” with “their individual area”. Also replace “The sum of all cell areas...” with “The total area of the remaining aggregated cells must be greater than 0.75L*^2.
- Page 11, Line 14: Replace sentence with “For each aggregate, mean strain rates (du/dx, du/dy, etc. - eq. 1) are computed from the individual strain rates in the aggregate by using the individual cell areas as weight. The deformation invariants ([...]) for the aggregates are then computed with those mean strain rates.”
- Page 11, Line 15: Replace “length scale” with “actual length scale” and “sample” with “aggregate”
- Page 11, Line 29-30: “Our split in summer and winter…” It is not clear what this sentence is trying to say. Rephrase?
- Page 12, Line 13: “length scale L = 20 km” → “nominal length scale L* = 20 km” ?
- Page 12, Line 13: Add “are then calculated for all winters…” after “for absolute divergence” and delete “were then calculated”.
- Page 12, Line 25,27: Do you have the errors on the slopes for the model as well?
- Page 12, Line 26: Remove “mostly”
- Page 12, Line 31: Replace “especially the 4.5 km solutions” with “the 4.5 km solutions especially”
- Page 12, Line 32: Replace “from the about 50% lower deformation rates” with “since the deformation rates are about 50% lower as discussed in section XX”
- Page 15, Line 8: Typo, “an sensitivity” should be “a sensitivity”
- Page 17, Line 25: Typo, “overlineB” should be in equation mode.