

Interactive comment on “Characterizing sudden changes in Arctic sea ice drift and deformation on synoptic timescales” by Jennifer V. Lukovich et al.

Anonymous Referee #1

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General comments: This paper investigated the deformation processes of sea ice in the southern Beaufort Sea from the analysis of several buoy data with special attention to the sudden changes in sea ice drift and its relevance to atmospheric forcing, ice conditions, and the effect of shore. The goal of this study is placed in developing a framework for understanding sudden changes in ice drift trajectories. For this purpose, firstly the authors set 4 triplet areas composed of three buoys for each, and then traced the temporal evolution of each triple. As a result of analysis during the period from September to November in 2009, they detected eight “sudden change” events and examined the kinetic deformation parameters in relevance to the atmospheric forcing, ice conditions, and the effect of shore. They used triplet area, perimeter-to-area, the Okubo-Weiss criterion as diagnostic parameters. From their analysis, they concluded that sudden change occurred reflecting sea ice deformation, associated with

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the transition of atmospheric forcing and the interaction with the coastal line, and so on. I understand the importance of this topic and find that it may be useful to understand the dynamical features of sea ice near the shore on a daily time scale and on a sub-grid spatial scale. And that must be what the author aims at in this paper. I see that the authors attempted to make the most of available several buoy data to reveal them, and their efforts should be appreciated. However, I feel the manuscript is a bit more descriptive and the conclusion does not necessarily seem clear. My opinion is that the paper would be improved much if the author show more clearly what is a new finding of this study in the context of the research history on sea ice dynamics. Thus my evaluation is somewhat reserved at this stage. My major concerns are as follows:

- 1) Discussion and conclusion seems to me a bit qualitative. I mean that to correlate the sudden change events with the change in atmospheric forcing or the interaction with coastal line, it would be helpful to show how much forcing (e.g. change in wind speed, or shear of sea ice drift) was needed and examine if the result can be explained in the present framework of sea ice dynamics. It might be difficult to draw quantitative conclusion just from the available datasets. Even so, it would be possible to make additional figures which explain the thought of the authors more clearly, such as scatter plots as a function of the distance from the coast or a schematic picture. The figures in the present manuscript are only time series of physical parameters. It is not necessarily easy to understand the essence of this paper just from the time series.
- 2) Sorry, but I am a bit skeptical about the analytical method of deformation parameters using triplets. Although I agree that this method would be useful if the side lengths of the triplet are of almost similar magnitude, I feel it is questionable if the triplet becomes so distorted that the lengths of base and height have significantly different magnitude, as shown in Figure 6a. This is because the divergence or deformation parameters would take different values, depending on the horizontal scales. In such situation as the side lengths of the triplet are different by more than one-order, I wonder if the obtained values are representative of the region and therefore this method is really applicable. If the authors are convinced about this matter, it would be helpful to add some explanation.
- 3) About the

terminology. Several expressions about “sudden change” events might be a bit confusing. The authors used “sudden changes”, “shear shock events”, or “shock-response” and whatever for the similar events. Do they mean the same phenomena? If so, it would make the manuscript more readable to unify the expression after defining them at the beginning. 4) I would like to know more about the motivation of investigating the “sudden change” events. I also consider that this is a very important issue in the sea ice dynamics because it can induce the crack or formation of leads which would affect a large scale dynamics of sea ice area. So it would make the paper more impressive if the authors show some pictures which show how cracks were formed associated with the “sudden change” events. Personally, I think it might be interesting to discuss it from aspect of the yielding mechanics, namely the transition from viscous to plastic behavior in the VP rheology in the numerical sea ice model. To do so, separate the events which appeared in the persistent atmospheric forcing from those that occurred corresponding to the change in the atmospheric forcing. This might be one idea to the manuscript more quantitative.

Specific points: *(P3L24) “(Kwok, 2006)” is missing in the reference lists. *(P9L6) “Figure 2b” seems missing. *(P11L5) “Results show reduced total deformation with increasing distance from the coastal line (figure 8)” For me it is not so clear just from Fig.8. Especially the difference between A and B cannot be explained so well. *(P11L9-10) “Noteworthy is the existence of vorticity-dominated flow. . .” Please explain why this is noteworthy. *(P12L19) “indicating the impact of ice interactions with coastline” Please explain more about the reason. *(P13L28-29) “a continued increase in temperature. . .” I wonder that the reason for this interpretation is not enough because other factors such as the change in synoptic atmospheric circulation might have affected the temperature. Please add some more explanation. *(P14L5) “Noteworthy also is increasing SAT” Please specify the period of this phenomena. *(P16L13) How did you estimate “ice strength”. *(P16L19) “vorticity superimposed on shear weakens ice strength” I could not understand this. Please explain more.

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Technical corrections: *(Figure 1b) I recommend to have the edge of each circle colored in black because some circles are hard to see. *(Figure 3) It would be helpful if the “sudden change” events are shown by arrows in the figure. (Figure 6a) Please magnify the numbers of latitude and longitude. And please designate which color corresponds to A – D. (Figure 6b, 7, 8) Please magnify the scales of the figures. They are hard to see.

That is all. Faithfully yours.

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