The Cryosphere Discuss., 8, C2269–C2273, 2014
www.the-cryosphere-discuss.net/8/C2269/2014/

The Cryosphere
Discussions
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Interactive comment on "On producing sea ice deformation dataset from SAR-derived sea ice motion" *by* S. Bouillon and P. Rampal

Anonymous Referee #1

Received and published: 4 November 2014

General Comments:

This interesting paper outlines a new method of perhaps obtaining more accurate estimates of the sea ice deformation from a set of discreet points tracked from one SAR image of the ice to another. Determining the deformation of a material element using a finite set of discreet points leads to a "boundary definition" error for the line integral that increases as the number of points decreases. The RGPS data set uses four-point cells to compute the deformation. The method proposed here starts with just three points, the minimum possible and the configuration with the maximum error. Thorndike (1986) discusses how the number of nodes determines the accuracy of the deformation estimates. Three nodes are worse than four by a factor of 2 or 3 (his Figure 23b). These 3-point estimates of the deformation are then smoothed based on a threshold in

the total deformation and a variable number of adjacent triangles above the threshold, hence the spatial scale of the smoothing is variable. Where there are no cells above the threshold there is no smoothing.

By using just three nodes the unfiltered estimates are by nature very noisy and these noisy estimates are then combined in the smoothing procedure which presumably then reduces the uncertainty again. This is fine but then we are left to wonder just how many cells have been used for each estimation (since only cells above a threshold are used) and what is the spatial scale of the estimate. The spatial scale of the filtered data is ambiguous because the deformation is smoothed with between 1 to 10 or more triangles, so what is the spatial scale of each observation in the smoothed data? How is the spatial scale determined for the scaling analysis? The smoothing procedure has reduced the noise at the expense of spatial scale, as must always be the case with discreet points for the velocity. Can the authors please more fully explore these ideas in the introduction?

Thorndike, A. S. (1986), Kinematics of Sea Ice, in The Geophysics of Sea Ice, NATO ASI Series, edited by N. Untersteiner, Plenum Press, New York, pp 489-549.

Specific comments:

5106-2: Your method is far from nearly noise free.

5106-17: Please give the original references for the cross-correlation techniques applied to SAR images.

5106-20: Also maybe reference GlobeICE here.

5107-27: What fraction of the RGPS deformation estimates is afflicted with this problem? Does it change the scaling analysis? How big a problem is this and can unrealistic values be easily filtered out? This seems to be one of your main motivations, but you have not really shown it to be a big problem.

5108-1: It would be useful here to elaborate on the difficulty in determining the line integral of the velocity for a material element (a cell) using a finite number of points. This might be a good place to have a complete discussion of the ideas presented by Thorndike (1986) about the error of deformation estimates due to the boundary definition and the number of points used.

5110-14: experience –> experiment

5110-20: What is "normalized resolution"?

5110-8: What becomes of the cells below the threshold? Is the filtering applied to these?

5111-4: What is the equation for performing the smoothing? Are the tensor components smoothed or just the invariants? Exactly how are the kernel triangles selected? For example, are triangles included if there are no others above the threshold between a kernel triangle and the target triangle? (e.g. if there is a gap in the total deformation). Are all target triabgles smoothd, even if the are below the threshold? For example if a triangle is near but not part of an LKF, is the smoother applied to it is well? Or if it is part of the LKF, but below the threshold, is the smoother applied? How would the two cases be distinguished?

5111-11: Can you show that your smoother is unbiased? The mean divergence along the crack should be zero for both the unfiltered and the smoothed data and the mean shear should be the same or both. Does the thresholding method introduce a bias? You may need to use a much longer crack.

5111-19: The line with the disks in Fig.2 seems to go down to 5 or 6%, not 10%. What is the "residual error"?

5113-1: RGPS updates a cell only when all four points are simultaneously updated. There is no asynchronous error.

5113-5: The cell update time is in fact the same as the update times for all the nodes. I can't find the exact reference that states this, but it is implied in the RGPS user

documentation. If you actually find the node times from the Lagrangian product and compare them to the deformation update times you will find this to be true. This is a bit tricky because the nodes for each cell are not identified, but it can be done. As you indicate, it would make no sense for it to be otherwise.

5114-13: How are isolated deformation features treated? Is there a minimum kernel size?

5114-18: Why n=3?

5114-21: For the threshold of 0.02, what is the range of the quality index for different dates in 2006-2007?

5115-25: A shear crack that is not straight may exhibit both opening and closing.

2116-21: Please give more information about how the scaling was computed. How are the scales determined given that the smoothing introduces a highly variable spatial scale for the individual triangles? Is the area associated with each smoothed triangle retained? How are the strain tensors computed?

5117-10: Please show the results for the RGPS deformation product as well. The unfiltered version of course has very large errors at small scales, as you indicate, so it is of less interest.

5117-18: What are the min-max errors for some other (n, threshold) pairs? How specific is this optimal solution? And what is it for the RGPS 4-point cell data?

5118-14: Again, the unfiltered data are of less interest because the 3-point deformations rates are very poorly determined. What are the values for the RGPS data? The whole point of your paper is to improve on the RGPS deformation values, not the unfiltered data set.

5120-6: You have not shown how the scaling from the RGPS deformation product differs from that of the new smoothed data set.

Fig. 1: Clearly the classical smoother you use has a much larger spatial scale than the new method. More interesting would be to show what the results would look like for a square grid of nodes, similar to the RGPS cells. Maybe replace the classical smoother, which doesn't make much sense anyway, with a 4-node version. Just define a square grid of nodes and show the deformation for the 4-point cells, for the unfiltered triangles from the same grid, and for the new smoothed version.

Fig 3: What is normalized resolution?

Fig.6: Please add the black triangles here too so we can see which are smoothed.

Figs 10-12: What are the scaling relationships for the RGPS deformation data? The unfiltered data is not very interesting, since you have added a lot of noise by using just three points at the smallest scale. The more interesting question is how the RGPS data compares.

Interactive comment on The Cryosphere Discuss., 8, 5105, 2014.