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Interactive comment on "Sea ice local surface topography from single-pass satellite InSAR measurements: a feasibility study" *by* Wolfgang Dierking et al.

A. Mahoney (Referee)

armahoney@alaska.edu

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Summary

This manuscript presents what I believe may be the most comprehensive review of the application of InSAR to the study of sea ice. The authors focus their attention on the use of single-pass InSAR for the measurement of sea ice topography, but their discussion addresses many aspects that are relevant for other sea ice applications of InSAR such as the detection of motion or deformation. These include the physical constraints on useful baselines, incidence angles and radar wavelengths for deriving useful estimates of sea ice surface height. The authors also consider the influence of sea ice type, surface roughness and snow depth on the accuracy of these mea-

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surements. In addition to discussing the potential opportunities for InSAR-derived ice topography measurements from existing and future SAR constellations, the manuscript also presents topographic results derived from a bistatic InSAR acquisition over sea ice near Point Barrow, Alaska. Overall, the manuscript is well written and is likely to be an important contribution to the sea ice InSAR literature, particularly as we enter a new era of publicly available data from a growing number of SAR constellations. I have some minor comments about the discussion of elevation results over thin and drifting, which I describe in more detail below, but I believe these should be relatively easy to address.

General comments

1. Clarification of phase interpretation over young and drifting ice In Figure 4a, the authors present surface elevation derived from phase variations over sea ice near Point Barrow. The accompanying SAR amplitude image (Fig 4b) shows a region of landfast ice attached to the coast and separated from drifting sea ice by a lead, which contains bands of frazil. For readers unfamiliar with SAR images of sea ice, it might be helpful to label these features in the amplitude image. In the text, the authors note the "non-negligible height offset" due to surface motion that occurred during the 6 ms temporal baseline between image acquisitions. I recognize that the focus of the paper is on the retrieval of sea ice topography, but this is an interesting and important result that I think would be worth discussing further. For example, in section 5.1 the authors could apply equation 9 to derive the look direction component of ice velocity. This could even be validated using ice velocity measurements from the Barrow sea ice radar (referenced in Fig 3) or from an oceanographic mooring located in the vicinity of point A in Fig 4 (doi:10.18739/A2MT1D).

Also, the authors drawn attention to the apparent roughness of the surface of the lead, which they attribute to "alternating water and frazil stripes", but I feel this explanation could be expanded. The preceding text discusses the phase contribution due to surface currents parallel to the look direction and also makes references to Langmuir

circulation, but it is left to the reader to connect the dots. For readers not familiar with slant-range geometries or Langmuir circulation I would suggest the following changes:

i) label the look direction on Fig 4a and b (see also my note about Fig's 2 and 4 below)

ii) indicate the wind direction, which can be estimated based on the orientation of the frazil bands

iii) state or illustrated how surface currents might vary according to Langmuir circulation.

Specific comments

P1, Line 24:

I would not describe the change in ice surface topography as "steady". Perhaps "near-constant" would be a better phrase.

P2, Line 2:

I feel that "surface roughness" might be amore appropriate term than "surface height variations"

P3, Lines 31-32:

I suggest replacing "neither" with "not" and beginning the sentence with "Also" so that it reads: "Also, if the alongtrack baseline is zero, the interferometric phase is not affected by ice drift".

P8, Line 3:

Note that as of December 1, 2016, the city of Barrow changed its name to UtqiaÄąvik. I suggest replacing all references to city of Barrow with its new name and adding "(formerly known as Barrow)" after the first instance. Note that Point Barrow has not changed its name.

P8, Lines 16-17:

Actually, independent measurements of sea ice topography were made for a region of landfast sea ice within the coverage of this DEM. These data are presented in an article by D.O. Dammann recently submitted to the IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing.

P11, Line 15:

It should be noted that surface wave amplitudes can be much greater in the marginal ice zone and so this statement should be qualified by noting that infra-gravity waves can be neglected in the central ice pack.

P11, Line 27: According to the stated definition, I believe the authors mean “average height of each sail”, rather than “average sail height”

P12, Line 1: I realize that this is partly a matter of style, but I recommend the authors read the following short article on parentheses use:

Robock, A. (2010), Parentheses are (are not) for references and clarification (saving Space), Eos Trans. AGU, 91(45), 419–419, doi:10.1029/2010EO450004.

P12, Lines 1-2: I do not feel this statement is correct in the case where ridges are larger than the resolution cell of the SAR data. While the elevation of the cells near the peak of the sail might be higher than the average height of the overall sail, the cells on the flanks of the sail will have lower-than-average elevations.

P12, Lines 16-18:

Could the authors please provide a citation for these penetration depths?

P13, Line18:

Should this be “2.5” instead of “2-5”?

P14, Line 19:

Correct “elder” to “older”

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Figure 2:

It would help the reader interpret these results if the data in panels (a) and (b) could be presented in the same projection.

Figure 4:

As with Figure 2, it would be helpful if the data in panels (a) and (b) could be presented in the same projection. It might also help if there were tick marks at key intervals along the AB transect, with corresponding marks on panel (c).

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