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The Cryosphere Discussions

Interactive comment on "Seasonal timeline for snow-covered sea ice processes in Nunavik's Deception Bay from TerraSAR-X and time-lapse photography" *by* Sophie Dufour-Beauséjour et al.

Anonymous Referee #1

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This paper analyses the seasonal evolution of X-band VV backscatter from snow-covered first-year sea ice from Deception Bay, using TerraSAR-X with collocated time-lapse photography, with focus on freeze-up and break-up stage characterization. This is a timely research topic especially with various regions in the Canadian Arctic experiencing greater variability in seasonal sea ice conditions, inter-annually and that SAR is a useful tool to monitor these changes. The authors also need to appreciate their effort to collect and process a lot of time-lapse photography and make good use of it.

However, with the current draft, this manuscript needs considerable discussion based on the observations (currently, there are way too many assumptions, especially the

scattering mechanisms during the seasonal regime). The paper, although focuses importantly on a community-level study, suffer from several shortcomings that weaken significantly its message and needs to be addressed before the paper could be accepted. I list my major concerns now. I have left out the minor comments for now and will review them in the revised version.

Major Comments.

My major concern with this paper now is how authors have justified the similarity in the backscatter evolution of X-band and C-band. See Line 485 under section 7.2. "The TerraSAR-X backscattering time-series presented in this article exhibits the same seasonal evolution as that of the C-band (Sect. 2), which was expected due to the spectral proximity of both bands.". This sentence reads like the author already knew about the results and as an afterthought. This has lead to authors more or less assuming the scattering mechanisms during the seasonal evolution (like that with C-band), based on past literature. This is scientifically misleading. If there was similarity in scattering mechanisms at two different frequencies, our scientific community wouldn't have launched TerraSAR-X and RADARSAT-2 (for e.g.).

Although the reviewer agrees with the observations from the time-lapse photography related to freeze-up and break-up processes, the authors provide little to no information about

a) Although the objective of this manuscript was to focus more on how X-band SAR can be used to provide the first-baseline signature of X-band VV backscatter. However, the majority of the paper is about analyses from time-lapse photographs and very little focus was given to analyzing the SAR signature section. I would suggest using the SAR images as the focal point of analysis (with snow/sea-ice geophysical explanation of changes in VV backscatter), 'supported' by time-lapse photography.

a) how they classified ice types (what method) from the TerraSAR-X images, based on beta-naught values? What is the advantage of using beta-naught over traditional

sigma-naught? The authors may be reminded that the scattering mechanisms discussed in this paper (mostly based on previous literature) are applicable for sigma-naught values (significantly dependent on polarization). Therefore, substantial justification should be provided on why beta-naught values are used. And if they are, how does the scattering mechanisms change?

b) The interesting part is how authors easily interpret different ice types (grease ice, nilas, pancake ice, and grey-white ice) without any geophysical explanation (or the least scattering mechanism) justifying the backscatter occurrence from these ice types. This needs to be clarified. Although the authors have demonstrated diversity in VV (figure 10) for different ice types, the authors should demonstrate the proof of how they classified or interpreted them as these 'specific' ice types. For another example, the authors talk about 'frost flower maximum' which causes the first X-band inflection point. But the authors do not provide any proof of frost flower formation

c) The third missing point of this paper is the lack of scattering mechanism explanation (mostly assumptions and backing up from past literature on C-band now) or sometimes explaining without any clarity in this regard. The authors should explain what they observe from the VV backscatter, based on the incidence angle range used in this study (and if they have in situ observations of snow and sea ice properties) and NOT based on agreeing with that they see from the SAR imagery, against past literature (using different incidence angle ranges from C-band imagery).

d) If the authors haven't noticed, one advantage of the X-band signature time series across three years is its utility to detect melt and pond onset from SAR images (which is always challenging) and how varied the dates are for these three years. The authors, if interested should consider using this application as a tool to improve this manuscript. In addition to freeze-up and break up, another application in which the science community and also local communities are interested in how the timing of melt and ponding changes and how it can be effectively detected from SAR images. Just a suggestion for improvement.

Overall, if the authors would like to stick with the objective to provide a baseline understanding of X-band signature evolution, here are my suggestions

a) Even though data for all three years are available, use signatures from one year as the baseline and study the evolution of the X-band signature. That would be your baseline (which should also include describing the X-band scattering mechanisms).

b) With lack of in situ snow and sea ice observations of geophysical properties, the authors have the freedom to speculate the scattering mechanisms (never a drawback, and always room for improvements) instead of blind conviction.

c) Once the baseline signature is explained for one season, use it to differentiate different core regimes changes in the region. For eg. Table 3 shows differences in winter onset, melt onset and pond onset from SAR images for all three years. Use this info as a strong point to showcase the utility of X-band to effectively detect these changes (which can be then integrated into talking about the importance for local communities).

d) Use time-lapse photographs more as an ancillary data to explain the X-band signature evolution, and not the other way. Remember what your primary objective is.

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