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Discussions

# Interactive comment on "Virtual radar ice buoys – a method for measuring fine-scale dynamic properties of sea ice" *by* J. Karvonen

**J. Karvonen**

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Dear Dr. Weiss,

Thank You for Your comments. This is just a shortish reply, not covering all the detailed comments, I'll provide a more detailed replies with my reply to all the reviewer comments as soon as I have them available.

I agree that the manuscript is technical, but it also includes samples of applying the method and can be applied continuously and operationally and these samples show what kind of ice information can relatively easily be extracted from the produced data.

I'll make a revised version after I have received all the reviewer comments. I'll improve and clarify the details as suggested in the revised manuscript to make the details of

the algorithm (including the pre-processing) more clear, and also revise the section on results.

In the sense that the algorithm continuously monitors ice drift in a high temporal (2 minutes) and spatial resolution (tens of meters) it is novel. The novel things are the identification of virtual buoys based on the local image features and adding them after a predefined amount of them have been lost by the algorithm. It (radar image capturing device and the software) can also be installed to any coastal or ship radar and run operationally to give near-real-time information of the sea ice dynamics.

I am familiar with the work by Kwok et al.. The approach in his papers is different (basically maximum cross-correlation and some feature based tracking is some areas where MCC does not work well) and SAR imagery where the time differences are much longer. In practice it is not often possible to track an ice object from one SAR image to another between a time series of SAR images (typically the ice drift from SAR imagery is tracked between co-registered SAR image pairs where it is possible, but predefined objects are not tracked) In our algorithm we use optical flow which is e.g. used in tracking motion in video sequences where the time difference (and motion) is not long, and sub-pixel tracking is necessary. This seems to work fine for our 2 minute data, and even for 10 minute data (2 min data when available would be recommendable, and this is what we have available from our coastal radars). We have also studied the ice drift estimation based on SAR imagery at FMI (e.g. Karvonen, Ocean Sci., 8, 473–483, 2012) using maximum phase-correlation approach, but it is just defining ice drift between the co-registered SAR images in a coarser spatial and especially temporal scale, not tracking defined objects. For example average velocities for SAR imagery with a time difference 1-2 days does not make much sense as we do not know about the ice motion between the SAR acquisitions. The use of radars will thus give use complementary information on the (spatial and temporal) fine-scale ice motion.

The accuracy for coastal radars is sub-pixel. We have visually checked from image sequences that the objects are really tracked by the algorithm. As the coastal radars

have a fixed rigid platform and fixed measuring geometry the precision is high for them, better than e.g. for GPS buoys. For a ship radar the precision is not so good, even if we give motion with respect to the ship, because the ship is the platform and the transmitter and receiver are also tilting and moving with the ship. And if we want to give the motion in a fixed coordinate system where the ship position has been compensated based on the ship GPS data the error will further be increased because of GPS inaccuracies. I'll also include some discussion on the precision in the revised version.

Thank You! Sincerely, Juha Karvonen, FMI

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