Ice Dfift Estimation based on SAR and Radar Data

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Ice drift or ice motion is an important ice parameter for the ice navigation, for example the ice compression can be derived from the ice motion and this information can be used in ship routing. We have developed an algorithm to compute the ice motion vector fields from both SAR data and from ship or coastal radar data. The algorithm is based on phase correlation between image windows from two geolocated images from different time instants. The ice motion is computed in two resolutions, first in the coarse resolution to get the large scale motion and then the motion estimation is refined in high resolution.

From SAR data the large scale ice motion can be obtained, and this information can be used directly for navigation and also for ice model motion field validation. From radar data the fine scale ice motion can be obtained and this information is also useful for fine-scale ice model validation, and in the future this information can also be used for navigation directly, after a system delivering this information to ships from a network of radars in near-real-time is available.

Before computing the motion estimation, some image pre-filtering is necessary. The featured areas are located based on edge detection and the featureless areas are masked off, because they would not give any useful results in correlation computation. Before correlation computation also a speckle filtering is performed for the SAR data. For radar data a temporal averaging is performed to reduce typical radar artifacts. This is possible because the radar data is acquired continuously and the temporal difference between two radar rotations is only a few seconds. Also the ship motion must be compensated in the case of ship radar.

In the correlation computation also slight rotations to both directions are studied to also find the cases in which some rotation has occurred. Both in the coarse resolution and in the high resolution multiple motion vector candidates corresponding to multiple correlation maxima are included in the final decision. The final decision is made between the candidates based on the global and local motion conditions around the studied location. We for example require that the vectors are in coherence with the neighborhood and that too large convergence is not allowed. These are reasonable geophysical conditions. This kind of filtering is necessary because some ice edges can be very similar in the images and some erroneous motion estimates can result without filtering the algorithm output.

From ice motion some interesting derived quantities can be computed. Navigationally most interesting quantities are probably convergence and divergence of the motion field. This information can for example indicate high ice compression areas which should be avoided or opening of leads. Currently we compute divergence and curl for the motion vector fields. The mean ice drift velocity is also computed by dividing the detected ice motion by the time between the acquisitions of an image pair over the same area.

We will show some examples of computed SAR-based ice motion fields for the Baltic Sea and the Kara Sea. We have used both Radarsat-2 ScanSAR wide mode data and Envisat ASAR wide swath mode data. We will also show some examples of fine scale ice motion based ship radar in the Baltic Sea.