SeaSAR 2018

Accuracy of a Phase-Correlation Technique for Fully Automated Sea Ice Motion Retrieval based on Sequential SAR Images

Anja Frost, Stefan Wiehle, Sven Jacobsen (German Aerospace Center - DLR)

Abstract:

In order to improve ship routing in polar waters, we present a software processor to retrieve high resolution sea ice motion fields from spaceborne Synthetic Aperture Radar (SAR) image sequences fully automatically.

Sea ice is almost continually in motion. Within hours, wind and ocean currents can cause significant changes within the sea ice. When the ice is pulled apart by winds or currents from opposite directions, the ice fractures, and open water leads appear. When ice is strongly pushed together by converging wind and currents, the ice sheet will break and either pile up randomly one piece over another, forming a thick, uneven surface, or be forced upwards, creating high walls called ridges. Such obstacles are difficult or impossible even for icebreakers to overcome.

SAR satellites such as TerraSAR-X or Sentinel-1 are well suitable to map different structures in the sea ice. Due to their near-polar orbit, spatially and temporally near coincident acquisitions in high latitudes are possible on a daily basis.

The core of the presented software processor for sea ice motion retrieval is the well-known phase correlation technique, executed within a hierarchical motion estimation framework presented in our previous work. The output of the processor is a vector field indicating the sea ice displacement, which can be converted into sea ice velocity. Now, we investigate the accuracy of the retrieved displacement.

Our test deals with a series of TerraSAR-X ScanSAR mode images acquired over drift buoys that are located in arctic waters, as well as with collocated Sentinel-1 acquisitions for comparison. We monitored the buoys during July 2017 and January 2018. In the winter sequences, an ice concentration of >90 % is predominant, while the summer acquisitions capture an ice concentration of 50 % - 80 %. Altogether, the accuracy of motion vectors estimated from TerraSAR-X image pairs amounts to 30 m (1σ-error). The motion field has a resolution of 150 m x 150 m, which gives a very detailed look into the local sea ice motion, detecting small variations.

The presented processor is intended to be part of the operational data processing chain at DLR Ground Station Network sites. In ongoing work, we implement parallel processing in order to reduce computing time so vessels in ice infested waters can receive information on local sea ice motion in near real-time.