Geophysical Research Abstracts
Vol. 19, EGU2017-4232, 2017
EGU General Assembly 2017

Observation of Drifting Icebergs and Sea Ice from Space by TerraSAR-X and TanDEM-X

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Detection and monitoring drifting icebergs and sea ice is of interest across wide range of Arctic and Antarctic coastal studies such as security of navigation, climatic impact, geological impact, etc. It is not easy to discriminate drifting ices from stationary ones, and to measure their drifting speeds. There is a potential to use space-borne SAR for this purpose, but it is difficult to precisely measure because the drift velocity is usually very slow. In this study, we investigate two approaches for discriminating drifting ices on the sea from surrounding static ones and for measuring their range velocity. The first method is to utilize the quad-pol TerraSAR-X which adopts dual receive antenna (DRA), and the second one is to examine the potential use of TanDEM-X bistatic along-track interferometry (ATI). To utilize DRA mode quad-pol SAR as ATI, it is necessary to remove the phase difference of scattering centers between transmitted H- and V-pol signals. By assume that the individual scattering center of returned signal does not change for a few inter-pulse periods, it is possible to measure the Doppler frequency induced by motion through measuring slow-time (or azimuth time) Doppler phase derivative of co-pol or cross-pol pairs. Results applied to TerraSAR-X quad-pol data over the Cape Columbia in the Arctic Ocean are to be presented and discussed. It was successful to detect and measure drift sea ice that was flowing away from the antenna with a velocity of about 0.37 m/s (or 1.4 km/h) to 0.67 m/s (or 2.4 km/h) while neighboring ones were static. A more sophisticated approach would be a bistatic ATI which exploits a long along-track baseline for observation of slowly moving ground objects. TanDEM-X bistatic ATI pairs are examined, which were acquired at an Antarctic coast. The ATI interferograms show an innovative capability of TanDEM-X/TerraSAR-X constellation. An along-track baseline of a few hundred meters is superior to a few meter baseline of DRA mode ATI system. However, topographic phase is inevitably mixed with Doppler phase associated with target motion because of a non-zero perpendicular baseline (or effective baseline). Thus it is necessary to separate target motion components from topographic components that are unknown for icebergs. Here we examine characteristics of the topographic phase of drift sea ice in the bistatic ATI interferograms, and discuss a detouring approach to quick detection of drifting icebergs by TanDEM-X bistatic ATI. The results demonstrate that it would be efficient to detect drifting icebergs and sea ice from space by utilizing high resolution SAR systems while the precise measurement of the drifting speeds requires further studies.