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Satellite altimetry in sea ice regions – detecting open water for estimating sea surface heights

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The Greenland Sea and the Farm Strait are transporting sea ice from the central Arctic ocean southwards. They are covered by a dynamic changing sea ice layer with significant influences on the Earth climate system. Between the sea ice there exist various sized open water areas known as leads, straight lined open water areas, and polynyas exhibiting a circular shape. Identifying these leads by satellite altimetry enables the extraction of sea surface height information.

Analyzing the radar echoes, also called waveforms, provides information on the surface backscatter characteristics. For example waveforms reflected by calm water have a very narrow and single-peaked shape. Waveforms reflected by sea ice show more variability due to diffuse scattering.

Here we analyze altimeter waveforms from different conventional pulse-limited satellite altimeters to separate open water and sea ice waveforms. An unsupervised classification approach employing partitional clustering algorithms such as K-medoids and memory-based classification methods such as K-nearest neighbor is used. The classification is based on six parameters derived from the waveform's shape, for example the maximum power or the peak's width. The open-water detection is quantitatively compared to SAR images processed while accounting for sea ice motion.

The classification results are used to derive information about the temporal evolution of sea ice extent and sea surface heights. They allow to provide evidence on climate change relevant influences as for example Arctic sea level rise due to enhanced melting rates of Greenland's glaciers and an increasing fresh water influx into the Arctic ocean. Additionally, the sea ice cover extent analyzed over a long-time period provides an important indicator for a globally changing climate system.