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SARin lead dectection algorithm for Cryosat-2 using unsupervised classification

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The sea surface slope can be determined from satellite altimetry and used to determine geostrophic surface currents. If these currents change over time, heat transport in the oceans will change as well, with potential impacts on continental temperatures. In Europe these temperatures are partly
influenced by geostrophic currents in the Arctic Ocean and it is therefore of great interest to know whether these currents have changed in the past 10-20 years.

One of the primary altimetry missions used for observing the Arctic region is CryoSat-2. Its advantages include a high inclination angle and the use of altimetric interferometry. The CryoSat-2 SARin acquisition mode has the highest spatial resolution and mostly covers coastal areas.

Altimetric sea surface measurements are sparse in the Arctic, due to the presence of sea ice, reduced data quality near the coast, and limited satellite coverage near the pole. The detection of leads (openings in the sea ice) allows for measurements of the sea surface, even in the presence
of sea ice. Reliably detecting locations of leads is therefore the first step in determining the sea surface slope in the Arctic Ocean. This study aims to increase the number of accurately detected leads, by designing and implementing an unsupervised machine learning algorithm for CryoSat-2 SARin data.

Sea ice and leads have different scattering properties, resulting in different altimetry waveform shapes. By defining a set of quantitative features to describe the waveform shape, the waveforms can be clustered based on similarities within this feature space. The features are chosen to provide
a clear distinction between sea ice and leads. A great advantage of the unsupervised classification is that no pre-labelled data are required. When new data are made available, waveforms can be assigned to an existing cluster by the K-nearest-neighbour method. Therefore, the creation of the
clusters has to be done only once.

In order to validate the algorithm, the classification results are compared with the outputs of lead detection algorithms based on other data sources. Due to the limited number of SARin observations, results from both optical imagery and SAR imagery are used for statistical robustness.