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Analysis of airborne synthetic aperture radar waveforms over arctic sea ice

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The sea ice thickness and its changes are one of the biggest uncertainties in the Arctic climate system. To address these uncertainties CryoSat has been launched in 2010. Onboard is the SAR/Interferometric Radar Altimeter (SIRAL) which uses the synthetic aperture radar technique to enhance the resolution along track. The new, improved sampling technique and the resulting changes in the signal shape lead to the question weather a distinction of different sea ice types may be possible. To answer this question we analyze radar altimeter data over the arctic ocean from CryoSats' pre-launch validation campaigns. During these campaigns the Airborne SAR/Interferometric Altimeter System ASIRAS has been operated over different surface regimes what allows for a detailed analysis of the radar waveform shape over different sea ice types. In our study we in particular investigate if the lead detection can be improved and if it is possible to distinguish between first year ice and multi year ice based on the shape of the radar echo waveform alone. We define various parameters to describe the width and strength of the returned radar waveform and select the most appropriate parameters for the surface classification. With a bayesian based method we are able to identify around 80 percent of the waveforms correctly. For the detection of leads we find the widely used threshold method sufficient enough to detect more than 90 % of the leads. However we found that the use of the maximum of the radar echo power as a classification parameter can minimize the rate of false detection compared to the widely used Pulse Peakiness parameter. The possibility to distinguish between different ice types makes it possible to improve the freeboard retrieval and the conversion into sea ice thickness by applying more suitable values for the sea ice density and snow load. More analysis however is required to test the presented method for satellite based altimeters.