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Arctic Lead Detection Using a Waveform Unmixing Algorithms from CryoSat-2

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ABSTRACT

Arctic areas consist of ice floes, leads, and polynyas. While leads and polynyas account for small parts in the Arctic Ocean, they play a key role in exchanging heat flux, moisture, and momentum between the atmosphere and ocean in wintertime because of their huge temperature difference In this study, a linear waveform unmixing approach was proposed to detect lead fraction. CryoSat-2 waveforms for pure leads, sea ice, and ocean were used as end-members based on visual interpretation of MODIS images coincident with CryoSat-2 data. The unmixing model produced lead, sea ice, and ocean abundances and a threshold (> 0.7) was applied to make a binary classification between lead and sea ice. The unmixing model produced better results than the existing models in the literature, which are based on simple thresholding approaches. The results were also comparable with our previous research using machine learning based models (i.e., decision trees and random forest). A monthly lead fraction was calculated, dividing the number of detected leads by the total number of measurements. The lead fraction around Beaufort Sea and Fram strait was high due to the anti-cyclonic rotation of Beaufort Gyre and the outflows of sea ice to the Atlantic. The lead fraction maps produced in this study were matched well with monthly lead fraction maps in the literature. The areas with thin sea ice identified from our previous research correspond to the high lead fraction areas in the present study. Furthermore, sea ice roughness from ASCAT scatterometer was compared to a lead fraction map to see the relationship between surface roughness and lead distribution. Active heat loss from ocean accelerates new ice in the leads. The leads weaken the internal strength