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Assessment of Sea Ice Lead Detection based on SAR imagery and Altimeter data

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Altimeters measure the topography of the surfaces they fly over, but in the Arctic context where sea ice can be found, it is important to determine whether the measurement corresponds to open ocean, ice floe or leads within the sea-ice. The knowledge of the surface type is critical to potentially invokes a retracker (algorithm that provides the range corresponding to the surface) that can be different for lead and ice floe returns (physical or empirical retracker). It is also important for data interpretation and the computation of the freeboard obtained by difference between the open water level and the floe surface level. Ice thickness estimate is then derived from the freeboard estimate. The distinction between open water and ice floe must be done using the altimeter signal, since the leads are narrow swiftly-evolving features that cannot be captured in any static database or routinely acquired from other sensors.

In this study, the classification of the altimeter echo shapes has been done thanks to a Neural Network (NN) classifier. The validation of this classification process can be done exploiting other satellite measurements like SAR images as for example those provided by Copernicus Sentinel-1 (S-1).

In this study, a robust and consistent methodology for the joint assessment of SAR and Altimeter lead detector has been developed. Compared to the existing state of the art, it is proposed to fully account the 2-D geometric problem when comparing 1-D altimeter track and 2-D SAR image. The distance from nadir and the surface of leads within the altimeter footprint are especially considered when building the SAR-based reference database. A dedicated S-1 lead detector has been implemented as well.

We work with the newly launched Copernicus S-1 SAR imagers and Sentinel-3 SRAL altimeter. We collocated S-1 / SRAL S-3 data with time lag less than 8 minutes, corresponding to 169 S-1 images. The overall accuracy between the S-3 and S-1 lead maps is good with more than 90 % of good agreement depending upon how the SAR-based reference dataset is built. The False Positive Rate is very low with less than 3-6 %. A new criterion, the so called Matthews coefficient, is introduced, and provide new potential parametrization for the SRAL S-3 lead detector. A tradeoff between false alarms and good detection is numerically found. The impact of the new parameterization is finally tested over the estimation of the Sea Level Anomaly, and then the freeboard.

A comparison with collocated French-Indian SARAL AltiKa altimeter and S-1 data is also provided. The benefit of the SAR mode of SRAL S-3 data is clearly shown, providing the capabilities for enhanced sea ice thickness maps.