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Arctic Wintertime Sea Ice Lead Detection from Sentinel-1 SAR Images

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Leads are almost linear fractures within the ice pack, and are commonly observed in the polar regions. In winter, leads promote energy flux from the underlying ocean to the atmosphere. Synthetic aperture radar (SAR) can monitor leads with a fine spatial resolution, regardless of solar illumination and atmospheric conditions. SAR-based lead detection methods proposed earlier are restricted to a specific dataset or condition. In this paper, we present a more generalized deep-learning-based approach for automatic sea ice lead detection (SILDET) in the Arctic wintertime using Sentinel-1 SAR images. The validation results show that SILDET has the capability of detecting open and frozen leads at different stages of freezing. Compared with visual interpretation of Sentinel-1 images, the overall detection accuracy is 97.80% and the Kappa coefficient is 0.88 (for all types). The lead map of a regional study obtained from SILDET is compared to that from a previous SAR-based lead detection method and a lead dataset based on Moderate Resolution Imaging Spectroradiometer (MODIS) data. It is also validated using Sentinel-2 images. The result shows that SILDET can provide a more detailed distribution of leads and better estimation of lead width and area. SILDET is applied to present the Arctic lead distribution from January and April 2023 with a spatial resolution of 40 m. The Arctic-wide lead width distribution follows a power law with an average exponent of 1.65. SILDET can be expected to provide long-term high-resolution lead distribution records.