

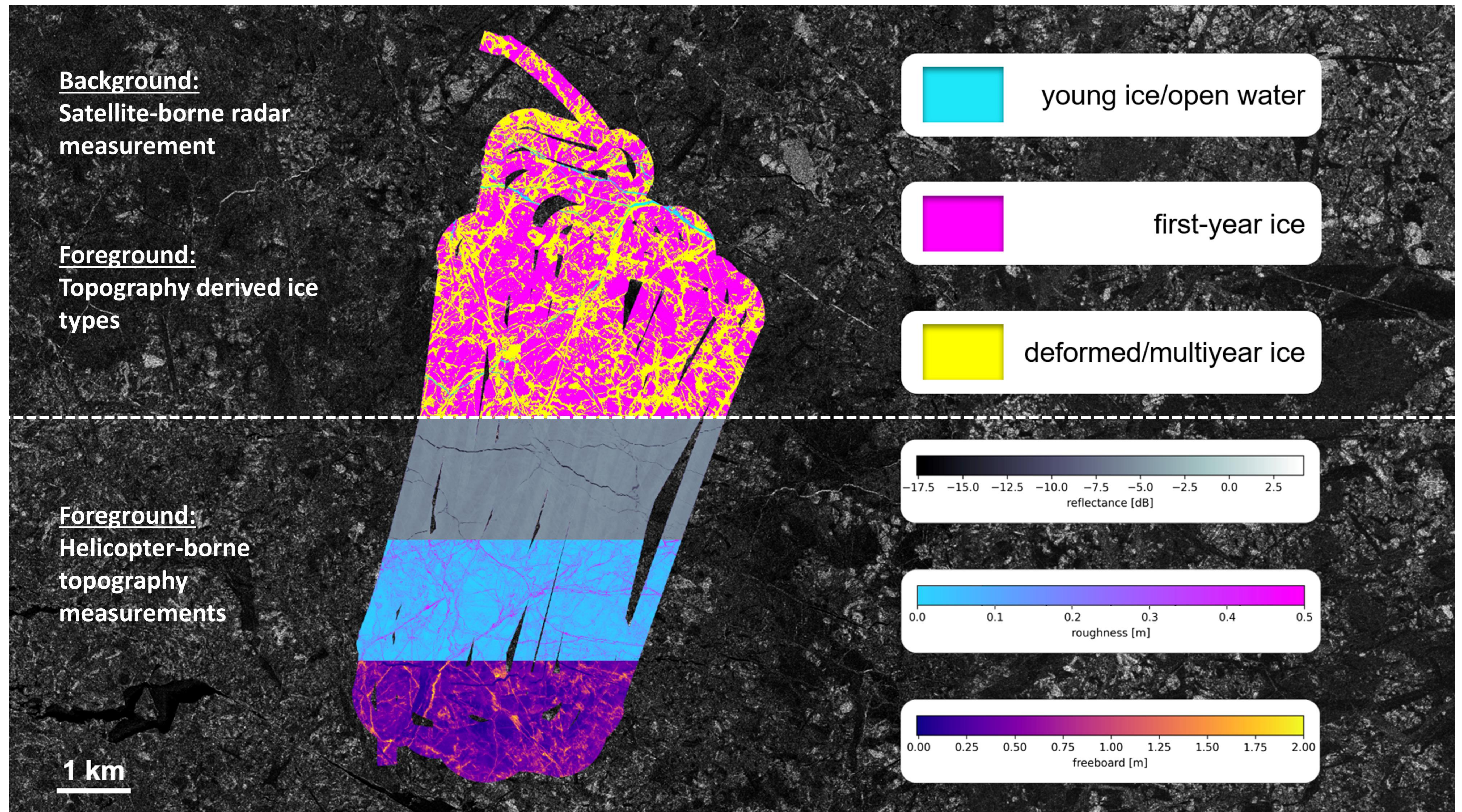
Automated Sea Ice Mapping Using SAR: Assessing Machine Learning Approaches on Labels Derived from Topography Measurements

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Ice type labels are derived from helicopter borne topography measurements acquired with an airborne laser scanner LiDAR instrument and fused with near coincident Synthetic Aperture Radar (SAR) imagery. Radar features can be compared directly to ice properties.

Model Type	Name	Accuracy on labels from measurement [%]	Accuracy on manual labels (literature) [%]
centre-pixel classifiers	VGG16	44.0 ± 1.8	80 [1], 99 [2], 98 [3]
	ConvNext	44.7 ± 1.5	-
	cCNN	47.7 ± 1.9	88 [1]
semantic segmentation models	Unet	65.2 ± 1.1	92 [4], 96 [5], 96 [6]
	Unet++	66.2 ± 1.3	96 [7]

Model performances on a disjoint test set show disparity between labels from measurement and human annotation. Segmentation models have a clear advantage.

The study showed a clear disparity between the performance of models when trained and evaluated on coarse human made annotations versus precisely mapped labels derived directly from measurement.

This reveals a disconnect between actual sea ice properties and human interpretation. As the latter is the current standard in the literature, it poses a new question:

How do models of the future need to be designed to allow for retrieval of ice properties near the resolution of the sensor?

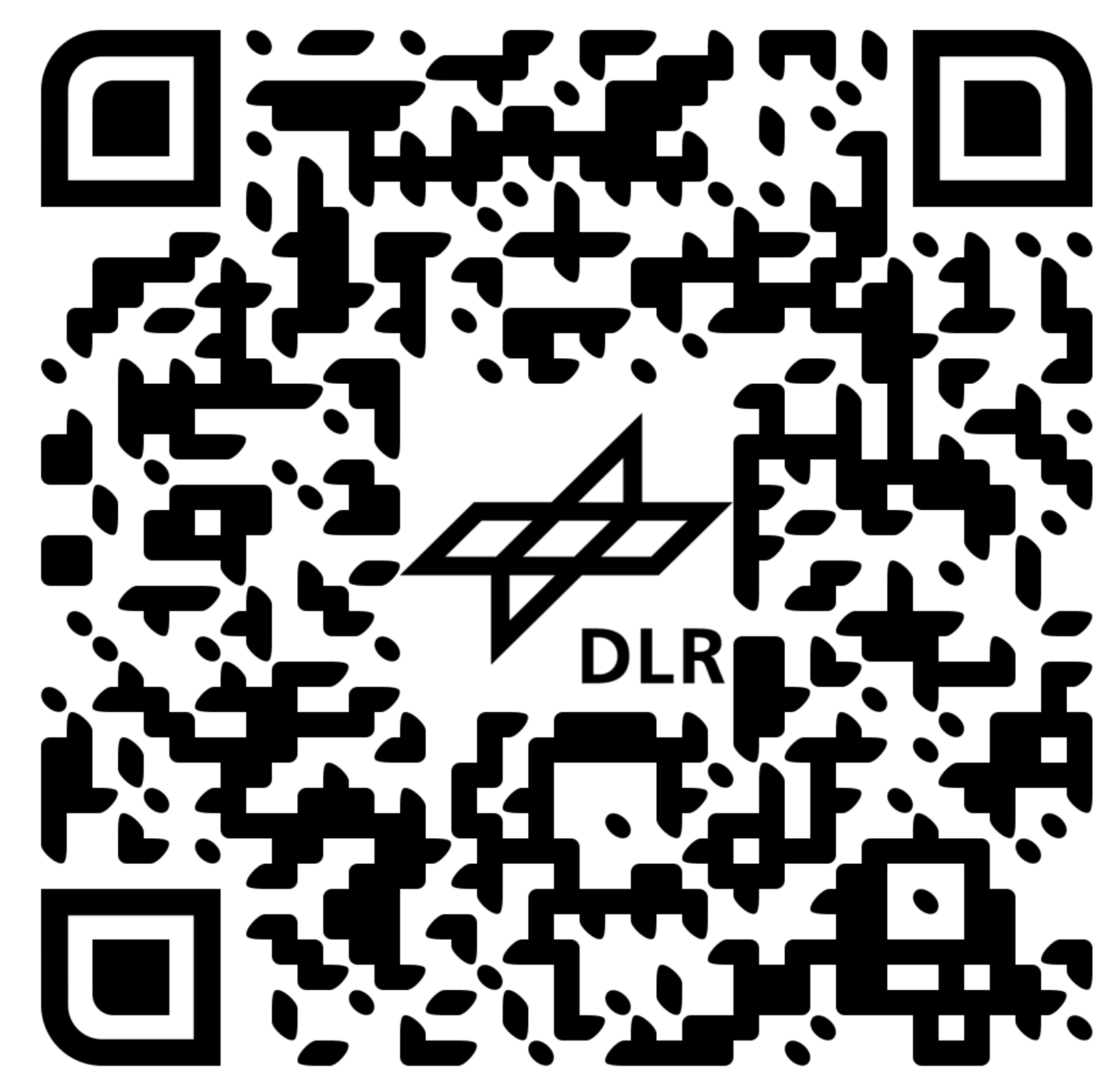
- Semantic segmentation models with access to the label distribution
- Training dealing with possible human biases
- Account for only weak correlations with ice properties even in optimal conditions

References:

[1] K. Kortum et al., 2023; [2] S. Khaleghian et al., 2021; [3] H. Ullah et al., 2021; [4] Y. Ren et al., 2020; [5] K. Radhakrishnan et al., 2021; [6] Y.-R. Wang et al., 2021, [7] Murashkin et al., 2021

The data was collected during the year long MOSAiC expedition (Multidisciplinary Drifting Observatory for the Study of Arctic Climate).

- Largest dataset of co-located in-situ sea ice data and SAR spanning 20 scenes over 8 months, totalling 1000 km² @ 3.5m resolution
- Colocation is achieved by reversing the sea ice drift using the Polarstern (ship) track
- Thresholds to derive labels are based on characteristics of the measurements' probability density function



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