Deep learning methods for sea-ice imaging using radar Sentinel-1 data

Internship supervision

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Internship description

Arctic sea-ice extent has been decreasing since the 90's, which speeds up the warming of the Arctic ocean since sea-ice insulates the ocean from the atmosphere and has a high albedo reducing the absorbed heat. To model this processus at a fine-scale, high resolution maps of sea-ice thickness are needed. It is possible to acquire images from satellite sensors either optical or radar to identify ice classes. The ESA program Copernicus provides images from both sensors: Sentinel-2 images in the optical range and Sentinel-1 images with a radar sensor. Although optical images can be used to provide labels by ice-floe segmentation [König2020], only few cloud-free Sentinel-2 (S2) multispectral images are available per year to get the pixel-based sea-ice floe labeling. Moreover, since the two images are not acquired at the same time, a sea-ice drift compensation needs to be applied to match the two images (and also a re-sampling step). An example of two pairs of S1 and S2 images acquired on the same day, separated by 1 day is shown in Figure 2.

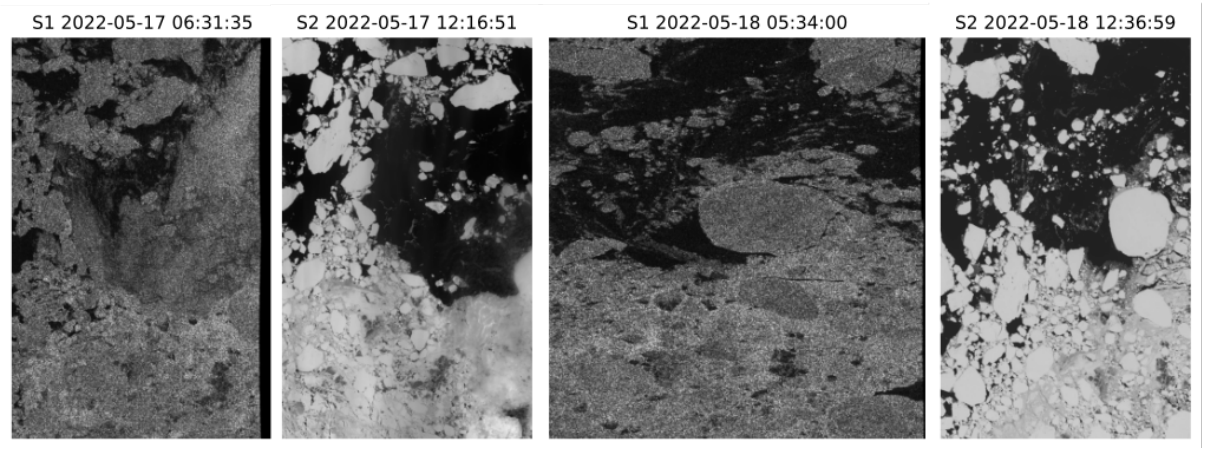

Figure 2: coarse co-registration between S1 EW SLC images and S2 band 3 images.

Although SAR (Synthetic Aperture Radar) images are very convenient for sea-ice mapping they present a strong level of fluctuations due to the speckle phenomenon due to coherent imaging. Recently very efficient self-supervised methods have been proposed to reduce speckle on these data.

The objective of this internship is first to develop speckle reduction methods and then to pixelwise classify the SAR images.

Concerning the first step, the main objective is to adapt MERLIN approach [Dalsasso2022] to the context of sea-ice images. The Sentinel-1 images need some specific processing of their spectrum as described in [Dalsasso2024b]. This self-supervised deep learning method exploiting the splitting of the data in real and imaginary parts will be trained

on Artic area with sea-ice images. A comparison with the generic version will be done and an evaluation of the interest of the refined training with the ice texture will be analyzed. Besides since pairs of images with different polarizations can be acquired simultaneously with sentinel-1 sensor, a joint despeckling will be investigated using the MuChaPro approach [Denis2024].

In the second part of the internship classification methods will be investigated on the sea-ice images. A possible strategy will be to exploit the learned representation during the despeckling task to define a weakly supervised segmentation approach taking inspiration from [Dalsasso2022]. If time permits the use of corresponding Sentinel-2 images will be considered.

Candidate profile

We are looking for candidates with a master's degree or the equivalent within the fields of signal and image processing and deep-learning. Good statistical skills and coding skills (python) are required. An interest in physics and climate sciences, with a focus on sea-ice, is an advantage.

Application

The candidate should send a CV and recent transcripts (M1 level or equivalent and on-going semester if possible).

References

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