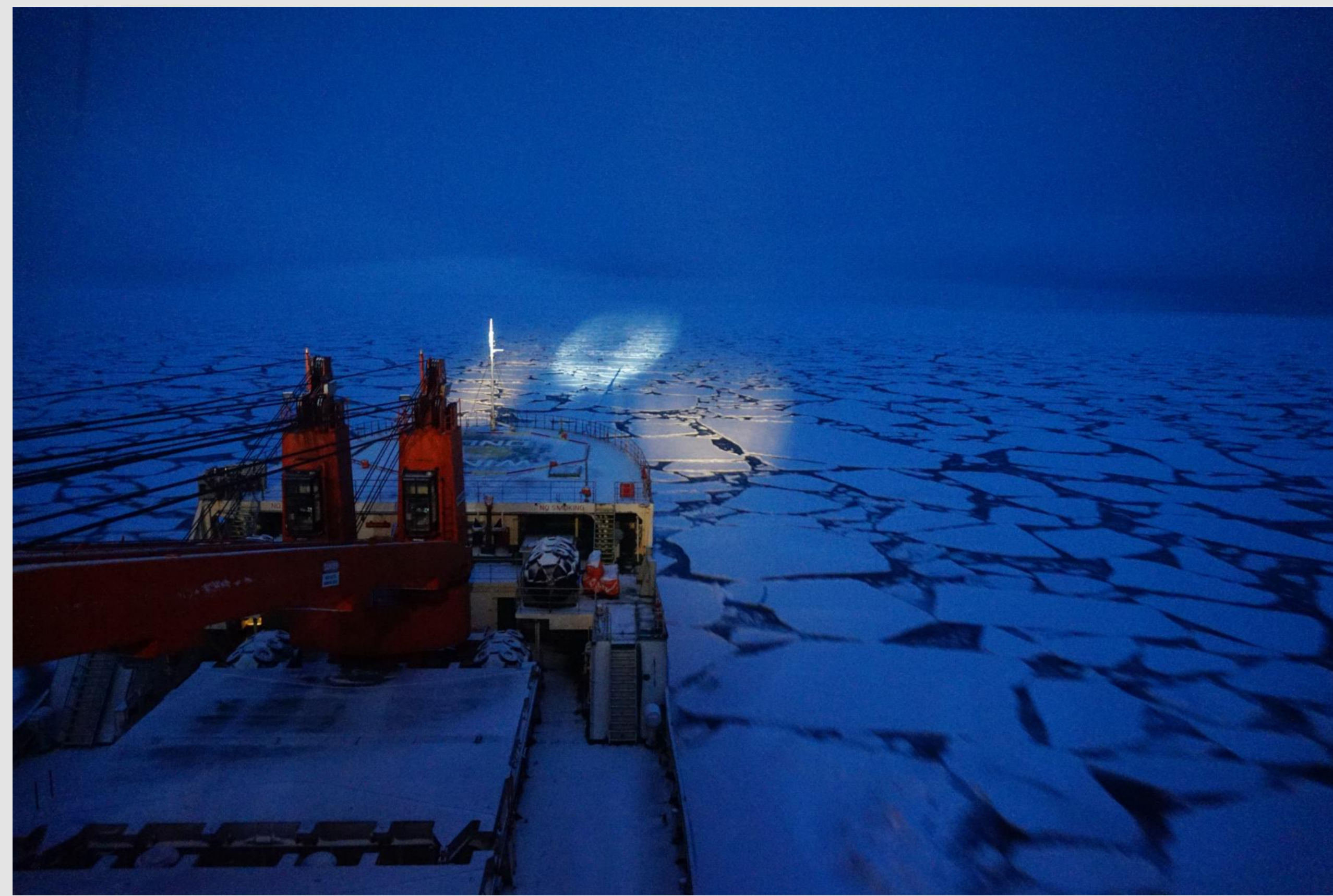# Arctic Sea Ice Mapping with Sentinel-1 SAR scenes

A map of sea ice types is of a great importance for ships operating in the Arctic. Information on sea ice situation in the surrounding of a ship is very limited. Ice radar installed on ships helps to choose the path through sea ice, but it has limited range and does not allow to make strategic decisions. Synthetic Aperture Radar (SAR) is an active instrument operating in microwave frequencies that is able to provide radar backscatter information about the ocean and ice surfaces all year round, independently on weather conditions and presence of daylight. The resolution of satellite SAR systems can reach 1 meter, but often a courser resolution is used to increase the spatial coverage. Despite its advantages, the use of satellite SAR images onboard of ships operating in the Arctic is limited due large image size (and low internet bandwidth in high-altitude areas). Also, information in microwave spectrum is harder to interpret compared to optical images. Thus, a regional sea ice map based on SAR images would be a helpful tool for ship route planning.
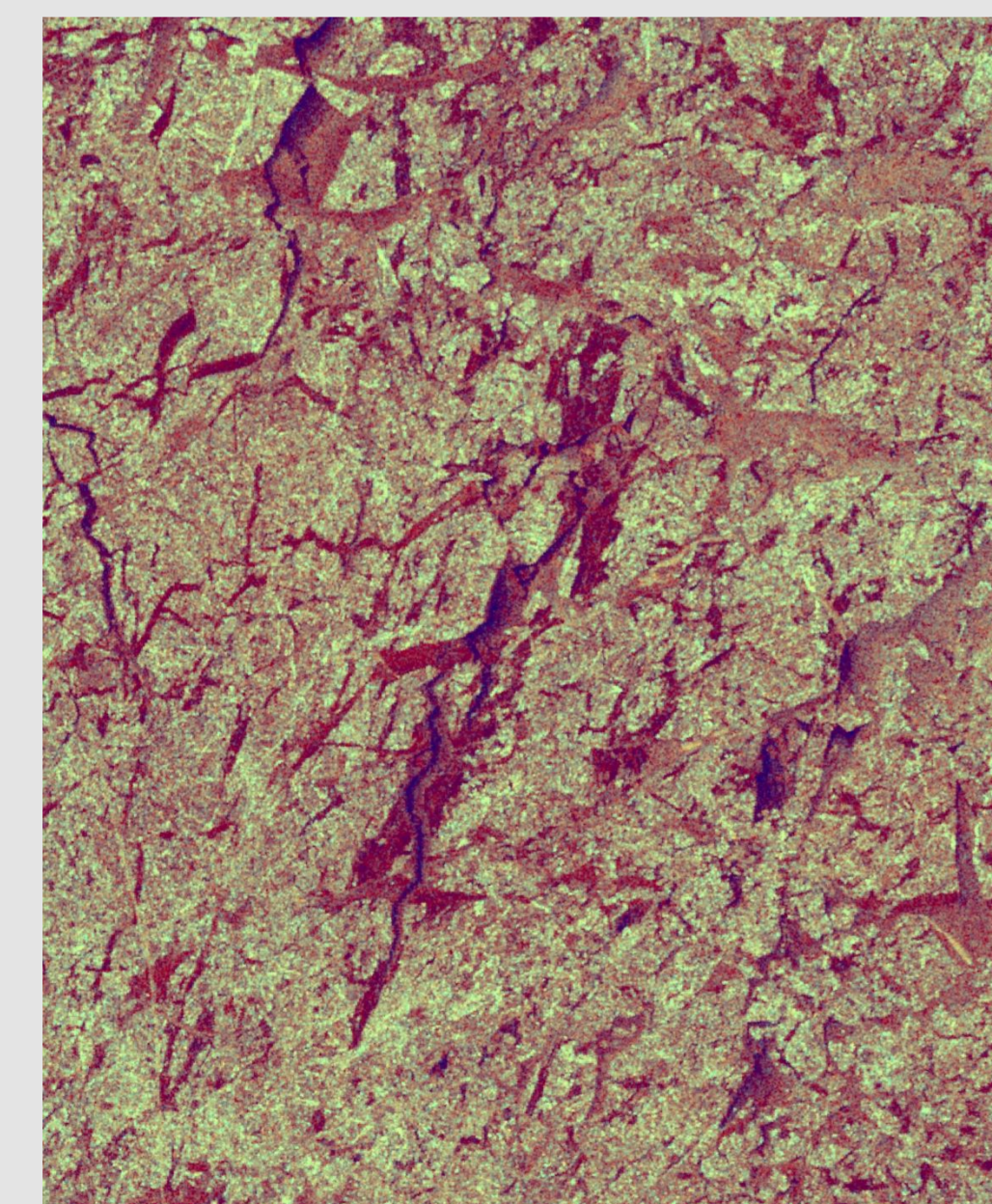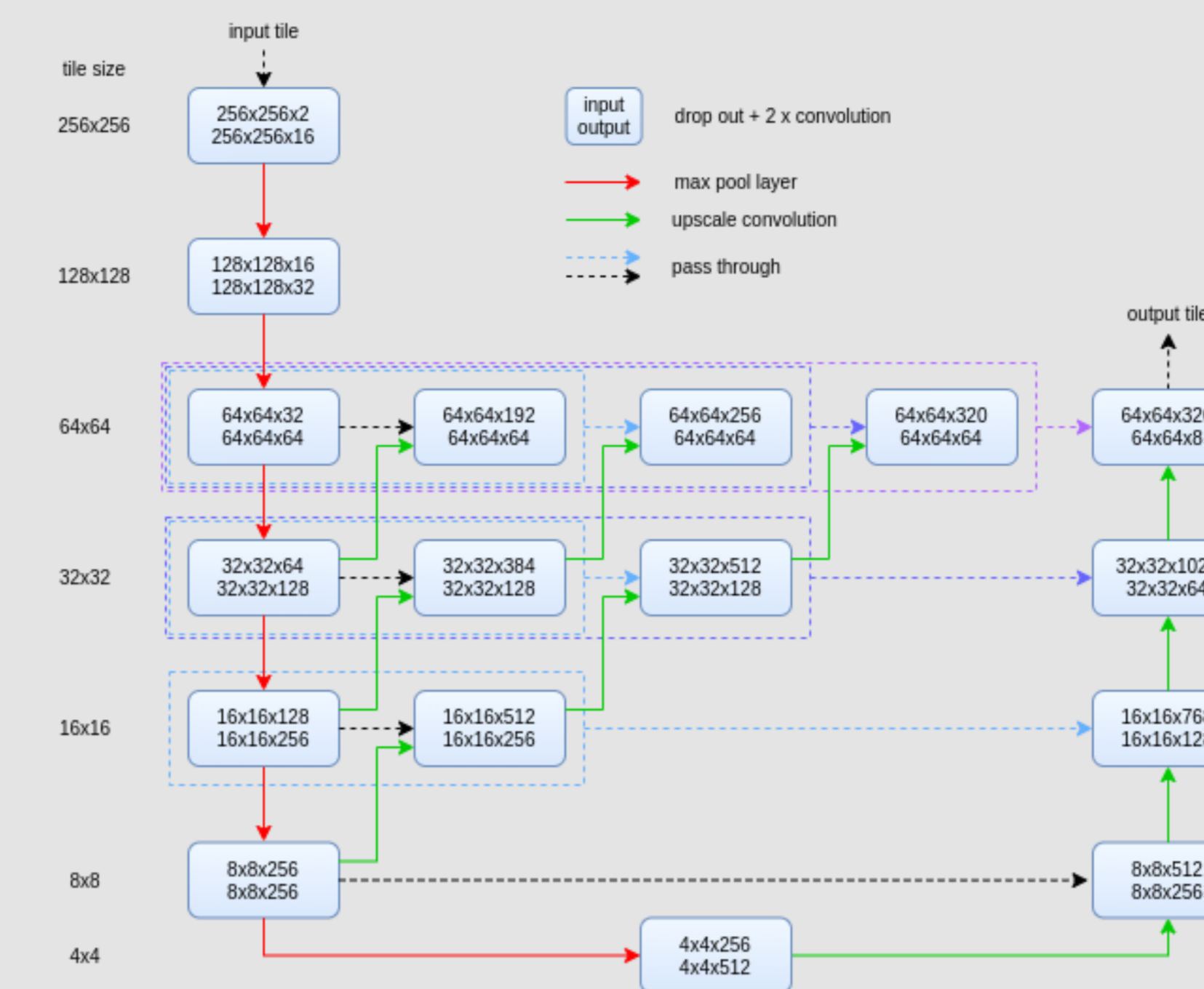

Sentinel-1 pseudoRGB (HH, HV, HV/HH)

Sentinel-2 optical image

Image labeling

The following sea ice types are labeled on Sentinel-1 SAR images:

- Multiyear ice
- First-year ice
- New ice
- Leads and open water (smooth surface)
- Lead and open water (wind rough surface)
- Rough ice

Whenever possible, a corresponding Sentinel-2 optical image is used for label evaluation


Classification algorithm

For classification we employ UNET++ convolutional neural network architecture. The scheme is shown above. The model allows to combine features of various scale at each level of the decoder (right part of the image). The depth of the decoder (left part of the scheme) is increased to six layers to account for image texture at a larger surrounding. Input images have 40 meters size, the classified scene has 160 meter resolution.
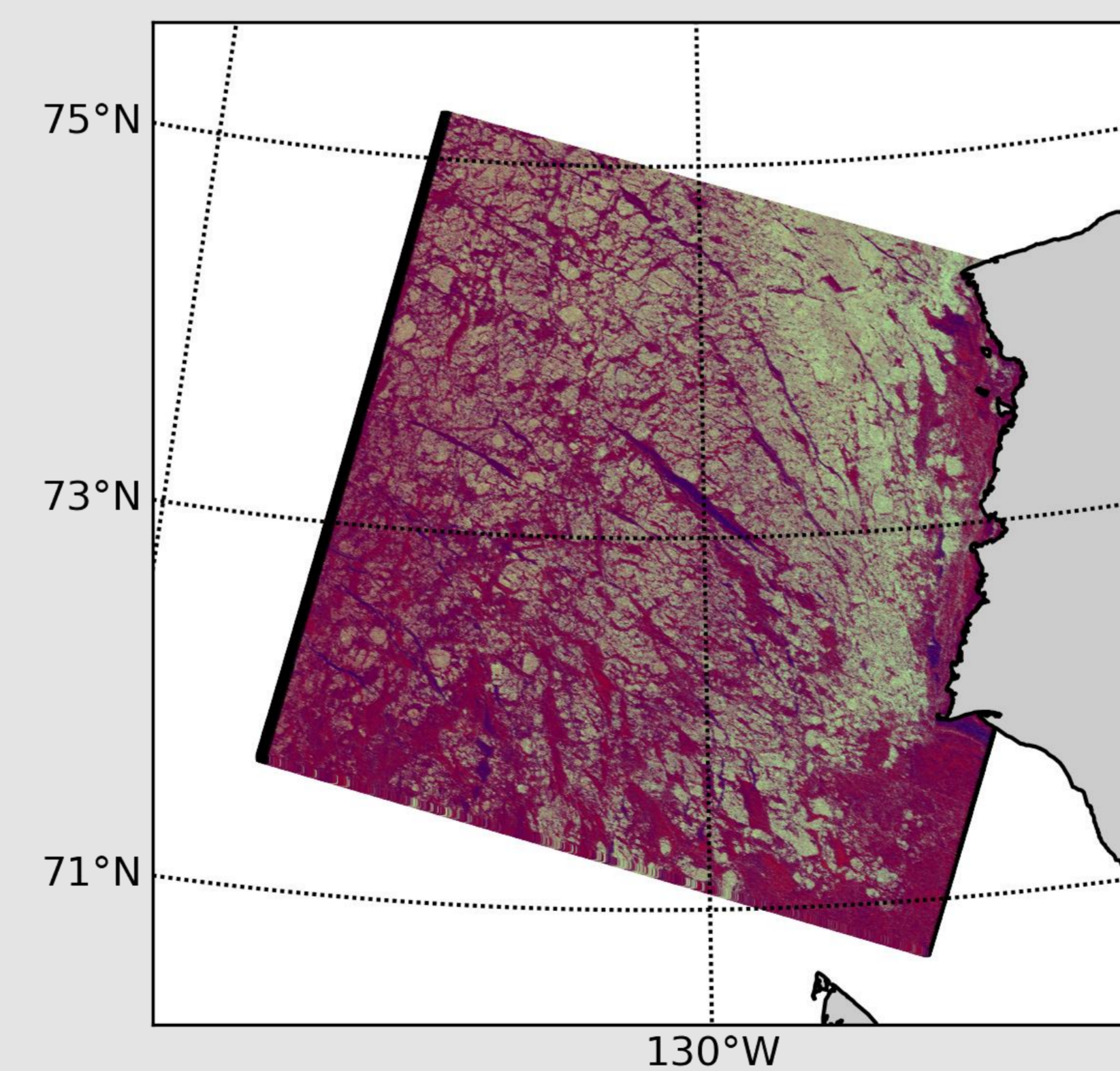
Sentinel-1 scene taken over the Beaufort Sea, pseudoRGB (HH, HV, HV/HH)
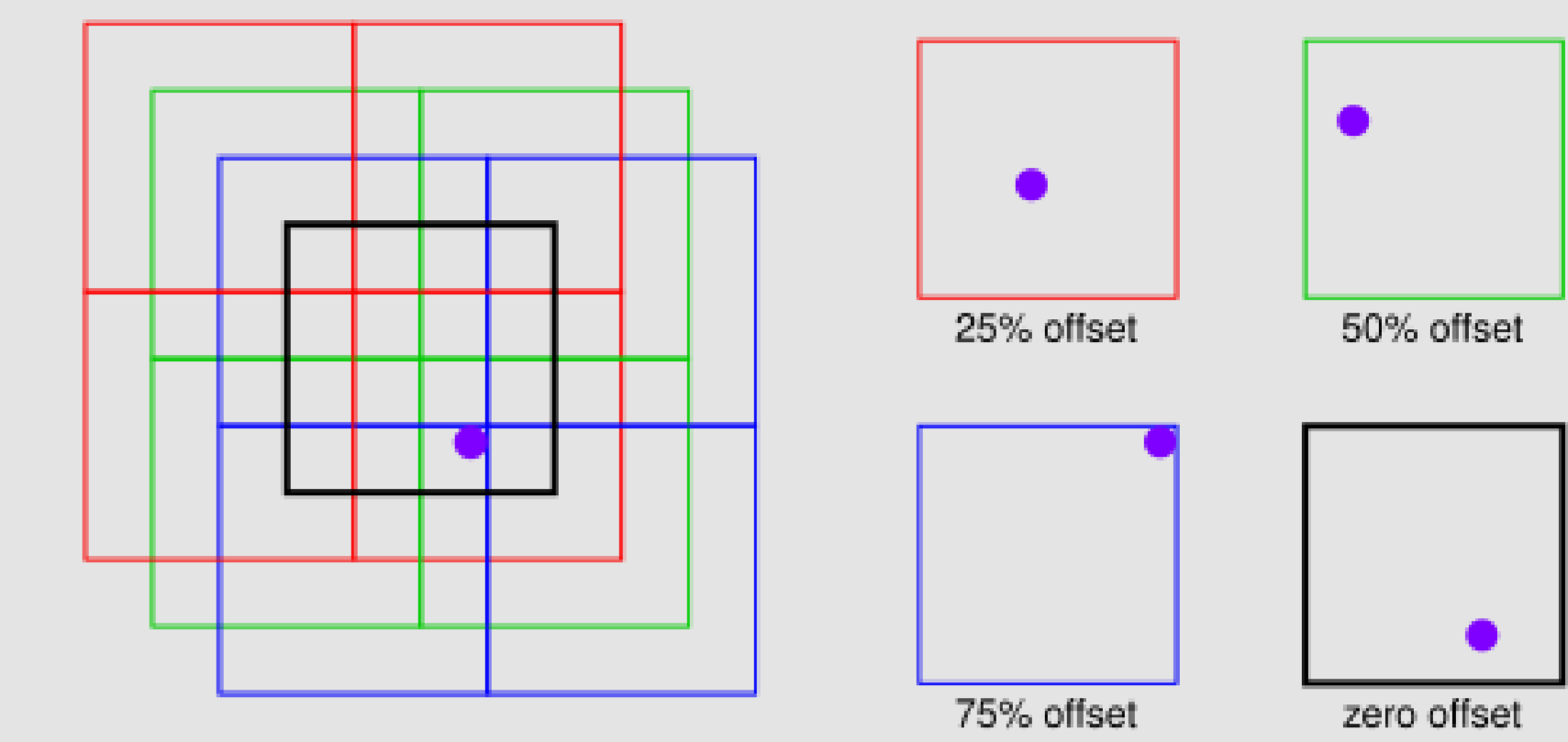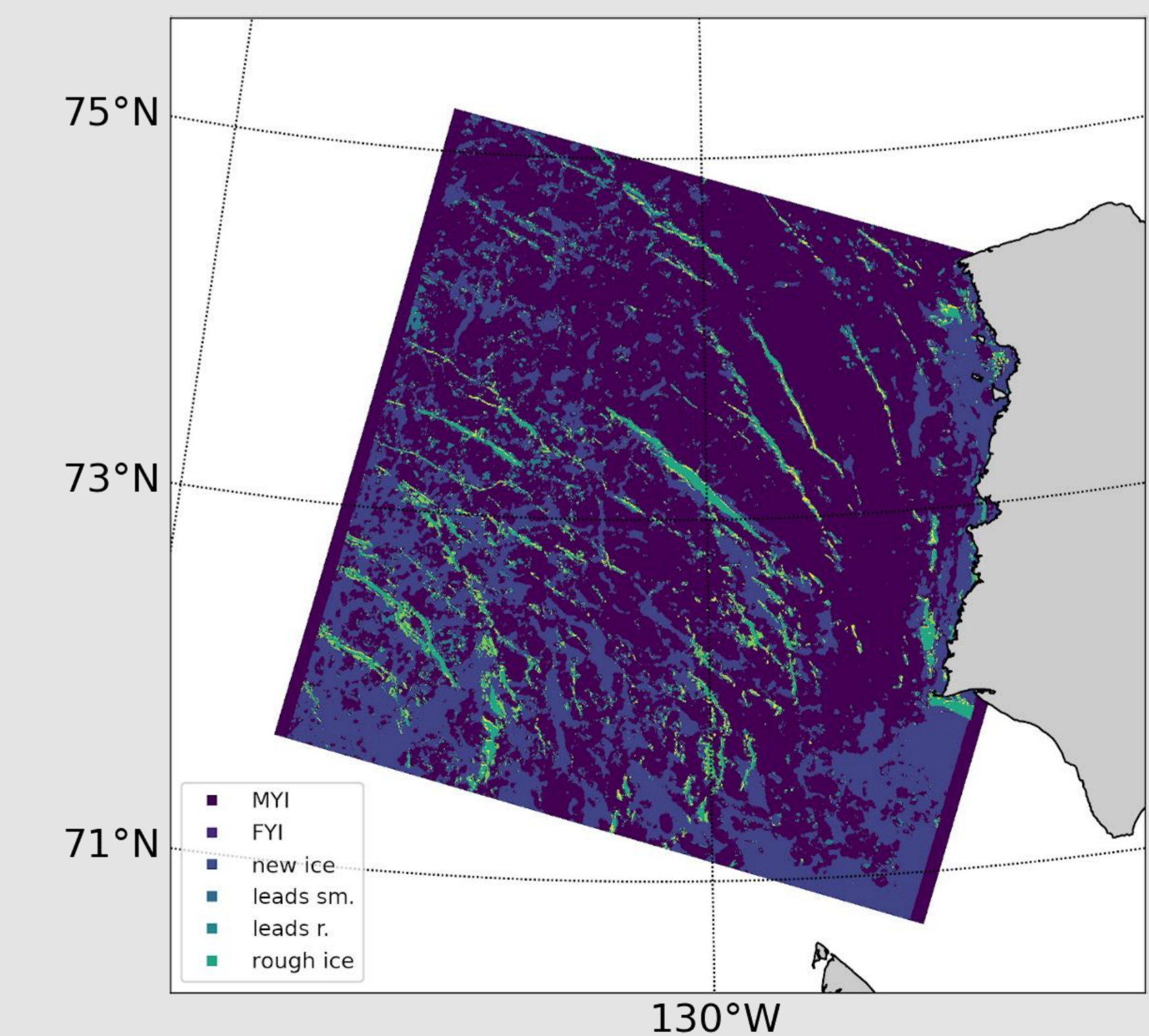

Tiling edge effect

A large Sentinel-1 scene is split into tiles 256 pixel size. When classified tiles are merged back together a classification discontinuity might occur. To avoid this effect the classification is applied four times to the same scene. Each time the scene is cut into tiles with an offset as shown above.

The four results are merged with every pixel class probability value being weighted by its distance from an edge of its tile. This way every pixel (for instance one is shown in lila) will appear at a different place of a tile and result is averaged.

Result

A classified scene taken over the Beaufort Sea is shown below.

Sea ice map derived from Sentinel-1 scene taken over the Beaufort Sea

Dmitrii Murashkin[1,2] ,Anja Frost[1]
1 DLR, EOC, Bremen;
2 University of Bremen

Deutsches Zentrum für Luft- und Raumfahrt

Universität Bremen