Master Thesis

Detection and statistical analysis of air-bubble inclusions in Arctic sea ice

The research focus of this master project is to derive statistical information about air-bubbles, which frequently occur in the upper layers of (Arctic) sea ice. Satellite sensors operating in the microwave range are the primary tool to monitor the global sea ice cover since the 1970s. The Institute of Environmental Physics at the University of Bremen has a long history in developing methods for satellite remote sensing of sea ice (www.seaice.uni-bremen.de).

In the microwave range (from 1 GHz to 300 GHz) air-bubble inclusions alter the ice emissivity and scattering and thus influence the signal observed from microwave radiometer and radar satellites over sea ice. In order to investigate these effects, simulations of the microwave emission of Arctic sea ice are needed. Those simulations require detailed knowledge about the size, circularity, and distribution of the air-bubble inclusions.

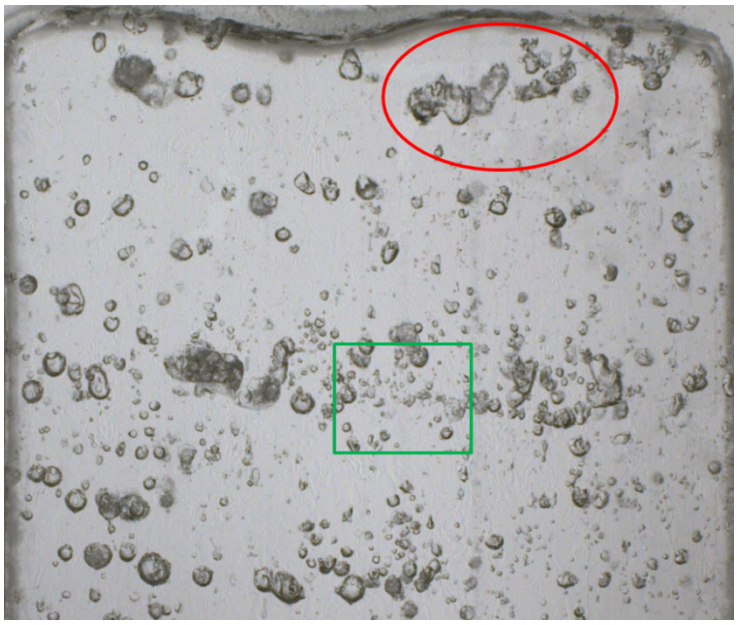

Figure 1: Thick section photography of an ice core sample. The red circle shows an area with overlapping air-bubbles. The green box frames and area with small air-bubbles which are hard to distinguish from the ice.

In this project, images obtained from ice cores (mainly thick sections of 0.5 cm; Figure 1) will be analyzed using image processing tools (e.g. OpenCV). In the pictures, the air-bubbles are clearly visible (dark "blobs"). However, the derivation of the air-bubble statistics faces many problems. Often, air-bubbles overlap each other (e.g. red circle in figure 1) or the contrast between air-bubbles and ice is low (e.g. green box in figure 1). In addition to air bubbles also brine channels with a different shape might be present in the image. Therefore, it can be challenging to detect air bubbles reliably. In OpenCV many tools exist that could help to mitigate these problems, e.g., by denoising the pictures or by increasing the contrasts between air and ice. The images have to be segmented and the objects like air bubbles and brine channels classified. Statistical parameters of the geometry of the objects and the frequency of their occurrence finally can be derived. Results of this study will be used to improve methods to derive sea ice properties (e.g., ice area or snow depth) from satellite measurements. Depending on the interest of the candidate first experiments to simulate microwave emission based on the found bubble statistics can be conducted.

What you need and what you will learn

The aim of this work is to develop an (semi-) automatic method to process the ice core images and to derive statistical information about the air-bubbles. The work requires basic mathematical understanding of image processing. In addition, basic knowledge about Linux systems would be useful. Some experience in computer programming like Python, Matlab, and/or OpenCV are needed.

You will learn about image processing and classification methods in the context of active and passive microwave remote sensing of sea ice. Our working group offers an open discussion atmosphere and worldwide contacts to the leading institutions in the field.

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