Extracting methane bubble metrics from Aris imaging-sonar datasets using machine learning

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Methane emissions at well locations or natural seeps can create bubble plumes. In the North Sea, various measuring techniques are used to quantify the amount of methane released into the environment. Some of these techniques consist of imaging the seabed using cameras. Since the North Sea is a shallow sea, the poor visibility often hampers the use of conventional cameras. Therefore, we use an imaging sonar camera to provide direct observations of the methane bubbles. Imaging sonars transmit sound pulses and convert the returning echoes into digital images (Fig. 1A), much like a medical ultrasound sonogram. Here, we aim to estimate the amount of methane escaping from the seafloor by evaluating the bubble metrics, specifically quantifying the size and the number of bubbles.

However, extracting bubble metrics from multiple plumes in a large sonar video dataset required an automatic method. We thus use machine-learning methods to detect, count, and track methane bubbles in sonar videos (Fig. 1B), thereby evaluating bubble size, velocity, and emission rate from the seabed. Our machine-learning workflow includes computer vision techniques and an object detection algorithm, so-called "YOLO", that we trained for bubble detection specifically. We demonstrate the ability of the developed workflow to detect and track bubbles for well A15-03 (Doggers Bank). This yields an estimated probability distribution of the bubble diameter and bubble rising speed. Based on the probability of the bubble diameter, velocity, and the average number of detected bubbles, we provide insights into the methane emission at the location of A15-03.

Overall, we demonstrate the ability of the developed machine-learning workflow to quantify bubble metrics using bubble plume observations from sonar videos. These preliminary results suggest that the method could be applied at other offshore locations, where gas emissions are observed. Finally, a large-scale application of the current workflow could help quantify North Sea methane emissions better.

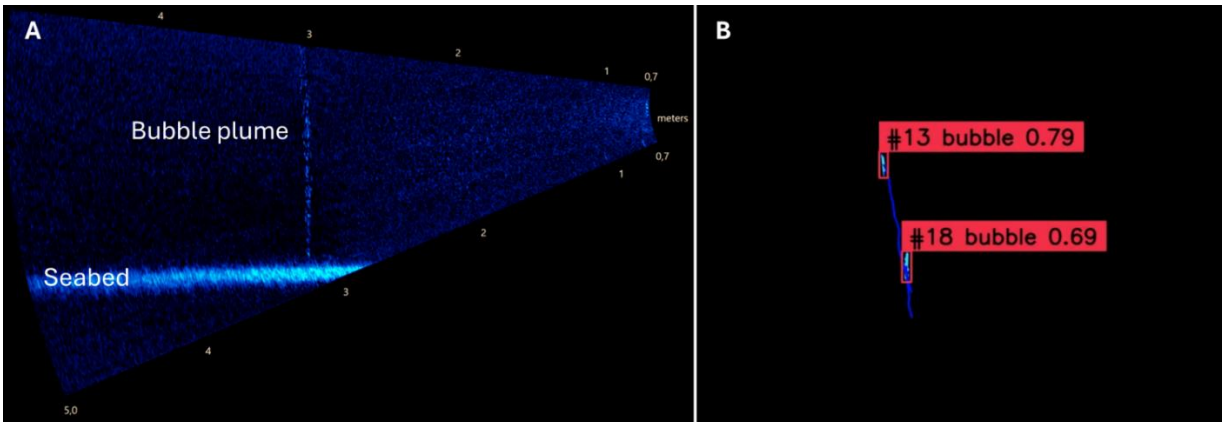

Figure 1: A) Aris sonar image showing a bubble plume above the seabed. B) Shows two detected and tracked bubbles, where each detected bubble (red bounding box) is numbered with a detection ID and a confidence value. When the same bubble is recognized through several video frames, a blue line (track) indicates the bubble trajectory in the water column.

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