

Challenges of Tidal Flat Monitoring with Sentinel-1 SAR – A Case Study in the German Wadden Sea

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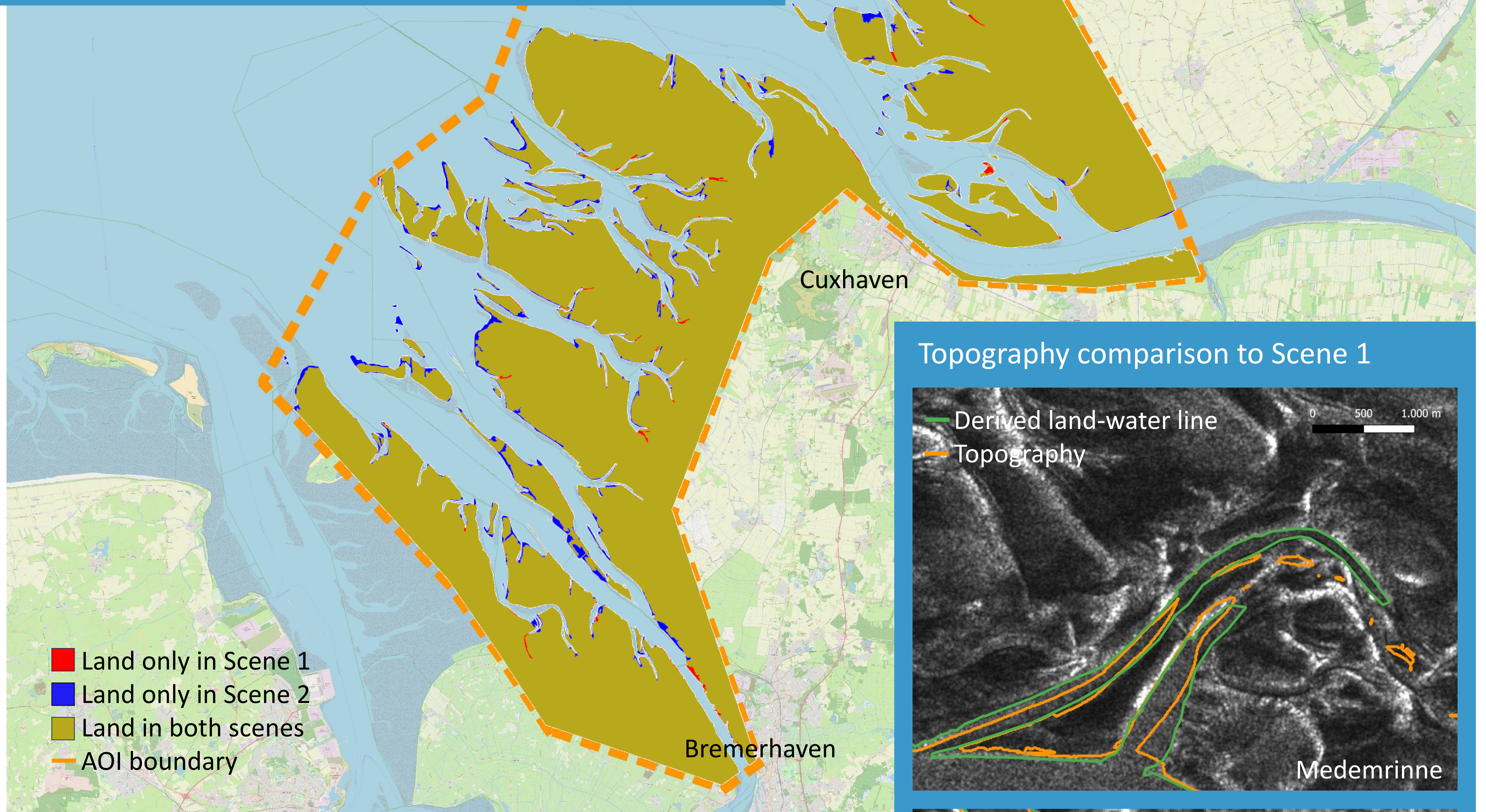
Abstract

The fixed acquisition schedule of Sentinel-1 is very suitable for monitoring and change detection. This case study compares the tidal flat boundaries between two Sentinel-1 scenes with only 36 hours time difference:

Scene 1: 2020-03-21, 17:08 UTC, gauge level: 291 cm

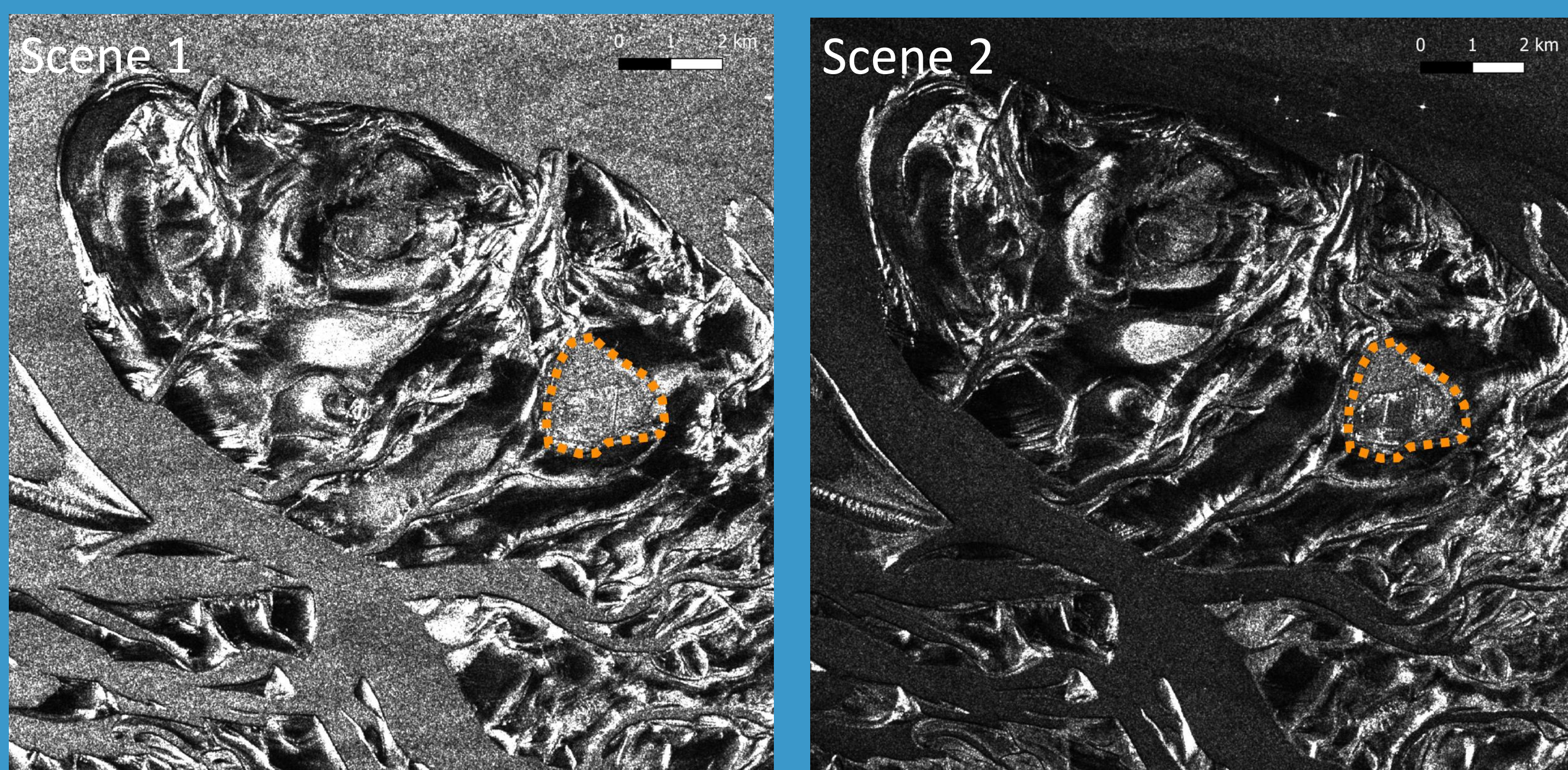
Scene 2: 2020-03-23, 05:40 UTC, gauge level: 293 cm

With no actual topographic changes and almost identical water level, 3.3% of land pixels were different between scenes, resulting from different water levels farther from Cuxhaven gauge since the captured tidal phase was different, as well as different look direction and contrast between scenes.



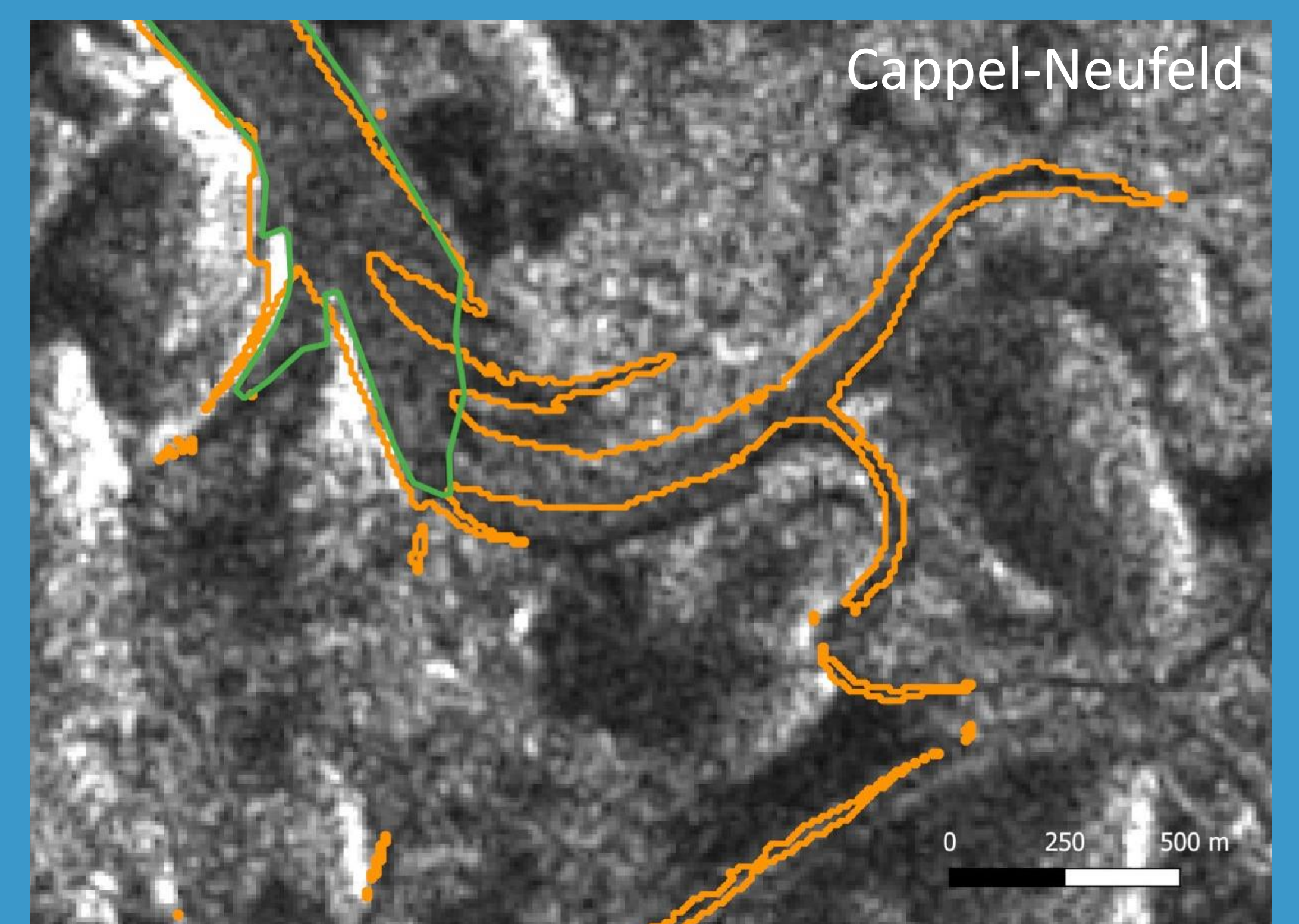
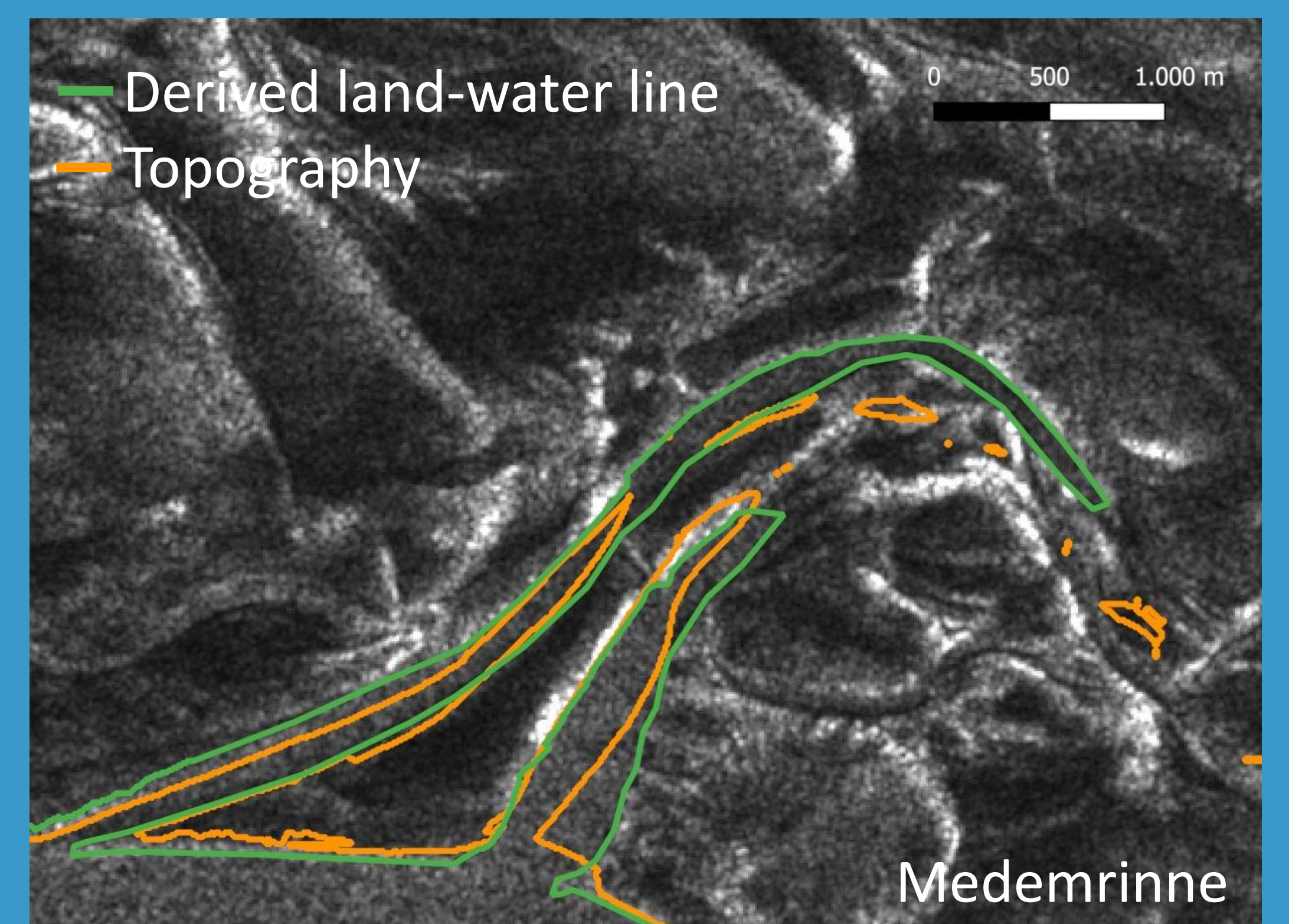
Differences in retrieved tidal flat extensions between both scenes. The tidal phase offset between both acquisitions (10 minutes before low water in Scene 1 vs. 47 minutes in Scene 2) causes higher differences in water level farther away from the gauge at Cuxhaven.

Visual differences between scenes



Visual comparison of both scenes around the island of Neuwerk (orange outline). The differences are likely caused by different wind speeds (5 bft vs 4 bft), the opposite look direction (ascending vs. descending orbit), and remnant water due to different times before low water.

Topography comparison to Scene 1



Derived land-water line from Scene 1 compared to TriLaWatt annual topography 2020 (Lepper et al., 2025). The course of some tidal channels differs, which is well visible in SAR (top). The end of channels is often hardly visible due to backscatter intensity changes and reduced contrast (bottom)

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