

Exploring the Sea-Level Modes in Eyjafjörður: Insights from Observations and Numerical Simulations



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Abstract

We analyzed the long-term time series from the tide gauge installed by Vegagerðin, located near Akureyri. This station recorded tidal data from 1 January 2023 to 24 June 2024, showing a characteristic long-period fluctuation in sea level with alternating high and low states of approximately 2 hours. To investigate this, we computed spectrograms of the tide gauge data to identify a persistent mode that distinguishes this station from other nearby tide gauges.

We then conducted a single perturbation analysis to further characterize the fjord's response, using the non-linear shallow-water equation model, GeoClaw. We placed 112 synthetic tide gauges along Eyjafjörður and introduced a single perturbation at the fjord's mouth, tracking the temporal response at each synthetic station to monitor the high-state mode along the coastline. This allowed us to pinpoint regions where this mode is detected and show its significant difference in behavior at the fjord's end compared to areas near the mouth.

Our model successfully replicates the high-state mode observed in the tide gauges, suggesting it is a powerful tool for understanding wave propagation within fjords.

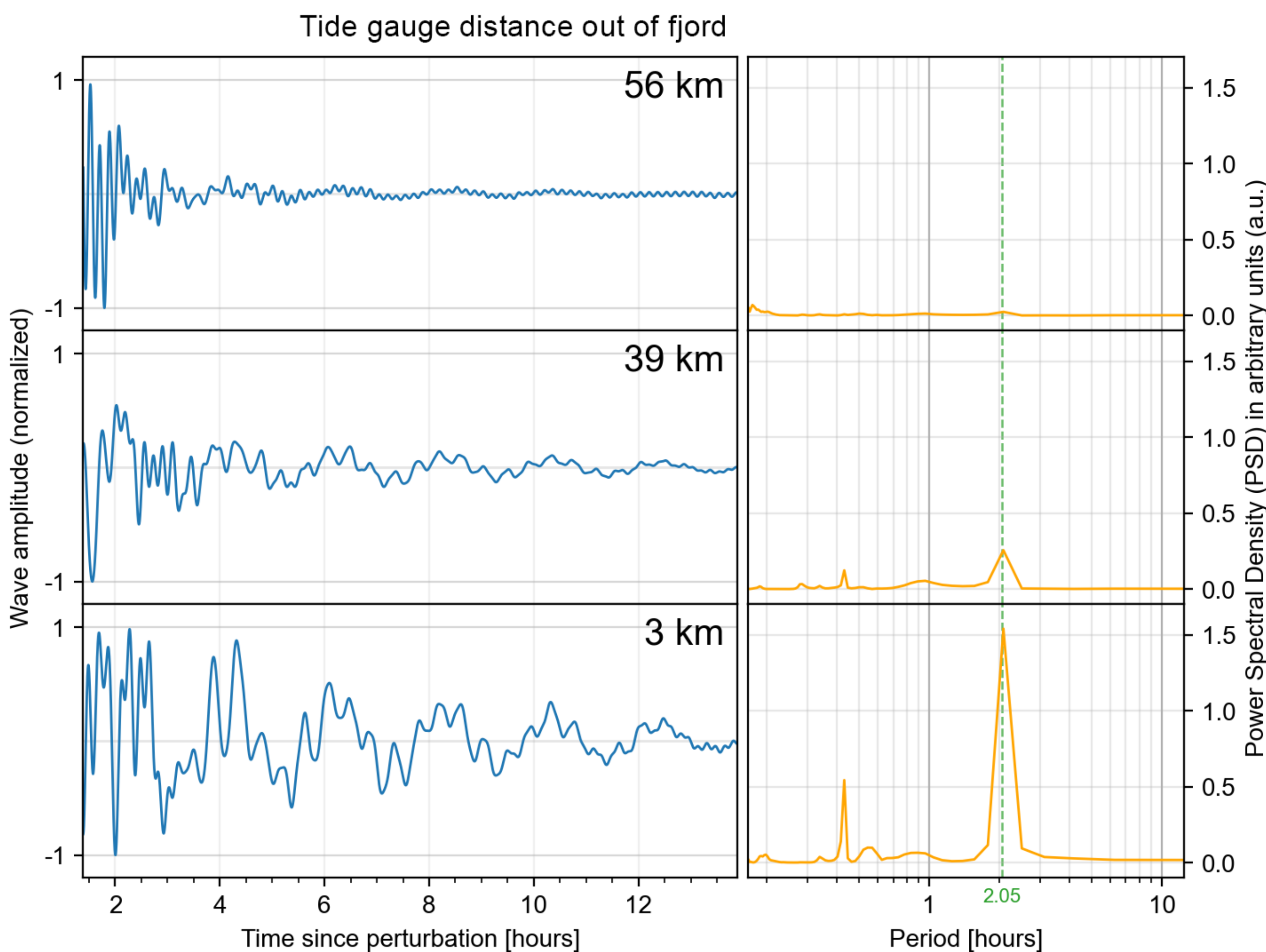


Figure 1. Normalized wave height time series (left) and frequency content (right) in arbitrary units (a.u.) for three synthetic tide gauges positioned progressively further out of the fjord. A drop in mode amplitude with increasing distance out of the fjord is evident in the plot.

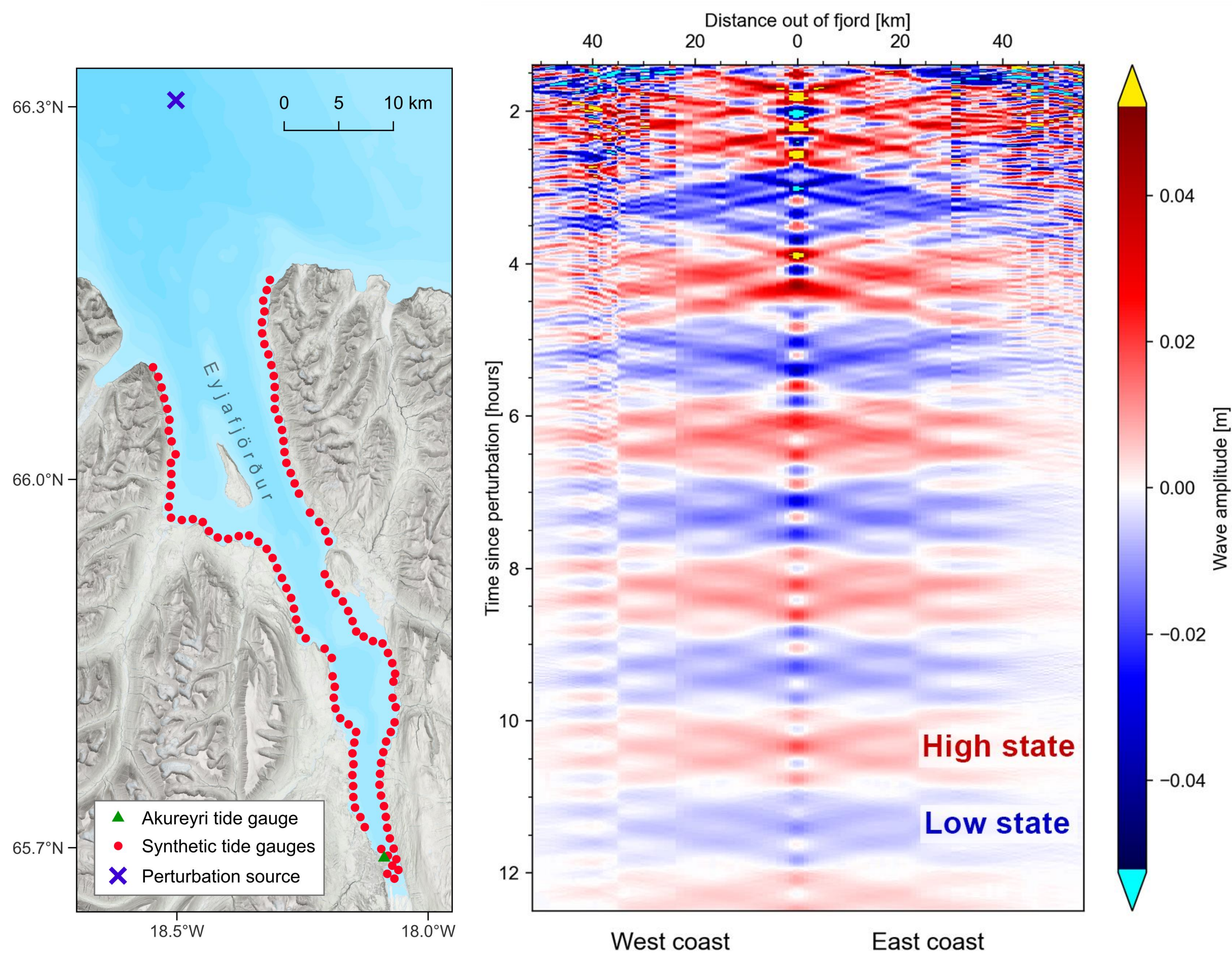


Figure 2. (left) Map of Eyjafjörður showing synthetic tide gauges, the Akureyri tide gauge, and the perturbation source.

Figure 3. (right) Unwrapped time series of all tide gauges along Eyjafjörður, showing the temporal evolution of high and low states from the fjord's mouth to its inner regions.

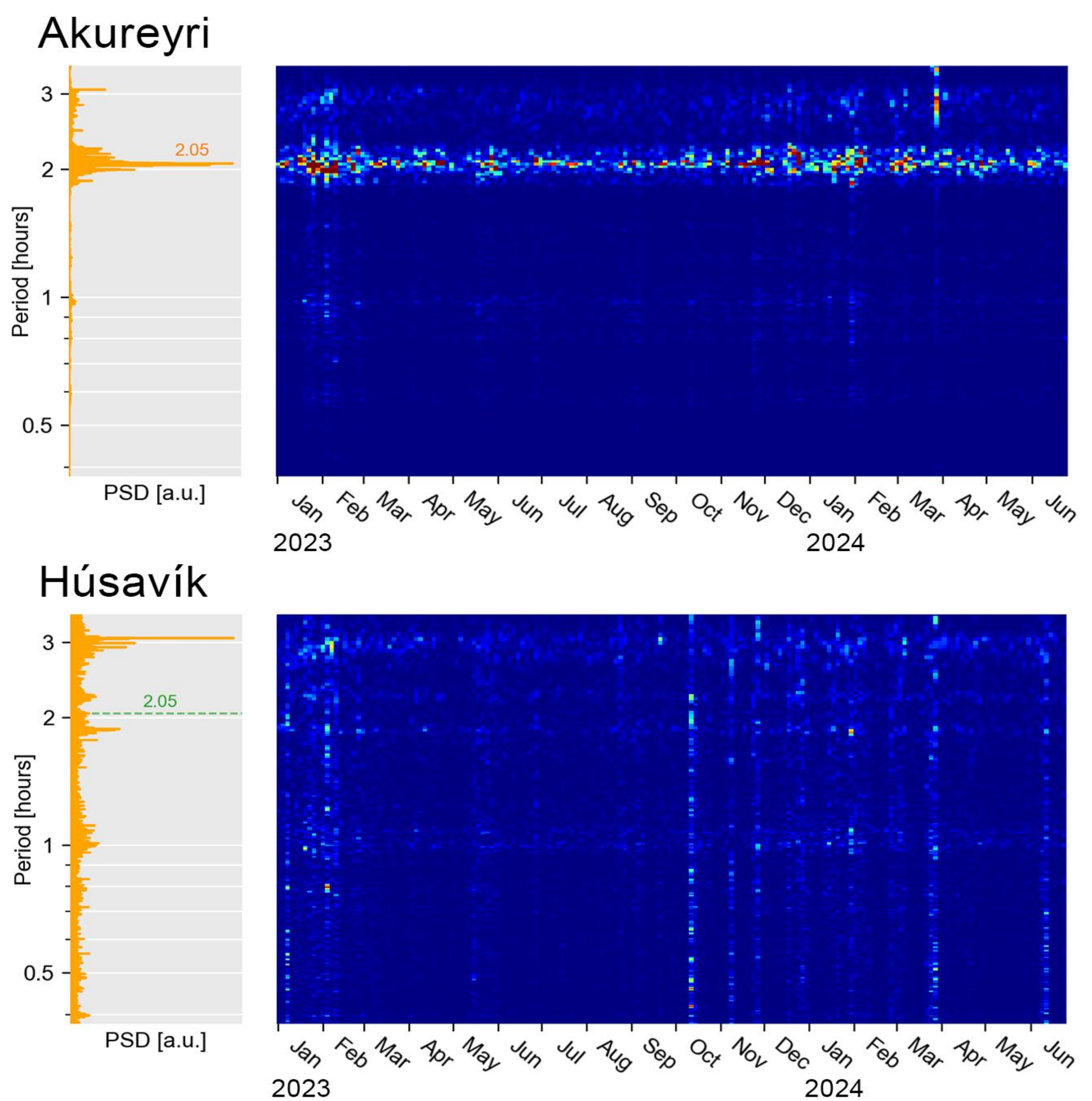


Figure 4. Spectrograms and power spectral density (PSD, a.u.) for the installed tide gauges at Akureyri (inside Eyjafjörður) and Húsavík (outside Eyjafjörður), covering 1 January 2023 to 24 June 2024. No mode is observed at Húsavík, as it is located outside of the fjord.