Design of Acoustic Noise Interferometry Network for Placement in the Vicinity of the New England Seamounts

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Acoustic noise interferometry in the ocean relies on synchronized measurements of ambient sound at spatially separated points to passively measure the acoustic travel times between receiver locations. A network of four autonomous, moored, near-bottom acoustic noise receivers will be deployed in the vicinity of the New England Seamounts as part of the larger New England Seamount Acoustics (NESMA) experiments. The noise interferometry network aims to investigate the feasibility of passive acoustic remote sensing of the environment in a highly dynamic ocean region with complex bathymetry. Strong ocean variability at the experimental site is caused by its proximity to the Gulf Stream. This paper discusses the receiver network optimization for the purposes of acoustic characterization of the water column variability. Ecological restrictions required the hydrophones to be at depths greater than 2000m. This depth restriction placed the hydrophones in an environment where the sound speed gradient was positive with upward refracting ray paths. To separate the effects of water column variability from the potentially larger effects of ocean surface roughness and uncertainties in the bathymetry, it is imperative to have water-borne acoustic paths that connect the moorings without bottom or surface reflections. To achieve this in an upward-refracting environment, the hydrophones are placed at varying depths from 2500–4475 m on the sides of seamounts, which requires lateral separation of 5–18 km. Such propagation ranges are expected to provide a proper trade-off between the conflicting requirements of increasing with range sensitivity to temperature variations and decreasing signal-to-noise ratio. Also, for maximum efficiency of the network, it was desirable for each of the four near-bottom hydrophones to have ray paths connecting them to the other three hydrophones without surface or bottom reflection, for a total of six effective hydrophone pairs. Since acoustic ocean interferometry relies on ambient noise as the probing signal, it was also important to have the ray paths extend to noise sources on the ocean surface. In case the weather conditions prevent deployment of the moorings at the selected locations, a contingency plan was developed for deployment at an alternative nearby location on the continental slope. Ecological restrictions also affect the contingency network, and the moorings are planned in a shallow area of less than 400 m depth with a positive sound speed gradient near the bottom. The main tool used for modeling sound propagation between the four hydrophones was Bellhop ray tracing software with inputs from GEBCO (General Bathymetric Chart of the Oceans) and NOAA for bathymetry along with GDEM (General Digital Environmental Model) for historic Sound Speed Profiles.

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