Waveform Modeling of Seismo-Acoustic Records from MERMAID Instruments in the Pacific

Sirawich Pipatprathanporn[1],
Frederik J. Simons[1], Joel D. Simon[1], Jessica C.E. Irving[2]
[1]Princeton University, [2]University of Bristol

May 17, 2022

A fleet of passively drifting profiling floats equipped with hydrophones, MERMAID (Mobile Earthquake Recording in Marine Areas by Independent Divers), monitors worldwide seismic activity from inside the oceans. The instruments are programmed to float at 1500–2000 m depth, where they detect acoustic pressure conversions from teleseismic earthquakes, surfacing to transmit them, before diving again. Reporting short seismograms autonomously in near-real time, the instruments are not usually recovered, but they do allow for requests from a one-year buffer. About fifty instruments were deployed in French Polynesia in 2018–2019 and remain active, adrift in the South Pacific. Together they have yielded an unprecedented data base of sound recorded at depth in the frequency range between 0.1–20 Hz. We present highlights from our earthquake catalog and discuss the changing character and cause of the background noise. We use the instrumental response function to convert the raw hydrophone records to time series of acoustic pressure. We focus on modeling the detailed shape of earthquake-generated waveforms in the few seconds that include the first arrival. Understanding and correcting for the effects of the oceanic layer on seismo-acoustic waveforms will ensure that MERMAID's pressure records can be used for tomographic imaging of Earth's interior. We use SPECFEM-2D, a high-resolution spectral-element method for seismic-acoustic wave propagation to determine the transfer function between a displacement field on the ocean bottom to pressure recorded by a MERMAID in the water column nearby. Parameterizing teleseismic arrivals as slanted planar or nearly spherical wavefronts, this allows us to consider the influence of the oceanic wavespeed profile, ocean-bottom topography, and the crustal elastic structure in the neighborhood of the seismo-acoustic conversion point on the seafloor, which in turn enables us to use a global wave propagation code, AxiSEM/InstaSeis, to make synthetic predictions for global earthquakes, which we compare to our observations in preparation for waveform tomography.

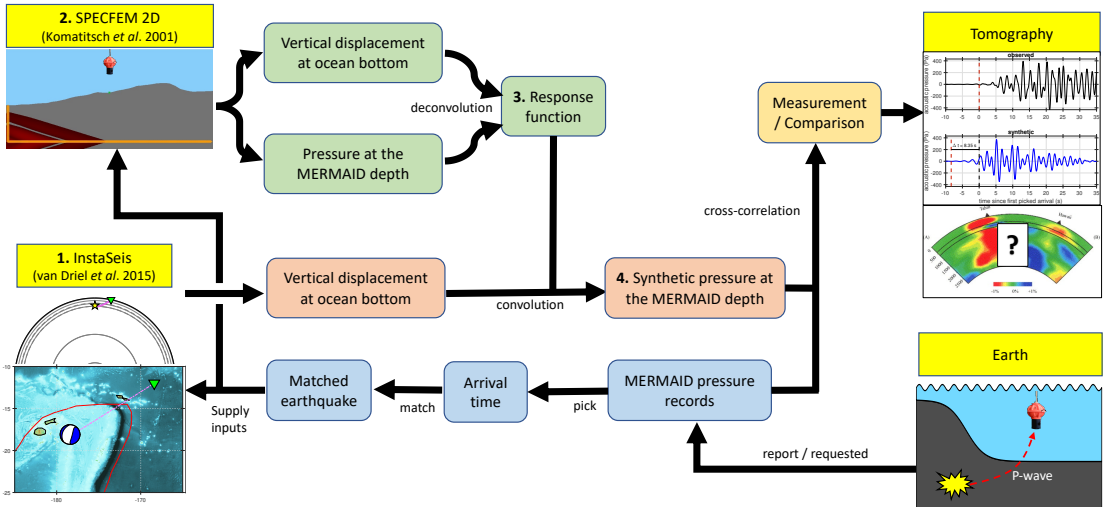

Figure 1: MERMAID waveform modeling workflow.