Installation of a floating hydrophone system within the SOFAR channel

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Unequal geographical data coverage continues to fundamentally limit the quality of tomographic reconstructions of seismic wave speeds in the interior of the Earth. Only at great cost can geophysicists overcome the difficulties of placing seismographs on the two thirds of the Earth’ s surface that is covered by oceans. The lack of spatial data coverage strongly hampers the determination of the structure of the Earth in the uncovered regions. Therefore, three-dimensional Earth models are marked by blank spots in areas where little or no information can be obtained. Improving this problem requires the observation of seismic waves in the oceans. Ocean bottom seismometers are capable of addressing the coverage gap, but they are expensive to manufacture and deploy using vessels.

Oceanographers had designed robotic floating instruments, floats that spend their lives at depth but surface periodically, using a pump and bladder, to make temperature and salinity profile measurements (the large-scale international Argo project). Such low-cost Sounding Oceanographic Lagrangian Observers (SOLO) (Davis et al., 2001) could be equipped with a hydrophone to record water pressure variations induced by compressional waves. Such a floating seismometer would surface upon detection of a useful seismic event, determine a GPS location, and transmit the waveforms to a satellite, which is nicknamed MERMAID for ‘mobile earthquake recorder in marine areas by independent divers’. The great promise of this technology has been demonstrated since the first voyage in 2003, clearly illustrates its contributions to global seismology.

We installed five MERMAID floats in the South Pacific Ocean in late December of 2018 to early January of 2019 during the MR18-06 Leg 1 cruise from Japan to Chile using the R/V Mirai of JAMSTEC under an international project of SPPIM (South Pacific Plume Imaging with MERMAIDs). The launching locations for MERMAIDs are (01-42.256N,146-12.472W), (03-19.696S, 139-31.973W), (15-55.626S, 120-07.688W), (18-31.285S, 114-57.378W) and (20-59.832S, 109-59.513W), respectively. All floats have been drifting to almost west since the deployment as recording to transfer the land at sea surface every 10 days. So far, MERMAID detected several seismic events, for example, the Mw 6.8 Brazil deep focus earthquake at depth of 575 km on January 5. MERMAID recorded a clear incoming P-wave whose precise arrival time can be determined to within a fraction of a second. In addition to recording teleseismic P-waves, they would pick up hydroacoustic phases (T-waves) trapped waves propagating in the SOFAR (Sound Fixing and Ranging) channel. They might be complementary to the global seismic network including CTBTO stations to recognize unknown enigmatic events.

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