Probing the Solid Earth and the Hydrosphere with Ocean-Bottom Distributed Acoustic Sensing

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Distributed Acoustic Sensing (DAS) is a cutting-edge technology that transforms fiber-optic cables into dense arrays of sensors measuring ground vibrations over large distances (e.g., every ~1-20 m over tens of kilometers). Of particular interest are Ocean-Bottom DAS (OBDAS) systems, which use existing ocean-bottom fiber-optic cables to provide high-fidelity measurements of the seismic wavefield, overcoming the challenges and costs of deploying seismometers offshore.

In the first part of this talk, we explore the use of seismological techniques to characterize the shallow Earth beneath oceans using OBDAS data. Local geological conditions can significantly amplify incoming seismic waves from earthquakes, threatening human-made structures. We demonstrate that high-resolution images of the shallow Earth can be inverted from continuous OBDAS data, providing a better understanding of complex earthquake wavefields (Figure 1). Furthermore, we use OBDAS earthquake recordings to characterize the response of shallow and unconsolidated offshore sediments, which tend to behave non-linearly even during relatively weak ground motions.

In the second part of the talk, we will focus on the use of OBDAS for oceanography purposes, specifically for probing the dynamics of ocean waters on continental shelves. These areas are crucial drivers of biogeochemical ocean activity, and OBDAS has been shown to be sensitive to movements of the water column, such as ocean surface gravity waves. By analyzing four months of OBDAS data offshore Oregon, we demonstrate the ability of OBDAS to monitor the ocean dynamics.



Figure 1: (a) Strain waveforms of a M_w 3.7 earthquake recorded along a fiber offshore Japan. Direct *P* and *S* waves arrive around 15 and 25 s after the origin time, respectively. Regions where surface waves (SW) are locally generated are shown by the vertical red arrows. (b) Shallow S-wave velocity model (From Viens et al., 2022, GJI).