Session 1pPA

Physical Acoustics and Signal Processing in Acoustics: Multiple Stochastic Scattering of Elastic and Seismic Waves

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Chair's Introduction—1:00

Invited Papers

1:05

1pPA1. From seismology to oceanography: Locating the sources of the Earth's hum. Barbara Romanowicz and Junkee Rhie (Berkeley Seismological Lab., 215 McCone Hall, Berkeley, CA 94720)

The observation of continuously excited free oscillations of the Earth, in the absence of earthquakes, was first made by Japanese scientists in 1998. Since then, attention has focused on elucidating the physical mechanism responsible for them. The mechanism must be shallow, as fundamental modes appear to be preferentially excited and it shows seasonal variability. An array-based method has been developed to detect and locate sources of very long period surface wave energy, utilizing the dispersive properties of Rayleigh waves and data from two large aperture arrays of very long period seismometers, in California and in Japan. It is shown that, for each array, there is a well defined preferential direction, which is stable over one season but changes significantly from winter to summer. The fluctuations as a function of time of the maximum stack amplitudes are correlated across the two arrays and point to the northern Pacific Ocean in the northern hemisphere winter and the southern oceans in the summer, correlating with the distribution of maximum wave height. It is inferred that the background oscillations originate primarily in the oceans, and are caused by a non-linear coupling mechanism involving the atmosphere (winds), the oceans (infragravity waves) and the seafloor.

1:30

1pPA2. Correlation in ambient seismic noise and the reconstruction of Green function. Michel Campillo, Laurent Stehly (Observatoire de Grenoble, BP 53, 38041 Grenoble, France, Michel.Campillo@ujf-grenoble.fr), Nikolai Shapiro, and Mike Ritzwoller (Univ. of Colorado, Boulder, CO)

Cross-correlations between long continuous records of ambient seismic noise at distant stations are investigated. The dominant part of the Green function, namely Rayleigh waves, are reconstructed in a broad period range. This property reminds of the fluctuation-dissipation theorem that relates the random fluctuations of a linear system and the system's response to an external force. Ambient seismic noise is indeed not a thermal noise but it can be considered as a random and isotropic wave field both because the distribution of the ambient sources responsible for the noise randomizes when averaged over long periods and because of scattering from heterogeneities that occur within the Earth. The dispersion curves of Rayleigh waves for the paths between the stations are measured from the correlations. On paths where direct measurements between earthquake and station are available, we show that they are in good agreement with those deduced from noise correlation. The measurement of correlation along paths crossing different geological structures allows to differentiate them, opening the way for a passive imaging of the Earth structure. The dispersion measurements are applied to seismic tomography at the regional scale. They make it possible to image crustal structures with a resolution higher than conventional techniques.

1:55

1pPA3. Seismic interferometry, with applications in passive reflection imaging. Kees Wapenaar and Deyan Draganov (Dept. of Geotechnology, Delft Univ. of Technol., P.O. Box 5028, 2600 GA Delft, The Netherlands, c.p.a.wapenaar@citg.tudelft.nl)

Seismic interferometry is the process of generating new seismic responses by crosscorrelating seismic observations at different receiver locations. A first version of this principle was derived in 1968 by Claerbout, who showed that the reflection response of a horizontally layered medium can be synthesized from the autocorrelation of its transmission response. Later he conjectured a similar principle for crosscorrelations of 3-D wave fields. In a similar fashion, Schuster (2001) introduced the principle of interferometric imaging, i.e., forming an image of the subsurface from crosscorrelated seismic traces. In this paper we first discuss the theory of seismic interferometry for arbitrary 3-D inhomogeneous media (deterministic or random). Starting with the Rayleigh-Betti reciprocity theorem and the principle of time-reversal, we derive a number of relations that form the basis for seismic interferometry (amongst others these relations prove Claerbouts conjecture). Despite the difference in assumptions, these relations show a close resemblance with those of Weaver and Lobkis (2001) for the retrieval of the Greens function from diffuse wave field correlations. Next we discuss a number of applications, like passive seismic reflection imaging, surface wave reconstruction, improving sparse data sets and interferometric imaging for different geometries.