8:50

2aSA3. The potential for extracting the electromagnetic earth response from uncorrelated noise. Evert Slob, Kees Wapenaar (Dept. of Geotechnology, Delft Univ. of Technol., Stevinweg 1, 2628 CN, Delft, Netherlands, e.c.slob@tudelft.nl), and Roel Snieder (Ctr. for Wave Phenomena, Colorado School of Mines, Golden, CO 80401-1887)

Thermal electromagnetic radiation from an absorbing medium allows for extracting the response of this medium. In the earth, thermal noise is usually very weak and other forms of electromagnetic noise prevail. Noise below radio frequencies is generated in the atmosphere, ionosphere, and magnetosphere, while cosmic noise generates electromagnetic waves above radio frequencies that reach the earth's surface. The noise requirements are discussed for energy and Lagrangian forms of earth response extraction by correlation and multi-dimensional deconvolution. It is shown that if the uncorrelated noise sources are located outside the earth, only the earth response to incident electromagnetic waves can be extracted. Potential applications are found for ground-penetrating radar, and these are illustrated with numerical examples. For coupled seismic waves and electromagnetic fields in fluid-filled porous media, uncorrelated seismic noise is shown to be sufficient to approximately extract the electro-seismic earth response.

9:15

2aSA4. Imaging and monitoring with ambient vibrations: A review. Larose Eric (ISTERRE, CNRS, & UJF, BP 53, 38041 Grenoble cedex 9, France)

The principle of passive imaging and reconstructing the Green functions by means of correlating ambient vibrations or noise will be reviewed. Some basic processing procedures for optimizing the convergence of the correlations, along with the role of multiple scattering, will also be presented. Monitoring with ambient noise constitutes a different goal that relies on different assumptions on the background noise structure. Similarities and differences between the imaging and the monitoring approaches will be addressed.

9:40

2aSA5. Correlation processing of ocean noise. W.A. Kuperman (Marine Physical Lab. of the Scripps Inst. of Oceanogr., Univ. of California, San Diego, La Jolla, CA 92093-0238)

Correlation processing of ocean ambient noise has been a topic of growing interest. While theory confirms the efficacy of this procedure, experimental confirmation has been limited to a few data sets. The basic issue of the potential utility of this procedure is the time needed to build up the relevant cross-correlation peaks that are diagnostic of the ocean environment. This time is a function of frequency/bandwidth, the ocean environment and noise structure/distribution, sensor separation and, if employed, the array configuration. After reviewing some basic background, a selection of experimental results for noise originating from ships, surface generated sources, and geophysical sources is presented.

10:05–10:15 Break

10:15

2aSA6. Using cross-correlations of ambient vibrations for passive structural health monitoring of a high-speed naval ship. Karim G. Sabra (School of Mech. Eng. Georgia Inst. of Technol., 771 Ferst Dr., NW Atlanta, GA 30332-0405)

Previous studies have used the cross-correlation of ambient vibrations (CAVs) technique to estimate the impulse response (or Green's function) between passive sensors for passive imaging purposes in various engineering applications. The technique (CAV) relies on extracting deterministic coherent time signatures from the noise cross-correlation function computed between passive sensors, without the use of controlled active sources. Provided that the ambient structure-borne noise field remains stable, these resulting coherent waveforms obtained from CAV can then be used for structural monitoring even if they differ from the actual impulse response between the passive sensors. This article presents experimental CAV results using low-frequency random vibration data (>50 Hz) collected on an all-aluminum naval vessel (the HSV-2 Swift) operating at high speed (up to 40 kn) during high sea states. The primary excitation sources were strong wave impact loadings and rotating machinery vibrations. The consistency of the CAV results is established by extracting similar coherent arrivals from ambient vibrations between the pairs of strain gages, symmetrically located across the ship's centerline. The influence of the ship's operating conditions on the stability of the peak coherent arrival time, during the 7 days trial, is also discussed. [Sponsored by ONR, N00014-09-1-0440.]

10:40

2aSA7. Extracting information from an array of sensors in a diffuse noise field using random matrix theory. Ravi Menon, Peter Gerstoft, and William Hodgkiss (Scripps Inst. of Oceanogr., Univ. of California San Diego, La Jolla, CA 92093)

Isotropic noise fields are often used to model several practical diffuse noise fields. For an array of equidistant sensors in such a noise field, the cross-spectral density matrix (CSDM) of the array is a Toeplitz sinc matrix. Here, the eigenvalues of the CSDM for ideal isotropic noise fields are first derived for infinite arrays. The eigenvalues have close connections with classical array processing concepts such as the invisible region in frequency-wavenumber space (region where there is no propagating energy, but a spectrum can be calculated). Random matrix theory deals with eigenvalue distributions of random matrices and its concepts are applied here by modeling the array snapshot vectors as zero-mean, unit variance Gaussian random variables, with a sinc covariance matrix. Using the Stieltjes transform, the eigenvalues of the ideal CSDM are related to those of the sample CSDM, and an analytical solution for the distribution of the eigenvalues of the sample CSDM is obtained. At frequencies where the array is spatially undersampled, increasing the number of observations results in the noise masquerading as a signal, which could lead to erroneous signal detections. We demonstrate how knowing and understanding the eigenvalue distribution helps improve the extraction of information from ocean ambient noise.