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Ground-truth observations and modeling of an extensive air-gun seismic survey recorded at two hydroacoustic stations of the IMS network

Ronan Le Bras (1), Peter Nielsen (1), and Albert Brouwer (2)
(1) CTBTO, IDC, Vienna, Austria , (2) International Institute for Applied Systems Analysis (IIASA), Laxenburg, Austria

A seismic survey (PICTURES) was conducted by the Marcus G. Langseth oceanographic vessel off the coast of Peru between October and December 2016. The scientific campaign was led by scientists from the Oregon State University, USA. The controlled air-gun array was emitting signals fired shots at various repetition rates with the majority at intervals of approximately 120 s over 30 days. This vast amount of impulse-like signals was received on the CTBT IMS hydrophone station HA03 with a high signal to noise ratio. The signals from the same survey were also received at HA11 with a much lower signal to noise ratio but still detectable. The distance to hydrophone station HA03 is between 13.5 and 16.8 degrees and HA11 is much further away between 134 and 136.5 degrees. The bathymetry and sound speed profiles change significantly between the air gun and hydrophone locations along the survey track. It is essential to possess the capability to accurately predict the acoustic propagation characteristics for changing underwater environmental conditions if these received underwater acoustic signals are going to be used for monitoring purposes. Detailed 2D modeling using a parabolic equation approach with bathymetry and environmental models shows that the change in bathymetry in the area of the survey has a large influence on the received levels and on the details of the signal characteristics at the IMS hydrophones. This approach should be applicable to all six CTBT IMS hydrophone stations when the exact location and time of the air gun shots are available. Considering the large number of such surveys worldwide, for both exploration and scientific purposes, this should constitute a valuable worldwide database of propagation characteristics. Analysis of the observed variations in azimuth also leads to constraining the uncertainties in the hydrophone exact location due to their being mounted on anchored buoyed cables. This is possible because of the high sampling frequency afforded by signals from the survey.