University of Victoria | Graduate Studies

Notice of the Final Oral Examination
for the Degree of Master of Science

of

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BSc (University of Victoria, 2010)

"Bayesian Geoacoustic Inversion of Seabed Reflection Data at the New England Mud Patch"

School of Earth and Ocean Sciences

Monday, August 20, 2018
10:00 A.M.
Bob Wright Centre
Room A319

Supervisory Committee:
Dr. Stan E. Dosso, School of Earth and Ocean Sciences, University of Victoria (Supervisor)
Dr. N. Ross Chapman, School of Earth and Ocean Sciences, UVic (Member)
Dr. Jan Dettmer, School of Earth and Ocean Sciences, UVic (Outside Member)

External Examiner:
Dr. Megan Ballard, Applied Research Laboratory, University of Texas

Chair of Oral Examination:
Dr. Daler Rakhmatov, Department of Electrical and Computer Engineering, UVic

Dr. David Capson, Dean, Faculty of Graduate Studies

Abstract

This thesis presents Bayesian geoacoustic inversion of seabed reflection-coefficient data as part of the U.S. Office of Naval Research Seabed Characterization Experiment 2017 at the New England Mud Patch. First, a linearized, ray-based Bayesian inversion of acoustic arrival times is carried out for high-precision estimation of experiment geometry and uncertainties, representing an important first step to inferring seabed properties using geoacoustic inversion methods such as reflection inversion. The highprecision estimates for source-receiver ranges, source depths, receiver depths, and water depths at reflection points along the survey track are used to calculate grazing angles, with angle uncertainties computed using Monte Carlo methods. The experiment geometry uncertainties are obtained using analytic linearized estimates, and verified with nonlinear analysis. Second, a trans-dimensional (trans-D) Bayesian inversion of reflection-coefficient data is carried out for geoacoustic parameters and uncertainties of fine-grained/cohesive sediments. The trans-D inversion samples probabilistically over an unknown number of seabed interfaces and the parameters of a zeroth- or first-order autoregressive error model. The numerical method of parallel tempering reversible jump Markov-chain Monte Carlo sampling is employed. Spherical-wave reflection coefficient modelling is applied using plane-wave decomposition in the Sommerfeld integral. The inversion provides marginal posterior probability profiles for Buckingham's viscous grain-shearing parameters: porosity, grain-to-grain compressional modulus, material exponent, and compressional viscoelastic time constant as a function of depth in the sediment. These parameters are used to compute dispersion relationships for each layer in the model, providing marginal posterior probability profiles for compressional-wave velocity and attenuation at different frequencies, as well as density. The geoacoustic inversion results are compared to independent measurements of sediment properties.