PUBLICATIONS

Articles in Refereed Journals: Published or Accepted

[1] Walsh, J., W. Huang, and **E.W. Gill**, The First-order HF Radar Cross Section of the Ocean Surface Incorporating an Antenna on a Moving Platform, *IEEE Transactions on Antennas and Propagation*, Vol.58, No. 9, pp. 2994-3003, 2010.

[2] Green, D., **E.W. Gill**, and W. Huang, Extraction of Wind Speed from High Frequency Ground Wave Radar Oceanic Backscatter, *IEEE Transactions on Geoscience and Remote Sensing*, Vol. 7, No. 10, pp. 3338-3346, 2009.

[3] **Gill, E.W.**, and J. Walsh, A Combined Sea Clutter and Noise Model Appropriate to the Operation of High Frequency Pulsed Doppler Radar in Regions Constrained by External Noise, *Radio Science*, 43, RS4012, doi:10.1029/2007RS003757, 15pp., 2008.

[4] **Gill, E.**, W. Huang, and J. Walsh, The Effect of Bistatic Scattering Angle on the High Frequency Radar Cross Sections of the Ocean Surface, *IEEE Geoscience and Remote Sensing Letters*, Vol. 5, No. 2, pp. 143-146, 2008.

[5] **Gill, E.W.**, W. Huang, and J. Walsh, On the Development of a Second-order Bistatic Radar Cross Section of the Ocean Surface – A High Frequency Result for a Finite Scattering Patch. *IEEE J. Oceanic Eng. Special Issue on HF/VHF Sea Surface Radar*, Vol.31, No. 4, pp. 740-750, 2006. (Invited paper).

[6] Zhang, J., and **E. Gill**, Extraction of Ocean Wave Information from Simulated Noisy High Frequency Bistatic Radar Data, *IEEE J. Oceanic Eng. Special Issue on HF/VHF Sea Surface Radar*, Vol.31, No. 4, pp. 779-796, 2006. (Invited paper).

[7] Huang, W., **E.W. Gill**, S. Wu, B. Wen, Z. Yang, and J. Hou, Measuring Surface Wind Direction over the Eastern China Sea by Monostatic HF Ground-wave Radar, *IEEE J. Oceanic Eng.*, Vol.29, No. 4, pp. 1032-1037, 2004.

[8] Huang, W., S. Wu, **E.W. Gill**, B. Wen, and J. Hou, HF Radar Wave and Wind Measurement over the Eastern China Sea, *IEEE Trans. on Geoscience and Remote Sensing*, Vol.40, No. 9, pp. 1950-1955, 2002.

[9] **Gill, E.W.**, and J. Walsh, J., High Frequency Bistatic Cross Sections of the Ocean Surface. *Radio Science*, Vol.36, No. 6, pp. 1459-1476, 2001.

[10] **Gill, E.W.**, and J. Walsh, The Bistatic Form of the Electric Field Equations for the Scattering of Vertically Polarized High Frequency Ground Wave Radiation from Slightly Rough, Good Conducting Surfaces, *Radio Science*, Vol. 35, No. 6, pp. 1323-1335, 2000.

[11] Walsh, J. and **E.W. Gill**, An Analysis of the Scattering of High Frequency Electromagnetic Radiation from Rough Surfaces with Application to Pulse Radar Operating in Backscatter Mode, *Radio Science*, Vol. 35, No. 6, pp. 1337-1359, 2000.

[12] **Gill, E.W.**, M. Khandekar, R. Howell, and J. Walsh, Ocean Surface Wave Measurement Using a Steerable High-Frequency Narrow-Beam Ground Wave Radar, *J. of Atmos. and Ocean. Tech.*, Vol. 13, No. 3, pp. 703-713, 1996.

[13] Hickey, K., **E.W. Gill**, J. Helbig, and J. Walsh, Measurement of Ocean Surface Currents Using a Long-range FMICW Steerable Radar. *IEEE J. of Oceanic Eng., Special Issue on Advanced Control and Signal Processing for Ocean Applications*, Vol. 19, No. 4, pp. 549-554, 1994.

[14] Dobson, F.W., S.D. Smith, R.J. Anderson, P.W. Vachon, D. Vandemark, D., J.R. Buckley, M. Allingham, M. Khandekar, R. Lalberharry, and **E. Gill**, The Grand Banks ERS-1 SAR Wave Experiment, *EOS Transactions*, *AGU*, Vol. 74, No. 4, 1993.

[15] **Gill, E.W.**, and J. Walsh, Extraction of Ocean Wave Parameters from HF Backscatter Received by a Four-element Array: Analysis and Application, *IEEE J. of Oceanic Eng.*, Vol. 17, No. 4, pp. 376-386, 1992.

Submitted or In Preparation for Submission to Refereed Journals

[16] Zhang, J., **E.W. Gill**, and J. Walsh, Inherent Limitations in High Frequency Radar Remote Sensing Based on Bragg Scattering from Gaussian Rough Surfaces (under revision for *IEEE Journal of Oceanic Engineering*).

[17] Zhang, J., **E.W. Gill**, and J. Walsh, High Frequency Radar Cross Sections of the Ocean Surface for the FM Waveforms (revision under review for *IEEE Journal of Oceanic Engineering*).

[18] Walsh, J., W. Huang, W., and **E.W. Gill**, The Second-order HF Radar Cross Section of the Ocean Surface Incorporating an Antenna on a Moving Platform (in preparation for submission to *IEEE Transactions on Antennas and Propagation*).

[19] Bobby, P. and **E.W. Gill**, and W. Huang, Vector Surface Currents Beyond the Region of Overlapping Coverage for Narrow Beam HF Radars. (In preparation)

Refereed International and National Conferences

[20] Zhang, J., ***E.W. Gill**, and J. Walsh, 2009. Comparison of Simulated HF Radar with Field Data for a Frequency Modulated Continuous Wave (FMCW) Source, *Oceans'09, IEEE Conference,* Bremen, Germany. (Extended abstract review)

[21] Walsh, J., W. Huang, W., and **E.W. Gill**, The Second-order Monostatic HF Radar Cross Section Incorporating Antenna Barge Motion, *Canadian Conference on Electrical and Computer Engineering*, St. John's, Newfoundland, pp. 19-22, 2009. (Full-paper review)

[22] Zhang, J., **E.W. Gill**, and J. Walsh, High Frequency (HF) Radar Cross Sections of the Ocean Surface Incorporating a Continuous Wave Frequency Modulated Source *Oceans'08, MTS/IEEE Conference and Exhibition*, Quebec City, Canada, 2008. (Extended abstract review)

[23] Heron, M.L., **E.W. Gill**, and A. Prytz, An investigation of double-peaked HF radar spectra via a convolution/de-convolution algorithm, *Oceans'08, MTS/IEEE Conference and Exhibition*, Kobe, Japan, pp. 1-4, 2008. (Extended abstract review)

[24] Walsh, J., **E. Gill**, and W. Huang, A Monostatic Ocean Scattering Cross Section for the Case of Surface Wave Radar Operating from a Floating Barge, *Oceans'08, MTS/IEEE Conference and Exhibition*, Kobe, Japan, pp. 1-4, 2008. (Extended abstract review)

[25] Walsh, J., **E.W. Gill**, and W. Huang, On the Problem of Antenna Platform Motion for High Frequency Surface Wave Radar Applications, *Canadian Conference on Electrical and Computer Engineering*, Niagara Falls, Ontario, pp. 471-474, 2008. (Full-paper review)

[26] Zhang, J., **E.W. Gill**, J. Walsh, and W. Huang, Inherent Limitations in High Frequency Surface Wave Radar Remote Sensing Based on Bragg Scattering from Gaussian Rough Surfaces. *Proc. 12th International Symposium on Antenna Technology and Applied Electromagnetics [ANTEM] and Canadian Radio Sciences [URSI/CNC]*, Montreal, Quebec, Jul. 16-19, 2006. (Full-paper review)

[27] Churchill, S., C. Randell, **E. Gill**, and D. Power, Data Fusion: Cumulative Effects of Discrete Fusion on Target Detection Probability. *Proc. International Geoscience and Remote Sensing Symposium (IGARSS'06)*, Denver, Colorado, 2006. (Extended abstract review)

[28] Zhang, J., **E.W. Gill**, and J. Walsh, Variability of High Frequency Sea Echo Based on the Random Phase Content of the Electric Field Equations for a Pulsed Dipole Source, *Proc. AGU Ocean Sciences Mtg.*, Honolulu, USA, 2006. (Refereed Abstract)

[29] Green, D.W. and **E.W. Gill**, Extracting Wind Parameters from High Frequency Ground Wave Radar Backscatter, IEEE AP-S International Symposium and USNC/URSI National Radio Science Meeting, Washington, DC, 2005.

[30] Churchill, S., Randell, C., D. Power, and **E. Gill**, Data Fusion: Remote Sensing for Target Detection and Tracking, *Proc. International Geoscience and Remote Sensing Symposium (IGARSS'04)*, Anchorage, Alaska, 2004. (Extended abstract review)

[31] Sircar, S., D. Power, C. Randell, J. Youden, J. and **E. Gill**, Lateral and Subsidence Movement Estimation Using INSAR, *Proc. International Geoscience and Remote Sensing Symposium (IGARSS'04)*, Anchorage, Alaska, 2004.

[32] **Gill, E.W.**, W. Huang, and J. Zhang, An Alternate Analysis for the Second-Order High Frequency Bistatic Radar Cross Section of the Ocean Surface – Patch Scatter and its Inversion, *Proc. Oceans 2003*, San Diego, Calif., 2003. (Invited Paper).

[33] Bobby, P. and **E. Gill**, Evaluation of Vector Current Measuring Techniques using Long-Range HF GWR Radar, *Proc. IEEE Canadian Conference on Electrical and Computer Engineering*, Montreal, Canada, 2003.

[34] **Gill, E.W.**, A. Ponsford, and J. Zhang, High Frequency Surface Wave Radar Operating in Regions of Shallow Water, *Proc. Canadian Meteorological and Oceanic Society Symp*., Ottawa, Canada, 2003.

[35] Bobby, P., K. Hickey, and **E.W. Gill**, Techniques for Surface Current Measurement on the Grand Banks Using High Frequency Surface Wave Radar, *Proc. Canadian Meteorological and Oceanic Society Symp.*, Ottawa, Canada, 2003.

[36] Zhang, J. and **E.W. Gill**, The Inversion of HF Bistatic Doppler Radar Spectra for Arbitrary Water Depth – A Simulation, *Proc. Canadian Meteorological and Oceanic Society Symp*., Ottawa, Canada, 2003.

[37] Churchill, S., C. Randell, **E. Gill**, and D. Power, An Outline of Fusion and Sensor Combinational Methodologies for Disparate, Sparse Multi-Sensor Networks, *Proc. International Geoscience and Remote Sensing Symposium (IGARSS'02) and the 24thCanadian Symposium on Remote Sensing,* Toronto, 2002. (Invited Paper).

[38] **Gill, E.**, and J. Walsh, A Perspective on Two Decades of Fundamental and Applied Research in Electromagnetic Scattering and High Frequency Ground Wave Radar on the Canadian East Coast, *Proc. International Geoscience and Remote Sensing Symposium (IGARSS'02) and the 24thCanadian Symposium on Remote Sensing*, Toronto, 2002. (Invited Paper).

[39] Hickey, K., **E. Gill**, and J. Walsh, Some Fundamental Statistics associated with the Estimation of Ocean Surface Currents Using a Dual Station, Long-range, High Frequency Ground Wave Radar, *Proc. International Geoscience and Remote Sensing Symposium (IGARSS'02) and the 24thCanadian Symposium on Remote Sensing*, Toronto, 2002. (Invited paper).

[40] **Gill, E.W.**, and J. Walsh, High Frequency Cross Sections of the Ocean Surface – Comparisons and Recent Enhancements, *Proc. XXVIIth URSI General Assembly*, Maastricht, Netherlands, 2002.

[41] **Gill, E.W.**, and J. Walsh, A Relationship Between External Noise and the Ocean Clutter Models for Bistatic Operation of Pulsed High-Frequency Radar, *Proc. IEEE Canadian Conference on Electrical and Computer Engineering*, Toronto, ON, Canada, 2001.

[42] **Gill, E.W.**, and J. Walsh, The Scattering of High Frequency Ground Wave Radiation from Highly Conducting Surfaces with Emphasis on Bistatic Reception, *Proc. of the XXVIth General Assembly of the International Union of Radio Science*, Toronto, Ontario, Canada, J., 1999.

[43] **Gill, E.W.**, and J. Walsh, On the Second-order High Frequency Ground Wave Radar Cross Section of the Ocean Surface, *Proc. IEEE Canadian Conference on Electrical and Computer Engineering*, St. John's, Newfoundland, Canada, 1997.

[44] **Gill, E.W.**, M. Khandekar, R. Howell, and J. Walsh, Over-the-Horizon Ocean Surface Wave and Wind Measurements Using Narrow Beam Ground Wave Radar: Validation Against Models and In Situ Instrumentation. *Proc. Canadian Conference on Electrical and Computer Engineering*, Halifax, Canada, 1994.

[45] **Gill, E.W.**, R. Howell, K. Hickey, and J. Walsh, High Frequency Ground Wave Radar Measurement of Ocean Surface Parameters During the ERS-1 Calibration-Validation Experiment, *Proc. IEEE OCEANS '93*, Vol. 1, pp. 55-60, Victoria, Canada, 1993.

[46] Khan, R.H., **E.W. Gill**, S.A. Saoudy, K. Hickey, B.J. Dawe, and J. Walsh, Experimental Results from a Long-Range HF Ground Wave Coastal Surveillance Radar. *Proc. IEEE National Radar Conference*, Boston, pp. 20-22, 1993.

[47] **Gill, E.W.**, R. Howell, and J. Walsh, Estimation of Ocean Surface Parameters by High Frequency Radar. Proceedings, *ANTEM '92, Symposium on Antennas and Applied Electromagnetics*, Winnipeg, Canada, pp. 683-688, 1992.

[48] Dobson, F.W., S.D. Smith, R.J. Anderson, P.W. Vachon, D. Vandemark, J.R. Buckley, M. Allingham, M., Khandekar, R. Lalberharry, and **E. Gill**, The Grand Banks ERS-1 SAR Wave Spectra Validation Experiment, *Proc. European Space Agency ERS-1 Symposium*, Cannes, France, 1992.

[49] **Gill, E.W.**, and J. Walsh, Extraction of Ocean Wave Parameters from Wide Beam HF Radar (CODAR) Backscatter: Application at Lumsden, *Proc. Ports and Oceans under Arctic Conditions (POAC '91)*, St. John's, Canada, pp. 997-998, 1991.

<u>Radiowave Oceanography Workshop Contributions</u>

This is a yearly international 4-day workshop of 35 to 40 HF radar experts and users (mainly physicists and engineers) where the latest models and applications of the science and technology associated with the remote sensing of the oceans via HF radar, as well as required research directions, are discussed. While it is **not a 'refereed'** workshop, it is probably the single most important venue for the dissemination of research expertise in this field and input is invited from a small group of experts. Our group at Memorial University is among a minority of participants who are deeply involved with the basic and applied science underlying the technology.

[50] Walsh, J., **E.W. Gill**, and W. Huang, Further Analysis of Antenna Platform Motion, *Radiowave Oceanography 9th International Workshop*, Split, Croatia, 2009. (Invited Paper).

[51] Zhang, J., **E.W. Gill**, and J. Walsh, A Consideration of Bragg Fluctuations in High Bandwidth FMCW Spectra and Other Recent Results, *Radiowave Oceanography 8th International Workshop*, Honolulu, Hawaii, 2008. (Invited Paper).

[52] Zhang, J., **E.W. Gill**, and J. Walsh, The Effect of Transmitter Pulse Width on Bragg Positions in Pulsed Doppler Radar, *Radiowave Oceanography 6th International Workshop*, Hamburg, Germany, 2006. (Invited Paper).

[53] Zhang, J., **E. Gill**, D. Green, and J. Walsh, 2005. Examination of Fluctuations in the Bragg Peaks Under the Assumption of a Stationary Gaussian Process and Other Recent Developments, *Radiowave Oceanography 5th International Workshop*, Costanoa, California, May, 2005. (Invited Paper).

[54] **Gill, E.W.**, W. Huang, and J. Walsh, HF Surface Wave Radar in the Eastern Canada Context – Toward Bistatic Operation, *Radiowave Oceanography 4th International Workshop*, Magnetic Island, Townsville, Australia, 2004. (Invited Paper).

[55] **Gill, E.W.**, and J. Walsh, A Note on Near-forward Scattering in the Context of HF Bistatic Radar Operating in a Marine Environment. *Radiowave Oceanography 2th International Workshop*, Landeda, France, 2003. (Invited Paper).

<u>Other Conference/Workshop Contributions</u>

(All, but one, of the following were presentations at the local yearly Newfoundland Electrical and Computer Engineering Conference (*NECEC*) and appear in the Proceedings.)

[56] Zhang, J., E. W. Gill, J. Walsh, and K. Gurgel Comparison of Simulated HF Radar Data with Field Data for a Frequency Modulated Continuous Wave (FMCW) Source, *IEEE NECEC*, St. John's, Newfoundland, 2008. (**Best Student Paper Award**)

[57] Walsh, J., W. Huang, Andrew Myrden, and **E.W. Gill**, The Second-order HF Radar Cross Section for an Antenna with Barge Motion, *IEEE NECEC*, St. John's, Newfoundland, 2008.

[58] Zhang, J., **E.W. Gill**, and J. Walsh, HF Radar Remote Sensing with Frequency Modulated Sources, *IEEE NECEC*, St. John's, Newfoundland, 2007.

[59] Walsh, J., **E.W. Gill**, and W. Huang, Analytical Considerations for High Frequency Surface Wave Radar Operating from a Moving Ocean Platform, *IEEE NECEC*, St. John's, Newfoundland, 2007. (**Best Industry Paper Award**)

[60] Hickey, K., **E.W. Gill**, and J. Walsh, Modeling the Ocean Clutter for Ship Detection Purposes Using a Narrow-beam High Frequency Ground Wave Radar System: A Heuristic Approach, *IEEE NECEC*, St. John's, Newfoundland, 2007.

[61] Zhang, J., **E.W. Gill**, and J. Walsh, J., The Fluctuations of the First-order Peaks When HF Radar is Used in Ocean Surface Current Measurement, *IEEE NECEC*, St. John's, Newfoundland, St. John's, Newfoundland, Canada, 2006.

[62] Jin, Q., and **E.W. Gill**, Extraction of Ocean Surface Current Velocity from Simulated Bistatic Radar Data, *IEEE NECEC*, St. John's, Newfoundland, Canada, 2005.

[63] Hickey, K., **E. Gill**, and J. Walsh, J., A Spectral Estimation Technique for the Extraction of Small Ocean Surface Currents Using a Narrow-beam High-Frequency Ground Wave Radar, *IEEE NECEC*, St. John's, Newfoundland, 2005.

[64] Green, D., and **E.W. Gill**, Extracting Wind Information from HFGWR Oceanic Backscatter (Part 2), *IEEE NECEC*, St. John's, Newfoundland, 2004.

[65] Zhang, J., and **E.W. Gill**, Time Series of a Backscattered Vertically Polarized HF Electric Field from the Ocean Surface, *IEEE NECEC*, St. John's, Newfoundland, 2004.

[66] Zhang, J., and **E.W. Gill**, Extraction of Ocean Wave Information from Simulated Noisy Bistatic High Frequency Radar Spectra, *IEEE NECEC*, St. John's, Newfoundland, 2003.

[67] Sircar, S., D. Power, C. Randell, J. Youden, and **E. Gill**, Fusion of Ascending and Descending Pass D-InSAR Pairs for Lateral Ground Movement Measurements: Technique and Validation with Synthetic Data, *IEEE NECEC*, St. John's, Newfoundland, 2003.

[68] Churchill, S., C. Randell, D. Power, and **E. Gill**, Data Fusion: Associations of Detections for Multiple Hypothesis Tracking using Remote Sensing, *IEEE NECEC*, St. John's, Newfoundland, 2003.

[69] Huang, W., **E.W. Gill**, and J. Walsh, Verification of the Second-Order HF Bistatic Radar Cross Section of ``Patch Scatter" on Ocean Surface, *IEEE NECEC*, St. John's, Newfoundland, 2003.

[70] Green, D.W., and **E. Gill**, Extraction of Wind Speed from High Frequency Ground Wave Radar Second Order Cross Section, *IEEE NECEC*, St. John's, Newfoundland, 2003.

[71] Bobby, P. and **E. Gill**, On the Use of the Continuity Equation for Vector Current Extrapolation using HF Radar, *IEEE NECEC*, St. John's, Newfoundland, 2002.

[72] Hickey, K., **E. Gill**, and J. Walsh, Vector Surface Currents Using a Long-Range, High-Frequency Radar Station: A Practical Approach, *IEEE NECEC*, St. John's, Newfoundland, 2002.

[73] Sircar, S., D. Power, J. Youden, **E. Gill**, and P. Han, Lateral Movement Estimation from Space-borne Radar by Differential Interferometry, *IEEE NECEC*, St. John's, Newfoundland, 2002.

[74] Zhang, J., and **E. Gill**, Extraction of Ocean Wave Information from Simulated High Frequency Bistatic Radar Data, *IEEE NECEC*, St. John's, Newfoundland, 2002.

[75] Churchill, S., C. Randell, D. Power, and **E. Gill**, Toward Fusion of Satellite SAR and other Remotely Sensed Marine Data for Wide-Area Operational Monitoring, *IEEE NECEC*, St. John's, Newfoundland, 2001.

[76] Hickey, K., **E. Gill**, and J. Walsh, Ocean Surface Current Mapping Using a Dual, Long-Range, High-Frequency Ground Wave Radar System, *IEEE NECEC*, St. John's, Newfoundland, 2001.

[77] **Gill, E.W.**, J. Walsh, and P. Bobby, Characterization of External Noise Limitations in the Operation of Pulsed HF Ground Wave Radar, *IEEE NECEC*, St. John's, Newfoundland, 2000.

[78] **Gill, E.W.**, and J. Walsh, An Investigation of the Significant Portions of the High Frequency Bistatic Ground Wave Radar Cross Sections of a Highly Conducting, Slightly Rough Time Varying Surface, *IEEE NECEC*, St. John's, Newfoundland, 1998.

[79] Walsh, J., B.J. Dawe, and **E.W. Gill**, An Investigation of the First-order Bistatic Radar Cross Section of the Ocean Surface, *IEEE NECEC*, St. John's, Newfoundland, 1996.

[80] **Gill, E.W.**, K. Hickey, J. Helbig, and J. Walsh, Radial Surface Current Measurement Using an FMICW Ground Wave Radar: Validation Against Current Drifters on the Grand Banks, *IEEE NECEC*, St. John's, Newfoundland, 1994.

[81] Khan, R. H., **E.W. Gill**, S.A. Saoudy, K. Hickey, B.J. Dawe, and J. Walsh, Experimental Results from a HF Ground Wave Radar Operating in an Ocean Environment, *IEEE NECEC*, St. John's, Newfoundland, 1993.

[82] **Gill, E.W.**, R. Howell, and J. Walsh, Estimation of Environmental Parameters Using Narrow Beam Ground Wave Radar, *IEEE NECEC*, St. John's, Newfoundland, 1992.

[83] **Gill, E.W.**, Measurement of Ocean Waves and Surface Currents with HF Radar. Radar Workshop (Radar and Remote Sensing), Institute for Aerospace Studies, Toronto1992. (Invited Paper).

[84] **Gill, E.W.**, and J. Walsh, Extraction of Ocean Wave Parameters from Wide Beam HF Radar (CODAR) Backscatter: Application at Lumsden, *IEEE NECEC*, St. John's, Newfoundland, 1991.

[85] **Gill, E.W.**, and J. Walsh, Extraction of Ocean Wave Parameters from Wide Beam HF Radar Backscatter – A Simulation, *IEEE NECEC*, St. John's, Newfoundland, 1990.

Other Publications

[86] **Gill, E.W.**, The Scattering of High Frequency Electromagnetic Radiation from the Ocean Surface: An Analysis Based on a Bistatic Ground Wave Radar Configuration. Ph.D. thesis, Memorial University of Newfoundland, St. John's Newfoundland, Canada. (Received the **Governor-General's Gold Medal in Graduate Studies** and the **Dunsiger Award for Thesis Excellence** (Engineering and Applied Science)), 1999.

[87] Hickey, K., **E.W. Gill**, J. Walsh, and B.J. Dawe, Results of the Surface Current and Waves Measurement Program Using the Northern Radar Cape Race Ground Wave Radar System, Contract Report for Dept. of Fisheries and Oceans, Northwest Atlantic Fisheries Centre, St. John's, Canada, 1992.

[88] **Gill, E.W.**, An Algorithm for the Extraction of Ocean Wave Parameters from Wide Beam HF Radar (CODAR) Backscatter. M.Eng. thesis, Memorial University of Newfoundland, St. John's Newfoundland, Canada. (Received the **Dunsiger Award for Thesis Excellence** (Engineering and Applied Science)), 1990.