

## 1. PERSONAL

June 2017

1.1. Name: David R. Lyzenga

1.2. Education:

- B.S.E. University of Michigan, 1967, Physics
- M.S. Yale University, 1968, Physics
- Ph.D. University of Michigan, 1973, Electrical Engineering

1.3. Positions at The University of Michigan:

- 2016- Research Scientist Emeritus, Department of Naval Architecture and Marine Engineering
- 1996-2016 Research Scientist, Department of Naval Architecture and Marine Engineering
- 1993-1996 Visiting Associate Research Scientist, Department of Naval Architecture and Marine Engineering
- 1991-1992 Adjunct Associate Professor, Department of Naval Architecture and Marine Engineering
- 1970-1972 Research Assistant, Space Physics Research Laboratory

1.4. Positions at Other Organizations:

- 2010- Senior Research Engineer, SRI International, Ann Arbor
- 2000-2009 Research Scientist, General Dynamics Applied Information Systems, Ann Arbor
- 1989-1999 Research Scientist, ERIM International and Veridian Systems Division, Ann Arbor
- 1987-1989 Associate Professor, College of Marine Studies, University of Delaware, Newark
- 1980-1987 Research Engineer, Radar Division, Environmental Research Institute of Michigan, Ann Arbor
- 1973-1980 Research Engineer, Applications Division, Environmental Research Institute of Michigan
- 1968-1969 Instructor in Mathematics and Physics, Calvin College, Grand Rapids, Michigan
- 1967-1968 Research Assistant, Department of Physics, Yale University, New Haven, Connecticut

## 2. TEACHING

At the University of Michigan, I taught NA/AOSS 528 (Remote Sensing of Ocean Dynamics) during the Winter 1994, 1996, and 1999 terms, and a portion of NA522 (Signal Processing) in the Spring terms from 2006 through 2009. While at the University of Delaware, I introduced two new courses entitled Hydrologic Optics (1987) and Radar Basics and Applications (1988), and chaired three M.S. committees. I co-chaired two Ph.D committees and was a member of five Ph.D committees at the University of Michigan, the Massachusetts Institute of Technology, and the University of Delaware. I sponsored an international exchange graduate student in 1993-94 and a post-doctoral Visiting Scholar in 2006-07. I collaborated on the development of electronic learning materials in the area of remote sensing as part of an international curriculum project funded by the U.S. Department of Education from 2004-06. I was also involved in the Undergraduate Research Opportunity Program (UROP) from 2008-2015.

## 3. RESEARCH

My research interests have been in the area of ocean remote sensing, and my accomplishments include the development of methodologies for measuring ocean waves and other surface phenomena using shipboard, airborne and spaceborne radars. Earlier in my career I developed methods for estimating water depth and water quality using multispectral and hyperspectral optical sensors. As part of this work I developed models for the interaction of electromagnetic radiation with the ocean surface, and investigated the relationship between remotely sensed signals and various geophysical processes such as oceanic internal waves, winds, fronts, and current boundaries, with a particular interest in microwave backscatter from breaking waves. I have also developed microwave emissivity models for the ocean surface and devised new algorithms for estimating ocean surface wind vectors using passive microwave radiometric measurements. Most recently I developed methods of estimating ocean wave spectra and wave fields from shipboard radar data during two projects funded by the U.S. Office of Naval Research. This work has resulted in two provisional patent applications.

## 4. PUBLICATIONS

4.1. Articles in Refereed Journals

- Lyzenga, D.R., Polar Fourier transform processing of marine radar signals, *J. Atmospheric and Oceanic Tech.* 34, 347-354, 2017.
- Lyzenga, D.R. and D.T. Walker, A Simple Model for Marine Radar Images of the Ocean Surface, *IEEE Geoscience and Remote Sensing Letters* 12, 1-4, 2015.
- Nwogu, O.G. and D.R. Lyzenga, Surface-wavefield estimation from coherent marine radars, *IEEE Geoscience and Remote Sensing Letters* 7, 631-635, 2010.
- Lyzenga, D.R., Effects of Nonlinear energy transfer on short surface waves, *J. Geophys. Res.* 115, C10001, doi:10.1029/2009JC005872, 2010.
- Johnson, J.T., R.J. Burkholder, J.V. Toporkov, D.R. Lyzenga, and W.J. Plant, A numerical study of the retrieval of sea surface height profiles from low grazing angle radar data, *IEEE Trans. Geoscience and Remote Sensing*, 47,1641-1650, 2009.
- Kim, D.-J. and D.R. Lyzenga, Efficient model-based estimation of atmospheric transmittance and ocean wind vectors from WindSat data, *IEEE Trans. Geoscience and Remote Sensing*, 46, 2288-2297, 2008.
- Kim, D.-J., D.R. Lyzenga, W. Choi, and Y. Kim, Evolution of internal waves near a turning point in the South China Sea using SAR imagery and numerical models, *Korean Journal of Remote Sensing*, 23, 385-391, 2007.
- Lyzenga, D.R., N.P. Malinas, and F.J. Tanis, Multispectral bathymetry using a simple physically based algorithm, *IEEE Trans. Geoscience and Remote Sensing*, 44, 2251-2259, 2006.
- Lyzenga, D.R., Comparison of WindSat brightness temperatures with two-scale model predictions, *IEEE Trans. Geoscience and Remote Sensing*, 44, 549-559, 2006.
- Lyzenga, D.R., Ocean wave spectrum and dissipation rate derived from CMOD4 model function, *J. Geophys. Res.* 109, C07019, 2004.
- Haller, M.C. and D.R. Lyzenga, Comparison of radar and video observations of shallow water breaking waves, *IEEE Trans. Geoscience and Remote Sensing* 41, 832-844, 2003.
- Lyzenga, D.R. and J.F. Vesecky, Two-scale polarimetric emissivity model: Efficiency improvements and comparisons with data, *Electromagnetic Waves PIER* 37, 205-219, 2003.
- Lyzenga, D.R., Unconstrained inversion of waveheight spectra from SAR images, *IEEE Trans. Geoscience and Remote Sensing* 40, 261-270, 2002.
- Dano, E.B., D.R. Lyzenga, G. Meadows, L. Meadows, H. Van Sumeren, and R. Onstott, Radar backscatter from mechanically generated transient breaking waves, Part 2: Azimuthal and grazing angle dependence, *IEEE Journal of Oceanic Engineering* 26, 201-215, 2001.
- Dano, E.B., D.R. Lyzenga, and M. Perlin, Radar backscatter from mechanically generated transient breaking waves, Part 1: Angle of incidence dependence and high resolution surface morphology, *IEEE Journal of Oceanic Engineering* 26, 181-200, 2001.
- Ericson, E.A., D.R. Lyzenga, and D.T. Walker, Radar backscatter from breaking waves, *J. Geophys. Res.* 104, 29679-29695, 1999.
- Marmorino, G.O., D.R. Lyzenga, and J.A.C. Kaiser, Comparison of airborne synthetic aperture radar imagery with in situ surface-slope measurements across Gulf Stream slicks and a convergent front, *J. Geophys. Res.* 104, 1405-1422, 1999.
- Espedal, H.A., O.M. Johannessen, J.A. Johannessen, E. Dano, D. Lyzenga, and J.C. Knulst, COASTWATCH '95: A tandem ERS-1/2 SAR detection experiment of natural film on the ocean surface, *J. Geophys. Res.* 103, 24969-24982, 1998.
- Ericson, E.A. and D.R. Lyzenga, Performance of a numerical iterative solution of the surface current integral equation for surfaces containing small radii of curvature, *Radio Science* 33, 205-217, 1998.
- Lyzenga, D.R. and E.A. Ericson, Numerical calculations of radar scattering from sharply peaked ocean waves, *IEEE Trans. Geoscience and Remote Sensing* 36, 636-646, 1998.

- Lyzenga, D.R. and G.O. Marmorino, Measurement of surface currents using sequential synthetic aperture radar images of slick patterns near the edge of the Gulf Stream, *J. Geophys. Res.* 103, 18769-18777, 1998.
- Lyzenga, D.R., Effects of intermediate-scale waves on radar signatures of ocean fronts and internal waves, *J. Geophys. Res.* 103, 18759-18768, 1998.
- Donato, T.F., F. Askari, G.O. Marmorino, C.L. Trump, and D.R. Lyzenga, Radar imaging of sand waves on the continental shelf east of Cape Hatteras, NC, U.S.A., *Continental Shelf Research* 17, 989-1004, 1997.
- Lyzenga, D.R. and N.P. Malinas, Azimuth falloff effects in two-antenna SAR measurements of ocean wave spectra, *IEEE Trans. Geoscience and Remote Sensing* 34, 1020-1028, 1996.
- Walker, D.T., D.R. Lyzenga, E.A. Ericson, and D.E. Lund, radar backscatter and surface roughness measurements for stationary breaking waves, *Proc. Royal Soc. Lond. A.* 452, 1953-1984, 1996.
- Wang, M., D.R. Lyzenga, and V.V. Klemas, Measurement of optical properties in the Delaware Estuary, *J. Coastal Res.* 12, 211-228, 1996.
- Hara, T., E.J. Bock and D.R. Lyzenga, In situ measurements of capillary-gravity wave spectra using a scanning laser slope gauge and microwave radars, *J. Geophys. Res.* 99, 12593-12602, 1994.
- Mognard, N., J. Johannessen, C. Livingstone, D. Lyzenga, R. Shuchman, and C. Russel, Simultaneous observations of ocean surface winds and waves by Geosat radar altimeter and airborne synthetic aperture radar during the 1988 Norwegian Continental Shelf Experiment, *J. Geophys. Res.* 96, 10467-10486, 1991.
- Johannessen, J., R. Shuchman, O. Johannessen, K. Davidson, and D. Lyzenga, Synthetic aperture radar imaging of upper ocean circulation features and wind fronts, *J. Geophys. Res.* 96, 10411-10422, 1991.
- Lyzenga, D.R., Interaction of short surface and electromagnetic waves with ocean fronts, *J. Geophys. Res.* 96, 10765-10772, 1991.
- Hayt, D., W. Alpers, C. Bruening, R. DeWitt, F. Henyey, D. Kasilingam, W. Keller, D. Lyzenga, W. Plant, R. Schult, O. Shemdin, and J. Wright, Focusing simulations of synthetic aperture radar ocean images, *J. Geophys. Res.* 95, 16245-16261, 1990.
- Wallenberger, A.P. and D.R. Lyzenga, Measurement of the surface tension of water using microwave backscatter from gravity-capillary waves, *IEEE Trans. Geoscience and Remote Sensing* 28, 1012-1016, 1990.
- Monaldo, F.M. and D.R. Lyzenga, Comparison of SIR-B ocean wave image spectra with linear model predictions based on aircraft measurements, *J. Geophys. Res.* 93, 15374-15388, 1988.
- Lyzenga, D.R., An analytic representation of the synthetic aperture radar image spectrum for ocean waves, *J. Geophys. Res.* 93, 13859-13865, 1988.
- Lyzenga, D.R. and J.R. Bennett, Full-spectrum modeling of SAR internal wave signatures, *J. Geophys. Res.* 93, 12345-12354, 1988.
- Lyzenga, D.R., The physical basis for estimating wave energy spectra from SAR imagery, *Johns Hopkins APL Technical Digest* 8, 65-69, 1987.
- Beal, R.C., F.M. Monaldo, D.G. Tilley, D.E. Irvine, E.J. Walsh, F.C. Jackson, D.W. Hancock III, D.E. Hines, R.N. Swift, F.I. Gonzalez, D.R. Lyzenga, and L.F. Zambresky, A comparison of SIR-b directional ocean wave spectra with aircraft scanning radar spectra, *Science* 232, 1531-1535, 1986.
- Lyzenga, D.R., Numerical simulation of synthetic aperture radar image spectra for ocean waves, *IEEE Trans. Geoscience and Remote Sensing* 24, 863-872, 1986.
- Monaldo, F.M. and D.R. Lyzenga, On the estimation of wave slope and height variance spectra from SAR imagery, *IEEE Trans. Geoscience and Remote Sensing* 24, 543-551, 1986.
- Shuchman, R.A., D.R. Lyzenga, and G.A. Meadows, Synthetic aperture radar imaging of ocean-bottom topography via tidal-current interactions: Theory and observations, *Int. J. Remote Sensing* 6, 1179-1200, 1985.

Hasselmann, K., R.K. Raney, W.J. Plant, W. Alpers, R.A. Shuchman, D.R. Lyzenga, C.L. Rufenach, and M.J. Tucker, Theory of synthetic aperture radar ocean imaging: A MARSEN view, *J. Geophys. Res.* 90, 4659-4686, 1985.

Lyzenga, D.R., Shallow-water bathymetry using combined lidar and passive multispectral scanner data, *Int. J. Remote Sensing* 6, 115-125, 1985.

Lyzenga, D.R., R.A. Shuchman, J.D. Lyden, and C.L. Rufenach, SAR imaging of waves in water and ice: Evidence for velocity bunching, *J. Geophys. Res.* 90, 1031-1036, 1985.

Burns, B.A. and D.R. Lyzenga, Textural analysis as a SAR classification tool, *Electromagnetics* 4, 309-322, 1984.

Lyzenga, D.R. and R.A. Shuchman, Analysis of scatterer motion effects in MARSEN X-band SAR data, *J. Geophys. Res.* 88, 9769-9775, 1983.

Lyzenga, D.R., R.A. Shuchman, and C.L. Rufenach, Synthetic aperture radar measurements of ocean surface currents, *Geophysical Research Letters* 9, 747-750, 1982.

Lyzenga, D.R., Remote sensing of bottom reflectance and water attenuation parameters in shallow water using aircraft and Landsat data, *Int. J. Remote Sensing* 2, 71-82, 1981.

Lyzenga, D.R., Passive remote sensing techniques for mapping water depth and bottom features, *Applied Optics* 17, 379-383, 1978.

Wezernak, C.T. and D.R. Lyzenga, Analysis of Cladophora distribution in Lake Ontario using remote sensing, *Remote Sensing of Environment* 4, 37-48, 1975.

#### 4.2. Shorter communications in Refereed Publications

Lyzenga, D.R. and J.R. Bennett, Estimation of ocean wave spectra using two-antenna SAR systems, *IEEE Trans. Geoscience and Remote Sensing* 29, 463-465, 1991.

Lyzenga, D.R., A.L. Maffett, and R.A. Shuchman, The contribution of wedge scattering to the radar cross section of the ocean surface, *IEEE Trans. Geoscience and Remote Sensing* 21, 502-505, 1983.

Lyzenga, D.R., Reflectance of a flat ocean in the limit of zero water depth, *Applied Optics* 16, 282-283, 1977.

Lyzenga, D.R., Note on the modified two-stream approximation of Sagan and Pollack, *Icarus* 19, 240-242, 1973.

#### 4.3. Refereed Conference and Symposium Presentations

Lyzenga, D.R., O.G. Nwogu, R.F. Beck, A. O'Brien, J.T. Johnson, A. dePaolo, and E. Terrill, Real-time estimation of ocean wave fields from marine radar data, *Proc. International Geoscience and Remote Sensing Symposium*, Milan, Italy, 26-31 July, 2015.

Alford, L.K., R. F. Beck, J. T. Johnson, D. Lyzenga, O. Nwogu, and A. Zundel, A real-time system for forecasting extreme waves and vessel motions, *34th International Conference on Ocean, Offshore and Arctic Engineering*, St. John's, Newfoundland, Canada, May 2015.

Alford, L.K., R. F. Beck, J. T. Johnson, D. Lyzenga, O. Nwogu, and A. Zundel, Design, implementation, and evaluation of a system for environmental and ship motion forecasting, *30th Symposium on Naval Hydrodynamics*, Hobart, Tasmania, Australia, 2-7 November 2014.

Smith, G., N. Majurec, A. O'Brien, J. Pozderac, C. Baker, J. Johnson, D. Lyzenga, O. Nwogu, D. Trizna, D. Rudolf, and G. Schueller, High power coherent-on-receive radar for marine surveillance, *2013 International Conference on Radar*, Adelaide, South Australia, pp. 434-439, 9-12 Sept. 2013.

Lyzenga, D.R. and O.G. Nwogu, Shipboard radar measurements of ocean waves for real-time prediction of nonlinear ship motions, *28th Symposium on Naval Hydrodynamics*, Pasadena, California, 12-17 September 2010.

Lyzenga, D., O. Nwogu, D. Trizna, and K. Hathaway, Ocean wave field measurements using X-Band Doppler radars at low grazing angles, *International Geoscience and Remote Sensing Symposium*, Honolulu, HI, 25-30 July 2010.

Lyzenga, D.R., Nonlinear effects in the interaction of surface waves with internal waves, *American Geophysical Union Fall Meeting*, San Francisco, CA, 11-15 December, 2006.

Choi, W. and D.R. Lyzenga, Nonlinear surface wave dynamics in slowly varying ocean environments, *26<sup>th</sup> Symposium on Naval Hydrodynamics*, Rome, Italy, 17-22 September, 2006.

Lyzenga, D.R., Reconciliation of WindSat observations with model predictions, *WindSat Science Workshop*, Washington, DC, November 19-20, 2002.

Lyzenga, D.R. and J. Vesecky, Two-scale model implementation issues and comparisons with available data, *Progress in Electromagnetics Research Symposium*, Cambridge, MA, July 2002.

Lyzenga, D.R. and J. Vesecky, An efficient two-scale emissivity model with application to radiometric measurements of oceanic wind vectors, *International Geoscience and Remote Sensing Symposium*, Toronto, CA, June 2002.

Donato, T.F., D.R. Lyzenga, and X. Yan, A comparative analysis of Landsat TM and Radarsat SAR signatures in restricted tidal channels, *International Geoscience and Remote Sensing Symposium*, Toronto, CA, June 2002.

Lyzenga, D.R., J. Vesecky, and N-Y. Wang, An analytical two-scale model for the microwave emissivity of the ocean surface, *International Union of Radio Science Symposium*, Boston, MA, July 2001.

Lyzenga, D.R. and D.B. Trizna, Comparison of model predictions of wave energy dissipation with radar backscatter measurements in the surf zone, *American Geophysical Union Spring Meeting*, Boston, MA, May 1998.

Lyzenga, D.R. and E.A. Ericson, Numerical calculations of radar backscatter from sharply crested waves at intermediate and low grazing angles, *Progress in Electromagnetics Research Symposium*, Cambridge, MA, July 1997.

Lyzenga, D.R. and C.C. Wackerman, Detection and Classification of Ocean Eddies using ERS-1 and Aircraft SAR Images, *Third ERS Symposium*, Florence, Italy, April 1997.

Lyzenga, D.R., Effects of wave breaking on SAR signatures observed near the edge of the Gulf Stream, *Proc. Int'l Geoscience and Remote Sensing Symposium*, 1996.

Lyzenga, D.R., SAR response to spatially and temporally varying wind fields, *Proc. Int'l Geoscience and Remote Sensing Symposium*, 1996.

Johannessen, O., J. Johannessen, A. Jenkins, K. Davidson, D. Lyzenga, R. Shuchman, P. Samuel, H. Espedal, J. Knulst, E. Dano, and M. Reistad, CoastWatch-95: ERS-1/2 SAR applications of mesoscale upper ocean and atmospheric boundary layer processes off the coast of Norway, *Proc. Int'l Geoscience and Remote Sensing Symposium*, 1996.

Marmorino, G.O., D.R. Lyzenga, J.A.C. Kaiser and C.L. Trump, Synthetic aperture radar imagery of the coastal ocean near Cape Hatteras, NC, *Proc. Int'l Geoscience and Remote Sensing Symposium*, 1996.

Lyzenga, D.R. and G.O. Marmorino, Measurement of ocean current velocities using multitemporal SAR observations of slick patterns near the edge of the Gulf Stream, *Third Thematic Conference on Remote Sensing for Marine and Coastal Environments*, Seattle, WA, 1995.

Lyzenga, D.R., R.A. Shuchman, J.A. Johannessen, H. Espedal, and B. Holt, Multifrequency SAR observations of ocean surface features off the coast of Norway, *MAC Europe 91 Final Results Workshop Proceedings*, Lenggries, Germany, 4-6 October 1994, ESA WPP-88, pp.243-254, January 1995.

Lyzenga, D.R. and N.P. Malinas, Airborne radar measurements of coastal ocean currents and waves, *Second Thematic Conference on Remote Sensing for Marine and Coastal Environments*, New Orleans, LA, 1994.

Lyzenga, D.R., Radar backscatter from breaking waves, *Progress in Electromagnetics Research Symposium*, Noordwijk, Netherlands, 1994.

Lyzenga, D.R. and N.P. Malinas, Estimation of ocean wave spectra from interferometric SAR signals, *Progress in Electromagnetics Research Symposium*, Pasadena, CA, 1993.

Lyzenga, D.R., Surface roughness and radar backscatter variations near the edge of the Gulf Stream, *American Geophysical Union Fall Meeting*, San Francisco, CA, 1992.

- Lyzenga, D.R., Interaction of short surface waves and electromagnetic radiation with ocean fronts, *American Geophysical Union Spring Meeting*, Baltimore, MD, 1991.
- Lyzenga, D.R. and N.P. Malinas, Polarization and incidence angle dependence of ocean wave modulation transfer functions observed in airborne SAR data, *International Union of Radio Science Signatures Conference*, Hyannis, MA, 1990.
- Lyzenga, D.R., C.L. Rufenach and N.P. Malinas, Wind speed and incidence angle dependence of ocean wave modulation transfer functions observed in airborne SAR data, *International Geoscience and Remote Sensing Symposium*, Baltimore, MD, 1990.
- Lyzenga, D.R., J.R. Bennett, F. Askari and W. Keller, On the interaction of short surface waves with ocean fronts, *International Geoscience and Remote Sensing Symposium*, Baltimore, MD, 1990.
- Lyzenga, D.R. and C.C. Wackerman, Modeling of focus effects in SAR images of the ocean surface, *International Geoscience and Remote Sensing Symposium*, Ann Arbor, MI, 1987.
- Lyzenga, D.R. and J.R. Bennett, Comparison of numerical simulations with SAR images of ocean surface waves in the New York Bight, *International Geoscience and Remote Sensing Symposium*, Ann Arbor, MI, 1987.
- Lyzenga, D.R., Simulation of SAR images of ocean waves observed during the TOWARD experiment, *American Geophysical Union Fall Meeting*, San Francisco, CA, 1986.
- Lyzenga, D.R., Estimates of the extent of small-scale wave breaking and its influence on radar backscatter from the ocean surface, *International Union of Radio Science Symposium on Wave Propagation*, Durham, NH, 1986.
- Lyzenga, D.R., Simulations of SAR wave spectra using high resolution spectral estimates from the SCR and ROWS instruments, *International Geoscience and Remote Sensing Symposium*, Amherst, MA, 1985.
- Lyzenga, D.R., C.C. Wackerman, and R.A. Shuchman, Synthetic aperture radar image simulations, *Oceans '84*, Washington, D.C., 1984.
- Lyzenga, D.R., R.A. Shuchman, E.S. Kasischke, and G.A. Meadows, Modeling of bottom-related surface patterns imaged by synthetic aperture radar, *International Geoscience and Remote Sensing Symposium*, San Francisco, CA, 1983.
- Lyzenga, D.R., R.A. Shuchman, J.L. Walker, and C.L. Rufenach, Measurement of ocean surface currents by synthetic aperture radar, *International Geoscience and Remote Sensing Symposium*, Munich, Germany, 1982.
- Lyzenga, D.R., Remote bathymetry using active and passive techniques, *International Geoscience and Remote Sensing Symposium*, Washington, D.C., 1981.
- Lyzenga, D.R., Shallow water reflectance modeling with applications to remote sensing of the ocean floor, *Proc. 13th Int'l. Symposium on Remote Sensing of Environment*, 583-602, Ann Arbor, MI, 1979.
- Lyzenga, D.R., Evaluation of an algorithm for mapping bottom features under a variable depth of water, *Proc. 13th International Symposium on Remote Sensing of Environment*, 1767-1779, Ann Arbor, MI, 1979.

#### 4.4. Chapters in Books

- Lyzenga, D.R., Microwave Surface Scattering and Emission, in *Encyclopedia of Remote Sensing*, ed. by Eni G. Njoku, Springer Publications, New York, 2014.
- Lyzenga, D.R., J. Johannessen, and G. Marmorino, Ocean currents and current boundaries, in *SAR Marine User's Manual*, ed. by J. Apel and C. Jackson, US Govt. Printing Office, Washington, DC, 2004.
- Jackson, F.C. and D.R. Lyzenga, Microwave techniques for measuring directional wave spectra, in *Surface Waves and Fluxes*, ed. by G.L. Geernaert and W.J. Plant, Kluwer Pub. Co., Amsterdam, 1990.
- Polcyn, F.C. and D.R. Lyzenga, Multispectral sensing of water parameters, in *Remote Sensing and Water Resources Management*, Proc. No. 17, American Water Resources Association, 1973.

#### 5. SERVICE TO GOVERNMENT AND PROFESSIONAL ORGANIZATIONS

Member of the Optical Society of America, American Geophysical Union, Institute of Electrical & Electronics Engineers, and the American Meteorological Society.

Reviewer for the American Society of Civil Engineers, Boreal Environment Research, Chinese Journal of Oceanology and Limnology, Great Lakes Research, Geophysical Research Letters, Geoscience and Remote Sensing Letters, IEEE Proceedings, International Journal of Remote Sensing, Institute of Physics, Journal of Atmospheric and Oceanic Technology, Journal of Geophysical Research, Journal of Oceanography, Journal of Physical Oceanography, Journal of Ship Research, Open Archaeology, Photogrammetric Engineering and Remote Sensing, Research Council of Norway, Remote Sensing, Strategic Environmental Research and Development Program, and Transactions on Geoscience and Remote Sensing.

NASA SIR-C Science Peer Review Panel, 1988

ONR Board of Visitors, Ocean Engineering Division, 1989

U.S. Army Corps of Engineers Technical Review Committee, 1988-91

Associate Editor, Journal of Geophysical Research, 1988-91

NRL Ocean Remote Sensing External Review Committee, 2003, 2006

Member, NRL Battlespace Programs External Review Panel, 2009

Chair, NRL Battlespace Programs External Review Panel, 2012

## 6. HONORS AND AWARDS

Summa Cum Laude, College of Engineering, University of Michigan (1967)

Member, Tau Beta Pi (1967), Phi Kappa Phi (1967), and Sigma Phi (1971)

Institute for Environmental Quality Fellow, University of Michigan (1972-1973)