

Nicholas Constantine Makris

Secretary of the Navy, Chief of Naval Operations Scholar of Oceanographic Sciences
Professor of Mechanical and Ocean Engineering

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Professional Areas: Acoustics, Sensing and Perception, Ocean Exploration, Marine Ecology, Scattering and Propagation in Random Media, Statistical Estimation, Marine Geophysics, Musical Instrument Acoustics and Evolution, Polar and Icy Satellite Exploration

Appointments

2008-present Professor, MIT Department of Mechanical Engineering
2000-2008 Associate Professor, MIT Department of Mechanical Engineering, Ocean Engineering
1997-2000 Assistant Professor, MIT Department of Ocean Engineering
1991-1997 Research Physicist, Naval Research Laboratory

Professional Preparation: MIT SB, Physics 1983; MIT PhD Ocean Eng. 1990; MIT Post-doc 1990

Chief Scientist of Programs and Field Experiments

January 2012-2014 Chief Scientist of Nordic Seas Wide-Area Fish Shoal and Marine Mammal Behavioral Dynamics Experiment, Joint ONR and Institute of Marine Research Norway

Fall 2011-2012 Exploring New Ground Fish Survey Methods in the Gulf of Maine, for Massachusetts State

March 2008-2011 Chief Scientist of Joint ONR, Mexican Navy, US Department of Homeland Security, NOAA Seagrant, Experiment Series: Hurricane Quantification with Natural Undersea Sound, Isla Socorro, Mexico.

Sept-Oct 2006 Chief Scientist of National Oceanographic Partnership Program Ocean Acoustic Waveguide Remote Sensing (OAWRS) Fish Group Behavior and Population Assessment Experiment on Georges Bank and Gulf of Maine Fall 2006.

April-May 2003 Chief Scientist of ONR Acoustic Clutter (Geoclutter) Program and Experiment including OAWRS Fisheries Demonstration Mid-Atlantic Bight 2003

April -May 2001 Chief Scientist of ONR Acoustic Clutter (Geoclutter) Reconnaissance Experiment, Mid-Atlantic Bight, 2001.

June 1995	Chief Scientist NRL Beach Noise Imaging Experiment, Camp Pendleton, CA
Sept-Aug 1993	Designed, Selected Sites, Directed Main Acoustics Experiment of the Decade Long ONR Special Research Program on Seafloor Reverberation, Mid-Atlantic Ridge.

Honors and Awards

- NASA Group Achievement Award to Jupiter Icy Moons Orbiter Science Definition Team
- Doherty Professor of Ocean Utilization
- Edgerly Fellow
- Secretary of the Navy/Chief of Naval Operations Scholar of Oceanographic Sciences
- Fellow of the Acoustical Society of America
- ONR Young Investigator
- Alan Berman Outstanding Publication Award, NRL
- A. B. Wood Medal, Institute of Acoustics, UK
- Navy Special Act Award
- MIT Nautical Association Service Award
- Comodore MIT Nautical Association

Journal Publications

(** indicated papers with Makris' students)

1. **S. Jagannathan, Elizabeth T. Kusel, Purnima Ratilal and N. C. Makris, "[Scattering from extended targets in range-dependent fluctuating ocean-waveguides with clutter from theory and experiments](#)," J. Acoust. Soc. Am. 132 (2), 680-693, August 2012.
2. **Nicholas Makris, "Unidentified floating objects: New sonar imagery reveals mysterious echos to be enormous schools of fish," IEEE Spectrum (feature paper), August 2011.
3. **N.C. Makris and I. Bertsatos, "[Resolving Lambertian surface orientation from fluctuating radiance](#)", J. Acoust. Soc. Am. 130, 1222, 2011.
4. ** S. Jagannathan, B.K. Horn, P. Ratilal, N.C. Makris, "[Force estimation and prediction from time-varying density images](#)", IEEE Trans Pattern Anal Mach Intell. 2011 June 33(6) 1132-46. (highlighted paper)
5. **I. Bertsatos and Nicholas Makris, "Estimating the Instantaneous Velocity of Randomly Moving Target Swarms in a Stratified Ocean Waveguide by Doppler Analysis," J. Acoust. Soc. Am. 130, 84, 2011.
6. **I. Bertsatos, M. Zanolin, T.R. Chen, P. Ratilal, N.C. Makris, "General second order covariance of Gaussian Maximum Likelihood Estimate applied to passive source localization in a fluctuating ocean waveguide," J. Acoust. Soc. Am. 128, 2635-2651 (2010).
7. **M. Zanolin, S. Vitale, N. C. Makris, "Asymptotic expansions of Maximum Likelihood Estimators, with an application to gravitational waves generated in the inspiral phase of binary mergers," Phys. Rev. D 81, 124048 (2010) [16 pages] .
8. ** Nicholas Makris, Srinivasan Jagannathan and Anamaria Ignisca, "Ocean Acoustic Waveguide Remote Sensing: Visualizing Life Around Seamounts," Oceanography, vol 23, 2010. (Invited)

9. **I. Bertsatos and N. C. Makris, "Statistical biases and errors inherent in photoclinometric surface slope estimation with natural light," *Icarus* 208, 798-810 (2010).
10. **S. Jagannathan, I. Bertsatos, D. Symonds, T. Chen, H. T. Nia, A. Jain, M. Andrews, Z. Gong, R. Nero, L. Ngor, M. Jech, O. R. Godø, S. Lee, P. Ratilal, Nicholas Makris, "Ocean Acoustics Waveguide Remote Sensing (OAWRS) of marine ecosystems," *Marine Ecology Progress Series*, Vol. 395, 137-160 (2009). (Invited Paper)
11. **Z. Gong, M. Andrews, S. Jagannathan, R. Patel, J. M. Jech, N. C. Makris, P. Ratilal, "Low-frequency target strength and abundance of shoaling Atlantic herring *Clupea harengus* in the Gulf of Maine during the Ocean Acoustic Waveguide Remote Sensing (OAWRS) 2006 Experiment" *J. Acoust. Soc. Am.* 127, 104-123 (2010).
12. [**Nicholas C. Makris, Purnima Ratilal, Srinivasan Jagannathan, Zheng Gong, Mark Andrews, Ioannis Bertsatos, Olav Rune Godoe, Redwood W. Nero, J. Michael Jech, "Critical Population Density Triggers Rapid Formation of Vast Oceanic Fish Shoals", *Science*, Vol. 323, No. 5922, 1734-1737 \(March 27, 2009\).](#)
13. ** T. Chen, P. Ratilal, N. C. Makris, "Temporal coherence after multiple forward scattering through random three-dimensional inhomogeneities in an ocean waveguide," *J. Acoust. Soc. Am.* 124, 2812-2822 (2008)
14. **J. D. Wilson and N. C. Makris, "Quantifying hurricane destructive power, wind speed, and air-sea material exchange with natural undersea sound," *Geophysical Research Letters* 35, L10603 1-5 (2008)
15. **M. Betke, D. E. Hirsh, N. C. Makris, G. F. McCracken, M. Procopio, N. I. Hristov, S. Tang, A. Bagchi, J. Reichard, J. Horn, S. Crampton, C. J. Cleveland, and T. H. Kunz, "Thermal Imaging Reveals Significantly Smaller Brazilian Free-tailed Bat Colonies than Previously Estimated." *Journal of Mammalogy*, 89(1):18-24, February 2008
16. **A. Galinde, N. Donabed, S. Lee, N. C. Makris, and P. Ratilal, "Range-dependent waveguide scattering model calibrated for bottom reverberation in continental shelf environments" *J. Acoust. Soc. Am.* 123, 1270-1281 (2008)
17. [** N.C. Makris, P. Ratilal, D. Symonds, S. Jagannathan, S. Lee, R. Nero, "Fish population and behavior revealed by instantaneous continental-shelf-scale imaging," *Science*, Volume 311, 660-663 \(February 3, 2006\).](#)
18. **J. D. Wilson and N.C. Makris, "Ocean Acoustic Hurricane Classification," *J. Acoust. Soc. Am.* 119, 168-181 (2006).
19. **S. Lee and N.C. Makris, "The array invariant," *J. Acoust. Soc. Am.* 119, 336-351 (2006).
20. **P. Ratilal and N.C. Makris, "Mean and covariance of the forward field propagated through a stratified ocean waveguide with three-dimensional inhomogeneities," *J. Acoust. Soc. Am.* 118, 3560-3574 (2005).
21. **T.R. Chen, P. Ratilal and N.C. Makris, "Mean and variance of the forward field propagated through three-dimensional random internal waves in a continental-shelf waveguide," *J. Acoust. Soc. Am.* 118, 3532-3559 (2005).
22. **S. Lee, B. Pappalardo, N.C. Makris, "Mechanics of tidally induced fractures in Europa's ice shell," *Icarus* 177, 367-379 (2005).
23. **Ratilal et al and N.C. Makris, "Long range remote imaging of the continental shelf environment: The Acoustic Clutter Reconnaissance Experiment 2001 Experiment," *J. Acoust. Soc. Am.* 117, 1977-1998 (2005).
24. **M. Zanolin, I. Ingram, A. Thode, N. C. Makris, "Asymptotic accuracy of geoacoustic inversions" *J. Acoust. Soc. Am.* 116, 2031-2042 (2004)
25. **S. Lee, M. Zanolin, A. Thode, R. Pappalardo, N.C. Makris, "Probing Europa's Interior with Natural Sound Sources," *Icarus* 165, 144-167 (2003)

26. **Yisan Lai and N. C. Makris, "Spectral and modal formulations for the Doppler-shifted field scattered from an object moving in a stratified medium," *J. Acoust. Soc. Am.* 113, 223-244 (2003).
27. **A. Thode, E. Naftali, I. Ingram, P. Ratilal and N. C. Makris, "Necessary conditions for a maximum likelihood estimate to become asymptotically unbiased and attain the Cramer-Rao lower bound Part II: Range and depth localization of a sound source in an ocean waveguide," *J. Acoust. Soc. Am.* 112, 1890-1910 (2002).
28. **P. Ratilal, Y. Lai and N. C. Makris, "Validity of the sonar equation and Babinet's principle for scattering in a stratified medium," *J. Acoust. Soc. Am.* 112, 1797-1816 (2002).
29. **P. Ratilal and N. C. Makris, "Extinction theorem for object scattering in a stratified medium," *J. Acoust. Soc. Am.* 110, 2924-2945 (2001).
30. **E. Naftali and N. C. Makris, "Necessary conditions for a maximum likelihood estimate to become asymptotically unbiased and attain the Cramer-Rao lower bound, Part I: General approach with an application to time-delay and Doppler shift estimation," *J. Acoust. Soc. Am.* 110, 1917-1930 (2001).
31. M. Betke and N. C. Makris, "Recognition, resolution and complexity of objects subject to affine transformation," *International Journal of Computer Vision* 44, 5-40 (2001).
32. **N. C. Makris and P. Ratilal, "A unified model for reverberation and submerged object scattering in a stratified ocean waveguide," *J. Acoust. Soc. Am.* 109, 909-941 (2001).
33. **C. S. Chia, L., N. C. Makris and T. Fialkowski, "A comparison of bi-static scattering from two geologically distinct abyssal hills," *J. Acoust. Soc. Am.* 108, 2053-2070 (2000)
34. **N. C. Makris, C. S. Chia, L. T. Fialkowski, "The bi-azimuthal scattering distribution of an abyssal hill," *J. Acoust. Soc. Am.* 106, 2491-2512 (1999)
35. N. C. Makris, "A spectral approach to 3-D object scattering in stratified media applied to scattering from submerged spheres," *J. Acoust. Soc. Am.* 104, 2105-2113 (1998).
36. N. C. Makris, "The effect of saturated transmission scintillation on ocean-acoustic intensity measurements," *J. Acoust. Soc. Am.* 100, 769-783 (1996).
37. N. C. Makris, "Parameter resolution bounds that depend on sample size," *J. Acoust. Soc. Am.* 99, 2851-2861 (1996).
38. N. C. Makris, "A foundation for logarithmic measures of fluctuating intensity in pattern recognition," *Optics Letters* 20, 2012-2014 (1995).
39. N. C. Makris, L. Avelino, R. Menis, "Deterministic reverberation from ocean ridges," *J. Acoust. Soc. Am.* 97, 3547-3574 (1995). (Also appears in full in a special volume commemorating ONR's 50th Anniversary.)
40. N. C. Makris, F. Ingenito and W. A. Kuperman, "Detection of a submerged object insonified by surface noise in an ocean waveguide," *J. Acoust. Soc. Am.* 96, 1703-1724 (1994).
41. M. D. Collins, N. C. Makris and L. T. Fialkowski, "Noise-cancellation and source localization," *J. Acoust. Soc. Am.* 96, 1773-1776 (1994).
42. N. C. Makris and J. M. Berkson, "Long-range backscatter from the Mid-Atlantic Ridge," *J. Acoust. Soc. Am.* 95, 1865-1881 (1994).
43. N. C. Makris, "Imaging ocean-basin reverberation via inversion," *J. Acoust. Soc. Am.* 94, 983-993 (1993).
44. M. D. Collins, J. M. Berkson, W. A. Kuperman, N. C. Makris, and J. S. Perkins, "Applications of optimal time-domain beamforming," *J. Acoust. Soc. Am.* 93, 1851-1865 (1993).
45. N. C. Makris and I. Dyer, "Environmental correlates of arctic ice edge noise," *J. Acoust. Soc. Am.* 90, 3288-3298 (1990).
46. N. C. Makris and I. Dyer, "Environmental correlates of pack ice noise," *J. Acoust. Soc. Am.* 79, 1434-1440 (1986).

47. Z. Gong, T. Chen, P. Ratilal, N.C. Makris, "Temporal coherence of the acoustic field forward propagated through a continental shelf waveguide with random internal waves," *J. Acoust. Soc. Am.* 134, 3476-3485 (2013)
48. A. Jain, A. Ignisca, D. H. Yi, P. Ratilal, N.C. Makris, "Feasibility of Ocean Acoustic Waveguide Remote Sensing (OAWRS) of Atlantic Cod with Seafloor Scattering Limitations," *Remote Sensing* 6, 180-208 (2013)

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49. J. M. Berkson, N. C. Makris, R. Menis, T. L. Krout, and G. L. Gibian, "Long-range measurements of seafloor reverberation in the Mid-Atlantic Ridge area," in *Ocean Reverberation*, edited by H. Urban, J. Preston and D. Ellis, Kluwer Academic Publishers, Dordrecht (1993).
50. N. C. Makris, J. M. Berkson, W. A. Kuperman, and J. S. Perkins, "Ocean-basin scale inversion of reverberation data," in *Ocean Reverberation*, edited by H. Urban, J. Preston, and D. Ellis, Kluwer Academic Publishers, Dordrecht (1993).
51. M. D. Collins, L. T. Fialkowski, N. C. Makris, W. A. Kuperman and J. S. Perkins, "Source localization in noisy ocean environments," in *Sea Surface Sound '94*, edited by M. J. Buckingham and J. R. Potter, Kluwer Academic Publishers, Dordrecht (1994).
52. N. C. Makris, W. A. Kuperman and F. Ingenito "Bounds on the detection of a submerged object insonified by surface noise in a shallow water waveguide," in *Sea Surface Sound '94*, edited by M.J. Buckingham and J.R. Potter, Kluwer Academic Publishers, Dordrecht (1994).
53. N. C. Makris, R. Menis, L. Avelino and J. M. Berkson, "Deterministic reverberation from the Mid-Atlantic Ridge," in *Proceedings of the Second European Conference on Underwater Acoustics*, edited by L. Bjorno, European Commission, Brussels (1994).
54. Kristensen, A. Caiti, F. Ingenito, M. Max, J. M. Berkson, M. D. Collins, L.T. Fialkowski, N. C. Makris, B. E. McDonald, J. S. Perkins and W. A. Kuperman, "Geoacoustic inversion and focalization in shallow water environments," in *Full Field Inversion Methods in Ocean and Seismic Acoustics*, edited by O. Diachok, Kluwer, Dordrecht (1994).
55. N. C. Makris, S.P. Heckel, J.S. Perkins and J. Catipovic, "Optimizing experimental design for shallow water sound speed inversion," in *Full Field Inversion Methods in Ocean and Seismic Acoustics*, edited by O. Diachok, Kluwer, Dordrecht (1994).
56. M. Betke and N.C. Makris, "Fast object recognition in noisy images using simulated annealing," *Proceedings of the 5th International Conference on Computer Vision*, MIT, Cambridge MA (June, 1995).
57. N. C. Makris, "A statistical foundation for logarithmic intensity measures in ocean acoustics," in *Proceedings of the Third European Conference on Underwater Acoustics*, edited by J. Papadakis, European Commission, Brussels (1996).
58. N. C. Makris, "Estimating surface orientation from sonar images," in *High Frequency Acoustics in Shallow Water*, edited by N.G. Pace, Kluwer, Dordrecht (1997).
59. N. C. Makris, "The Statistics of Ocean-Acoustic Ambient Noise," in *Sea Surface Sound '97*, edited by T. Leighton, Kluwer Academic Publishers, Dordrecht (1997).
60. Betke and N.C. Makris, "Information-Conserving Object Recognition," *Proceedings of the 6th International Conference on Computer Vision*, Bombay, India (Jan. 1998).
61. ** M. Betke, E. Naftali and N. C. Makris, "Necessary Conditions to Attain Performance Bounds on Structure and Motion Estimates of Rigid Objects," *Proceedings of the IEEE Computer Vision and Pattern Recognition Conference CVPR 2001*, Kauau, Hawaii (December 2001).
62. **M. Betke, D.E. Hirsh, A. Bagchi, N.I. Hristov, N.C. Makris, and T.H. Kunz. "Tracking Large Variable Numbers of Objects in Clutter." *Proceedings of the IEEE Computer Society Conference on Computer Vision and Pattern Recognition*, Minneapolis, MN, (June 2007)