

Philip L. Richardson

Physical Oceanographer

Scientist Emeritus

Woods Hole Oceanographic Institution

Professional Preparation:

B.S., University of California, 1964 (Civil Engineering); M.S., University of Rhode Island, 1970 (Physical Oceanography); Ph.D., University of Rhode Island, 1974 (Physical Oceanography).

Appointments:

Scientist Emeritus, 2000–present; Senior Scientist, 1989–2000; Department Chair, 1994–1998; Associate Scientist, 1978–1989; awarded tenure, 1981; Assistant Scientist, 1974–1978; Woods Hole Oceanographic Institution. Guest Instructor, 2007–2008, U.S. Coast Guard Academy (New London, CT). Assistant Professor of Oceanography, 1973–1974; Research Assistant, 1969–1973; Graduate Assistant, 1967–1969; Graduate School of Oceanography, University of Rhode Island. Officer, U.S. Coast and Geodetic Survey, USESSA, 1964–1966 (Rockville, Maryland).

Visiting Scientist, 1978–1979, Laboratoire d'Océanographie Physique, Museum National d'Histoire Naturelle, Paris

Visiting Scientist, August–October 1983, Centre Océanographique de Bretagne, Brest

Visiting Scientist, January–April, 1986, Scripps Institution of Oceanography, La Jolla, CA

Visiting Scientist, January–February, 1990, University of Hawaii, Honolulu

Affiliated with the Associated Scientists at Woods Hole, 1999–2004, and the Woods Hole Research Center, 2002–2005.

Guest Instructor, 2007–2008, U.S. Coast Guard Academy, New London, CT.

Member, American Association for the Advancement of Science, American Geophysical Union, American Meteorological Society

Research Interests: albatross flight and dynamic soaring; the general ocean circulation and its low-frequency variability; Gulf Stream, North Atlantic Current, Benguela Current, equatorial currents, Deep Western Boundary Current, and ocean eddies.

Author or co-author of 81 refereed scientific publications.

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Publications

- Richardson, Philip L., and John A. Knauss, 1971. Gulf Stream and western boundary undercurrent observations at Cape Hatteras. *Deep-Sea Research*, **18**, 1089–1109.
- Richardson, P. L., A. E. Strong, and J. A. Knauss, 1973. Gulf Stream eddies: recent observations in the western Sargasso Sea. *Journal of Physical Oceanography*, **3**(3), 297–301.
- Betzer, Peter R., Philip L. Richardson, and Herman B. Zimmerman, 1974. Bottom currents, nepheloid layers and sedimentary features under the Gulf Stream near Cape Hatteras. *Marine Geology*, **16**, 21–29.
- Richardson, Philip L., and Kenneth Mooney, 1975. The Mediterranean outflow – a simple advection-diffusion model. *Journal of Physical Oceanography*, **5**(3), 476–482.
- Cheney, R. E., and P. L. Richardson, 1976. Observed decay of a cyclonic Gulf Stream ring. *Deep-Sea Research*, **23**(2), 143–155.
- Cheney, R. E., W. H. Gemmill, M. K. Shank, P. L. Richardson, and D. Webb, 1976. Tracking a Gulf Stream ring with SOFAR floats. *Journal of Physical Oceanography*, **6**(5), 741–749.
- Richardson, Philip L., 1977. On the crossover between the Gulf Stream and the Western Boundary Undercurrent. *Deep-Sea Research*, **24**, 139–159.
- Richardson, P. L., R. E. Cheney, and L. A. Mantini, 1977. Tracking a Gulf Stream ring with a free drifting surface buoy. *Journal of Physical Oceanography*, **7**(4), 580–590.
- Johnson, David L., and Philip L. Richardson, 1977. On the wind-induced sinking of Sargassum. *Journal of Experimental Marine Biology and Ecology*, **28**, 255–267.
- Lai, David Y., and Philip L. Richardson, 1977. Distribution and movement of Gulf Stream rings. *Journal of Physical Oceanography*, **7**(5), 670–683.
- The MODE Group, 1978. The Mid-Ocean Dynamics Experiment. *Deep-Sea Research*, **25**(10), 859–910.
- Richardson, P. L., R. E. Cheney, and L. V. Worthington, 1978. A census of Gulf Stream rings, spring 1975. *Journal of Geophysical Research*, **83**(C12), 6136–6144.
- Richardson, P. L., C. Maillard, and T. B. Sanford, 1979. The physical structure and life history of cyclonic Gulf Stream Ring Allen. *Journal of Geophysical Research*, **84**(C12), 7727–7741.
- Richardson, Philip L., 1980. Gulf Stream ring trajectories. *Journal of Physical Oceanography*, **10**(1), 90–104.
- Richardson, Philip L., 1980. Benjamin Franklin and Timothy Folger's first printed chart of the Gulf Stream. *Science*, **207**, 643–645.
- Cheney, Robert E., Philip L. Richardson, and Barry P. Blumenthal, 1980. Air deployment of satellite-tracked drifters. *Journal of Geophysical Research*, **85**(C5), 2773–2778.
- Richardson, Philip L., 1980. The Benjamin Franklin and Timothy Folger charts of the Gulf Stream. In: *Oceanography: The Past, Proceedings of the Third International Congress on the History of Oceanography*, September 22–26, 1980, Woods Hole, Massachusetts; M. Sears and D. Merriman, editors; Springer-Verlag Inc., New York; pp.703–717.
- Cheney, Robert E., Philip L. Richardson, and Koichi Nagasaka, 1980. Tracking a Kuroshio cold ring with a free-drifting surface buoy. *Deep-Sea Research*, **27A**, 641–654.

- Richardson, P. L., 1980. Anticyclonic eddies generated near the Corner Rise seamounts. *Journal of Marine Research*, **38**(4), 673–686.
- Ring Group, The (Richard H. Backus, Glenn R. Flierl, Dana R. Kester, Donald B. Olson, Philip L. Richardson, Andrew C. Vastano, Peter H. Wiebe, and John H. Wormuth), 1981. Gulf Stream cold-core rings: Their physics, chemistry, and biology. *Science*, **212**(4499), 1091–1100.
- Schmitz, William J., Jr., James F. Price, Philip L. Richardson, W. Brechner Owens, Douglas C. Webb, Robert E. Cheney, and H. Thomas Rossby, 1981. A preliminary exploration of the Gulf Stream system with SOFAR floats. *Journal of Physical Oceanography*, **11**(9), 1194–1204.
- Richardson, P. L., J. F. Price, W. B. Owens, W. J. Schmitz, H. T. Rossby, A. M. Bradley, J. R. Valdes, and D. C. Webb, 1981. North Atlantic subtropical gyre: SOFAR floats tracked by moored listening stations. *Science*, **213**, 435–437.
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- Richardson, P. L., 1983. Gulf Stream rings. Chapter 2 in: *Eddies in Marine Science*, A. R. Robinson, editor, Springer-Verlag, Berlin, pp. 19–45.
- Richardson, Philip L., 1983. A vertical section of eddy kinetic energy through the Gulf Stream system. *Journal of Geophysical Research*, **88**(C4), 2705–2709.
- Richardson, Philip L., 1983. Eddy kinetic energy in the North Atlantic from surface drifters. *Journal of Geophysical Research*, **88**(C7), 4355–4367.
- Richardson, P. L., and T. K. McKee, 1984. Average seasonal variation of the Atlantic equatorial currents from historical ship drifts. *Journal of Physical Oceanography*, **14**(7), 1226–1238.
- Richardson, P. L., 1984. Drifting buoy trajectories in the Atlantic North Equatorial Countercurrent during 1983. *Geophysical Research Letters*, **11**(8), 745–748.
- Richardson, P. L., 1984. Moored current meter measurements in the Atlantic North Equatorial Countercurrent during 1983. *Geophysical Research Letters*, **11**(8), 749–752.
- Richardson, P. L., 1985. Drifting derelicts in the North Atlantic 1883–1902. *Progress in Oceanography*, **14**, 463–483.
- Richardson, P. L., 1985. Average velocity and transport of the Gulf Stream near 55°W. *Journal of Marine Research*, **43**(1), 83–111.
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- Richardson, Philip L., and David Walsh, 1986. Mapping climatological seasonal variations of surface currents in the tropical Atlantic using ship drifts. *Journal of Geophysical Research*, **91**(C9), 10,537–10,550.

- Richardson, P. L., and S. G. H. Philander, 1987. The seasonal variations of surface currents in the tropical Atlantic Ocean: a comparison of ship drift data with results from a general circulation model. *Journal of Geophysical Research*, **92**(C1), 715–724.
- Richardson, P. L., and G. Reverdin, 1987. Seasonal cycle of velocity in the Atlantic North Equatorial Countercurrent as measured by surface drifters, current meters, and ship drifts. *Journal of Geophysical Research*, **92**(C4), 3691–3708.
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- Owens, W. B., P. L. Richardson, W. J. Schmitz, Jr., H. T. Rossby, and D. C. Webb, 1988. Nine-year trajectory of a SOFAR float in the southwestern North Atlantic. *Deep-Sea Research*, **35**(12), 1851–1857.
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- Richardson, P. L., 1993. A census of eddies observed in North Atlantic SOFAR float data. *Progress in Oceanography*, **31**, 1–50.
- Richardson, Philip L., and William J. Schmitz, Jr., 1993. Deep cross-equatorial flow in the Atlantic measured with SOFAR floats. *Journal of Geophysical Research*, **98**(C5), 8371–8387.
- Spall, Michael A., Philip L. Richardson, and James Price, 1993. Advection and eddy mixing in the Mediterranean Salt Tongue. *Journal of Marine Research*, **51**(4), 797–818.
- Richardson, P. L., G. Hufford, R. Limeburner, and W. S. Brown, 1994. North Brazil current retroflection eddies. *Journal of Geophysical Research*, **99**(C3), 5081–5093.
- Muller-Karger, F., P. L. Richardson, and D. McGillicuddy, 1995. On the offshore dispersal of the Amazon's Plume in the North Atlantic. *Deep-Sea Research*, **42**, 2127–2137.
- Walsh, David, Philip L. Richardson, and Jim Lynch, 1996. Observations of tilting Meddies. *Journal of Physical Oceanography*, **26**(6), 1023–1038.
- Richardson, Philip L., 1997. Drifting in the wind – leeway error in shipdrift data. *Deep-Sea Research*, **44**, 1877–1903.
- Richardson, Philip L., and Aude Tychensky, 1998. Meddy trajectories in the Canary Basin measured during the Semaphore experiment, 1993–1995. *Journal of Geophysical Research*, **103**(C11), 25,029–25,045.
- Boebel, Olaf, Russ E. Davis, Michel Ollitrault, Ray G. Peterson, Philip L. Richardson, Claudia Schmid, and Walter Zenk, 1999. The intermediate depth circulation of the western South Atlantic. *Geophysical Research Letters*, **26**, 3329–3332.
- Fratantoni, David M., and Philip L. Richardson, 1999. SOFAR Float observations of an intermediate-depth eastern boundary current and mesoscale variability in the eastern tropical Atlantic Ocean. *Journal of Physical Oceanography*, **29**, 1265–1278.
- Garzoli, Silvia L., Philip L. Richardson, Christopher M. Duncombe Rae, David M. Fratantoni, Gustavo J. Goñi, and Andreas J. Roubicek, 1999. Three Agulhas Rings observed during the Benguela Current Experiment. *Journal of Geophysical Research*, **104**, 20,971–20,983.
- Richardson, Philip L., and David M. Fratantoni, 1999. Float trajectories in the Deep Western Boundary Current and deep equatorial jets of the tropical Atlantic. *Deep-Sea Research II*, **46**, 305–333.
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- Richardson, P. L., and S. L. Garzoli, 2003. Characteristics of intermediate water flow in the Benguela Current as measured with RAFOS floats. *Deep-Sea Research II*, **50**(1), 87–118.

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- Shoosmith, D. R., P. L. Richardson, A. S. Bower, and H. T. Rossby, 2005. Discrete eddies in the northern North Atlantic as observed by looping RAFOS floats. *Deep-Sea Research II*, **52**, 627–650.
- Richardson, P. L., 2005. Caribbean Current and eddies as observed by surface drifters. *Deep-Sea Research II*, **52**, 429–463.
- Núñez-Riboni, I. O. Boebel, M. Ollitrault, Y. You, P. L. Richardson, and R. Davis, 2005. Lagrangian circulation of Antarctic Intermediate Water in the subtropical South Atlantic. *Deep-Sea Research II*, **52**, 545–564.
- Fratantoni, D. M., and P. L. Richardson, 2006. The evolution and demise of North Brazil Current Rings. *Journal of Physical Oceanography*, **36**(7), 1241–1264.
- Ollitrault, M., M. Lankhorst, D. Fratantoni, P. Richardson, and W. Zenk, 2006. Zonal intermediate currents in the equatorial Atlantic Ocean. *Geophysical Research Letters*, **33**, L05605, doi:10.1029/2005GL025368.
- Cherubin, L. M., and P. L. Richardson, 2007. Caribbean current variability and the influence of the Amazon and Orinoco freshwater plumes. *Deep-Sea Research I*, **54**, 1451–1473.
- Richardson, P. L., 2007. Agulhas leakage into the Atlantic estimated with subsurface floats and surface drifters. *Deep-Sea Research I*, **54**, 1361–1389, doi:10.1016/j.dsr.2007.40.010.
- Richardson, P.L., 2008. On the history of meridional overturning circulation schematic diagrams. *Progress in Oceanography*, **76**(4), 466–486.
- Lankhorst, M., D. Fratantoni, M. Ollitrault, P. Richardson, U. Send, and W. Zenk, 2009. The mid-depth circulation of the northwestern tropical Atlantic observed by floats. *Deep Sea Research Part I: Oceanographic Research Papers*, **56**(10), 1615–1632.
- Richardson, P.L., 2011. How do albatrosses fly around the world without flapping their wings? *Progress in Oceanography*, **88**(1–4), 45–58.
- Richardson, P. L., 2015. Upwind dynamic soaring of albatrosses and UAV’s. *Progress in Oceanography*, **130**, 146–156.

Non-refereed Publications

- Richardson, Philip L., 1972. Tracking a Gulf Stream eddy. *Maritimes*, **16**(3), 15–16.
- Richardson, P. L., 1976. Gulf Stream rings. *Oceanus*, **19**(3), 65–68.
- Vastano, A. C., and P. L. Richardson, 1976. Gulf Stream cyclonic rings. *Naval Research Reviews*, **29**(9), 31–36.
- Richardson, P. L., 1978. Tracking Gulf Stream rings with free-drifting satellite buoys. International Council for the Exploration of the Sea (ICES) Document, C.M. 1978, Hydrography Committee C:20.
- Richardson, P. L., 1980. Gulf Stream System: The average temperature field at a depth of 450 m. International Council for the Exploration of the Sea (ICES) Document, C.M. 1980, Hydrography Committee C:31.
- Richardson, P. L., 1980. Progress on the Gulf Stream. *The Geographical Magazine*, London, LII(8), 575–581.
- Richardson, P. L., 1981. The distribution of eddy kinetic energy from surface drifters. International Council for the Exploration of the Sea (ICES) Document, C.M. 1981, Hydrography Committee C:28.
- Richardson, P. L., 1982. Western North Atlantic: a vertical section of eddy kinetic energy along 55W. International Council for the Exploration of the Sea (ICES) Document, C.M. 1982, Hydrography Committee C:21.
- Richardson, P. L., 1982. Gulf Stream. In: *Encyclopedia of Science and Technology*, McGraw-Hill, New York, 416–417.
- Richardson, P. L., contributor, 1983. To: The ocean–atmosphere system, in *The Times Atlas of the Oceans*, A. Couper, editor, Times Books Ltd., London, pp. 44–53.
- Richardson, P. L., 1983. Drifting derelict trajectories in the North Atlantic 1883–1902. International Council for the Exploration of the Sea (ICES) Document, C.M. 1983, Hydrography Committee C:20.
- Fuglister, Frederick C., Philip L. Richardson, William J. Schmitz, Jr., and Henry M. Stommel, 1983/84. An account of the usefulness of new techniques of measurement in the study of the Gulf Stream. *Marine Technology Society Journal*, **17**(4), 13–18.
- Richardson, Philip L., 1984. Drifting derelict trajectories in the North Atlantic. *Eos, Transactions, American Geophysical Union*, **65**(40), 730–731.
- Richardson, Philip L., 1985. Derelicts and drifters. *Natural History*, 94(6), 42–49.
- Richardson, Philip L., and Roger A. Goldsmith, 1987. The Columbus landfall: Voyage track corrected for winds and currents. *Oceanus*, **30**(3), 2–10.
- Richardson, Philip L., 1991. SOFAR floats give a new view of ocean eddies. *Oceanus*, **34**(1), 23–31.
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- Richardson, P. L., 1993. Tracking ocean eddies. *American Scientist*, **81**, 261–271.
- Richardson, Philip L., 1994. Giant eddies of South Atlantic water invade the north. *Oceanus*, **37**(1), 19–21.

- Richardson, P. L., 1994. Cross-equatorial flow of Atlantic Deep Western Boundary Current. *International WOCE Newsletter*, **16**, 3–5.
- Richardson, P. L., 1995. Tracking ocean eddies. In: *The Third Edition of Oceanography – Contemporary Readings in Ocean Sciences*, Oxford University Press, reprinted from *American Scientist*, 1993, **81**(3), 261–271.
- Richardson, P. L., and C. M. Wooding, 1995. Subsurface float data. *International WOCE Newsletter*, **21**, 24–26.
- Boebel, O. S., C. Duncombe-Rae, S. Garzoli, J. Lujeharms, P. L. Richardson, H. T. Rossby, C. Schmid and W. Zenk, 1998. Float experiment studies interocean exchanges at the tip of Africa. *EOS*, **79**, 1, 7–8.
- Richardson, P. L., A. S. Bower, and W. Zenk, 1999. Summary of Meddies tracked by floats. *International WOCE Newsletter*, **34**, 18–20.
- Richardson, P. L., and D. M. Fratantoni, 1999. Atlantic Deep Equatorial Jets and the Equatorial CFC plume. *International WOCE Newsletter*, **34**, 5.
- Boebel, O., C. Barron, P. Richardson, J. Lutjeharms, and R. Davis, 2000. Mixing of Antarctic Intermediate Water from the Atlantic and Indian Ocean at the Agulhas Retroflexion. *International WOCE Newsletter*, **39**, 9–12.
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- Richardson, P. L., 2001. Vignette. *Oceanography, In Celebration of the 75th Birthday of John A. Knauss*, **14**, p. 26.
- Richardson, P. L., 2005. WHOI and the Gulf Stream, an online expanded science feature accompanying: Cullen, V., 2005. *Down to the Sea for Science: 75 Years of Ocean Research, Education, and Exploration at the Woods Hole Oceanographic Institution*. Woods Hole Oceanographic Institution, Woods Hole, MA 02543, 174 pp. <http://www.whoi.edu/75th/book/whoi-richardson.pdf>
- Richardson, P.L., 2012. High-Speed Dynamic Soaring. *Radio-Controlled Soaring Digest*, **29**(4), 36–49.
- Richardson, P.L., 2012. High-Speed Robotic Albatross: Unmanned Aerial Vehicle powered by dynamic soaring. *Radio-Controlled Soaring Digest*, **29**(6), 4–18.
- Richardson, P.L., 2012. Fritz Fuglister’s Oceanography. *Spritsail, A Journal of the History of Falmouth and Vicinity Published by the Woods Hole Historical Collection*, **25**(1), 27–33.

Technical Reports (and Theses)

- Richardson, P. L., and J. A. Knauss, 1970. Transport and velocity of the Gulf Stream at Cape Hatteras. Technical Report No. 31, Ref. No. 70-1, Graduate School of Oceanography, University of Rhode Island.
- Richardson, P. L., 1970. Transport and velocity of the Gulf Stream at Cape Hatteras. M.S. Thesis, University of Rhode Island, 106 pp.
- Richardson, P. L., 1974. Current measurements under the Gulf Stream near Cape Hatteras, North Carolina. Ph.D. Thesis, University of Rhode Island, 181 pp.
- Cheney, Robert E., and Philip L. Richardson, 1974. The observed decay of a cyclonic Gulf Stream ring. Technical Report Ref. No. 74-2, Graduate School of Oceanography, University of Rhode Island, 132 + vii pp.
- Richardson, Philip L., 1974. Current measurements under the Gulf Stream near Cape Hatteras, North Carolina. Technical Report Ref. No. 74-3, Graduate School of Oceanography, University of Rhode Island, 136 + vi pp.
- Lai, D. Y., and P. L. Richardson, 1977. Distribution and movement of cyclonic Gulf Stream Rings. Technical Report Ref. No. 77-1, Graduate School of Oceanography, University of Rhode Island, 139 pp.
- Richardson, P. L., J. J. Wheat, and D. Bennett, 1979. Free drifting buoy trajectories in the Gulf Stream system (1975–1978), a data report. *Woods Hole Oceanographic Institution Technical Report* WHOI-79-4, 159 + v pp.
- Levy, Ellen, and Philip L. Richardson, 1984. Moored current meter data from the Atlantic North Equatorial Countercurrent near 6°N, 28°W (February–September, 1983), Vol. XXXIV. *Woods Hole Oceanographic Institution Technical Report* WHOI-84-16, 15 p. + 29 figs.
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- Levy, Ellen, and Philip L. Richardson, 1985. Moored current meter data from the Atlantic North Equatorial Countercurrent near 6°N 28°W (March–October, 1984), Volume XXXVII. *Woods Hole Oceanographic Institution Technical Report* WHOI-85-7, 52 pp.
- Richardson, Philip L., and Christine M. Wooding, 1985. Surface drifter measurements in the Atlantic North Equatorial Countercurrent 1983–1985. *Woods Hole Oceanographic Institution Technical Report* WHOI-85-31, 131 pp.
- Price, James F., Theresa K. McKee, James R. Valdes, Philip L. Richardson and Laurence Armi, 1986. SOFAR Float Mediterranean Outflow Experiment: Data from the first year, 1984–1985. *Woods Hole Oceanographic Institution Technical Report* WHOI-86-31, 199 pp.
- Zemanovic, M., P. L. Richardson, J. R. Valdes, J. F. Price and L. Armi, 1988. SOFAR float Mediterranean outflow experiment, data from the second year 1985–1986. *Woods Hole Oceanographic Institution Technical Report*, WHOI-88-43, 230 pp.
- Zemanovic, Marguerite E., Philip L. Richardson, and James F. Price, 1990. SOFAR float Mediterranean Outflow Experiment: Summary and data from 1986–1988. *Woods Hole Oceanographic Institution Technical Report* WHOI-90-01, 239 + iv pp.

- Goldsmith, R. A., and P. L. Richardson, 1992. Numerical simulations of Columbus' Atlantic crossings. *Woods Hole Oceanographic Institution Technical Report* WHOI-92-14, 39 pp.
- Richardson, P. L., M. E. Zemanovic, C. M. Wooding, W. J. Schmitz, Jr., and J. F. Price, 1992. SOFAR float trajectories from an experiment to measure the Atlantic cross equatorial flow (1989–1990). *Woods Hole Oceanographic Institution Technical Report* WHOI-92-33, 187 pp.
- Richardson, P. L., M. E. Zemanovic, C. M. Wooding, and W. J. Schmitz, Jr., 1994. SOFAR float trajectories in the Tropical Atlantic 1989–1992. *Woods Hole Oceanographic Institution Technical Report* WHOI-94-33, 185 pp.
- Roubicek, A. J., S. L. Garzoli, P. L. Richardson, C. M. Duncombe Rae, and D. M. Fratantoni, 1998. Benguela Current Experiment: RV *Seward Johnson* SJ 9705, Cape Town September 4, 1997–Recife September 30, 1997. *NOAA Data Report* ERL AOML-33.
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