

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.

Associate Editor, Deep-Sea Research, 1993-1994, 2000-2015.

Associate Editor, Reviews of Geophysics, 1987-1989.

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

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

Author or co-author of 84 refereed scientific publications.

Refereed Publications

Richardson, P. L., 2018. Leonardo da Vinci's discovery of the dynamic soaring by birds in wind shear. *Royal Society Notes & Records* doi:10.1098/rsnr.2018.0024.

Richardson, P. L., Wakefield, E. D., Phillips, R. A., 2018. Flight speed and performance of the wandering albatross with respect to the wind. *Movement Ecology* 6:3,

<https://doi.org/10.1186/s40462-018-0121-9>.

- Richardson, P. L., 2017. Da Vinci's observations of soaring birds. *Physics Today* 70 (11), 78-79.
- Richardson, P. L., 2015. Upwind dynamic soaring of albatrosses and UAV's. *Progress in Oceanography*, **130**, 146-156.
- Richardson, P.L., 2011. How do albatrosses fly around the world without flapping their wings? *Progress in Oceanography*, **88**(1-4), 45-58.
- 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., 2008. On the history of meridional overturning circulation schematic diagrams. *Progress in Oceanography*, **76**(4), 466-486.
- 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.
- 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.
- 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.
- 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.
- 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.
- Richardson, P. L., 2005. Caribbean Current and eddies as observed by surface drifters. *Deep-Sea Research II*, **52**, 429-463.
- 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., J. R. E. Lutjeharms, and O. Boebel, 2003. Introduction to "Interocean Exchange Around South Africa." *Deep-Sea Research II*, **50**(1), 1-12.
- Schmid, C., O. Boebel, W. Zenk, J. R. E. Lutjeharms, S. L. Garzoli, P. L. Richardson, and C. Barron, 2003. Early evolution of an Agulhas Ring. *Deep-Sea Research II*, **50**(1), 141-166.
- 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.
- Bower, A. S., B. Le Cann, T. Rossby, W. Zenk, J. Gould, K. Speer, P. L. Richardson, M. D. Prater, and H-M. Zhang, 2002. Directly measured mid-depth circulation in the northeastern North Atlantic Ocean. *Nature*, **419**, 603-607.
- Richardson, Philip L., Amy S. Bower and Walter Zenk, 2000. A census of meddies tracked by floats. *Progress in Oceanography*, **45**(2), 209-250.

- 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.
- 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.
- 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.
- 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.
- 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.
- Richardson, Philip L., 1997. Drifting in the wind – leeway error in shipdrift data. *Deep-Sea Research*, **44**, 1877–1903.
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- 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.
- 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.
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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.
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- Richardson, P. L., 1992. Velocity and eddy kinetic energy of the Gulf Stream system from 700~m SOFAR floats subsampled to simulate pop-up floats. *Journal of Atmospheric and Oceanic Technology*, **9**(4), 495–503.
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- Richardson, P. L., D. Walsh, L. Armi, M. Schröder, and J. F. Price, 1989. Tracking three Meddies with SOFAR floats. *Journal of Physical Oceanography*, **19**(3), 371–383.
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- Richardson, P. L., 1985. Average velocity and transport of the Gulf Stream near 55°W. *Journal of Marine Research*, **43**(1), 83–111.
- Richardson, P. L., 1985. Drifting derelicts in the North Atlantic 1883–1902. *Progress in Oceanography*, **14**, 463–483.
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- 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, P. L., 1983. Gulf Stream rings. Chapter 2 in: *Eddies in Marine Science*, A. R. Robinson, editor, Springer-Verlag, Berlin, pp. 19–45.
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- 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, Philip L., 1980. Benjamin Franklin and Timothy Folger's first printed chart of the Gulf Stream. *Science*, **207**, 643–645.
- Richardson, Philip L., 1980. Gulf Stream ring trajectories. *Journal of Physical Oceanography*, **10**(1), 90–104.
- 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, 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.
- The MODE Group, 1978. The Mid-Ocean Dynamics Experiment. *Deep-Sea Research*, **25**(10), 859–910.
- Lai, David Y., and Philip L. Richardson, 1977. Distribution and movement of Gulf Stream rings. *Journal of Physical Oceanography*, **7**(5), 670–683.
- 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.
- 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.
- Richardson, Philip L., 1977. On the crossover between the Gulf Stream and the Western Boundary Undercurrent. *Deep-Sea Research*, **24**, 139–159.
- 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.
- Cheney, R. E., and P. L. Richardson, 1976. Observed decay of a cyclonic Gulf Stream ring. *Deep-Sea Research*, **23**(2), 143–155.
- Richardson, Philip L., and Kenneth Mooney, 1975. The Mediterranean outflow – a simple advection-diffusion model. *Journal of Physical Oceanography*, **5**(3), 476–482.
- 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, 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.
- Richardson, Philip L., and John A. Knauss, 1971. Gulf Stream and western boundary undercurrent observations at Cape Hatteras. *Deep-Sea Research*, **18**, 1089–1109.

Non-refereed Publications

- Richardson, P. L. and Adams, N. T., 2018. Uncharted Waters--Nantucket Whalers and the Franklin-Folger chart of the Gulf Stream. *Historic Nantucket*, **68**(1), Spring 2018, 17-24.
- 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.
- 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. High-Speed Dynamic Soaring. *Radio-Controlled Soaring Digest*, **29**(4), 36–49.
- 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.
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- Richardson, P. L., 2001. Vignette. *Oceanography, In Celebration of the 75th Birthday of John A. Knauus*, **14**, p. 26.
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- Richardson, P. L., and D. M. Fratantoni, 1999. Atlantic Deep Equatorial Jets and the Equatorial CFC plume. *International WOCE Newsletter*, **34**, 5.
- Richardson, P. L., A. S. Bower, and W. Zenk, 1999. Summary of Meddies tracked by floats. *International WOCE Newsletter*, **34**, 18–20.

- 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., and C. M. Wooding, 1995. Subsurface float data. *International WOCE Newsletter*, **21**, 24–26.
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- Richardson, Philip L., 1994. Giant eddies of South Atlantic water invade the north. *Oceanus*, **37**(1), 19–21.
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- Brown, W. S., W. E. Johns, K. D. Leaman, J. P. McCreary, R. L. Molinari, P. L. Richardson and C. Rooth, 1992. A Western Tropical Atlantic Experiment (WESTRAX). *Oceanography*, **5**, 73–77.
- Richardson, Philip L., 1991. SOFAR floats give a new view of ocean eddies. *Oceanus*, **34**(1), 23–31.
- Richardson, Philip L., and Roger A. Goldsmith, 1987. The Columbus landfall: Voyage track corrected for winds and currents. *Oceanus*, **30**(3), 2–10.
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- Vastano, A. C., and P. L. Richardson, 1976. Gulf Stream cyclonic rings. *Naval Research Reviews*, 29(9), 31–36.
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Technical Reports (and Theses)

- Richardson, P. L., M. A. Pacheco, and C. M. Wooding, 2003. KAPEX RAFOS float data report 1997–1999. Part B. Float trajectories at 750 m in the Benguela Current. *Woods Hole Oceanographic Institution Technical Report*, WHOI-2003-02.
- Wooding, C. M., P. L. Richardson, M. A. Pacheco, D. A. Glickson, and D. M. Fratantoni, 2002. North Brazil Current Rings Experiment: RAFOS float data report November 1998–June 2000. *Woods Hole Oceanographic Institution Technical Report*, WHOI-2002-08, 87 pp.
- Fleurant, C., D. Wilson, W. Johns, S. Garzoli, R. Smith, D. Fratantoni, P. Richardson, and G. Goni, 2000. CTD/O₂, LADCP and XBT measurements collected aboard the R/V *Seward Johnson*, December 1998: North Brazil Current Rings Experiment cruise 1 (NBC-1). NOAA Data Report OAR AOML-39, 274 pp.
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- 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.
- 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.

- 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.
- 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.
- 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.
- 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.
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