

# Raffaele Ferrari

**Breene M. Kerr Professor of Physical Oceanography**  
**Director of the Program in Atmospheres, Ocean and Climate**

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## Degrees

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2000 PhD in Oceanography, Scripps Institution of Oceanography  
1999 PhD in Fluid Dynamics, Politecnico di Torino  
1994 MS and BS in Physics, Università di Torino

## Employment

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2009–present Full Professor, Massachusetts Institute of Technology  
2006–2009 Associate Professor, Massachusetts Institute of Technology  
2002–2006 Assistant Professor, Massachusetts Institute of Technology  
2000-2002 Postdoctoral Scholar, Woods Hole Oceanographic Institution  
1995–2000 Graduate Research Assistant, Scripps Institution of Oceanography  
1994–1999 Visiting Scholar, Politecnico di Torino

## Honors

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Cody Award, Scripps Institution of Oceanography, 2016  
Cecil and Ida Green Chair, MIT, 2016-present  
Moore Distinguished Scholar, Caltech, 2013  
Breene M. Kerr Chair, MIT, 2011-2016  
Editors Citation for Excellence in Refereeing, Geophysical Research Letters, 2010  
Cecil and Ida Green Chair, MIT, 2007-2011  
Nicholas P. Fofonoff Award, American Meteorological Society, 2007  
Killian and Lee Scholar Award, MIT, 2004  
Victor P. Starr Career Development Chair, MIT, 2003  
Woods Hole Postdoctoral Scholarship, Woods Hole Oceanographic Institution, 2000  
Woods Hole Geophysical Fluid Dynamics Fellowship, Woods Hole Oceanographic Institution, 1999  
Fulbright Fellowship, U.S. Department of State, 1995

## Undergraduate Students Supervised

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Solomon Hsiang, Valerie Wong, Amitra Masurkar, Erin Munsell, Elizabeth Maroon, Todd Mooring  
Freshmen advisor, 2009-2010, 2015-1216, 2016-2017

## Master and PhD Students Supervised

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Maxim Nikurashin	2002-2008, PhD Thesis: “Radiation and Generation of Internal Waves Generated by Geostrophic Motions Impinging on Small-scale Topography,” now assistant professor at the University of Tasmania, Australia
Jessica Benthuyzen	2004-2006, Master Thesis: “Heat and Mass Transport in Horizontal Convection”, now associate investigator at the University of Tasmania, Australia
Malte Jansen	2007-2012, PhD Thesis: “Macroturbulent Equilibration of the Extratropical Atmosphere,” now assistant professor at the University of Chicago
Jörn Callies	2011-2015, PhD Thesis: “Submesoscale turbulence in the upper ocean”, now postdoc at MIT
Sophia Merrifield	2010-2015, master student, now postdoctoral fellow at Scripps Institution of Oceanography, La Jolla
Marianna Linz	2012-2013, master student, now Ph.D. student in the MIT/WHOI Joint Program
Maike Sonnewald	2014 (three months), visiting PhD student from University of Southampton
Luca Filippi	2015 (three months), visiting Ph.D. student from University of Torino, Italy
Oceane Richet	2015 (four months), visiting Ph.D. student from Ecole Doctorale de L’Ecole Polytechnique, France
Madeleine Youngs	2015-present, Ph.D student
Henri Drake	2015-present, Ph.D student

## Postdoctoral Researchers Supervised

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Giulio Boccaletti	2003-2005, Global Managing Director for Water, The Nature Conservancy, New York
Ivana Cerovecki	2004-2005, Project Scientist at the Scripps Institution of Oceanography, La Jolla
Baylor Fox-Kemper	2004-2007, Associate Professor, Brown University, Providence
Yu Zhang	2009-2010, Associate Professor, Ocean University of China, Qingdao, China
John Taylor	2008-2011, Lecturer, University of Cambridge, Cambridge, UK
Andreas Klocker	2009-2011, ARC Fellow, University of Tasmania, Hobart, Australia
Louis-Philippe Nadeau	2013-2014, Assistant Professor, Université du Québec Rimouski, Canada
Alexandre Mignot	2012-present
Alireza Mashayek	2013-present
Jörn Callies	2015-present
Gregory Wagner	2016-present

## Publications

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### Refereed Journals

80. McDougall, T., and R. Ferrari, Abyssal upwelling and downwelling driven by near-boundary mixing, *J. Phys. Oceanogr.*, under review.
79. Mashayek, A., R. Ferrari, S. Merrifield, J. Ledwell, L. St. Laurent, and A. Naveira Garabato, *Nature Comm.*, under review.
78. Callies, J., O. Bühler, and R. Ferrari, The dynamics of mesoscale winds in the upper troposphere and lower stratosphere, *J. Atmos. Sci.*, in press.
77. Balwada, D., K.G. Speer, J.H. LaCasce, W. Brechner Owens, J. Marshall, and R. Ferrari, Circulation and Stirring in the Southeast Pacific Ocean and the Scotia Sea Sectors of the Antarctic Circumpolar Current, *J. Phys. Oceanogr.*, **46**, 2005–2027, 2016.
76. Mignot, A., R. Ferrari, and K. A. Mork, Spring bloom onset in the Nordic Seas, *Biogeosciences*, **13**, 1–18, 2016.
75. Ferrari, R., A. Mashayek, T. McDougall, M. Nikurashin, and J. M. Campin, Turning ocean mixing upside down, *J. Phys. Oceanogr.*, **46**, 2239–2261, 2016.
74. Callies, J., G. Flierl, R. Ferrari, B. Fox-Kemper, The role of mixed layer instabilities in submesoscale turbulence, *J. Fluid Mech.*, **788**, 5–41, 2016.
73. Naveira-Garabato, A., C., K. L. Polzin, R. Ferrari, J. D. Zika, A. Forryan, A microscale view of mixing and overturning across the Antarctic Circumpolar Current, *J. Phys. Oceanogr.*, **46**, 233–254, 2016.
72. Burke, A., A. L. Stewart, J. F. Adkins, R. M. Ferrari, M. F. Jansen, and A. F. Thompson, The glacial mid-depth radiocarbon bulge and its implications for the overturning circulation, *Paleoceanogr.*, **30**, 1021–1039, 2015.
71. Mashayek, A., R. Ferrari, M. Nikurashin, and W. R. Peltier, Influence of enhanced abyssal diapycnal mixing on stratification and the ocean overturning circulation, *J. Phys. Oceanogr.*, **45**, 2580–2597, 2015.
70. Shcherbina A. Y., and the Latmix group, The LatMix Summer Campaign: Submesoscale Stirring in the Upper Ocean, *Bull. Am. Meteor. Soc.*, **96**, 1257–1279, 2015.
69. Nadeau, L.-P., and R. Ferrari, The role of closed gyres in setting the zonal transport of the Antarctic Circumpolar Current, *J. Phys. Oceanogr.*, **45**, 1491–1509, 2015.
68. Callies, J., R. Ferrari, J. Klymak, and J. Gula, Seasonality in submesoscale turbulence, *Nature Comm.*, **6**, doi: 10.1038/ncomms7862, 2015.
67. Kunze, E., J. M. Klymak, R.-C. Lien, R. Ferrari, C. M. Lee and L. Goodman, Submesoscale Water-Mass Spectra in the Sargasso Sea, *J. Phys. Oceanogr.*, **45**, 1325–1338, 2015.
66. Jansen, M. and R. Ferrari, Diagnosing the vertical structure of the eddy diffusivity in real and idealized atmospheres, *Quart. J. R. Met. Soc.*, **141**, 631–641, 2015.
65. Ferrari, R., S. Merrifield and J. Taylor, Shutdown of convection triggers increase of surface chlorophyll, *J. Marine Systems*, **147**, 116–122, 2015.

64. Nikurashin, M., R. Ferrari, N. Grisouard and K. Polzin, The impact of finite amplitude bottom topography on internal wave generation in the Southern Ocean, *J. Phys. Oceanogr.*, **44**, 2938–2950, 2014.
63. Ferrari, R., What goes down must come up, *Nature*, **513**, 179–180, 2014.
62. Callies, J., R. Ferrari, and O. Bühler, Transition from geostrophic turbulence to inertia-gravity waves in the atmospheric energy spectrum, *Proc. Nat. Acad. Sciences*, **11**, 17033–17038, 2014.
61. Bühler, O., J. Callies and R. Ferrari, Wave-vortex decomposition of one-dimensional ship track data, *J. Fluid Mech.*, **756**, 1007–1026, 2014.
60. Tulloch, R., R. Ferrari, O. Jahn, A. Klocker, J. LaCasce, J. Ledwell, J. Marshall, M.-J. Messias, K. Sperr, and A. Watson, Direct estimate of lateral eddy diffusivity upstream of Drake Passage, *J. Phys. Oceanogr.*, **44**, 2593–2616, 2014.
59. Ferrari, R., M. Jansen, J. Adkins, A. Burke, A. Stewart and A. Thompson, Antarctic sea ice control on ocean circulation in present and glacial climates, *Proc. Nat. Acad. Sciences*, **111**, 8753–8758, 2014.
58. Bates, M., R. Tulloch, J. Marshall and R. Ferrari, Rationalizing the spatial distribution of mesoscale eddy diffusivity in terms of mixing length theory, *J. Phys. Oceanogr.*, **44**, 1523–1540, 2014.
57. Stewart, A. L., Ferrari, R., A. F. Thompson, On the Importance of Surface Forcing in Conceptual Models of the Deep Ocean, *J. Phys. Oceanogr.*, **44**, 891–899, 2014.
56. LaCasce, J., R. Ferrari, R. Tulloch, D. Balwada, and K. Speer, Float-derived isopycnal diffusivities in the DIMES experiment, *J. Phys. Oceanogr.*, **44**, 764–780, 2014.
55. Callies, J. and R. Ferrari, Interpreting energy and tracer spectra of submesoscale turbulence, *J. Phys. Oceanogr.*, **43**, 2456–2474, 2013.
54. Mashayek, A., R. Ferrari, G. Vettoretti and W. R. Peltier, The role of the geothermal heat flux in driving the abyssal ocean circulation, *Geophys. Res. Lett.*, **40**, 3144–3149, 2013.
53. Jansen, M. and R. Ferrari, Equilibration of an Atmosphere by Adiabatic Eddy Fluxes, *J. Atmos. Sci.*, **70**, 2948–2962, 2013.
52. Nikurashin, M. and R. Ferrari, Overturning circulation driven by breaking internal waves in the deep ocean, *Geophys. Res. Lett.*, **12**, 3133–3137, 2013.
51. Thomas, L., J. Taylor, R. Ferrari, and T. Joyce, Symmetric Instability in the Gulf Stream, *Deep-Sea Res.*, **91**, 96–110, 2013.
50. Mazloff, M. R., R. Ferrari and T. Schneider, The force balance of the Southern Ocean meridional overturning circulation, *J. Phys. Oceanogr.*, **43**, 1193–1208, 2013.
49. Jansen, M. and R. Ferrari, The Vertical Structure of the Eddy Diffusivity and the Equilibration of the Extra-Tropical Atmosphere, *J. Atmos. Sci.*, **70**, 1456–1469, 2013.
48. Haney, S., S. Bachman, B. Cooper, S. Kupper, K. McCaffrey, L. Van Roekel, S. Stevenson. B. Fox-Kemper and R. Ferrari, Hurricane wake restratification rates of 1, 2 and 3-dimensional processes, *J. Mar. Res.*, **70**, 824–850, 2012.
47. Klocher A., R. Ferrari, and J. LaCasce, Estimating suppression of eddy mixing by mean flows, *J. Phys. Oceanogr.*, **42**, 1566–1576, 2012.
46. Klocher A., R. Ferrari, J. LaCasce and S. Merrifield, Reconciling float-based and tracer-based estimates of eddy diffusivities, *J. Mar. Res.*, **70**, 569–602, 2012.

45. Lévy, M., R. Ferrari, P. Franks, A. Martin and P. Rivière, Bringing physics to life at the submesoscale, *Geophys. Res. Lett.*, **39**, L14602, 2012.
44. Jansen, M. and R. Ferrari, Macroturbulent Equilibration in a Thermally Forced Primitive Equation System, *J. Atmos. Sci.*, **69**, 695–713, 2012.
43. Taylor, J., and R. Ferrari, The role of density fronts in the onset of phytoplankton blooms, *Geophys. Res. Lett.*, **38**, L23601, 2011.
42. Taylor, J., and R. Ferrari, A shutdown of turbulent convection can trigger the spring phytoplankton bloom, *Limnology & Oceanography*, **56**, 2293–2307, 2011.
41. Naveira-Garabato, A., R. Ferrari, and K. Polzin, Eddy Mixing in the Southern Ocean, *J. Geophys. Res.*, **116**, C09019, 2011.
40. Ferrari, R., Oceanic fronts: a challenge for climate models, *Science*, **332**, 316–317, 2011.
39. Nikurashin, M., and R. Ferrari: Global energy conversion from geostrophic flow into internal lee waves in the deep ocean, *Geophys. Res. Lett.*, **38**, L08610, 2011.
38. Fox-Kemper, B., G. Danabasoglu, R. Ferrari, S. M. Griffies, R. W. Hallberg, M. M. Holland, M. E. Maltrud, S. Peacock and B. L. Samuels, Parameterization of Mixed Layer Eddies. III: Implementation and Impact in Global Ocean Climate Simulations, *Ocean Modelling*, **39**, 61–78, 2011.
37. Ferrari, R. and D. Ferreira, What processes drive the ocean heat transport?, *Ocean Modelling*, **38**, 171–186, 2011.
36. Lund, D., J. Adkins and R. Ferrari: Abyssal Atlantic Circulation during the Last Glacial Maximum, *Paleoceanography*, **26**, PA1213, 2011.
35. Holmes-Cefron, M., O. Buhler, and R. Ferrari, Particle dispersion by random waves in the rotating Boussinesq system, *J. Fluid Mech.*, **670**, 150–175, 2011.
34. Taylor, J., and R. Ferrari, Buoyancy and wind-driven convection at mixed layer density fronts, *J. Phys. Oceanogr.*, **40**, 1222–1242, 2010.
33. Ferrari, R. and M. Nikurashin, Suppression of eddy mixing across jets in the Southern Ocean, *J. Phys. Oceanogr.*, **40**, 1501–1519, 2010.
32. Nikurashin, M., and R. Ferrari, Radiation and dissipation of internal waves generated by geostrophic motions impinging on small-scale topography: Application to the Southern Ocean, *J. Phys. Oceanogr.*, **40**, 2025–2042, 2010.
31. Nikurashin, M., and R. Ferrari, Radiation and dissipation of internal waves generated by geostrophic motions impinging on small-scale topography: Theory, *J. Phys. Oceanogr.*, **40**, 1055–1074, 2010.
30. Jansen, M., R. Ferrari, and T. Mooring, The effect of the seasonal cycle on heat anomalies generated in the wake of tropical cyclones, *Geophys. Res. Lett.*, **37**, L03602, 2010.
29. Ferrari, R., S. M. Griffies, and G. K. Vallis, A Boundary Value Problem for the Parameterized Mesoscale Eddy Transport, *Ocean Modelling*, **32**, 143–156, 2010.
28. Ferrari, R., and C. Wunsch, The distribution of eddy kinetic and potential energies in the global ocean, *Tellus A*, **62**, 92–108, 2010.
27. Mahadevan, A., A. Tandon, and R. Ferrari, Rapid Restratification of the Mixed Layer by Submesoscale Eddies in the presence of Wind, *J. Geophys. Res.*, **115**, C03017, 2010.

26. Marshall, J. and the CLIMODE group, Observing the cycle of convection and restratification over the Gulf Stream System and the subtropical gyre of the North Atlantic ocean: preliminary results from the CLIMODE campaign, *Bull. Am. Meteor. Soc.*, **90**, 1337–1350, 2009.
25. Fox-Kemper, B. and R. Ferrari, An Edifying Parsons Model, *J. Phys. Oceanogr.*, **39**, 3216–3227, 2009.
24. Smith, S., and R. Ferrari, Production of compensated T-S variance by mesoscale stirring in the NATRE region, *J. Phys. Oceanogr.*, **39**, 2477–2501, 2009.
23. Jansen, M., and R. Ferrari, The latitudinal distribution of tropical cyclones and ocean heat transport, *Geophys. Res. Lett.*, **36**, L06604, 2009.
22. Taylor, J., and R. Ferrari, The role of secondary shear instabilities in the equilibration of symmetric instability, *J. Fluid Mech.*, **622**, 103–113, 2009.
21. Ferrari, R. and C. Wunsch, Ocean Circulation Kinetic Energy–Reservoirs, Sources and Sinks, *Ann. Rev. Fluid Mech.*, **41**, 253–282, 2009.
20. Thomas, L. and R. Ferrari, Friction, frontogenesis, frontal instabilities and the stratification of the ocean surface mixed layer, *J. Phys. Oceanogr.*, **38**, 2501–2518, 2008.
19. Fox-Kemper, B., R. Ferrari, and R. W. Hallberg, Parameterization of Mixed Layer Eddies. I: Theory and Diagnosis, *J. Phys. Oceanogr.*, **38**, 1145–1165, 2008.
18. Fox-Kemper, B., and R. Ferrari, Parameterization of Mixed Layer Eddies. II: Prognosis and Impact. *J. Phys. Oceanogr.*, **38**, 1166–1179, 2008.
17. Ferrari, R., J. C. McWilliams, V. Canuto, and D. Dubovikov, Parameterization of eddy fluxes at the ocean boundaries, *J. Climate*, **31**, 2770–2789, 2008.
16. Danabasoglu G., R. Ferrari and J. C. McWilliams, Sensitivity of an Ocean General Circulation Model to a Parameterization of Near-Surface Eddy Fluxes, *J. Climate*, **21**, 1192–1208, 2008.
15. Boccaletti G., R. Ferrari, and B. Fox-Kemper, Mixed Layer Instabilities and Restratification, *J. Phys. Oceanogr.*, **37**, 2228–2250, 2007.
14. Ferrari, R., and K. L. Polzin, Temperature and salinity finestructure in NATRE, *J. Phys. Oceanogr.*, **35**, 1437–1454, 2005.
13. Boccaletti G., R. Ferrari, D. Ferreira, A. Adcroft, and J. Marshall, The vertical structure of the oceanic heat transport, *Geophys. Res. Lett.*, **32**, L10603, 1–4, 2005.
12. Jochum M., R. Murtugudde, R. Ferrari, and P. Rizzoli, The impact of horizontal resolution on the equatorial mixed layer heat budget in ocean general circulation models, *J. Climate*, **18**, 841–851, 2005.
11. Plumb, R., and R. Ferrari, Transformed Eulerian-mean theory. I: Non-quasigeostrophic theory for eddies on a zonal mean flow, *J. Phys. Oceanogr.*, **35**, 165–174, 2005.
10. Ferrari, R., and G. Boccaletti, Eddy Mixed-Layer Interaction in the Ocean, *Oceanography*, **17**, 12–21, 2004.
9. Wunsch, C., and R. Ferrari, Vertical Mixing, Energy, and the General Circulation of the Oceans, *Ann. Rev. Fluid Mech.*, **36**, 281–314, 2004.
8. Polzin, K. L., and R. Ferrari, Lateral dispersion in NATRE, *J. Phys. Oceanogr.*, **34**, 247–257, 2004.
7. Ferrari, R. and F. Paparella, Thermohaline alignment and compensation in the ocean mixed layer, *J. Phys. Oceanogr.*, **33**, 2214–2223, 2003.

6. Fox-Kemper, B., R. Ferrari, and J. Pedlosky, A Note on Determination of Rotational and Divergent Eddy Fluxes, *J. Phys. Oceanogr.*, **16**, 875–881, 2003.
5. Ferrari, R., and P. Cessi, Seasonal synchronization in a chaotic ocean–atmosphere model, *J. Climate*, **33**, 478–483, 2003.
4. Ferrari, R., A. J. Manfroi, and W. R. Young, Weakly and strongly self-similar diffusion, *Physica D*, **154**, 111–137, 2001.
3. Ferrari, R., and Rudnick, D.L., Thermohaline structure of the upper ocean, *J. Geophys. Res.*, **105**, 16857–16883, 2000.
2. Rudnick, D.L., and R. Ferrari, Compensation of horizontal temperature and salinity gradients in the ocean mixed layer, *Science*, **283**, 526–529, 1999.
1. Ferrari, R., and W. R. Young, On the development of thermohaline correlations as a result of nonlinear diffusive parameterizations, *J. Mar. Res.*, **55**, 1069–1101, 1997.

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### Non-Refereed Journals

15. Scott, R.B., M. Bourassa, D. Chelton, P. Cipollini, R. Ferrari, L.L. Fu, B. Galperin, S. Gille, H.-P. Huang, P. Klein, N. Maximenko, R. Morrow, B. Qiu, E. Rodriguez, D. Stammer, R. Tailleux, C. Wunsch (2010): Integrating satellite altimetry and key observations: what weve learned, and whats possible with new technologies, in Proceedings of the "OceanObs09: Sustained Ocean Observations and Information for Society" Conference (Vol. 2), Venice, Italy, 21-25 September 2009, Hall, J., Harrison D.E. and Stammer, D., Eds., ESA Publication WPP-306.
14. Fu, L.-L., and R. Ferrari, Observing oceanic submesoscale processes from space, *EOS*, **89**, 2008.
13. Fox-Kemper, B., G. Danabasoglu, R. Ferrari, and R. W. Hallberg, Parameterizing Submesoscale Physics in Global Climate Models, *CLIVAR Exchanges*, **13**, 3–5, 2008.
12. Ferrari, R., Statistics of dispersion in flows with coherent structures, *Proceedings of the 'Aha Huliko'a Winter Workshop*, Honolulu, Hawaii, 2007.
11. Ferrari, A., and R. Ferrari, Il mutamento climatico: fatti e miti, Quaderni - Mercoledì dell'Accademia XI, Accademia delle Scienze di Torino, **13**, 25–46, 2006.
10. Ferrari, R., The US CPT Clivar Program, *U.S. CLIVAR Variations*, **4**, 1–2, 2006.
9. Ferrari, R., Eddy-mixed layer interactions in the ocean, *U.S. CLIVAR Variations*, **4**, 3, 2006.
8. Ferrari, R., Ocean Mixing, BASC report entitled "Improving the Scientific Foundation for Atmosphere-Land-Ocean Simulations: Report of a Workshop", National Academy of Sciences, 2005.
7. Bretherton, C. S., R. Ferrari, and S. Legg, Climate Process Teams: A new approach to improving climate models, *U.S. CLIVAR Variations*, **2**, No. 1, 1–6, 2004.
6. Ferrari, R., and A. Plumb, Mesoscale eddy fluxes at the boundaries in ocean circulation models. *Proceedings of the 'Aha Huliko'a Winter Workshop*, Honolulu, Hawaii, 2003.
5. Ferrari, R., D.L. Rudnick, W. R. Young, and F. Paparella, The temperature-salinity relationship of the surface mixed-layer, *Proceedings of the 'Aha Huliko'a Winter Workshop*, Honolulu, Hawaii, 2001.
4. Ferrari, R., Dispersion of active and passive scalars in the upper ocean. Doctoral Dissertation. Scripps institution of Oceanography, La Jolla, 2000.

3. Ferrari, R., The temperature-salinity relationship in the mixed layer, *Proceedings of the Geophysical Fluid Dynamics Program*, 1999.
2. Ferrari, R., Distribuzioni di temperatura e salinitá negli strati piú superficiali degli oceani. Doctoral dissertation. Politecnico di Torino, 1999.
1. Ferrari, R., Integrazione numerica di equazioni solitoniche multidimensionali. Master thesis. Univer-sitá di Torino, 1994.