# Carl Wunsch - Curriculum Vitae

February 20, 2025

**Date of Birth**: May 5, 1941 **Place of Birth**: Brooklyn, New York

**Education**: Massachusetts Institute of Technology S.B. in Mathematics, June 1962. Ph.D. in Geophysics, September 1966 (PhD adviser, Henry Stommel)

**Positions Held**:

Lecturer in Oceanography, M.I.T., 1966-1967

Assistant Professor of Oceanography, M.I.T., 1967-1970

Associate Professor of Oceanography, M.I.T., 1970-1975

Professor of Physical Oceanography, M.I.T., 1975-1976

Cecil and Ida Green Professor of Physical Oceanography, M.I.T. 1976-2012. Emeritus, 2013+

Head, Department of Earth and Planetary Sciences, M.I.T., 1977-1981

Secretary of the Navy Research Professor, MIT, 1985-1989

Visiting Professor: Harvard University, 1980, and Visitor, 2007-2012; University of Washington, 1980

Senior Visiting Fellow, Department of Applied Mathematics and Theoretical Physics, University of Cambridge 1969, 1974-1975, 1981-1982. Life Member, Clare Hall, 1981+

Senior Visiting Scientist, Geophysical Fluid Dynamics Laboratory, Princeton University, 1993-94

Visiting Scientist, Groupe de Recherche de Géodesie Spatiale-CNES/CNRS, Toulouse, France, 1994

Distinguished Visiting Scientist, Jet Propulsion Laboratory, 1994-2011

Moore Distinguished Scholar, California Institute of Technology, 2000

Visiting Professor, University College London and Visiting Scientist, Southampton Oceanography Centre, 2001

George Eastman Visiting Professor, Dept. of Atmospheres, Oceans and Planetary Physics, and Fellow, Balliol College, Oxford University, 2011-2012

Visiting Professor of Physical Oceanography and Climate, Harvard University, 2013-2023; Associate of Department of Earth and Planetary Sciences, 2023-

**Honors:** Sigma Xi; James B. Macelwane Award, American Geophysical Union, 1971; Fellow, American Geophysical Union,1971; Founders' Prize, Texas Instruments Foundation, 1975; Member, National Academy of Sciences, 1978; Fellow, American Academy of Arts and Sciences, 1979; Fulbright Scholar, 1981-1982; John Simon Guggenheim Foundation Fellow, 1981-82; A. G. Huntsman Prize, Bedford Institute of Oceanography and Government of Nova Scotia, 1988; Maurice Ewing Medal, American Geophysical Union and U.S. Navy, 1990; Fellow, American Meteorological Society, 1991; Public Service Medal, National Aeronautics and Space Administration, 1993; Henry Stommel Research Prize, American Meteorological Society, 2000; Foreign Member, Royal Society of London, 2002; Member, American Philosophical Society, 2003; Fellow, American Association for the Advancement of Science, 2004; Bowie Medal, American Geophysical Union, 2006; Prince Albert $1^{er}$ Medal (of Institut Oceanographique, Paris) 2007; Honorary Fellow, Royal Meteorological Society,

2012; Walter Munk Medal, The Oceanography Society and US Navy, 2015; Fellow, California Academy of Sciences, 2019; Prince Albert $1^{er}$ Medal (of Internat.l Assoc. for the Phys. Sciences of the Oceans; IAPSO), 2021.

**Professional Groups**: American Geophysical Union; American Meteorological Society; The Oceanography Society; Society for Industrial and Applied Mathematics; European Geosciences Union; Royal Meteorological Society.

**Selected, Past Miscellaneous Outside Service**: Space Science Board - NRC/National Academy of Sciences (NAS). Committee on Earth Sciences -NRC/NAS. Chairman, Ocean Studies Board - NRC/NAS. Chairman, Science Working Group for Altimetry (TOPEX) - NASA. Member, Editorial Board, The MIT Press. Member, JASON. Co-editor, Monographs on Applied Mechanics and Applied Mathematics, Cambridge Un. Press. Chairman and Co-chairman, International Steering Group for World Ocean Circulation Experiment (WOCE), and Co-chairman, US Steering Committee for WOCE; Report Review Committee, NAS/NRC.

**Author or co-author of about 300 scientific papers and five books**

**PhD Students, Completed Degrees:**

Christopher Welch, *On the calculation of windstress curl over open ocean areas from synoptic meteorological data with application to time dependent ocean circulation*, 1969 (co-supervised with N. Fofonoff).

David Cacchione, *Experimental study of internal gravity waves over a slope*, 1970 (co-supervised with J. Southard).

Nelson Hogg, *The influence of topography on steady currents and internal waves*, 1971.

Ross Hendry, *The generation, energetics and propagation of internal tides in the western North Atlantic Ocean*, 1975.

James Richman, *Kinematics and energetics of the mesoscale mid-ocean circulation: MODE*, 1976.

Charles Eriksen, *Measurements and models of fine-structure, internal gravity waves and wave breaking in the deep ocean,* 1976.

Dean Roemmich, *The application of inverse methods to problems in ocean circulation*, 1979.

Lee-lueng Fu, *Observations and models of inertial waves in the deep ocean,* 1980.

Douglas Luther, *Observations of long period waves in the tropical oceans and atmosphere*, 1980.

Bruce Cornuelle, *Inverse methods and results from the 1981 ocean acoustic tomography experiment*, 1983.

Victor Zlotnicki, *The oceanographic and geoidal components of seasurface topography*, 1983.

Eli Tziperman, *Mixing and general circulation dynamics: theory and observations,* 1987.

Steven Rintoul, *The transport of mass, heat and nutrients in the Atlantic Ocean determined by inverse methods*, 1988.

Ichiro Fukumori, *Efficient representation of the hydrographic structure of the North Atlantic Ocean and aspects of the circulation from objective methods*, 1989.

Pascal Legrand, *What do paleo-geochemical tracers tell us about the deep ocean circulation during the last ice age?*, 1994.

Alison M. Macdonald, *Oceanic fluxes of mass, heat and freshwater: a global estimate and perspective,* 1995.

Michael Chechelnitsky, *Adaptive error estimation in linearized ocean general circulation models,* 1999.

Alexandre Ganachaud, *Large Scale Ocean Circulation and Fluxes of Freshwater, Heat, Nutrients and Oxygen,* 1999.

Xiaoyun Zang, *Spectral Description of Low Frequency Oceanic Variability,* 2000

Xingwen Li, *Constraining the North Atlantic Circulation with Transient Tracer Observations,* 2002.

Geoffrey Gebbie, *An Eddy-Resolving State Estimate of the Subduction Experiment*, 2004.

Peter Huybers, *The Origins of Ice Ages: Insolation Forcing, Age Models, and Nonlinear Climate Change,* 2004.

Matthew Mazloff, *The Southern Ocean Meridional Overturning Circulation as Diagnosed from an Eddy Permitting State Estimate,* 2008.

Ian Fenty, *State Estimation of the Labrador Sea with a Coupled Sea Ice-Ocean Adjoint Model,* 2010.

Holly Dail, *Atlantic Ocean Circulation at the Last Glacial Maximum: Inferences from Data and Models,* 2012.

Cimarron Wortham IV, *A Multi-Dimensional Spectral Description of Oceanic Variability with Applications,* 2012.

Ru Chen, *Energy Pathways and Structures of Oceanic Eddies from the ECCO2 State Estimate and Simplified Models,* 2012 (co-supervised with Glenn Flierl).

Alex Kalmikov, *Uncertainty Quantification in Ocean State Estimation,* 2012 (co-supervised with Patrick Heimbach).

Daniel Amrhein, *Inferring Ocean Circulation during the Last Glacial Maximum and Last Deglaciation Using Data and Models,* 2016.

**Masters Students, Completed Degrees**: Stephen Miller, Ronald Regal, Stephen Riser, William Dewar, Fran Hotchkiss, Rui Ponte, Joyce Federiuk, Kris Holderied, Jeffrey Campbell, Xiaoming Zhang, Alison MacDonald, Xiaoyun Zang, Guienaelle Jeunhomme, Sarah Samuel, Peter Huybers, Zan Stine, Matt Mazloff, Elise Olson, Shaoyu Yuan, Antoine Cogez (Paris), Charlotte Siberlin, Daniel Amrhein

**Post-Docs**: Richard Scarlet, Fred Newman, Jack Calman, Lee Gordon, D. Edmund Harrison, J.-F. Minster, C.-K. Tai, Fabienne Gaillard, Herlé Mercier, Jens Schröter, Laurent Mémery, Mitsuhiro Kawase, Reiner Schlitzer, Yehuda Agnon, Phillipe Gaspar, Norman Barth, Nathan Bindoff, Françoise Martel, Jerome Benveniste, Jochem Marotzke, Ric Williams, Daniel Jamous, Detlef Stammer, Dimitris Menemenlis, Kirill Pankratov, Rowan Hughes, Jeremy Harris, Ralf Giering, Nadia Ayoub, Christian Eckert, Patrick Heimbach, Francis Condi, Samar Khatiwala, Jeffrey Scott, Martin Losch, Benjamin Martinez-Lopez, Gaël Forget, Johanna Baehr, Martin Scharffenberg, Fabien Roquet, Xinfeng Liang, Maike Sonnewald (with P. Heimbach), Jörn Callies

**Publications: Carl Wunsch**

(1) Wunsch, C., The multiple spectral factorization procedure of Wiener and Masani, *IEEE Trans. Inform. Th.*, 11, 175-182, 1965.
(2) Wunsch, C., The long-period tides, *Revs. Geophys.*, 5, 447-476, 1967.
(3) Wunsch, C., On the propagation of internal waves up a slope, *Deep-Sea Res.*, 15, 251-258, 1968.
(4) Wunsch, C., Progressive internal waves on slopes, *J. Fluid Mech.*, 35, 131-145, 1969.
(5) Wunsch, C., D. Hansen and B. Zetler, Fluctuations of the Florida Current inferred from sealevel records, *Deep-Sea Res.*, 16 (Supplement. Fuglister Volume), 447-460, 1969.
(6) Martin, S., W. F. Simmons and C. Wunsch, Resonant internal wave interactions, *Nature*, 224, 1014-1016, 1969.
(7) Wunsch, C., On oceanic boundary mixing, *Deep-sea Res.*, 17, 293-301, 1970.
(8) Wunsch, C. and J. Dahlen, Preliminary results of internal wave measurements in the main thermocline at Bermuda, *J. Geophys. Res.*, 75, 5889-5908, 1970.
(9) Wunsch, C., Note on some Reynolds stress effects of internal waves on slopes, *Deep-Sea Res.*, 18, 583-592, 1971.
(10) Wunsch, C., Internal waves - Quadrennial review of XVth General Assembly IUGG, Moscow, *EOS, Trans. Am. Geophys. Union,* 52, 233-235, 1971.
(11) Wunsch, C., Bermuda sea level in relation to tides, weather, and baroclinic fluctuations, *Revs. Geophys.*, 10, 1-49, 1972.
(12) Martin, S., W. F. Simmons and C. Wunsch, The excitation of resonant triads by single internal waves, *J. Fluid Mech.*, 53, 17-44, 1972.
(13) Wunsch, C., Temperature microstructure on the Bermuda slope, with application to the mean flow, *Tellus*, 24, 350-367, 1972.
(14) Wunsch, C., The spectrum from two years to two minutes of temperature fluctuations in the main thermocline at Bermuda, *Deep-Sea Res.*, 19, 577-593, 1972.
(15) Wunsch, C. and R. Hendry, Array measurements of the bottom boundary layer and internal wave field on the continental slope, *Geophys. Fl. Dyn.*, 4, 101-145, 1972.
(16) Miller, S. P. and C. Wunsch, The pole tide, *Nature* Physical Science, 246, No.155, 98-102, 1973.
(17) Regal, R. and C. Wunsch, M2 tidal currents in the western North Atlantic, *Deep-Sea Res.*, 20, 493-502, 1973.
(18) Hendry, R. and C. Wunsch, High Reynolds number flow past an equatorial island, *J. Fluid Mech.*, 58, 97-114, 1973.
(19) Wunsch, C., On the mean drift in large lakes, *Limnol. and Oceanog.*, 18, 793-795, 1973.
(20) Wunsch, C. and J. Dahlen, A moored temperature and pressure recorder, *Deep-Sea Res.*, 21, 145-154, 1974.
(21) Taft, B., B. Hickey, C. Wunsch and D. J. Baker, Jr, Equatorial undercurrent and deeper flows in the Central Pacific, *Deep-Sea Res.*, 21, 403-430, 1974.
(22) Cacchione, D. A. and C. Wunsch, Experimental study of internal waves on a slope, *J. Fluid Mech.*, 66, 223-239, 1974.
(23) Gould, W. J., W. J. Schmitz, Jr. and C. Wunsch, Preliminary field results for a mid-ocean dynamics experiment (MODE-0), *Deep-Sea Res.*, 21, 911-932, 1974.

(24) Wunsch, C., Dynamics of the pole tide and the damping of the Chandler wobble, *Geophys. J. Roy. Astron.* Soc., 39, 539-550 (Errata, *Geophys. J. Roy. Astron.* Soc., 44, 539, 1975), 1974.
(25) Wunsch, C., Simple models of the deformation of an earth with a fluid core, I, *Geophys. J. Roy. Astron.* Soc, 39, 539-550, 1974.
(26) Wunsch, C., Deep ocean internal waves: what do we really know?, *J. Geophys. Res.*, 80, 339-343, 1975.
(27) Wunsch, C., Internal tides in the ocean, *Revs. Geophys.* and Space Phys., 13, 167-182, 1975.
(28) Luther, D. S. and C. Wunsch, Tidal charts of the Central Pacific, *J. Phys. Oc.*, 5, 222-230, 1975.
(29) Wunsch, C., Simple models of the deformation of an earth with a fluid core, II: Dissipation and magnetohydrodynamic effects, *Geophys. J. Roy. Astron.* Soc., 41, 165-184, 1975.
(30) Wunsch, C. and A. E. Gill, Observations of equatorially trapped waves in Pacific sea level variations, *Deep-Sea Res.*, 23, 371-390, 1976.
(31) Wunsch, C., Geographical variability of the internal wave field: a search for sources and sinks, *J. Phys. Oc.*, 6, 471-485, 1976.
(32) Richman, J., C. Wunsch and N. Hogg, Space and time scales of meso-scale motion in the western North Atlantic , *Revs. Geophys. and Space Phys.*, 15, 385-420, 1977.
(33) Wunsch, C., Determining the general circulation of the oceans: A preliminary discussion, *Science,* 196, 871-875, 1977.
(34) Wunsch, C. and M. Wimbush, Simultaneous pressure, velocity and temperature measurements in the Florida Straits, *J. Mar. Res.*, 35, 75-104, 1977.
(35) Wunsch, C., Response of an equatorial ocean to a periodic monsoon, *J. Phys. Oc.*, 7, 497-511, 1977.
(36) McCammon, C. and C. Wunsch, Tidal charts of the Indian Ocean north of 15°S, *J. Geophys. Res.*, 82, 5993-5998, 1977.
(37) Wunsch, C., The North Atlantic general circulation west of 50°W determined by inverse methods, *Revs. Geophys. and Space Phys.*, 16, 583-620, 1978.
(38) Moore, D., P. Hisard, J. McCreary, J. Merle, J. O'Brien, J. Picaut, J.-M. Verstraete and C. Wunsch, Equatorial adjustment in the Eastern Atlantic, *Geophys. Res. Letters,* 5, 637-640, 1978.
(39) MODE Group, The, Mid-Ocean Dynamics Experiment, *Deep-Sea Res.*, 25, 859-910, 1978.
(40) Munk, W. and C. Wunsch, Ocean acoustic tomography: A scheme for large scale monitoring, *Deep-Sea Res.*, 26A, 439-464, 1979.
(41) Wunsch, C. and S. Webb, Climatology of deep ocean internal waves, *J. Phys. Oc.*, 9, 235-243, 1979.
(42) Wunsch, C., Properties for inverse analysis of sound propagation in simple oceanic waveguides, *J. Mar. Res.*, 38, 413-433, 1980.
(43) Wunsch, C. and E. M. Gaposchkin, On using satellite altimetry to determine the general circulation of the oceans with application to geoid improvement, *Revs. Geophys and Space Phys.*, 18, 725-745, 1980.
(44) Wunsch, C., Meridional heat flux of the North Atlantic Ocean, *Proc. Nat. Acad. Scis.*, USA, 77, 5043-5047, 1980.

(45) Wunsch, C., An interim relative sea surface for the North Atlantic Ocean, *Mar. Geod.* 5, 103-119, 1981.

(47) Wunsch, C., Low frequency variability of the sea, in *Evolution of Physical Oceanography: Scientific Surveys in Honor of Henry Stommel*, 342-374, B. A. Warren and C. Wunsch, eds., The MIT Press, Cambridge, 1981.

(48) Fu, L.-l., T. Keffer, P. Niiler and C. Wunsch, Observations of mesoscale variability in the western North Atlantic: A comparative study, *J. Mar. Res.*, 40, 809-848 , 1982.

(49) Munk, W. and C. Wunsch, Observing the ocean in the 1990s, *Phil. Trans. Roy. Soc. A*, 307, 439-464, 1982.

(50) Roemmich, D. and C. Wunsch, On combining satellite altimetry with hydrographic data, *J. Mar. Res.*, 33 *(Worthington Volume supplement)*, 605-619, 1982.

(51) Wunsch, C. and B. Grant, Towards the general circulation of the North Atlantic Ocean, *Prog. in Oceanog., 11, 1-59, 1982.*

(52) Wunsch, C. and J.-F. Minster, Methods for box models and ocean circulation tracers: Mathematical programming and non-linear inverse theory, *J. Geophys. Res.*, 87, 5647-5662, 1982.

(53) Zlotnicki, V., B. Parsons and C. Wunsch, The inverse problem of constructing a gravimetric geoid, *J. Geophys. Res.*, 87, 1835-1848, 1982.

(54) Hotchkiss, F. S. and C. Wunsch, Internal waves in Hudson Canyon with possible geological implications, *Deep-Sea Res.*, 29, 415-442, 1982.

(55) Ocean Tomography Group, The, A demonstration of ocean acoustic tomography, *Nature*, 299, 121-125, 1982.

(56) Munk, W. and C. Wunsch, Up/down resolution in ocean acoustic tomography, *Deep-Sea Res.*, 29, 1415-1436, 1982.

(57) Munk, W. and C. Wunsch, Ocean acoustic tomography: rays and modes, *Revs. Geophys.* and Space Phys., 21, 777-793, 1983.

(58) Tai, C.-K. and C. Wunsch, Absolute measurement by satellite altimetry of dynamic topography of the Pacific Ocean, *Nature*, 301, 408-410, 1983.

(59) Wunsch, C., D.-X. Hu, and B. Grant, Mass, heat, salt and nutrient fluxes in the South Pacific Ocean, *J. Phys. Oc.*, 13, 725-753, 1983.

(60) Wunsch, C., Western North Atlantic interior, in *Eddies in Marine Science*, 46-65, A. R. Robinson, ed., Springer-Verlag, 1983.

(61) Roemmich, D. and C. Wunsch, Apparent change in the climatic state of the deep North Atlantic Ocean, *Nature*, 307, 447-450, 1984.

(62) Tai, C.-K. and C. Wunsch, An estimate of global absolute dynamic topography, *J. Phys. Oc.*, 14, 457-463, 1984.

(63) Wunsch, C. and V. Zlotnicki, The accuracy of altimetric surfaces, *Geophys. J. Roy. Astron. Soc.*, 78, 795-808, 1984.

(64) Wunsch, C. , The ocean circulation in climate, *The Global Climate*, 189-203, J. T. Houghton, ed., Cambridge University Press, Cambridge, 1984.

(65) Wunsch, C., An eclectic Atlantic Ocean circulation model. Part I: The meridional flux of heat, *J. Phys. Oc.*, 14, 1712-1733, 1984.

(66) Wunsch, C., An estimate of the upwelling rate in the equatorial Atlantic based on the distribution of bomb radiocarbon and quasigeostrophic dynamics, *J. Geophys. Res.*, 89, 7971-7978, 1984.

(67) Luyten, J., H. Stommel, and C. Wunsch, A diagnostic study of the North Atlantic subpolar gyre, *J. Phys. Oc.*, 15, 1344-1348, 1985.
(68) Munk, W. and C. Wunsch, Biases and caustics in long-range acoustic tomography, *Deep-Sea Res.*, 32, 1317-1346, 1985.
(69) Roemmich, D. and C. Wunsch, Two transatlantic sections: Meridional circulation and heat flux in the subtropical North Atlantic Ocean, *Deep-Sea Res.* 32, 619-664, 1985.
(70) Wunsch, C. and D. Roemmich, Is the North Atlantic in Sverdrup balance?, *J. Phys. Oc.*, 15, 1876-1880, 1985.
(71) Wunsch, C., Can a tracer field be inverted for velocity?, *J. Phys. Oc.*, 11, 1521-1531, 1985.
(72) Cornuelle, B., C. Wunsch, D. Behringer, T. Birdsall, M. Brown, R. Heinmiller, R. Knox, K. Metzger, W. Munk, J. Spiesberger, R. Spindel, D. Webb, and P. Worcester, Tomographic maps of the ocean mesoscale, part 1, Pure acoustics, *J. Phys. Oc.*, 15, 133-152, 1985.
(73) Joyce, T. M., C. Wunsch, S. D. Pierce, Synoptic Gulf Stream velocity profiles through simultaneous inversion of hydrographic and acoustic doppler data, *J. Geophys. Res.*, 91, 7573-7585, 1986.
(74) Schröter, J. and C. Wunsch, Solution of non-linear finite difference ocean models by optimization methods with sensitivity and observational strategy analysis, *J. Phys. Oc.*, 16, 1855-1874, 1986.
(75) Wunsch, C., Dynamics of the North Sea pole tide revisited, *Geophys. J. Roy. Astron.* Soc., 87, 869-884, 1986.
(76) Wunsch, C., Calibrating an altimeter: how many tide gauges is enough?, *J. Atm. and Oceanic Tech.*, 3, 746-754, 1986.
(77) Wunsch, C., Reply to Veronis, *J. Phys. Oc.*, 16, 1731-1732, 1986.
(78) Wunsch, C., Using transient tracers: The regularization problem, *Tellus*, 39B, 477-492, 1987.
(79) Munk, W. and C. Wunsch, Bias in acoustic travel time through an ocean with adiabatic range-dependence, *Geophys. and Astrophys. Fl. Dyn.*, 39, 1-24, 1987.
(80) Schröter, J. and C. Wunsch, Reply to P. C. McIntosh, *J. Phys. Oc.*, 17, 841-842, 1987.
(81) Wunsch, C., Acoustic tomography by Hamiltonian methods including the adiabatic approximation, *Revs. Geophys.*, 25, 41-53, 1987.
(82) Wunsch, C., Transient tracers as a problem in control theory, *J. Geophys. Res.* 93, 8099-8110, 1988.
(83) Wunsch, C., Eclectic modelling of the North Atlantic. II. Transient tracers and the ventilation of the eastern basin thermocline, *Phil. Trans. Roy. Soc.,* A, 201-236, 1988.
(84) Barth, N. and C. Wunsch, Oceanographic experiment design by simulated annealing, *J. Phys. Oc.*, 20, 1249-1263, 1989.
(85) Gaspar, P. and C. Wunsch, Estimates from altimeter data of barotropic Rossby waves in the northwestern Atlantic Ocean, *J. Phys. Oc.*, 19, 1821-1844, 1989.
(86) Wunsch, C., Sampling characteristics of satellite orbits, *J. Atmo. and Oceanic Tech.*, 6, 891-907, 1989.
(87) Wunsch, C., Tracer inverse problems, in *Oceanic Circulation Models: Combining Data and Dynamics*, 1-77, D. L. T. Anderson and J. Willebrand, eds., Kluwer, Dordrecht, 1989.
(88) Mémery, L. and C. Wunsch, Constraining the North Atlantic circulation with tritium data, *J. Geophys. Res.*, 95, 5229-5256, 1990.

(89) Sirkes, Z. and C. Wunsch, Note on apparent systematic and periodic errors in GEOSAT orbits, *Geophys. Res. Letters*, 17, 1307-1310, 1990.

(90) Wunsch, C., Using data with models; Ill-posed problems, in, *Oceanographic and Geophysical Tomography*, 205-248, Y. Desaubies, A. Tarantola, and J. Zinn-Justin, eds., North-Holland, Amsterdam, 1990.

(91) Rintoul, S. R. and C. Wunsch, Mass, heat oxygen and nutrient fluxes in the North Atlantic Ocean, *Deep-Sea Res.*, 38A, (*Supplement, J. Reid Volume)*, S355-S377, 1991.

(92) Fukumori, I., F. Martel and C. Wunsch, The hydrography of the North Atlantic in the early 1980's. An atlas, *Prog. in Oceanog.*, 27, 1-110 1991.

(93) Fukumori, I. and C. Wunsch, Efficient representation of the North Atlantic hydrographic and chemical distributions, *Prog. in Oceanog.,* 27, 111-195, 1991.

(94) Wunsch, C., Global-scale sea surface variability from combined altimetric and tide gauge measurements, *J. Geophys. Res.*, 96 (C8), , 1991.

(95) Wunsch, C., Large-scale response of the ocean to atmospheric forcing at low frequencies, *J. Geophys. Res.*, 15,083-15,092, 1991.

(96) Bindoff, N. and C. Wunsch, Comparison of synoptic and climatologically mapped sections in the South Pacific Ocean, *J. of Climate*, 5, 631-645 1992.

(97) Wunsch, C., Decade-to-century changes in the ocean circulation, *Oceanography*, 5 (2) 99-106, 1992.

(98) Martel, F. and C. Wunsch, The North Atlantic circulation in the early 1980s - an estimate from inversion of a finite difference model, *J. Phys. Oc.*, 23, 898-924, 1993.

(99) Fukumori, I., J. Benveniste, C. Wunsch and D. B. Haidvogel, Assimilation of sea surface topography into an ocean circulation model using a steady state smoother, *J. Phys. Oc.*, 23, 1831-1855, 1993.

(100) Martel, F. and C. Wunsch, Combined inversion of hydrography, current meter data and altimetric elevations for the North Atlantic circulation, *Manuscripta Geodaetica*, 18, 219-226, 1993.

(101) Marotzke, J. and C. Wunsch, Finding the steady state of a general circulation model through data assimilation: application to the North Atlantic Ocean, *J. Geophys. Res.*, 98, 20,149-20,167, 1993.

(102) Chester, D., P. Malanotte-Rizzoli, J. Lynch, and C. Wunsch, The eddy radiation field of the Gulf Stream as measured by ocean acoustic tomography, *Geophys. Res. Letts.*, 21, 181-184, 1994.

(103) Wunsch, C., Dynamically consistent hydrography and absolute velocity in the eastern North Atlantic Ocean, *J. Geophys. Res.*, 99, 14,071-14,090, 1994.

(104) Stammer, D. and C. Wunsch, Preliminary assessment of the accuracy and precision of TOPEX/POSEIDON altimeter data with respect to the large scale ocean circulation, *J. Geophys. Res.*, 99, 24,584-24,604, 1994.

(105) LeGrand, P. and C. Wunsch, Constraints from paleo-tracer data on the North Atlantic circulation during the last glacial maximum. *Paleoceanography*, 10, 1011-1045, 1995.

(106) Fieguth, P. W., W. C. Karl, A. S. Willsky and C. Wunsch, Multiresolution optimal interpolation and statistical analysis of TOPEX/POSEIDON satellite altimetry, *IEEE Trans. Geoscience on Geoscience and Remote Sensing*, 33, 280-292, 1995.

(107) Wunsch, C. and D. Stammer, The global frequency-wavenumber spectrum of oceanic variability estimated from TOPEX/POSEIDON altimetric measurements, *J. Geophys. Res.*,

100, 24,895-24,910, 1995.
(108) Stammer, D. and C. Wunsch, The determination of the large-scale circulation of the Pacific Ocean from satellite altimetry using model Green's functions, *J. Geophys. Res.*, 101, 18,409-18,432, 1996.
(109) Menemenlis, D. and C. Wunsch, Linearization of an oceanic general circulation model for data assimilation and climate studies, *J. Atm. and Oceanic Tech.*, 14, 1420-1443, 1997.
(110) D. Stammer, R. Tokmakian, A. Semtner and C. Wunsch, How well does a 1/4° circulation model simulate large-scale oceanic observations? *J. Geophys Res.*, 101, 25,779-25,811, 1996.
(111) Macdonald, A. and C. Wunsch, The global ocean circulation and heat flux, *Nature*, 382,436-439, 1996.
(112) Wunsch, C. and D. Stammer, Atmospheric loading and the oceanic "inverted barometer" effect, *Revs. Geophys.*, 35, 79-107, 1997.
(113) Ganachaud, A., C. Wunsch, M.-C. Kim, and B. Tapley, Combination of TOPEX/-POSEIDON data with a hydrographic inversion for determination of the oceanic general circulation, *Geophys. J. Intl.*,128, 708-722, 1997.
(114) Shum, C.-K., P. L. Woodworth, O. B. Andersen, G. Egbert, O. Francis, C. King, S. Klosko, C. Le Provost, X. Li, J. Molines, M. Parke, R. Ray, M. Schlax, D. Stammer, C. Tierney, P. Vincent, and C. Wunsch, Accuracy assessment of recent ocean tide models, *J. Geophys. Res.*, 102, 25,173-25,194, 1997.
(115) Menemenlis, D., A. T. Webb, C. Wunsch, U. Send and C. Hill, Basin-scale ocean circulation from combined altimetry, tomography and model data, *Nature*, 385, 618-621, 1997.
(116) Menemenlis, D., P. Fieguth, C. Wunsch and A. Willsky, Adaptation of a fast optimal interpolation algorithm to the mapping of oceanographic data, *J. Geophys. Res.*, 102, 10,573-10,584, 1997.
(117) Wunsch, C., The vertical partition of oceanic horizontal kinetic energy, *J. Phys. Oc.*, 27, 1770-1794, 1997.
(118) Wunsch, C., D. B. Haidvogel, M. Iskandarani, R. Hughes, Dynamics of long-period tides, *Prog. in Oceanography* (D. Cartwright Volume), 40, 81-108, 1997.
(119) Fieguth, P., Menemenlis, D.,T. Ho, A. Willsky and C. Wunsch, Mapping Mediterranean altimeter data with a multiresolution optimal interpolation algorithm, *J. Atm. Oc. Tech.*, 15535-546, 1998.
(120) Munk, W. and Wunsch, C. Abyssal recipes II. Energetics of the tides and wind. *Deep-Sea Res.,* 45, 1976-2009, 1998.
(121) Wunsch, C. and D. Stammer, Satellite altimetery, the marine geoid and the oceanic general circulation. *Annual Reviews of Earth and Planetary Sciences*, 26, 219-254, 1998.
(122) ATOC Consortium, Ocean climate change: comparison of acoustic tomography, satellite altimetry, and modeling, *Science,* 281, 1327-1332, 1998.
(123) Wunsch, C. The work done by the wind on the oceanic general circulation. *J. Phys. Oc.,* 28, 2331-2339, 1998.
(124) Stammer, D. and C. Wunsch, Temporal changes in the mesoscale variability of the oceans, *Deep-Sea Res.,* II, 46, 77-108, 1999.
(125) Wunsch, C. Where do ocean eddy heat fluxes matter? *J. Geophys. Res.,* 104, 13,235-13,250, 1999.
(126) Wunsch, C., A summary of North Atlantic baroclinic variability. *J. Phys. Oc.,*29, 3161-3166, 1999.

(127) Wunsch, C., The interpretation of short climate records, with comments on the North Atlantic and Southern Oscillations. *Bull. Am. Met. Soc.,* 80, 245-255, 1999.
(128) Zang, X. and C. Wunsch, The observed dispersion relation for North Pacific Rossby wave motions, *J. Phys. Oc.,* 29, 2183-2190, 1999.
(129) Ganachaud, A., C. Wunsch, J. Marotzke, and J. Toole, The meridional overturning and large-scale circulation of the Indian Ocean. *J. Geophys. Res.,* 105, 26,117-26,134, 2000.
(130) Wunsch, C., Global problems and global observations. In, *Ocean Circulation and Climate. Observing and Modelling the Global Ocean.* G. Siedler, J. Church and J. Gould, Eds., 47-80, Academic, San Diego, 2001.
(131) Wunsch, C., Reply to Comments by Trenberth and Hurrell on ."The interpretation of short climate records, with comments on the North Atlantic and Southern Oscillations", *Bull. Am. Met. Soc.,* 80, 2723, 1999.
(132) Wunsch, C., On sharp spectral lines in the climate record and the millennial peak. *Paleoceano.,* 15, 417-424, 2000.
(133) Stammer, D., C. Wunsch, and R. Ponte, De-aliasing global altimetric records with a general circulation model. *Geophys. Res. Letts.* 27, 1175-1178, 2000.
(134) Ganachaud, A. and C. Wunsch, Improved estimates of global ocean circulation, heat transport and mixing from hydrographic data. *Nature,* 408, 453-456, 2000.
(135) Zang, X. and C. Wunsch, Spectral description of low frequency oceanic variability. *J. Phys Oc.,* 31, 3073-3095, 2001.
(136) Ponte, R., D. Stammer, and C. Wunsch, Improving ocean angular momentum estimates through ocean state estimation. *Geophys Res. Letts.,* 28, 1775-1778, 2001.
(137) Comments on "Windstress forcing of the North Sea pole tide", by W. P. O'Connor et al., *Geophys. J. Intl.,* 146, 264-265, 2001.
(138) Wunsch, C., Reply to Meeker et al., *Paleoceanography,* 16, 548, 2001.
(139) Ganachaud, A. and C. Wunsch, Oceanic nutrient and oxygen fluxes during the World Ocean Circulation Experiment and bounds on export production. *Global Biogeochemical Cycles,* 16(4), 1057, DOI:10.1029/2000GB001333, 2002.
(140) Stammer, D., C. Wunsch, R. Giering, C. Eckert, P. Heimbach, C. Hill, J. Marotzke, J. Marshall, Global ocean state during 1992-1997, estimated from ocean observations and a general circulation model. *J. Geophys. Res.,* DOI: 10.1029/2001JC000888, 2002.
(141) Zang, X., L.-L. Fu, and C. Wunsch, Observed reflectivity of the boundary of the western tropical Pacific Ocean, *J. Geophys. Res.,* DOI:10.1029/2000JC000719, 2002.
(142) Wunsch, C., Oceanic age and transient tracers. Analytical and numerical solutions. *J. Geophys. Res.,* 107(C6), 1-1 to 1-16, DOI:10.1029/2001JC000797, 2002.
(143) Ganachaud, A. and C. Wunsch, Large-scale ocean heat and freshwater transports during the World Ocean Circulation Experiment, *J. of Climate,* 16, 696-705, 2002.
(144) Wunsch, C., What is the thermohaline circulation?, *Science,* 298, 1180-1181, 2002.
(145) Wunsch, C., The spectral description of climate change including the 100KY energy, *Clim. Dyn.,* DOI 10.1007/s00382-002-0279-z, 2003.
(146) Stammer, D., C. Wunsch, R. Giering, C. Eckert, P. Heimbach, J. Marotzke, A. Adcroft, C. Hill, J. Marshall, Volume, heat and freshwater transports of the global ocean circulation 1992-1997, estimated from a general circulation model constrained by WOCE data, *J. Geophys. Res.,* DOI: 10.1029/2001JC001115, 2002 C1, 2003.

(147) Wunsch, C., Determining paleoceanographic circulations, with emphasis on the Last Glacial Maximum, *Quaternary Sci. Revs.,* 22/2-4, 371-385, 2003.
(148) Wunsch, C. and D. Stammer, Global ocean data assimilation and geoid measurements. *Space Sci. Revs.,* 108, 147-162, 2003.
(149) Losch, M. and C. Wunsch, Bottom topography as a control variable in an ocean model, *J. Atm. Ocean Tech.,* 20, 1685-1696, 2003.
(150) Wunsch, C. and D. E. Gunn, A densely sampled core and climate variable aliasing, *Geo-Mar. Letts.,* 23(1), DOI: 10.1007/s00367-003-0125-22003, 2003.
(151) Li, X. and C. Wunsch, Constraining the North Atlantic circulation with transient tracer observations, *J. Geophys. Res.* 108(C10), 3318, 10.1029/2002JC001765, 2003.
(152) Wunsch, C., Greenland—Antarctic phase relations and millennial time-scale climate fluctuations in the Greenland cores, *Quaternary Sci. Revs.* 22, 1631-1646, 2003.
(153) Huybers, P. and C. Wunsch, Rectification and precession signals in the climate system, *Geophys. Res. Letts,* 30, 19, 2011,doi:10.1029/2003GL017875, 2003.
(154) Stammer, D., K. Ueyoshi, W. B. Large, S. Josey, and C. Wunsch, Estimating air-sea fluxes of heat, freshwater, and momentum through ocean data assimilation, *J. Geophys. Res.,* 109, C05023, doi:10.1029/2003JC002082, 2004.
(155) Wunsch, C. and R. Ferrari, Vertical mixing, energy, and the general circulation of the oceans, *Ann. Rev. Fluid Mech.,* 36, doi:10.1146/annurev.fluid.36.050802.122121, 2004.
(156) Condi, F. and C. Wunsch, Measuring gravity field variability, the geoid, ocean bottom pressure fluctuations, and their dynamical implications, *J. Geophys. Res.,* 109,-doi:10.1029/2002JC0001727, 2004.
(157) Li, X. and C. Wunsch, An adjoint sensitivity study of chlorofluorocarbons in the North Atlantic, *J. Geophys. Res.,* 109, No. C1, C01007, 10.1029/2003JC002014, 2004.
(158) Huybers, P. and C. Wunsch, A depth-derived Pleistocene age model: uncertainty estimates, sedimentation variability, and nonlinear climate change, *Paleoceanog.,* 19, PA1028, doi:10.1029/2002PA000857, 2004.
(159) Wunsch, C. Quantitative estimate of the Milankovitch-forced contribution to observed climate change. *Quat. Sci. Revs.,* 23/9-10, 1001-1012, 2004.
(160) Wunsch, C., Thermohaline loops, Stommel box models and Sandström's theorem. *Tellus,* 57A, 1-16, 2004.
(161) Wunsch, C., Reply to Severinghaus et al., *Quat. Sci. Revs.,* 23, 2054-2055, 2004.
(162) Wunsch, C., Speculations on a schematic theory of the Younger Dryas. *J. Mar. Res.,* 63 (Fofonoff Vol.) , 315-333, 2005.
(163) Huybers, P. and C. Wunsch, Obliquity pacing of the glacial cycles. *Nature,* 414, 491-494, 2005.
(164) Wunsch, C. The total meridional heat flux and its oceanic and atmospheric partition, *J. Climate,* 18, 4374-4380, 2005.
(165) Yuan, S. and C. Wunsch. Stress-driven thermohaline loops. *Physics of Fluids*, 17, DOI: 10.1063/1.1927887, 2005.
(166) Stammer, D., C. Wunsch, and K. Ueyoshi, Temporal changes in ocean eddy transports. *J. Phys. Oc.,* 36, 543-550, 2006.
(167) Wunsch, C. Abrupt climate change. An alternative view. *Quat. Res.* 65, 191-203, doi:10.1016/j.yqres.2005.10.1006, 2006.

(168) Gebbie, G., P. Heimbach, and C. Wunsch. Strategies for nested and eddy-resolving state estimation. *J. Geophys. Res.* C10073,doi:10.1029/2005JC003094, 2006.

(170) Tziperman, E., M. E. Raymo, P. Huybers, C. Wunsch, Consequences of pacing the Pleistocene 100kyr ice ages by nonlinear phase locking to Milankovitch forcing, *Paleoceanography*, 21, PA4206, doi:10.1029/2005PA001241, 2006.

(169) Wunsch, C. and P. Heimbach, Practical global oceanic state estimation. *Physica D,* 230, 197-208, 2007.

(171) Wunsch, C. and P. Heimbach, Decadal changes in the North Atlantic meridional overturning circulation and heat flux. *J. Phys. Oc.,* 36, 2012-2024, 2006.

(172) Ponte, R., C. Wunsch and D. Stammer, Spatial mapping of time-variable errors in TOPEX/-POSEIDON and Jason-1 seasurface height measurements. *J. Atm. Ocean. Tech.,* 24, 1078-1085, 2007.

(173) Forget, G. and C. Wunsch, Global hydrographic variability and the data weights in oceanic state estimates. *J. Phys. Oc.,* 37*,* 1997-2008, 2007.

(174) Stammer, D., A. Köhl and C. Wunsch, Impact of accurate geoid fields on estimates of the ocean circulation, *J. Atm Ocean Tech.,* 24*,* 1464-1478, 2007.

(175) Wunsch, C. The past and future ocean circulation from a contemporary perspective, in *Ocean Circulation: Mechanisms and Impacts,* AGU Monograph, 73, A. Schmittner, J. C. H. Chiang, and S. Hemming, Eds., 53-74, 2007.

(176) Wunsch, C., R. Ponte, P. Heimbach, Decadal trends in global sealevel patterns, *J. Climate,* 20, 5889-5911, 2007.

(177) Ponte, R. M., K. J. Quinn, C. Wunsch and P. Heimbach, A comparison of model and GRACE estimates of the large-scale seasonal cycle in ocean bottom pressure. *Geophys. Res. Letts.,* 34, L09603, doi:10.1029/2007GL029599, 2007.

(178) Vinogradov, S. V., R. M. Ponte, P. Heimbach, and C. Wunsch, The mean seasonal cycle in sea level estimated from a data-constrained general circulation model, *J. Geophys. Res.*, 113, C03032, doi:10.1029/2007JC004496, 2008.

(179) Utke, J., U. Naumann, M. Fagan, N. Tallent, M. Strout, P. Heimbach, C. Hill, and C. Wunsch, A modular open source tool for automatic differentiation of Fortran codes. *ACM Trans. on Math. Software*, 34(4), Article 18, 2008.

(180) Wunsch, C. and P. Heimbach, How long to ocean tracer and proxy equilibrium? *Quat. Sci. Revs.,* doi:10.1016/j.quascirev.2008.01.006, 27, 639-653, 2008.

(181) Wunsch, C., On measuring mass and volume transport variability in an eddy-filled ocean, *Nature Geoscience*, 1, 165-168, doi:10.1038/ngeo126, 2008.

(182) Wunsch, C. and P. Heimbach, Reply to P. M. Saunders et al., *J. Phys. Oc.,* 2108-2110, 2008.

(183) Wunsch, C. and P. Heimbach, The global zonally integrated ocean circulation (MOC), 1992-2006: Seasonal and decadal variability, *J. Phys Oc.,* 39, 351–368, 2009.

(184), Ferrari, R. and C. Wunsch, Ocean circulation kinetic energy—reservoirs, sources and sinks. *Ann. Revs. Fluid Mechs.,* 41, 253-282, 2009.

(185) Wunsch, C., The oceanic variability spectrum and transport trends. *Ocean-Atmosphere* (the C. Garrett Volume), **47**, 281-291, 2009.

(186) Wunsch, C., P. Heimbach, R. Ponte and I. Fukumori and the ECCO-Consortium members, The global general circulation of the oceans estimated by the ECCO-Consortium, *Oceanography,* 22, 89-103, 2009.

(187) Wunsch, C., A perpetually running ENSO in the Pliocene?. *J. Clim.,* 22, 3506–3510, 2009.
(188) Huybers, P. and C. Wunsch, Paleo-physical oceanography with an emphasis on transport rates, *Ann. Revs. Mar. Sci.*, 2, 1-34, 2010.
(189) Wunsch, C. Variability of the Indo-Pacific exchanges. *Dyn Atm. Oc.,* 50, 157-173, 2010.
(190) Wunsch, C., Towards a mid-latitude ocean frequency-wavenumber spectral density and trend determination, *J. Phys. Oc.,* 40, 2264–2281, 2010.
(191) Mazloff, M., P. Heimbach, and C. Wunsch, An eddy-permitting Southern Ocean state estimate, *J. Phys. Oc.,* 40, 880–899, 2010.
(192) Ferrari, R. and C. Wunsch, The distribution of eddy kinetic and potential energies in the global ocean. *Tellus A,* 62A, 92-108, 2010.
(193) Wunsch, C. Towards understanding the paleocean. *Quat. Sci. Rev.,* 29, 1960-1967, 2010.
(194) Heimbach, P., C. Wunsch, R. M. Ponte, G. Forget, C. Hill and J. Utke. Timescales and regions of the sensitivity of Atlantic meridional volume and heat transport magnitudes: toward observing system design, *Deep-Sea Res-II*, 58, 1858-1879, 2011.
(195) Siberlin, C. and C. Wunsch, Oceanic tracer and proxy time scales revisited. *Clim. of Past,* 7, 1-14, 2011.
(196) Wunsch, C., The decadal mean ocean circulation and Sverdrup balance. *J. Mar. Res.,* (V. Kamenkovich Vol.) 69, 417-434, 2011.
(197) Roquet, F., C. Wunsch, and G. Madec, On the patterns of wind-power input to the ocean circulation, *J. Phys. Oc.,* 41, 2328-2342, 2011.
(198) Wunsch, C., Covariances and linear predictability of the North Atlantic Ocean, *Deep-Sea Res. II*, (H. T. Rossby Vol.) DOI: 10.1016/j.dsr2.2012.07.015, 2012.
(199) Zhai, X., H. L. Johnson, D. P. Marshall and C. Wunsch, On the wind power input to the ocean general circulation. *J. Phys Oc.,* 42, 1357-1365, 2012.
(200) Wunsch, C., Baroclinic motions and energetics as measured by altimeters. *J. Atm. Oc. Tech., 30,* 140-150, 2013.
(201) Wunsch, C. and P. Heimbach, Dynamically and kinematically consistent global ocean circulation and ice state estimates *Ocean Circulation and Climate 2nd Edition,* Siedler, G., Griffies, S., Gould, J., Church, J. Eds., Elsevier, 553-579, 2013.
(202) Wunsch, C. and P. Heimbach, Two decades of the Atlantic Meridional overturning circulation: Anatomy, variations, prediction, and overcoming its limitations, *J. Climate*, 26, 7167-7186, 2013.
(203) Zhai, X. and C. Wunsch, On the variability of wind power input to the oceans with a focus on the subpolar North Atlantic, *J. Clim.,* 26, 3892-3903, 2013.
(204) Dail, H. and C. Wunsch, Dynamical reconstruction of upper ocean conditions in the Last Glacial Maximum Atlantic, *J. Clim.,* 27, 807-823, 2013.
(205) Wortham, C. and C. Wunsch, A multi-dimensional spectral description of ocean variability, *J. Phys. Oc.,* 44, 944-966, 2013.
(206) Roquet, F., C. Wunsch, G. Forget, P. Heimbach, C. Guinet and 24 others, Improved estimates of the Southern Ocean general circulation from marine mammal-based data, *Geophys. Res. Letts.,* 40, 6176–6180, doi:10.1002/2013GL058304, 2013.
(207) Wunsch, C. and P. Heimbach, Bidecadal thermal changes in the abyssal ocean and the observational challenge, *J. Phys. Oc.,44,* 2013-2030, 2014.
(208) Chen, R., G. R. Flierl and C. Wunsch, A description of local and non-local eddy-mean flow interaction in a global eddy-permitting state estimate. *J. Phys. Oc., 44,* 2336–2352,

2014.
(209) Liang, X., C. Wunsch, P. Heimbach, G. Forget, Vertical redistribution of oceanic heat content. *J. Phys. Oc.*, 28 3821-3833, 2015.
(210) Chen, R., G. R. Flierl and C. Wunsch, Quantifying and interpreting striations in a subtropical gyre: a spectral perspective, *J. Phys. Oc.,* 45, 387-406, 2015.
(211) Amrhein, D., G. Gebbie, O. Marchal, C. Wunsch. Inferring surface water equilibrium calcite $\delta^{18}$O for the last deglacial period from benthic foraminiferal records: Implications for ocean circulation. *Paleoceanography,* 30, doi:10.1002/2014PA002743, 2015.
(212) Liang, X. and C. Wunsch, Note on the redistribution and dissipation of tidal energy over mid-ocean ridges. *Tellus A,* 5, 67, 27385, http://dx.doi.org/10.3402/tellusa.v67.27385, 2015.
(213) Forget, G., J.-M. Campin, P. Heimbach, C. N. Hill, R. M Ponte, and C. Wunsch, ECCO version 4: an integrated framework for non-linear inverse modeling and global ocean state estimation, *Geo. Sci. Model Dev.,* 8, 3071–3104, 2015.
(214) Wunsch, C. Global ocean integrals and means, with trend implications. *Ann. Revs. Mar. Sci,* 8:11.1–11.33, 2016.
(215) Liang, X., C. Wunsch, P. Heimbach, and G. Forget. Vertical redistribution of oceanic heat content. *J. Clim.,* 28, 3821-3833, 2016.
(216) Wunsch, C., Pore fluids and the LGM ocean salinity—reconsidered. *Quat. Sci. Revs.*, 135, 154-170, 2016.
(217) Wunsch, C., Tides of global ice-covered oceans. *Icarus,* 274, 122–130, 2016.
(218) Wunsch, C., Last glacial maximum and deglacial abyssal seawater oxygen isotopic ratios, *Climate of the Past,* 12, 1-16, 2016.
(219) Wunsch, C., Ocean Mixing, in *Oxford Encyclopedia of Climate*, DOI: 10.1093/acrefore/-9780190228620.013.90, 2016. (Link: http://climatescience.oxfordre.com/view/10.1093/-acrefore/9780190228620.001.0001/acrefore-9780190228620-e-90)
(220) Liang, X., M. Spall and C. Wunsch, Global ocean vertical velocity from a dynamically consistent ocean state estimate. *J. Geophys. Res.*, DOI 10.1002/2017JC012985, 2017.
(221) Liang, X. F., Piecuch, C. G., Ponte, R. M., Forget, G, Wunsch, C., Heimbach, P.,Change of the global ocean vertical heat transport over 1993-2010. *J. Clim.*, 30, 5319-5327, 2017.
(222) Sonnewald, M., C. Wunsch, P. Heimbach, Linear predictability: A sea surface height case study. *J. Climate,* 31, 2599-2611, 2018.
(223) Fukumori, I., P. Heimbach, R. M. Ponte, C. Wunsch, A dynamically-consistent ocean climatology. *Bull. Am. Met. Soc., 99(10)* October*,* doi:10.1175/BAMS-D-17-0213.1,2107-2127, 2018.
(224) Amrhein, D., C. Wunsch, O. Marchal, G. Forget, A global glacial ocean state estimate constrained by 2 upper ocean temperature proxies. *J. Climate*, 31, 8059-8079, 2018..
(225) Wunsch, C. Towards determining uncertainties in global oceanic mean values of heat, salt, and surface elevation *Tellus A,* 1-14, 70, DOI: 10.1080/16000870.2018.1471911 2018.
(226) Wunsch, C. and R. Ferrari, One hundred years of the ocean circulation, Met. Monographs, *A Century of Progress in Atmospheric and Related Sciences: Celebrating the American Meteorological Society Centennial*, Ch. 7, 7.1-7-32, https://doi.org/10.1175/AMSMONOGRAPHS-D-18-0002.1, 2018.
(227) Sonnewald, M., C. Wunsch, P. Heimbach, Unsupervised learning reveals geography of global ocean dynamical regions. *Earth and Space Science,* 6, 784-794, 2019.

(228) Heimbach P., Fukumori I., and others. Putting it all together: Adding value to the global ocean and climate observing systems with complete self-consistent ocean state and parameter estimates. *Front. Mar. Sci.* 6:55. doi: 10.3389/fmars.2019.00055, 2019.

(229) Wunsch, C., Multi-year ocean thermal variability. *Tellus A,* 72, 1-15, 2020.

(230) Wunsch, C., Is the ocean speeding up? Ocean surface energy trends. *J. Phys. Oc.,* 50, 3205-3217, 2020

(231) Wunsch, C. and J. Wunsch, Baroclinic tidal conversion: Note on a paper of L. R. M. Maas, *J. Fluid Mech.*, vol.946, A47, doi:10.1017/jfm.2022.637, 2022.

(232) Wunsch, C., Can oceanic flows be heard? Abyssal melodies *J. Am. Acoust. Soc.*,152, 2160; doi: 10.1121/10.0014603, 2022.

(233) Roquet F. and Wunsch, C.. The Atlantic meridional overturning circulation and its hypothetical collapse. *Tellus A*: 74(1), 393–398. DOI: http://doi.org/10.16993/tellusa.679, 2022.

(234) Wunsch, C.,Williamson, S., Heimbach, P. Potential artifacts in conservation laws and invariants from sequential state estimation. *Ocean Sci.*,19,1253–1275, 2023.

(235) Wunsch C., Physical oceanography: The shift to a global view and its changing culture. *Perspectives of Earth and Space Scientists*, 4, https://doi.org/10.1029/2022CN000204, 2023.

(236) Wunsch, C., A simplified ocean physics? Revisiting abyssal recipes. *J. Phys. Oc., 55,*1387–1400, 2023. https://doi.org/10.1175/JPO-D-22-0229.1, 2023

(237) Wunsch, C. A time-average ocean: Thermal wind and flow spirals. *Prog. Oceanog.*, 2024, https://doi.org/10.1016/j.pocean.2024.103206, 2024.

(238) Wunsch, C., Patterns of kinetic energy conversion in a time-average upper ocean, Prog. Oceanog., in press, 2025.

(239) Wunsch, C. Statistical features of a time-averaged global state estimate: Strong regional variations and implications for sea level and heat content change. Submitted for publication, 2025.

(240) Ray, R. and Wunsch, C. Comments on "Linkage of El Niño-Southern Oscillation to astronomic forcing." Env. Res. Letts., in press, 2025.

(*Many of the most recent papers are available as pdf files on http://ocean.mit.edu/~cwunsch, or send me an email)*

**Books:**

Warren, B. A. and C. Wunsch (editors), *Evolution of Physical Oceanography. Scientific Surveys in Honor of Henry Stommel*, 623pp, The MIT Press, Cambridge (http://ocw.mit.edu-/ans7870/resources/Wunsch/wunschtext.htm), 1981.

Munk, W., P. Worcester, and C. Wunsch, *Ocean Acoustic Tomography*, Cambridge Univ. Press, Cambridge, 433 pp., 1995.

Wunsch, C., *The Ocean Circulation Inverse Problem,* Cambridge University Press, 437 pp., 1996.

Wunsch, C., *Discrete Inverse and State Estimation Problems. With Geophysical Fluid Applications,* Cambridge Un. Press, Cambridge 371pp., 2006.

Wunsch, C. *Modern Observational Physical Oceanography: Understanding the Global Ocean*, Princeton University Press, 492 pp., 2015.

**Other Publications: Carl Wunsch**

(1) Wunsch, C., Review of "Tides", by D. H. MacMillan, *Science*, 155, 61, 1967.

(2) Wunsch, C., Review of "The Ever Changing Sea" by D. B. Ericson and G. Wollin, *Science*, 159, 969, 1968.

(3) Wunsch, C., Array measurements of oceanic internal waves, *Trans. New England Regional Meeting of the IEEE, II,* 168-169, 1969.

(4) Wunsch, C., Review of the "The New World of the Oceans" by D. Behrman, *Science*, 165, 1343, 1969.

(5) Wunsch, C., Review of "Waves on Beaches and Resulting Sediment Transport", R. E. Meyer, ed., *Science*, 179, 1120-1121, 1973.

(6) Wunsch, C., Time Series Analysis (Lectures) , in Notes of *WHOI Geophysical Fluid Dynamics Summer Program*, Vol. I, 48-70, 1973.

(7) Wunsch, C., Review of "Dynamics of the Homogeneous and the Quasi-homogeneous Ocean", by W. B. Krauss, *EOS, Trans. Am. Geophys. Un.*, 55, 665-666, 1974.

(8) Wunsch, C., Internal waves in the sea, *Naval Res. Revs.*, 28, 4-17, 1976.

(9) Wunsch C., The Mid-Ocean Dynamics Experiment, *Oceanus*, 19, 45-53, 1977.

(10) V. Lee and C. Wunsch, eds., *Atlas of the Mid-Ocean Dynamics Experiment*, by the MODE-I Atlas Group, 274pp, US POLYMODE Office, MIT, Cambridge ,1977.

(11) Wunsch, C., Observations of equatorially trapped waves in the ocean, *Proceedings of FINE Summer Workshop*, Nova/NYIT Press, 1977.

(12) Wunsch, C., Review of "Variability of the Oceans", by A. S. Monin, V. M. Kamenkovich and V. G. Kort, *Nature*, 271, 286, 1978.

(13) Wunsch, C., Review of "The Sea, Vol. 6", E. D. Goldberg, et al., eds, *EOS, Trans. Am. Geophys. Un.*, 59, 539, 1978.

(14) Wunsch, C., Review of "Modelling and Predicting the Upper Layers of the Ocean", E. B. Kraus, Ed., *J. Fluid Mech.*, 92, 539, 1979.

(15) Member of Delegation, *Oceanography in China,* CSCPRC Rept. No. 9, 106pp, National Academy of Sciences, 1980.

(16) TOPEX Science Working Group (C. Wunsch, chairman), *Satellite Altimetric Measurements of the Ocean*, 78pp, Jet Propulsion Lab., Pasadena, 1981.

(17) Wunsch, C., Review of "Oceanography, The Past", M. Sears and D. Merriman, eds, *Science*, 212, 792-793, 1981.

(18) Wunsch, C., The promise of satellite altimetry, *Oceanus*, 24, 3, 17-26, 1981.

(19) Wunsch, C., Acoustic tomography and other answers, in *A Celebration in Geophysics and Oceanography, 1982, in Honor of Walter Munk*, 47-62, Scripps Inst. of Oceanog., La Jolla, 1984.

(20) Steering Group (C Wunsch, chairman), *Report of Workshop on Global Observations and Understanding of the General Circulation of the Oceans*, Woods Hole Ma, August 8-12, 1983, Nat. Acad. Scis., Washington, 1984.

(21) Born, G., C. Yamarone, and C. Wunsch, TOPEX - Observing the oceans from space, *EOS, Trans. Am. Geophys. Un.,* 65, 433-434, 1984.

(22) Wunsch, C., Review of "Modern Concepts of Oceanography", G. E. R. Deacon and M. B. Deacon, eds., *Bull. Am. Met. Soc.*, 65, 987-989, 1984.

(23) Wunsch, C., Testimony before Senate Subcommittee on Environmental Protection, of the Committee on Environment and Public Works, *Congressional Record* of 10 June 1986,

1986.
(24) Wunsch, C., Testimony before Senate Subcommittee on Environmental Protection, of the Committee on Environment and Public Works, *Congressional Record* of 14 Sept. 1988, 1988.
(25) Wunsch, C., Comments on oceanographic instrumentation development, *Oceanography,* 2, No.2, 26-27, 64, 1989.
(26) Willebrand, J. and C. Wunsch, Inversion of ocean general circulation models, *EOS*, January 2, 1990, 2-3,5, 1990.
(27) Wunsch, C., Review of "El Niño, La Niña and the Southern Oscillation", by S. G. H. Philander, *Science*, 248, 904-905, 1990.
(28) Wunsch, C., The ocean circulation from space, *Oceanus*, Summer, 1992, 9-17, 1992.
(29) Wunsch, C. Marine sciences in the coming decades, *Science*, 259, 296-297, 1993.
(30) Wunsch, C., The ocean circulation and climate, in *The General Circulation of the Oceans, Proceedings of the June 1991 Summer School, Istituto di Scienze Lettere ed Arti,* Venice Italy, 9-53, 1993.
(31) Wunsch, C., Physics of the ocean circulation, in F. Sansò and R. Rummel, eds., *Oceanography and Geodesy*, Springer-Verlag, 1993.
(32) Wunsch, C., Scientific surprises, in *Global Environmental Accords: Implications for Technology, Industry and International Relations. Symposium Proceedings,* N. Choucri, ed. MIT, 178-186, 1993.
(33) Wunsch, C., Introduction to papers on Strategy and Outlook, in *Collected Papers of Henry Stommel,* N. Hogg and R.-X. Huang, eds., American Meteorological Society, I115-I117, 1996.
(34) Wunsch, C., The ocean and climate - separating myth from fact. Twentieth Doherty Lecture on Oceans Policy of the Center for Oceans Law and Policy, Univ. of Virginia School of Law, May 2, 1996. *Marine Technology Soc. Journal*, 20, 65-68, 1996.
(35) Wunsch, C., Henry Stommel, *Biographical Memoirs of the National Academy of Sciences*, 72, 1-22, 1997. Also *Biographical Memoirs of the Fellows of the Royal Society of London,* 43, 491-502, 1997.
(36) Wunsch, C., Review of "The Life and Legacy of G. I. Taylor", by G. Batchelor, *Science*, 274, 1846, 1996.
(37) Wunsch, C., Uncertainty in oceanic general circulation models. In *Methods of Theoretical Physics Applied to Oceanography. Proceedings 9th Aha Hulika'a Hawaiian Winter Workshop*, January, 1997, SOEST Special Publication, U. of Hawaii, P. Müller and D. Henderson eds., 1-10, 1997.
(38) Stammer, D., C. Wunsch, R. Giering, Q. Zhang, J. Marotzke, J. Marshall, and C. Hill, *The Global Ocean Circulation Estimated from TOPEX/POSEIDON Altimetry and a General Circulation Model.* Report of the Center for Global Change Science, Dept of Earth, Atmospheric, and Planetary Sciences, MIT, Cambridge 40 pp., 1997.
(39) Munk, W. and C. Wunsch, The moon, of course.... *Oceanography,* 10*,* 132-134*,* 1997.
(40) Hughes, C., C. Wunsch and V. Zlotnicki, Measuring ocean bottom pressure from space. Report of a meeting. *EOS,* 81(7), p. 68, 2000.
(41) Wunsch, C., Inverse methods, in Steele, J. H., K. K. Turekian and S. A. Thorpe, *Encyclopedia of Ocean Sciences.* Academic Press, 2000.
(42) Wunsch, C., Moon, tides and climate. *Nature,* 405, 743-744, 2000.

(43) Wunsch, C., Ocean observations and the climate forecast problem, in *Meteorology at the Millennium.* R. P. Pearce, Ed., 217-224, Academic, London, 2002.
(44) Wunsch, C., Review of "Nonlinear and Nonstationary Signal Processing," W. J. Fitzgerald, R. L. Smith, A. T. Walden, and P. C. Young (Eds.), Cambridge University Press, *EOS,* 83(16), p. 180, 2002.
(45) Stammer, D., C. Wunsch, I. Fukumori, and J. Marshall, State estimation in modern oceanographic research, *EOS,* 83(27), 289&294-295, 2002.
(46) Frye, D., N. Hogg and C. Wunsch, Ultramoor: a new generation telemetering subsurface mooring system. *EOS,* 83(34), pp. 365,370-371, 2002.
(47) Frye, D., N. Hogg and C. Wunsch, A long duration mooring for ocean observation. *Sea Technology,* 45, 29-39, 2004.
(48) Wunsch, C., Towards the World Ocean Circulation Experiment and a bit of aftermath, in *Physical Oceanography: Developments Since 1950*, 181-201, Springer-Verlag, M. Jochum, R. Murtugudde, Eds., 2006.
(49)Wunsch, C., A hot topic, Letter to Editor, *The Economist*, 00130613, 9/30/2006, Vol. 380, Issue 8497, 2006.
(50) Wunsch, C. and J.-F. Minster, The ocean and climate. In *Comprendre le Changement Climatique,* C. Gauthier and J.-F. Fellous, Eds. Odile Jacob, Paris, 2007.
(51) Wunsch, C., Review of "Useless Arithmetic. Why Environmental Scientists Cannot Predict the Future" by O. H. Pilkey and L. Pilkey-Jarvis. *Am Sci.,* March-April, 171-172, 2007.
(52) Wunsch, C., Response to presentation of Bowie Medal. *EOS, Trans. Am. Geophys. Union,* 88(2), 16-17, 2007.
(53) Wunsch, C., Extremes, patterns, and other structures in oceanographic and climate records, in *Extreme Events. Proceedings Aha Huliko'a Hawaiian Winter Workshop*, January, 2007, SOEST Special Publication, U. of Hawaii, C. Garrett, P. Müller and D. Henderson Eds., 141-148, 2007.
(54) Baker, D. J., R. W. Schmitt and C. Wunsch, Long-term observations: Endowments and new institutions. *Oceanography,* 20(4), 10-14, 2007.
(55) Wunsch, C. The circulation of the ocean and its variability. *Prog. Physical Geography,* 32, 463-474, 2008.
(55a) Wunsch, C. Physics of the ocean circulation. In *Satellite Altimetry in Geodesy and Oceanography*, R. Rummel and F. Sansò, Eds., Springer, 10-98.
(56) Wunsch, C., Preface. *Seventy Years of Exploration in Oceanography. A Prolonged Weekend Discussion with Walter Munk*, by H. von Storch and K. Hasselmann, v-vii, Springer, Berlin, 2010.
(57) Wunsch, C., *Observational Network Design for Climate* doi:10.5270/OceanObs09.pp.41, (Vol. 1), 2010.
(58) Wunsch, C., R. A. Schmitt, D. J. Baker, Climate change as an intergenerational problem, *Proc. National Acad. Sci.,* 110, 4435-4436, 2013.
(59) ECCO Consortium, *A Twenty-Year Dynamical Oceanic Climatology: 1994-2013. Part 1: Active Scalar Fields: Temperature, Salinity, Dynamic Topography, Mixed-Layer Depth, Bottom Pressure.* Available online at MIT DSpace, 2017a.
(60) ECCO Consortium, *A Twenty-Year Dynamical Oceanic Climatology: 1994-2013. Part 2: Velocities, Property Transports, Meteorological Variables*, Mixing Coefficients, Available online at MIT DSpace, 2017b.

(61) Wunsch, C., TOPEX/POSEIDON As A Science Mission. To appear (in French) in French Institute on the History of Space (IFHE) book on space meteorology, atmospheric and ocean sciences. J-L Fellous Ed., 2017.
(62) Wunsch, C. Once Again—A Preface to Walter Munk. *For update of von Storch and Hasselmann book*. SIO, 2017.
(63) Wunsch, C., A Conversation with Walter Munk, *Annual Rev. Mar. Sci.*, 11, 15-25, with video, 2019.
(64) Wunsch, C., Walter Munk, 1917, *Nature,* 567, 14 March 2019..
(65) Garrett, C. and C. Wunsch, Walter Munk, *Biographical Memoirs of the Royal Society of London*, https://royalsocietypublishing.org/doi/10.1098/rsbm.2020.0003, 2020.
(66) Wunsch, C. Right place, right time: An informal memoir. *Ann Revs. Mar. Sci.*, 13, 1-21, 2021.
(67) Wunsch, C. The rise of dynamical oceanography: A fragmentary historical note: The Stommel-Munk Correspondence, 1947-1953. *Oceanography,* 34(1), 46-50, https://doi.org/10.5670-/oceanog.2021.101, 2021.
(68) Review of *A Book of Waves, by Stefan Helmreich.* IEEE Technology and Society Magazine,43(2), 2024.

Orcid No. 0000-0001-6808-3664