

## NEWELL GARFIELD, III

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### Education:

University of Rhode Island, Ph.D., 1990, Physical Oceanography. Dissertation Title: "The Brazil Current at Subtropical Latitudes." Prof. David L. Evans, Dissertation Committee Chairman. Profs. John A. Knauss, H. Thomas Rossby, and Frank M. White, committee members.

University of Delaware, M.S., 1977, Marine Sciences (Physical Oceanography). Thesis Title: "A Box Model Study of the Middle Atlantic Bight." Prof. Stuart L. Kupferman, Thesis Advisor.

Williams College, B.A., 1973, Geology.

### Professional Employment:

2001-present: Associate Professor of Geosciences, San Francisco State University, San Francisco, CA

1998-2001: Assistant Professor of Geosciences, SFSU, San Francisco, CA

1998-present: Visiting Professor, Naval Postgraduate School, Monterey, CA

1992-1998: Research Assistant Professor, Naval Postgraduate School, Monterey, CA

1997-1998: Part-time Lecturer, Cal. State Univ. Monterey Bay, Seaside, CA

1989-1992: Adjunct Research Professor, Naval Postgraduate School, Monterey, CA

1989: Assistant Marine Scientist, Graduate School of Oceanography, University of Rhode Island, Kingston, RI

1983-1989: Graduate Research Assistant, Graduate School of Oceanography URI, Kingston, RI

1976-1983: Research Associate, Bigelow Laboratory for Ocean Sciences, West Boothbay Harbor, ME

1973-1976: Graduate Research Assistant, College of Marine Studies, University of Delaware, Newark, DE

### Professional Experience:

Research interests include the hydrodynamics of coastal areas and currents along continental margins. Research projects have included studies of the Slope Water off the northeastern United States, circulation and water mass formation in the Gulf of Maine, measurement of the Brazil Current between 24° and 30° S, measurements of the California Current and Undercurrent, and determination of nearshore bathymetry using hyperspectral sensors. Investigative techniques have emphasized combining traditional *in situ* data and new *in situ* measuring techniques with satellite remotely sensed data. Involvement in both primarily physical oceanography programs and multidisciplinary programs.

Extensive seagoing experience with over 40 major research cruises to both hemispheres of the Atlantic and Pacific oceans. Research conducted from all types of vessels, from rowboats to sailboats, submersibles to 400+' research vessels. Chief scientist for more than 20 cruises, most on UNOLS research vessels, and served as captain on a 48' coastal research vessel. Worked with all aspects of conventional oceanographic equipment.

Teaching experience (Appendix B) includes teaching three undergraduate and three undergraduate/graduate courses at SFSU: Introductory Oceanography, Introduction to Oceanography Laboratory, Computer methods for Geoscientists, Physical Oceanography, Coastal Processes, and Remote Sensing for Geoscientists. At NPS I taught five graduate-level courses: Remote

Sensing of the Atmosphere and Ocean, Advanced Topics in Satellite Oceanography, Introductory Descriptive Physical Oceanography, Operational Oceanography, and Air/Ocean Remote Sensing for Interdisciplinary Curricula. I have been Thesis Advisor or Co-advisor (Appendix A) to ten candidates for Masters Degree and have been on three PhD committee. Currently serving on one masters committee. Have taught an undergraduate general oceanography course at Hartnell Community College, Salinas, CA. and undergraduate physics at CSU Monterey Bay, Seaside, CA.

Computer experience includes Digital VAX's, IBM mainframes, SGI and Sun UNIX workstations, and IBM, HP, and Apple (Macintosh) personal computers. Versatile in BASIC and FORTRAN and have a working knowledge of C. Also have extensive experience with many packages including MATLAB, IDL and ENVI, PlotPlus, TeraScan Systems, and the DSP satellite processing software developed by the University of Miami.

Awards:

NASA ASEE Summer Fellowship, 1999 and 2001  
Outstanding Instructional Performance Award, Naval Postgraduate School, October 1995  
Bonus Performance Awards, Naval Postgraduate School, September 1993 and 1995  
Outstanding Student Paper Award, American Geophysical Union 1988 Fall Meeting

Professional Memberships:

American Geophysical Union  
The Oceanography Society (Charter Member)  
Alliance for Marine Remote Sensing Association  
Eastern Pacific Oceanographic Conference

Professional Service Activities

Chairman, Ocean Sciences Section Meeting Committee, American Geophysical Union 2002–present  
Steering Committee ALERT (Augmented Learning Environment and Renewable Teaching), a CSU/NASA partnership for pre–service teacher earth–science education 2000–2001  
Secretary–Physical Oceanography, Ocean Sciences Section, American Geophysical Union 2000–2002  
Meeting Co–Chairman, Ocean Sciences Section, American Geophysical Union 2001 fall meeting  
Meeting Chairman, Ocean Sciences Section, American Geophysical Union 2000 fall meeting  
Secretary–Physical Oceanography, Ocean Sciences Section, American Geophysical Union 1998–2000  
Meeting Chairman, Ocean Sciences Section, American Geophysical Union 1999 fall meeting  
Meeting Chairman, Ocean Sciences Section, American Geophysical Union 1998 fall meeting  
Meeting Chairman, 1994 Eastern Pacific Oceanography Conference  
Contributor and Reviewer – Monterey Bay National Marine Sanctuary EIS, 1992  
Manuscript Reviewer – *J. Geophysical Res.*, *J. Phys. Oceanogr.*, and others as requested  
Proposal Reviewer – National Science Foundation, as requested

Community Service Activities

Judge, Marin County Science Fair, March 1999 and January 2000, 2001  
Participant, RTC Discovery Day October 1998, 1999, 2000 and 2001  
Presenter, “Coastal Ecology Teacher’s Workshop,” April 2000, March 2001  
Presenter, “Teachers’ Day by the Bay,” San Francisco Bay Educator’s Workshop, November 1999  
Presenter, “Point Reyes National Seashore Oceanography Workshop,” March 1999

Bibliography:

Journal Articles:

Published Since Joining the SFSU Faculty

Garfield, Newell, Mathew E. Maltrud, Curtis A. Collins, Thomas A. Rago, and Robert G. Paquette, Lagrangian flow in the California Undercurrent, an observation and model comparison. *J. Mar. Sys.* **29**, 201–220, 2001.

Collins, C. A., N. Garfield, T. A. Rago, F. W. Rischmiller and E. Carter, Mean structure of the inshore countercurrent and California Undercurrent off Pt. Sur, California. *Deep-Sea Res.*

47(5-6), 765-782, 2000.

Steger, John M., Franklin B. Schwing, Curtis A. Collins, Leslie K. Rosenfeld, Newell Garfield, and Erhan Gezgin, Circulation and water masses in the Gulf of the Farallones. *Deep-Sea Res.* **47**(4-5), 907-946, 2000.

Garfield, N., C. A. Collins, R. G. Paquette, E. Carter, Lagrangian exploration of the California Undercurrent, 1992-1995. *J. Phys. Oceanogr.* **29**(4), 560-583, 1999.

Steger, John, Curtis A. Collins, Frank Schwing, Marlene Noble, Newell Garfield, and Marc Steiner, An empirical model of tidal currents in the Gulf of the Farallones. *Deep-Sea Res.*, **45**(8-9), 1471-1505, 1998.

Published Prior to Joining the SFSU Faculty

Lupton, John E., E. T. Baker, N. Garfield, G. Massoth, R. Feely, J. Cowen, R. Greene, T. A. Rago, Tracking the evolution of a hydrothermal event plume using a RAFOS neutrally buoyant drifter. *Science* **280**, 1052-1055, 1998.

Collins, C. A., N. Garfield, A. S. Mascarenhas, Jr., and M. G. Spearman, Ocean current measurements across the entrance to the Gulf of California in April and December, 1992. *J. Geophys. Res.* **102**(C9), 20927-20936, 1997.

Collins, C. A., N. Garfield, R. G. Paquette, and E. Carter, Lagrangian measurements of subsurface poleward flow between 38°N and 43°N along the west coast of the United States during summer, 1993. *Geophys. Res. Lett.*, **23**(18), 2461-2464, 1996.

Rosenfeld, L. K., F. B. Schwing, N. Garfield, and D. E. Tracy, Bifurcated flow from an upwelling center: a cold water source for Monterey Bay. *Cont. Shelf Res.* **14**(9), 931-964, 1994.

Garfield, N., T. A. Rago, K. J. Schnebele, and C. A. Collins, Evidence of Strong Episodic Bottom Currents in Monterey Submarine Canyon Associated with the 1989 Loma Prieta Earthquake. *Cont. Shelf Res.* **14**(6), 673-686, 1994.

Schwing, F. B., D. M. Husby, N. Garfield, and D. E. Tracy, Mesoscale Response of Coastal Waters off Central California to Wind Events Following the Spring 1989 Transition: Analysis of CTD Surveys and AVHRR Imagery. *Calif. Coop. Oceanic Fish. Invest. Repts.* **32**, 47-62, 1991.

Garfield, N., The Brazil Current at Subtropical Latitudes. University of Rhode Island, Kingston RI, Ph.D. dissertation, 122 p, 1990.

Garfield, N., and D. L. Evans, Shelf Water Entrainment by Gulf Stream Warm-core Rings, *J. Geophys. Res.*, **39**(12), 13003-13012, 1987.

Hopkins, T. S., and N. Garfield, Physical Origins of Georges Bank Water, *J. Mar. Res.*, **39**(3), 465-500, 1981.

Yentsch, C. S., and N. Garfield, Principal Areas of Vertical Mixing in the Waters of the Gulf of Maine, with Reference to the Total Productivity of the Area, in *Oceanography from Space*, J. F. R. Gower, ed., Plenum Publishing Corp., pp. 303-312, 1981.

Hopkins, T. S., and N. Garfield, Gulf of Maine Intermediate Water, *J. Mar. Res.*, **37**(1), 103-109, 1979.

Kupferman, S. L., and N. Garfield, Transport of Low-salinity Water at the Slope Water-Gulf Stream Boundary, *J. Geophys. Res.*, **82**(24), 3481-3486, 1977.

Journal Articles in Preparation:

Garfield, Newell, Richard C. Olsen, and L. Douglas Stuffle, Lake Tahoe bathymetry derived from HYDICE hyperspectral visible imagery.

Recent Conference, Seminar and Workshop Presentations (partial listing):

## Presentations Since Joining the SFSU Faculty

- Garfield, N., J. Largier, and D. Peterson, Hydrography off Bodega, CA, During June 2000 and 2001 CoOP/WEST Survey Cruises. *EOS* **83**(4) Ocean Sciences Suppl. OS21S–03 2002.
- Garfield, N., Wind Events and Shelf Transport (WEST): Survey cruises off Bodega during June 2000 and 2001. Gulf of the Farallones National Marine Sanctuary 6<sup>th</sup> Biennial Workshop on Research. San Francisco, CA., October 25, 2001
- Garfield, N., and J. Largier, Ship-based Observations of Wind-Driven Oceanographic variability over the shelf near Bodega Bay, California, during June 2000. *EOS* **81**(48) F685 2000.
- Collins, C.A., N. Garfield, T.A. Rago, R.G. Paquette, E. Carter, Lagrangian Measurements of Intermediate Level Flow in the California Current System. *EOS* **81**(48) F661 2000.
- Garfield, N., M. Maltrud, C. A. Collins, T. A. Rago, and R. G. Paquette, Lagrangian view of the California Undercurrent: Observations and Models. LAPCOD Meeting, Ischia, Italy. October 2000.
- Ralph T. Cheng, Donald E. Barrick, Jeffrey W. Gartner, and Newell Garfield, Application of HF Radar in San Francisco Bay for Spatial Mapping of Tidal Circulation. 10th International Conference on Physics of Estuarine and Coastal Seas, Norfolk, VA. November 2000
- Garfield, N., The California Undercurrent as observed with Lagrangian subsurface floats and in a near-global ocean model simulation. Moss Landing Marine Laboratory Seminar Series, September, 2000
- Barrick, D., R. Cheng, N. Garfield, J. Paduan, J. Gartner, and L. Pederson, Toward Bay/Harbor Circulation Model Improvement Incorporating HF Radar Data Based on SeaSonde Deployments on San Francisco Bay. OCEANS 2000 MTS/IEEE
- Garfield, N., M. Maltrud, C. A. Collins, T. A. Rago, and R. G. Paquette, Lagrangian view of the California Undercurrent: Observations and Models. *EOS* **80**(49), OS100 1999.
- Barrick, Donald E., R. T. Cheng, P. M. Lilleboe, J. W. Gartner and N. Garfield, Optimizing SeaSonde algorithms for high-resolution mapping of circulation near harbors for assimilation into models. *EOS* **80**(49), OS80, 1999
- Garfield, Newell, The outer limits: A Lagrangian Study of the California Undercurrent. Gulf of the Farallones National Marine Sanctuary 5<sup>th</sup> Biennial Workshop on Research. San Francisco, CA., January 11, 2000
- Garfield, N., C. A. Collins, R. G. Paquette, M. Maltrud, T. A. Rago, and E. Carter, Lagrangian measurements of intermediate level flow in the California Current System, 31<sup>st</sup> International Liege Colloquium on Ocean Hydrodynamics, Liege, Belgium, May, 1999.
- Garfield, N., R. C. Olsen and L. D. Stuffle, Lake Tahoe Bathymetry from Hyperspectral Imagery, *EOS* **79**(17) Supplement S169, 1998

## Presentations Prior to Joining the SFSU Faculty

- Garfield N., C. A. Collins, R. G. Paquette, T. A. Rago and E. Carter, Lagrangian measurements of the California Undercurrent off central and northern California, *EOS* **77**(46), F344, 1996.
- Lupton, J. E., E. T. Baker, N. Garfield, R. Greene, and T. A. Rago, Successful tracking of a hydrothermal event plume with a RAFOS neutrally-buoyant drifter, *EOS* **77**(46), F1, 1996.
- Garfield, N., E. Carter, T. A. Rago, C. A. Collins, and R. G. Paquette, California Undercurrent RAFOS Study, RAFOS float technology workshop, Woods Hole Oceanographic Institution, Woods Hole, MA, January 13-14, 1994.
- Garfield, N., T. A. Rago, M. G. Spearman, and C. A. Collins, Hydrographic and Pegasus observations at the mouth of the Gulf of California, *EOS* **75**(3), 123, 1994.

- Jessen, P. F., S. R. Ramp, and N. Garfield, Hydrographic and ADCP data from May 1993: initial conditions for a mesoscale eddy in the California Current System, *EOS* **75**(3), 140, 1994.
- Rischmiller, F. W., N. Garfield, C. A. Collins, and T. A. Rago, Seasonal variability of Ocean Currents off Pt. Sur, California. *EOS* **74**(43), 325, 1993.
- Garfield, N., F. B. Schwing, S. R. Ramp, C. A. Collins, P. F. Jessen, T. A. Rago, and L. K. Rosenfeld, Gulf of Farallones hydrography: upper layer water mass seasonal variability. *EOS* **73**(43), 315, 1992.
- Garfield, N., T. A. Rago, C. A. Collins, and K. J. Schnebele, Movement of Bottom-Deployed Instruments in Monterey Bay Canyon During the 17 October 1989 Loma Prieta Earthquake. *EOS* **72**(44), 246, 1991.
- Collins, C.A., E. Carter, and N. Garfield, The California Undercurrent: New Meanders for the 90's. EPOC and CALCOFI joint session, Lake Arrowhead, CA, 1991.
- Garfield, N., The Brazil Current at Subtropical Latitudes, Univ. Autonoma de Baja Calif., Enseñada, BC, 5 June 1991.

Nonrefereed Publications (partial listing):

- The AGU Fall Meeting Program Committee, Frequently Asked Questions About Abstract Submissions, *EOS***81**(19) 212, 2000

Technical Reports (partial listing):

- Ramp, S. R., N. Garfield, C. A. Collins, L. K. Rosenfeld, and F. B. Schwing, Circulation studies over the continental shelf and slope near the Farallon Islands, CA. Executive Summary for a study sponsored by the U. S., Environmental Protection Agency. Naval Postgraduate School, Monterey, CA. NPS-OC-95-004, 22pp plus figures, 1995.
- Garfield, N., C. A. Collins, T. A. Rago, A. Mascarenhas, and A. Sanchez Devora, Pegasus in the Sea of Cortes Area (PESCAR): Pegasus Data Report for PESCAR Cruises in April and December, 1992. Naval Postgraduate School, Monterey, CA. NPS-OC-95-001, 80pp, 1995.
- Locke, J. G., T. A. Rago, C. A. Collins, N. Garfield, and P. F. Jessen, Hydrographic data from California waters between the Santa Rosa/Cortes Ridge and the Farallones: May through October 1990. Naval Postgraduate School, Monterey, CA. NPS-OC-93-002, 143p, 1993.
- Rago, T. A., R. Mitchell, L. F. Navarro-Olache, N. Garfield, and C. A. Collins, Hydrographic Data from the Pegasus in the Sea of Cortes Area Cruise (PESCAR-01). Naval Postgraduate School, Monterey, CA. NPS-OC-92-009, 125pp, 1992.
- Jessen, P. F., S. R. Ramp, C. A. Collins, N. Garfield, L. K. Rosenfeld, and F. W. Schwing, Hydrographic and acoustic doppler current profiler (ADCP) data from the Farallones shelf and slope study: 29 October – 3 November 1991. Naval Postgraduate School, Monterey, CA. NPS-OC-92-007, 183pp, 1992.
- Jessen, P.F., S. R. Ramp, C. A. Collins, N. Garfield, L. K. Rosenfeld, and F. B. Schwing, Hydrographic and Acoustic Doppler Current Profiler (ADCP) data from the Farallones Shelf and Slope Study, 13-18 February 1991. Naval Postgraduate School, Monterey, CA NPS-OC-92-003, 167 pp, 1992.
- Garfield, N., Hydrographic Data from Leg II, R/V Gyre Cruise 84G7, 25-29 June, 1984, Bigelow Laboratory Technical Report 46, 6 p. plus data tables, 1984.
- Garfield, N., G. E. Friederich, and L. A. Codispoti, INDEX 1979: Chemical Oceanographic Observations from off the Somali Coast during 1979, Bigelow Laboratory Technical Report 34, 11 p. plus data tables, 1983.
- Garfield, N., L. A. Codispoti, and T. T. Packard, FRAM III Chemical and Biochemical Data

- Obtained by Bigelow Laboratory Investigators, Bigelow Laboratory Technical Report 26, 52 p., 1982.
- Parker, C. E., and N. Garfield, Station Data Obtained in Northwestern Gulf of Maine Coastal Area, October, 1979, Bigelow Laboratory Technical Report 15, 117 p., 1981.
- Parker, C. E., and N. Garfield, Station Data Obtained in Northwestern Gulf of Maine Coastal Area, April 1979, Bigelow Laboratory Technical Report 15, 117 p., 1981.
- Kilpatrick, K., N. Garfield, G. Grunseich, and D. Phinney, R/V Oceanus “68”, August 17-30, 1979, Bigelow Laboratory Technical Report 10, 113 p., 1979.
- MacIsaac, J. J., J. E. Kogelschatz, B. H. Jones, Jr., J. C. Paul, N. F. Breitner, and N. Garfield, JOINT II R/V Alpha Helix Productivity and Hydrographic Data, March–May 1976, I. O. O. E. - C. U. E. A. Data Report No. 48, Bigelow Laboratory Technical Report 2-79, 1979.
- Hopkins, T. S., and N. Garfield, Physical Oceanography, In *A summary and Analysis of Environmental Information on the Continental Shelf from Bay of Fundy to Cape Hatteras*, Center for Natural Areas, South Gardiner, ME., Vol 1, book 1, pages IV-1 to IV-177, 1977.

## APPENDIX A

## Completed Masters Theses Supervised by Newell Garfield

- Variations in coastal circulation off central California, Spring-Summer of 1993, 1994, and 1995, LT (NOAA Corps) Heather A. Parker, Master of Science in Physical Oceanography, Naval Postgraduate School, Monterey, CA, December, 1996 (co-advised with Dr. Frank Schwing, NOAA).
- Bathymetry from hyperspectral imagery, LT (USN) L. Douglas Stuffle, Master of Science in Physics, Naval Postgraduate School, Monterey, CA, December, 1996 (co-advised with Prof. Richard Olsen).
- Spring–summer sea surface temperature variability off northern and central California from AVHRR satellite imagery, Edward M. Armstrong, Master of Science in Marine Science, San Francisco State University, San Francisco, CA, May 1966 (co-advised with Prof. William Broenkow, MLML, and Dr. Frank Schwing, NOAA).
- High frequency subsurface Lagrangian measurements in the California Current with RAFOS floats, LT (USN) Kirk R. Benson, Master of Science in Meteorology and Physical Oceanography, Naval Postgraduate School, Monterey, CA, September 1995.
- Detiding shipboard–mounted ADCP data: an analysis of model data and observations using a polynomial interpolation method, LT (USN) Marc T. Steiner, Master of Science in Meteorology and Physical Oceanography, Naval Postgraduate School, Monterey, CA, December 1994 (co-advisor with Dr. Frank Schwing, NOAA).
- Seasonal variability of ocean currents off Pt. Sur, California from May 1988 to April 1991, LT (USN) Frederick W. Rischmiller, Master of Science in Physical Oceanography, Naval Postgraduate School, Monterey, CA, December 1993.
- Water masses and the thermohaline circulation at the entrance to the Gulf of California, LT (USN) Monty G. Spearman, Master of Science in Physical Oceanography, Naval Postgraduate School, Monterey, CA, September 1993 (co-advised with Prof. Curtis Collins).
- Determination of near–surface velocity fields in the CTZ using combined altimetric and inverse modelling, by LCDR (USN) Douglas M. Taggart, Master of Science in Meteorology and Physical Oceanography, Naval Postgraduate School, Monterey, CA, March 1991 (co-advised with Prof. Steven R. Ramp).
- An analysis of hydrographic data collected off Point Sur, California in June 1990, by LT (Hellenic Navy) Georgios Tziagidis, Master of Science in Physical Oceanography, Naval Postgraduate School, Monterey, CA, September 1991.
- Source of cold water in Monterey Bay observed by AVHRR satellite imagery, CDR (NOAA Corps) Dan E. Tracy, Master of Science in Physical Oceanography, Naval Postgraduate School, Monterey, CA, December 1990 (co-advised with Dr. Leslie Rosenfeld, MBARI, and Dr. Frank Schwing, NOAA).

PhD committee member

The Assimilation of Satellite Altimeter Data into a Global Ocean Eddy Resolving Model, Robin Tokmakian, PhD in Physical Oceanography, Naval Postgraduate School, Monterey, CA, June 1997.

Use of ship-mounted acoustic doppler current profiler data to study mesoscale oceanic circulation patterns in the Archipiélago De Colon (Galapagos Islands) and the Gulf of the Farallones, LTCR (NOAA Corps) John M. Steger, PhD in Physical Oceanography, Naval Postgraduate School, Monterey, CA, June 1997.

Kinematics and dynamics of a cyclonic eddy off Pt. Arena, California, May 1993, LT (Portuguese Navy) Rogério P. A. Chumbinho, PhD in Physical Oceanography, Naval Postgraduate School, Monterey, CA, December 1994.

## APPENDIX B

## Summary of Courses Taught by Newell Garfield

## SFSU classes

- Geol/Metr 102 Introduction to Oceanography: (taught six times) Basic principles of oceanography stressing the components of the dynamic ocean system. Topics include formation of ocean basins, oceanic influences on climate; waves and tides; human relationship to and impact on the ocean; source of fresh water and energy. Designed for non-science majors.
- Geol/Metr 103 Introduction to Oceanography Laboratory: (taught twice) Field trips and laboratory exercises to provide students with direct experience with the principles taught in Geol/Metr 102. The class includes a one day cruise on the *R/V Point Sur*. Designed for non-science majors.
- Geol 415 Computer Techniques in Geology (taught once): This class is an introduction to programming in MATLAB. The course is designed to introduce geoscience, marine biology students and others interested in learning to program. Since programming is not a spectator sport, during the lectures students are at a computer terminal trying out the posed examples and then the laboratory period is used for answering questions and writing project code.
- Geol 465/765 Introductory Physical Oceanography: (taught twice) The dynamic character of the ocean environment with emphasis on the properties of sea water, surface heat transfer, Coriolis force, surface and deep ocean circulation, deep and shallow wave phenomena, and underwater sound and optics. Designed for both the physical scientist and marine biologist. Classwork, two units; laboratory and fieldwork, one unit.
- Geol 452/752 Coastal Processes: (taught twice) This class focuses on the physical factors affecting the coastal zone in both high (beaches) and low (estuaries) energy regions. The course is a combination of seminar type class work, field studies and a formal research project.
- Metr 490/790 Remote Sensing for Geoscientists: (taught once) This course treats the collection of remote sensing imagery as a system and presents the major elements of the system. The system includes the principles of radiative transfer of electromagnetic energy through the atmosphere, satellite orbit and sensor design considerations and the basic elements of image processing, manipulation and interpretation. Emphasis is placed on passive sensors imaging in the visible and infrared portion of the spectrum. Class work is devoted to exploration of the radiative transfer equation through the atmosphere and the design considerations of sensors and satellites. Laboratory exercises demonstrates these principles through examination of a wide variety of data collected from different operational sensors.

## NPS classes

- OC3230 Descriptive Physical Oceanography: (taught twice) This class introduces the physical properties of sea water and the processes which control the distribution of heat, salt and density in the ocean. After introducing the basic balance of forces on a rotating planet, the distinction between wind driven and thermohaline circulation is developed. The final segment covers description of the of the world ocean water masses and circulation. A one day cruise on the *R/V Point Sur* provides an introduction to sampling instruments and at-sea data collection.
- OC3520 and OC3522 Remote Sensing of the Atmosphere and Ocean: (taught 3 times) This class offers an introduction to the theory and practice of using satellite-transported instruments to obtain geophysical data on the atmosphere and ocean. Satellite systems and the physical and mechanical considerations of obtaining data from space comprise the first third of the class. Development of the radiative transfer equation solution, and application to passive remote sensing of environmental phenomena using energy in the visible to the microwave portion of the electromagnetic spectrum are covered in the middle portion of the class. The final segment of the class is a presentation of active remote sensing instruments, altimeters, scatterometers and synthetic aperture radar. The laboratory component demonstrates how the classroom developed concepts are implemented.

OC3570 Operational Oceanography: (taught once) This class presents the students with the problems of planning, collecting and evaluating oceanographic data by conducting a five day oceanographic cruise aboard the R/V Point Sur. This hands-on class uses the time before the cruise to plan each individual project and to present the capabilities of XBTs, CTDs, ADCPs, rosette samplers, shipboard environmental and navigational systems, and satellite imagery. Following the cruise, the students prepare and present their projects. This course could easily be adapted to include biological, chemical, and geological oceanography and could be taught at either the undergraduate or graduate level.

OC4520 Topics in Satellite Remote Sensing: (taught once) This elective is a seminar course where the students first study selected oceanographic studies using remotely sensed data and then prepare for class presentation and discussion a research paper on a satellite remote sensing topic. Students often use this class as preparation for their thesis research.

SS3525 Air/Ocean Remote Sensing for Interdisciplinary Curricula: (taught once) The Space Systems Academic Group is responsible for students in the Space Systems Operations, Space Systems Engineering, Anti-Submarine Warfare, Underwater Acoustics and other interdisciplinary curricula. This class exposes the engineers to the remotely sensed information needed by environmental science. The principles of radiative transfer and sensor capabilities of both active and passive sensors are developed. The laboratory sessions illustrate the lecture concepts and provide experience with manipulating environmental digital data with interactive computer systems.

Hartnell College class

Oceanography 1: (taught once) This general oceanography undergraduate course presents an introduction to the science of oceanography. The topics covered include a history of oceanography sciences, plate tectonics and coastal geology, sediments, physical and chemical properties of seawater, ocean circulation, weather, and biological oceanography.

CSU Monterey Bay class

ESSP 220 & 221 (Physics 1 & 2): Earth Systems Applications (taught laboratory component three times) A two-semester lab and lecture sequence that develops a quantitative understanding of the fundamental principles of physics and their applications to earth systems. The first semester is a required course for students in the Earth Systems Science and Policy curriculum. The second semester is an optional course.