Climate Change - Course Outline
John M. Murray

Climate Change

Vision: Weaving a New, Regenerative World

Blue Marble, Apollo 17, December, 1972

Courtesy NASA

What We Want to Achieve:

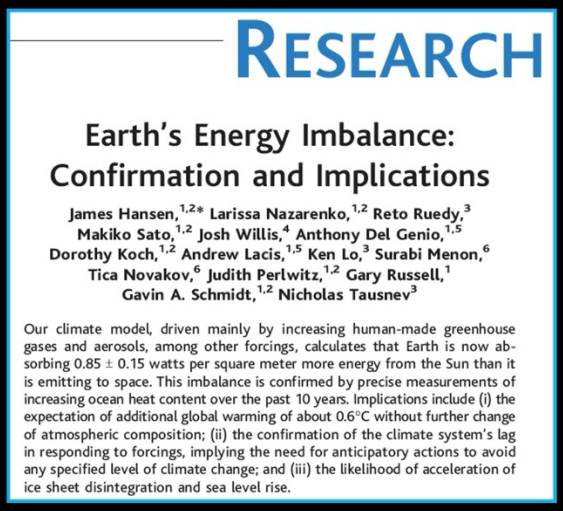
- What is climate change?
- Why is the climate changing?
- How will it affect us?
- How long will it last?
- What can we do about it?
- What will it cost?
- Synthesis: What fundamental transformations will be required to deal with climate change?

Happy Cly, Navajo Weaver
Courtesy Joseph Muench

Navajo Rug, Holy People
Courtesy Emily Malone

Climate Change

"All ethics so far evolved rest upon a single premise: that the individual is a member of a community of interdependent parts."
- Aldo Leopold, *The Land Ethic*



RESEARCH

Earth's Energy Imbalance: Confirmation and Implications

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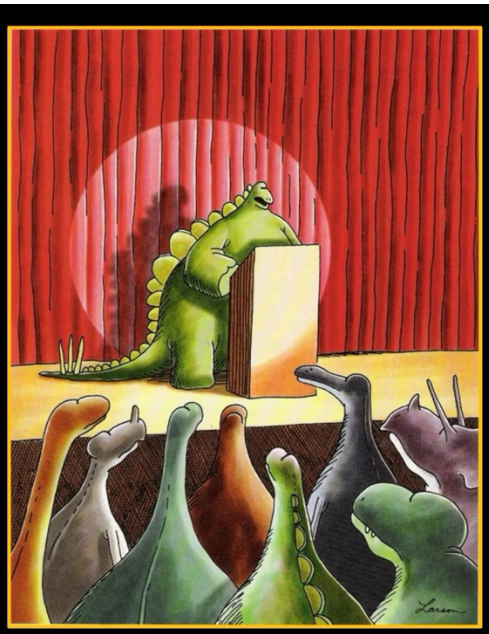
Our climate model, driven mainly by increasing human-made greenhouse gases and aerosols, among other forcings, calculates that Earth is now absorbing 0.85 ± 0.15 watts per square meter more energy from the Sun than it is emitting to space. This imbalance is confirmed by precise measurements of increasing ocean heat content over the past 10 years. Implications include (i) the expectation of additional global warming of about 0.6°C without further change of atmospheric composition; (ii) the confirmation of the climate system's lag in responding to forcings, implying the need for anticipatory actions to avoid any specified level of climate change; and (iii) the likelihood of acceleration of ice sheet disintegration and sea level rise.

Courtesy *Science Vol. 308 3 June, 2005*



The picture's pretty bleak gentlemen. The world's climates are changing, the mammals are taking over, and we all have a brain about the size of a walnut."

Courtesy Gary Larson

“This institution will be based on the illimitable freedom of the human mind. For here we are not afraid to follow truth wherever it may lead, nor tolerate any error so long as reason is left free to combat it.”

- Thomas Jefferson, regarding the University of Virginia, in *Jefferson and His Time, Volume Six: The Sage of Monticello* by Dumas Malone

“ The American war is over: but this is far from being the case with the American revolution. On the contrary, nothing but the first act of the great drama is closed. It remains yet to establish and perfect our new forms of government; and to prepare the principles, morals, and manners of our citizens, for these forms of government, after they are established and brought to perfection.”

- Benjamin Rush, *Address to the People of the United States*, American Museum, January 1787

“When a vision comes from the thunder beings of the West, it comes with terror like a thunder storm; but when the storm of vision has passed, the world is greener and happier; for wherever the truth of vision comes upon the world, it is like a rain. The world, you see, is happier after the terror of the storm...you have noticed that truth comes into this world with two faces. One is sad with suffering, and the other laughs; but it is the same face, laughing or weeping... as lightning illuminates the dark, for it is the power of lightning that heyokas have.”

- Black Elk (Hehaka Sapa), in *Black Elk Speaks,* by John Neihardt

There are moments when I am in kinship with all, seeing into the world and its life, sometimes even the universe.

- Linda Hogan, *The Radiant Lives of Animals*

“Give us your tired and weak / And we will make them
strong / Bring us your foreign songs / And we will sing along.”

- Willie Nelson, *Promiseland*

Week 1. Introduction

1.1 Vision: Weaving a New, Regenerative World
1.2 Climate Change: A Broad Canvas Encompassing Art, Ethics, Politics, and Science
1.3 Course Philosophy
1.4 Exploration: Scenes of Visionary Enchantment
1.5 Thumbnail Biosketch
1.6 Wernher von Braun, John F. Kennedy at Marshall Space Flight Center, Huntsville, Alabama
1.7 Beyond the Bounds of the Solar System
1.8 Mentors: Jack S. Kilby & Jay W. Lathrop, Dallas, Texas & Clemson University
1.9 Intel 8086 Microprocessor, Santa Clara, California
1.10 Douglas Fir Forest, Eugene, Oregon
1.11 Six Mile Cypress Slough Preserve, Fort Myers, Florida
1.12 Planetary Motion
1.13 Planetary Atmospheres
1.14 Energy
1.15 Climate Change: An Unprecedented Experiment With Earth
1.16 Climate Change: An Unprecedented Experiment With Earth (Continued)
1.17 Warming Indicators
1.18 Climate Change Impacts: Physical and Biological
1.19 Energy Balance & Temperature
1.20 Ethics, Earth’s Energy Imbalance, and Extinctions
1.21 Thinking About the World Holistically: The Systems Thinking “Iceberg” and The Earth System

1.22 Climate Change Scenarios: Computer Simulations of Global Temperature Anomalies
1.23 Silicon Solar Panels at Water Lily Farm in China, Graph of Carbon Dioxide Emissions vs. Time
1.24 Western and Indigenous Histories: Western Perspectives (Petrarch, Donella Meadows)
1.25 Neo-Classical Economic Theory: Economics Independent of the Biophysics of Natural Systems
1.26 Western and Indigenous Histories: Indigenous Perspectives (Kills Two, Winter Count)
1.27 Climate Change in Fiji, Indigenous Perspectives, Reverend Thomas Baker
1.28 Scientific Research in Fiji: A Coconut Story
1.29 Scientific Research in Fiji (Continued)
1.30 Map of Beqa Lagoon, Beqa Lagoon Fauna
1.31 Climate Change in Beqa Lagoon
1.32 Nautical Diplomacy in Fiji
1.33 Western and Indigenous Histories: Indigenous Perspectives (Albert White Hat, "Hello, my relatives…")
1.34 Western and Indigenous Histories: Indigenous Perspectives (White Hat Family, 1942)
1.35 Western and Indigenous Histories: Indigenous Perspectives (Spring Creek, South Dakota)
1.36 Western and Indigenous Histories: Indigenous Perspectives (Hollow Horn Bear, 1900)
1.37 Western and Indigenous Histories: Indigenous Perspectives (Independence Day Pow Wow, 2000)
1.38 Climate Change in Antarctica
1.39 Climate Change in The Wild
1.40 Climate Change in Utah and South Florida
1.41 The Intersection of Science, Culture, Policy, and Justice
1.42 The National Center for Atmospheric Research (NCAR), Boulder, Colorado
1.43 Climate Change Solutions: An On-Grid, Solar Photovoltaic System
1.44 Climate Change Solutions: *Raine House*, A Pro Bono,1,200 Square-Foot, Direct-Gain, Passive Solar Home on the Navajo Nation
1.45 The National Renewable Energy Laboratory (NREL), Golden, Colorado
1.46 Climate Change Solutions: *Vagabond House*, An 8' x 19' x 13' Tiny House with a 1.0 kW Solar Photovoltaic Electrical System
1.47 Climate Change Solutions: A Year-Round, Passive Solar Greenhouse with Energy Storage
1.48 Climate Change Solutions: Net Zero Energy Homes
1.49 Climate Science: Climate and Weather
1.50 Climate Change: Trusting Science
1.51 How Science Works
1.52 How Science Works (Continued)
1.53 How Science Works (Continued)
1.54 Scientific Consensus
1.55 Scientific Information, Disinformation, and Denial
1.56 Transformations of Culture

Week 2. Is the Climate Changing?
2.1 Temperature Anomalies
2.2 Recent Climate Change
2.3 Climate Over the Earth's History

Week 3. Radiation and Energy Balance
3.1 Work and Energy
3.3 Temperature and Energy
3.4 U.S. Energy Use, U.S. Energy Sources, Global Energy Considerations
3.5 Electromagnetic Radiation: Particles and Waves, The Electromagnetic Spectrum
3.6 Blackbody Radiation
3.7 Energy Balance, The First Law of Thermodynamics

Week 4. A Simple Climate Model (All Models are Wrong, Some Models are Better Than Others)

- 4.1 The Sun: The Source of Energy for Our Climate System
- 4.2 Energy Loss to Space
- 4.3 The Greenhouse Effect
- 4.4 Other Planets
- 4.5 Advanced Climate Models and Computer Simulations, The National Center for Atmospheric Research (NCAR), Other Global Centers

Week 5. The Carbon Cycle

- 5.1 Greenhouse Gasses and Our Atmosphere's Composition
- 5.2 Atmosphere-Land-Biosphere-Ocean Carbon Exchange
- 5.3 Atmosphere-Rock Exchange
- 5.4 How Are Humans Perturbing the Carbon Cycle?
- 5.5 Commonly Asked Questions about the Carbon Cycle
- 5.6 The Long-term Fate of Carbon Dioxide
- 5.7 Methane
- 5.8 Other Greenhouse Gasses

Week 6. Forcings, Feedback, and Climate Sensitivity

- 6.1 Time Lags in the Climate System
- 6.2 Radiative Forcings
- 6.3 Climate Sensitivity
- 6.4 Slow Feedbacks

Week 7. Why is the Climate Changing and What Can We Do About it?

- 7.1 The Context of Recent Warming: Natural and Other Processes
- 7.2 The First Suspect: Plate Tectonics
- 7.3 The Sun
- 7.4 The Earth's Orbit
- 7.5 Unforced Variability
- 7.6 Greenhouse Gasses

Week 8. Predictions of Future Climate Change

- 8.1 The Context of Recent Warming: Natural and Other Processes
- 8.2 The First Suspect: Plate Tectonics
- 8.3 The Sun
- 8.4 The Earth's Orbit
- 8.5 Unforced Variability
- 8.6 Greenhouse Gasses
- 8.7 Uncertainties

Week 9. Impacts of Climate Change

- 9.1 Why Should You Care about Climate Change?
- 9.2 Physical Impacts
  - 9.2.1 Temperature
  - 9.2.2 Precipitation
  - 9.2.3 Sea Level Rise
  - 9.2.4 Ocean Acidification
  - 9.2.5 Hurricanes
  - 9.2.6 Human Health
  - 9.2.8 Agriculture

9.2.9 Insurance, Architecture, Economics
9.2.10 Climate Migration,
9.2.11 National Security
9.2.12 Attribution Science

9.3 Biological Impacts
9.3.1 Biochemical, Cellular, and Organismal Responses
9.3.2 Ecological, Evolutionary, and Biogeographic Implications
9.3.3 The Earth System, Nutrient Cycles, The Great Acceleration, Planetary Boundaries
9.3.4 Impacts of Climate Change on Nature: Species Range Shifts, Phenology (Event Timing), Extinction
9.3.5 Ecosystem Changes (Tropical, Cloud Forest, Temperate, High Mountain, Glacier and Snowpack, Polar and Marine, Coastal, Tropical Marine, Pelagic, Ecosystem Feedbacks)
9.3.6 Biodiversity Changes

9.4 Abrupt Climate Change
9.5 Uncertainties

Week 10. Fundamentals of Climate Change Policy
10.1 Adaptation
10.4 Mitigation
10.4.1 Renewable Energy and Decarbonization
10.4.2 "Here Comes the Sun," Solar Photovoltaic Systems
10.4.3 Net Zero Energy Buildings
10.4.4 Wind
10.4.5 Hydro
10.4.6 Geothermal Energy
10.4.7 Electric Vehicles
10.4.8 Forest Management
10.4.3 Sustainable Agriculture
10.4.4 Energy Efficiency

10.5 Solar Radiation Management
10.6 Carbon Dioxide Removal

Week 11. Mitigation Policies
11.1 The Economic Basis of Climate Change
11.2 Conventional Regulations
11.3 Market-based Regulations
11.4 Information and Voluntary Methods
11.5 Putting the Approaches Together
11.6 Misinformation and Disinformation

Week 12. A Brief History of Climate Science and Environmental Policy
12.1 The Beginnings of Climate Science and Policy
12.1.1 Joseph Fourier (1820), Eunice Foote (1856), John Tyndall (1859), Svante Arrhenius (1896)
12.1.2 Guy Stewart Calendar (1938)
12.1.3 Rachel Carson (1941, 1951, 1955, 1962)
12.1.4 Roger Revelle, Hans Suess (1957)
12.1.5 Charles Keeling (1957)
12.1.6 Syukuro Manabe (1966)
12.1.7 Eugene P. Odum, Howard T. Odum (1953, 1971, 2007)
12.1.8 Donella Meadows (1972)
12.1.9 Donella Meadows (1972, 2008)

12.1.10 Nathaniel Reed (1971, 1972, 1973)
12.1.11 Christopher Stone (1972)
12.1.12 Stephen Schneider (1974)
12.1.13 James Hansen (1981, 1988)
12.1.14 Al Gore (2006)
12.1.15 Greta Thunberg (2018)

12.2 The Emergence of Environmentalism
12.3 The 1970's and 1980's: Ozone Depletion and Acid Rain
12.4 The 1970's and 1980's: The Ascendence of Free Markets
12.5 Climate Science in the 1970's
12.6 The Year Everything Changed: James Hansen's 1988 testimony to Congress and the formation of Intergovernmental Panel on Climate Change (IPCC)
12.7 The Earth Summit in Rio de Janeiro (1992) and the Framework Convention on Climate Change: The First Climate Treaty
12.8 The Kyoto Protocol
12.9 The George W. Bush Years
12.10 The Obama Years 2009-2017
12.11 The Paris Agreement (2016)
12.12 The Black Snake Prophecy and Standing Rock (2016-2017)
12.13 The Trump Years : 2017-2021
12.14 The Biden Years: 2022-2024
12.15 The Trump Years: 2025-
12.16 Fundamental Limits, Future Possibilities
12.17 Effective Climate Communication

Videos, Guest Speakers (TBA), Journal Articles (TBA),

Suggested Readings

1. Dessler, Andrew E., 2022, *Introduction to Modern Climate Change*, *3rd Edition*, ISBN-13: 978-1108793872, Cambridge University Press.
2. Kasting, James, Lee Kump, and Robert Crane, 2023, *The Earth System, 4th Edition*, ISBN-13: 978-1792404368, Kendall Hunt Publishing.
3. Leopold, Aldo, 2020, *A Sand County Almanac: And Sketches Here and There*, ISBN-13: 978-019750026, Oxford University Press.
4. Craighead, Frank, 2001, *For Everything There Is a Season: The Sequence of Natural Events in the Grand Teton-Yellowstone Area*, ISBN-13: 978-1560441878, Falcon Press Pub. Co.
5. Weisman, Alan, 2008, *Gaviotas, A Village to Reinvent the World*, ISBN-13: 978-1603580564, Chelsea Green.
6. Nerburn, Kent, 2019, *Neither Wolf Nor Dog: On Forgotten Roads with an Indian Elder*, ISBN-13: 978-1608686384, New World Library.
7. Purdy, Jedediah, 2021, *This Land is Our Land: The Struggle for a New Commonwea*lth, ISBN-13: 978-0691216799, Princeton University Press.
8. Purdy, Jedediah, 2010, *A Tolerable Anarchy: Rebels, Reactionaries, and the Making of American Freedom*, ISBN-13: 978-1400095841, Vintage.
9. Havel, Vaclav, 1997, *The Art of The Impossible: Politics As Morality In Practice*, ISBN-13: 978-0676970494, Knopf Canada.
10. Hunt-Hendrix, Leah and Astra Taylor, 2025, *Solidarity: The Past, Present, and Future of a World-Changing Idea*, ISBN-13: 978-0593686997, Vintage.
11. Sandel, Michael, 2010, *Justice: What's the Right Thing to Do?,* ISBN-13: 978-0374532505, Farrar, Straus and Giroux.
12. Mann, Michael E., and Peter Hotez, 2025, *Science Under Siege: How to Fight the Five Most Powerful Forces That Threaten Our World*, ISBN-13: 978-1541705494, Public Affairs.
13. Hayhoe, Katharine, 2022, *Saving Us: A Climate Scientist's Case for Hope and Healing in a Divided World*, ISBN-13: 978-198214384, Atria/One Signal Publishers.
14. Solnit, Rebecca, Thelma Young Lutunatabua, 2023, *Not Too Late: Changing the Climate Story from Despair to Possibility*, ISBN-13: 978-1642598971, Haymarket Books.
15. Todrys, Katherine Wiltenburg, 2021, *Black Snake: Standing Rock, the Dakota Access Pipeline, and Environmental Justice*, ISBN-13: 978-1496222664, Bison Books.
16. Weart, Spencer R., 2008, *The Discovery of Global Warming: Revised and Expanded Edition,* ISBN-13: 978-0674031890, Harvard University Press.
17. Houghton, John, 2015, *Global Warming: The Complete Briefing, 5th Edition*, ISBN-13: 978-1107463790, Cambridge University Press.
18. deBuys, William, 2013, *A Great Aridness: Climate Change and the Future of the American Southwest*, ISBN-13: 978-0199974672, Oxford University Press.
19. Lustgarten, Abrahm, 2024, *On the Move: The Overheating Earth and the Uprooting of America*, ISBN-13: 978-1250371836, Farrar, Straus and Giroux.
20. Orr, David W., 2023, *Democracy in a Hotter Time: Climate Change and Democratic Transformation*, ISBN-13: 978-0262048590, MIT Press.
21. Orr, David W., 2016, *Dangerous Years: Climate Change, the Long Emergency, and the Way Forward*, ISBN-13: 978-0300222814, Yale University Press.
22. Primack, Richard B., 2014, *Walden Warming: Climate Change Comes to Thoreau's Woods*, ISBN-13: 978-0226682686, University of Chicago Press.
23. Rawlence, Ben, 2022, *The Treeline: The Last Forest and the Future of Life on Earth*, ISBN-13: 978-1250905963, Griffin.
24. Odum, Eugene, and Gary W. Barrett, 2004, *Fundamentals of Ecology, 5th Ed.,* ISBN-13: 978-0534420666, Cengage.
25. Hannah, Lee, 2021, *Climate Change Biology*, *3rd Edition*, ISBN-13: 9780081029756, Academic Press.

26. Lovejoy, Thomas E., and Lee Hannah, 2019, *Biodiversity and Climate Change: Transforming the Biosphere*, ISBN-13: 978-0300206111, Yale University Press.
27. Frankopan, Peter, 2024, *The Earth Transformed: An Untold History*, ISBN-13: 978-0593082133, Vintage.
28. Kolbert, Elizabeth, 2024, *The Sixth Extinction: An Unnatural History (10th Anniversary Edition),* ISBN-13: 978-1250887313, Holt Paperbacks.
29. Meadows, Donella, 2008, *Thinking in Systems*, ISBN-13: 978-1603580557, Chelsea Green.
30. Meadows, Donella, et. al., 1972, *Limits to Growth*, ISBN-13: 978-0451136954, Signet.
31. West, Geoffrey, 2018, *Scale: The Universal Laws of Life, Growth, and Death in Organisms, Cities, and Companies*, ISBN-13: 978-014311090, Penguin Books.
32. Smil, Vaclav, 2018, *Energy and Civilization: A History*, ISBN-13: 978-0262536165, The MIT Press.
33. Koestler, Arthur, 1990, *The Sleepwalkers: A History of Man's Changing Vision of the Universe*, ISBN-13: 978-0140192469, Penguin Books.
34. Koestler, Arthur, 2021*, The Act of Creation*, ISBN-13: 978-1939438744, Last Century Press.
35. Grudin, Robert, 1990, *The Grace of Great Things: Creativity and Inno*vation, ISBN-13: 978-0899199405, Ticknor and Fields.
36. Hyde, Lewis, 2019, *The Gift: How the Creative Spirit Transforms the Wo*rld, ISBN-13: 978-1984897787, Vintage.
37. Thoreau, Henry David, 1992, *Walden and Other Writings*, ISBN-13: 978-0679600046, Modern Library.
38. Abbey, Edward, 1988, *Desert Solitaire*, ISBN-13: 978-0816510573, University of Arizona Press.
39. McPhee, John, 1987, *Rising from the Plains*, ISBN-13: 978-0374520656, Farrar, Straus and Giroux.
40. McPhee, John, 1982, *Basin and Range,* ISBN-13: 978-0374516901, Farrar, Straus and Giroux.
41. Smith, Robert B., and Lee J. Siegel, 2000, *Windows into the Earth: The Geologic Story of Yellowstone and Grand Teton National Parks*, ISBN-13: 978-0195105971, Oxford Univ. Press.
42. Craighead, John, et. al., 1995, *The Grizzly Bears of Yellowstone: Their Ecology In The Yellowstone Ecosystem*, ISBN-13: 978-1559634564, Island Press.
43. Turner, Jack, 1996, *The Abstract Wild*, ISBN-13: 978-0816513949, University of Arizona Press.
44. Peacock, Doug, 1996, *Grizzly Years: In Search of the American Wilderness*, ISBN-13: 978-0805045437, Holt Paperbacks.
45. Worster, Donald, 2002, *A River Running West: The Life of John Wesley Powell*, ISBN-13: 978-0195156355, Oxford University Press.
46. Berry, Wendell, 2015, *The Unsettling of America: Culture & Agriculture, 2nd Edition,* ISBN-13: 978-1619025998, Counterpoint.
47. Snapp, Sieglinde, and Barry Pound, *Agricultural Systems: Agroecology and Rural Innovation for Development*, 2nd Edition, ISBN-13: 978-0128020708, Academic Press.
48. Carson, Rachel, 2002, *Silent Spring*, ISBN-13: 978-0128020708, Houghton Mifflin Harcourt.
49. Carson, Rachel, 2021, *Rachel Carson: The Sea Trilogy: Under the Sea-Wind / The Sea Around Us / The Edge of the Sea*, ISBN-13: 978-1598537055, Library of America.
50. Ricketts, Edward, et. al., 1992, *Between Pacific Tides, 5th Edition,* ISBN-13: 978-0804720687, Stanford University Press.
51. Steinbeck, John, 2002, *Cannery Row (Centennial Edition),* ISBN-13: 978-0142000687, Penguin Books.
52. Steinbeck, John, 1995, *The Log from the Sea of Cortez*, ISBN-13: 978-0140187441, Penguin Classics.
53. Zim, Herbert S., Lester Ingle, 1955, *Seashores: A Guide to Shells, Sea Plants, Shore Birds, and Other Natural Features of American Coasts*, ASIN: B000MV0Y4E, Golden Press.
54. Safina, Carl, 1998, *Song for the Blue Ocean: Encounters Along the World's Coasts and Beneath the Seas*, ISBN-13: 978-0805046717, Henry Holt & Co.
55. Nybakken, James, Mark Bertness, 2004, *Marine Biology: An Ecological Approach*, *6th Edition,* ISBN-13: 978-0805345827, Benjamin Cummings.
56. Garrison, Tom, and Robert Ellis, 2021, *Oceanography: An Invitation to Marine Science*, ISBN-13: 978-0357452752, Cengage Learning.

57. Feynman, Richard P., Robert B. Leighton, Matthew Sands, 2011, *The Feynman Lectures on Physics*, ISBN-13: 978-0465023820, Basic Books.
58. Sandoz, Mari, 2008, *Crazy Horse: The Strange Man of the Oglalas*, ISBN-13: 978-0803217874, Bison Books.
59. Sandoz, Mari, *Hostiles and Friendlies: Selected Short Writings of Mari Sandoz*, ISBN-13: 978-1496240798, Bison Books.
60. Erdoes, Ricard, and John (Fire) Lame Deer, 1994, *Lame Deer: Seeker of Visions*, ISBN-13: 978-0671888022, Simon and Schuster.
61. White Hat, Albert, 1994, *Reading and Writing the Lakota Language*, ISBN-13: 978-0874805727, University of Utah Press.
62. Hall, Edward T., 1994, *West of the Thirties: Discoveries Among the Navajo and Hopi*, ISBN-13: 978-0385424219, Doubleday.
63. Iverson, Peter, and Monty Roessel, 2002, *Diné: A History of the Navajos*, ISBN-13: 978-0826327154, University of New Mexico Press.
64. Farella, John R., 1990, *The Main Stalk: A Synthesis of Navajo Philosophy*, ISBN-13: 978-0816512102, University of Arizona Press.
65. Childs, Craig, 2007, *House of Rain: Tracking a Vanished Civilization Across the American Southwest*, ISBN-13: 978-0316608176, Little, Brown and Company.
66. Childs, Craig, 2019, *Atlas of a Lost World: Travels in Ice Age America*, ISBN-13: 978-0307908650, Pantheon.
67. Kimmerer, Robin Wall, 2015, *Braiding Sweetgrass: Indigenous Wisdom, Scientific Knowledge and the Teachings of Plants,* ISBN-13: 978-1571313560, Milkweed Editions.
68. Nelson, Melissa, Dan Shilling, 2021, *Traditional Ecological Knowledge*, ISBN-13: 978-1108450447, Cambridge University Press.
69. Hogan, Linda, 2020, *The Radiant Lives of Animals*, ISBN-13: 978-0807047927, Beacon Press.
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71. Lewis, Oscar, 2011, *The Children of Sanchez: Autobiography of a Mexican Family*, ISBN-13: 978-030774453, Knopf Doubleday Publishing Group.
72. Eakin, Marshall, 2007, *The History of Latin America: Collision of Cultures*, ISBN-13: 978-1403980816, St. Martin's Griffin.
73. Pawel, Miriam, 2014, *The Crusades of Cesar Chavez: A Biography*, ISBN-13: 978-1608197132, ISBN-13: 978-1608197101, Bloomsbury Press.
74. Fourché, Carolyn, 2020, *What You Have Heard Is True: A Memoir of Witness and Resistance*, ISBN-13: 978-0525560395, Penguin Books.
75. Blitzer, Jonathan, 2024, *Everyone Who Is Gone Is Here: The United States, Central America, and the Making of a Crisis*, ISBN-13: 978-1984880802, Penguin Press.
76. Grandin, Greg, 2025, *America, América: A New History of the New World*, ISBN-13: 978-0593831250, Penguin Press.
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84. Lyndon, Donlyn, and Charles W. Moore, *Chambers for A Memory Palace*, ISBN-13: 978-0262621052, MIT Press.
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89. Mazria, Edward, 1979, *The Passive Solar Energy Book (Expanded Professional Edition)*, ASIN: B01FGMUS6W, Rodale Press.
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92. Wujek, Joseph B. and Frank R. Dagostino, 2009, *Mechanical and Electrical Systems in Architecture, Engineering, and Construction*, *5th Edition,* ISBN-13: 978-0135000045, Pearson.
93. DeKay, Mark, and G.Z. Brown, 2014, *Sun, Wind, and Light: Architectural Design Strategies, 3rd Edition*, ISBN-13: 978-0470945780, Wiley.
94. Lechner, Norbert M. and Patricia Andrasik, 2021, *Heating, Cooling, Lighting: Sustainable Design Strategies Towards Net Zero Architecture, 5th Edition*, ISBN-13: 978-1119585749, Wiley.
95. Corner, Donald, Jan Fillinger, and Alison Kwok, *Passive House Details: Solutions for High-Performance Design*, ISBN-13: 978-1138958265, Routledge.
96. Maclay, William, 2014, *The New Net Zero: Leading-Edge Design and Construction of Homes and Buildings for a Renewable Energy Future*, ISBN-13: 978-1603584487, Chelsea Green Publishing.
97. McKibben, Bill, 2025, *Here Comes the Sun: A Last Chance for the Climate and a Fresh Chance for Civilization*, ISBN-13: 978-1324106234, W. W. Norton.
98. Messenger, Roger A., and Homayoon Abtahi, 2024, *Photovoltaic Systems Engineering, 5th Edition*, ISBN-13: 978-1032726212, CRC Press.
99. Gipe, Paul, 2016, *Wind Energy for the Rest of Us: A Comprehensive Guide to Wind Power and How to Use It*, ISBN-13: 978-0997451818, windworks.org.
100. Manwell, et. al., 2024, *Wind Energy Explained: On Land and Offshore, 3rd Edition*, ISBN-13: 978-111936745, Wiley.

Links

National Center for Atmospheric Research (NCAR)
https://ncar.ucar.edu

National Renewable Energy Laboratory (NREL)
https://www.nrel.gov

The Fifth National Climate Assessment (Archived)
https://nca5.climate.us

Intergovernmental Panel on Climate Change (IPCC)
https://www.ipcc.ch

Met Office Hadley Centre for Climate Science and Services
https://weather.metoffice.gov.uk/climate/met-office-hadley-centre/index

National Aeronautics and Space Administration (NASA)
https://science.nasa.gov/climate-change/

National Oceanic and Atmospheric Administration (NOAA)
https://www.noaa.gov/climate

American Association for the Advancement of Science
https://www.aaas.org

Science (Journal)
https://www.science.org

Nature (Journal)
https://www.nature.com

Proceedings of the National Academy of Science (PNAS)
https://www.pnas.org

National Weather Service (NWS)
https://www.weather.gov

Yale Program on Climate Communication
https://climatecommunication.yale.edu

American Institute of Architects
https://www.aia.org

Architecture 2030
https://www.architecture2030.org

Climate Central
https://www.climatecentral.org

Inside Climate News

https://insideclimatenews.org

Skeptical Science
https://skepticalscience.com

The Center for American Progress
https://www.americanprogress.org

Utah Clean Energy
https://utahcleanenergy.org

Utah Department of Natural Resources
https://naturalresources.utah.gov

Stanford University: Doerr School of Sustainability
https://sustainability.stanford.edu/news/climate/climate-change

Stanford Energy Seminar
https://energy.stanford.edu/events/energy-seminar/about-energy-seminar

National Environmental Policy Act
https://www.epa.gov/nepa/what-national-environmental-policy-act

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https://www.epa.gov/laws-regulations/summary-clean-water-act

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https://www.fws.gov/law/endangered-species-act

Scientific American
https://www.scientificamerican.com

Union of Concerned Scientists
https://www.ucs.org

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https://thebulletin.org/#navbar-brand

Audubon
https://www.audubon.org

World Wildlife Fund
https://www.worldwildlife.org

National Geographic Society
https://www.nationalgeographic.org/society/

Nature Conservancy

https://www.nature.org/en-us/

The Wilderness Society
https://www.wilderness.org

Third Act
https://thirdact.org

High Country News
https://www.hcn.org

Sunrise Movement
https://www.sunrisemovement.org

Fridays for the Future
https://fridaysforfutureusa.org

Extinction Rebellion
https://rebellion.global

Greenpeace
https://www.greenpeace.org/international/

Natural Resources Defense Council (NRDC)
https://www.nrdc.org

Environmental Defense Fund
https://www.edf.org

Earth Justice
https://earthjustice.org

Environmental Law Institute
https://www.eli.org

The American Prospect
https://prospect.org

American Civil Liberties Union (ACLU)
https://www.aclu.org

Curriculum Vitae

John M. Murray, Ph.D.
Associate Professor, Physics, School of Science, Technology, Engineering, and Mathematics (Emeritus, 2025)
Diné College, Tsaile, AZ, 86556. Phone: (239) 287-7897; Email: jmurray9999@gmail.com

Education

Clemson University, Clemson, SC, USA
Ph.D., Bioengineering, 1974
University of South Florida, Tampa, FL, USA
M.S., Engineering, 1970
University of South Florida, Tampa, FL, USA
B.S., Engineering, 1970

Professional Experience

- Associate Professor, Physics, 2016-2025
  School of Science, Technology, Engineering, and Mathematics, Diné College, Navajo Nation, Tsaile, AZ.
  Additional Areas of Instruction: Sustainable Architecture, Climate Change Biology, Mathematics, Engineering
- Associate Professor, Engineering (Tenured), Sustainable Design/Build Program, 2007-2016
  Department of Engineering, Southern Utah University, Cedar City, UT
- Executive Director, 2006-2007
  CREW (Corkscrew Regional Ecosystem) Land & Water Trust (60,000-acre Wetland), Estero, FL
- Founder and Computer Science Program Leader; Associate Professor, 1996-2005
  Department of Computer Science, Florida Gulf Coast University, Fort Myers, FL
- Department Head, 1994-1996
  Department of Computer Science, Sinté Gleska University, Rosebud Sioux Indian Reservation, Mission, SD
- The Senior Lecturer and Research Lead, UVB Radiation Monitoring and Environmental Data Acquisition Project, 1991-1994
  Department of Physics, University of the South Pacific, Suva, Fiji
- Associate Professor, 1987-1991, VLSI System Design Consultant
  Department of Electrical Engineering, Oregon State University, Corvallis, OR,
- Hardware Architect, Database Machine Project; Consulting Engineer; Professional Development Manager, 1982-1986
  Digital Equipment Corporation, Colorado Springs, CO
- Assistant Professor, 1978-1982; VLSI Design Consultant
  Department of Electrical Engineering, University of Colorado, Colorado Springs, CO
- Staff Engineer, 8086 Microprocessor Design Team, 1976-1977
  Intel Corporation, Santa Clara, CA
- Assistant Professor, 1975-1976
  Department of Electrical Engineering, Texas A&M University, College Station, TX
- President,1972-1974
  Research Oriented Engineering, Industrial Bio-Telemetry Firm, Clemson, South Carolina,
- University of South Florida Co-operative Education Student, 1965-1967, Contributed to Apollo Countdown Clock Project
  NASA, Marshall Space Flight Center, Huntsville, Alabama

Refereed Publications

1. Murray, J., R. Sommerfeld, G. Longhurst, C. Bithell, C. Wilson, A. Yamamoto, H. Ogiso, A. Bradshaw, H. Louis, D. Penny, T. Morton, and D. Young, 2014, *DesignBuildBLUFF: Coyote Architecture on the Colorado Plateau*, Eco-Architecture 2014 Conference, September 24-26, Siena, Italy.
2. Murray, J., E. Elder, R. Bingham, G. Longhurst, D. Penny, and T. Morton, 2014, *The Design and Construction of a Tiny House: Small is Beautiful*, 2014, ASEE Zone IV Conference, Long Beach, California.
3. Murray, J.M., 2012. *Taking it to the Streets: Sustainable Communities for the 21st Century*, American Society for Engineering Education (ASEE) Region IV Conference, March 2, 2012, Ogden, Utah.
4. Murray, J.M., W. Murray, and J. Kakareka, 2011. *Across the Divide: An Expedition into the American Wes*t, American Society for Engineering Education (ASEE) Region IV Conference, April 15, 2011, Rapid City, South Dakota.
5. Murray, J., and B. Brooks-Solveson, R. Clark, J. da Frota, C. Dabbs, M. Duever, W. Hammond, A. Karuna-Muni, J. Key, C. Knight, 2005. *Hydrology, Ecology, and Simulation of the Six Mile Cypress/Ten Mile Canal Watershed System*, First National Conference on Ecosystem Restoration, Orlando, Florida.
6. Murray, J., and B. Brooks-Solveson, R. Clark, J. da Frota, Jeff Key, 2004, *Scientific Evaluation and Simulation of the Six Mile Cypress Watershed: Final Report to Lee County, Florida and the South Florida Water Management District.*
7. Greene, P., and J. Murray, 2004. *Simulation and Modeling: The Future of Education*, National Educational Computing Conference, New Orleans, Louisiana.
8. Ahn, B., and J. M. Murray, 1989. *A Pipelined, Expandable VLSI Sorting Engine Implemented in CMOS Technology*, ISCAS '89 Proceedings.
9. Murray, J. M. and E. K. Cheng, 1987. *Silicon Compilation and Digital Systems Architecture: An Educational Experience*. University Government Industry Microelectronics Symposium, Rochester, New York.
10. Murray, J. M., and K. Klingenstein, 1982. *The Architecture of an Electronic Book*, IEEE Transactions on Industrial Electronics and Control Instrumentation, January 1982.
11. Murray, J. M., and J. Oleszek, 1979. *Design Considerations in Class D MOS Power Amplifiers*, IEEE Transactions on Industrial Electronics and Control Instrumentation, November 1979.
12. Murray, J. M., and C. A. Wiatrowski, 1978. *Microcomputer Peripherals*, Invited Paper, IEEE Transactions on Industrial Electronics and Control Instrumentation, November 1978.
13. Murray, J. M., 1977. *A Universal Peripheral Interface Device (Intel 8041),* Proceedings IEEE Conference on Industrial Electronics and Control Instrumentation.
14. Bowers, James C. and Stephen R. Sedore, 1971, *SCEPTRE: A Computer Program for Circuit and Systems Analysis, Chapter 3, Semiconductor Device Modeling,* Prentice Hall.

Works in Progress

1. Murray, J. M., 2025, *Honoring the Wild, Weaving a New World: A Memoir*

Major Research Projects

- Acquisition and testing of four Net Zero Energy homes from PassiveDom Corporation for an experiment in sustainable living on the Diné College campus. Tsaile, AZ, 2018, The acquisition and testing of these off-grid homes is currently a work in progress. Funding by Diné College. $400,000.
- Design, thermal simulation, construction, and testing of a year-round 30’ x 15’ x 14’ passive solar greenhouse with thermal storage for the Diné College Land Grant Institute, Tsaile, AZ. Funding by Diné College. $30,000. 2018.
- Design and construction of a 20’L x 8’W x 13’ H, off-grid, solar-energized Tiny House by undergraduate students at Southern Utah University for an external client. 2014. Private funding. $15,000.

- Design, thermal simulation, construction, and testing of a 1200 square-foot, direct gain, AIA award-winning, passive solar home for Navajo Lorraine Toney and her family SE of Bluff, Utah with the software support from NREL (National Renewable Engineering Laboratory, Golden, Colorado). Funding provided by DesignBuildBLUFF, a non-profit organization in Park City, Utah, 2012. $180,000.
- CREW Land and Water Trust, Estero Florida. $5,000,000 Private Land Acquisition Grant from Collier County Florida. Three hundred sixty (360) acres, primarily wetlands and uplands, were purchased from Judge Starnes, a retiring Lee County, Florida family court judge, then incorporated into the 60,000-acre CREW Land and Water Trust, a public-private, non-profit partnership, thus placing the land in permanent preservation. 2006.
- Ecosystem Research Grant (Ecosystem Restoration Project, Six Mile Cypress Slough), Western Everglades, Funding by Lee County, Florida, $40,000, 2004-2005. Grant P.I. Dr. John Murray.
- NSF Model Institutions for Excellence (MIE) Grant. This five-year, $12,000,000 grant, awarded to Oglala Lakota College, Kyle, South Dakota and Sinte Gleska (Spotted Tail) University, Mission, South Dakota. 1995-2000. Grant Co-Author.
- Computer Laboratory Development Grant, Ultraviolet-B Radiation Monitoring Research Project, Governments of Australia & New Zealand. Physics Department, University of the South Pacific. $64,000, 1992. Grant P.I. Dr. John Murray
- Sandia National Laboratories Grant. Oregon State University, Design of a state-of-the-art data encryption chip using a software-based silicon compiler from Silicon Compilers, Inc. $40,000/yr., for 2 years. Grant Co-PIs: Dr. John Murray, Dr. Ted Lewis, 1989-1990.
- Silicon Compilers Incorporated Grant, San Jose. Oregon State University Silicon compiler system development and application. Funding level $340,000, 1987. Grant P.I. Dr. John Murray.
- Digital Equipment Corporation, Colorado Springs, Colorado. Hardware Architect, Database Machine, DEC Advanced Development Group, 1982-1985.
- Digital Equipment Corporation Grant, Maynard. VLSI (Very Large Scale Integrated Circuit) research & development, University of Colorado. Funding level: $10,000, 1980. Grant P.I. Dr. John Murray.
- Intel Corporation, Santa Clara, California, 8086 Microprocessor, the 16-bit, 64,000-transistor, silicon chip which, following architectural modifications (Intel 8088), became the heart of the first IBM PC in 1981. Design Assurance Team, 1976-1977.
- Clemson University, Clemson South Carolina, Ph.D. Dissertation, A Heart Rate Monitoring System Utilizing Advanced Microelectronic Concepts, 1974.

Awards

- AIA (American Institute of Architects), People's Choice Award, Denver, Colorado, 2013 for *Raine House*, a 1200 square-foot passive solar home, DesignBuildBLUFF Project, Navajo Nation, SE Utah.
- Outstanding Faculty Award, Department of Integrated Engineering, Southern Utah University, 2010, 2012, 2013
- Manatee-embossed stainless steel coffee mug, awarded for Six Mile Cypress Slough Ecosystem Restoration Research Project, presented by Friends of Six Mile Cypress Slough, Fort Myers, Florida, 2005.
- Red key lanyard, awarded for $12 Million NSF Model Institutions for Excellence Grant, presented by Oglala Lakota College, Kyle, South Dakota, 1995.

Professional Leadership Activities

- AAAS, Member.

Journal Activities

- Associate Editor, IEEE Transactions on Industrial Electronics and Control Instrumentation, 1977-1982.

Mentoring and Student Advising

- Thesis/Dissertation Major Advisor/Chair
  4 PhD students, 22 MS students