Life in the Hothouse: How a Living Planet Survives Climate Change, by Melanie Lenart (Tucson: University of Arizona Press, 2010).

Notes to accompany the text of the published book. Last updated March 10, 2010.

Introduction

page 2, within a livable range.
This so-called homeostasis aspect of Gaia theory is more controversial than some other aspects of the theory, and even among its supporters the premise can encompass a range of ideas. The ideas expressed here come from Lovelock's 1979 book *Gaia: A New Way of Looking at Life*, Oxford University Press, Oxford, United Kingdom, 157 pp.

page 3, comparing the world to a machine.
Abrams, D., 1991. The mechanical and the organic: on the impact of metaphor in science, pp. 66–77 *in* Schneider, S., and Penelope Boston (eds.), *Scientists on Gaia*, Massachusetts Institute of Technology, Cambridge, Mass.

page 4, since the mid-1970s.
Values for Arizona statewide temperatures (1970–2004) were derived from an online tool posted by the Western Regional Climate Center at this Web site:
http://www.wrcc.dri.edu/cgi-bin/divplot1_form.pl?0202.
The site can be used to obtain data for the 50 U.S. states for a variety of time frames back through 1890.

page 5, Anthony Westerling and colleagues documented.
Westering, A.L., H.G. Hidalgo, D.R. Cayan, and T.W. Swetnam, 2006. Warming and earlier spring increase western U.S. forest wildfire activity. *Science* 313: 940–943.

page 5, when conditions are right.
Lenart, M., June 2006. Hurricane intensity rises with sea surface temps. *Southwest Climate Outlook*, June 2006. Monthly publications of the University of Arizona Climate Assessment for the Southwest are available through the following link:
http://www.climas.arizona.edu/pubs.html

page 5, through the early 2000s.
Alaska's average annual temperature has increased by about 3.5 degrees Fahrenheit in 30 years, while its winter temperatures have increased by 6.3 degrees F, according to the Alaska Climate Research Center, affiliated with the Geophysical Institute of the University of Alaska, Fairbanks. See *http://climate.gi.alaska.edu/ClimTrends/Change/TempChange.html*

page 6, which accelerates melting.
Thomas, R., E. Frederick, W. Krabill, S. Manizade, and C. Martin, 2006. Progressive increase in ice loss from Greenland. *Geophysical Research Letters* 33: L10503 (1–4), doi: 10.1029/2006GL026075. Abdalati, W., W. Krabill, E. Frederick. S. Manizade, C. Martin, J. Sonntag, R. Swift, R. Thomas, W. Wright, and J. Yungel, 2001. Outlet glacier and margin elevation changes: near-coastal thinning of the Greenland ice sheet. *Journal of Geophysical Research* 106: 33,729–33,741.

page 6, the size of Los Angeles for a year.
Kerr, R.A., 2006. A worrying trend of less ice, higher seas. *Science* (News) 311(5768): 1698–1701.

page 6, researcher Anthony Brazel and colleagues show.

Brazel, A., N. Selover, R. Vose, and G. Heisler, 2000. The tale of two climates—Baltimore and Phoenix urban LTER sites, *Climate Research* 15: 123–135.

page 6, Phoenix simmering about 20 degrees warmer than nearby rural areas at night.
Personal communication, Joseph Zhender, Arizona State University. Also see Brazel, A.J., 2003. *Future Climate in Central Arizona: Heat and the Role of Urbanization*, Consortium for the Study of Rapidly Urbanizing Regions Research, vignette no. 2 (September), available through the ASU Center for Environmental Studies. The 20-degree Fahrenheit nighttime difference refers to Tempe, a municipality within the Phoenix metropolitan area.

page 6, big cities similarly act as heat traps.
DeGaetano, A.T., and R.J. Allen, 2002. Trends in Twentieth-Century temperature extremes across the United States, *Journal of Climate* 15: 3188–3205.

page 6, heat-related deaths than do their rural counterparts.
Buechley, R.W., J. Van Bruggen, and L.E. Truppi, 1972. Heat Island = Death Island? *Environmental Research* 5: 85–92. Clark, J.F., 1972. Some effects of the urban structure on heat mortality. *Environmental Research* 5: 93–104. Smoyer, K.E., 1998. A comparative analysis of heat waves and associated mortality in St. Louis, Missouri—1980 and 1995. *International Journal of Biometeorology* 42: 44–50.

page 8, since the instrumental record began in 1850.
The World Meteorological Organization issued the following press release on December 8, 2009: 2000-2009, The Warmest Decade. It is accessible at
http://www.wmo.int/pages/mediacentre/press_releases/pr_869_en.html
NASA's Goddard Institute for Space Studies followed suit on January 21, 2010, issuing the following press release: 2009: Second Warmest Year on Record; End of Warmest Decade. http://www.giss.nasa.gov/research/news/20100121/

page 9, nears the end of her life.
Lovelock, J., 2006. *The Revenge of Gaia: Why the Earth Is Fighting Back—and How We Can Still Save Humanity*, Allen Lane, an imprint of Penguin Books, London (p. 162), 177 pp.

page 9, faces no risk from mere humans.
Margulis, L., 1998. *Symbiotic Planet: A New Look at Evolution*, Basic Books, Perseus Books Group, New York, 147 pp.

Chapter 1
page 10, threatened by floodwaters, later reports revealed.
Committee on Natural Disasters, 1994. *Hurricane Hugo: Puerto Rico, the U.S. Virgin Islands and South Carolina*, Natural Disaster Studies, vol. 6, published by the National Academy of Sciences, Washington, D.C., 276 pp.

page 12, he modeled in a 1999 *Nature* paper.
Emanuel, K., 1999. Thermodynamic control of hurricane intensity. *Nature* 410: 665–669.

page 12, without passing over warm water.
Regarding the scale of different hurricane seasons: data from Christopher Landsea provided to *National Geographic* for its August 2005 issue [208 (2): 72–85]. Regarding the scale of individual storms, see Michaels, P.J., P.C. Knappenberger, and R.E. Davis, 2006. Sea-surface temperatures and tropical cyclones in the Atlantic basin, *Geophysical Research*

Letters 33: L09708, 1–4. The latter argues that there is no linear effect from sea surface temperature, while the data presented suggests that a threshold (non-linear) change is involved.

page 12, Gulf of Mexico's 1995 Hurricane Opal.
Shay, L.K., G.J. Goni, and P.G. Black, 2000. Effects of a warm oceanic feature on Hurricane Opal, *Monthly Weather Review* 128: 1366–1383.

page 13, get cold feet if they head north.
Lenart, M., 2004. Forecasters expect below-normal East Pacific hurricane activity despite likely El Niño development this season, *Southwest Climate Outloo*k: http://www.climas.arizona.edu/forecasts/articles/hurricanes_june2006.pdf. Publications by the University of Arizona Climate Assessment for the Southwest are available through the following link: http://www.climas.arizona.edu/forecasts/swarticles.html

page 13, an intact eye and the extra punch that comes with it.
Aguado, E., and J.E. Burt, 1999. *Understanding Weather and Climate*, p. 309. Prentice Hall, Upper Saddle River, New Jersey, 474 pp.

page 13, documented in a 2000 paper.
Bender, M.A., and I. Ginis, 2000. Real-case simulations of hurricane-ocean interaction using a high-resolution coupled model: effects on hurricane intensity. *Monthly Weather Review* 128: 917–945.

page 13, mid-80s in degrees Fahrenheit.
Geophysical Fluid Dynamics Laboratory Web site: http://www.gfdl.noaa.gov/visualization-gallery . Link to a graphic that illustrates a cool wake in Katrina's path (accessed March 14, 2010): http://www.gfdl.noaa.gov/pix/tools_and_data/gallery/katrina-2520x1419.png

page 13, from about 80 miles per hour to 65 miles per hour.
NASA/Goddard Space Flight Center Scientific Visualization Studio animation at *http://svs.gsfc.nasa.gov/stories/hurricanes/*

page 14, they lingered over an area.
Bender, M.A., I. Ginis, and Y. Kurihara, 1993. Numerical simulations of tropical cyclone–ocean interaction with a high-resolution coupled model. *Journal of Geophysical Research* 98: 23,245–23,263.

page 14, between 1982 and 2001.
Sriver, R., and M. Huber, 2007. Observational evidence for an ocean heat pump induced by tropical cyclones. *Nature* 447: 577–580.

page 15, higher than their earlier estimates.
Sriver, R.L., M. Huber, and J. Nusbaumer, 2008. Investigating tropical cyclone–climate feedbacks using the TRMM Microwave Imager and Quick Scatterometer. *Geochemistry, Geophysics, Geosystems* 9, Q09V11.

page 15, Kevin Trenberth and John Fasullo in a 2008 paper.
Trenberth, K.E., and J. Fasullo, 2008. Energy budgets of Atlantic hurricanes and changes from 1970. *Geochemistry, Geophysics and Geosystems* 9, Q09V08.

page 16, some relate to the Cantonese phrase *tái fung* (great wind).

Kerry Emanuel goes into a more detailed description of the origin and evolution of the words "hurricane" and "typhoon" on pp. 18–21 in his 2005 book *Divine Wind: The History and Science of Hurricanes*, Oxford University Press.

page 17, a more manageable Category 3.
Bennett, S.P., and R. Mojica. 1999. Hurricane Georges preliminary storm report. National Weather Service, Carolina, Puerto Rico. 15 pp.
http://www.nhc.noaa.gov/1998georges.html

page 18, in the weeks after the storm.
Bennett, S.P., and R. Mojica. 1999. Hurricane Georges preliminary storm report. National Weather Service, Carolina, Puerto Rico. 15 pp. http://www.nhc.noaa.gov/1998georges.html
Also see Centers for Disease Control and Prevention report at
http://www.cdc.gov/MMWR/preview/mmwrhtml/00055476.htm .

page 19, in the New Orleans area alone.
Knabb, R.D., J.R. Rhome, and D.P. Brown, 2005. Tropical Cyclone Report, Hurricane Katrina (p. 12) released by the National Hurricane Center on December 20, 2005.
www.nhc.noaa.gov/pdf/TCR-AL122005_Katrina.pdf

page 19, estimated at $92 billion.
Platt, Rutherford H., 2000. Extreme natural events: some issues for public policy. Discussion paper prepared for presentation at the Extreme Events Workshop, Boulder, Colorado, June 7–9, 2000. http://www.isse.ucar.edu/extremes/papers/platt.PDF

page 20, matter most to hurricane dynamics.
Emanuel, K., 1999. Thermodynamic control of hurricane intensity. *Nature* 410: 665–669.
Emanuel, K., C. DesAutels, C. Holloway, and R. Korty, 2004. Environmental control of tropical cyclone intensity. *Journal of Atmospheric Sciences* 61: 843–858.

page 20, but they were both scorchers.
NASA's Goddard Institute for Space Studies announced that 2005 was the warmest recorded on Earth's surface since modern measurements began in the 1890s. For example, see *http://www.nasa.gov/vision/earth/environment/2005_warmest.html* . The NASA measurements include extrapolated estimates for areas not covered by measuring stations. However, the Intergovernmental Panel on Climate Change's 2007 report cited other sources considered more authoritative for maintaining 1998 as the hottest year on record through 2006.

page 20, with tragic results.
The kinetic energy of wind is a function of the windspeed squared, while the damage the winds can do increases at a faster rate, with the cube of windspeed being a better estimate. Personal communication (2006), Christopher Landsea, science and operations officer, National Hurricane Center, Miami, Florida.

page 20, destructive force of Dennis's winds.
Knabb, R.D., J.R. Rhome, and D.P. Brown, 2005. Tropical Cyclone Report, Hurricane Katrina, released by the National Hurricane Center on December 20, 2005.
www.nhc.noaa.gov/pdf/TCR-AL122005_Katrina.pdf Gust reported by Pearl River County Emergency Operations Center.

page 21, qualified for Category 3 status.

The kinetic energy of wind is a function of the windspeed squared, while the damage the winds can do increases at a faster rate, with the cube of windspeed being a better estimate. Personal communication (2006), Christopher Landsea, science and operations officer, National Hurricane Center, Miami, Florida.

page 21, estimated $100 billion in damages.
Knabb, R.D., J.R. Rhome, and D.P. Brown, 2005. Tropical Cyclone Report, Hurricane Katrina, released by the National Hurricane Center on December 20, 2005. www.nhc.noaa.gov/pdf/TCR-AL122005_Katrina.pdf

page 21, accompanying storm surges.
Gray, W.M., J.D. Sheaffer, and C.W. Landsea, 1997. Climate trends associated with multidecadal variability of Atlantic hurricane activity, in Diaz, H.F., and R.S. Pulwarty (eds.), *Hurricanes: Climate and Socioeconomic Impacts*, Springer, Berlin, pp. 15–54. The authors also refer readers to Landsea, C.W., 1991, West African monsoonal rainfall and intense hurricane associations. Dept. of Atmospheric Science Paper No. 484, Colorado State University, Fort Collins, p. 280.

page 21, died in floods.
Cosgrove, Peter, 2005. "The economy: How bad a blow," p. 48 of *National Geographic* magazine special edition, Katrina: Why it became a man-made disaster; Where it could happen again.

page 21, mainly in the Dominican Republic and Haiti.
Bennett, S.P., and R. Mojica. 1999. Hurricane Georges preliminary storm report. National Weather Service, Carolina, Puerto Rico. 15 pp.

page 21, over the past few decades.
Knabb, R.D., J.R. Rhome, and D.P. Brown, 2005. Tropical Cyclone Report, Hurricane Katrina, released by the National Hurricane Center on December 20, 2005. www.nhc.noaa.gov/pdf/TCR-AL122005_Katrina.pdf

page 22, using satellite imagery.
Cerveny, R.S., and L.E. Newman, 2000. Climatological relationships between tropical cyclones and rainfall. *Monthly Weather Review* 128: 3329–3336 (September). Tropical cyclones include hurricanes, typhoons, and cyclones, as well as tropical cyclones with winds below the 74-mile-an-hour threshold for a name-worthy storm.

page 22, warming of tropical oceans.
Knutson, T.R., and R.E. Tuleya, 2004. Impact of a CO_2–induced warming on simulated hurricane intensity and precipitation: sensitivity to the choice of climate model and convective parameterization. *Journal of Climate* 17(18): 3477–3495.

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Robert Corell made this comment during a keynote talk at the December 2006 conference Tribal Lands and Climate, held in Yuma, Arizona.

page 22, colleagues reported in 2005.
Webster, P.J., G.J. Holland, J.A. Curry, and H.R. Chang, 2005. Changes in tropical cyclone number, duration and intensity in a warming environment. *Science* 309(5742): 1844–1846. Also see Hoyos, C.D., P.A. Agudelo, P.J. Webster, and J.A. Curry, 2006. Deconvolution of the factors contributing to the increase in global hurricane intensity. *Science* 312: 94–97.

page 22, included in the analysis.
Sriver, R., and M. Huber, 2006. Low-frequency variability in globally integrated tropical cyclone power dissipation. *Geophysical Research Letters* 33: L11705.

page 23, since about the mid-1970s.
Emanuel, K., 2005. Increasing destructiveness of tropical cyclones over the past 30 years. *Nature* 436: 686–688.

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Emanuel, K., R. Sundararajan, and J. Williams, 2008. Hurricanes and global warming: results from downscaling IPCC AR4 simulations. *Bulletin of the American Meteorological Society* 89(3): 347–367.

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Mann, M.E., and K.E. Emanuel, 2006. Atlantic hurricane trends linked to climate change. *Eos: Transactions of the American Geophysical Union* 87(24): 233–244 (13 June).

page 24, natural climate variability.
Lenart, M., 2006. Hurricane intensity rises with sea surface temps. *Southwest Climate Outlook*, June. Monthly publication by the University of Arizona Climate Assessment for the Southwest available through the following link:
http://www.climas.arizona.edu/forecasts/articles/hurricanes_june2006.pdf

page 24, burning gas, coal, oil, and forests.
Levitus, S., J.I. Antonov, T.B. Boyer, and C. Stephens, 2000. Warming of the world ocean. *Science* 287: 2225–2228. Barnett, T.P., D.W. Pierce, K.M. AchutaRao, P.J. Gleckler, B.D. Santer, J.M. Gregory, and W.M. Washington, 2005. Penetration of human-induced warming in the world's oceans. *Science* 309: 284–287.

page 24, 2007 book *Storm World*.
Mooney, C., 2007. *Storm World: Hurricanes, Politics and the Battle over Global Warming*, Harcourt Inc., Orlando, Florida. 392 pp.

page 24, recipe for hurricane formation.
Gray, W.M., 1979. Hurricanes: their formation, structure and likely role in the tropical circulation, pp. 155–218 *in Meteorology over the Tropical Oceans*, James Glaisher House, Bracknell, Eng., Royal Meteorological Society.

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Goldenberg, S.B., C.W. Landsea, A.M. Mestas-Nuñez, and W.M. Gray, 2001. The recent increase in Atlantic hurricane activity: causes and implications. *Science* 293: 474–478.

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Wang, C., S.-K. Lee, and D.B. Enfield, 2008. Atlantic Warm Pool acting as a link between Atlantic Multidecadal Oscillation and Atlantic tropical cyclone activity. *Geochemistry, Geophysics, Geosystems* 9(5): 1–17.

page 27, including the current climate.
Hobgood, J.S., and R.S. Cerveny, 1988. Ice-age hurricanes and tropical storms. *Nature* 333: 243–245.

page 27, modern-day Chicago?

Wing, S.L., and D.R. Greenwood, 1993. Fossils and fossil climate: the case for equable continental interiors in the Eocene. *Transactions of the Royal Society* (London) 341: 243–252.

page 27, at these high altitudes.
Huber, M., and L. Sloan, 2000. Climatic responses to tropical sea surface temperature changes on a "greenhouse" Earth. *Paleoceanography* 15: 443–450.

page 27, late Cretaceous and Eocene hothouses.
Pearson, P.N., P.W. Ditchfield, J. Singano, K.G. Harcourt-Brown, C.J. Nicholas, R.K. Olsson, N.J. Shackleton, and M.A. Hall, 2001. Warm tropical sea surface temperatures in the Late Cretaceous and Eocene epochs. *Nature* 413: 481–487.

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Pearson, P.N., B.E. van Dongen, C.J. Nicholas, R.D. Pancost, S. Schouten, J.M. Singano, and B.W. Wade, 2007. Stable warm tropical climate through the Eocene epoch, *Geology* 35(3): 211–214.

p. 28, the Cretaceous hothouse.
Bice, K.A., D. Birgel, P.A. Meyers, K.A. Dahl, K.U. Hinrichs, and R.D. Norris, 2006. A multiple proxy and model study of Cretaceous upper ocean temperatures and atmospheric CO_2 concentrations. *Paleoceanography* 21: PA2002, 1–17.

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Ito, M., A. Ishigaki, T. Nishikawa, and T. Saito, 2001. Temporal variation in the wavelength of hummocky cross-stratification: implications for storm intensity through Mesozoic and Cenozoic. *Geology* 29: 87–89.

page 30, northeastern U.S. continental shelf.
Davis, A., and X.H. Yan, 2004. Hurricane forcing on chlorophyll-a concentration off the northeast coast of the U.S. *Geophysical Research Letters* 31: L17304. The authors compared "before" and "after" satellite images of continental shelf waters for seven hurricanes traveling along the northeast U.S. coast between 1998 and 2003. Another research team reported similar findings in their study of 13 hurricanes during the years 1998 through 2001: Babin, S.M., J.A. Carton, T.D. Dickey, and J.D. Wiggert, 2004. Satellite evidence of hurricane-induced phytoplankton blooms in an oceanic desert. *Journal of Geophysical Research* 109: C03043.

page 31, from the air above.
Matthews, B.J.H., 1999. The rate of air-sea CO_2 exchange: chemical enhancement and catalysis by marine microalgae. Ph.D. dissertation, School of Environmental Sciences, University of East Anglia, Norwich.

page 31, oxygen-starved fish.
For instance, see the following paper: Paerl, H.W., J.D. Bales, L.W. Ausley, C.P. Buzzelli, L.B. Crowder, L.A. Eby, J.M. Fear, M. Go, B.L. Peieris, T.L. Richardson, and J.S. Ramus, 2001. Ecosystem impacts of three sequential hurricanes (Dennis, Floyd, and Irene) on the United States' largest lagoonal estuary, Pamlico Sound, NC. *Proceedings of the National Academy of Sciences* 98(10): 5655–5660.

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Gupta, A., 2000. Hurricane floods as extreme geomorphic events, in *The Hydrology-Geomorphology Interface: Rainfall, Floods, Sedimentation, Land Use*, Proceedings of the

Jerusalem Conference, May 1999, IAHS Publ. no. 261: 215–228, citing Thomas, H., 1991. Water quality analysis for the period 1988–1990; UNDP, UNEP, and Government of Jamaica project—Environmental management of the Hope River Watershed. JAM/87/008–009 UNDP, unpublished report. University of the West Indies, Mona.

page 32, *New York Times* **story.**
Baker, Al. "Remembering Help Received After Sept. 11, New York sends officers to Louisiana." *New York Times*, September 7, 2005.

page 32, Labor Day in 1935.
Kang, W.J., and J.H. Trefry, 2003. Retrospective analysis of the impacts of major hurricanes on sediments in the lower Everglades and Florida Bay. *Environmental Geology* 44: 771–780.

page 33, before they sink.
Maser, C., and J.R. Sedell, 1994. *From the Forest to the Sea: The Ecology of Wood in Streams, Rivers, Estuaries, and Oceans*, St. Lucie Press, Delray Beach, Florida, p. 200.

page 33, director Ariel Lugo.
Lugo, Ariel E., 2000. Effects and outcomes of Caribbean hurricanes in a climate change scenario. *The Science of the Total Environment* 262: 243–251.

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See *Biotropica* 23(4A), December 1991, Special Issue: Ecosystem, Plant, and Animal Responses to Hurricanes in the Caribbean.

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Walker, L.R., 1991. Tree damage and recovery from Hurricane Hugo in Luquillo Experimental Forest, Puerto Rico, *Biotropica* 23(4A): 379–385.

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Yih, K., D.H. Boucher, J.H. Vandermeer, and N. Zamora, 1991. Recovery of the rain forest of southeastern Nicaragua after destruction by Hurricane Joan. *Biotropica* 23(2): 106–113.
Boucher, D.H., J.H. Vandermeer, K.Yih, and N. Zamora, 1990. Contrasting hurricane damage in tropical rain forest and pine forest. *Ecology* 71(5): 2022–2024.

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Lenart, M.T., 2003. A comparative study of soil disturbance from uprooted trees, and mound and pit decay in Puerto Rico and Colorado. Ph.D. dissertation, School of Natural Resources, University of Arizona. The plots were 500 square meters, roughly 5,400 square feet.

page 34, debris in urban areas.
Gray, Kevin, 1998. Debris management: the grind after the storm. *BioCycle*, November, pp. 38–41. In the Florida Keys, Georges left about 900,000 cubic yards of debris, mostly trees and branches.

page 34, in Louisiana alone.
Eaton, Leslie, 2006. After hurricanes come tempests over cleanups. *New York Times*, February 24, 2006.

page 35, both in Florida.

Knabb, R.D., J.R. Rhome, and D.P. Brown, 2005. Tropical Cyclone Report, Hurricane Katrina, released by the National Hurricane Center on December 20, 2005. www.nhc.noaa.gov/pdf/TCR-AL122005_Katrina.pdf

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Scatena, F.N., S. Moya, C. Estrada, and J.D. Chinea, 1996. The first five years in the reorganization of aboveground biomass and nutrient use following Hurricane Hugo in the Bisley Experimental Watersheds, Luquillo Experimental Forest, Puerto Rico. *Biotropica* 28 (4a): 424–440.

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Sanford, R.L., W.J. Parton, D.S. Ojima, and D.J. Lodge, 1991. Hurricane effects on soil organic matter dynamics and forest production in the Luquillo Experimental Forest, Puerto Rico: results of simulation modeling. *Biotropica* 23(4a): 364–372.

page 35, lead author Scatena.
Scatena, F.N., and M.C. Larsen, 1991. Physical aspects of Hurricane Hugo in Puerto Rico. *Biotropica* 23(4a): 317–323.

page 36, in Tegucigalpa, Honduras.
Collier, M., and R.H. Webb, 2002. *Floods, Droughts, and Climate Change*, University of Arizona Press, Tucson, pp. 96, 153.

page 38, in its own right.
Lovelock, J.E., 1979. *Gaia: A New Look at Life on Earth*. Oxford University Press, Oxford, England.

Chapter 2
page 39, specifically an animal.
Scofield, Bruce, 2004. Gaia: the living Earth—2,500 years of precedents in natural science and philosophy, pp. 151–160 *in* Schneider, S.H., J.R. Miller, E. Crist, and P.J. Boston (eds.), *Scientists Debate Gaia: The Next Century*, MIT Press, Cambridge, Mass.

page 40, at a 2006 conference.
Margulis used the term "homeorrhesis" during a brief conversation we had on October 14, 2006, at a conference on Gaia theory.

page 40, cool desert nights.
Lovelock, J., 2006. *The Revenge of Gaia: Why the Earth Is Fighting Back—and How We Can Still Save Humanity*, Allen Lane, an imprint of Penguin Books, London (p. 177).

page 40, of interglacial periods.
Siegenthaler, U., T.F. Stocker, E. Monnin, D. Lüthi, J. Schwander, B. Stauffer, D. Raynaud, J.M. Barnola, H. Fischer, V. Masson-Delmotte, and J. Jouzel, 2005. Stable carbon cycle-climate relationship during the Late Pleistocene. *Science* 310: 1313–1317. See also Petit, J.R., J. Jouzel, D. Raynaud, N.I. Barkov, J.-M. Barnola, I. Basile, M. Bender, J. Chappellaz, M. Davis, G. Delaygue, M. Delmotte, V.M. Kotlyakov, M. Legrand, V.Y. Lipenkov, C. Lorius, L. Pepin, C. Ritz, E. Saltzman, and M. Stievenard, 1999. Climate and atmospheric history of the past 420,000 years from the Vostok ice core, Antarctica. *Nature* 399: 429–436.

page 40, between the two states.

Alley, R.B., J. Marotzke, W.D. Nordhaus, J.T. Overpeck, D.M. Peteet, R.A. Pielke Jr., R.T. Pierrehumbert, P.B. Rhines, T.F. Stocker, L.D. Talley, and J.M. Wallace, 2003. Abrupt climate change. *Science* 299: 2005–2010.

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Emanuel, K., 2002. A simple model of multiple climate regimes. *Journal of Geophysical Research-Atmospheres* 107(D9): 4077, 1–10.

page 41, editing the sun.
Thomas, Lewis. *The Lives of a Cell: Notes of a Biology Watcher*, Viking Press, New York, (p. 145), 153 pp.

page 41, from the cell's nucleus.
Mann, C., 1991. Lynn Margulis: science's unruly Earth Mother. *Science* (News) 252: 378–381.

page 42, alternating as principal author.
Lovelock, J.E., and L. Margulis, 1974. Atmospheric homeostasis by and for the biosphere: the gaia hypothesis. *Tellus* 24 (1–2): 2–9. Margulis, L., and J.E. Lovelock, 1974. Biological modulation of the Earth's atmosphere. *Icarus* 21: 471–489.

page 42, to the wraith of Gaia."
Lovelock, J.E., 1979. *Gaia: A New Look at Life on Earth*, Oxford University Press, Oxford, England (p. 11) 157 pp.

page 42, climates of Earth and Mars.
Sagan, C., and G. Mullen, 1972. Earth and Mars: evolution of atmospheres and surface temperatures. *Science* 177 (4043): 52–56. Also see Sagan, C., 1977. Reducing greenhouses and the temperature history of Earth and Mars. *Nature* 269: 224–226.

page 42, worked on the United Kingdom.
Mann, C., 1991. Lynn Margulis: science's unruly Earth Mother. *Science* (News) 252: 378–381.

page 42, as the following passage shows:
Odum, E.P., in collaboration with H.T. Odum, 1959. *Fundamentals of Ecology*, 2nd edition, W.B. Saunders Company, Philadelphia (pp. vi, 16), 546 pp.

page 43, and other predecessors.
For instance, in his essay Reflections on Gaia (pages 1–6 in the 2004 *Scientists Debate Gaia*, published by MIT Press, Cambridge, Massachusetts), Lovelock acknowledges A.C. Redfield and G.E. Hutchinson, as well as V.I. Vernadsky.

page 43, J.R. Newman put it.
Webster's Third New International Dictionary.

page 43, so the atmosphere changed.
Lenart, M., 1994. Recharting a course for Biosphere 2, p. 38 of *The San Juan Star*, a daily English-language newspaper published in San Juan, Puerto Rico. Carbon dioxide levels reached as high as 4,000 parts per million within the enclosed structure. Levels would have been even higher, but the concrete was absorbing some of the carbon dioxide, as a team led by oceanographer Wallace Broecker discovered (personal communication described in the article).

page 45, ridiculed and ignored it.
Lovelock describes the scientific disdain for his theory in several places, including the revised preface for his 1987 version of *Gaia: A New Look at Life on Earth*, Oxford University Press, Oxford, England, 157 pp.

page 45, prevails across the planet.”
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Richard Dawkins, the author of the 1976 book *The Selfish Gene (Oxford University Press, USA)*, has been particularly critical of this perceived shortcoming of Gaia theory.

page 47, as did others.
Stephan Harding, a professor at Schumacher College in Devon, was modeling Daisyworld with 23 differently colored species of daisy, as well as herbivores that eat the daisies and carnivores that eat the herbivores. As Lynn Margulis puts it in *Symbiotic Planet* (p. 127): “What has emerged is the mathematical outline of an overlap between natural selection and global temperature regulation.”

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Cerling, T.E., J.M. Harris, B.J. MacFadden, M.G. Leakey, J. Quade, V. Eisenmann, and J.R. Ehleringer, 1997. Global vegetation change through the Miocene/Pliocene boundary. *Nature* 389: 153–158.

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Cerling, T.E., J.M. Harris, B.J. MacFadden, M.G. Leakey, J. Quade, V. Eisenmann, and J.R. Ehleringer, 1997. Global vegetation change through the Miocene/Pliocene boundary. *Nature* 389: 153–158.

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