Chapter 14

Biotic Earth, Biotic Climate

Abstract: Meteorological changes include biotic patterns in addition to periodic and chaotic ones. As a superorganism, the planet appears to evolve in a biotic fashion rather than be homeostatically regulated. The supremacy of the most complex planetary level, the human, is developing enantiodromically, both destroying biological species and generating a new level of world consciousness.

14.1 Novelty in the Ancient Nile

Egypt is, in Herodotus' famous phrasing, the child of the Nile, being totally dependent on its yearly flooding for irrigation. In legendary antiquity, Joseph interpreted pharaoh's dream of seven fat cows followed by seven thin ones as a prediction of seven years of good flood followed by seven of low flood. He had apparently discovered that there was a tendency for a good flood year to be followed by another good flood year, and for a low flood year to be followed by another. We can demonstrate partial autocorrelation (lag 1: 0.83; lag 2 to 5: 0.19 to 0.11).

The British engineer H. E. Hurst rediscovered this non-random run in the twentieth century when he conducted a study of 800 years of records of the Nile's flooding (the Roda gauge at the Nile reaches back to the year 622 AD). Hurst[1] found significant correlations among fluctuations in Nile river outflows and described these correlations in terms of power laws; Fig. 14.1 shows the 1/f power spectrum and the

[1] Hurst, H. E. (1951). Long-term storage capacity of reservoirs. *Tr. of the American Society of Civil Engineers* 116: 770-808.

corresponding wavelet plot. Mandelbrot and Wallis[2] used the term Joseph effect to refer to such persistence phenomena. Hurst quantified the phenomenon with a measure now known as the Hurst exponent, which turned out to be 0.91 for the annual levels of the Nile, indicating strong persistence. The calculation of this exponent is fraught with problems,[3] and involves detrending the data – a transformation that, as discussed previously (Section 4.1), precludes the observation of essential components of creativity. When the data are not detrended, isometry analysis shows marked novelty (Fig. 14.2) and well-delineated complexes without high consecutive recurrence, as also observed in other series with a 1/f power spectrum.

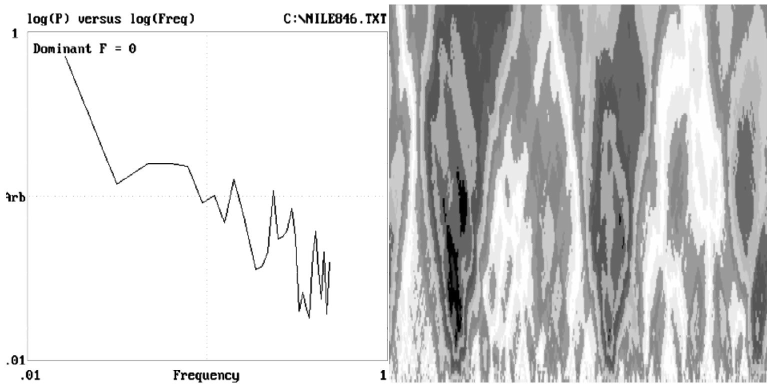

Fig. 14.1 Power spectrum and wavelet plot of Nile levels.

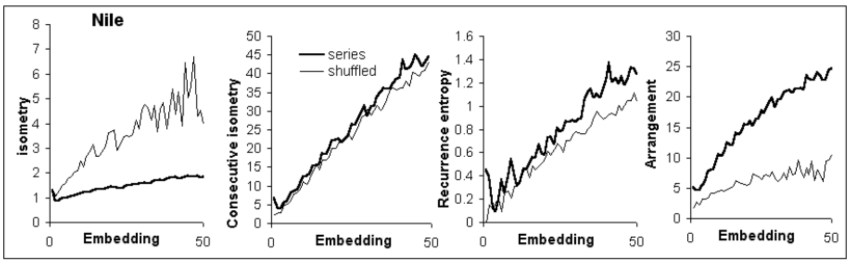

Fig. 14.2 Isometry analysis of Nile levels.

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[2] Mandelbrot, B. B. and Wallis, J. R. (1968). Noah, Joseph, and Operational Hydrology. *Water Resources Research* 4: 909-918.

[3] Calculating the Hurst exponent for Nile levels with the CDA gives values below 0.5. In this and other statistical packages, the Hurst exponent is estimated rather than calculated. A wide variety of techniques are used to this effect. After much frustration, I found that the accuracy of these estimations is often doubtful and that I was not alone in questioning reported measurements.

14.2 In Peoria, the Weather is Biotic

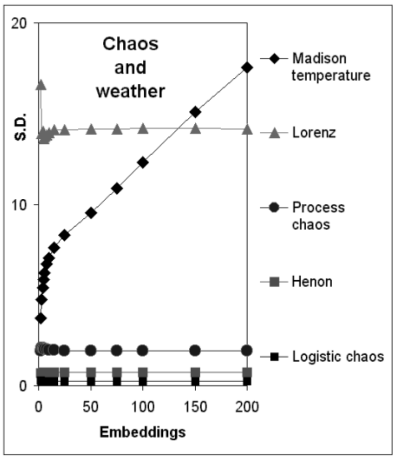

Fig. 14.3 Air temperature in Madison (Wisconsin) shows local diversification (increase S.D. with embedding) absent in chaotic series.

The study of the weather pioneered by Lorenz brought chaotic processes to the forum.[4] Atmospheric flows, for instance, exhibit self-similar fluctuations on all scales of space and time. Evidence of chaos indicates the need to test for bios. Diversification is found in a number of meteorological time series: temperature changes for several Midwest[5] (Fig. 14.3) and California locations (Fig. 14.4), water temperatures in the Pacific Ocean (Fig. 14.5), and in paleoclimatic indicators from coral samples.[6] Recurrence plots of these series showed distinct episodic complexes, not the stationary patterns observed with chaos. Comparison with shuffled copies indicates novelty with (Fig. 14.6), or without

[4] Lorenz, E. N. (1993). *The Essence of Chaos*. Seattle: University of Washington Press; Fraedrich, K. and Schönwiese, C.D. (2002). Space-time Variability of the European Climate. In *The Science of Disasters*, A. Bunde, J. Kropp, and H. J. Schellnhuber (Eds). Berlin: Springer.

[5] Sabelli, H. (2000). In Peoria, the weather is biotic. *General Systems Bulletin* 29: 9-10.

[6] Charles, C. D., Hunter, D. E., and Fairbanks, R. G. (1997). Interaction between the ENSO and the Asian monsoon in a coral record of tropical climate. *Science* 277: 925-928; Charles, C. D., Hunter, D. E., and Fairbanks, R. G. (1997). Seychelles coral d18O, IGBP PAGES/World Data Center-A for Paleoclimatology Data Contribution Series # 97-032. NOAA/NGDC Paleoclimatology Program, Boulder CO, USA; Sabelli, H., Sugerman, A., Kauffman, L., Kovacevic, L., Carlson-Sabelli, L., Patel, M., Messer, J., Konecki, J., Walthall, K., and K. Kane (in press). Bios Data Analysis. Part 11. Biotic patterns in biological, economic and physical processes. *Journal of Applied Systems Studies,* special issue edited by H. Sabelli.

consecutive recurrence (Fig. 14.17). Arrangement is high, indicating nonrandom complexity. Wavelet plots, Lyapunov exponent, clumpiness test, and all other analyses are also compatible with biotic pattern. Temperature variation in several parts of the globe has a clear biotic pattern within its seasonal periodicity.

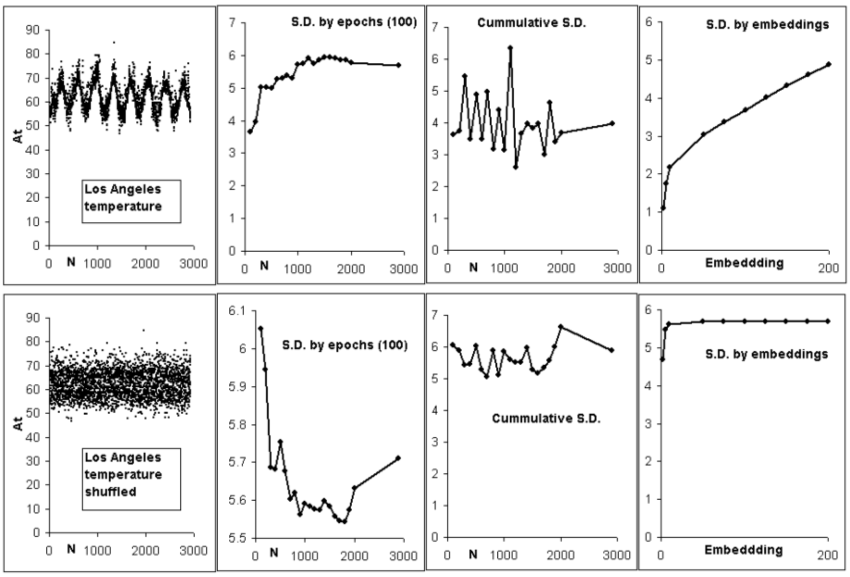

Fig. 14.4 Local diversification in evident in the series of LA temperature, and it is absent in shuffled copy.

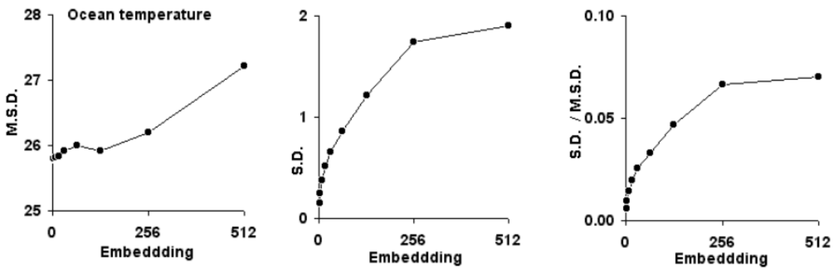

Fig. 14.5 Local diversification is greater than local diffusion, as demonstrated by an increase in their ratio.

In sharp contrast to temperature recordings, precipitation averages in the Midwest and the South (Fig. 14.8) of the USA are either random or chaotic according to each of the above tests. This finding agrees with our intuition that temperature is more predictable than precipitation. Yet, torrential rains and other severe convective weather conditions appear to be predictable[7] and may be modeled by "blown-ups".[8] Apparently, atmospheric processes include flows, cycles, chaos and bios. Only in mathematical models do we find examples of single processes with unmixed pattern; real processes contain several types of components that not only add but also interact.

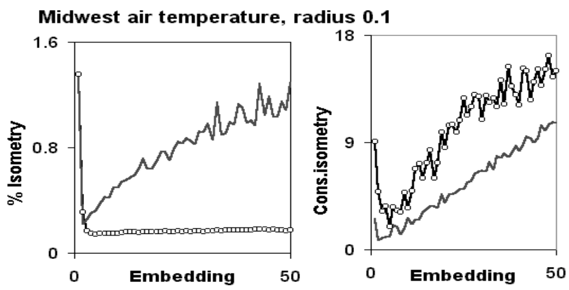

Fig. 14.6 Embedding plot of atmospheric temperature (Madison, Wisconsin).

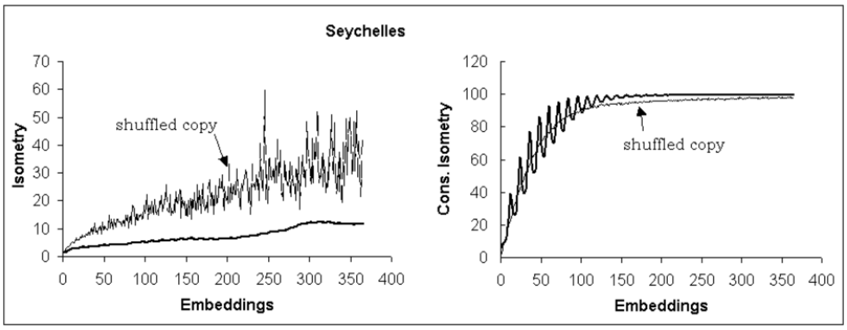

Fig. 14.7 Embedding plot of oxygen-18 content time series in corals. Data are monthly values of d18O from July 1846 to February 1995 from a 3-m Porites lutea coral colony collected from Beau Vallon Bay Mahe Island, Republic of the Seychelles[9].

[7] Fraedrich, K. and Schönwiese, C. D. (2002). Space-time Variability of the European Climate. In *The Science of Disasters*, A. Bunde, J. Kropp, and H. J. Schellnhuber (Eds). Berlin: Springer.
[8] Lin, Y. and Wu, Y. (1998). Blown-ups and the concept of whole evolution in systems science. *Problems of Nonlinear Analysis in Engineering Systems* 4:16-31.
[9] Charles, C. D., Hunter, D. E., and Fairbanks, R. G. (1997). Interaction Between the ENSO and the Asian Monsoon in a Coral Record of Tropical Climate. Science 277: 925-928.

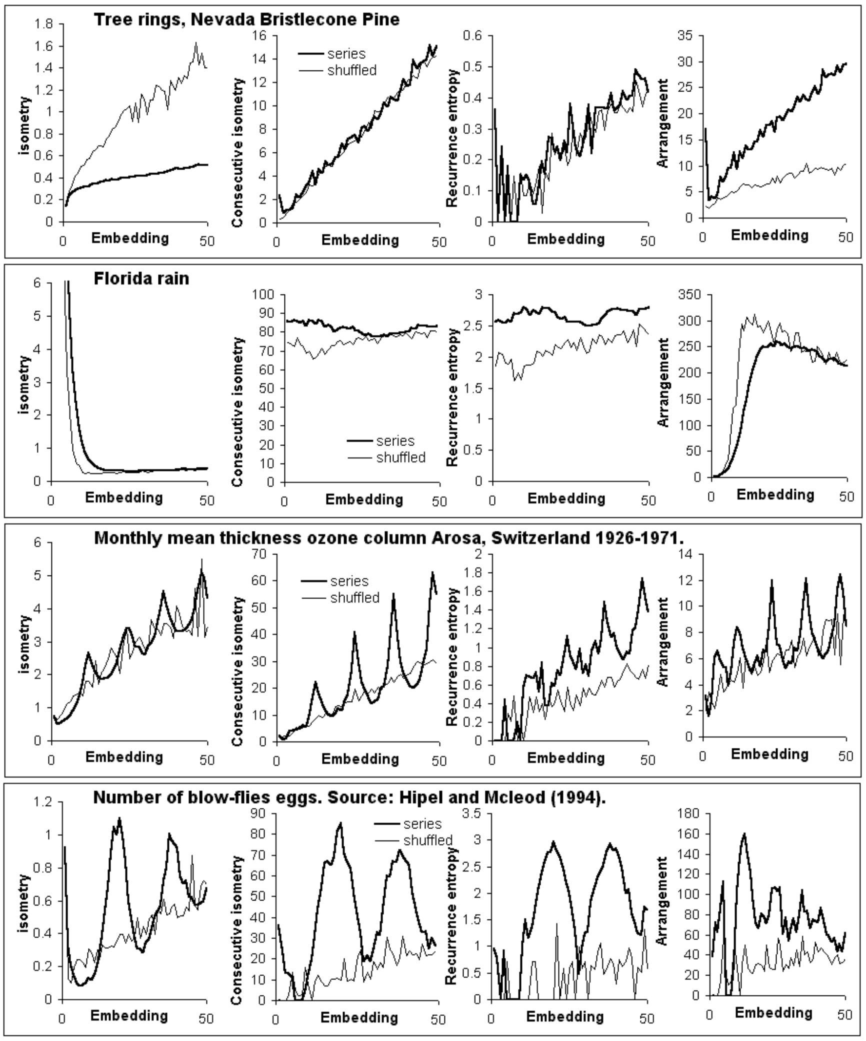

Fig. 14.8 Embedding plots of various planetary processes illustrate the diversity of patterns observed including novelty (top), chaos (second row) and periodicity (third and bottom rows).

As the actual realization of an open system, the earth's atmosphere demonstrates that gases do not spontaneously tend to equilibrium and uniformity as in a closed system, nor continuously expand as in an idealized open system, but show uninterrupted molecular flux (temperature), flow (wind), asymmetric cycling of opposites (circulation patterns), and adopt a spheroid shape with tridimensional organization (night-day variation in the East West direction, North-South bipolarity, and a vertical hierarchy of pressure). There are seasonal periodicities, and chaotic patterns resulting from interactions with land and sea. But, as the data shows, there are also biotic patterns.

14.3 Biotic Earth: Gaia and Bios

The Earth's climate is biotic because the planetary surface is biotic. Seen from space, our planet is green. Even the chemically poor oceans teem with life.[10] The biosphere is a thin layer on the surface of the Earth where all organisms live. The atmosphere and the earth's surface are created, maintained and modified by living organisms. Life evolves only at the interphase of water, air and solid matter. Planets without life, like Mars or Venus, have neither water nor soil. It is living organisms that create soil. They have contributed to maintain water on the earth's surface. Without life, there might be no clouds, rain, rivers or oceans. Without water, the tectonic plates responsible for continental movement might not move. The chemical reactions of life (e.g., photosynthesis-respiration, carbonate precipitation, etc.) have determined the chemical composition of the atmosphere. The fact that life is a major geological force illustrates the supremacy of the complex.

Just as each of us lives in symbiosis with many species,[11] every species lives in conjunction with its entire ecosystem. There is a growing consensus among scientists that the earth should be regarded as a single, self-regulating system.[12] The Greek physiologists considered the world as alive. Newton compared the planet to a living organism. The Russian scientist Vladimir Vernadsky developed the modern concept of "biosphere" in the early twentieth century. The biosphere is a thin layer

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[10] The "microbial ocean" was, surprisingly, discovered only after methods were developed to detect life on Mars. The pelagic bacteria that account for most of the ocean biomass, over 99% of the bacteria in the sea, were first detected in 1977 and viruses were not studied until 1989 [Azam, F. and A. Z. Worden. Microbes, molecules and marine ecosystems. *Science* 303: 1622-1624, 2004].

[11] About 400 different microorganisms inhabit the human gut, accounting for 1 kg of mass.

[12] See, for instance, the *Amsterdam Declaration on Global Change* (2001), co-signed by more than 1,500 scientists from over 100 countries.

on the surface of the Earth where all organisms live. The biosphere involves many differentiated ecosystems, but it functions as a more or less integrated system, including significant horizontal genetic transfers. James Lovelock,[13] a leading environmentalist, proposed that living organisms regulate the atmosphere (a fact that seems evident) in their own interest (a purposefulness that to me seems rather doubtful). He thus regards the biosphere as a superorganism, named Gaia after the Greek Earth Goddess. The Gaia hypothesis states that the earth, as living organisms, involves a multiplicity of positive and negative feedback processes to maintain homeostasis. The notion of homeostasis needs reformulation regarding individual organisms (Chapter 5). It is not applicable to life as a process that involves the birth and death of individuals and entire species.

14.4 The Drama of Privatization Versus the Tragedy of the Commons

According to Lovelock, Gaia is aging. Planetary self-regulation does not imply that nature can tolerate whatever humans do to it. On the contrary, humans are very much part of the system, and can counteract or accelerate its aging.

The Gaia hypothesis contradicts the Darwinist view of life. First, synergistic processes take the lead over competition. Second, biological organisms co-determine the evolution of the planet (supremacy of the complex) rather than serve as the passive recipients of climatic changes.

The Gaia model has great scientific and social value, as it has stimulated research and environmental protection. However, homeostatic models tend to ignore essential change. An instructive and significant example is the story of the hole in the ozone layer.[14] Living organisms

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[13] Lovelock, J. (2000). The Ages of Gaia. Oxford University Press.

[14] During the 20th century, industrial sources released enormous amounts of chlorofluorocarbons (CFCs) into the atmosphere. These compounds were regarded as indestructible (i.e., unreactive). A process view indicates that nothing is indestructible. Based on this assumption, Mexican post doctoral fellow Mario Molina and University of California Sherry Rowland explored the potential consequences of CFCs reacting in the upper atmosphere and found that this could lead to the depletion of ozone in the atmosphere. The other piece of relevant philosophy that entered into their investigation was the environmental consciousness created by the 1960s generation. Molina and

create the planetary cortex. We are now witnessing its radical change by the action of the top member of the biosphere –our species. Just as actual homeostasis, planetary homeostasis is neither a point nor a cyclic attractor dynamical system. Self-regulation is accompanied by temporal evolution. This combination of homeostatic features with nonstationarity (Lovelock's "aging") is found in homeobios but not in stochastic noise, chaotic attractors, or random systems. Thus Gaia must be a biotic, or more precisely, homeobiotic system. This is consistent with the coexistence of positive and negative feedback processes described by Lovelock. As expected from bipolar feedback, the well-known planetary cycles (water, oxygen, carbon, nitrogen) show biotic trajectories. They do not maintain equilibrium as in the homeostatic and homeokinetic models, but create anew. Physical and chemical biotic cycles are engines for evolution.

Biotic processes involve not only creation but also destruction. The biosphere is not aging. It is literally being killed. Industrial progress and commercial interests are responsible for one of the most severe extinctions of animals and plants in planetary history. For instance, fisheries are declining as a result of their overexploitation, mostly during the twentieth century; from 1900 to 1999, biomass has decreased by a factor of ten or more.[15] This accompanies human self-destruction by war.

Determinism and creative choice provide different portraits of our current environmental crises and indicate opposite courses of action. In a much quoted 1968 *Science* article, recently celebrated on the cover of the same leading scientific journal, Garret Hardin defined the current environmental crises as a Tragedy of the Commons, for which there are

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Rowland made their results known to the public in 1974. The industry mounted a powerful campaign to continue its practice, alleging that there was no scientific evidence for deleterious effects on the ozone layer. Here entered a third piece of sound philosophy: the precautionary principle according to which one need not await proof that something has already caused damage if there is evidence that it could. Against the massive opposition of the industry, the use of CFCs was discontinued. A. Irwin's An Environmental Fairy Tale (In *It Must Be Beautiful*, G. Farmelo (ed). London: Granta Books, 2002.) beautifully narrates a further chapter of the story, in which a wrong philosophy delays scientific insight. British scientists recorded low ozone readings in Antarctica, [14] but refrained from publishing for three years because a NASA satellite that was in much better condition to observe the ozone layer had reported no significant changes. The NASA satellite had also recorded the reduction in ozone, but its scientists had given instructions to the computer to ignore low recordings as probable errors! This illustrates the consequences of discarding extreme values as outliers.

[15] Pauly, D. and Maclean, J. (2003). *In a Perfect Ocean.* Island Press.

only two solutions −centralized government and private property. The term ‘commons’ refers to pasture areas communally owned and used by English villagers. Used efficiently for centuries, they were ruined by overutilization as a result of the transformation from feudal to capitalist modes of production. The destruction of the commons was the consequence of the privatization of ownership. In Hardin’s speculation, each herdsman tries to keep as many cattle as possible on the commons to maximize his own gain, and as this strategy is employed by each and every herdsman, depletion of the resource follows unavoidably. The British commons were not destroyed in this fashion. When individual persons belong to their community, they protect it as their own. But the entrepreneur who lives elsewhere does not belong to the community and is alienated from it. While Hardin and others consider the behavior of alienated individuals as normal and rational, the psychiatrist remembers that alienation means insanity.

The term Tragedy of the Commons is an ideological misnomer that obscures scientific discussion. It is not tragedy and it is not produced by public ownership. It is not tragedy because the term refers to unavoidable catastrophes resulting from the very essence of the protagonist, the hero’s ‘fatal flaw’ in Aristotle’s words. The Tragedy of the Commons is drama, that is to say, it involves struggle between opposite parties. It is not the consequence of human nature. The misnomer Tragedy of the Commons distracts our attention from the true problem: the drama of privatization and statization. Privatization allows the destruction of what should be used and protected in common by private greed. Statization places control of what should be used and protected in common in the hands of governments that often promote privateers, a name originating under English law that encouraged pirates to pillage Latin America. Neither privatization nor statization will prevent environmental destruction. In fact corporations seeking profit and governments seeking economic development and military power are responsible for polluting air, soil, rivers, and oceans, depleting forests and fisheries, and even altering the global climate.[16] Often, corporations and governments are

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[16] Watson, R. T. (2003). Climate change: The political situation. *Science* 302: 1925-1926; Houck, O. (2003). Tales from a troubled marriage: Science and law in environmental policy. *Science* 302: 1926-1929.