ENVIRONING MEDIA

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Introduction

The biosphere is generally seen as *one among other spheres* of the Earth system whose structure and functioning pertain to Earth system scientists' investigations. Emerging in the early 1980s to study the interactions among the geosphere, the atmosphere, the hydrosphere and the cryosphere, Earth System Science (ESS) has also come to subsume the sphere of life within the realm of its literacy. Yet if we begin to historicize the notion of the Earth system, we see that *environing media* practices that resulted from mid-20th-century science and technology, in particular cybernetics, have led their advocates to falsely construe our planet as a techno-ecological system. In this system, humans are a peripheral driver experiencing the Earth from the *outside*. As a result, a representation of the biosphere as one *part* of the Earth system has emerged as dominant.

This chapter shows that the recognition that human processes have been pushing the Earth into the Anthropocene, imposing new directions on Earth system processes from the *inside*, revives the biosphere as a protagonist of the Earth system, prompting us to re-evaluate historical attempts to conceptualize biosphere genealogies and the history of a human-reconfigured biosphere. Therefore, studying the history of the biosphere as coupled with human history is the first step toward recognizing the predicament of the Anthropocene, which is in turn fundamental to redirecting the pathway toward a more sustainable feature.

A theory of the biosphere addressing the interaction of life with the geophysical and atmospheric environment of the Earth can be dated back to the early decades of the 20th century. In this chapter, I will mostly refer to the ideas of Vladimir Vernadsky, a Russian mineralogist who conceptualized the biosphere as susceptible to change under human global activity. In this early elaboration, the biosphere seems to possess features similar to the contemporary Earth system

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notion. The inclusion of human factors in Earth System theory and modeling is indeed becoming increasingly fundamental. However, the entanglement, in the 1980s, of ESS with the National Aeronautics and Space Administration (NASA) led to the promotion of the Earth system as a groundbreaking revolutionary concept that incorporates the "biosphere" merely as one of its subsystems. By adopting this narrative, ESS's advocates have provided an often-simplistic reconstruction of a far more complex historical transition from the biosphere to the Earth system theory.[1] In this transition, some features that characterized the early 20th-century elaboration of the biosphere either got lost, were overshadowed or were later incorporated to legitimize ESS as a comprehensive theory of the human-Earth system relationship. In this respect, intellectual history of the concept of the biosphere and the history of environing media can help us understand what led to the bifurcation between the notion of the biosphere and that of the Earth system and how these two concepts came into being. As this chapter shows, a historical reconstruction of the emergence of the biosphere concept offers insights (among other things) into how humanity and nature became conceived of as one tightly interconnected system – how historians and naturalists, in recognizing the human capacity to transform portions and properties of the biogeochemical environment, started a process of self-reflection that brought them to attribute a geological force to humanity. This self-reflection can be seen in other terms at the very core of *environing*, because it is through acting upon and within nature that human perception, experience and representation of the environment develops and changes across time. The process of environing is both material and conceptual. It implies an intervention into nature that is always mediated by pre-existing (technical and intellectual) knowledge. Therefore, environing is a media process that is enabled by certain tools, models, practices and ideas. In the case of the biosphere and the Earth system notions, we will see how different media were at work in building the epistemology of a tightly interconnected system.

The notion of the biosphere is usually used to describe the interdependency of biological communities at large – including human societies – and the surrounding environment. The influence of life sciences on the formation of this object shaped the understanding of the biosphere as a large ecosystem where organisms and environments are plotted by material and energy transfers.[2] This model, scaled up to the planetary level, environed the biosphere as a territory of the Earth that is primarily experienced on the *ground*. In some definitions of the biosphere, the *pedosphere* (the sphere of soil) in fact occupied a prominent role. One example are the investigations of the Russian mineralogist Vasily V. Dokuchaev, whose expeditions across European Russia – conducted with the aim of *ecologizing* agricultural practices to preserve soil functions – led to the environing of the soil's biosphere as a "global natural object" that evolves under the action of climatic and geological but also biotic and anthropogenic forces.[3] The science of the pedosphere, seen as a system that stands in mutual dependence and chemical exchange with the atmosphere and the hydrosphere, emerged from everyday practical experience with the goal of ameliorating aspects of human health and economy.[4] Likewise, new branches of science, such as geography, cartography and mineralogy, received an enormous boost as disciplines necessary for orientation, to conquer new areas and geo-locate resources. At the same time, life sciences (along with systematics and taxonomy) helped situate the point from which to observe the biosphere within the biosphere itself, offering an *inside* perspective of its processes seen in relation to human experience. Geographers like Dokuchaev had to experience the land in order to understand how it works. The development of an *inside* perspective was facilitated primarily by the naturalistic observation during expeditions, thanks to the presence of vast pristine lands. Geographical explorations indeed acted as an environing media practice, which shaped understanding of flora and fauna as ecosystems. Moreover, they triggered the study of the morphology of different soils in relation to changing climatic factors and the coevolving relationship between organisms and their environment.[5]

In contrast to the biosphere notion, the Earth system has primarily been acknowledged as an object to be experienced from the *outside*. At the base of the emergence of the Earth system lies the convergence (in the 1960s and 1970s) of ecology and technology, as embodied, for instance, in the powerful "Spaceship Earth" metaphor. By depicting the Earth as a precarious vessel with limited resources, this metaphor raised awareness of the vulnerability of our environment and the finitude of its resources. Most importantly, however, Spaceship Earth had the side effect of legitimizing a technocratic vision of our planet according to which the sciences shall guide societies to the correct and efficient use and administration of lands, air, waters and the organisms inhabiting them. Together with the iconic images of the Apollo missions, Spaceship Earth became fundamental in generating knowledge about and representations of the Earth as a body observable at a distance. Satellites are instruments placed into orbit that are used for many purposes, but one of their most important applications is taking pictures of the planetary surface to create maps of the Earth or registering events. Satellites not only capture and transmit information but contribute to co-create environments by participating in a process of knowledge formation that becomes the basis for any further comprehension, action and transformation of the environment. In this respect, satellites offered a key demonstration of the act of environing the natural world with the aid of technologies that detach the observer's eye from the human scale.[6]

As the Earth turns into a techno-ecological system experienced from the outside, the biosphere becomes less and less perceivable; however, a separating line between the Earth and the biosphere is harder to draw now than ever before. Considering the biosphere as one part of the Earth system is a misconstruction since the biosphere has turned into a large-scale technological system of human production, for which Peter Haff has proposed the term "technosphere".[7] The biosphere is not simply a part of the Earth system – in the Anthropocene, it is the Earth itself.

This chapter shows how visions of the biosphere and the Earth system that are scientific, economic, social and material have been engendered by specific environing media in the form of instruments, models and discourses used to produce that knowledge. Against this background, our ability to formulate meaningful ideas and strategies to overcome the current predicaments posed by the Anthropocene also depends on our effort to revisit these visions and thus inform our present-day discussions. This is all the more important as historical visions of the biosphere and the Earth system reflect different moments of global environmental knowledge, including at the political and governmental level, that have allowed these notions to propagate and attain international credibility through specific programs. One of the consequences of legitimizing competing environing media is that a perspective that integrates human-biosphere studies and Earth System Science, despite various attempts, has not yet been attained. Realizing this integration is of the utmost importance for devising pathways toward new Earth system futures.

The biosphere as a cosmic medium

Austrian geologist Eduard Suess, one of the founders of tectonics, introduced the biosphere in a book on the geological formation of the Alps in the 1870s. As he portrays it, this celestial body consisting of organic life is situated between the air and rocks and represents the "face of the Earth".[8] Life interacts with both the atmosphere and the lithosphere; however, the former is singled out as an autonomous, concentric system which occupies a specific layer of the Earth, limited in space and time. *Solidarity* among the living populations is a predominant characteristic of the biosphere, but it does not exercise any specific influence on other parts of the Earth.

Suess's understanding of the biosphere was expanded on by Vernadsky a few decades later. The Russian geochemist historicized the biosphere in its role as a transformative driver of the whole Earth. Where Suess sandwiched the *film* of life between the lithosphere and the atmosphere, Vernadsky attributed to the biosphere a more holistic and ubiquitous function. All parts of the Earth, its spaces and physical matters, have been affected by life in some way, which leads to the conclusion that the history of organisms reveals the history of the Earth itself.[9]

In early 20th-century Russia, the predominant form of experiencing nature was naturalistic observation and specimen collection. Vernadsky was not accustomed to working in artificial settings. Already at an early age, he had been exploring nature, observing biogeographical variations of the Russian soil and moving beyond localities to imagine processes that were scalable, stretching out the biosphere as a planetary environment. He inferred that biotic and abiotic components can only be studied with the help of an integrated approach combining biology, chemistry and geology.[10] As Vernadsky saw it, there is barely any area of the Earth that has not been affected by living organisms. The biosphere articulates the overall functioning of the Earth by translating solar energy into biogeochemical *living matter*: it is "the sum total of living organisms that creates innumerable chemical compounds by photosynthesis and extends the biosphere at incredible speed as a thicker layer of new molecular systems".[11]

In this portrayal, the ubiquitous role of the biosphere in the configuration of the Earth is grounded in its capacity to perform a global biogeochemical function which entails the transformation of any element that touches its ground, evaporates in its air and drops back into the ocean. Jacques Grinevald echoes Vernadsky when he writes, "the biosphere has no *geographical boundary*[12] outside the observer's choice. Its extent is defined by the scale of observation" – hence there is nothing small or large in nature.[13] Borders or frontiers (in Russian *granitsa*) are themselves media that translate the biogeochemical information from one sphere to another and among the different *geospheres* as in a process of emergent communication.[14] Gabrys refers in her book *Program Earth* to Gilbert Simondon's concept of mediation. Simondon develops the use of mediation and communication by addressing phases of being and becoming. As an example, he describes a plant communicating and mediating between the cosmic and the mineral, the sky and the ground, taking up and transforming energies and materials through its processes. The *associated milieu* operates as this mediatory space, a transversal ground through which transformations play out and new phases of being emerged.[15] Likewise, in Vernadsky, borders are not meant simply as interfaces that enable the passage of elements. During the transfer of elements from one area of the biosphere to another, there is always a process of creation of new emerging entities. Mediation is always a creative process (that gives rise to something new).

For Vernadsky, the biosphere is as much terrestrial as it is cosmic. It does more than just wrap around the Earth horizontally or define it by the verticality of its relation to the sun. It is a matrix of biogeochemical interactions that involve land, ocean and air with cosmic energy. As the region where solar radiation is intercepted and transformed into active energy by living matter, the biosphere itself can be understood as an environing *medium* connecting the Earth with the cosmos. Radiations across space shaped the surface of the planet and thus our understanding of the role of energy for the existence and perpetuation of life on Earth. Radiation in the form of light, heat and electricity according to its type and wavelength – says Vernadsky – made the biosphere in the way we know it.[16] The immense range of the spectrum of radiation is constantly being extended by scientific discovery; thus, our understanding of the biosphere as a medium between the cosmos and the Earth will be progressively enriched by the science of radiometry, for example. Here again, the concept of mediation and communication through science and technics is particularly relevant to understand the process of environing.

Vernadsky investigated human biogeochemical alteration of the biosphere, which today is referred to as the Earth's "critical zone" – a heterogeneous space of interaction of biogeochemical components. He derived his interest in earthly geochemical interactions from the study of crystals and minerals as dynamic entities. Mineralogy allowed him to construct a view of the Earth as an evolving system subject to historical processes. Specifically, minerals such as aluminosilicates, the most abundant on Earth, are involved in its geological formation, while crystals are solid products of its chemical reactions; all together, they reveal the Earth's history.[17]

The appreciation of crystallography and mineralogy as historical disciplines allowed Vernadsky not only to see the Earth as an evolving system under the influence of endogenous forces, but also to comprehend the biosphere as the arena where those minerals circulate, accumulate, form sediment and get transformed. In this sense, the intervention of living organisms, and specifically humans, is known to act on the very core of the Earth, producing artificial minerals, rocks and new materials that have changed Earth's geochemistry, altering cycles and flows of minerals.

In Vernadsky's time, technologies allowing humans to grow their power at the expense of their surrounding environments generated uneven access to culture, education, wealth and health in different parts of the world. The concept of "environing technologies" developed by Nina Wormbs and Sverker Sörlin[18] is particularly suited in this context. By technology the authors refer to a terraforming practice that is a conceptual and a material process. Indeed Vernadsky has described the development of human technologies as oriented toward the comprehension of the world as a global integrated system, and this comprehension is the precondition for any intervention, being tightly connected to it. For instance, according to Vernadsky, the invention of the printing press made it possible to produce and share knowledge about previously inaccessible areas of the globe. The mastery of new forms of energy – steam, electricity, atomic energy or radioactivity – facilitated the study of the biosphere as a thermodynamic system where solar energy is absorbed and then radiated back in the form of heat, while the penetration into the surface of the Earth by mining, boring and drilling in search of coal, oil and ores made it possible to perceive the profundity of the Earth's crust and the transformative geological capacity of human activities. The invention of telegraph and radio made communication between faraway places possible, shortening distances and contributing to the sense of interconnectedness of our globe. All these and later processes, firmly grounded in human scientific and technological developments, have completely changed the biosphere, which has been heavily reconfigured and redefined both in its own biological components and in the way it interacts with other spheres of the Earth such as the atmosphere and the lithosphere.[19] According to Vernadsky, since the mid-20th century we have been living in a system called the *noosphere*, an epoch in which humans have become aware of their ability to perform a geological role on Earth. At the same time, humans have acknowledged that their power can be disruptive, realizing the urgency of reversing the march of progress that has characterized Western civilization since early modern times.[20] Jürgen Renn has aptly used the concept of "epistemic evolution" to define a new stage of cultural evolution that becomes the dominant process of human history and in which science becomes existential. However, while humans become aware of their power in terraforming the Earth, in effect becoming a geological force, it is plausible that science could emerge and become a dominant factor of our current state without being the necessary result of some initial conditions, but following a process that is also contingent, as in Darwin's theory of evolution.[21]

Similar to the notion of a technosphere, the noosphere is characterized by the increase of Earth's demography; by the transformation and globalization of communication and trade across the planet; by the predominance of humanity's geological role on Earth; by the industrial exploitation of new sources of energy, just to make one example. This concept is reminiscent of the Great Acceleration notion and the resulting Anthropocene model that would emerge later in the 20th century.[22] At the same time, the noosphere appears to have a constructive quality. It is attended by values that could prevent social and environmental catastrophe, namely democracy and equality, creating a real possibility to end malnutrition, hunger, misery and war. Even though humankind's technological force has the potential to irreversibly change the biosphere, this does not have to be the case. These forces must stop or be reoriented toward safe operating thresholds; otherwise, the unintended consequences of human action will generate environmental processes that may expose societies to a full collapse.

Initially, Vernadsky's work did not have a widespread influence on Western narratives of the biosphere. The biosphere theories that emerged in the 1970s, thanks to the work of ecologist Eugene Odum and later chemist James Lovelock, were prompted by different media. The development of technologies in the aftermath of World War II environed the biosphere, remolding its functions. In particular, drawing on cybernetics, new visions of the biosphere emphasized *regulatory aspects* of ecosystems and the *stability* of certain variables that remain constant over change and transformative action.[23] Even in those cases where Vernadsky did exercise an influence on the development of American ecology – for example on limnologist George Evelyn Hutchinson, who was highly fascinated by his biogeochemical approach – the idea that humanity could act as a transforming force of the biosphere was not considered as meaningful, as it lacked scientific basis and empirical evidence.[24]

Odum and Hutchinson promoted a vision of the biosphere as a *self-regulating* system. This definition emerged from the convergence between ecological discourses and cybernetics, which acted as an important trigger to the rise of the Earth system concept in the early 1980s. Following in the footsteps of Hutchinson, Odum claimed in a pioneering article (co-authored with Bernard Patten) that ecosystems *are* cybernetic systems, ushering in a new language which explained the cycling of energy and materials through ecosystems in terms of *input* and *output*, information flow and feedback governing the whole biosphere and the exchange among its parts.[25] Cybernetics mediated an understanding and representation of nature as a complex system to be controlled and managed because nature and society share a universal feedback logic.[26]

Where Vernadsky stressed co-evolutionary processes involving the biosphere and the geospheres as *emergent phenomena* grounded in the convergence of the global biogeochemical function of living matter with the geophysical properties of human technological systems – much like Haff's technosphere – Hutchinson described the biosphere as the place of interaction of two separate entities, organisms and environments, forming one *closed* ecosystem. This can be seen as an *autopoietic* system that reproduces itself from its own properties, shutting out all external perturbations. As Patten would have it, "the *environ*[27] here is delineated as a closely linked structure, a particulate unit of evolution" that introduces a sense of system.[28] Along the same lines Hutchinson proposed the idea of "circular causal system" in ecology, where ecosystems are explained as *networks* of biotic and abiotic components that interact through mechanisms of information feedback.

The notable Macy conferences on Circular Causal and Feedback Mechanisms in biological and social systems, which took place from 1946 to 1953, played a fundamental role in fostering interdisciplinary dialogue under the banner of cybernetics.[29] In 1948, the same year Wiener published his manifesto,[30] Hutchinson, a participant of the Macy conferences, published an article in which he attributed to ecosystems the capability to *self-correct*, arguing that there was little need for concern about anthropogenic increases of carbon dioxide, for example, as the self-regulating mechanisms of the biosphere were capable of correcting imbalances in carbon, whether natural or artificially produced.[31]

The Earth system: Environing from outside

The confluence of cybernetic and ecological discourses embodied in visions of the ecosystem and the biosphere promoted by Hutchinson and Odum, which represents an important catalyst in the rise of ESS, environed natural systems, and the biosphere in particular, as mechanistic entities. In this context, information science offered a solid basis to authorize and legitimize the circulation of concepts ranging from biophysical systems to mind, behavior and technology, unifying them under the epistemic roof of cybernetics as a universal science of control, in turn made possible by the development of the computer and artificial intelligence.[32]

Historian Greg Mitman has emphasized how cybernetics turned ecology into a technoscience in the service of managerial capitalism: "Nature had become a system of components that could be managed, manipulated and controlled. The ecologist's task increasingly became that of environmental engineer" who could monitor and fix the environmental problems created by human society.[33] Along the same lines, David Munns argues that the exigencies of environmental control in the early Cold War turned biologists into technologists, capable of mastering engineering and computer models in order to measure and optimize the climate conditions for a plant to grow in a facility.[34] Along the same lines, as Taylor would put it, Hutchinson and Odum's work in the field of systems ecology, adopts that "technological optimism" that characterizes the social context of the Postwar Years and is constitutive of their methods and research.[35]

The proliferation of terminologies imported by the cybernetic lexicon featured prominently in ecological discourses to explain Earth's responses to changes induced by external perturbations, for example, homeostatic behavior, feedback loops, balance, stability and resilience. Drawing on the interpretation of ecosystem as a cybernetic apparatus characterized by the imperative of energy and information flow, both Hutchinson and Odum – and later, more vigorously, Lovelock, who recognized Hutchinson as a mentor – promoted an understanding of natural systems as entities, comparable with artificial devices, that can both be understood and managed by means of the same cybernetic principles. In Lovelock's view, the ensemble of living organisms – constituting what he, together with Lynn Margulis, named *Gaia*, or the Earth as a living organism – has acted as a single entity to purposefully regulate the chemical composition, surface pH and atmosphere of the Earth. It is these supposed regulatory properties which then led Lovelock to compare the living planet – Gaia – with a gigantic homeostatic system. For physician Walter Cannon, our body is able to keep a physiological stability by buffering perturbations coming from the external environment, a function otherwise ascribed to the *milieu intérieur* theorized by Claude Bernard. Lovelock transferred this capability to the biosphere itself.[36] He maintained that life, since its appearance, has acquired control of the planetary environment via feedback loops.[37]

Cybernetic interpretation of the biosphere made it possible to regard any subsystem involved in its functioning as an equal contributor to the stability and integrity of the whole. One may infer that humans have become part of the Earth's metabolism without bringing any interference to its basic processes, any substantial change. All components regulating this large entity are mutually formative. The only privileged status is ascribed to microbial activity through which the planet has acquired enough resilience, which has in turn equipped the Earth with the ability to transform its gases, like CO_2 and other chemical components, in response to microbial life's metabolic pressure to expand its domain. Gaia is indeed, like Hutchinson's ecosystem, an autopoietic, microbe-centric entity: it is microbial life that controls the global environment.[38]

While many believe that this view of the biosphere has contributed to removing the flaws of anthropocentrism, giving prominence to a human-centered Earth, the vision it has actually propelled is that of a planet that dislodges the *Anthropos* by refusing the very notion of a human species or by denying the possibility of perceiving ourselves as a species.[39] But when humanity fails to recognize its own geological agency and humans are left with no power to change the Earth's processes, they can only act as supervisors who look at the Earth from a distance, adopting a certain neutrality that reinforces, other than dismisses, anthropocentric perspectives. Technologies can therefore be tolerated by the biosphere, as artificial and natural processes are both part of the same entity and do not harm the functioning of the biosphere as a large techno-ecological system.[40]

This position would justify Lovelock's call for engineering efforts to remedy the climate crisis instead of arguing against the fossil fuel economy. At any rate, it is quite curious that those who are still committed to invoking Gaia as a way to awaken global consciousness in a time of anthropogenic impact on the Earth system are doing so at the cost of departing from the original theory.[41]

Visions of the biosphere as a cybernetic system would not have been so compelling had they not been complemented by visions of Earth from outer space, in which the biosphere is hard to spot.

Iconic photographs taken during the Apollo missions such as Blue Marble or Earthrise are environing media that conveyed the vision of a global Earth, or to speak with Elizabeth DeLoughrey, that forged the *American* image of the globe.[42] Moreover, they helped build the narrative of a planet in need of care, which in turn installed the idea of the Earth as an entity requiring *stewardship*.[43]

The integration of cybernetics and ecology that is manifested in the rise of systems and global ecology, along with distant views of the Earth, environed our planet as an "objective" reality. This construed reality became the seed for the emergence of the paradigmatic Earth system notion and the associated science that addresses its functioning.[44] This science had to be characterized by a strong emphasis on self-regulatory functions and on the recognition of the Earth as an integrated entity as well as a system that required new forms of modeling, observations and visual representations, primarily from space.

This view of the Earth found a place in international scientific initiatives of the early 1980s. For example, the International Geosphere-Biosphere Programme (IGBP),[45] launched in 1987, was meant to study how the interaction of human activity with the biological, chemical and physical dimensions of the Earth brought about global change.[46] The program drew on complex models, simulations and especially the Earth Observing System (EOS) to promote a new recognition of the Earth as a system.[47] Despite the intention to pursue ample trajectories that would combine different methodologies and approaches, it was primarily NASA's role to inform the aims and objectives of the program. Breaking off from previous initiatives that were more openly centered around the biosphere,[48] the promoters of the IGBP (e.g.) John Kendrew, Herbert Friedman and Thomas Malone) benefited from the program's scientific and institutional intertwinement with the NASA Earth System Sciences Committee chaired by meteorologist Francis Bretherton, the author of the paradigmatic Bretherton diagram published in 1986. The diagram illustrates one of the primary attempts to include the human dimension in the Earth as a complex system. It was criticized, however, for providing a mechanical description of the Earth system, while the box representing "human activities" was positioned at the margins of the diagram as an external, peripheral force (Figure 4.1).[49]

The IGBP's initial focus on data gleaned from Earth observation satellites neglected local and regional studies as well as land-use problems that were central to sustainability and conservation.[50] The need for the IGBP to embrace wider research trajectories was felt within the communities of ecologists and geographers, as some lamented the lack of focus in the IGBP on the study of landscape heterogeneity and regional developments. The absence of the human sciences stood in contradiction to a program seeking to address anthropogenic interferences with the Earth system.[51] Against this backdrop, NASA Earth system research was thus oriented toward a wide application of space surveillance and monitoring, which in the 1980s constituted the main research line within the IGBP as well.

As Sebastian Grevsmühl has noted, Earth imagery produced by NASA fundamentally promoted Western values of science and nature, eluding questions about the uneven access to the large-scale environmental surveillance infrastructures that grew mostly out of Cold War efforts to monitor the dynamics of the Earth system. Images distributed by the space agency hardly addressed the underlying "geographies of power" so as to avoid highlighting, for example, where the main sources of pollutants came from.[52] Along these lines, Joseph Masco and Elizabeth DeLoughrey have both pointed out that militarism was key to how we map and *visualize* the globe as a planetary biosphere.[53] I would add that militarism, in particular nuclear militarism, created a new environmental and geophysical globalism that consolidated images of the Earth system. These images rendered problems homogeneous, removing discrepancies and the possibility of critical analysis by appealing to the iconic (and rhetorical) image of the Earth as a cybernetic system.

Remote-sensing technologies became environing media that rendered the Earth as a computable planet, as data obtained from remote observations could then be translated into models used, for instance, for climate simulations.[54] As space science was indeed the privileged angle from which to look at the Earth system, life, still very much considered in a cybernetic way, was reduced to its role of controlling the atmosphere and its chemical compounds in order to sustain the Earth's biosphere – Gaia. ESS has therefore circumscribed the role of the biosphere to a regulative dispositive of the planet's atmosphere. The human-reconfigured biosphere as a subsystem of the Earth does not really change, alter or disrupt the Earth's metabolism, and humans do not trigger processes that melt the ice or pollute the oceans.[55] On the contrary, the Earth system became dehumanized and dehistoricized, as it lost human history and scale.[56]

Satellite technologies have defined the scale at which our planet is perceived and conceptualized scientifically.[57] As Schneider and Walsh have pointed out, this *zooming tool* "is a rhetorical trope – both verbal and visual – that manufactures logical and political continuity from what is in reality a diverse and incommensurable set of views".[58] The operation of a scaled-down visualization of the Earth does not easily solve the problem. It neutralizes political tensions of local communities by selling a synoptic picture of global problems. The subjugation of localities to a centralized global picture contributes to *freezing* the planet in space and time. Although images are transmitted *down to Earth* at the speed of light, they seem to be alien to the human history of which they capture fixed instants that correspond in no way to real human events and experience.[59]

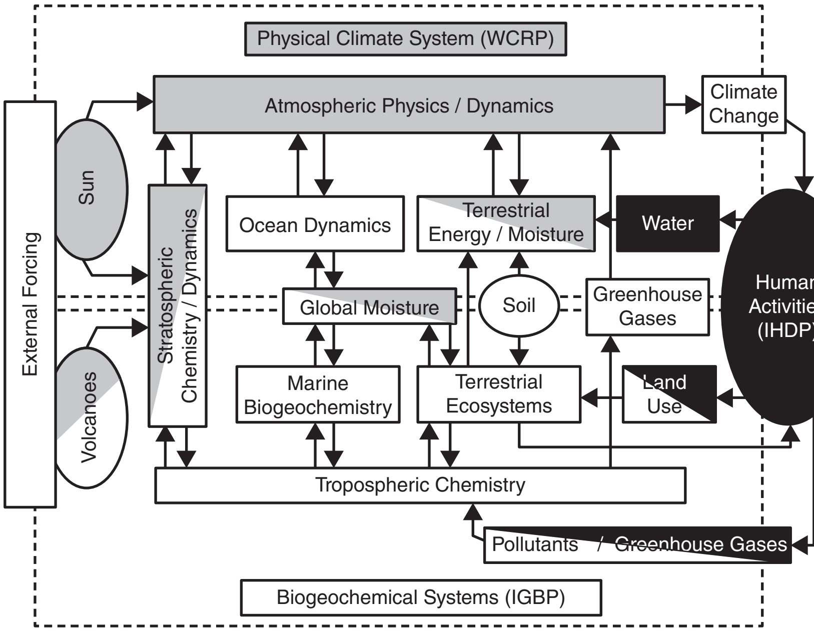

FIGURE 4.1 The Bretherton diagram. Source: Earth System Science Overview: A Program for Global Change. Earth System Sciences Committee, NASA Advisory Council.

A more substantial approach to biosphere studies would mitigate the predominance of geophysical and climatic investigations of the Earth system. Therefore, if the image of the Earth from space opened the way for global environmental consciousness, this rhetoric was conveyed through images of the Earth that once again disregarded human responsibilities.

Efforts of including a terrestrial ecological perspective were pursued in other scientific initiatives insisting on the need to dwell upon a terrestrial dimension of the biosphere but failing to come to an integration with ESS's theoretical basis and methods. A program called *Sustainable Development of the Biosphere*, launched under the aegis of the International Institute of Applied Systems Analysis (IIASA),[60] brought into focus the idea of the biosphere as a system that is no longer *self-governing* in the same way – but undergoes unprecedented processes driven by new components (like new polluting chemicals, new minerals produced within a new fertilization regime, new toxic substances).[61] Therefore, a concerted study of global ecological and geophysical systems in relation to industrial development and resource depletion was strongly emphasized. Such ambitious program, combining regional studies with modeling techniques and geospatial investigation from above in order to study the relationship between humankind and the biosphere, was not easy to achieve considering the resources available for international collaboration, and it came soon to an end.[62] Also, it probably failed to embrace an ESS perspective. However, this initiative showed an alternative way to environ the Earth in a time in which the scenario was primarily dominated by an Earth system approach mediated by the IGBP.

Conclusion

In this chapter I have argued that the emergence and consolidation of ESS is rooted in the idea that all spheres of the Earth are elements of a totality, each contributing to the functioning of the whole system in a mutually reinforcing fashion. The biosphere is seen as one sphere of the Earth that has evolved to keep the Earth's chemical metabolism stable through feedback loops that make the planet habitable.[63] The image and concept of the biosphere has mediated the perception and understanding of the Earth from the outside where the sphere of life, or, as Vernadsky used to define it, the *face of the Earth* is reduced to a regulative function of a larger planetary system. In this process of mediating knowledge about the biosphere, Hutchinson's systems ecology and Lovelock's Gaia theory – which led to the emergence of the Earth system concept – have played a prominent role. These theories acted as environing media in producing an understanding of the biosphere's functioning as restricted and mapped to a biological cybernetic model by which segregated components are seen to contribute to the *stability* of the whole. The theory of *homeostasis* and the use of concepts like *self-regulation* and *control* inscribed in the legacy of cybernetics mediated a narrative of the biosphere in which resilience and adaptation – as well as the autopoietic characteristics of ecosystems – are prioritized over disruption and transformation resulting from human manipulation. I have showed that, contrary to this tradition, the biosphere-noosphere theory elaborated by Vladimir Vernadsky in the first half of the 20th century was based on the awareness that human science and technology are responsible for driving the biosphere toward irreversible changes that dramatically involve all other parts of the Earth system. In this interpretation, human activity is studied in terms of its power to *environ* the Earth while knowledge and awareness resulting from environing technologies further inform our representation of the human-Earth system as a global systemic entity.

While Vernadsky's early biosphere theory was based on the idea that a human-reconfigured biosphere is *reenacting* our planet from the *inside*, Lovelock's biosphere is indebted to the idea of the Earth as visible from the *outside*, where the transformative power of humanity is barely recognizable. This view has environed the Earth as a synoptic whole while contributing to the failure to translate global sources into local knowledge.

The media of satellite technologies and the photographs they produced environed the Earth as a "system". And as the Earth system concept took hold, it obscured the idea of the "biosphere" as a global dynamic process, closing it off as a self-regulating sphere in which microbial life acted to keep the Earth habitable and comfortable in its chemistry and climate. Detached from the *ground*, humans turned into external spectators while the Earth becomes an *objective* reality. Gaia does not recognize the predicament of the Anthropocene but implies that the latter is a "natural" consequence of life's expansion on the planet.

The idea that the biosphere is one part of the Earth system is no longer adequate to explain the state we are in, the Anthropocene. The effect of the biosphere is no longer to reinforce Earth's resilience and stability. And insofar as they are the main actors of the biosphere, humans must be recognized as biogeochemical agents with a major perturbing function in driving the Earth system's parameters. Such an awareness requires current and future initiatives to address the human-reconfigured biosphere as the main driver toward changes in how the Earth system functions.

As Vernadsky's case shows, the rediscovery of visions of the biosphere and the Earth that go beyond the institutional foundation of ESS allows us to study different ways in which humans have environed the planet, in turn allowing us to make sense of the Anthropocene as a historical fact and, mindful of the flaws of anthropocentrism, to highlight human responsibilities in this history.

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