

Beyond the Anthropocene

Un-Earthing an Epoch

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■ **ABSTRACT:** As “the Anthropocene” emerges as a geological term and environmental analytic, this paper examines its emerging rhetorical topology. We show that Anthropocene narratives evince a macroscale division between an “inner” and “outer” environment. This division situates an Anthropocenic environment that matters in the surface zone between Earth’s subsurface and the extraterrestrial “outer spaces” that we address here. We review literature in the sciences and social sciences to show how contemporary environmental thinking has been informed by understandings of Earth’s broader planet-scaled environmental relations. Yet, today’s Anthropocene conversation draws analytic attention inward and downward. Bringing in literature from scholars who examine the role of the extraterrestrial and outer environmental perspectives in terrestrial worlds, we suggest that Anthropocenic theorizations can productively incorporate inclusive ways of thinking about environments that matter. We argue for keeping “Anthropocene” connected to its spatial absences and physical others, including those that are non-*anthropos* in the extreme.

■ **KEYWORDS:** Anthropocene, Earth, ecology, environment, extraterrestrial, geography, outer space, planet, system

“Welcome to the Anthropocene!” In scientific and social scientific literatures that feature the Anthropocene concept, it is often invoked as a threshold. Readers are invited to cross the threshold of the Holocene (“new whole”) into the Anthropocene (“new human”), a term that geologists Paul Crutzen and Eugene Stoermer offered their colleagues in the year 2000 as an improved designation for the contemporary epoch (Crutzen and Stoermer 2000). The Anthropocene started, according to its scientific proponents, when three centuries of anthropogenic processes began to significantly alter the planet’s surface stratigraphy. The term rapidly took on a conceptual life beyond geology. “Anthropocene” now appears in a variety of narratives as a term that points not just to the start of a new geological era but to the emergence of a new physical and conceptual space within which to know and act on the future of human being, dwelling, and relating. Therefore, the Anthropocene is not only a concept of time but also a concept of space framed by a sense of inhabiting an environmental predicament that humans have made and now exist inside. Rather than taking this spatialization as self-evident, we ask: what does it mean to be *in* the Anthropocene? Our review extends this question by addressing the Anthropocene’s spatiality in terms of what is “in” as well as what is “out.”

This review’s aim is not simply to make visible how the Anthropocene environment evidences an inner/outer split; we also show how what we call the “outer environment” acts as an



“other” environment to define what counts and matters as the human environment. This “inner environment” stretches from the Earth’s surface to the exosphere, Earth’s outermost atmospheric stratum. In contrast, “outer environment” is a discontinuous spatiality. It includes the ultra-deep Earthly subsurface and core but also the zone we are primarily concerned with here: the unbracketable space beyond the Earth’s atmosphere. In this infinite arena certain things and processes, such as solar radiation and material bodies in motion, may obtain contingent inner environment significance via cultural interpretations of their terrestrial boundary-crossing significance. Other processes and things get bracketed out. In this way, and not unsurprisingly, the Anthropocene concept is overdetermined by anthropic relations with inner environment and underdetermined by anthropic relations with outer environment. Our aim is to focus on the Anthropocene’s emerging rhetorical topology and boundaries, although we also address problems of material inclusions and exclusions. We look forward to further examinations of the concept’s influence on theorizations of space, matter, and anthropos.

While the Anthropocene’s inner/outer division might be assumed logical given the specifically Earthly geological epochal schema that the concept serves, our review highlights how this division is both a definitive and contradictory aspect of the Anthropocene’s conceptualization. Despite ways in which extraterrestrial science and technologies contribute to understandings of environmental dynamics at enlarged spatial scales, the Anthropocene concept is being deployed in ways that privilege downward, inward, and spherically enclosed terra- and anthropocentric understandings of what counts as environment.¹ On the one hand, the Anthropocene concept solidifies the vitally powerful idea that there is no environmental “outside” and that everyday human life is ecological across scales. On the other hand, the concept relies on the knowledge of and reference to remote “other” and “outer” spaces to shape that containing human environment. The Anthropocene, therefore, encourages a broadened perception of the human environment but also exhibits scalar dividing practices and discourses that delineate spatial insides and outsides (Foucault 1982; Gregory 2006). The aim of this article is to make clear the ways in which the spatiality of the Anthropocene focuses almost exclusively on what we call “inner environment,” namely Earth’s surface environment, in ways that delineate a detached “outer environment.”

Our desire to introduce outer environments into the Anthropocene conversation (and indeed shift the conversation so the inner/outer divide becomes problematic) is motivated by a concern that to focus on inner environments undoes some of social science’s critical work engaging the spatial and scalar politics of boundary making. To be clear, we are interested in investigating the kinds of environments and scalar “cosmopolitics” (Stengers 2010) the Anthropocene concept is underwriting, not by any goal to validate or invalidate the concept itself. We observe productive work in social science and humanities Anthropocene narratives on “nature” as an outmoded term of inherent human/environment separation (Latour 2013; Morton 2007, 2013), on the dangers of anthropocentric thinking (Crist 2013; Palsson et al. 2013), and on how to evaluate critically the scalar terms used to characterize human/environment knowledge and relations (see Berkhout 2014; Johnson et al. 2014; Lövbrand et al. 2008; Ogden et al.; Orlove et al. 2014; Palsson et al. 2013; Price et al. 2011). Such work aims to critique or break down problematic inner/outer, us/other, here/there, calculative/experienced, now/then divisions on Earth. In the process, “environment” is at risk of coming to stand for the Earth itself and everything *within*. So what is *without* if not an extended environment to which humans are connected in physical and social ways? The answer, ironically, seems to be Nature, a category that has come to epitomize human/environment disconnection. Therefore, so far the Anthropocene does not completely reconcile the relationship between the human and the environmental, because in making these categories fundamentally co-constitutive at the scale of Earth, the concept pushes this problematic to a larger scale in which human-environment relations continue but human

environmental impact diminishes. In bringing “outer environment” into the conversation, we hope to underscore the value of considering how Earth and by extension human beings can be investigated as coexisting with other environmental agents in an environmental cosmos. Overall we are asking: what does an exclusive focus on the inner environment do to our anthropological understanding of the Anthropocene?

To track how the Anthropocene concept can result in representations of an inner environment/outer environment divide, we examine its specific topological and environmental manifestations in interrelated literatures drawn from the sciences, social sciences, and humanities. These literatures either (1) elaborate dimensional framings that are pertinent to a spatial comprehension of the Anthropocene, or (2) refer to macrospatial entities, including the planetary, the terrestrial, the Earthly, or the cosmic that illustrate tensions between inner and outer environment as here defined. In these literatures, inner environment delimits a normative terrestrial sphere for human experience—that is, humanity’s natural milieu. Identifying how the inner/outer break is constituted in these literatures also calls attention to how certain scales, physical scopes, geometric shapes, and material limits emerge or retire in relation to the Anthropocene. In attending to this problem we follow critical scholars of geography and environment who focus on the implicit spatial dimensions of temporalities (Harvey 1989; Massey 1992; May and Thrift 2003) and examine the making and politics of macroscale environmental perspectives (see inter alia Choy 2011; Clark 2011; Ingold 1993; Jasanoff and Martello 2004; Masco 2010).

Our review of the Anthropocene’s inner/outer environment schema has another objective as well: to call attention to scholarly engagements with the extraterrestrial as environment. In the early twentieth to mid-twentieth century, scholarly interest in social relationships with outer space ranged from astroarchaeology to critiques of spaceflight’s dehumanizing potentials (Arendt 1963). After the emergence of national space programs, there was limited social scientific interest in outer space as a future human space (Finney and Jones 1985; Maruyama and Harkins 2011[1978]). After mid-century, and where this review focuses, social scientific studies of human technical and scientific engagements with outer space continue to be a small body of work centered, as we show later in this article, on environmental perception and action fostered by views of the Earth from space, the social roles of remote sensing, space as empire-building, and space as cultural expression. We have also noticed that social science extraterrestrial case studies tend to be located at the end of edited collections (present volume excluded!), as final papers in conference panels, or as codas to studies of the normatively terrestrial. Overall, social studies of relations with outer space places and things can end up counted as rare outliers at best or peripheral at worst. Instead of reproducing the “outer-ness” of extraterrestrial inquiry relative to the Anthropocene concept, we offer a perspective on the topological, discursive, and semiotic dependence the concept has on outer spaces as “other spaces” against which terrestrial life can be defined and understood.

By “un-Earthing” the Anthropocene in this way we hope to motivate critical spatial analyses, particularly at the planetary scale, of this important emerging concept. To do so, we begin by offering a topology of the Anthropocene. We show how the spatiality of the Anthropocene is one that tends to exclude this outer environment and pulls sensibilities inward to focus on a bounded Earth. Such a bounded conceptualization of Earth is paradoxically linked, as we explore in the second section, to a less bounded mid-twentieth century scientific imagination of Earth as a planet orbiting in an outer space environment *with* other similar bodies. How, we ask following that section, can the current topology expand to critically examine social inclusions and exclusions of outer environments and thus offer a broader spatial and, by extension social theoretical, understanding of the Anthropocene? Our final section explores how such considerations open up different modes of producing and assessing planetary knowledge as well as

inquiries into the scalar politics of cosmologies, and how, at this early stage of Anthropocene theorization, we are perhaps best served by keeping cosmologies open, multiple, and inclusive.

An Anthropogenic Topology: Marking the Inner, Directing Downward

What is the topology of the Anthropocene? How do we look beyond its temporal markers to focus on the accompanying spatial dynamism (see May and Thrift 2003)? How is its inner/outer spatial topology delimited—implicitly or explicitly? We examine how commonly imagined contours of an Anthropogenic topology emerge in contemporary scientific, social theoretical, and social scientific arguments. As scientific debates about evidence of the Anthropocene as a macroscale temporal boundary take center stage, its Earth-bounded and inward facing spatiality is coalescing with less debate but no fewer socio-cultural and political stakes.

In this section we show how scientific and social scientific arguments that advance or make use of the Anthropocene concept evidence two key topological features: (1) a bounded, shell-like space of terrestrially scaled natural and social spheres that are only contingently connected to an outer extraterrestrial environment, and (2) an inward/Earthward perspective on what counts as the environment. To be sure, this topology reflects the concerns of geologists who are measuring and evaluating material evidence to determine whether or not an anthropogenic threshold of terrestrial stratigraphic change has been crossed. But it also marks the upper and lower spatial boundaries of an Anthropogenic environment that appear inherently terrestrial. This is despite ways in which, as we will argue, the extraterrestrial figures in the multidisciplinary production of Anthropogenic environmental knowledge, perspectives, and imaginaries. Before exploring how the outer can be used to open up these inner spatialities, we first examine why and how the Anthropocene's topology pulls the analyst's attention downward and inward and how the Anthropocene's human/environment relationship consequently gains strongly interiorized limits, beyond which is an "outer limits" environment that is only selectively linked to Earth or *anthropos*. The "geological turn" that the Anthropocene concept inspires (Yusoff 2013: 780) does not necessarily turn toward inclusion of other and outer geologies as *geos*, but is rather a geocentric turn inward and downward to a singular Earthly geology. This section, therefore, focuses on how geologists and other scientists draw Anthropogenic space as a prelude to looking at how social scientists perpetuate or critique this topology.

Topological Foundations in Scientific Discourse

A spatial reading of foundational scientific texts relevant to the Anthropocene concept evinces a bounded, inward-oriented topology. In Paul Crutzen's and Eugene Stoermer's (2000) inaugural argument for replacing "Holocene" with "Anthropocene," the extraterrestrial plays a dual provisional role. It takes a rhetorical and scientific role in establishing the scale of the Anthropogenic human's geophysical reach and perception; however, it also takes the role of "other space" against which a human-relevant Anthropogenic topology of terrestrial environmental science and action is implicitly defined. These roles appear right away in the piece. In the paper's introductory paragraph, the authors link Earth and outer space to define the kinds of impacted spaces and environmentally interactive human the Anthropocene is primarily concerned with. They start by noting that G. P. Marsh's sentinel 1864 book about human transformations of natural spaces originally entitled *Man and Nature* has been reprinted and retitled as *The Earth as Modified by Human Action*, and, on the heels of this observation, they state that an extreme example of such human impact occurred when "mankind" became able to "set foot on the moon" (17).

This voyage to the moon and associated spatial extension can be contrasted with other examples throughout the article in which breaches of the terrestrial boundary indicate a topology to fear. The hole in the ozone, mentioned only a few paragraphs after reference to the moon landing, acutely illustrates the atmospheric bounding of the Anthropocenic imagination. By connecting these events and sites, Crutzen and Stoermer call attention to how contemporary understandings of human/environment relations have progressed to focus on the broad scope and scale of human geophysical modification. At the same time, as the “hole” in the ozone layer suggests, such modifications threaten the boundaries upon which life on Earth depends. The topology stretches to encompass the Earth and its atmosphere, but holes must be plugged to maintain this environment. Later in the text, the authors bring in the outer spatial threat of asteroid impact as one among a list of anthropogenic and non-anthropogenic global environmental crises that humans could avert in the Anthropocene by harnessing the “noosphere” of human consciousness (borrowing a term developed by Soviet geochemist Vladimir Vernadsky [1944] to describe how human cognition acts as a transformative geological force) to create technical solutions to the large scale problem of how to “develop a world-wide accepted strategy leading to sustainable ecosystems” (18). In this way they dualize the extraterrestrial: it is a space normatively outside but also provisionally connected to an Anthropocenic human and Earthly environment.

The dualized environment of outer space in Crutzen and Stoermer’s argument calls attention to what we define here as the Anthropocene’s key topological features: delineation of normative terrestrial boundaries for geological and environmental science and selective reference to the extraterrestrial as a space of extremes and exceptions, which has the consequence of drawing attention inward and thus providing new ways to naturalize and politicize terrestrial/extraterrestrial divisions. Crutzen and Stoermer’s Anthropocenic Earth is a stratigraphic shell, bounded at geological surface-level and upper atmospheric strata, demarcating a zone in which it is possible to detect and evaluate accumulating human effects.

“Considering these and many other major and still growing impacts of human activities on earth and atmosphere, and at all scales, including global, it seems to us more than appropriate to emphasize the central role of mankind in geology and ecology by proposing to use the term “anthropocene” for the current geological epoch” (Crutzen and Stoermer 17).

Importantly, however, despite calling attention to “all scales,” this statement puts bounds on geology and ecology as disciplines normatively earthly and anthropocentric, thus delineating an inner environment. Because Earth’s moon and solar systemic asteroids lie beyond the space in which human impact takes a “central role,” they become tangential to the Anthropocene’s geology (17). The result is the delineation of a scientifically, rhetorically, and socially significant space of terrestrial inner-atmospheric geology and ecology that stands for “the environment.” Such dividing practices can obscure the contributions of comparative solar system-scale environmental science to Anthropocene concerns such as planetary habitability, change, atmospheric processes, and energy system sustainability.

While the Holocene/Anthropocene *temporal* boundary is debated according to how a swath of the Earth’s surface can be characterized, a *spatial* boundary takes shape undebated as a container for macro-environmental strata, spheres, and systems that matter. In a 2012 Environment and Energy Publishing article titled “Geologists Drive Golden Spike Toward Anthropocene’s Base,” publishing house reporter Paul Voosen interviews and synthesizes statements by geologists with leading roles within the Anthropocene concept’s discursive and decision-making network. Voosen includes quotes about the role of boundary-making in the Anthropocene debates, including Phil Gibbard’s naturalistic observation that “Humans, we like boundaries, don’t we?” (Voosen 2012). For Crutzen, Stoermer, and other natural scientists caught up in debates about

the Anthropocene as a term with both scientific and “pop culture” significance (Autin and Holbrook 2012: 60), the central boundary problem is to determine whether “an epoch-scale boundary has been crossed” (Zalasiewicz et al. 2011: 840). The Anthropocene’s scientific fate rests with its useful legitimacy as a “time term” and “stratigraphic concept” (Autin and Holbrook 2012: 60–61) that points to the incontrovertible detection of new “lithologic, fossil, mineral, chemical, or geophysical signatures” (Ibid.: 60) that signal human-induced material transfers among Earth’s planet-scale natural and social spaces. These spaces are described as spheres and spherically contained systems, such as atmosphere, stratosphere, cryosphere, lithosphere, and anthroposphere (Steffan, Crutzen, and McNeill 2007). If the strata of the “rock record” (Autin and Holbrook 2012: 60) evidence anthropogenic signatures of significant proportion and scope, such signatures can be interpreted to be contributing to the “transformation of the Earth’s surface environments” (Zalasiewicz et al 2011: 838). Although this literature also references “external drivers” to the Earth system such as “the flux of energy from the sun” (Steffan, Crutzen, and McNeill 2007: 615), the Anthropocene’s partial spherical swath in which human impact can be measured comes to represent a whole, bounded environmental world system. To its proponents, humans are affecting “Earth system as a whole” (Ibid.: 618) and Holocene is giving way to the “New World” of the Anthropocene (Zalasiewicz 2010: 2228). The Anthropocene may be debated as a temporal term, but its topology emerges undebated as a scientifically Earth-bounded spherical world.

This bounded topology is a powerful image not only in debating what the Anthropocene is, but also when articulating how to manage human environmental perception and action in the age of the Anthropocene. A large group of European and US scientists recently offered “planetary boundaries” as a framework of nine indicator processes that scientists should monitor to ensure that humans remain in a “safe operating space” (Rockström, Steffan, Noone, et al. 2009). Behind this notion of humans as “operators” lies unacknowledged reference to “Spaceship Earth,” a mechanistic metaphor that legitimates Western engineering imaginaries and solutions to environmental problems (Fuller and Snyder 1969). In the planetary boundaries framework, each boundary (a biosphere process deemed critical by these scientists) is quantified and given a threshold (a boundary) that humans should strive toward remaining below. For the “climate change” boundary, the goal is to keep carbon dioxide concentration below 350 parts per million. A common representation of these planetary boundaries is a picture of Earth divided up into nine equal slices. Each slice is labeled with one of the nine boundaries, like “biodiversity loss” or “ocean acidification.” Slices are filled to reflect how close we are to exceeding the safe boundaries. Those within which we are still safely operating glow green and are only partially filled. Boundaries that unmarked groups of “humans” are breaking are represented by the whole slice being filled in red and further extending beyond the crust of the Earth, fading away into the “outer.” Again, dangerous out-of-bounds environmental topologies are indicated by punctures in the Earth’s atmosphere. Planetary boundaries, described by these scientists, legitimate ways to quantify Anthropocene social life and simultaneously provide a bounded, inner topology of existential safety based on an unproblematized notion of the social bounds of environmental perception and action.

Tracing the Anthropocene Topology within the Social Science and Humanistic Discourse

Unlike natural scientists, social scientists and theorists who use the Anthropocene concept or study its attendant anthropogenic processes work within a disciplinary milieu that requires critical attention to hegemonic shapes, wholes, boundaries, and theories of relation. However, most

social scientists do not work with a polymorphous, shapeless, or infinite concept of environment. Social scientists and critical theorists may join scientists in referring to environmental spheres, globes, and grounds even though social science specializes in showing how containing wholes emerge socially rather than exist naturally. For example, worlds are simultaneously products of knowledge-making and space-making (Zhan 2009), the category of the global is constantly assembled and remade in interaction with the local (see Choy 2011; Lahsen 2004; Ong and Collier 2004; Tsing 2004), and topologies and scales of relations are a matter of differing modes of perception (Haraway 1988; Latour 1998; Barad 2007; Bennett 2005). Nevertheless, a hardbound Earth sphere shows up in otherwise broadly scoped writings about human surroundings. For example, anthropologist Tim Ingold critiques Western environmentalist perspectives that legitimate a “global outlook” in which humans sit outside the world, but the “lifeworld” experiential perspective he advocates is a human centered and explicitly spherical “world within which we dwell” (Ingold 2000: 216). Recently, philosopher Peter Sloterdijk’s “spherology” project critiques the survival of an Enlightenment cosmology that elevates a heavenly sphere over the sphere of “relevant boundaries” (Sloterdijk 2011: 28) to human existence, but it does not reject the global spherical as a master topological shape. He holds that “living in spheres means creating the dimension in which humans can be contained,” that the sphere is “the interior, disclosed, shared realm inhabited by humans” (Ibid.).

Another spatialized term that Anthropocene social science narratives wrestle with is “system.” This is not an inherently shape- or limit-dependent term, but scholars keep it within terrestrial bounds in order to use it or critique it. Scholars may refer to Earth systems thinking as vital to Anthropocene knowledge but then also criticize how systems thinking, like the aforementioned planetary boundaries, produces hegemonic knowledge about human and social agency relative to environmental processes and limits. Lövbrand et al. (2009) examine the “many methods, instruments, computation that have brought the ‘coupled human and ecological system’ ... into being as a natural kind” with imaginaries of making the Earth system a “governed reality” (9). They and others (DeLoughrey 2014, Palsson et al. 2013) point to how Earth Systems Science emerged from entanglements of field ecology, nuclear science, military earth surveillance, and national and global governance projects. They show how Earth system governmentality (Lövbrand et al. 2009) naturalizes calculative and delocalized perspectives on “human” or “social” systems that either marginalize or universalize human sociocultural agency (Palsson et al. 2013 use a NASA diagram to illustrate this) and do not account for unequally distributed forms of power and agency. These critiques of Earth and space-based systems imaginaries and governance stop at a terrestrial boundary even though government-funded space science environmental systems knowledge production does not. Terrestrial systems ideas are politicized, integrated with space via investments in extraterrestrial remote sensing, space weather science, asteroid mitigation, continuing practices of interplanetary comparison, viewing the sun as an energopolitical (Boyer 2011) environmental agent, and even the identification of “Earth like” exoplanets in other solar systems. This opens the question of how the Anthropocene era is also being shaped by what might be called, following Arun Agrawal’s work (2005), forms of *heliosystemic* environmentality.

Social scientific literature about the Anthropocene, therefore, may reject hegemonic anthropocentric Western and Northern wholes and problematize the global and systemic, but at the same time delineations of environmental macroscales *as* terrestrial meet with little critique. This focus on macrocategories also makes it easy for the Anthropocene’s *anthropos* to remain hegemonic and unproblematized. Geographer Rory Rowan argues that the Anthropocene concept reengages “macro-scale concerns after the eclipse of ‘globalization’” (Rowan in Johnson et al.

2014: 447). In this spirit, Anthropocene narratives focus on macroscale concerns with human/non-human relations and re-anchor them to a terrestrial, biotic master scale (see Johnson et al. 2014; Morton 2007; Sayre 2012; Trischler 2013). For example, social scientists emphasize “Earth as humanity’s home,” that the politics of “biosphere” management determines social futures (Dalby in Johnson et al. 2014: 444), that “one very strong metaphorical message that seems to come out of the Anthropocene idea is that it attributes to humans a rightful place on Earth” (Schwagerl 2013: 32), and that “nature’s politics in the Anthropocene” is one in which people at local levels must engage global assemblages in the name of planetary and Earthly stewardship (Ogden et al. 2013: 346). While these messages are aimed at productively collapsing human and non-human boundaries, they also create a larger framework of Earth-boundedness that renders “human” as a socially undifferentiated macrocategory in which each human is equally implicated in and victim of the changing environment. In contrast, un-Earthing the history of understandings of the “Earth/human” relationship draws attention toward, not away from, the production of planetary social differences. Nevertheless, social scientists often avoid outer space because they view it as an elite and dehumanizing space.

If, as we discussed in the first part of this section, scientific Anthropocene topologies selectively background the extraterrestrial environment, then contemporary social scientific topologies can go even further, marking outer space as a de-environmentalized technosite that produces alienating perspectives. While these works imaginatively extend their analyses beyond Earth, they often do so for the purpose of pulling attention back to the planet, thus producing ethically inflected appeals for an Earthly *grounding* of human spatial attention. Ecocritic Tim Morton heralds the end of globes and worlds as aesthetic wholes and the beginning of an “ecological awareness” of human “scalar dilemmas” that should exceed any ideas of “embeddedness” in a particular place, but he also offers that ecological thought must “unground the human by forcing it back onto the ground” (Morton 2013: 19). An active proponent of the Anthropocene and Gaia concepts, Bruno Latour (2013), in his “Telling Friend from Foe in the Anthropocene” lecture, embraces the current “return” to Earth trend being articulated at intersections of environmental science, social science, and philosophy (Brown and Toadvine 2003). While avoiding the idea of replacing Earth at the center of the cosmos, Latour centers it within a kind of anthroposphere that extends to “sublunary space” (Latour 2013: 7) and by interpreting *Gravity*, the 2013 stranded-astronaut film, as a reflection of a contemporary popular realization that “there is no longer any Frontier; no escape route except back to Earth. The direction is not forward, *plus ultra*, but inward, *plus intra*, back home” (Ibid.: 1). Although he advises that the Anthropocene concept should be used wisely to avoid “naturalization,” it should do so “while ensuring that the formal domain of the social, or that of the ‘human’ is reconfigured as being the land of the Earthlings or of the Earthbound” (Ibid.: 2). In this and in other social theoretical and scientific arguments, the Anthropocene pushes and presses downward; it has gravity, it goes to ground, and its cosmos is terrestrial.

In these contemporary works, we read a topology that emphasizes the inner environment—an atmospherically bounded Earth system that draws analytic attention inward and downward. As we next show, this conceptualization is at odds with what we call “proto-Anthropocene” imaginations. Scientific studies of the atmosphere and biosphere that shape the current Anthropocene conversation were deeply informed by understanding Earth’s relationship with other planetary worlds. In order to elucidate these earlier works that emphasize outer environments, this review turns now to mid-twentieth century conversations within the planetary sciences that promoted a comparative planetology and did not hermetically seal off our planet from its surrounding cosmos.

Comparative Planetology and Proto-Anthropocene Environmental Imaginations

The absence of the “outer environment” from discussions of Earth’s planetary present and future is striking because understanding Earth in the context of the solar system was crucial for what we might call proto-Anthropocene environmental imaginations. As Timothy Choy (2011) explains in his ethnographic analysis of environmentalist practices and senses of endangerment, environments and ecologies as particular spaces are delineated by comparative acts of connection and disconnection of spaces, people, experiences, and objects. It is no surprise, then, that understandings of Earth as a certain kind of planetary environment was influenced by comparative planetology. In this section, we outline how twentieth century scientific comparisons of Earth with other planets played a role in proto-Anthropocene engagements with the atmospheric and geological conditions of planetary habitability. Comparative planetology contributes in important ways to the imagination of Earth as planet, and consequently to the politics of hegemonic and counter-hegemonic interpretations of planetary belonging and interconnection (Chakrabarty 2009, 2012; Jasanoff and Martello 2004; Spivak 2003). Therefore, we argue that even though the Anthropocene’s scientific underpinnings situate Earth in the context of the solar system, these same underpinnings paradoxically play a part in enabling “the environment” and “planet” to become metonyms for Earth.

The Anthropocene, though a twenty-first century term, has a twentieth century intellectual context in which “environment,” “ecology,” and “ecosystem” became cross-disciplinary *and* trans-spatial terms (Golley 1986). In the 1950s, scientists from different sub-disciplines came together to form the new field of planetary science, creating the necessary infrastructures for scientists to conceive of planets as environmental objects, as opposed to astronomical objects, suitable for comparative study to each other and the Earth. A notable example is the work of UK-born scientist and futurist James Lovelock, who along with other collaborators, importantly American biologist Lynn Margulis, developed the Gaia theory in the late 1960s and early 1970s that put forth that Earth should be conceptualized as a self-contained, self-regulating ecosystem (Lovelock 1972; Lovelock and Margulis 1974). Leading up to the Gaia formulation, Lovelock was working for NASA’s Jet Propulsion Laboratory on novel instrumentation and techniques for detecting life on other planets (likely targets being Venus and Mars). While some scientists were focusing life detection efforts on remote analysis of soil samples (as NASA’s Viking landers would perform in the 1970s), Lovelock and others focused on planetary atmospheres.

To determine the chemical composition of a life-bearing atmosphere, scientists turned to the one atmosphere they knew to host life: Earth. In a 1969 paper where the seeds of the Gaia hypothesis were sewn, Lovelock and his co-author remark that this comparative planetology had an unexpected outcome: “This work was commenced with the goal of a life detection experiment for Mars; in terms of flight hardware, this goal has not been reached. Nevertheless, the search for life by this means has in true serendipity rediscovered an ancient life form; the Earth’s ecosystem or as it used to be known, ‘Nature’” (Giffin and Lovelock 1969). Furthermore, the article concludes that attending to Earth’s atmosphere is more important now than ever, as there are soon to be “ecological problems of global dimensions which involve the atmosphere” (Ibid.). With such a future, the authors end by chastising the decreasing budget of the NASA planetary exploration program. Though Gaia is in essence an imagined version of Earth that is living but contained, this interiorized Earth only made sense when comparing it with equivalent sites in an outer solar system environment.

While Gaia often sat on the fringe of the Western environmental movement, more a mascot than a scientific driver, another scientist who focused on atmospheric studies of other planets,

James Hansen, has been for several decades a movement spokesperson for scientific evidence of anthropogenic climate change. Like Lovelock, Hansen was employed by NASA. His doctoral work was studying the atmosphere of Venus and thus he spent time modeling the cause and implication of what has been called the runaway greenhouse effect that rendered Venus unspeakably hot and inhospitable to life as we know it. After a decade of writing about and studying the Venusian atmosphere, Hansen began applying some of those lessons to Earth. In 1980, he tentatively wrote about the effect of aerosols on Earth's atmosphere (Hansen, Lacis, Lee, and Wang 1980), and the following year about CO₂ (Hansen, Johnson, et al. 1981) and greenhouse gasses (Lacis, Hansen, et al. 1981). In these early papers, Hansen explicitly drew on comparisons with Venus, carefully placing Earth within an environment alongside planetary neighbors. Lovelock and Hansen began to focus exclusively on Earth after US space program funding was curtailed following the Apollo missions and in light of their awareness of the likely severity of climate change (see Weart 2008).

Scholars have noted that one of the lasting legacies of Apollo was the photograph of the Earth as seen from space (Garb 1985; Poole 2008), an icon that has come to stand for "environment" in the global north. The two most popular images bookend the Apollo missions, with "Earthrise" (in which a vibrantly blue Earth peeks out over the gray lunar surface) having been taken by the first crew to orbit the Moon (Apollo 8) and "Blue Marble," which captures the African continent slightly obscured by swirls of white clouds, taken by the crew of Apollo 17, the last humans to see Earth in its entirety from space. The iconography of these images has come to stand not for the feat of exploring outer space, but rather in advocacy for attending to and caring for our own planet (Cosgrove 1994; Jasanoff 2001). The Blue Marble quickly became the mascot of Earth Day (Maher 2004) and "Earthrise" was used on the cover of the counterculture publication "The Whole Earth Catalog" (Turner 2006; see also Helmreich 2011; Lazier 2011), both of which spurred the environmental movement as we know it today. These highly circulated photographs enabled the western world to imagine a planet in environmental crisis (Masco 2010). Though they were a product of the space age, they ultimately served to delineate Earth from its surrounding environment.

Even as the Earth-as-planet became a central scientific and cultural environmental object of focus, some scientists turned their attention to the openness of Earth's environmental boundary to outer space. We catch glimpses of this broader understanding of environment when considering not only how human action is destabilizing Gaia's self-regulating controls, but by placing such existential threats alongside others that emerge from the "outer environment." Catastrophe theory in geology and biology allowed new examinations of how planetary evolutionary processes were shaped by terrestrial bombardments as comets and asteroids brought water, proto-biological matter, and species extinction (Alvarez, Alvarez, et al. 1980). In the late twentieth century, "environment" often served as a boundary object (Star and Griesemer 1989) that facilitated boundary work (Gieryn 1999) between the natural science disciplines in order to remake theorizations of the solar system and galaxy as spaces of nonspherical, continuous, and dynamic material and energetic exchange. For example, asteroid impact prevention activities involve governments, military authorities, NGOs, astronomers, geologists, meteorologists, space scientists, and astronomer citizen scientists in competing efforts to create "planetary protection" environmental policies based on perceptions of space as a physical environment with materials and forces that have shaped Earthly geological and biological history by moving across planetary and orbital spheres. These activities remake global spaces of environmental vulnerability and technological inequality (Olson 2012), and shed light on how the Anthropocenic environment is already understood as a post-spherical and post-terrestrial geological and political space.

The Anthropocene's geology may be Earth centered, but social groups are investing in broadening what counts as the scope and scale of the human environment beyond Earth. In other words, what we are calling outer environment in this paper can also be understood simply as environment, and further, the environment to which Earth belongs. Today, given increasing artificial satellite "crowding" of Earth's exosphere and intensifying national space agency expansions of remote sensing technologies into extraterrestrial nature, the solar system has become an ecosystemic assemblage with an environmental history and political ecology (Olson 2013). It is a site impacted by territorialization and technological pollution (Rand 2014), subject to actual or imagined ecological colonization (Anker 2005; Heise 2011), and targeted for environmental planning schemes in relation to outer space asteroid and comet threats but also for technology-disrupting "space weather" solar discharges.

Studies of the Anthropocene have yet to engage in this conversation about bridges between the inner/outer environmental divide despite the fact that comparative planetology was instrumental in scientific understandings of Earthly environmental processes. Rather, as the 1960s and 1970s faded into the past, Earth became sealed off from its surroundings and environmental understandings separated from the prominent space age programs that spurred this knowledge. It is no surprise, then, to confront a topology of bounded and inward facing attention surrounding the Anthropocene. Yet, what alternative topologies and ecologies exist that, rather than prescribing this spatiality, scale terrestrially based projects upward and outward in order to include the environmental outer and alter? How is it possible, in the Anthropocene, to evaluate and theorize the various relationships humans, non-humans, and Earth systems have with *outer* environmental spaces, entities, and agents to which they are physically connected but on which they have little to no effect? How, in other words, can we bring cosmology back into today's Anthropocenic conversation and in so doing expand its topology?

Bridging an Inner and Outer Planetary Environment

Engaging with the "other and outer" side of the Anthropocene's Earthly space calls attention to the hidden terrestrial and interiorized boundary that shapes contemporary ideas like lifeworld relativism and human/nature symmetries. The Anthropocene is of course not the first conceptual force to pull the gaze inward, but rather it offers a tacit justification for doing so. What then, does it mean to push beyond this topology? Fraser MacDonald (2007) has called for a "critical geography of outer space" in which space is populated with the politics and sociality of the next military and imperial frontier. He observes how actions on Earth are already shaped by technologies of space, for example our ubiquitous dependence on navigational devices made possible by the GPS satellite network. Yet, MacDonald's analysis remains focused on topologies of space directly surrounding Earth, the spaces that can be most easily imagined as place because human technologies already inhabit these orbits. Instead, what if we were to challenge, as some social scientists have already done, the terrestrial grounding of concepts like being, life, time, and environment in order to open up alternative topologies of environmental relations that extend further. In these analyses, the extraterrestrial is a figure of the other, outer, and extreme (Valentine, Olson, and Battaglia 2012; see also Pyne 2010; Launius 2010) that abducts and disrupts nominal topological shapes and boundaries.

Instead of asking what it means to be a human on Earth, some scholars ask instead what it means to be a human on a planet situated within an extraterrestrial otherworld. Dean (1998), Lepselter (1997) and contributors to Battaglia (2006) explore how ideas of the extraterrestrial invade and pervade terrestrial life and senses of self. These alternative geographies show how the

alien need not be confined to dwelling outside of the familiar. As Battaglia writes, “Where this journey leads is perhaps unexpected, especially for the discourse of alien beings and unidentified flying objects. For the fact is that, far from fields of exotic Otherness—the space of technomartels and weird entities, epic enterprises, and terrors unrecognizable in their ‘structures of feeling’—we find ourselves instead in the presence of an extraterrestrial uncannily familiar and concrete” (2006: 1). Even with our feet planted firmly on Earth, images and imaginings of the more expansive and complex ecosystem through which the planet moves are impossible to turn away from. It is not only space scientists and engineers who carry with them a preoccupation of other worlds (see Denning 2011; Messeri in press; Mirmalek 2008; Olson 2010; Vertesi 2009). Try as people might to bind themselves, the extraterrestrial invades not only through science stories of newly discovered planets, but also in ancient cosmogonies, contemporary movies, and strange sightings in the sky. An Earth sealed off from the cosmos is more fanciful than Martian microbes.

Some social scientists of modern space and place argue that there are continuums that connect the downward with the outward when it comes to the science and management of Earthly life. Studying marine microbiologists as they probe the ocean’s deepest recesses, Helmreich suggests that the “figure of the alien” becomes “a sign of uncertainty about what the sea can tell us about life on Earth and the place of humans in this realm” (2009: xi). Even as the alien stands for the unknown, it also serves as an epistemological heuristic, connecting Earth’s deep sea with the potential watery mysteries of Jupiter’s moon, Europa. The alien microbe, whether as an ancient form of proto-life or as a potentially new kind of life, acts as a wormhole that places Earth and life itself in the same system with other bodies of the solar system. The rhetorical power of such extreme modern geographies echoes Redfield’s (2000) study of French Guiana and the reconfigurations of modernity, nature, and technology. He shows that the juxtaposition the French Guiana’s penal and colonial history with today’s French rocket launch facility shows how modernity’s geography flexes between the “perspective of the ground” and the “perspective of the sky” (190). As Messeri (in press) has similarly observed with the case of South American astronomical observatories, the majestic surroundings of the Andes mountains or the Atacama desert help astronomers relate to the awesomeness of their work, which is not focused on the Earthly but on the otherworldly (see also Hoeppe 2012). Like Helmreich’s “alien microbe,” rocket launchers and observatories materially connect here on Earth with elsewhere in the universe, beyond spaces of bounded systems and spheres.

While Anthropocene conversations are mostly grounded by problems of life on a threatened planet Earth, a handful of social scientists who are thinking with the Anthropocene concept venture into geographic and geological domains of the non-living—both on and off the planet. In the context of being asked about her thoughts on the Anthropocene as “monstrous geography” by interviewers Matt Coleman and Kathryn Yusoff (Yusoff 2014), anthropologist Elizabeth Povinelli explains how her “geontology” analytic uncovers how social systems regulate life by policing all kinds of life/non-life boundaries in order to disrupt social connections to geological place. In a similar spirit of attention to the politics of the non-living, geographer Nigel Clark (who is working on humans as geological agents in the Anthropocene) advocates that planet Earth should be understood as “shaky ground” in his *Inhuman Nature: Sociable Life on a Dynamic Planet* (2011). He mobilizes a variety of scientific and social scientific perspectives to emphasize that the surface space humans inhabit on Earth is inherently ungrounded, unfixed, and perennially influenced by a backgrounded solar system. Humans, in his view, are “late coming earthlings” to a natural space that includes a hospitable Earthly biosphere but also non-inhabited spaces on Earth and the infinite extraterrestrial scape of the “abyssal” dimensions of the inhuman (50). For Clark, the “conditions of possibility” for all life on Earth are inherently

“physical-chemical, biological, geological, astronomical” (52). He goes on to question current social scientific theoretical emphases on symmetrical human/nature relations given the “overwhelmingly inhuman expanse” (49) of nature beyond human reach. This point of view echoes what Helmreich (who co-authored with Kirksey a review of multispecies ethnography in the Anthropocene [2010]) terms “extraterrestrial relativism” (2012), a perspective that frames Earth not as “the planet” but as *a* planet in an inherently relative and open natural position. Such analyses broaden the scope of the Anthropocene’s human-environment predicament, making it also a problem of how to relate to non-life in cosmological terms.

Cosmologies of the Planetary

Contemporary social scientific debates about the politics of knowing and experiencing humanness in an age of broadly dispersed environmental destruction and risk is, we suggest, a cosmopolitics (Stengers 2010) of scale. Scholars are working to account for what is at stake in the making and unmaking of scales of knowing, belonging, locality, and globality. In Anthropocene narratives, Earth’s atmosphere becomes the strong scalar upper limit in debates about environmental meanings and politics, even though social scientists are well aware that planetary cosmological spaces vary and are not universal. To follow our discussion of the Anthropocene’s terrestrially bounded environmental topology with an examination of its planetary cosmology, we examine past and present debates over the production of planetary knowledge, relations, and order. These debates offer a cautionary note about the production and experience of dominant Earthly planetary knowledge and perceptions, but they also, we argue, offer a way into questioning the singularity and bounded scale of the Anthropocene’s planetary cosmology. We are interested in how the Anthropocene concept can accommodate multiple planetary cosmologies of environmental knowing and risk, including environmental cosmologies that scale beyond or “otherwise” (Povinelli 2011) to Earth.

Premodern Western cosmological definitions of “planet” as an object *in* an orderly systemic whole continues in modern efforts to know Earth *as* a systemic whole; today “whole planet” perspectives influence modes of spatial control and imaginaries. Anthropocene concept inventor Paul Crutzen and co-authors explicitly define the advent of Earth systems science as a cosmological shift—a “Second Copernican Revolution” in which “the scientific eye is re-directed from outer space to our ‘living Earth’” (Clark et al. 2005: 7; see also Schellnhuber 1999) so that humans can better understand how to control what some imagine as a Gaia-type alive planetary system. While, as we have shown, social scientists also laud the Anthropocene’s downward and inward turn away from outer space, they also actively critique the view from outer space as cosmologically alienated. There is half a century of social scientific critique leveled at space-based gazes that create authoritative “top down” perspectives on what it means to be an Earthling. Scholars show how technology-assisted “top down” views create surveillance regimes (Graham and Hewitt 2012), threaten to un-Earth humans and destroy their humanity (Arendt 1963), and act as imperialistic “Apollonian” eyes (the phrase Cosgrove [2001] uses to stand for a seemingly disinterested and rationally objective view from above) that legitimate total spatial management. Though some might argue that just the opposite occurred—that the view from above inspired sentiments of unity across some social domains—social scientists continue to critique fruitfully the technopolitics of environmental top down gazes as well. Earthly-scaled politics (Jasanoff and Martello 2004) result as satellite views that co-constitute political and environmental security spaces in ways that legitimate spatial control and violence (Kadir 2006; Masco 2010; Redfield 2000), depower global south experiences of climatic and landscape change (Lahsen 2004).

However, views outward from the planet are having cosmological impacts, such as those aiming to revise general theories of biology (Helmreich 2012), to provide new territories for capital (Valentine 2012), and for telescope- and satellite-based extensions of place-making (Hoeppel 2012; Messeri in press; Parks 2011).

Thinking at the planetary or interplanetary scale, then, is a delicate and complex matter in the Anthropocene. Tariq Jazeel (2011) raises several skepticisms and concerns over certain “planetary geographical imaginations,” specifically critiquing new social theoretical engagements with cosmopolitanism. Though cosmopolitanism is often framed as a way to move beyond the nation-state towards a less divided mode of living on Earth, Jazeel draws attention to the debt the term owes to a holistic cosmos and the unavoidable imperialism of an Apollonian gaze. Gayatri Spivak, Jazeel writes, has successfully called attention to this and offered an alternative with her term “planetarity” (Spivak 2003). Planetarity invites one to know the world from categories outside those of Western thought (an intellectual inner/outer divide). As Jazeel elaborates, “Planetarity itself demands that kind of persistent introspection over the objects we take-as-given in both the social sciences and humanities; a constant and humble decentering of the masterful gazes we cast over the things we think we know with certainty ... This is a willful wrenching away from the desire to know with any degree of certainty or singularity the object depicted in AS17-22727 [NASA’s Whole Earth Image]” (2011: 89). This call to understand the contingent limits of planetary knowledge and cosmologies sits in contrast to what might be called the confident Earthly spatialization of the Anthropocene. It allows us to think about planet Earth and indeed the Anthropocene as destabilized in some part, we argue, because of different ways to think about Earth as a planet and in planetary relation with other spaces.

Anthropocene narratives can also be characterized by hopes and fears tied to its cosmology of single-point planetarity: as goes the environmental Earth as we know it so goes without question the human species. Conspicuously absent in Anthropocene narratives are speculations about extreme forms of human adaptation post-Anthropocene, including off-planet life. Artists, writers, moviemakers, and members of space settlement activist groups express extraterrestrial utopian dreams in which living in outer space forces humans to be better environmental actors (Anker 2010, McCray 2012). Predictive expressions of Anthropocenic concern follow Bill McKibben’s articulation of a familiar terrestrial Earth morphed into a new and alien planet “Eearth” (McKibben 2010). They focus on a “future Earth” (Berkhout 2014: 158) in which the planet is rendered so unrecognizable as a result of human activities that it becomes a *terra incognita* (Steffen and Crutzen 2007: 614). Authors speculate on how the Anthropocene term becomes “archaic” as things fall apart (Oreskes 2014: 53) and remind the term’s users that it can only make sense as long as humans exist on Earth (Rull 2013). Narratives of conjoined Anthropocene/Earthly endings return to the term’s stratigraphic roots—to a fear that all terrestrial biology will dissolve, utterly and finally, into geology.

Conclusion: Un-Earthing the Anthropocene

In this review, we developed the idea of “inner environment” and “outer environment” in order to draw attention to how Anthropocene literature is trending towards the exclusion of the outer from discussions of Earthly environment. While the Anthropocene can be praised for knitting back together human and natural worlds, this separation is not entirely erased but rather displaced to spaces deeper and further beyond Earth’s surface. What is the broad environmental or deep ecological in these terms? As we have shown, understandings of outer space that figure in proto-Anthropocene environmental science and that shape alternative cosmologies, we argued,

should continue to matter in how social scientists comprehend the environmental and ecological today.

We hold that attending to how scientific and social scientific thinkers implicitly delimit spatialities when working with the temporality of the Anthropocene offers evidence of the many limits being inadvertently placed on understandings of environment-as-surrounding. We have examined these topologies, including their reliance on hegemonic shapings and boundaries, and pointed to other geometric and material boundaries and delineations being drawn in and out. It is precisely because the Anthropocene has caught the imagination of scholars in many disciplines that careful attention needs to be paid to the assumptions and exclusions, spatial and otherwise, that come with this concept. As Yusoff and Gabrys (2011) discuss, imagination guides and shapes how people materially interact with and shape the world (and vice versa). Following their discussion of imaginations of anthropogenic climate change, the authors offer the specific imagination of the Anthropocene as follows: “the Anthropocene provokes us to imagine ourselves as a population acting collectively, reorganizing the conditions of life in terrestrial, atmospheric, and oceanic spaces; passing out of the territories of man and into the territory of earth as the organizing condition of earth systems. The age of the anthropocene then invokes an imaginary that is also a cosmology, as it repositions humans as the driving force of change on earth” (529). The question we raise in this review is simply to ask how and why Anthropocenic imaginations of environmental agential interaction—and of environmental ethics and politics—“cut” off (Barad 2007) at Earth’s inner systems. Whether or not geologists vote the Anthropocene in as an official geological epoch, social scientists can decide how to engage the environmental entailments of the concept. We wish to invite scholars to open the problem of environment to include where Earth is situated in space and in dynamic meshworked (Ingold 2008) relations (human and otherwise) with other cosmic agents, materials, and forces. As we have shown, to un-Earth the Anthropocene is to question terracentric boundaries presently attached to the concept, to perceive the environment as polymorphous, and to bring together productive examinations of human relations with both inner *and* outer environments.

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NOTES

1. We focus on “environment” because of its explicit role in the Anthropocene definition and because its connotation of “spatial surrounding” keeps our review manageably centered on problems of boundary, space, and scale. We include ecology, as a concept focused on relationality within spaces, as the authors we review do.

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