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SPECIAL COLLECTION
Extreme: Humans at Home in the Cosmos

Political Ecology in the Extreme: Asteroid Activism and the Making of an Environmental Solar System

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ABSTRACT
This case study examines how, in a post-Cold War context, aerospace and astronautics practices and policies are becoming more comprehensively attached to national and international environmental politics. This is evident in the emergence of a dual identity for Near Earth Objects (asteroids and comets with orbits that bring them close to the Earth); they are astronomical as well as environmental objects that are considered to be threats as well as exploitable natural resources. The paper investigates two results of this dual categorization: 1) activist efforts to extend environmental governance beyond the terrestrial and 2) new technoscientific perceptions of the solar system as a heliospheric ecology. [Keywords: Environment, ecology, outer space, aerospace, environmentalism, disaster, solar system]

The Gulf Coast's largest US city, Houston, is exposed to some of Earth's most extreme weather, but buried beneath its modern landscape is a record of the entire planet's atmospheric vulnerability. The arid lands north and west preserve the Odessa meteor crater and the Sierra Madera astrobleme ("star wound") with their wide blast field remnants. Due

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southeast is the Chicxulub dinosaur-killer crater, imaged on satellite radar by petroleum geologists and astronauts. In a Houston bar in August 2008, meteor shower month, evening light shoots across the faces of six experts on Near Earth Objects or "NEOs"—the population of small and large asteroids and comets with orbits that bring them close to Earth. Drinking beer and eating pub fare are a physician, a neurobiologist, a physicist, and two astronomers who work for Houston's Johnson Space Center. This institution is the human space flight center within a constellation of nine centers that make up the National Aeronautics and Space Administration (NASA). The group around the table gathers regularly to discuss NEOs as auguries of an extending human/environment relationship that will require the explicitly *environmental* governance of outer space.

As members of an informal, unofficial, and loosely-organized American space policy advocacy network who call themselves "NEOphiles," these passionate experts advocate for asteroids to be recognized as ever-present threats but also spaceflight destinations with multi-purpose value. Some in the group are also members of the international Association of Space Explorers NGO that is currently petitioning the United Nations to make NEO impact deflection and mitigation a global environmental security project. Both groups see outer space as a zone within which to expand human capacities, following astronautics' focus as a discipline that contributes to re-defining human relationships with environmental extremes through exploration, experimentation, and implementing national defense and policy agendas. On the one hand, it is accurate to say that the modern category "extreme environment" has gone from denoting inhumanly abnormal or socially and politically exceptional spaces (see Agamben 1998, Kroll-Smith et al. 1997) to encompassing extraordinary spaces that can be made workaday and governable by virtue of technical extensions like remote sensing and robotics (see Battaglia this issue, Helmreich 2009, Lahsen 2004). Yet, NEO activism goes beyond the process of normalizing yet another extreme thing in the contemporary scheme of things (Wolf-Meyer and Taussig 2010). It advocates scaling up the Earthly environmental boundaries that count in technical and political terms. This trend is evident in the intensifying politics of extreme environment operations in subsurface depths, the cryosphere, the upper atmosphere, and beyond. As a result, the surface of planet Earth has become an inadequate boundary for environmental governance. Inhuman spaces formerly considered out of bounds are now being incorporated into everyday social and political worlds.

In what follows, I examine how NEO activism renders the solar system into a perceived political and ecological sphere. Since the early 20th century, people have engaged in efforts to characterize solar system spaces in environmental and ecological terms. Astronomers, geologists, and biologists collaborate on astrobiological projects to detect life or life-supporting zones in the cosmos, preparing the way for comparative and general theories of biology and ecology (Helmreich 2009, this issue). During my ethnographic fieldwork among NASA astronautics practitioners who put things and humans into extreme environments from the seafloor to outer space, I found multidisciplinary workgroups theorizing about cosmic ecologies in broader terms than those tied to specific searches for nonterrestrial life. As Cold War era anthropologists Ben Finney and Eric Jones (1985) and sociologist William Bainbridge (1983) argue, the discipline of astronautics as rocketry became the technical foundation for a form of social activism in which practitioner-advocates represent human ecology as fundamentally unbounded. Operating both within and outside the *realpolitik* context of national space science, defense, and technology policy activities, these advocates argue for an often conspicuously socially unmarked "human future" or "human survival" in which productive human/environment interactions are unlimited. Even more so than spaceflight activists in the past, contemporary advocates have access to information and technologies, such as asteroid detection data, spaceflight trajectory planning software, and spacecraft engineering specs, which allow them to make technically elaborate arguments. NEO policy activism exemplifies such arguments and also how space, security, technology, and environmental policy agendas have been converging over the past 20 years. In these arguments, the goal to expand frontiers as territory is reframed by intensifying understandings of frontiers as governable ecologies (see inter alia Cronon 1983, Whatmore 2002). As such, astronautics social activism today promotes explicitly the recognition of a human ecological sphere on an extreme spatial and temporal scale.

Although I could focus here on astronautical interest in NEOs purely as threats, following anthropological work on disaster preparedness and biosecurity (Collier and Lakoff 2008, Masco 2010, Samimian-Darash 2011), I want to show instead that their emergence as human ecological factors is, like radiation and fossil fuel energy, complicated by their dual identity as risky yet potentially useful things. The Houston NEOphile group and their international network of NEO-focused colleagues easily incorporate

into their worldviews both a dread of doomsday and a desire to prove how NEOs can be used as resources for knowledge and raw materials. As one NEOphile astronomer told me, the Blue Öyster Cult song "Don't Fear the Reaper" is on his playlist during long hours at the Mauna Kea Observatory searching for NEOs that can be explored by robotic spacecraft and astronauts.

I begin my analysis by describing how NEOs became environmental objects then turn to NEOphile activism and its contemporary astronautical vision not just of new rockets and new spaceflight destinations but also of a radically re-framed human ecology. I follow this discussion of NEOphilia with an analysis of the social life of a NEO called 99942Apophis and how such objects are enrolled to strengthen the Association of Space Explorers' claim in their UN petition that it is a species imperative to negotiate international management of an environmentally interconnected Earth and space.

From Astronomical to Ecospherical Objects

In news media, the small network of American NEO activists including the NEOphiles is called "an asteroid underground" or "rebels" because they have successfully made asteroids legitimate human spaceflight destination options within current American space policy (Augustine Commission 2009). Their success also illuminates two ongoing processes of environmental perception and policy-making: the emergence of NEOs as social policy concerns and the strategic importance of "the space environment" as a space policy concept. I have argued elsewhere that NEOs' disciplinary boundary-crossings, in which they are objects of astronomical observation as well as detectible environmental and security threats, create social as well as natural connections between terrestrial and extraterrestrial spaces (Olson 2010). Their dual categorization signals opportunities to analyze little-examined intersections (see Finney and Jones 1985, Ingold 1993, Redfield 2000, Codignola and Schrogl 2009, and Pyne 2010 for exceptions) of astronomical and astronautical history, the history and sociology of environmental and spatial perception and politics, and the study of contemporary environmentalist thought. Such intersections make it possible to understand how outer space is becoming a political ecological space.

In the late 19th century, the solar system changed from a sedately ordered realm to a dynamic and even dangerous assemblage of particles,

objects, and forces. Astronomers' use of comparative photographic observation techniques to detect new stars revealed non-planetary "small bodies" in disorderly orbits that sometimes intersect with each other and with planets. Throughout the 20th century, astronomers catalogued thousands of small bodies with planet-crossing orbits while geologists recorded the widespread presence of extraterrestrial meteoric matter on Earth. In the 1980s, NEOs were subsequently designated as a sub-category of the solar system's small bodies and their periodic Earth impacts were understood as factors in geological and biological history, the most notable being the Cretaceous-era extinction event (Alvarez et al. 1980). Through the use of remote sensing technologies and sample returns from spacecraft missions, multidisciplinary scientific teams are now evaluating Earth asteroids and comets as sources of preserved solar system origin material, undifferentiated raw materials including pure water, and even signs of terrestrial life's molecular origins. Asteroids have also become targets for futuristic scenario-building, fueled by astronautical visions of their potential (as accessible, low-gravity destinations) to enable off-world human migration, or, as one NEOphile explained to me in the manner of his activist colleagues, as factors in a cosmic evolutionary "species intelligence test" for survival. The 1980s, the decade that saw NASA's Challenger shuttle disaster and the formal end of the Cold War, marked a turning point for NEOs in the US: they moved beyond the domains of science, science fiction, and futurism and into national policy circles.

The shockingly close Earthly pass-by of a NEO detected in 1989 spurred a new provision in NASA's congressionally authorized scope of duties: to develop a systematic near asteroid and comet detection program. During the 1980s and 1990s, scientific and military bodies convened workshops to develop NEO policies, creating arenas of scientific and social debate about them, including disputes about their true policy importance, the extent to which nuclear weapons could be opportunistically repurposed as anti-asteroid devices for "planetary defense"(Mellor 2010), and how nations should share responsibility for the rare and remote but possibly cataclysmic risk of impact. The inaugural US detection study (later institutionalized as the ongoing "Spaceguard Survey") released a workshop report that emphasized the importance of Earthly impacts to its developing "ecosphere" as well as the importance of using technological ingenuity to avoid them now, calling this a "gestalt shift" in how humans should think about their relationships with NEOs (Morrison 1992:1.1). Subsequent

scientific reports now refer to asteroid impact both as a natural and an environmental hazard. Unlike the Moon and Mars, which wax and wane in national policy, NEOs are now understood as space objects of permanent concern within an extraterrestrial space that went from being described simply as "outer space" in the original US Space Act of 1958 to a "space environment" strategically equivalent with other "relevant" and risky environments in the Obama administration's policy portfolio (The White House 2010:7). As preparedness for war now intersects with preparedness for other kinds of disaster, and space agencies adjust their agendas in a post-Cold War political environment, space expands from a colonial or proxy war frontier to an extension of the governable Earthly environment.

NEO Preparedness and NEOphilia: Embracing a New Human Environmental Topology

From 2007 through 2010 I followed the work of the NEOphile campaign to make spacecraft-accessible NEOs into spaceflight destinations and to advocate for a new understanding of the solar system as an ecological staging ground for human progress and evolution. Their work is not just a labor of love attached to particular cosmic objects, but invokes "topophilia" (Tuan 1990) in its broadest sense, as a devotion to the full scope of astronautical topologies, from the pathways and emplacements of spacecraft, to the space made by the intersecting orbits of NEOs and planets, to the totalizing imaginary of what one NEOphile physicist and flight controller, Dan Adamo, explained to me as the "heliospheric bubble" of the sun's energetic influence. In 2006, Adamo developed proprietary computer "consultingware," MacHILT© (the H stands for "heliospheric"), to plot NEO trajectories. As NASA employees, advocates, and consultants, the NEOphiles gave interviews to journalists and presented scientific papers and talks in venues from NASA to universities to science fiction conventions, driven by activist sensibilities that one engineer-scientist summed up for me in an e-mail:

> I think this work is most important. It feels like a calling…the message that comes ringing loud and clear through all the bureaucratic nonsense and clutter is: use these unique astronautical tools to 1) explore the solar system via NEOs, 2) disperse ourselves, or 3) go extinct.

NEOphiles also use language that mirrors environmentalist discourse about ecological interconnectedness and ways to contend with limit-capacities. They campaign for a new understanding of a solar system in which Earthlings do not just dwell but act, where action means suturing visions of evolution and species survival onto utopian plans for extending social actions to secure, protect, claim, exploit, and alter the environment in its grandest sense. In this understanding, extreme environments demarcate the edges of a universal human environment (Tsing 2005) and create a perceptual and conceptual congruency between space exploration and environmental governance (Luke 1995, Agrawal 2005).

If environment has become a particular discursive designation for nature, NEOphiles advocate engaging with spatial and temporal environmental extremes in ways that trouble given assumptions about nature as a fundamentally Earthly category (see Helmreich this issue). On a fall day in 2007, I sat with a veteran NEOphile astronaut/scientist/ex-serviceman in a restaurant full of people who work within the local Houston cluster of NASA, defense contractor, and petrochemical industries. He responded expressively to my standard question "is space a part of nature?" by making a referential move that I found common among astronautics practitioners. In this move, "nature" becomes, for the purposes of futuristic technology and policy scenario-building, an "environment" marked by new technical frontiers and ex-frontiers.

> You know, I'm a product of down here, so it's obviously strange when you get to space, but I never got a sense of being outside my comfort zone, I always thought in my weeks in space, I always viewed my presence there as unusual in human experience, but something that human beings were perfectly capable of enduring or even enjoying, I think it's just an expansion of the envelope that we've already inhabited and there's no, there's nothing about us that prevents us from thriving in that environment as well, in fact it's so aesthetically stimulating to be there, that it's a great pleasure to be in space, every time you look up from what you're doing you get a sense of awe or marvel, at the scenery, and just the freshness of the experience of looking out at space, black space, looking down at the beautiful earth, it's so refreshing…So, I don't see from my point of view, a separate kind of dimension or world that we couldn't dream of inhabiting. I view it just as an expansion of our environment and people are so adaptable, in

> general, in terms of going to the poles of the earth and to the bottoms of the oceans, living on the frontier for the last few millennia, always trying to get to these very harsh places, by the standards of the day, that space is just another category of frontier, it's very natural for me to think of humans living there for the long run. We might think of it as very exotic today, but I don't think it's gonna be that way in 50 years.

Earth, in this view, is not a separate nature from outer space, just environmentally "down here" relative to orbit. During this interview, I asked the NEOphile to clarify a phrase I heard him make about the NEO/human relationship in a presentation at NASA Headquarters in Washington, DC several months earlier. The meeting was one among the NEOphiles' ongoing pitches to publics and decision-makers, which I had been following in the press and through direct observation, to promote their "humans to NEOs" mission concept. In his talk, the astronaut summoned a powerful image of future astronauts "manipulating with their own hands and machines something that could destroy us." He explained himself further by quoting the American Apollo-era astronaut who initiated the Association of Space Explorers petition for an international NEO detection and mitigation policy.

> Well, Rusty Schweickart has said it many times, and I agree with him, we're alive at the time when we actually have just developed the technology to prevent us from being snuffed by an asteroid, and we've been subject to extinction for as long as humanity's been around, with absolutely no ability to do anything about it and for the first time in history, our species is actually able to turn off a process that has been running the solar system since it began, so it's actually a pretty historic moment, to actually think of altering the way the solar system operates, in a way that preserves our ability to survive. So, our technology has actually caught up with the dynamics of this process and we're on the verge of being able to manipulate our way into some survival, in the way that the dinosaurs didn't have the capacity to do. So rather than being subject to the whims of celestial dynamics, we're now able to make sure that we don't get waxed by this process, [the] bombardment that's been going on. And I think it'll be very satisfying to actually have people nudging these bodies around or operating around them and really demonstrate that we have the capacity. It'll be quite momentous.

Here technological interactions with NEOs are portrayed as capable of being engineered now while the expense and effort to do so is justified by universalistic ideas of planetary defense and species survival. If, as another NASA NEO expert Donald Yeomans notes in a *New York Times* op-ed piece, "We owe our very existence and current position atop the food chain to these celestial visitors" (Yeomans 2009) then accessing and manipulating them becomes an extreme form of ecological security and expansion.

The NEOphiles base their campaign for human missions to NEOs on the idea that NEOs are logical "stepping stones" for a species that will eventually need more resources than the earth offers, which is a truth claim common to environmentalists and space exploration and exploitation activists (see Valentine this issue). The NEOphile campaign uses images and language that elaborate an understanding about the nature of the NEO/human relationship that surpasses the bounds of astronomy and geology. When giving lecture presentations with slideshows, NEOphiles flash on the screen a slide featuring the simple black and white graphical image of a sun orbited by the four inner planets, then add to this image more and more colored dots representing NEO detection discoveries until the orbital space is filled up with color. This drives home, with cognitive and emotional impact, the notion of an Earth settlement surrounded by an orbital spacescape of hostility and opportunity. This computational visualization aims to go beyond being astronomically contemplative. It underscores a common NEO scientist claim that Earth abides "within a cosmic shooting gallery" (see Chapman 2007:147) and invokes a scenario of environmental vulnerability that demands the production of plans for engagement. NEOphile presenters then go on to describe NEOs in attractive terms as sites of pure, rare, and common materials and water that makes them capable of serving as hydrogen and oxygen refueling depots for deep space travel. With NEOs as things that materialize new spatial boundaries for environmental security and exploitation, human space exploration progress gets mapped onto human evolutionary progress in the extreme. As NEO mission advocate and astronaut Tom Jones writes in one of his regular "The View from Here" columns for the journal *Aerospace America*, the goal of this progress is an environmentally flexible "multiplanet species" (Jones 2009:21). Darwinian selection, in this view, works via technological adaptation and competition on a heliospheric scale. In 2012, Jones joined a cadre of wealthy citizens, academics, and scientific and military experts who launched a venture capital asteroid mining startup company called Planetary Resources.

The NEOphiles' comprehensive ecological vision of a human species that can avoid the natural cataclysmic cycles of its niche world writes master narratives of solar system exploration onto narratives about spatial and environmental engineering. As the NEOphile astronaut-scientist I interviewed states, it is a reasonable human goal to "alter the way the solar system works." At the international policy level, the NEOphiles' colleagues within the Association of Space Explorers use the Earth/NEO relationship to create an extreme co-production of the social and natural orders (Jasanoff 2004). They warn in universalizing terms that human access to astronautical technologies now makes NEOs a fundamentally social rather than natural problem, and that a refusal of nations to unite to head it off in space or mitigate it on Earth amounts to a global social and ultimately human evolutionary failure. I examine next the Association of Space Explorers' (ASE) plans for UN-administered programs to formalize methods to assess and manage NEO impact in terms of risk and sacrifice, showing how they re-map global capabilities and inequalities in terms of a heliosphere-bounded total political ecology.

"We Invite You to Join this Ultimate Environmental Project": The Political Ecology of NEO Impact Responsibility, Deflection, and Mitigation

Since the early 2000s, the Association of Space Explorers has been extending NEO activism into the realm of global environmental risk management policy. The ASE is a non-governmental professional and spaceflight advocacy organization made up of "350 people from 35 nations who have flown in space," elite survivors of extreme risk that have what astronautics advocates call the orbital "overview effect" of Earth as a planetary environment (White 1987). Such distinctions have earned the ASE and its elected leadership observer status in the United Nation's Committee for the Peaceful Uses of Outer Space. Following a rhetorical pattern common in extreme environment preparation discourse (Kroll-Smith 1997:3), the Association takes the characterization of the Earth/NEO relationship from an "as if" notion (as if an asteroid could hit us) to a "what if" scenario (what if one is headed to do so). In 2008, the ASE's Near Earth Objects Committee members drafted a formal petition to the UN. While the ASE petition reflects what social scientists Collier and Lakoff describe as "a profusion of plans, schemas, techniques, and organizational initiatives that respond

to new kinds of perceived threats to collective security" (2008:30), it is also an activist document that declares both action and non-action to be political and represents astronautics in a new and ostensibly urgent way as a development relevant to human evolution (Schweickart et al. 2008). In proposing deflection technologies and impact risk management calculation formulae as a survival strategy, the ASE petition places the human species' future into a heliospheric rather than global context and links it to the future of astronautics. A pivotal and politically visible member of the ASE petition effort is American astronaut Rusty Schweickart who runs the B612 Foundation (named for the home of Antoine Saint-Exupery's Little Prince). In keeping with Saint-Exupery's depiction of a prince wise beyond his mortal appearance, the Foundation's name evokes the value of thinking about the NEO problem from a transcendental perspective.[1]

The B612 Foundation website invites visitors to "join" in the "ultimate environmental project" that they started in the US because of their dissatisfaction with the "current lack of action" to protect the Earth from Near Earth Asteroids.[2] Their goal is to "significantly alter the orbit of an asteroid in a controlled manner by 2015" using technologies like a "gravity tractor" to push or pull a NEO into a less threatening orbit. The 72-year-old Schweickart told a *Wall Street Journal* reporter about the small "campaign" he runs from his California wine country home, saying "You are looking at the world's expert in deflecting asteroids, and that is just inexcusable" (Gomes 2008). As Chair of the Foundation, Schweickart represents his and the Foundation's goals at public and governmental forums by expertly characterizing what the website calls "the current environment." The website explicitly states that this environment is not the quiescent "old solar system" but a dynamic space in which the Earth and its "sister planet," the Moon, inhabit a "neighborhood" heavily populated with small bodies that cross their orbits.[3]

In 2007, Schweickart gave one of his many US Congressional testimonies, calling into question the utility of thinking about NEO impact as an accident for individual nations to plan for. In doing so, he advocates for global, pre-impact prevention in the name of "evolutionary responsibility." During a 2007 Space and Aeronautics Subcommittee of the US House Committee on Science and Technology hearing on the NEO threat, Schweickart summed up his Foundation's perspective in the form of a testimony, revealing frustration with current national efforts. He ended with this statement:

> We do not need to "defend" against NEOs, we need to protect ourselves from their occasional impact, as we do with other natural hazards. Unlike other natural hazards, however, NEO impacts can be predicted well ahead of time and actually prevented from occurring. If we live up to our responsibility, if we wisely use our amazing technology, and if we are mature enough, as a nation and as a community of nations, there may never again be a substantially damaging asteroid impact on the Earth. We have the ability to make ourselves safe from cosmic extinction. If we cannot manage to meet this challenge, we will, in my opinion, have failed to meet our evolutionary responsibility (Schweickart 2007).

Schweickart and his ASE associates take the idea of species responsibility, and maturity, global. The ASE's UN petition frames the goal of "planetary defense" as a universal moral imperative to develop authoritative technocratic schemes of environmental protection planning based on pre-agreements about mechanisms of response, mitigation, and ultimately, regional sacrifice.

As the ASE UN petition was being drafted, the news media became an outlet for NEO detection and near-miss reporting, including ongoing controversies over calculating the threat of "99942Apophis." The asteroid, spotted in 2004, was named after an evil alien on the science fiction television series Stargate SG-1 who crosses spatial boundaries through a timegate to destroy and enslave—a character in turn named after the Egyptian light-eating god of utter destruction. While its orbit was being confirmed, 99942Apophis was graded on the Torino asteroid threat scale as a "potential threat" in 2036, if it passed through a kind of mathematical "stargate" called a "keyhole" in 2029. NASA scientists reported that if the NEO, now classed more specifically as a PHO (potentially hazardous object), passed through this orbital time/space plot it would collide with Earth at a TNT equivalent of 880 megatons. Boosted by popular cultural precedents that depict asteroids as destroyers as well as global uniters, Apophis quickly became a boundary object of thought and practice (Star and Griesemer 1989). Its threat became calculable and debatable within the domains of military science, meteorology, geology, and public policy as well as numerology ("It is expected to pass Earth the first time on April 13, 2029—a Friday the 13th. What's more, 2 + 0 + 2 + 9 = 13" [Boyle 2009]). In 2009, Apophis was downgraded to a non-existent threat for its pass on 2029

and to a practically non-existent threat in 2036, but its behavior when it passes Earth on both dates, as close as some geosynchronous satellites, will determine how much of a threat it may be on future passes. In this case, the play of scientific odds reframes the cultural concept of meteors and comets as auguries. Interpretation of their meaning now extends from simply sighting them to making sense of their probabilistic existence as trackable and neutralizable threats. The politics of tracking NEOs is linked to a politics of "taking responsibility" for them as objects of disorder and consequently this process starts from the moment of discovery and continues with each orbital pass, but calculating risks with every approach or pass-by requires re-drawing those spaces of responsibility. In 2007 an interdisciplinary workshop of scientists and social scientists funded by the International Council for Science convened to formally delineate what is at stake in perceiving NEO threats and taking responsibility for them, publishing the proceedings in *Comet/Asteroid Impacts and Human Society: An Interdisciplinary Approach* (Bobrowsky and Rickman 2007).

In 2008 the ASE petition to the UN came out as a report entitled "Asteroid Threats: A Call for Global Response" (Schweickart et al. 2008) which sets out legal and policy justifications for such a response by reinterpreting some key terms of the 1967 Outer Space Treaty. The ASE report links the Treaty's reference to the importance of scientific "planetary protection" from potentially harmful extraterrestrial material with an associated Treaty resolution in favor of using and sharing "remote sensing" information to prevent "a threat to Earth's natural environment" (Schweickart et al. 2008:46). The ASE claims that both statements combine to justify a global NEO impact prevention and mitigation strategy. To act responsibly, however, requires two things: a plan to try to deflect the NEO and the international capacity to adhere to pre-arranged political and even military agreements between affected regions. Such agreements are necessary because deflection technologies, whether non-weaponized nudges by a spacecraft or nuclear detonations, may end up simply changing the course or pattern of the impact. The ASE petition acknowledges that nations are unequally equipped to participate in deflection enterprises, and goes so far as to suggest that the earth has to be assessed terms of protection-worthy spaces and those that must "absorb" risk and damage (Schweickart et al. 2008:14). For this "rational" scheme to work, each nation bears an individual responsibility to recognize and pre-negotiate its survival. In this deflection and mitigation scenario, NEOs fit within a global

political ecological schema constituted by spaces that have unequal environmental protection and risk statuses, but such governable spaces of concern now extend upward from national depths and surfaces, through national airspaces, and far beyond the controversial atmospheric domains of "climate." This inaugurates a new way to use astronautics technologies as strategies for prestige and foreign policy-making, and one that also marks a change in the political notion of what counts as the limits of the contemporary global environment.

Within astronautical networks beyond the B612 Foundation and the ASE, NEO deflection is not the only astronautical "ultimate environmental project" imagined to have the power to save and sacrifice. In 1998, space news reporter and advocate James Oberg predicted that asteroid deflection would be an "extreme case" within an "entire spectrum of deliberate human intervention in Earth's biosphere" which will "be one of the most intense ideological and philosophical conflicts of the next century" (1998:1). Oberg presented this prediction to the US Space Command, the highly-funded but little known astronautics arm of the Air Force, which he predicts will be among the few organizations positioned to mount space-based environmental engineering missions as well as to counter what he describes as the "naïve" and "ideological" "hands off the Earth" strategies that have generated international treaties that prevent "deliberate environmental modification" (Oberg 1998). Plans to environmentally reengineer the Earth are also linked to efforts to blanket it with environmental sensors. While the ASE was drafting its petition in 2008, NASA's Ames Research Center in California announced its collaboration with the software mogul Cisco Systems to create a cybernetic and satellite based "planetary skin," "massive global environmental monitoring," and "decision support" system for subscriber governments and organizations.[4] These kinds of government-funded projects aspire to turn space-based surveillance into an extreme environment panoptic array that increases the sensitivity, specificity, and power of environmental futures knowledge. In this way, space-based environmental operations and engineering proposals remake the upper boundaries of what Sheila Jasanoff and Marybeth Long Martello call "Earthly politics" (Jasanoff and Martello 2004). Contemporary scientific and economic operations in spatial extremes, from below the seafloor to beyond the exosphere, are becoming more comprehensively political operations.

Conclusions: Ecological Object Lessons

NEO activism, in sum, goes beyond human spaceflight advocacy; it advances a perspective on the nature and politics of human environmental boundaries and limits that is being debated at large by networks of environmental scientists and technologists that include astronautics experts. In a post-Cold War era, astronautical environmental science and systems engineering is becoming more visually, materially, and discursively attached to "environment" as a target of national and geopolitical policy interventions. American national and international environmental policy makers now depend on space-based monitoring data and imagery to advance US environmental agendas in the name of "planetary" solutions (Jasanoff and Martello 2004). NASA's climate change experts join ecologists to argue that there are finite "planetary boundaries" that must be understood to ensure a "safe operating space for humanity" on Earth (Rockström et al. 2009), while NASA-based NEO activists argue that Earth's planetary boundaries must be understood as open in order to protect and enhance human life. Archaeologists have joined engineers to produce a handbook on managing outer space exploration landing sites as heritage sites (Darrin and O'Leary 2009); philosophers use outer space sites as limit or test cases for the logical extension of environmental ethics (Hargrove 1986). As a result, astronautical technologies and political activities continue to shape environmental perspectives beyond the production of planet Earth images, and outer space becomes more broadly identifiable as an Earthly extreme ecology rather than a military frontier or a separate kind of nature. Outer space has become a site for what Timothy Luke (1995) calls the "eco-knowledge" politics and what Arun Agrawal (2005) refers to as governmentality's mutation into "environmentality."

As I followed NEO experts working in Houston to remake ideas about planetary boundaries, American extremes, of all kinds, were converging in the Gulf Coast. Communities endured hurricane disasters described as statistical "extreme weather" trends while energy industries extracted deeply and, by virtue of a catastrophic oil spill, contaminated water and air to an unprecedented extent. Like hurricanes and tsunamis, NEO impacts today can be predicted but not averted, and all of these extreme events enter political domains of environmental governance when they are picked up by remote sensors and predictive tracking algorithms. Houston's NASA center is one among many sites producing authoritative data on such extreme ecological problems and scenarios, and the

emerging asteroid detection and utilization activism it fosters provides a window on how total human environments that matter are being remade in scope and scale. ■

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Endnotes:

[1]In *Esalen, America and the Religion of No Religion*, Jeffrey Kripal (2007) documents Schweickart's participation in the California social group's project to design and promote transcendental consciousness.

[2]Accessed from http://www.b612foundation.org/about/welcome.html on Oct 14, 2009.

[3]Accessed from http://www.b612foundation.org/info/current_environment.html on Oct 14, 2009.

[4]Accessed from http://blogs.cisco.com/ciscotalk/green/comments/skin_care on Oct 14, 2009.

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Foreign language translations:

Political Ecology in the Extreme: Asteroid Activism and the Making of an Environmental Solar System
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关于极端环境的政治生态学：陨石政治運動以及环保太阳能系统的构建
[**关键词：** 环境，生态学，外太空，航太，环保主义，灾难，太阳能系统]

Экстремальная политическая экология: астеройдный активизм и создание экологически обоснованной солнечной системы
[**Ключеве слова:** окружающая среда, экология, космос, аэрокосмический, эклогическое движение, стихия, солнечная система]

Ecologia Política no Extremo: Activismo de Asteroides e a Formação de um Sistema Solar Ambientalista
[**Palavras Chave:** Meio Ambiente; ecologia; o espaço, aeroespaço, ambientalismo, desastre, sistema solar]

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الكلمات الجامعة: المحيط، البيئة، الفضاء الخارجي، الفضاء الجوي، الاهتمام بالبيئة، الكوارث، المنظومة الشمسي