

Encountering the Biomachinic Planet

Thomas Storey

Independent researcher and writer

Attempts to figure the 'planetary' as a mode of ecological, transnational identity focus on its evocation of relationality and difference across social and environmental networks of interconnection. The 'planetary turn' is a critical trend that foregrounds the way in which environmental crisis alters our conception of shared terrestrial identity, while also foregrounding the globe as an object of hermeneutic and aesthetic import with a specific ecological valence. However, our awareness of the state of worldwide ecological systems that undergirds this turn also stems from the mediation of the planetary through technological systems of mapping and monitoring, carried out on behalf of climate science and other forms of environmental modelling. The combination of ecological inputs and computational mediation that results renders a conceptually fluid biomachinic planet, in which the organic object of enquiry is only given form through the abstractions of data. A corollary of such a conceptual process is the sense that the planet, in terms of climatological systems, global ecological networks and environmental processes, operates as a machine, which allows such systems to be made programmable and controllable. As I argue in this article, the implications of this spectre of computational planetarity are to minimise the contingency and excess of the planetary – its essential alterity. This formulation nonetheless remains potent as a form of techno-ecological thinking that sees environmental problems as computationally solvable, making an interrogation of its critical and cultural manifestation necessary.

Envisioning the Planetary

The escalating climate and environmental crises of the current moment present myriad conceptual challenges, not least in terms of the scalar problems presented by ecological impacts that are both worldwide and localised. Within critical discourse, the 'planetary' has emerged as an alternative framework for conceiving of environmental health and ecosocial identity transnationally, in a way that eschews the economic emphasis of the 'global'. The planetary has entered the

critical lexicon as a shorthand for forms of ecological interconnection that traverse the boundaries between the environmental and the social, and which operate in opposition to human exceptionalism and capitalism's extractive, quantifying imperatives. The concept provides a means of thinking through human and non-human interrelations as socio-ecological or bioconnective bonds that stretch across the globe, which bring together the organic and the inorganic – and which are made acutely palpable through ecological crisis. Hence, planetary health, planetary well-being and planetary limits have become significant concepts in environmental messaging and critical discourse through their figuration of the planet as an embodied totality, a system of systems, some of which are displaying signs of critical infirmity. However, the planetary as a form of conceptual ecological awareness also emerges from what Sean Cubitt (2017: 163–164) has called the 'datafication' of global climatic and environmental changes – the integration of monitoring systems throughout the natural world that, collectively, has created a model of planetary-scale computation. It is through the interface of such computation that we map the totality of planetary health or sickness, indexing such well-being in terms of local, human-scale impacts and global environmental metrics. What emerges from this convergence of technological systems of mapping and ecological processes is a cyborg amalgamation, in the sense that Donna Haraway (1991: 149) describes cyborg identity: 'A hybrid of machine and organism, a creature of social reality as well as a creature of fiction'. Through this conceptual amalgamation, we can see how the computational is profoundly immanent in the ways in which we understand the ecological or environmental – it is, in fact, the vector through which this knowledge comes about. Merging a computational system of knowledge-gathering with its ecological or climatological object, this planetary totality manifests as biomachinic, while reflecting what Tobias Boes (2014: 155) calls 'planetary mediation', in which the planet, through technological mediation, becomes a hermeneutic object with a profound representational capacity. How is such a biomachinic planet encountered? And what are the implications of the computational basis of our planetary paradigm?

The notion of the planetary as a counterpoint to the 'global' or other forms of terrestrial self-conceptualisation was first explicated by Gayatri Chakravorty Spivak (2012: 350), who wrote in 'Imperative to Re-imagine the Planet' that we must 'imagine anew imperatives that structure all of us, as giver and taker, female and male, planetary human beings'. For Spivak (2012: 338), the crucial value of the planetary lies in its retention of an essential duality, as we are both immanent in it and othered by it or from it: 'The planet is in the species of alterity, belonging to another system; and yet we inhabit it,

indeed are it'. The planetary retains this sense of alterity both because of its scope and because of the abstractions required to achieve any awareness of it. Imagining ourselves as 'planetary accidents' – beings whose continued existence is determined by contingent, worldwide socio-ecological inputs, rather than 'global agents' with the capacity to master the environment – allows us to think through the ways in which planetary alterity 'remains underived from us' (Spivak, 2012: 339). This alterity is not therefore a 'dialectical negation', and is neither 'continuous' nor 'discontinuous' with us; it is 'above and beyond our own reach' and 'contains us as much as it flings us away' (Spivak, 2012: 339). Taken up throughout critical theory and commentary, the discourse of the planetary can be considered what Amy J. Elias and Christian Moraru (2015: xi–xiii) call a 'reaction to the multiple and steadily widening inconsistencies between what the world is becoming and how this change registers in prevalent epistemologies and cultural histories'. In opposition to the socio-economic paradigm of globalisation, the planetary foregrounds the ethical and ecological dimensions left out of discourses of the global or cosmopolitan. What is most valuable within this 'planetary turn', according to Elias and Moraru (2015: xi–xiii, emphasis in original), is the notion of *'the planet as a living organism, as a shared ecology, and as an incrementally integrated system both embracing and rechanneling the currents of modernity'*, through which writers and artists can reconceptualise their work and practice.

Unlike the global, Spivak (2003: 72) explains, the planetary exists beyond the 'gridwork of electronic capital'; it refers to a 'differentiated political space' rather than an 'undivided "natural" space', and it is not drawn by the 'requirements of Geographical Information Systems'. The globe, Spivak (2003: 72) writes, is 'on our computers. No one lives there. It allows us to think that we can aim to control it'. The 'globe' therefore aligns with the Anthropocene as an expression of the species hegemony of the Anthropos; it is a conceptual outgrowth of what Kathryn Yusoff (2022: 18) calls 'totalizing Western colonial visions of the world', which fail to contend with the 'material and representative excess' of apparent closed world systems. If the global is a neocolonial and technological construction, absent of actual lived experience and figured as a governable space, as Spivak suggests, then the planetary is the evocation of ungovernability or excess, both environmentally and hermeneutically. It presents a 'non-negotiable ecological ground for human and nonhuman life' (Elias & Moraru, 2015: xxiii) and is inherently relational, while also being resistant to complete knowledge and determination. However, as I will explore in this article, just as the globe is on our computers, the planetary, and its ecological imperative, also emerges from computation; without the

massive accumulation of mapping technologies and environmental interfaces that coordinate our encounter with the natural world as a planetary phenomenon, this conception of a worldwide ecological shared space would not exist. It is only as a biomachinic entity, emerging from the conjoined operations of the technosphere and the biosphere, that the planetary becomes evident. The alterity that Spivak highlights can thus be seen to manifest itself in the friction between the epistemology of data capture and technological monitoring and the relationality and negotiation of difference that otherwise defines 'planetary', a concept that, as Elias and Moraru (2015: xxiii) explain, opens itself 'to the nonhuman, the organic, and the inorganic in all of their richness ... [and] affirms the planet as both a biophysical and a new cultural base for human flourishing'. Despite Elias and Moraru's claims for planetary's radical possibilities, the biomachinic foundations of this conception position it in a more ambivalent space. Indeed, some of the paradoxes of the planetary become evident here: it both emerges from the abstractions of technological modelling and, in Amanda Boetzkes's (2019: 62–63) words, 'preserves its zone of irreducibility'; it presents a biomachinic amalgamation, but resists the imperatives of complete computational control; and it references the possibilities of a new stratum of ecological awareness, while also, as we shall see, manifesting itself in response to ecological and climatological breakdown.

Climate and the Computational Earth

In climate science the aggregation of atmospheric data into a global totality, one expressed through a series of quantifiable indicators, represents most clearly a mode of perceiving environmental phenomena through technologically induced mediation. The picture of the health of the climate that results becomes one component of an overall model of planetary health, here figured as an accumulation of social and environmental effects, which together fulfil 'the ambitious task of understanding the dynamic and systemic relationships between global environmental changes, their effects on natural systems, and how changes to natural systems affect human health and wellbeing at multiple scales' (Pongsiri *et al.*, 2019: 402). Planetary health is therefore an expression of the contemporary imperative to think the ecological as a planetary-scale category, just as climate is conceived of as a planetary process that in recent decades has become profoundly destabilised. Technological mediation is essential to the construction of this form of planetary knowledge or awareness, as it is only through the medium of computation that such globe-encompassing systems can be traced, tracked and modelled. The computational mapping of the climate as a space that can become legible through data is expressed and communicated through

indicators such as the degree of warming above pre-industrial levels (taken as a global average), atmospheric CO₂ concentrations, sea level rise, species population, biodiversity metrics, vegetation health and many more. Collectively, these establish a holistic picture of the ecological status of the planet both in the present and, through climate modelling, in the future. The data inputs that form this holistic picture are produced by a myriad array of sensing devices and environmental monitoring systems, spread across the globe, that constitute a global system of planetary sensing, feeding into an architecture of planetary computation. What results is not simply planetary systems being monitored by machines, but planetary systems operating *as* machines, within a systematic totality that appears to be essentially machinic in nature – the planetary operating as technology rather than simply through technological mediation. Taken as a whole, this is where the sense of a biomachinic totality becomes clear: a system that connects ecological and climatic inputs to computational outputs, creating a cyborg globe that is always in a state of dynamic flux, that is recursively reconstituted abstractly in data, and that is always partial, in terms of both its index of environmental processes and its computational scope – it is this totality that informs our knowledge and awareness of the planetary, and it is in encounters with this totality that the alterity Spivak speaks of emerges, and the ambivalence of its ecological import is made evident.

For Paul Edwards (2010: 12), who tracked the growth of climate science as what he calls a ‘global knowledge infrastructure’ that ‘systematically produces knowledge of climate’, this global infrastructure should not be described as a single ‘centrally designed and controlled system’, but as a networked form in which multiple systems work in combination, at times fluidly and at times with friction and feedback. The computational structure established by this architecture is aimed at mapping the complexity of overlapping atmospheric and ecological systems to generate a holistic representation of their status over time, which can be presented in a form that can be quickly communicated, grasped and applied in policy terms. This is where the planetary becomes figured as a biomachine, as ecological processes become computational in a process of technological mediation that frames and translates the complexity of our environmental crisis. As Michael Richardson and Anna Munster (2023) explain, this machinic mediation of the planetary promises ‘an unprecedented capacity to transform earth into actionable and intelligible computational artifacts and operations’. Earth is thus framed as a programmable and controllable techno-ecological system, a framing that masks the ever-present dichotomy between what Edwards (2010: 80) calls ‘data friction’ –

the ‘great difficulty, cost, and slow speed of gathering large numbers of records in one place in a form suitable for massive calculation’ – and the computational impulse towards clarity and coherence within environmental monitoring and management. The spectre of a biomachinic planet, one that always appears in and through mediation, appears to forestall other modes of interfacing with the planetary and conceptualising planetary futures in favour of what Tega Brain calls a ‘systems view’ of the environment. As Brain (2018: 153) makes clear, this systematic view connotes the environment as ‘bounded, knowable, and made up of components operating in chains of cause and effect’. Framing the environment as such a bounded and quantifiable totality ‘strongly invokes possibilities of manipulation and control’ (Brain, 2018: 153). The focus on control and manipulation as the underlying functions of systems thinking reveals a paradox of computational planetarity and the biomachinic planet: the proliferation of technologies of environmental mapping engenders a sense of the planet as biomachinic, as somehow controllable and knowable, but the excessiveness of the environmental crisis refuses attempts at control and mastery. Spivak’s alterity is here evident in the way in which any conceptual projection of climate as machine, or environment as wholly systematic in nature, breaks down within the planetary paradigm or is revealed to be, as I have already suggested, partial or flawed as a totalising framework and incommensurable with the essential excess of the planetary.

Representing the Planetary Mind

Despite these paradoxes, the conceptualisation of planetary biomachinic computation remains potent, not least in the imagining of possible climate futures, even those without a specifically modernist or techno-utopian origin. Considering the instances in which computational planetarity has been identified as a means of climate mitigation allows us to see how pervasive, but underacknowledged, this conception is – particularly when such moments come in cultural works with an activist emphasis. It is thus notable that the possibility of a programmable earth underpins Kim Stanley Robinson’s utopian vision of a response to climate breakdown in *The Ministry for the Future*, published in 2020. In this novel, Robinson imagines a series of economic, geophysical and political projects that could provide a means of mitigating climate change and alleviating its harshest impacts. Robinson not only lays out what a green transition would look like, but takes his utopian ideas further to consider the cultural and social changes that would be necessary to make possible such a response to climate breakdown in the near future. One of these is the widespread acceptance of what he calls ‘the Great Internet of Things, the Quantified World, the World

as Data' (Robinson, 2020: 454), which provides a means of measuring in real time the impacts of every aspect of human industry and society to determine their effect on the environment. This planetary system of quantification and datafication provides reassurance that all 'these aspects of the problem were being measured, and the ocean's uptake or drawdown [of carbon] was measured to within a fairly small margin of error' (Robinson, 2020: 454). In Robinson's alternative future, nature is given primary importance within the cycle of a biomachinic planet, so that the outcomes of every endeavour are considered to ascertain their biospheric impact, rather than solely their importance for humans or their alignment with the imperative to increase profit margins. The globe is therefore encased in monitoring devices, feeding an architecture of autonomous computation, which is capable of expressing such impacts in real time and coordinating a response. The planetary intelligence that emerges is a cyborg entity that autonomously guarantees the equitable and just use of resources, both for the environment and for humans, while also taking into account the livelihoods of future generations. The nascent growth of such a movement is tracked from the contemporary era, as the novel states:

It can never be emphasized enough how important the Paris Agreement had been; weak though it might have been at its start, it was perhaps like the moment the tide turns: first barely perceptible, then unstoppable. The greatest turning point in human history, what some called the first big spark of planetary mind. The birth of a good Anthropocene. (Robinson, 2020: 474)

The 'good Anthropocene' that Robinson envisages is predicated on the effective technological management of the environment as a 'planetary mind', in which environmental metrics combine with social inputs, and which is seen as ultimately programmable in the sense of ecologically malleable, given the right geopolitical impetus and the correct use of geoengineering technologies. Such a vision of the future emerges from the notion that a level of planetary computation in which the biomachinic amalgamation of the technosphere and the biosphere is absolute is a necessary means of mitigating climate change.

A further example of this utopian form of biomachinic planetary representation can be found in Richard Powers's *The Overstory*, published in 2018 and now considered one of the standard bearers of the genre of climate fiction. Powers's novel, which is mainly concerned with the relation between humans and non-humans,

specifically trees, and the possibilities for communication and environmental action within that relation, ends with the initiation of a form of global technological mediation that echoes that of Robinson. Neelay Mehta, a computer programmer and one of the central protagonists of the text, releases a new piece of software that is intended to establish a more reciprocal relation to the natural world. The 'growing organism' the software is described as provides a 'venture into cooperation' in which 'creatures swallow up whole continents of data' based on pre-existing 'digital germplasm' (Powers, 2018: 482). The program's aim is to 'find out how big life is, how connected, and what it would take for people to unsuicide. The Earth has become again the deepest, finest game, and the learners just its latest players' (Powers, 2018: 482). The autonomous algorithms released by this program – the 'learners' – exist in the space between environmental forces and technological entity, as they are capable of transcending their computational basis and operating as technoeological appendages. They therefore mediate the ecological sphere across the globe and produce knowledge of that world for the consumption of humans, and for the betterment of the environment. Extended across the planet, as Mehta envisages, this epistemological system of environmental monitoring and technological planetarity will break down the distinctions between computability and environmentality, the ecological and the technological, and establish a biomachinic totality that can, somehow, solve the environmental crisis. Powers's novel, which has been acclaimed for its innovative representation of non-human ways of being and collectivity, ultimately finds ecological redemption in the transcendent possibilities of the technological, or, more specifically, in the promise of biomachinic planetary computation. As with Robinson's novel, the subsumption of the ecological within the technological is considered an efficacious means of reducing the friction between human enterprise and environmental well-being, and the ecological capabilities of an omniscient and autonomous bio-technological planet are taken for granted – despite evidence that such a totality is neither absolute nor guaranteed to be entirely benign in its impacts.

In contrast, artistic responses to the ideas addressed here focus on the oppositional potential of the tools of planetary computation. *Solar Protocol* by Tega Brain, Alex Nathanson and Benedetta Piantella, for example, is made up of a global 'network of solar powered web servers' that redirect traffic based on the provision of available energy generated by the sun. As the three artists suggest, this insertion of renewable energy into the loop of digital media offers a counterpoint to the modernist notion of machinic control of the environment. Instead, what Brain, Nathanson and Piantella propose for their artwork is this:

It's an experiment in community-run planetary-scale computing, it's an artwork that poetically reimagines internet infrastructure, it's an education platform for teaching about internet materiality, it's a bespoke distributed cloud – perhaps what might be called a 'data non-centre', and ... it's also a virtual, solar powered artist-run space. (Solar Protocol, n.d.)

By both localising planetary-scale computation and making the system responsive to environmental indicators, Brain, Nathanson and Piantella show how a form of biomachinic planetarity can ascribe intelligence to the environment without subsuming it within a technology-driven framework. *Solar Protocol* reverses the conventional model of artificial intelligence (AI)-driven environmental management and monitoring to show how intelligence can be an environmental property rather than an automated one. As Brain (cited in Cross, 2022) writes:

The project has catalysed conversations about AI and automation, since in-network user traffic is decided by solar energy, so we are using intelligence from natural and dynamic versus a data-driven machine learning model; it's an alternative proposition. Why not think of planetary limits as intelligence? After all, they will shape the future of life on earth whether we like it or not.

A focus on a specific aspect of the planetary environment, in this case solar energy, and the small scale of this project offers a counterpoint to the totalising imperative of much environmental management, while also providing a model of openness that does not seek to impose data categories on natural phenomena. As Brain (2018: 158–159) writes in reference to Anna Tsing's usage of the term 'assemblage', the 'edges of an assemblage are fuzzy – modes of interaction are always shifting and agencies within them are heterogeneous'. The intervention made by *Solar Protocol* is one that eschews the top-down control model of most technological systems in favour of a horizontal, open-ended protocol that can be reproduced. Further, it emphasises both the materiality of monitoring systems and their potential as vectors of environmental dialogue rather than control. It therefore transposes elements of the planetary biomachine but reverses its focus so that attention is paid to the intelligence of the biosphere, rather than the requirements and protocols of a data environment.

Platforms of Planetaryity

As *Solar Protocol* makes evident, the tools of digitally mediated planetaryity are not inaccessible; indeed, in the form of map apps and satellite-facilitated navigation tools such as Google Earth, these tools are increasingly mundane. These widely accessible tools are complemented by platforms created by technology companies for the use of environmental data, such as Microsoft's AI for Earth (2017) and Planetary Computer (2020) and the platform created by the Amazon-partnered start-up Overstory (2018), which claims to offer 'AI-powered vegetation intelligence for a more resilient grid' (its use of the title of Powers's novel appears to be coincidental). In 2024, the latest iteration of such platforms appeared with Microsoft partnering with Nasa to launch Earth Copilot. This platform promises to democratise access to geospatial data and, with the help of AI, make insights from Nasa's massive environment data sets available to all. In general, these platforms are part of broader trends towards the integration of AI into environmental data management, as a means of facilitating effective data analysis as well as optimising conservation and carbon reduction schemes. Further endeavours in the same field include Climate Trace (2025), which claims to harness remote sensing and AI to track human greenhouse gas emissions in real time, and Destination Earth (2022), a project funded by the European Commission, which models a digital planet as a means of tracking and predicting the interaction between environmental phenomena and human enterprise. As Richardson and Munster (2023) point out, 'the scale of commercial data, infrastructural, and financial resources amassed by corporations such as Microsoft, Amazon, and Palantir has literally facilitated a scaling up of platform dominion, reach, and imaginary that both captures and engenders the planet as a computable "object"'. These initiatives can therefore be seen as attempts to manage the data excess that comes from any harvesting of environmental planetary data, while at the same time integrating AI and environmental intelligence in the service of a green transition. The isomorphic relationship between technology and nature, as well as that between global digital networks and planetary ecological networks, can be seen in the way in which such platforms postulate the controllability of earth systems, as a function of the planet's biomachinic nature. Such ventures are evidence of what Jennifer Gabrys (2016: 4) calls 'the programming of Earth, [which] yields processes for making new environments not necessarily as extensions of humans, but rather as new configurations or "techno-geographies" that concretize across technologies, people, practices, and nonhuman entities'. Made programmable, as these ventures imply, a biomachinic earth system could be made to resolve environmental problems through a modulation of the inputs and outputs of the system.

However, as Richardson and Munster (2023) point out, ‘there is no planetary “object” that can be fully computationally observed since images of and imaginaries for the planetary are always already radically incomplete’. What constitutes the planetary is a system of systems, each of which oscillates between autonomy and interdependence, friction and fluidity, opacity and transparency, so that they collectively evoke the fragmentation and scalar disjunction of the planet and its totalising extent and import, its excess in relation to systems of knowledge production and aesthetic figuration. Contemporary computational systems counter this scalar disjunction through recourse to notions of scalability, in which, as Richardson and Munster (2023) make clear, ‘data, IT resources, and especially machine vision models and assemblages’ are presumed to be capable of scaling up to the extent that they remain ‘fully interoperable’ at planetary scale. Scalability is both the predicate of planetary computation and the point at which its fissures become evident, as it necessitates an elision of critical distinctions, which are homogenised in data sets that lack the scope to incorporate the full complexity and contingency of material reality. Scalability, therefore, ‘disguises such divisions by blocking our ability to notice the heterogeneity of the world; by its design, scalability allows us to see only uniform blocks, ready for further expansion’, as Tsing (2012: 505) notes. Her proposal of ‘nonscalability’ represents a means of considering the limits of computational planetarity, as it pays attention to the frictions that are elided in the postulation of the seemingly fluid transposition of environmental materialities to a data environment: ‘Nonscalability theory requires attention to historical contingency, unexpected conjuncture, and the ways that contact across difference can produce new agendas’ (Tsing, 2012: 505). When considering the implications of a biomachinic planetary totality, we should pay attention to the ways in which scalability fails – when systems do not become interoperable, as well as the points at which the presentation of the totality exposes fissures. That is where the biomachinic planet reveals its limitations as a model for considering environmental crisis, as the myth of a programmable and controllable world ecology breaks down into the contingency, unboundedness and nonscalable complexity of nature – a duality that becomes clearer when we consider the aesthetic and technical roots of the planetary biomachine in satellite technologies.

Satellite Planet

The totalising global imperative of technological monitoring systems is evident in the way in which mapping, sensing and modelling technologies, which form the basis for climate science, now extend far beyond that sphere to encompass aspects of social life, commerce and

communication. These technologies establish a secondary geography of digital signals and indicators that stretches across the globe. Such a digital superstructure is nonetheless essentially material in nature. As well as a range of signalling and monitoring devices, it encompasses internet cables that cross the oceans, data centres, and the infrastructure of digital communication that allows the autonomous maintenance of such mapping processes. The paradigmatic device for enacting forms of planetary mapping, sensing and modelling is the satellite, of which around 11,000 currently orbit the earth (Orbiting Now, 2025). The first of these, Sputnik, was launched by the Soviet Union on October 4, 1957, inaugurating what Marshall McLuhan (1974: 49) described as the 'largest conceivable revolution in information'. What Sputnik achieved, according to McLuhan (1974: 49), was to create a 'new environment for the planet. For the first time the natural world was completely enclosed in a man-made container'. At that point, 'the earth went inside this new artefact, Nature ended and Ecology was born. "Ecological" thinking became inevitable as soon as the planet moved up into the status of a work of art' (McLuhan, 1974: 49). McLuhan laid out in embryonic form the trajectory that would ultimately lead to the contemporary biomachine: the encasement of the globe in a human-made mediating vessel, designed to communicate with and ultimately map the terrestrial surface, which dismantles the spectre of separate nature and gives rise to ecology as a study of the interrelation of environmental and social habitats, and ultimately to ecology *as* technology. The environment is thereby transformed into a resource for data-gathering, while also operating as aesthetic object; an interconnected world becomes a data artefact, enclosed within the vessel of computation.

The 'information age' brought about by Sputnik was, paradoxically, environmental in character; it relied upon the aggregation of distinct ecosystems into one planetary totality, which came into being as an object of scientific enquiry. Sputnik established a mediating tissue that made the earth into a spectacle, a process that would reach its apotheosis in the form of the photographs 'Earthrise' and 'The Blue Marble', taken by Apollo missions in 1968 and 1972; the latter was subsequently used on the cover of Stewart Brand's *Whole Earth Catalog*. As with Sputnik, these photos encouraged a form of technologically enabled planetary distance, which established the globe as a holistic object to be studied, within a circuit that foregrounded the overlapping nature of the biosphere and what Peter Haff (2014: 301–302) describes as the 'technosphere' – 'the large-scale networked technologies that underlie and make possible' the modern economy, with the former subsuming the latter. Benjamin Bratton (2015: 86) says of the 'Earthrise' image that its perspective

from ‘outside’ reframes ‘the very figurability of territorial ground as such’; it therefore suggests a ‘single, absolute scale for Earthly culture and ecology and a single planetary “inside”’. As well as inaugurating a new information age, this figure of the externalised planet inspired the ‘popular ecology movement by providing it a self-evident domain to conserve, commune, or administer’ (Bratton, 2015: 86). As McLuhan suggested, such an understanding of the planetary was premised on the fluidity of ecological thought, its status as something in a constant process of change, which fed into the media spectacle generated by technologies of planetary awareness. Paradoxically, it is the satellite that, by establishing the distance necessary to make the earth into an aesthetic object, reveals how interconnected and intimate ecological planetary processes are; as Timothy Morton (2013: 128) writes, ‘ecological awareness is a detailed and increasing sense, in science and outside of it, of the innumerable interrelationships among lifeforms and between life and non-life’. Prompted by a satellite perspective, planetary awareness brings about ecological self-consciousness, which then encourages ecological systems to become the object of satellite technologies that capture, map, and monitor environmental processes – so the prothesis of planetary computation and vision envelops the global biosphere.

Following McLuhan, we can suggest that the launch of Sputnik could be said to have contributed on an epistemological level to the onset of the Anthropocene as much as any of the inception points that have been debated. The satellite perspective revealed, on a macro scale, humanity’s inscription upon the geosphere and biosphere, which have been transformed into a global interface indexing environmental degradation. The planet thus becomes, as Boes (2014: 155) states, an object of ‘planetary mediation’, both in the sense of operating as an iconic image via which we understand planetary-scale environmental changes, and by providing a canvas for humanity to inscribe its deleterious planetary impacts. The Anthropocene and planetarity both emerge from this moment of terrestrial self-consciousness as means of conceptualising anthropogenic impacts on the planet. Indeed, the paradigm of planetary sensing inaugurated by the satellite era is one that facilitated the naming of such a human-determined epoch through the mapping of environmental change. Moreover, the massive expansion in satellite technology since the 1960s has gone hand in hand with the development of other, terrestrial forms of monitoring, both for purportedly environmental aims and for other purposes. Satellites thus form one of the central elements of the transition from localised forms of industrial technology to a computational technology on what Gabrys (2022: 134) calls the “scale” of the planetary’. Thanks to the integration of such technologies in the monitoring of weather systems, the technosphere

becomes another component of the climate system, alongside the atmosphere, hydrosphere, cryosphere, lithosphere and biosphere. The extent of such a global communication and monitoring system gives rise to the scalar disjunction referenced by Gabrys (2022: 134), via which planetary technologies are conceived of in terms of their ‘massiveness’, as if they held the globe in a state of ‘complete capture’. In fact, as Gabrys and others make clear, such planetary technological systems are never as monolithic as they may appear; instead, as referenced above, they are constituted by a series of overlapping but discontinuous systems that do not fully cohere into anything approaching a homogenous, frictionless whole. Nonetheless, the projection of the total planetary view established by satellite technology suggests that a project of environmental capture and control has been initiated. Cartography here is an essential element of control – to map and monitor become functions of a larger system of global programmability that is evident throughout systems of environmental management.

Satellites as vectors of planetary sensing and data collection also make apparent the way in which planetary computation is a *media* form, which allows climate change to come ‘into view’ as a media phenomenon, that is, in the mediated form of data (Gabrys, 2022: 134). Satellites therefore represent a crucial element in both the becoming environmental and the becoming planetary of technological systems, as is evident in the environmental data management platforms referenced above. Satellites’ role in transforming the planet into a ‘digital earth’ occurs alongside the development of myriad other environmental and climatic monitoring technologies, which model environmental changes in the digital space (Gabrys, 2016: 3). While incorporating the technologies of sensing and monitoring, a biomachinic planet exists primarily within that digital space as a ‘datafied’ and quantified representation of the changing status of world ecologies and climatic processes. The rapid growth of such technologies, and the contemporaneous breakdown of a stable climate and environment, has meant that ‘our understanding of environmental systems is now bound up with communication technologies that sense earthly processes’ (Gabrys, 2016: 3). The ‘distributed array of sensing technologies’ that facilitates this knowledge-gathering stretches far beyond the satellite, but these technologies remain paradigmatic in widening the purview of technological monitoring systems to the level of the planetary and thereby generating an ecologically invested technosphere (Gabrys, 2016: 3). The becoming environmental of technological systems involves not only a focus on environmental processes and changes, however, but also the creation of digital environments that model those changes through data.

Nonetheless, these data environments, which are to some extent the locus of the biomachinic planet, should not obscure the materiality of planetary-scale computational systems, which constitute a massive, complex technostucture that incorporates ‘sensors, satellites, cables, communications protocols and software’ (Gilman, 2022). According to Nils Gilman (Gilman, 2022), the development of this structure ‘reveals and deepens our fundamental condition of planetarity – the techno-mediated self-awareness of the inescapability of our embeddedness in an Earth-spanning biogeochemical system’. In an interview with Gilman (Gilman, 2022), Bratton states that climate change models constitute a ‘a self-disclosure of Earth’s intelligence and agency, accomplished by thinking through and with a computational model’. They thereby bring into effect planetary-scale computational processes and, therefore, the possibility of planetary intelligence:

Bratton: We have constructed, in essence, not a single giant computer, but a massively distributed accidental megastructure. This accidental megastructure is something that we all inhabit, that is above us and in front of us, in the sky and in the ground. It’s at once a technical and an institutional system; it both reflects our societies and comes to constitute them. It’s a figure of totality, both physically and symbolically. (Gilman, 2022)

This computational megastructure emerges contingently from overlapping and at times competing systems, rather than as a result of purpose-driven design, but it is materially invested in terms of its reliance on an extractive economy of resource use. Whether it be energy production or the rare earth minerals that are necessary for the production of computational hardware, the biomachinic planet is interlaced with geological and material processes both at the level of its inputs and, as we have seen, at the level of outputs. As Bratton (2015: 12) states: ‘Planetary scale computation involves the whole Earth from which silica, steel, and all manner of conflict minerals are drawn. Computation is not virtual; it is deeply physical event’. The accidental megastructure of computation, which Bratton (2015: 83) calls ‘the Stack’, is not possible ‘without a vast immolation and involution of the Earth’s mineral cavities’. Following the incorporation of these materials into planetary computation, the megastructure produces waste that re-enters and further modulates the biosphere. The cycle of resource extraction and waste production, as well as the release of carbon and other pollutants, represents the material base of the biomachinic planetary totality, as it frames the planet as a geological component of a broader eco-technological system. It reveals how, in Jussi Parikka’s (2014: 13) words, ‘the earth

is part of media both as a resource and as transmission'. The extent of the carbon and mineral appetite of a planetary computational architecture could be said to reveal a paradox in which, as Bratton claims, planetary sensing is both the 'measurement and the event itself' (Sonic Acts, 2017); it is both the means of understanding that climate change is happening and one of the conditions for its perpetuation, revealing 'the paradoxical recursivity that undergirds the demand for global ecological omniscience' (Sonic Acts, 2017). Technical media is made operative by the materiality of the geophysical, facilitating a process of extraction that mines what Parikka (2015: 57–58) calls the 'deep time of the planet', which is then 'installed inside our machines' and 'crystallized as part of the political economy'. As a result, digital platforms of planetary computation are bound up with the materiality of geophysical deep time, which provides the resources – fossil fuels and rare earth minerals – for the extraction that has made the environment and climate objects of computational enquiry; hence the essential recursivity of the planetary biomachine.

Conclusion: Incommensurable Planetarity

The biomachinic planet is a composite of the environmental and social, emerging from systems of sensing, monitoring and mapping, and expressed through a system of algorithmic quantification and modelling. Underlying such a conception is the broader technification of nature, by which nature itself is conceived of as an instrumentalised, technological space, built on the basis of algorithmic processes that precede computability and which rely on a homeostatic modulation to develop and grow – a cybernetic conception of nature expressed by figures such as Howard T. Odum. Nature also becomes subsumed within the technological through its quantification as resource according to the imperatives of industrial extraction; these more local forms of ecological subsumption are modelled on a planetary level by computational planetarity, which both projects and represents nature's apparent essential computability. The biomachinic planet is both totality and accumulation of such forms of technification, and it therefore emerges as a precarious whole, in which overlapping processes are modulated and coordinated, at times in opposition. Moreover, the precariousness of this biomachinic planet, made legible by a massive accumulation of climatic and ecological data, also stems from a representational impasse: data, the networked form and complex systems lack a language of representation, or as Alexander R. Galloway (2012: 99) states, 'allegories' that could provide a 'poetics as such for this mysterious new machinic space'. The representational impasse referenced here points towards a broader dilemma of

'unrepresentability lurking within information aesthetics' (Galloway, 2012: 86, emphasis in original). Here, unrepresentability emerges as a function of algorithmic interfaces, one that becomes more acute as the efficiency of such interfaces increases: 'An increase in aesthetic information produces a decline in information aesthetics', leading to a situation in which 'algorithmic interfaces ... prove that something is happening behind and beyond the visible' (Galloway, 2012: 86). Opacity therefore comes to characterise what Ursula Heise (2008: 67) calls the 'database aesthetic' of modern planetary monitoring systems, which, despite their representational and modelling capabilities, nevertheless appear to resist figuration, at least in part because of the data excess and overwhelming complexity that defines them. One implication of this sense of overwhelming complexity is the demand to relinquish responsibility for oversight to computational systems, thereby furthering the extent of those systems' abstraction and lack of transparency.

Thus we are returned to Spivak's assessment of planetarity, as an ethical and relational counterpoint to the imposition of globalisation, in which ontological difference is registered, but which resists complete co-optation; it remains irreducibly other, which, ultimately, is part of its critical import. These paradoxes are heightened when we consider the operations of the planetary biomachine, and the processes of environmental technicisation that are at work within it. The subsumption of climatic and environmental data into a global architecture of computation is premised upon the profound interconnection of systems of ecological habitability and well-being, all of which are similarly interlaced with social and economic systems. Following the parameters of this systematic viewpoint, human and non-human worlds are seen to overlap and intertwine along the vectors of such ecological relations, so that the ecological, climatic and social spheres are always operative collectively, as non-discrete frameworks, which are further overlaid or underpinned by industrial and economic processes. Contingent inputs and effects, feedback loops and non-linearity characterise this totality, which is never absolute but always fractured by gaps, and which cannot be wholly expressed computationally – as Sergio Rubin and Michel Crucifix (2021: 1) state: 'Earth's complexity has formal equivalence to a self-referential system that inherently is non-algorithmic and, therefore, cannot be surrogated and simulated in a Turing machine'. Abstracted through data, planetary complexity becomes subsumed within a computational, algorithmic system that seeks to establish pattern and coherence, but which cannot fully contend with the nonscalable excess of planetary existence. Such a system is capable of delineating flows of goods, labour and capital alongside atmospheric variables and ecological markers, as well as the negative externalities that

impact on the health of the latter – emissions of carbon, pollutants, and the production of waste – but it remains always partial, even as it is recursively reconstituted. At its worst, such a system risks homogenising the complexity of its planetary object of enquiry and thereby reducing the possible scope of ecological interventions and outcomes. Thinking through the application of such a planetary form of computation therefore requires a sceptical awareness of the points at which the totality disintegrates and the conceptual, representational and material limitations of the mediating frames we have encased the planet within become clear.

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