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Ground bias: A driver for skepticisms about space exploration

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This paper introduces and develops the concept of "ground bias." The bias in question involves a background underestimation of the importance of space for an understanding of terrestrial processes. Underestimation then operates as a driver for various kinds of skepticism about space exploration. Ground bias is also more widespread than skepticism about space exploration and does not, on its own, entail it. There may need to be some further factor (such as populist political critique, fears about technology, or a generalized pessimism about the future of humanity) before space skepticism is embraced. Nonetheless, an appeal to ground bias can help to explain the stubborn persistence of skepticism about space exploration in the face of successive failed predictions about the negative impact of space programs upon humanity. The arc of the paper moves from an overview of space skepticisms to a clarification of the ground bias concept. The formal argument of the paper (that this bias helps to explain the persistence of skepticism about space exploration) is largely a foil to help set up the ground bias concept. The final section considers the standing of ground bias by comparison with other sorts of human bias, up to and including forms of irrational prejudice. Ground bias is significantly different from these, and closer to human biases about time (e.g., thinking of the future as more important than the past, and near events as more important than distant ones). However, it is also a good deal newer than bias about time, and less rooted in our human makeup.

KEYWORDS

ground bias, surface bias, land bias, space skepticism, Mars, ocean worlds

Introduction

My concern here will be with a form of bias that tends to block an appreciation of the importance of space exploration and space science. For convenience, I will refer to it as "ground bias." As a provisional gloss, the bias in question involves an underestimation of the importance of space for an understanding of scientific practice on Earth. This is only a provisional gloss. Clarification will follow, through consideration of the relation between this bias and skepticism about the value of human activities in space (Milligan, 2015). The central contention is that an appeal to ground bias helps to explain the stubborn persistence of space skepticism, in the face of repeated failures of prediction. Finally, the approach below will also be strongly conceptual or philosophical, in the sense that a

good deal of attention will be given to making sense of the concept of ground bias. The concluding section will consider the normative and ethical significance of the bias in question, and this again is a somewhat philosophical way to frame matters.

To convey an initial sense of the bias in question, a brief exemplar will be set out. The exemplar involves a historical failure: dismissal of the rocketry research of Robert Goddard in the 1920s as crank research, irrelevant to the pressing social needs of the times. The Goddard case runs as follows. Although groundbreaking, Robert Goddard's research was widely and publicly dismissed from 1920 onwards. Although arguably ahead of comparable German research into rocketry, at least for a time, it did not enjoy a similar feed into early space programs, partly because Goddard retreated into increasing privacy, even secrecy. Not until the Apollo 11 astronauts were a day into their journey to the Moon, and Western pioneers of spaceflight were sought as founding fathers who might be set against a prominent cluster of German, Russian, and then Soviet, pioneers, did the *New York Times* issue a belated public withdrawal of the early coverage of Goddard's research.

Within the space community, this case is relatively well known, but the precise reasons given for dismissal of Goddard are more obscure. The charge was that he did not understand basic mechanics and specifically Newton's third law concerning actions and reactions. He failed to realize that while rockets within the Earth's atmosphere were able to propel objects forwards by pushing against the air, this would not be possible in the near vacuum of space because rockets would have nothing to push against. And so, once out of the Earth's atmosphere, they would not be able to add any additional force. "That professor Goddard, with his 'chair' in Clark College and the countenancing of the Smithsonian Institution, does not know the relation of action to reaction, and of the need to have something better than a vacuum against which to react -- to say that would be absurd. Of course he only seems to lack the knowledge ladled out daily in high schools" (Smith, 2018). The objection itself was confused or, more simply, wrong. But what is important about it in the present context is the assumption that Newtonian mechanics primarily involved terrestrial laws for terrestrial circumstances. An assumption about the nature of the laws which sets aside the reconciliation of observed planetary motions and terrestrial observations that played a major role in the formulation of the laws. Newton's search for a set of absolutely general laws simply did not presuppose the kind of separation of terrestrial circumstances and planetary motion which was a driver for the dismissal (even ridicule) of Goddard on the grounds that he was mistakenly over-extending what were essentially rules for Earth. A very separate place from space. The 1969 retraction of this view was both gracious and long overdue. "Further investigation and experimentation have confirmed the findings of Isaac Newton in the 17th century, and it is now definitely established that a rocket can function in a vacuum as well as in an atmosphere" (Smith, 2018).

By pointing towards the case, I am not suggesting that the initial attacks were motivated only by an excessive separation of circumstances in space and on Earth. There were clearly a good many reasons why agents writing in 1920, against the background of millions of deaths in a recent war, and the deaths of millions in a rampant flu pandemic, might consider a proposal to spend money to send rockets to the Moon something of a distraction from more pressing concerns. Nonetheless, the way in which the objections to Goddard were made does seem to show strong, but ultimately mistaken over-separation between our understanding of space and of Earth, an over-separation shared by various of Goddard's critics, but not by Newton or predecessors such as Galileo, Kepler, and Copernicus. And so, insofar as some manner of bias may be detected in the entire journalistic approach to Goddard's work, it looks like it may be a relatively modern bias. It is also of note that in the case of objections to Goddard, this excessive separation was used to justify a broader skepticism about the entire project of sending humans into space. It is also noteworthy that, while the objections to Goddard depended upon predictions (about rocket failure in space) which turned out to be false, the associated skepticism about human activities in space was not abandoned but instead mutated. I will take it that this is in fact a typical sequence of events, with space skepticisms shapeshifting over time, and surviving in newer forms as successive predictions fail. From the 1950s onwards, we may think of claims that humans could not make it to the Moon because of the unsurvivable Van Allen radiation belts. (An idea which has become a regular feature of conspiracy theories about the Moon landings, with the failure of the prediction simply rejected.) We might also think of the claim that the overview of humans from space would be like that of behavioral scientists looking at rodents running around in a laboratory maze. With humanity's stature thereby diminished (Arendt [1963] 2006). Neither of these claims has turned out to be correct. Yet skepticism about space projects persists. And so, my thought is that this persistence is best explained by appeal to some further driver, sitting in the background, and unaffected by the failure of successive skeptical theories.

As a qualification of what is claimed, the kind of ground bias that I have in mind as the background driver may ordinarily be required for space skepticism to emerge, but it does not necessitate such skepticism in either a logical or psychological sense. Many of us may have some manner of ground bias, without ever going on to embrace skepticism about the value of human activities in space. Given the complexities of human psychology, additional factors may also be required. The most obvious of these are some manner of political motivation, which does seem to have played a role in the 1920s dismissals of Goddard; a general pessimism about humanity, or a fear of technology and modernity. Some factor or combination of factors of this sort may be required for actual space skepticism to emerge. However, this is not the same as

attributing causal primacy to any single factor while treating the others as merely additional. Rather, it involves only the more cautious claim that multiple factors feed into skepticism about space exploration, and that ground bias is generally to be found somewhere in the mix.

Space skepticism

The more extreme forms of space skepticism, i.e., actual denial of successful programs, denial that astronauts ever did make it through the Van Allen belts, and conspiracy theories about lunar landings, will be set aside in favor of mainstream value-focused versions. Not the denial of well-established facts, but a denial of the value of the more ambitious and expansive forms of direct and indirect human activity in space. "Space exploration" will be used as a general term for the latter, i.e., a term for activities beyond those whose value is now unassailable. It would be difficult to find any serious contemporary challenge to the value of the satellite systems upon whose operation so much of contemporary human life depends. These system allow us to communicate, to monitor climate change, and to have advanced, life preserving, notification of extreme weather events. Rather, what mainstream versions of space skepticism challenge are more ambitious and expansive activities such as putting actual humans into space; working towards footsteps and ultimately a permanent base on Mars; meeting the costs of increasingly expensive telescopes such as Webb and Hubble; and the value of the first tentative life supporting installations that humans have put into orbit (the International Space Station, the now defunct Russian Mir, and China's new Tiangong station).

While this is not an empirical study, it is consistent with the data on popular attitudes towards space activities in the US, such as the 2018 Pew Centre Survey. The survey found that only 11% of Americans were opposed to Earth monitoring, but 37% were opposed to a Mars mission, and 44% were opposed to sending humans back to the Moon. 27% were also opposed to the search for life and habitable worlds (Pew Centre, 2018). The further away from immediate terrestrial concerns, the less sense respondents had of the importance of the research or of the multiple ways in which these different kinds of activities (conducted in Earth orbit and further away) are entangled. And so, even while there is now a widespread realization of the value of satellite observation, contemporary space skepticism continues by shapeshifting and changing its focus of attention. Even to the extent that it is difficult to imagine *any* discovery or proven advantage of space research that would fully remove it from conversations about what we hope to accomplish in space.

While skepticism about the value of space exploration takes many forms and facilitates the resurgence of taboos concerning places that we should not go to, often it takes the form of seeing life on Earth in much the same way as many of the survey respondents, i.e., as separate and disentangled from a larger than Earthly context. A good deal of scientific research in space can then appear to be a luxury, compared to real down to Earth problems. Astrobiology, for example, may be dismissed as a discipline without an object because what we need to know about life can already be learned *here* rather than elsewhere. With the value of such expansive forms of scientific enquiry undermined, it then becomes intelligible to reduce the historically deep matter of our human future in space to a question of taxation, and whether or not ongoing space activities are worth the relatively small per capita amounts that they cost citizens on an annual basis. Amitai Etzione's *The* Moon-Doggle (1964), and Gerard De Groot's *The Dark Side of the Moon* (2006), take this skeptical line of attack, at opposite ends of the Apollo and Space Shuttle experience.

There is, however, something odd about evaluating any process of historic significance in this way. It is a little like thinking about the price at which we would agree to have all copies of Shakespeare and Plato burned, given that there are some things that we value more than these texts (e.g., finding a cure for cancer, and ending global poverty). In the case of space exploration, the aggregate costs are large enough for us to imagine some process whereby the sums involved might be transferred, without any intractable political obstacles, to meet the most urgent human needs. Gil Scott Heron's emotive space skeptical poem "Whitey on the Moon" (1970) presented space in this way, as a distraction from the more pressing realities of poverty, racism, and dissent. An idea in which we find echoes of one motivation behind the attacks upon Goddard, and something close to the standard form of contemporary space skepticism, i.e., the idea that it is a wasteful or misguided use of resources which might be deployed in better ways. However, any imagined transfer process that would deal with more pressing socio-economic problems, could just as readily tap into other sources of wealth, such as sport (which is also a social good but is more heavily funded). The difficulty is not one of finding funds, but of overcoming political barriers to their allocation and effective use within the regular bounds of liberal democracy. While we can imagine processes that might allow transfers to occur, they might well require some other, and illiberal, political arrangements with uncharacteristic levels of centralized political control.

Curiously, the pattern of actual dissent about space activities has tended to diverge from any manner of space skepticism. It is important that we do not imagine that the growing number of incidents of dissent around space infrastructure are driven by such skepticism and ultimately by the bias outlined below. While initial dissent over space programs, such as the late Civil Rights protest over the Moon landing in 1969 (De Groot 2006), did draw upon a cost-focused space skepticism, the most notable instances of dissent since then have focused instead upon the ways in which things are done rather than the legitimacy of programs as such. Their focus has also tended to be around installations, rather than

the urban environment which is at the heart of Gil Scott Heron's poem. In Hawaii there are long-running protests over telescope placement on the sacred site of Mauna Kea (Kahanamoku, 2019). In French Guiana, the European Space Agency's launch site has been a convenient target for occupation by local trades unionists and Indigenous agents in the face of disputes about French Government funding which are not specifically about the funding of space activities (France 24, 2017).

Overall, the pattern of dissent varies. In Sweden, there has been a rolling dispute over the impact of the Esrange launch site on traditional Sami herding lands (Sheehan, 2018). The issues at stake are those of sovereignty, cultural heritage, environmental impact, and financial support, rather than opposition to human activity in space. This is not to deny that such protests can feed space skepticism in some way, or to suggest that every leaflet and speech involves a glowing endorsement of space as a legitimate area of human activity. It would be odd to imagine that nobody ever starts off by participating in such protests and them moves on to embrace some form of space skepticism. Such transitions are possible. However, the overall or dominant targeting of dissent has not been the value of space programs. This suggests a divergence from the moon landing protest of 1969. However, until we have more detailed grassroots studies, it may be difficult to tell whether or not space skepticism is slowly building within such protests, and whether or not we might expect it to become a major political force at some future point in time.

As a qualification to what has been said, skeptical claims about space exploration can shade into ordinary and entirely legitimate disputes about the costings of individual programs, e.g., about whether or not the Space Shuttle offered good value for money. This can make it difficult to determine when someone is expressing doubts about *the whole business* of human activity in space, and when they are simply questioning whether a particular program or process is appropriate, well run, or cost effective. For example, James Van Allen's longstanding view that non-human missions offer better value for money (Van Allen, 2004), and the prediction by Donald Goldsmith and Martin Rees that publicly funded space activities will become largely robotic and human presence largely a private sector affair, will *not* count as space skepticism in the sense that is in play here (Goldsmith and Rees, 2022). Nor will the rejection of a colonization or terraforming of Mars (Billings, 2017; Stoner, 2017). It is perfectly possible to uphold the value of extensive forms of space research and space science while endorsing any or all of these views. They look like positions on issues which are liable to yield disagreement among reasonable agents without requiring any bias somewhere in the background.

This qualification is a matter of some importance. After all, "space skepticism" is not a natural kind concept (Kripke, 1981). It is not like CO_2 or H_2O in the sense of being fixed in some direct way by the sheer physical nature of things. Rather, the concept is a convenient tool that helps us to tell a story about what humans do, how we engage with one another, and how we think about space. As a philosophical point about *what concepts do*, a different concept or cluster of concepts might also get the same job done, without the choice of concepts becoming arbitrary. Reasons may be offered for going one way rather than another. Ultimately, we need concepts of some sort to build informative pictures of our world, even if our overall conceptual repertoire may be constituted in different but equally efficient ways. Concepts can be added and dropped, but the need for a conceptual repertoire of some sort cannot be set aside. In the present case, the concept of space skepticism helps us to understand certain patterns of generalized hostility that space programs and space science can face. This is part of the work that it does. And this work fixes its meaning. But the concept will only play its role effectively if it is not called upon to do too much work, or work of the wrong sort. Every kind of reasonable doubt and questioning cannot be an instance of space skepticism. Otherwise, the role of the concept would be to block critical appraisal. And that is not at all what is intended here.

Sustaining the plausibility of space skepticism, understood in these terms as a generalized hostility to the value of human activities in space, poses something of a challenge. Particularly when it is linked to some prediction(s) about the near human future. Here, we may think of one of the more prominent forms of space skepticism from the 1960s onwards, Amitai Etzione's claim that the Apollo program would create a brain drain and sap the vitality of science for a generation (Etzione 1964). Or a generation earlier, and closer to the ridicule of Goddard, we might think of the philosopher Ludwig Wittgenstein's use of the claim that men have never landed on the Moon or *could* ever do so as close to a logical truth, around which a larger body of certainties might be built [Wittgenstein (1950-51), 25]. Survival requires mutation and, in the case of space skepticism, a drift from doubts about physical possibilities, to doubts about value and outcome. The most recent and impressive version of skepticism, David Deudney's *Dark Skies: Space Expansionism, Planetary Geopolitics, and the Ends of Humanity* (2020), avoids the most vulnerable claims, but warns instead about a continuing and deepening of international political conflicts in space. A genuine possibility, even if not necessarily the only, or most obvious, direction of human travel. Deudney's work carries echoes of Carl Schmitt's post-war view that space activities would be continuous with familiar conflicts (Schmitt, 1954). But while Deudney does anticipate significant conflict change and acceleration, Schmitt saw only the same political dynamics in a new setting. A conservative vision of space, directed against utopian aspirations. Arendt ([1963] 2006), whose variant of space skepticism dates to the start of the Apollo era, is the most philosophically subtle, and it expresses a contrasting concern that *too much would change*, leaving us with a diminished negative overview of humanity. One in which we might look down upon humanity in much the same way that a

scientist might look down upon lab animals running through a maze.

The different ways of seeing human activities in space either as irrelevance or as threat vary greatly, but with cross-fertilization and punctuated thematic continuities. Ideas disappear from one kind of skepticism, only to resurface in later versions. Most recently, Arendt's fears about the diminished stature of ordinary humans have resurfaced in contemporary politicized skepticisms which carry influences from populist hostility towards elites. At their core is hostility to a billionaire elite which is assumed to be cohesive and assumed to be planning to escape from a ruined planet and from a mass of humanity with whom the elite now shares few bonds of community or solidarity. This is an idea which has been articulated widely in mainstream discourse as a response to private sector space activities, with varying degrees of conviction. A 2015 piece for *Newsweek* by bestselling business author Kevin Maney is a case in point: "It is nice to know Elon Musk and Jeff Bezos have a plan. They will help the richest people in the world go to Mars and start over, leaving the other 99 percent to suffer on a dying, warring planet" (Maney, 2015). However, articulation is not quite the same as commitment. Statements of this sort can be meant literally. Or they can lean more towards political alignment than literal description. In more figurative cases, the sense of what is said comes close to the idea that *these people would like to go to Mars, and leave us all behind, and that is why we should be suspicious about their space ventures*. The *we* in question is humanity at large, and *we* are diminished their projects.

While the presence of such ideas may be strongest in online media rather than scholarly texts, they draw upon culturally significant phenomena (such as cyberpunk fiction) and they intersect with the more scholarly end of populism where claims are set out in more guarded terms. Latour (2017) *Down to Earth: Politics in the New Climatic Regime* (2017) carries some of the same themes: ecological degradation has convinced a global elite, marked out by its wealth and power, to abandon the pretense of solidarity with the rest of humanity, and instead to chart out a separate, Earth-abandoning, future. A vision of the world in which there clearly is enough centralized co-ordination of activities, and choice in the hands of decision makers, for mass transfers of funds from space to Earth activities to be, at least notionally, politically viable even if elites might lack the motivation to carry it out. Latour's position is, however, nuanced and acknowledges a close integration of our ways of thinking about Earth and about space. His 2013 lecture "Telling Friend from Foe in the Time of the Anthropocene" extends the area of human influence to "sublunary space" (Latour, 2015: 7), even if the proper direction of movement is back home to Earth. While there is recognition of a larger and entangled sphere of human activity, the idea of an attempted escape from Earth by elites is more accessible and more readily taken up.

In the light of this populist turn in space skepticism, it is tempting to say that skepticisms about space tend to politicize. Yet they are often politicized from the outset and not from any single direction. Carl Schmitt's skepticism came from the political right. Populist worries about technology in the hands of elites, blend left and right influences (themes of inequality with a Schmitt style "friends and enemies" conception of politics). Concerns about colonialism in space tend to come from the left, and from a worry that structural features of domination may be transferred into a new space context, even in the absence of any Indigenous peoples of space who might be subject to 18th or 19th century forms of colonial control. Colonialism is then understood as reproduceable structure rather than history (Wolfe, 2006). This is an approach in which realistic concerns about power in space (Billings, 2017; Smiles, 2020) may co-habit with borderline elements of populist critique. Plausible challenges to particular kinds of space program, and to particular kinds of imagery (of conquest, colonization, and escape) may mingle with more straightforwardly skeptical lines of thought. The borders are not always clear.

In line with these observations, space skepticism appears to be more than one thing. It is made up of a multiplicity of doubts about space activities which have been clustered together under a single concept. This has been done on the basis that such skepticisms attempt, in different ways, to articulate an overlapping set of ethico-political intuitions about ambitious human activities in space as irrelevant to human well-being, or else a threat to it, or else an attempt to escape from our real and pressing ethico-political responsibilities which are located *here* in a way which is radically separate from *elsewhere* in space. The escapist charge is one of the oldest recognizably skeptical themes. Throughout the Apollo and Space Shuttle eras, J.G. Ballard focused in upon it in his series of "Cape Stories" the theme of which was that attempts to accelerate prematurely into a space age were doomed to failure (Ballard, 1981). A prediction that turned out to be correct. The programs in question did run out of momentum, were otherwise undermined, and eventually abandoned. Yet, there was something in Ballard's tales that reached beyond matters of timing and the allocation of funds, a pessimistic sense of where humanity was going, and this does seem to warrant the claim that his attitude was one of skepticism and not only well-grounded critique. As indicated above, the boundaries between reasonable criticism and a skepticism which arises from a larger sense of pessimism about humanity may be crossed.

Ground bias

In the light of the above outline of space skepticism, the most obvious way to fill out the ground bias concept, beyond the opening gloss, is by appeal to an *exaggerated disentangling* of Earth and space. Skepticism, in its various forms, draws upon precisely such an exaggerated disentangling or separation. In its absence, space skepticism makes very little sense. As an extension

of the opening gloss on the concept of ground bias, we may focus upon this problem in the revised formulation below.

Exaggerated disentangling formulation: ground bias involves an exaggerated disentangling of Earth and space such that our understanding of Earth, at a planetary level, is thought of as shaped by what happens *here*, rather than by thinking, in more relational terms, about *here* in the light of *elsewhere*.

While bias of this sort has been around for a long time, the more relational approach is historically more typical, and the more disentangled approach has become dominant only over the past couple of centuries. I will assume that the drivers for this shift are the obvious ones: navigation systems and agriculture have become disconnected from a direct farmer knowledge of the stars, agriculture has been marginalized by industry and urban life, and our view of the night sky has been compromised by illumination from the ground. Yet, at the same time, agriculture has a growing level of dependence upon satellite systems and ground monitoring, but in a way that does not require agents involved in farming to have detailed personal knowledge of constellations and seasonal change. There have been upsides to these processes, and few of us would want to turn back the clock, but there have also been significant downsides. Few of us now have the kinds of astronomical knowledge which were commonplace in pre-industrial societies, and which have an ongoing presence within Indigenous cosmologies in which sky and ground remain closely interconnected, and in which human origins are traced to a movement between the two. Here, we may think of First Nation origin stories in North America, such as the story of Skywoman who falls down from the Pleiades, tumbles into the ocean, and ends up living on Turtle Island (Kimmerer, 2020). But we might also think of origin stories elsewhere in the world, e.g., among China's *shaoshu minzu* (national minorities) such as the Nuosu, for whom all life originated in snow from the skies (Bender, 2016).

However we think about the dialogue between Indigenous Knowledge and science (understood in the conventional sense) such cosmologies do not radically separate off life on Earth from the broader context of space. Nor need we romanticize Indigenous agents in order to point this out. Ground bias may well be present among such agents in other forms, given high levels of interconnection with technological systems, e.g., through climate change monitoring. It is intelligible, perhaps even likely, that Indigenous agents in the Arctic might regard such monitoring primarily in terms of ground-based activities such as core sampling, which they are more likely to be directly involved with, rather than in terms of an ongoing interconnection of sampling and satellite monitoring with each complementing the limitations of the other. And so, when I point out that Indigenous cosmologies do not typically exhibit exaggerated disentangling, or ground bias, this should not be taken to imply a wholesale absence of the influence of such bias at the level of Indigenous individuals.

Be that as it may, only when such disentangling occurs does it start to make sense to suggest that we should concentrate our efforts and attention upon Earth *by setting aside or downplaying space exploration*. But with such disentangling in place, such a move may even seem attractive. Yet it is at odds with our best evidence for how rounded pictures of planetary level processes on Earth occur. Particularly in the case of terrestrial climate change. For example, our identification and understanding of the greenhouse effect is not the result of simply looking at satellite data about the Earth, but the result of combining such data with prior research into the atmosphere of Venus. Runaway global warming on Venus, researched during the 1960s and 70s when Venus (rather than Mars) was still thought of as a candidate for best neighbor and site for possible future terraforming, was the model that allowed us to make sense of what was going on down here when the satellite data started to flow in more detail during the 1980s (Leshner and Hogan, 2019). Similarly, our understanding that seemingly inert chemicals (chlorofluorocarbons) might be damaging the ozone layer was again heavily shaped by Venus research. Even the idea of Gaia, i.e., that the Earth's outer layer can be treated as a single giant biotic system, drew heavily upon James Lovelock's prior Venus and Mars research (Lovelock, 1965). There have also been suggestions, from Olson (2018) that the very idea of an eco*system* depends upon the application of a Galilean "sistemi" concept, put in place to help make sense of two rival systems for planetary motion. A suggestion to which I am sympathetic, but do not want to overwork, given the scope for reasonable disagreement about the history of science, and given that the impact of Venus research on our understanding of terrestrial climate change is more clear cut. In showing sympathy for Olson's claim, I am not denying the prior existence of the "system" concept's Greek and Latin precursors, the importance of its take-up in the hard sciences during the 19th century, or the importance of the ways in which systems thinking has been inflected by seminal 20th century science, e.g., through the work of Lovelock and Margulis (1974) about the Earth as a system. I am merely affirming the point that the Galilean use does appear to be distinctive and may well have shaped our very idea of a physical system, such as an environment (Warde et al., 2018: 268-9), culminating in the more recent idea of the Earth as a system with guardrails or "planetary boundaries" whose transgression would make it no longer safe for humanity (Rockström et al., 2009b).

More generally, our ways of understanding the Earth and making sense of our emerging environmental predicament, are saturated with imagery, analogies and covertly-present research from the *elsewhere* that is space. These have enabled what Linda Billings (2020) refers to as the social construction of the biosphere, in which the very concept of the biosphere has been shaped by the search for evidence of extraterrestrial life (Billings, 2020). A point that we can appreciate in the terminological shift within Billings' own home discipline of

astrobiology. The discipline emerged in the mid-20th century under the label of "exobiology." The terminological shift to "astrobiology" marks a conceptual change, a move towards viewing life here and elsewhere in more interconnected, rather than *exo* or *outside* terms.

This interconnection between ways of thinking about Earth and about elsewhere is just what we would expect given that conducting planetary science with only a single planet in view would be like trying to understand the concept of a *game* by appeal to solitaire and to nothing else. Knowledge is radically restricted when based upon only a single case. As a result, planetary science is not and cannot be *all about the Earth* if it is to be sufficiently robust and informative *about the Earth*. Looking elsewhere to extend planetary science is not a way of diminishing the ethical primacy of concern for the Earth.

Yet comparisons between Earth and elsewhere may conceal as well as disclose. On the one hand, it makes obvious sense to learn from other nearby planetary environments such as the Martian environment. Yet the choice of environment may itself be inflected by biases on the ground, biases that interact with ground bias (or even constitute a special case of the latter). We can begin to see this when thinking about the extent to which Mars may, at some future point in time, lose its priority as a point of comparison with Earth. There is certainly a good deal that we can learn from Mars, and a strong case for establishing a stable polar base for climate science given the importance of learning from seasonal fluctuations in polar ice and given the evidence for historic climate change on Mars. However, our ways of thinking about Mars may reinforce a tendency to adopt a blinkered view about terrestrial climate change by strengthening a focus upon what happens at the Earth's poles, and especially in the Arctic rather than thinking about other possible ways of measuring change. We may, instead, think of Earth as a water world, a place where just under 71% of the surface is covered in liquid water, in which case our attention will be drawn not to Mars, but to other water worlds across the Solar System as important points of comparison for terrestrial life and climate change. Here, I am also pointing to a trend that already seems to be quite strong, a long-term reorientation in the focus of space exploration. Mars will always be important because of its proximity and viability as a site for establishing an ongoing human presence, but its importance as a model of planetary systems may be overtaken by worlds sitting further out in the Solar System. In which case missions such as NASA's forthcoming Europa Clipper mission may ultimately matter as much as Mars missions, operating as a gateway to vital water world knowledge that may shape our future responses to terrestrial climate change in ways that we cannot now predict, just as nobody was in a position to predict the impact of Venus research during the 1960s.

For now, we understand climate change (and life on Earth) primarily in terms of *where the humans are*. And this encourages a land bias and a downgrading of the majority of the planetary surface. To some extent, this bias still applies when we think about the pre-human past. As a trivial illustration: most of us know the names of more land-based dinosaurs than ocean-based creatures of the Mesozoic. (At least, this applies in my own case. I am not describing a bias that I escape from, but something that is more of a social phenomenon in which most of us are societally caught up.) Yet if we were to encounter the Earth for the first time, through a view from the outside, it is far from clear that we would start with the land rather than with the seas. And even if we were to do so, it might require more justification than anything that is typically offered in the face of an apparent obviousness of our land-first approach.

While sympathetic to the idea that land bias is itself a special case of ground bias, and something that might well be included within the scope of the concept, I will remain officially neutral on this question. Such a move is not a necessary part of setting up the ground bias concept, but falls into the territory of further elaboration. Nonetheless, we may still see these biases as *at least* interrelated even if we do not try to unifying them. Minimally, we can point out that both land bias and ground bias show an anthropocentric concern with *where humans are* at the expense of *where we are not*. A focus that also appears to be at work in a third kind of bias, one sometimes referred to by geologists as "surface bias" (Bebbington and Bury, 2013) and which Olson (2018: 30) does tentatively link to our sense of the separability of the Earth's surface from everywhere else. Surface bias involves thinking about terrestrial processes without adequate consideration of the underlying geology.

Interestingly, a form of surface bias *may* be present in the formulation of the Lovelock-Margulis concept of Gaia as a living surface layer of our planet (Lovelock and Margulis, 1974). This concept does not refer to the whole of the Earth, but only to its living outer layer, and hence to surface more than depth geology, in spite of the many interconnections between these two. Interconnections which we routinely note in the case of other planets but which we sometimes fail to do justice in relation to the Earth. Yet they are there. Depth geology is a continual and pervasive influence even at the level of human behaviors. As a simple example, udon noodles have historically been preferred to rice in Kagawa Prefecture because of a combination of climate and an underlying geology of igneous rock that makes it unsuitable for rice cultivation. Surface systems, and food systems have not historically been radically autonomous from the rest of the planet that they are part of. Whether or not the Gaia concept is actually a case of surface bias is interesting but not altogether clear. A case can be made, perhaps around the idea that surface bias is a driver for Gaia theory rather than an internal feature of it. However, against going even this far, it may be pointed out that the living surface is such a distinctive feature of the Earth (even if it is not a fully autonomous feature) that we can hardly approach matters *here* in the way that we do in those cases where planetary surface elsewhere is positively biocidal. And that would be *every other planetary surface* that we currently know. A

recognition of the multiple levels of entanglement of our ways of thinking about Earth and our ways of thinking about elsewhere is not a license to ignore obvious differences.

Be that as it may, at the very least, there seem to be advantages to thinking about climate change *not primarily* in terms of its effects upon this outer planetary layer, but in the larger context of geology, in the context of a longer duration of time, and in the light of the concept of the Anthropocene. A concept which indicates that the impact of humans is itself significant at a geological level. The direction of influence is not all one-way. However, as with the Gaia idea, an acknowledgement of the importance of seeing the Earth in the light of the data from elsewhere, and in the light of our more geologically-inflected approaches to other planets, is no guarantee that those who recognize one bias will avoid all others. For example, in a recent and excellent popular text on the importance of thinking about climate and time in geological terms, Marcia Bjornerud stresses the importance of looking beyond the surface, even to explain events on the Earth's surface, but at the same time dismisses astrobiology, and does so in ways that play upon familiar skeptical claims about funding priorities (Bjornerud 2018).

So, with official neutrality over whether or not land bias and surface bias are special cases of ground bias, does this leave us only with the idea of ground bias as exaggerated disentangling? Perhaps not. There is at least one move that can be made which will help to fill out the concept in a little more detail. It involves appeal to a certain class of approaches to space which seem to accept Earth-space entanglement, and even to emphasize it, but in a problematic way. Here, I am thinking about cases where space is seen as a mere continuation of what we encounter on Earth. Space exploration then has little significance for an understanding of Earth systems or of life on Earth because what we need to know or what we can know is already available where we are, without any extensive modification in the light of an exploration of elsewhere. Figuratively, we may think of this as treating the sky as another ground. Interconnection is acknowledged at the price of a fuller recognition of differences.

Conclusion: All biases are not equal

The above provisional attempt to extend the provisional gloss on ground bias can itself now be reformulated in the terms given below:

An overall formulation for ground bias: This bias involves one of two ways of misunderstanding the entanglement of Earth and space. The first is an *exaggerated disentangling* such that our understanding of Earth, at a planetary level, is thought of as shaped by what happens *here*, rather than by thinking, in more relational terms, about *here* in the light of *elsewhere*. The second is an acceptance of entanglement that negates the difference of elsewhere by treating the sky as another ground.

The case for extending ground bias to include either or both land bias and surface bias is not made here, but the merits of such an extension are also not denied. And so, we might think of what is set out here as a restricted account which is focused upon doing justice to the value of space exploration (Latour, 2017). A restricted account that also leaves the door open to a more general account.

Either way, we can readily see why ground bias has been a driver for at least certain kinds of space skepticism over the past century: it leads us to imagine that we have less to learn from space than is in fact the case, or that the genuine risks of space (up to and including the risks of a new arena for familiar conflicts) are likely to outweigh the possible advantages of space programs, or at least the most ambitious and expansive space programs. Rather than seeing space programs as a normal extension of our long human entanglement with space, ground bias leads to an underestimation of the advantages of space programs, rather than a more balanced judgement in which both advantages and disadvantages are more fully considered. When various kinds of pessimism about the future of humanity and/or various kinds of political critique are added, judgement becomes skewed and space skepticism is the result.

Is it conceivable that space skepticism might be embraced without any sort of ground bias? This is an interesting possibility, from a philosophical point of view, but interesting in part because it would be atypical. Ground bias may not necessitate space skepticism, but it is ordinarily a component of the latter, at least in the versions of skepticism identified above. Perhaps this would be more easily seen if we did allow an extension of the concept to include land bias and surface bias, at which point the anthropocentric side of space skepticism (its focus on *where the humans are*) might come through more clearly.

As a final cautionary note, and to do justice to the many interesting insights of space skepticism, it is important to acknowledge that "bias" in this context need not be read as "irrationality" and should not be read as "prejudice." All biases are not equal, and anthropocentrism is a normal limitation of familiar ways of thinking, rather than a special failure. Humans are, in obvious ways, subject to various kinds of bias without, on this account, being prejudiced, or otherwise having their rationality compromised. Part of the reason for this is that our norms for rationality, i.e., our ways of distinguishing between what does and does not constitute a good and rational response, are built into and drawn out of human practices rather than practices of any other sort. Acknowledging familiar kinds of human bias is, therefore, the same as acknowledging the limitations of having a human point of view. And all points of view, ours and any other, will have limitations of some sort. Our experience of the world, ways of seeing and ways of worldmaking have evolved under the influence of natural selection. When a particular bias has offered a survival advantage (at whatever level we think of natural selection as operative), it has sometimes become part

of our biological heritage. This point extends to certain kinds of egocentricity as well as some forms of altruism, although the former involves a clear bias in favor of the importance of the self over others. The same point about the evolutionary role of at least some biases can be made in relation to various biases about time. Typically, we worry more about suffering in the near future than we do about suffering in the distant future (Parfit, 1986). Yet it would be odd to think of this as a prejudice rather than a product of evolution.

In philosophical terminology, this distinction between prejudice and mere bias has normative significance. That is to say: it is important in ways that give us reasons for different kinds of action and response. Biases are not, from an ethical or rational point of view, down on all fours with each other. Bias about time is not much the same as bias about perceived racial characteristics or gender. We have far more of an ethical responsibility to resist some biases rather than others. We have more of an ethical responsibility to resist biases that clearly do involve prejudice, and which are obviously not structured into *being human* but are, instead, more open to change. Many biases are both prejudices and the result of history, and often of quite recent history. Racism may have been around for a long time but does not go back beyond the present millennium in any pervasive and modern form. Antisemitism is older, and has morphed into racism, but (trivially) it cannot be older than Judaism. Gender biases vary, and are both older and younger. Older in relation to the historic processes subordinating women, but younger in relation to newer gender identities. We appeal to prejudice, in part, to mark out the differences between those classes of bias which involve some major ethical or rational failing, and other classes of bias which do not compromise either rationality or ethics. Typically, we talk about prejudice when the bias in question concerns some other group of humans. Although, there is a case for extending the concept of prejudice so that it covers at least some ethically problematic attitudes towards animals. For what it is worth, I would support this extension, but an overall grasp of the concept of prejudice does not depend upon it. Nor does the claim that ground bias is not automatically prejudice, even if there are ways for it to feed into prejudices.

Ground bias lacks the visceral moral failures of racism, gender bias and antisemitism. Yet this is *not* because it runs deeper within our humanity. It is not structured into our deep biological history in the way that bias about time seems to be so structured. True, it draws upon anthropocentrism through a preoccupation with *where the humans are*. And a tendency towards anthropocentrism may well be partly constitutive of the human, and not fully eradicable. However, ground bias is not *just* anthropocentrism. It is a more recent development. A historically atypical disentangling of sky and ground, or Earth and space. Its widespread influence dates back no further than the past few centuries, to times when the importance of knowledge about the skies declined, at least for the routine purposes of daily life as part of industrialized rather than agrarian societies.

What this appraisal of the significance of ground bias also points towards is the possibility of overcoming it in a way that exceeds our ability to overcome anthropocentrism, bias about time, or any other bias that runs deep within our humanity. Moreover, while some biases run deep within our humanity because they are advantageous, ground bias offers few obvious advantages to compensate for its many drawbacks. The most obvious of which is a failure to grasp the importance of space for our understanding of terrestrial processes.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material further inquiries can be directed to the corresponding author.

Author contributions

The author confirms being the sole contributor of this work and has approved it for publication.

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