Progress in Human Geography
1–23

DOI: 10.1177/0309132517747727
journals.sagepub.com/home/phg

Geographies of outer space: Progress and new opportunities

Oliver Dunnett
Queen's University Belfast, UK

Andrew S. Maclaren
University of Aberdeen, UK

Julie Klinger
Boston University, USA

K. Maria D. Lane
University of New Mexico, USA

Daniel Sage
Loughborough University, UK

Abstract
Research into outer space has burgeoned in recent years, through the work of scholars in the social sciences, arts and humanities. Geographers have made a series of useful contributions to this emergent work, but scholarship remains fairly limited in comparison to other disciplinary fields. This forum explains the scholarly roots of these new geographies of outer space, considering why and how geographies of outer space could make further important contributions. The forum invites reflections from political, environmental, historical and cultural geographers to show how human geography can present future avenues to continued scholarship into outer space.

Keywords
culture, environment, geography, history, labour, outer space, politics

I Introduction

Human geographers have begun to re-engage with outer space as an object of their research. Much of this work has drawn inspiration from a landmark paper by Denis Cosgrove (1994), which examined the Apollo astronaut photographs of the earth from space, and their significance in the genealogy of the global imagination in western culture. Cosgrove thereby opened up extra-terrestrial perspectives in contemporary studies of geographical representations. A further significant intervention

Corresponding author:
Oliver Dunnett, Department of Geography, School of Natural and Built Environment, Queen's University Belfast, University Road, Belfast BT7 1NN, UK.
Email: O.Dunnett@qub.ac.uk

was Fraser MacDonald's (2007) paper in this journal, which argued that outer space should no longer be seen as remote and detached from the everyday geographies of people's lives, as it has become instrumental to many modern technologies and forms of mobility. Such lines of argument have echoed more recently, with Jason Beery (2016: 68) suggesting that geographers should 'reject . . . anxieties about engaging with outer space', and grasp the opportunities therein.

Indeed, outer space matters, and its engagement through critical voices in the humanities and social sciences has become more important with the increasing presence of outer space technologies in people's everyday lives (Johnson, 2016), the growing diversity of human activity in outer space, with private companies described to be launching 'a new space race' (Grady, 2017), and the imaginative configurations of outer space that continue to shape human understandings of the universe, influenced by unprecedented developments in astrophysical science (NASA, 2017). With geography specifically meaning 'earth writing', some may wonder why there is a need for *geographies* of outer space. Yet outer space and geography have historic connections, from the ages of Classical and Medieval cosmography up until Alexander Von Humboldt's *Cosmos* (1849). We argue that outer space should be of pressing concern within contemporary human geography given the increasing prominence of outer space within culture and politics, and the need to fully contextualize this. Human geographers are well-placed to draw on a breadth of conceptual developments from its range of subdisciplinary perspectives, including an established engagement with concepts of scale (Sheppard and McMaster, 2004), and a postmodern cultural turn that has created the possibility for 'an extra-terrestrial human geography' (Cosgrove, 2008: 47). With the rise of planetary geomorphology in physical geography (Craddock, 2012) and interdisciplinary science (Mackwell et al., 2013), as well as significant new studies on outer space in history, sociology and anthropology (Geppert, 2012; Dickens and Ormrod, 2016; Messeri, 2016), there is a compelling need for human geographers to catch up with this 'turn to space' and the diverse influences outer space has had, and is having, on earth and its inhabitants.

What form, then, might such new geographies of outer space take, and how might we theorize engagements that have already started to emerge? One starting point would be to think through specific geographical terminologies and how they might apply to studies of outer space. The most obvious connection, noted by MacDonald (2007), is the term 'space' itself, a homonym that denotes both the most widely-adopted 'unit of geography' and also the cosmic void between planetary and other cosmic bodies, drawing on notions of absence, vacuity or nothingness. Space, however, is too vague a term for the immensity and diversity of the cosmic realm, and adopting more specific geographical terms such as place, surface, environment, volume, trajectory or landscape could open up the multiplicity of meanings behind these varied and distinct extra-terrestrial spaces. This approach also generates a whole range of outer-space-specific terminologies and nomenclatures as possible objects of study. Thinking through the nuances of the 'spaces of outer space' through terms such as extra-terrestrial or extra-global space, earth-orbital space (involving polar, parabolic or geostationary trajectories), interplanetary space, exo-planetary space, interstellar or celestial space, the cosmos, or even the heavens, invokes a variety of scales and understandings to help unpick and focus in on particular objects of study. What these suggestions offer is a specific lexicon for geographers to take forward in future research to critically interpret these different spaces, thinking beyond the simplistic binary separation of 'outer' space from 'terrestrial' space.

Geographers' limited involvement with outer space has occurred mostly through critical geopolitics, or 'critical astropolitics', interrogating

terrestrial power relations embedded in spaceflight industries (Warf, 2007; Collis, 2009; Beery, 2012), space-promoting organizations (MacDonald, 2007; Dunnett, 2017), and outer space in popular culture (MacDonald, 2008). The significance of national space programmes (Sage, 2014) or outer space cultures (Dunnett, 2012) has also shown the entwined nature of outer space with national identities and military-industrial complexes. Recent developments afford geographers further possibilities for study, with newly-industrialized nations becoming increasingly involved with spaceflight (Pace, 2015) and new private sector engagements with research, development and manufacturing disrupting Cold War-era concepts of nationalism in outer space. With existing studies often focusing on the national and global politics of outer space, there has been a comparative lack of research on the localized political and economic geographies of production embedded in the newly-emergent space industries. In this forum, Daniel Sage looks to address this shortfall by articulating geometries of power and dispossession inherent in the labour geographies of upcoming space projects that operate in contrast to the utopian visions of 'NewSpace' magnates such as Elon Musk.

Cosgrove's landmark paper (1994) helped establish the significance of space imagery in engendering a sense of environmental unity in the earth. Subsequent studies have expanded the concept of 'environment' beyond earthly limits, considering, for example, representations of the planet Mars in the early and late 20th century (Lane, 2011; Dittmer, 2007). Researchers have also examined how earth-orbital imagery, rocketry and planetary visualization have helped to configure a sense of frontier expansionism through narratives of discovery and exploration (Sage, 2014; MacDonald, 2015). Such studies have investigated the connections between humans and the extra-terrestrial environment, but have only made limited progress in comparison to the multitude of ways in which people have understood off-world spaces in various national, regional and local contexts. Thinking through the meaning of earth's place in the cosmos raises broader questions regarding the limits of human influence in the solar system, and the role of humanity in safeguarding environmental futures in the long term. In the forum contributions that follow, Julie Klinger and Maria Lane seek to address these issues by configuring potential new geographies of nature-culture relations in outer space, through both contemporary and historical research, looking at examples such as off-earth mining and the mapping of other planets.

Part of MacDonald's (2007) argument in promoting the study of outer space was to draw attention to the terrestrial geographies that are connected to the technologies and discourses of outer space. Others have shown how certain places on earth, such as the Antarctic continent, mountains and deserts, have been seen as proxies of extra-terrestrial spaces (Collis, 2016; Lane, 2008; Dittmer, 2007). This work makes significant progress in understanding geographies of outer space through earthly analogy. There is, however, further scope for studies that investigate the more accessible and everyday spaces through which people derive meaning from outer space. In the penultimate section of this forum, Oliver Dunnett examines how landscapes of outer space have been articulated through popular representations and experience, seeking also to configure the moral geographies of outer space in popular understandings. Finally, Andrew Maclaren examines the concept of affective nationalism in the contemporary context of NASA space shuttle exhibits in various museum spaces across the United States, thinking through how 'space heritage' has become a major focus in everyday narratives of human engagement with outer space.

This brief overview has pointed out a significant but underdeveloped corpus of work in the new geographies of outer space that has

emerged in the past decade or so. This work has intervened successfully in areas such as critical astropolitics, planetary environmentalism and earth-space analogies, in explaining various human understandings of the cosmos. These interventions, and those that follow in the main sections of this forum, seek to take advantage of geography's unique traditions and perspectives in understanding the spaces of outer space, and what they mean to people on earth in various social, cultural and economic contexts. In an era in which human interactions with outer space are only likely to develop, such perspectives are all the more important.

Oliver Dunnett
Queen's University Belfast, UK
Andrew S. Maclaren
University of Aberdeen, UK

II Labour geographies of the space age: Astro-capitalist organizing and its alternatives

In 2007 NASA's now Deputy Chief Historian, Glen Asner, drew attention to how 'individuals on the lowest rung of the employment ladder' (Asner, 2007: 393) had, despite their work constructing and maintaining launch facilities, producing experimental technologies, and ensuring safety in high-risk conditions, been consistently marginalized in scholarly histories of space exploration. Read against the sub-discipline of labour geography (Castree, 2007; Herod, 1997), this inattention to the daily lives and experiences of space workers, as opposed to senior managers and politicians, cannot be regarded as insignificant. Rather, it reveals and reinforces a recurrent vision that the significance of spaceflight is determined by forces of capital, not labour (cf. Herod, 1997). As such, space exploration can be variously understood as: a catalyst to drive consumer, manufacturing and managerial innovation (Johnson, 2016), a place to extract resources (Capova, 2016), and a way to train globally competitive knowledge workers while creating new 'off world' consumers, such as space tourists (Beery, 2012). We might celebrate this vision like Jeff Bezos, Amazon founder, CEO and space booster, as a 'huge dynamic entrepreneurial explosion in space' (quoted in Davenport, 2016) or lament it as a pernicious 'up scaling' of the over-accumulation crises, and social inequalities, of terrestrial capitalism (Dickens and Ormrod, 2007; MacDonald, 2007). But either way, the future of space exploration, which, for Bezos and other space entrepreneurs, often appears as our *only* future, appears increasingly determined by capital.

While space capitalists like Bezos are undoubtedly gripped by multiple, even conflicting, visions for space exploration, including species survival, colonialism, and libertarian politics, what seems certain is that 'they cannot imagine exchange and social relations outside the framework of capitalism and profit; it is the basis for human sociality in space' (Valentine, 2012: 1061). However, as Valentine (2012) suggests, critically-minded social scientists should avoid simply echoing, and thus naturalizing, this astro-capitalist teleology in their critiques. In what follows I propose that one way of opening up astro-capitalism is to challenge the assumption that space workers function as a passive appendage to the organization of astro-capitals. Far too often the agency of labour in shaping astro-capitalism and other space futures remains invisible, or else, as with Wills' rare study of space labour, is figured as subservient to 'powerful forces . . . [of] . . . capital' (2016: 118). My call here for labour geographies of the space age focusses upon the potential for further examination of how the agency of space labour (Herod, 1997) is relationally afforded a certain autonomy from capital to cope with, rework, even resist, astro-capitalism – spanning actualized and potential, terrestrial and extra-terrestrial, geographies. Such a line of inquiry is vital if we are, as many

critically minded scholars propose (e.g. Dickens and Ormrod, 2007; Valentine, 2012), to understand and resist the foreclosing of the future by astro-capitalists. To be clear, I am not proposing that capital does not shape uneven economic geographies related to space travel but rather that it is not the only, or even sometimes most significant, influence. Drawing reference to workers in and around NASA, I will now sketch out two strands of enquiry into how we might develop such labour geographies.

First, labour geographers have consistently stressed how the agency of labour has reproduced itself at sites of production, helping to enable the production of uneven capitalist economic geographies (Castree, 2007). In contrast, analyses of the relationship between space and uneven terrestrial economic geographies have tended to exclusively focus on its determination by capital: from the use of satellite tracking to optimize the profit margins of multi-national shipping corporations moving raw materials from the Global South to the North, to the availability of satellite communication to support the high-speed trading of global financial centres (MacDonald, 2007).

To gain sight of the agencies of labour in the production of these uneven geographies, we might consider labour at space production facilities, specifically individuals such as Jean Alexander, NASA's last directly-employed spacesuit technician at Kennedy Space Center. Interviewed in 1998 as part of NASA's oral history program, Jean was responsible for pre-launch interactions with the space shuttle crews during launch and return. The checking procedures Jean carried out on helmets, pressure suits and straps were vital to the success of dozens of commercial, military and scientific satellite launches. Strikingly, Jean describes how these crucial, yet painstakingly exacting, procedures were accompanied by light-hearted camaraderie, fun and practical jokes. It is difficult to read Jean's recollections of how she and her colleagues relieved boredom, stress and tension by tricking astronauts, as entirely passive to the flow of capital into outer space or as part of a false consciousness (Jean is highly critical of the increasing use of private subcontractors in NASA during the 1990s). If Jean did not ward off boredom, or anxiety, this might not only lead to a mistake which could endanger a multimillion-dollar satellite owned by a media corporation (and thus her career), but might compromise a workplace that fosters the reproduction of emotionally rewarding self and group identities and agencies. The affective encounters and atmospheres reported by Jean appear as an ingredient in both her own and her colleagues' self-reproduction *and* the reproduction of astro-capitalism. Similar accounts of the affective registers that helped workers cope with monotonous and pressurized work in and around NASA can be found within NASA's growing oral history collection, popular films such as Theodore Melfi's 2016 release, *Hidden Figures*, as well as scholarly accounts (McCurdy, 1993; Faherty, 2002). Labour geographers, and other labour scholars, might build on these brief accounts of space labour in the workplace with primary research that examines how the uneven economic geographies of astro-capitalism are bound up with the circulation of labouring affects, identities and agencies.

Secondly, labour geographers have long been concerned with how groups of workers can formally organize their interests and agendas in the workplace to rework and resist capitalist modes of production (Herod, 1997). While labour agency is certainly not pre-determined to rework and resist capital, the workplace remains an important site for geographers to identify and understand how labour agency can be collectively organized along these lines. To glimpse the significance of such collective organizing we might consider the United Launch Alliance (ULA), which employs over 3400 skilled workers at two sites in Alabama and Texas, in addition to thousands more employees across its global supply chain. ULA's production site in

Decatur, Alabama, alone employs 850 people. ULA is a joint venture formed from the long-established, and rival, space divisions of Lockheed Martin and Boeing, which have since 2006 had a 100 per cent success rate in launching unmanned *Atlas* and *Delta* rockets for NASA, the Department of Defence and commercial customers.

The majority of ULA staff at Decatur and elsewhere are represented by the International Association of Machinists and Aerospace Workers Local Lodge 44. While Lodge 44 has struggled in recent years to mobilize its members to strike to oppose a professed degradation of pay and conditions at ULA (purportedly due to resistance from members at ULA launch sites outside Decatur that are less affected by recent contract changes), it has become increasingly critical of one strand of astro-capitalism. Specifically, Lodge 44 has sought to challenge the rise of SpaceX, a commercial space launch company of 5000 largely non-unionized employees owned and run by PayPal owner Elon Musk.

Since its formation in 2002, SpaceX has sought to compete with ULA on price terms – the cost of a SpaceX Falcon 9 satellite launch is $60 million versus the lowest ULA launch cost of $164 million (Grush, 2016). Musk's utopian vision for SpaceX centres around a drive to 'make space flight accessible to almost anyone' (quoted in CBS News, 2016). However, since 2010, Falcon 9 has experienced two full launch failures. After the Falcon 9 launch failure on 1 September 2016, Lodge 44 argued, via its publicly-accessible Facebook site, that SpaceX had overworked its employees to produce cheaper, yet dangerous, rocket technologies. Lodge 44's list of criticisms against SpaceX included 'several lawsuits filed against them from employees that claim to have had to work off the clock to stay employed, unfair terminations, ignoring the Cal WARN Act [a piece of California legislation protecting workers from mass layoffs], and working their employees 60–80 hours per week without rest or meal breaks' (Lodge 44, 2016). Such concerns are supported by comments made by a current SpaceX engineer explaining how: 'If you believe that a task should take a year then Elon wants it done in a week. . . . Of course reality kicks in and either junk product gets flown or something terrible happens' (Anon, 2016).

The critique of SpaceX articulated by Lodge 44 revolves around a vision of space exploration that is explicitly at odds with the form of astro-capitalism effected by space entrepreneurs such as Bezos and Musk. Lodge 44 argue that the extreme complexities and risks inherent to space exploration can only be translated into opportunities, to whatever end, if the agencies and interests of labour are protected by what reads like a well-balanced, and monopolistic, military-industrial-union complex. Put simply, entrepreneurial work intensification and precarity is not an effective way to realize spaceflight. Intriguingly, this labour-orientated, if technocratically astro-capitalist, vision of spaceflight appears complicated by a recent security demand to ULA by the US government that it replace the Russian built RD180 engines used in its Atlas V rocket with a US design – the agreed supplier of the new engine is Blue Origin, a company owned by Jeff Bezos. Lodge 44 has, thus far, remained quiet on their efforts to assure that Blue Origin and Bezos are aligned with their espoused vision of space travel.

The two examples of labour geographies that I have discussed here provide a necessarily limited illustration of the significance of labour agencies to both enable, rework, and even resist, astro-capitalist ways of organizing space travel. Astro-capitalism remains one of the most potent, and potentially pernicious, conduits in which totalizing futures of uneven economic geographies, including labour geographies, are worked upon, and closed, in advance of their realization. As a minimum, the development of labour geographies of the space age can prevent these teleologies from appearing as

pre-determined by structural forces of capital. More progressively, research can help us understand how outer space, as a societal-level future imaginary, can be harnessed, as with Lodge 44, to rework and resist future work precarity and intensification. In either case, what is distinctive, and salient, about such labour geographies is how they can shed light on the ways in which future agential capacities, not just current abilities, of labour are being shaped far beyond the space industry itself. To this end, it is also important to stress that while my arguments here have developed around a labour geography of singular, formal workplaces and largely class-based interests, labour geographers could also undertake analyses that consider global production networks, as well as sites of informal work, care and consumption, and intersectionalities with class and race, gender, nationality, disability, sexuality and religion (e.g. Sage, 2014; Valentine, 2012). At its core my proposal for the development of labour geographies of the space age stems from a simple recognition that, currently at least, the realization of spaceflight is impossible without a diverse human labour. By developing geographies of the experiences, desires and voices of this labour we can start to understand more precisely the diversity of lives and socialites that are being brought into being, or not, under the promises of the space age.

Daniel Sage
Loughborough University, UK

III Environmental geography and outer space: Pollution and natural resources

The human-environment interactions that lie at the heart of environmental geography are not confined to the spaces within our atmosphere. In the contexts of intensifying climate change impacts and protracted armed conflicts, outer space is being reimagined as an ecosystem in which human activities could be supported beyond earth (Messeri, 2016). With our discourses, property right regimes and material practices, we are transforming outer space into a contested terrain in which peace, violence, enclosure, and accumulation are all possible. This commentary briefly presents some of these key discourses and practices, and makes the case for an environmental geography of outer space.

I Discourses and imaginaries

Although human imaginings of off-earth environs have a long and storied history (e.g. Lane, 2011), key contemporary discourses wield an unprecedented political potency. These typically include one or more of the following elements:

1. Humans (of which there are too many) have polluted the earth beyond repair (e.g. Pelton, 2016);
2. Intensifying resource scarcity is making life unlivable on this planet and is condemning us to perpetual war (e.g. Westing, 2013);
3. The solutions lie in colonizing outer space, because the infinite expanse of the cosmos holds an infinite quantity of resources and possibilities, which are free for exploitation by the brightest and boldest of the human race (e.g. Dolman, 2016).

In the majority of these discourses, near-term earthly apocalypse and/or human extinction is inevitable. This seemingly peculiar blend of eschatology and cornucopianism is not unique to space mavens. It has been a familiar trope in the imperialist adventures driving global environmental change over the past five hundred years (Richards, 2003). The colonial frontiers of the past were conjured in contrast to the crowded and degraded lands of Western Europe, where social inequalities had immiserated millions at the dawn of the industrial revolution. Observing this, urban elites concluded that the world was heading towards a population-induced Malthusian disaster. The salvation of

civilization was to be found in conquering the resource frontiers of the Americas, Africa, and Australasia. Whatever already existed there was fit only for sacrifice to the 'greater good' of colonial civilization. The imaginaries of frontiers and sacrifice zones continue to be key features of globalization processes (Tsing, 2005), and, I would argue, a central feature of our drive to colonize extra-global space.

In our age of intractable global challenges, environmentally-inflected arguments in favour of space exploration possess a compelling logic. To wit: if pollution and resource scarcity are at the heart of so much conflict on earth, why not send our waste to outer space while harvesting the infinite resources of the cosmos (Zabarah, 2015)? In a slightly different vein: if regulation and social issues pose barriers to investment and extraction on earth, why not move extractive industries to entirely unpopulated places beyond our terrestrial home (Lamb, 2010)?

Perhaps it is because these imaginaries rely on familiar colonial logics that these discourses have found sympathetic audiences in elite political, scientific, and financial circles. Some of the many results have been a renewed popular fascination with colonizing Mars, new legislative practices that empower private enterprises intent on exploiting outer space, and the channelling of massive sums of capital to support a nascent global 'NewSpace' industry (Valentine, 2012; Martin, 2014). The contemporary arrangement of power and technology lends fantastic space exploration narratives an unprecedented air of possibility.

2 Governing the 'free gifts' of the cosmos

The physical, legal and logistical realities governing human engagement with outer space should serve to temper these fantastic discourses. The 'free gifts' of the cosmos are in fact governed by robust treaty regimes. Our capacity to exploit the 'infinity' of outer space is mediated by geographical factors such as location and access (MacDonald, 2007). Even in the supposedly consequence-free terrain offered by the immensity of outer space, we must reckon with the environmental outcomes of our actions. How we relate to our environments is defined by a diverse array of practices enacted over time through contingent processes shaped by multiple competing forms of power.

In other words, outer space is in no small part what we make of it. The first 50 years of space exploration proceeded under terms very different from the colonialist extractivism that had defined the preceding centuries and has re-emerged this decade. According to Article 1 of the 1967 Outer Space Treaty (OST), any data gathered in the course of outer space research is legally enshrined as the 'province of all [hu]mankind' (United Nations, 1967). No part of outer space can be claimed as the exclusive domain of any state or entity, and any use of outer space whatsoever must be for peaceful purposes. According to the 1984 Moon Agreement, any resource extraction must be governed by the international community and carried out in a way that takes the interest of all of humanity into account, with special emphasis on the needs and interests of developing countries (United Nations, 1984).

The OST is among the most robust scientific treaty regimes in the contemporary era, with 124 signatories including all space-faring powers. Yet it may prove to be a temporary article. Recent legislative developments in the US and Luxembourg officially recognize the private property rights of their citizenry to outer space resources (114–90, Public Law, 2015; l'Économie, 2016). This legislation is one example of how outer space can be transformed from 'the common heritage of all [hu]mankind' to a privatized frontier for capitalist accumulation by a shifting set of ideas empowered by changing political economies. By opening up outer space to private property rights, states can stake territorial claims through other means. In outer space, as on earth, political economy is a driving

force of land use change, even if we are not referring to 'land' in the terrestrial sense.

3 The physical limits of infinity

In this new, exploitation-driven space race, it is not uncommon to encounter claims that the infinite expanse of the cosmos affords infinite opportunities for both accumulation and pollution. After all, the sheer quantity of mineral resources in outer space is staggering, and it would be physically impossible for human wastefulness to fill outer space in the manner that we have overburdened air, sea, and land on earth. In this way, outer space is framed as the ultimate sacrifice zone. Not only is it thought of as an uninhabited immensity that can be used and polluted as much as humanly possible, the fact that it is infinite is taken to mean that human activities will not have any meaningful consequences (Klinger, 2017).

These discourses are common among NewSpace industries, investors, and advocates, but they demonstrate a rather serious scientific illiteracy. Most basically, the infinity of the cosmos is unavoidably mediated by our place-based engagement with it. Space may be infinite, but we are not. This fundamental fact structures our behaviour. Our bodies and our technologies are always located in specific places, and therefore produce geographies that, however expansive, are nevertheless limited in space and time.

Infinity has a geography, and one aspect of that geography is environmental. An example of this is the orbital debris surrounding earth. Currently, half a million pieces of space junk clutter earth orbits, posing dangers to the international space station, satellites and new space launches (Damjanov, 2015). Traveling at speeds of up to 28,000 km per hour, an item the size of a small screw could seriously damage or disable other space vehicles. This highlights the vulnerability of human beings and technologies in outer space. The debris generated by the first decades of space exploration constrains the already limited number of exit and re-entry routes for new space launches and limits access to orbital pathways for future space-faring powers (NRC, 2011). The state of affairs raises questions of historical responsibility for contamination and remediation of our immediate near-earth environment. Like the oceans and the atmosphere, once thought to be too immense to be affected by human activity, even the infinity of outer space cannot provide an infinite dumping ground.

Whether our engagement with outer space holds promise or peril for our species is not determined by outer space itself. As with earthly environs, the immensity of a given place or the abundance of a given resource does not, by its mere existence, offer salvation or condemnation. What matters is how specific places and resources are valorized, by whom, and towards what ends.

4 An environmental geography of outer space

These circumstances charge an environmental geography of outer space with three primary purposes, which align with the broader objectives of critical geography (Peake and Sheppard, 2014). The first is disciplinary. Environmental geography is concerned with the processes and practices that define human-environment interactions. As such, it is an expansive and diversely-populated 'middle ground' (Castree et al., 2009) in which specialists in physical and human geography take different approaches to common concerns. One need not look far to realize that an environmental geography of outer space must necessarily be both wide-ranging and specific. It not only concerns specific places and environments beyond our atmosphere which we engage either directly or via robotic surrogates, but also our terrestrial practices that inform our engagement with outer space and shape our conceptions of what it is useful for.

The second purpose is empirical. Environmental geographers have been at the forefront

of interrogating the nature-culture paradigm, uncovering how ideas of nature shape our relationship to it in concrete ways. Over the past decades, this has transformed the ways we educate younger generations and formulate programs for change. Policy and physics are equally critical factors governing our engagement with outer space. Also important is the state of science and technology, cultural trends, and capital flows. These myriad factors are concrete, knowable, specific and subject to intervention. At a time when the terms of human engagement with outer space are being transformed by militarist and accumulationist interests, empirical engagement with the spaces of outer space as we imagine and produce them is urgently needed.

This leads to the third purpose, which is ethical. Many environmental geographers are driven by an ethos to uncover how injustices are reproduced through the discourses and practices with which we transform our physical environment. Despite clear physical differences, outer space environments are like earthly environments insofar as there is no place where destruction is ethically unambiguous or pollution is truly consequence-free. This invites both epistemological and ontological inquiries into how environmental geography clarifies our relationship to outer space, and likewise how our multiple relationships to outer space might improve rather than normalize the geographies of environmental injustice we are producing on earth. It is precisely this ethos that makes an environmental geography of outer space both timely and necessary.

Julie Klinger
Boston University, USA

IV Historical geographies of outer space: knowledge, imagination, nature

Although many engagements with outer space have focused on futuristic concerns with space travel, exploration, and the potential for human settlement beyond earth, there are clear avenues for productively engaging with outer space geographies from a historical standpoint. Recent scholarship in historical geography, in fact, takes up numerous themes that could be directly applied to outer space, helping ground current debates and decisions within a longer intellectual history and remedying unfortunate assumptions that outer space is a mere side-note to terrestrial history. This essay traces several relevant trends in recent historical-geographic research to illustrate the dividends that would accrue from their application to outer space geographies.

1 Geographies of knowledge

Historical geographers have now spent two decades exploring past 'geographies of knowledge' (see Offen, 2012, for an outline). Primarily, this line of work involves leveraging insights from colleagues in science and technology studies (STS) to critically examine the ways that people and institutions produce truth, at different times and in different places. It requires excavating social contexts, parsing the components of expertise, and tracing the acts of negotiation, translation, or witnessing that determine whether knowledge claims come to be considered 'true'.

Although the roots of the STS intellectual tradition lie in sociology, geographers have made significant contributions by illuminating the spatial patterns that animate knowledge production and scientific truth claims. Using Livingstone's (2003) concepts of 'site', 'region' and 'circulation', historical geographers have focused productively not only on individual sites of scientific work, but also on the broader regional geographies of scientific institutions and networks, as well as the spatial pathways and networks along which scientific claims travel (Powell, 2007; Finnegan, 2008).

This line of inquiry clearly has much to contribute to outer space geographies, especially in

historical terms. Despite the existence of some excellent works that critically consider historical and modern contexts of outer space knowledge production (Markley, 2005; Vertesi, 2015; Messeri, 2016), very few have yet explicitly considered the *geographies* of outer space knowledge production (Dittmer, 2007; Lane, 2011). Given the sheer scale of the scientific programs undertaken to visit and/or photograph celestial bodies in the last century, however, it stands to reason that historical investigators should critically investigate their geographical dimensions. From the marshalling of extensive financial and human resources, to the coordination of numerous research teams, and to the control and staging of publicity events, the production of outer space knowledge claims is clearly defined by vivid geographies of site, region, and circulation. Historical geographers are leading much of the theoretical development in geographies of science and are thus well placed to deepen current understanding of outer space geographies.

2 Geographic imaginations

Although historical geographers have certainly embraced (and built on) STS methods that prioritize attention to the mechanics and logics of scientific knowledge production, the subdiscipline has also remained steadfastly committed to the core humanistic imperative of tracing meaning. In this work, historical geography intersects with other disciplines such as literary studies, cultural geography, and the history of cartography to explore 'geographic imaginations' and their meanings in different times and places.

In tracing the intersection of historical geographies of meaning with historical geographies of knowledge, we turn inevitably to the role of maps and cartography as imaginative agents. Critical histories of cartography have convincingly shown that map production, circulation, and consumption must be viewed as expressions of power even as they purport to represent reality (Harley, 1988; Cosgrove, 1999). Historical geographers have incorporated these insights in two ways. First, they have engaged in critical analyses of the cultures of cartography and the role of maps in a variety of historical and modern institutions. From nation-building to land management to the control of indigenous landscapes, maps play a powerful discursive role that goes far beyond innocent representation and acts to produce and discipline new realities (e.g. Kirsch, 2002; Roth, 2008). Second, historical geographers have also started to more critically consider the nature of their own mapmaking and the powers it wields in the world. Recent works have wrestled with questions of how to undertake historical cartography in ways that open multiple ways of understanding past landscapes and experiences, rather than presenting them as incontestable or determined by the mapmaker (Crampton, 2009; Pearce, 2012).

Outer space geographies could benefit from these multiple approaches for exploring geographic imaginations. Since well before celestial bodies were considered physically reachable, outer space geographies have been explored through fiction and via visual technologies. More recently, cartography has become a primary form of recording, analysing and presenting knowledge about outer space, in turn influencing fictional engagements with the spaces of outer space. Productive historical geographies of outer space, then, would examine these past episodes of mapmaking and meaning-making, tracing the multiple geographical imaginations at work. The early maps of Mars, for instance, were produced by small communities of expert astronomers and consumed by broad public audiences whose cartographic literacy allowed them to equate claims about Martian landscapes with those emanating from European colonial realms. Fierce public interest and debate in the Mars maps then disrupted some of the astronomical community's

emerging professional norms, creating a complex episode of knowledge production that defies the false conceptual divide between 'scientific' and 'popular' geographies and imaginations (Lane, 2011).

In thus excavating the underlying political and economic geographies that animate human interest in outer space, or even by engaging in alternate cartographies of outer space, historical geographers could help us move past current narratives that prioritize technoscientific studies as 'correct' and fictional engagements as 'imaginative'. Instead, we should investigate the ways that both types of knowledge production are imaginative and are used to make meaning, leveraging these insights to influence current agendas and imaginations.

3 Nature-society geographies

One of the most provocative areas of geographic imagination – in historical geographic scholarship and also in the study of outer space – concerns the relationship between nature and society. Historical geography has long focused on the environment, tracing not only the past states of specific environmental features (as is still the focus of environmental history) but also the past states of human-environment interactions, nature-society paradigms, and environmental knowledge (Naylor, 2006). The most recent historical geography work in this vein takes two related pathways: one concerned with 'environmental imaginations and change under colonialism and imperialism' (Offen, 2012: 532), and another concerned very specifically with 'the meaning of climate and climate change' (Offen, 2014: 476).

Engaging with political ecology, historical geographers have chronicled the ways that colonial and imperial institutions functioned in the past not only to control peoples and environments, but also to thoroughly rewrite the rules for environmental engagement and knowledge-gathering in ways that would themselves reinforce the control of non-European peoples (Davis, 2006). The legacies of colonial/imperial approaches to environment thus linger in ways that are difficult to trace or challenge, given their foundational and underlying status in the modern postcolonial state. With specific regard to climate, deterministic imaginations have been used to justify the entirety of imperial and colonial projects (Livingstone, 2002), and historical geography has recently exploded with a raft of publications that analyse past 'cultures of climate' to trace the many narratives and meanings that have surrounded human-climate interactions (Daniels and Endfield, 2009; Heymann, 2010).

These efforts have direct importance for the emerging subfield of outer space geographies, which merits far greater attention from historical and critical geographers concerned with cultures and narratives of climate and climate change. First, many early imaginations of extra-terrestrial bodies during the 'telescopic era' were concerned with climate, especially in attempts to divine where potential inhabitants of the moon or Mars might fit on a climatically-determined hierarchy of cultures. These early imaginations, replete with assumptions about climatic and environmental determinism, show both that nature-society geographies were important to understandings of outer space *and* that knowledge about outer space participated in the larger intellectual evolution of nature-society thinking. Second, more recent historical imaginations during the 'satellite era' have radically changed human understandings of the nature-society relationship, primarily by shifting perspective to a location beyond earth. As Cosgrove (1994) showed, the first images of earth as seen from space upended beliefs about the nature-society relationship and ushered in the first political movements devoted to changing human impacts at a global scale. Concerns about human impacts on the earth's surface are now regularly reinforced by satellite-based imagery programs that have chronicled the

shrinking of the Aral Sea, for instance, and the Arctic ice cap. Third, current developments in the 'Rover era' reveal that our imaginations of outer space are fundamentally tied to beliefs about planetary climate change. NASA's investigation of terraforming Mars, for example, presented a hopeful view of purposefully-engineered climate change that could make Mars habitable for humans (Fogg, 1995; McKay and Marinova, 2001). Furthermore, recent announcements by SpaceX and Boeing that they are racing to put humans on Mars are based in a related, though more dystopian, view that humans will need an escape hatch in case earth's own climate changes irreversibly to a state that is uninhabitable for humans (Vance, 2015).

The study of outer space geographies is thus sorely in need of historical scholarship that chronicles the specific nature-society geographies that have influenced or governed various episodes of investigation, exploration, and claims-making about realms beyond earth's surface. The elements of this chronicle must focus not only on the geographic imagination evident in maps, cartography, imagery and narrative, but also on the modes, contexts and logics of knowledge production across multiple sites and scales of claims-making. From individual astronomical observatories to international academic conferences to rover mission control rooms to SpaceX press conferences, outer space geographies are produced in multiple forms. This knowledge competes for legitimacy and circulates asymmetrically through myriad networks that feed back into the imagined 'body of knowledge' that itself constrains the next steps in producing knowledge and imagination.

Approaches from historical geography can help illuminate the nature of this intellectual process and its points of intersection with other more explicitly political or economic forces. Historical geographers have been especially effective at illuminating the power relations that underlie our landscapes, institutions, and beliefs about the earth as a human-supporting environment. There is no reason these same insights could not be applied to outer space as well. Is the impulse to expand human settlement to Mars driven by colonial instincts, or is it based in globalization ideals that will further challenge the premise of state-based territorialism? Are the recent recognitions of a climatic Anthropocene and of non-human agency related to ongoing identification of a vast heavens beyond earth? Will access to celestial bodies and landscapes be driven by competition, or will it veer toward cooperation, and to what extent will these extra-terrestrial engagements open new imaginative possibilities for social relations in the terrestrial realm?

Historical-geographic scholarship can provide the analyses and chronicles that will help answer these questions and thus help rescue outer space from mistaken conceptualizations that it is extra-natural or extra-territorial or extra-political space. To the extent that this rescue can be carried out through stories that are oriented for public consumption, historical geographies of outer space have the potential to make immediate impacts on ongoing public discourses and decisions.

K. Maria D. Lane
University of New Mexico, USA

V Cultures of landscape and the moral geographies of outer space

Two concepts in cultural geography can be usefully re-purposed to consider the cultural relevance of outer space in society: cultures of landscape and moral geographies. In forging these concepts, cultural geographers have investigated the ways in which landscape can be understood not just as a 'way of seeing', but also as an embodied experience of natural and cultural environments. Here, researchers have investigated how particular landscapes have been co-constitutive of human cultures, such

as in national park spaces (Matless, 1994) or through night-time outdoor art installations (Morris, 2011). Concurrently, those investigating moral geographies have sought to explain the ways in which certain spaces are assigned moral and ethical characteristics, and how people engage with such spaces through particular behaviours, enacting certain moral codes (Livingstone, 2002). Applying these conceptual engagements to the 'spaces of outer space' will not only help scholars to understand the practical implications of human and robotic space exploration but also help us to comprehend more fully the fundamental relationships between humankind and the cosmos, especially in dealing with contemporary questions of scale, affect and the sublime. Such potential engagements with the cultural geographies of outer space shall be explored briefly here through a number of case studies that deal with a range of representational and practice-based cultures including science fictional paintings, landscape installations and written texts.

1 Landscape and cultures of outer space

When considering outer space, landscape may not come to mind as a primary register of thought, perhaps due to its long association with traditional works of art, in contrast to the hypermodern imagery that has characterized the 'space age'. Furthermore, thinking about outer space commonly connects with notions of emptiness or blankness, the lack of a sense of verticality and the conventional separation between ground and sky that traditionally characterizes landscape. However, there are many ways in which the conventions of landscape have been adapted for representing and experiencing outer space, including through photography and painting, but also in landscape installations and public art.

Indeed, perhaps the most famous of all images of outer space, the Apollo astronaut photographs of the 1960s and 1970s, have played with our understandings of landscape in interesting ways. Looking at the 'earthrise' series, taken from orbit around the moon aboard Apollo 8 in 1968, it is possible to trace the production of these photographs to see the ways in which their orientation and arrangement were deliberately manufactured to align with landscape conventions, thereby familiarizing an otherwise alien place (Cosgrove, 1994). While the 'earthrise' series contains undoubtedly some of the most famous and widely-circulated of the Apollo images, there are many additional Apollo photographs that have largely evaded scholarly interpretation, receiving critical attention only in the eyes of conspiracy theorists. Concurrently, historical accounts of Apollo have largely focused on astronaut narratives, alongside analyses of space policy or space hardware (Launius, 2006). Offering a new opportunity to engage with the Apollo space photographs, the full collection has recently been released in high-resolution to an online Flickr account by space enthusiast Kipp Teague in collaboration with NASA (Project Apollo Archive, 2015). It contains many less-known visions of the moon and earth, such as an 'earth-set' image taken from aboard Apollo 17, or Apollo 12 astronauts cast in shadow on the lunar surface.

Landscape visions of outer space such as the Apollo photographs were in many ways foreshadowed by the science fictional renderings of space artists such as Chesley Bonestell (1888–1986) and RA Smith (1905–1959). Indeed, research by Sage (2014) has demonstrated how Bonestell's paintings of imagined future landscapes of American space exploration were embedded within a particular tradition of frontier landscape imagery connected to understandings of the sublime in western art. Understandings of landscape and the sublime have also been identified in contemporary images of outer space taken by the earth-orbiting Hubble Space Telescope in the 1990s. Such images, while nominally dispensing with

the terrestrial, similarly evoke the sublime in cosmic features such as the Eagle Nebula's 'Pillars of Creation'. Kessler characterizes such images as 'Astronomy's Romantic Landscapes', noting the ways in which Hubble images 'bear a striking resemblance to Earthly geological and meteorological formations' (2012: 5). In such cases, images of outer space, whether from high-tech space photography or imaginative renderings, are valued in relation to sublime spaces on earth, rather than as evidence of scientific objectivity attained through transcending terrestrial limits.

Whereas such examples can help us to understand how to deal with landscape imagery of outer space, other ways of engaging with landscape can be brought to bear on the cultural geographies of outer space. Indeed, geographers have dealt with the embodied experience of landscape through practices such as walking (Wylie, 2005) and nocturnal air travel (Robinson, 2013). Similarly, the crafted landscapes of stately homes and sculpture parks have been examined as physical manifestations of artistic and aesthetic values, inviting lived experience as well as pictorial representation (Daniels, 1982; Warren, 2013). Here, work in the geographies of outer space can engage with particular types of landscape designed to help in the public understanding of the cosmos. Echoing the assumed intentions of Neolithic sites such as Stonehenge in southern England, one example of such a 'landscape of outer space' is Armagh Observatory Astropark in Northern Ireland, a landscape park designed to encourage visitors to reflect on cosmic concepts of scale, distance and the composition of the universe. Here, a combination of sculptural forms and land art have been incorporated into the historic Observatory's grounds, such as the logarithmically-arranged 'Hill of Infinity' and a 'Human Orrery' in which visitors can embody the movement of celestial objects. This type of understanding of landscape can help demonstrate the relevance of cultural geography to making sense of outer space, and the variety of ways in which landscapes of outer space can be interpreted through embodied experience.

2 Moral geographies of outer space

In many ways outer space can be considered as a moral or ethical space, whether this refers to the act of human space exploration, or affective encounters with outer space that people have on earth. This can be seen in 20th-century scientific, literary and philosophical debates about space exploration, as well as in broader questions on the moral claims of scientific progress. One of the few sustained critics of human space exploration in the 20th century was the author and scholar CS Lewis (1898–1963). In a series of interventions in fictional, academic and epistolary texts, Lewis explained how the onset of space exploration could be seen in terms of an immoral extension of modern science to outer space (Dunnett, forthcoming). Lewis criticized this modern conception of empty, blank 'space', with all its imperial connotations, in favour of an earlier, medieval understanding of the cosmos as a realm of harmony and spirituality. In 1954 Lewis had the opportunity to discuss these views with one of the most prominent pro-space advocates of the age, Arthur C Clarke (1917–2008), when they met in an Oxford pub with Lewis's colleague JRR Tolkien and Clarke's associate in the British Interplanetary Society, Arthur 'Val' Cleaver. While the precise contents of these discussions remain unknown, Clarke's later account of the meeting had it ending with Lewis commenting, 'I'm sure you're very wicked people – but how dull it would be if everyone was good' (Clarke, 2003: 34). This characterization of space exploration in terms of good versus wicked thereby distils the debate as an essentially moral conflict. Whereas Clarke held the view that humanity must move into outer space in order to fulfil its destiny as a species (Bjørnvig, 2012), Lewis was of the belief that the vast astronomical distances

separating the planets represented 'God's quarantine regulations' (Lewis, 1943: 73). As such, Lewis can be understood as someone who framed his understanding of outer space in specifically moral terms, drawing on his personal spiritual and ethical convictions.

Whereas Lewis viewed space exploration as a moral transgression, others have sought to claim the inhabitation of outer space as a moral right. Here we can look back to the Russian Cosmism movement of the 1920s, which followed the teachings of Nicolai Fedorov (1829–1903) and Konstantin Tsiolkovsky (1857–1935). Drawing on Christian narratives of the Second Coming as part of his *Philosophy of the Common Task*, Fedorov announced that 'conquest of the path to space is an absolute imperative, imposed on us as a duty in preparation for the Resurrection' (cited in Siddiqi, 2010: 80). Fedorov's Anarchist-Biocosmist followers declared that 'the two basic human rights [are] the right to live forever and the right to unimpeded movement in interplanetary space' (2010: 107). This philosophy of Cosmism was seen as an antidote to Western Enlightenment ideals of empiricism, rationalism and humanism, and found cultural expression in the New Economic Policy era of Revolutionary Russia through the paintings of avant-garde artists such as Konstantin Yuon (1875–1958) and in science fiction films such as *Aelita: Queen of Mars* (1924).

These imagined futures view space exploration in moral terms: as a basic human right variously associated with religious narratives and discourses of trans-humanism. Far from being dismissed as quirky and irrelevant, researchers such as Siddiqi have shown how these cultures of outer space were important pre-cursors to national space programmes, with once-maligned figures such as Tsiolkovsky being rehabilitated and celebrated as the forefathers of the Soviet space programme. Indeed, we might point towards connections between Russian Cosmism and contemporary transhumanism, whose adherents acclaim 'the converging influences of bioethics, science fiction, life extension medicine, artificial intelligence . . . space exploration [and] secular humanism' (Hughes, 2004: xviii). Like Fedorov and the bio-Cosmists of revolutionary Russia, here we can find adherents of a liberal attitude to scientific and technological advances in the space age, who see post-terran futures for humankind in a moral and ethical framework. Such framings of outer space and space exploration are surely pertinent to the anticipation of future human activities in outer space.

The case studies highlighted in this commentary show some of the ways in which outer space might be dealt with from a cultural geography perspective, particularly through the conceptual frameworks of landscape and moral geographies. In treating outer space as a cultural landscape or as a moral and ethical space, we can open up discourses of outer space to new critical attention. This is particularly relevant in an age in which a proliferation of new space ventures look set to explore and exploit outer space in the interests of those who are capable of sponsoring such efforts. As such, it is just as important to think through the ways in which outer space has been conceptualized imaginatively, as well as through direct encounters in human and robotic spaceflight, a vision which Cosgrove (2008: 35) foresaw as a 'cosmography for the twenty-first century . . . as extra-terrestrial space itself takes on a more complex human geography'.

Oliver Dunnett
Queen's University Belfast, UK

VI Nationalism and outer space

'Atlantis Go' . . . 'Good luck to you and your crew on the final flight of this true American icon.' (NASA Mission Crew & Mission Specialist, Cited in Shukman, 2011: Video)

Tim Peake is seen preparing his space suit for his spacewalk, the Union Jack is emblazoned, obvious with the white background, upon the suit's left arm – he is the first British astronaut to travel to and live aboard the International Space Station. His doing so has captured the nation's imagination. (adapted from Briggs, 2016)

The geographies of outer space are inherently linked to terrestrial understandings of nations and nationalism. Recent research, by both social scientists and geographers, has explored the relationship between nationalism and a variety of social practices and materialities (Merriman and Jones, 2017; Militz and Schurr, 2016; Penrose, 2011). My opening vignettes aim to resonate with this interest, through the discourses of nationalism, both visual and textual, included in human spaceflight programmes, and what this means on an embodied level, both individually and collectively. Using the Space Shuttle programme as an example, I look to demonstrate why a geography of outer space matters to the study of nationalism. First, I will consider some of the iconography that surrounds human spaceflight and the discourses they encode. Second, I will consider the importance of the embodied aspect of nationalism (Closs Stephens, 2016; Merriman and Jones, 2017; Militz and Schurr, 2016), particularly in line with contemporary interest in non-representational geographies and affect (Anderson, 2014).

Sage (2014) has argued how outer space itself influenced the cultural imagination of the United States from the mid-20th-century through to the late-2000s. This leads to further considerations around the agency of spaceflight discourses and representations that emerged in the United States, and beyond, of an 'American' spaceflight. Indeed, it can be argued that the discourses encoded in spaceflight iconography are important signifiers of the nation, in line with Brunn's assertion that when 'states emphasise "the visual" . . . they inform and educate their own populations and those beyond about where they are, who they are, and what they are about' (2011: 19). Material cultures of human spaceflight thus present an interesting avenue to investigate the interests of a state reflecting and reifying its own sense of identity.

To turn to an example of this I draw on some research on the iconography of the Space Shuttle mission patches (NASA, 2011). Mission patches were a tradition stemming from the military, from where the first astronauts were recruited. The patches were designed uniquely for each mission, led by the astronauts with input from other NASA officials. The patches were then included in mission-related documents, on the suits of astronauts and in a variety of Space Shuttle related publications. They became commonly recognized symbols of the US space program. The use of flags, stars and eagles in many patches created an undoubtedly 'American' object.

Figure 1 speaks to this visual culture and the relation that material cultures of human spaceflight have within a context of geopolitical positioning, in that the mission patches ask us to reflect on the discourses that surround their production. In asking these questions, we begin to paint a picture of a patch's intertextuality. The patch was created during the Cold War and STS-36's mission objective was classified owing to its operation by the US Department of Defence. The images contained within the patch, most prominently a bald eagle (the national emblem of the USA) and an American flag, taken within the context of a Cold War Department of Defence mission, tell a particular story of what the astronauts wanted to represent their mission. This might be interpreted as the symbolization of the critical role spaceflight was seen to play in waging the Cold War, as well as perpetuating an American manifest destiny into outer space (Sage, 2014). The further circulation of the patch into museums and its consumption as a souvenir then begin to not only reflect an image of American spaceflight but also to reify the discourses encoded within.

Figure 1. STS-36 (1990) Mission Patch (NASA, 2011).

Attending to these visual cultures of outer space is important and in particular the kinds of images that become associated with spaceflight, within particular national contexts. This work can more widely speak to debates around how 'state and non-state agents and institutions reproduce social relations of "stateness"' (Penrose, 2011: 439) towards outer space, which is supposed to be 'stateless' (Collis, 2016). Beginning with the mission patches opens up questions of what is symbolized in the images and why, but also who designed them and how that individual, or group, came to choose them. Geographers have been interested in these questions with other material objects, for example banknotes (Penrose, 2011). Attending to visual cultures of outer space might add new layers and assemblages of discourses, that have become entangled through the messiness of a space program being for one nation, in my example the USA, but at the same time being seen as a benefit of and for humanity as a whole. How discourses are presented in visual culture, in this case mission patches, leads us to consider new questions of nationalism in relation to a space that is not territorialized but is a bounded entity through terrestrial borders. There is much mileage still in considering discourses, and what they are seen to show or relate to, and through this we can attend to the cultures that human spaceflight has created and is creating even now in an increasingly globalized, and arguably visual, world.

Discourses, though, can only tell us so much, presenting a partial perspective from a respondent's or scholar's reading of the object of study. The question that follows on is what do discourses of nationalism do? In response to movements in geography around non-representational theories (Anderson, 2014), the nature of experience and of 'being in the world' has come into question, and its engagement with a plethora of sub-disciplines in geography has been called for, with political geographies and nationalism being of particular relevance here (Merriman and Jones, 2017; Müller, 2015). If a discourse is a written, spoken or visual form of communication, then how that is represented is important. If we then accept, within the turn to relational geographies, that 'a representation may function as a "small cog in an extra-textual practice" (Deleuze, 1972 in Smith, 1998) . . . [then] we must pay attention to how representations function affectively and how affective life is imbued with representations' (Anderson, 2014: 14). This trajectory of thought has begun to take hold within geographic enquiry into nationalism (Closs Stephens, 2016; Merriman and Jones, 2017; Militz and Schurr, 2016).

Kennedy Space Center, Space Shuttle Atlantis Exhibit

The music rises, as the model spacecraft that opened the video swoops out of the screen towards us, with the globe spread out as a backdrop: '33 missions, 26 years, over 126 million miles, Atlantis, welcome home'. The model morphs into the Space Shuttle. The Shuttle comes into focus at an oblique angle as it would be seen

> by an astronaut in orbit above the earth. The music has reached its crescendo, the screen, suddenly no longer there, the actual shuttle is what we were staring at. Whoops and hollers sound out through the crowd, a voice chants 'USA', people gasp, the atmosphere is 'abuzz', ablaze with excitement as the group, steadily, walk toward it . . .
>
> . . . we are standing toward the back of the shuttle now, the exhaust end of the orbiter, the red white and blue American flag is clear on the inside of the open shuttle payload bay, another emblazoned on its left side. Nationalistic pride is clear for all to see, this was the United States' Shuttle. But a little red maple leaf is present on the robotic arm, 'ha [chortles/snorts] look at Canada trying to get in there. It's our shuttle . . . '. (adapted from research notes; see also NASA, 2013)

Anderson and Ash have argued that the 'more everyday, banal, or quotidian atmospheres, [. . .] may in fact be more important to the ongoing maintenance of social life or the performance of power and politics [than intense atmospheres of fear or panic]' (2015: 36). The vignette above presents the idea that 'national forces, feelings and identifications can . . . be approached as emergent and relational' (Merriman and Jones, 2017: 613) through mediated interactions between environments, materialities and individuals. The assemblage of the music, the presentation of the shuttle above the Earth, and its subsequent 'welcome home' to the Florida museum, the centre of American spaceflight, affected individuals to openly and overtly express the nationalistic feeling this assemblage had created within them through patriotic shouts. This can be seen as the culmination of the effect of the Space Race through its production of a Space Shuttle and the subsequent development of its capacity to be recognized as an intrinsically American symbol.

Despite the overt flagging of American nationalism, the international cooperation that developed within spaceflight is also apparent, with the appearance of the Canadian flag. Amidst the affective atmosphere that was created at the start of the exhibit, this was seen as an 'out-of-place' flagging, an intrusion, in a moment within a space that was felt to be solely about American nationalism and American spaceflight.

Since the retirement of the remaining fleet of Space Shuttle orbiters, they have been donated to museums across the USA. The Space Shuttle fleet has thus become a new body within a constructed assemblage of remembering human spaceflight, whilst also bringing together the discourses that surround the broader legacy of the program into its exhibits. Work in nationalism has started to engage with this, with people's experience of spaces and places becoming part of national affective atmospheres (Closs Stephens, 2016) that contribute to a feeling of national identity, to which, it has been argued, outer space has been an integral contributor in America (Sage, 2014).

This heritage of American human spaceflight becomes entwined with national ideals of 'American-ness' and what that means. These spaces of heritage and memorial, such as the Kennedy Space Centre, where the vignette is drawn from, is an example of the kind of work geographers could, and have begun to consider (Sage, 2014), and might speak to debates ongoing in human geography around non-representational geographies and nationalism (Merriman and Jones, 2017). Human interest and activity in outer space has created terrestrial spaces of memory and thus inquiry, particularly in museums, that contribute not only to an affective relation to and of outer space in our everyday lives, but also reflect the relationship between space and nationalism through their display. In order to attend to these non-representational interests, scholars are still debating appropriate methods (Vannini, 2015). Here I have presented building a layered perspective of place in order to get at the textures of those spaces. This could involve ethnography in order to consider a place's materialities, the images associated with the space, the

performances of people and objects within it, rules and regulations (implied and expected) as well as the affects and feelings the researcher encounters and has.

In this section, in relation to contemporary debates and discussions, I have outlined some of the ways nationalism is bound to the geographies of outer space, both through the discourses and representations of the visual cultures of outer space and our interpretations of these, but also of where the terrestrial spaces of outer space might expand our understandings of the affective, embodied and non-representational aspects of nationalism.

Andrew S. Maclaren
University of Aberdeen, UK

Acknowledgements

The editors of this forum would like to acknowledge productive contributions to a thematic session at the RGS-IBG Annual International Conference 2016 on 'Geographies of Outer Space'. We are also grateful to the editorial board of this journal for their support of this endeavour.

Declaration of conflicting interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

References

114–90, Public Law (2015) Spurring Private Aerospace Competitiveness and Entrepreneurship. In: 114th Congress (ed.) *H.R. 2262*. Washington, DC: congress.gov.

Anderson B (2014) *Encountering Affect: Capacities, Apparatuses, Conditions*. Aldershot: Ashgate.

Anderson B and Ash J (2015) Atmospheric methods. In: Vannini P (ed.) *Non-Representational Methodologies: Re-Envisioning Research*. London: Routledge, 34–51.

Anon (2016) What is it like to work with Elon Musk? *Quora*. Available at: https://www.quora.com/Elon-Musk/What-is-it-like-to-work-with-Elon-Musk/answers/5559684? srid=n2Fg&share=1 (accessed 1 December 2017).

Asner G (2007) Space history from the bottom-up. In: Dick SJ and Launius R (eds) *Societal Impact of Spaceflight*. Washington, DC: NASA, 387–406.

Beery J (2012) State, capital and spaceships: A terrestrial geography of space tourism. *Geoforum* 43: 25–34.

Beery J (2016) Terrestrial geographies in and of outer space. In: Dickens P and Ormrod JS (eds) *The Palgrave Handbook of Society, Culture and Outer Space*. Basingstoke: Palgrave Macmillan, 47–70.

Bjørnvig T (2012) Transcendence of gravity: Arthur C. Clarke and the apocalypse of weightlessness. In: Geppert A (ed.) *Imagining Outer Space: European Astroculture in the Twentieth Century*. New York: Palgrave Macmillan, 127–146.

Briggs H (2016) Five things about Tim Peake's spacewalk. Available at: http://www.bbc.co.uk/news/science-environment-35322257 (accessed 1 December 2017).

Brunn DS (2011) Stamps as messengers of political transition. *The Geographical Review* 101(1): 19–36.

Capova K (2016) The new space age in the making: Emergence of exo-mining, exo-burials and exo-marketing. *International Journal of Astrobiology* 15(4): 307–310.

Castree N (2007) Labour geography: A work in progress. *International Journal of Urban and Regional Research* 31(4): 853–862.

Castree N, Demeritt D and Liverman D and Rhoads D (eds) (2009) *A Companion to Environmental Geography*. Chichester: Wiley-Blackwell.

CBS News (2016) Space X entrepreneur's race to space. *CBS News 60 Minutes*. Available at: http://www.cbsnews.com/news/spacex-entrepreneurs-race-to-space/5 (accessed 1 December 2017).

Clarke AC (2003) Preface. In: Miller R (ed.) *From Narnia to a Space Odyssey: The War of Ideas between Arthur C Clarke and CS Lewis*. New York: ibooks, 33–34.

Closs Stephens A (2016) The affective atmospheres of nationalism. *Cultural Geographies* 23(2): 181–198.

Collis C (2009) *The geostationary orbit*: In: Parker M and Bell D (eds) *Space Travel and Culture: From Apollo to Space Tourism*. Oxford: Blackwell, 26–47.

Collis C (2016) *Res communis*?: A critical legal geography of outer space, Antarctica, and the deep seabed. In: Dickens P and Ormrod JS (eds) *Palgrave Handbook of Society, Culture and Outer Space*. Basingstoke: Palgrave Macmillan, 270–291.

Cosgrove D (1994) Contested global visions: One-world, whole-earth, and the Apollo space photographs. *Annals of the Association of American Geographers* 84(2): 270–294.

Cosgrove D (1999) *Mappings*. London: Reaktion Books.

Cosgrove D (2008) *Geography and Vision*. London: IB Tauris.

Craddock RA (2012) Aeolian processes on the terrestrial planets. *Progress in Physical Geography* 36(1): 110–124.

Crampton JW (2009) Cartography: Maps 2.0. *Progress in Human Geography* 33(1): 91–100.

Damjanov K (2015) The matter of media in outer space: Technologies of cosmobiopolitics. *Environment and Planning D: Society and Space* 33(5): 889–906.

Daniels S (1982) Humphrey Repton and the morality of landscape. In: Gold J and Burgess J (eds) *Valued Environments*. London: Allen and Unwin, 124–144.

Daniels S and Endfield GH (2009) Narratives of climate change: Introduction. *Journal of Historical Geography* 35(2): 215–222.

Davenport C (2016) The inside story of how billionaires are racing to take you into space, *Washington Post*. Available at: https://wpo.st/xfue2 (accessed 1 December 2017).

Davis DK (2006) Resurrecting the granary of Rome: Environmental history and French colonial expansion in North Africa. In: Webb JLA (ed.) *Series in Ecology and History*. Athens, OH: Ohio University Press.

Dickens P and Ormrod JS (2007) *Cosmic Society: Towards a Sociology of the Universe*, London: Routledge.

Dickens P and Ormrod JS (2016) Introduction. In: Dickens P and Ormrod JS (eds) *The Palgrave Handbook of Society, Culture and Outer Space*. Basingstoke: Palgrave Macmillan, 15–43.

Dittmer JN (2007) Colonialism and place creation in Mars Pathfinder media coverage. *Geographical Review* 97(1): 112–130.

Dolman EC (2016) *Can Science End War?* Cambridge: Polity Press.

Dunnett O (2012) Patrick Moore, Arthur C. Clarke and 'British outer space' in the mid-twentieth century. *Cultural Geographies* 19(4): 505–522.

Dunnett O (2017) Geopolitical cultures of outer space: The British Interplanetary Society, 1933–1965. *Geopolitics* 22(2): 452–473.

Dunnett O (forthcoming) CS Lewis and the moral threat of space exploration, 1938–1964. In: Geppert A, Seibeneichner T and Brandau D (eds) *Militarizing Outer Space: Astroculture, Dystopia and the Cold War*. Basingstoke: Palgrave Macmillan.

Faherty W (2002) *Florida's Space Coast*. Gainesville: University Press of Florida.

Finnegan D (2008) The spatial turn: Geographical approaches in the history of science. *Journal of the History of Biology* 41: 369–388.

Fogg MJ (1995) *Terraforming: Engineering Planetary Environments*. Warrendale, PA: Society of Automotive Engineers, Inc.

Geppert A (ed.) (2012) *Imagining Outer Space: European Astroculture in the Twentieth Century*. New York: Palgrave Macmillan.

Grady M (2017) Private companies are launching a new space race – here's what to expect. *The Conversation*Available at: https://theconversation.com/private-companies-are-launching-a-new-space-race-heres-what-to-expect-80697 (accessed 1 December 2017).

Grush L (2016) SpaceX and the United Launch Alliance may finally compete to launch a military satellite. *The Verge*. Available at: http://www.theverge.com/2016/8/3/12370592/spacex-ula-air-force-gps-satellite-contract-competition (accessed 1 December 2017).

Harley JB (1988) Maps, knowledge, and power. In: Cosgrove D and Daniels S (eds) *The Iconography of Landscape*. Cambridge: Cambridge University Press, 277–312.

Herod A (1997) From a geography of labour to a labour geography: Labour's spatial fix and the geography of capitalism. *Antipode* 29(1): 1–31

Heymann M (2010) The evolution of climate ideas and knowledge. *Wiley Interdisciplinary Reviews: Climate Change* 1(4): 581–597.

Hughes J (2004) *Citizen Cyborg: Why Democratic Societies Must Respond to the Redesigned Human of the Future*. Cambridge, MA: Westview Press.

Johnson MR (2016) The social impacts of space science. In: Dickens P and Ormrod JS (eds) *The Palgrave Handbook of Society, Culture and Outer Space*. Basingstoke: Palgrave Macmillan, 243–269.

Kessler E (2012) *Picturing the Cosmos – Hubble Space Telescope Images and the Astronomical Sublime*. London: University of Minnesota Press.

Kirsch S (2002) John Wesley Powell and the mapping of the Colorado Plateau, 1869–1879. *Annals of the Association of American Geographers* 92(3): 548–572.

Klinger JM (2017) *Rare Earth Frontiers*. Ithaca, NY: Cornell University Press.

Lamb R (2010) The ethics of planetary exploitation and colonization. *Discovery News*. Available at: http://news.discovery.com/space/astronomy/the-ethics-of-planetary-exploration-and-colonization.htm (accessed 1 December 2017).

Lane KMD (2008) Astronomers at altitude: Mountain geography and the cultivation of scientific legitimacy. In: Cosgrove D and Della Dora V (eds) *High Places: Cultural Geographies of Mountains, Ice and Science*. London: IB Tauris, 126–144.

Lane KMD (2011) *Geographies of Mars: Seeing and Knowing the Red Planet*. Chicago: University of Chicago Press.

Launius RD (2006) Interpreting the moon landings: Project Apollo and the historians. *History and Technology* 22(3): 225–255.

l'Économie Ministère de (2016) Projet de loi sur l'exploration et l'utilisation des resources de l'espace. Government of Luxembourg (eds). Available at: www.luxembourg.public.lu (accessed 1 December 2017).

Lewis CS (1983 [1943]) *Perelandra (Voyage to Venus)*. London: Pan.

Livingstone D (2002) Race, space and moral climatology: Notes toward a genealogy. *Journal of Historical Geography* 28: 159–180.

Livingstone D (2003) *Putting Science in its Place: Geographies of Scientific Knowledge*. Chicago: University of Chicago Press.

Lodge 44 (2016) This is what happens with 'low bid' contracts. *Facebook status update, International Association of Machinists and Aerospace Workers*. Available at: https://www.facebook.com/iamaw44 (accessed 1 December 2017).

MacDonald F (2007) Anti-astropolitik: Outer space and the orbit of geography. *Progress in Human Geography* 31(5): 592–615.

MacDonald F (2008) Space and the atom: Popular geopolitics of Cold War rocketry. *Geopolitics* 13(4): 611–634.

MacDonald F (2015) Instruments of science and war: Frank Malina and the object of rocketry. In: MacDonald F and Withers C (eds) *Geography, Technology and Instruments of Exploration*. Farnham: Ashgate, 219–240.

Mackwell SJ, Simon-Miller AA, Harder JW and Bullock MA (eds) (2013) *Comparative Climatology of Terrestrial Planets*. Tucson: University of Arizona Press.

Markley R (2005) *Dying Planet: Mars in Science and the Imagination*. Durham, NC: Duke University Press.

Martin GL (2014) NewSpace: The emerging commercial space industry. International Space University's 2014 Space Studies Program, McGill University, Montreal, 30 June.

Matless D (1994) Moral geography in Broadland. *Ecumene* 1(2): 127–155.

McCurdy H (1993) *Inside NASA: High Technology and Organizational Change in the U.S. Space Program*. Baltimore: Johns Hopkins University Press.

McKay CP and Marinova MM (2001) The physics, biology and environmental ethics of making Mars habitable. *Astrobiology* 1(1): 89–109.

Merriman P and Jones R (2017) Nations, materialities and affects. *Progress in Human Geography* 41(5): 600–617.

Messeri LR (2016) *Placing Outer Space: An Earthly Ethnography of Other Worlds*. Durham, NC: Duke University Press.

Militz E and Schurr C (2016) Affective nationalism: Banalities of belonging in Azerbaijan. *Political Geography* 54: 54–63.

Morris N (2011) Night walking: Darkness and sensory perception in a night-time landscape installation. *Cultural Geographies* 18(3): 315–342.

Müller M (2015) More-than-representational political geographies. In: Agnew J, Mamadouh V, Secor AJ and Sharp J (eds) *The Wiley-Blackwell Companion to Political Geography*. Chichester: John Wiley & Sons, 409–423.

NASA (2011) Space Shuttle mission patches. Available at: http://history.nasa.gov/shuttle_patches.html (accessed 1 December 2017).

NASA (2013) Space Shuttle Atlantis, Kennedy Space Center Visitor Complex. Available at: https://www.youtube.com/watch? v=UP5s-Buyt60 (accessed 1 December 2017).

NASA (2017) Largest batch of earth-size, habitable zone planets. *NASA Exoplanet Exploration*. Available at: https://exoplanets.nasa.gov/trappist1/ (accessed 1 December 2017).

Naylor S (2006) Historical geography: Natures, landscapes, environments. *Progress in Human Geography* 30(6): 792–802.

NRC (2011) *Limiting Future Collision Risk to Spacecraft: An Assessment of NASA's Meteoroid and Orbital Debris Programs*. Washington, DC: National Academies Press.

Offen K (2012) Historical geography I: Vital traditions. *Progress in Human Geography* 36(4): 527–540.

Offen K (2014) Historical geography III: Climate matters. *Progress in Human Geography* 38(3): 476–489.

Pace S (2015) Security in space. *Space Policy* 33: 51–55.

Peake L and Sheppard E (2014) The emergence of radical/critical geography within North America. *ACME: An International Journal for Critical Geographies* 13(2): 305–327.

Pearce MW (2012) Introduction to special issue: Digital historical geography: Representation, archive and access. *Historical Geography* 40: 33–37.

Pelton JN (2016) *The New Gold Rush: The Riches of Space Beckon*! *Cham*, Switzerland: Springer International Publishing.

Penrose J (2011) Designing the nation: Banknotes, banal nationalism and alternative conceptions of the state. *Political Geography* 30: 429–440.

Powell RC (2007) Geographies of science: Histories, localities, practices, futures. *Progress in Human Geography* 31(3): 309–329.

Project Apollo Archive (2015) Available at: https://www.flickr.com/photos/projectapolloarchive/ (accessed 1 December 2017).

Richards JF (2003) *The Unending Frontier: An Environmental History of the Early Modern World*. Oakland: University of California Press.

Robinson J (2013) Darkened surfaces: Camouflage and the nocturnal observation of Britain 1941–45. *Environment and Planning A* 45: 1053–1069.

Roth RJ (2008) 'Fixing' the forest: The spatiality of conservation conflict in Thailand. *Annals of the Association of American Geographers* 98(2): 373–391.

Sage D (2014) *How Outer Space Made America: Geography, Organization and the Cosmic Sublime*. London: Ashgate.

Sheppard E and McMaster RB (eds) (2004) *Scale and Geographic Enquiry: Nature, Society and Method*. Oxford: Blackwell.

Shukman D (2011) Space Shuttle Atlantis makes historic last launch. Available at: http://www.bbc.co.uk/news/science-environment-14087642 (accessed 1 December 2017).

Siddiqi A (2010) *The Red Rockets' Glare: Spaceflight and the Soviet Imagination, 1857–1957*. Cambridge: Cambridge University Press.

Tsing AL (2005) *Friction: An Ethnography of Global Connection*. Princeton: Princeton University Press.

United Nations (1967) *Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies*.

United Nations (1984) *Agreement Governing the Activities of States on the Moon and Other Celestial Bodies*.

Valentine D (2012) Exit strategy: Profit, cosmology, and the future of humans in space. *Anthropological Quarterly* 85(4): 1045–1067.

Vance A (2015) *Elon Musk: Tesla, SpaceX, and the Quest for a Fantastic Future*. New York: Harper Collins.

Vannini P (ed.) (2015) *Non-Representational Methodologies: Re-Envisioning Research*. New York: Routledge.

Vertesi J (2015) *Seeing Like a Rover: How Robots, Teams, and Images Craft Knowledge of Mars*. Chicago: University of Chicago Press.

Von Humboldt A (1849) *Cosmos: A Sketch of the Physical Description of the Universe*. London: Henry G Bohn.

Warf B (2007) Geopolitics of the satellite industry. *Tijdschrift voor Economische en Sociale Geografie* 98(3): 385–397

Warren S (2013) Audiencing James Turrell's Skyspace: Encounters between art and audience at Yorkshire Sculpture Park. *Cultural Geographies* 20(1): 83–102.

Westing AH (2013) *From Environmental Security to Comprehensive Security*. New York: Springer.

Wills J (2016) Satellite surveillance and outer-space capitalism: The case of MacDonald, Dettwiler and Associates. In: Dickens P and Ormrod JS (eds) *The Palgrave Handbook of Society, Culture and Outer Space*. Basingstoke: Palgrave Macmillan, 94–122.

Wylie J (2005) A single day's walking: narrating self and landscape on the South West Coast Path. *Transactions of the Institute of British Geographers* 30: 234 – 247.

Zabarah R (2015) Neil deGrasse Tyson on asteroid mining, best sci-fi movies, and more. *Popular Mechanics*. Available at: http://www.popularmechanics.com/culture/movies/a15177/watch-neil-degrasse-tyson-space-scifi/ (accessed 1 December 2017)