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Climate change on a fluid earth: The movement of matter in the spaces of global politics

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Abstract

The dominant understandings of space that inform International Relations (IR) theories struggle to account for the material dynamism of the natural environment. From neo-realism through to constructivism and post-structuralist IR perspectives, the natural environment is relegated to the background of analysis as the seemingly stable backdrop against which humans do global politics. Supporting this relegation is an associated tendency among IR theorists to view nature abstractly, rather than materially, in alignment with the cartographic imagination. Meanwhile, realist scholars adhering to the tenets of classical geopolitics foreground the natural environment as a factor in global politics yet view it as ontologically static and materially deterministic in its effects. In an era of unprecedented spatial flux amid human-induced climate change, this article seeks to contribute to ongoing efforts in IR and political geography to develop alternative spatial frameworks that can account for the natural environment's material dynamism and instability. To do so, the article adopts a post-humanist framework that centres matter's ontological fluidity and mobility. By affording primacy to matter-in-motion, it is argued, a richer understanding of space as performatively produced through relational processes can be developed, where attention is attuned not only to what matter 'does', but also how it moves.

Keywords: climate change; materiality; motion; post-humanism; space

Introduction

The materiality of the natural environment – the soil, sand, clay, rock, air, water, ice, and so on that global politics occurs in relation with – is ontologically mobile and fluid. In the current era of anthropogenic climate change, this dynamism is becoming increasingly unstable, with formerly familiar and reliable earthly cycles and movements shifting into new patterns and temporalities. Climate change draws attention to what was there all along, but not fully understood or considered within Western-Eurocentric social and political theories. Not only does the earth *move*, but that movement is capable of shifting into something markedly different, with dramatic social and political effects.[1] As philosopher Thomas Nail writes, 'the earth is suddenly proving to be more mobile and eccentric than we thought possible'.[2]

Much thinking and writing is currently taking place in International Relations (IR) in response to climate change and the popular notion of the Anthropocene. Many IR scholars believe that the

[1]Nigel Clark, 'Volatile worlds, vulnerable bodies: Confronting abrupt climate change', *Theory, Culture & Society*, 27:2–3 (2010), pp. 31–53.

[2]Thomas Nail, *Theory of the Earth* (Redwood City, CA: Stanford University Press, 2021), p. 7.

discipline in its hegemonic form is not up to the task of addressing climate change so long as the Euro-descended liberal modernist imaginary remains an influential foundation.[3] There is a sense that acknowledging the realities of the Anthropocene demands a shift in how global politics can and should be studied, with notions of human exceptionalism and a concomitant separation of nature from politics within IR theories among the key assumptions problematised.[4] To overcome these assumptions, some suggest moving beyond notions of global or international politics to that of planet or earth politics.[5] Methodologically, complexity theory, assemblage theory, and other ecological, materialist, and post-humanist perspectives are adopted as more appropriate lenses through which to understand the complex, dynamic, and non-linear nature of life on earth.[6]

Space has not been immune to this commentary. Scholarship oriented towards climate change and the Anthropocene is clear in its critique of a dominant tendency within IR to view the natural environment as a stable backdrop for human action.[7] Operating in tandem with this trend is an associated tendency to think about nature abstractly, rather than materially.[8] From neo-realism through to constructivism and even many post-structuralist IR perspectives, the natural environment is treated as if it were synonymous with its cartographic representation as a blank and inert surface. Some realist scholars offer an exception to this rule by foregrounding geography in their work, but this is a geography that is ontologically static and constrained by the conceptual limitations of material determinism.[9] All told, the predominant approaches to studying global politics struggle to offer an account of the natural environment's material dynamism.

The separation of nature from politics that underlies IR's static spatial imaginary is in alignment with a particular view of space that has defined modernity and its systems of colonial/neocolonial violence and wealth accumulation. This is Cartesian space, where nature exists in strictly abstract terms, disembodied from its material basis through the mathematical conceptualisation of space in a grid and coordinate system.[10] In a world made up of Cartesian space, nature is composed to be a smooth stage for human action. Writing on the humanist project that unfolded in England from the 16th century, Adrian Franklin describes this transition and its intended effects: 'Hills, forests and streams that were once alive and active … were thus turned into inert, neutral, dead matter fit only as an exploitable resource base for humans, the only creative entity.'[11]

This article aims to contribute to ongoing efforts in IR and political geography to pull away from the Cartesian worldview and the static spatial imaginaries it supports by developing alternative

[3]Anthony Burke, Stefanie Fishel, Audra Mitchell, Simon Dalby, and Daniel Levine, 'Planet politics: A manifesto from the end of IR', *Millennium: Journal of International Studies*, 44:3 (2016), pp. 499–523.

[4]Delf Rothe, Franziska Müller and David Chandler, 'Introduction: International Relations in the Anthropocene', in David Chandler, Franziska Müller, and Delf Rothe (eds), *International Relations in the Anthropocene* (Cham: Palgrave Macmillan, 2021), pp. 1–16 (p. 9).

[5]Burke et al., 'Planet politics'; Delf Rothe, 'Governing the end times? Planet politics and the secular eschatology of the Anthropocene', *Millennium: Journal of International Studies*, 48:2 (2020), pp. 143–64; Joana Castro Pereira, 'Towards a politics for the earth: Rethinking IR in the Anthropocene', in David Chandler, Franziska Müller, and Delf Rothe (eds), *International Relations in the Anthropocene* (Cham: Palgrave Macmillan, 2021), pp. 21–37.

[6]For an overview of some of these approaches, see Erika Cudworth and Stephen Hobden, 'Post-human security', in Anthony Burke and Rita Parker (eds), *Global Insecurity: Futures of Global Chaos and Governance* (London: Palgrave Macmillan, 2017), pp. 65–81.

[7]Emilian Kavalski and Magdalena Zolkos, 'The recognition of nature in International Relations', in Patrick Hayden and Kate Schick (eds), *Recognition and Global Politics: Critical Encounters between State and World* (Manchester: Manchester University Press, 2016), pp. 139–56 (p. 144); Judith Nora Hardt, 'Encounters between security and Earth System Science: Planetary Boundaries and Hothouse Earth', in David Chandler, Franziska Müller, and Delf Rothe (eds), *International Relations in the Anthropocene* (Cham: Palgrave Macmillan, 2021), pp. 39–57 (p. 40).

[8]Olaf Corry, 'Nature and the international: Towards a materialist understanding of societal multiplicity', *Globalizations*, 17:3 (2020), pp. 419–35.

[9]John Mearsheimer's thinking on the 'stopping power of water' is a notable contemporary example. See John Mearsheimer, *The Tragedy of Great Power Politics* (New York: W. W. Norton & Company, 2001).

[10]Mihnea Tănăsescu, *Ecocene Politics* (Cambridge: Open Book Publishers, 2022), pp. 23–5.

[11]Adrian Franklin (ed.), *The Routledge International Handbook of More-Than-Human Studies* (London: Routledge, 2023), p. 6.

frameworks that are better able to contend with anthropogenic climate change and the material realities of spatial flux. To do so, this article focuses its attention on matter's ontological fluidity and mobility. I argue that affording primacy to matter-in-motion provides a richer understanding of space as performatively produced through relational processes, where attention is attuned not only to what matter 'does' but also how it *moves*.

In turning to materiality and an understanding of worlds as constituted by events or processes rather than things, this article is situated within IR and political geography literature on post-humanist performativity. This perspective sees matter as a generative and dynamic variable in social and political life, where political possibilities and outcomes emerge from situated relations between diverse material (human and non-human) processes. Where this article departs from and seeks to contribute to existing literature is in drawing out motion as a source of matter's influence and effect, and how these insights pertain to understanding space in IR. While notions of relations and relationality are receiving growing attention within the discipline[12] (and spatial theorising by and large)[13] amid a broader effort to rethink taken-for-granted Euro-descended metaphysical assumptions, this is less the case for motion – an equally vital component of a post-humanist perspective. Ocean waves cannot be explained without reference to the entanglement of wind and water, but neither can they be explained without reference to the circular motion that is produced by energy passing through the water. Everything is in motion, and those movements shape how worlds are constituted.

I build off this first argument on the value of affording primacy to matter-in-motion in spatial theorising to contend, secondly, that a spatial framework premised on motion is apt for understanding climate change and addressing some of its most significant political-ethical implications: from the unequal effects of climate change across place to the inevitable incongruencies between an international political system premised on a spatial fixity and the realities of spatial impermanence. By looking at climate change, first, through the lens of space and, second, through the lens of motion, this article conceptualises climate change as performatively produced through heterogeneous relational processes across a multiplicity of spatial and temporal scales, which contribute to both a high degree of planetary interconnectedness and a high degree of local disparity.[14] In advancing this approach, the article seeks to offer a framing for future IR research that encourages more critical engagement with climate change, particularly when placed into conversation with postcolonial/decolonial/anticolonial accounts of apocalypse,[15] extinction,[16] mobility,[17] and climate change.[18]

[12]See, for example, Daniel Nexon and Patrick Jackson, 'Relations before states: Substance, process and the study of world politics', *European Journal of International Relations*, 5:3 (1999), pp. 291–332; Milja Kurki, *International Relations in a Relational Universe* (Oxford: Oxford University Press, 2020); Ronnie Lipschutz, 'Beyond International Relations and toward International Relationality?', *International Relations*, 38:3 (2024), pp. 427–34; and the special issue on Pluriversal Relationality published in the *Review of International Studies* in 2022.

[13]Doreen Massey, *For Space* (London: Sage, 2005); Orit Gazit, 'A Simmelian approach to space in world politics', *International Theory*, 10:2 (2018), pp. 219–52; Stuart Elden, *Terror and Territory: The Spatial Extent of Sovereignty* (Minneapolis: University of Minnesota Press, 2009).

[14]Suvi Alt, 'Environmental apocalypse and space: The lost dimension of the end of the world', *Environmental Politics*, 32:5 (2023), pp. 903–22 (p. 907).

[15]Kyle Whyte, 'Our ancestors' dystopia now: Indigenous conservation and the Anthropocene', in Ursula Heise, Jon Christensen, and Michelle Niemann (eds), *The Routledge Companion to the Environmental Humanities* (London: Routledge, 2017), pp. 206–15; Audra Mitchell and Aadita Chaudhury, 'Worlding beyond "the" "end" of "the world": White apocalyptic visions and BIPOC futurisms', *International Relations*, 34:3 (2020), pp. 309–32.

[16]Audra Mitchell, *Revenant Ecologies: Defying the Violence of Extinction and Conservation* (Minneapolis: University of Minnesota Press, 2023).

[17]Samid Suliman, Carol Farbotko, Hedda Ransan-Cooper, et al., 'Indigenous (im)mobilities in the Anthropocene', *Mobilities*, 14:3 (2019), pp. 298–318; Kyle Whyte, Jared Talley, and Julia Gibson, 'Indigenous mobility traditions, colonialism, and the Anthropocene', *Mobilities*, 14:3 (2019), pp. 319–35 (pp. 328–31).

[18]Bawaka Country, Sarah Wright, Sandie Suchet-Pearson, et al., 'Gathering of the clouds: Attending to Indigenous understandings of time and climate through songspirals', *Geoforum*, 108 (2020), pp. 295–304.

The article will unfold in four parts. The first will outline a tendency in the study of global politics to approach space abstractly, rather than materially. This will involve an overview of the treatment of space within both IR theories and the geopolitics tradition to illustrate a gradual shift over time towards abstraction of the natural environment. The second will move to look at more-than-human spatial approaches, primarily in geography, which shift the debate beyond both abstraction and material determinism. The third will develop an understanding of space as matter-in-motion to outline in the fourth how this framework helps to elucidate the material non-uniformity and instability of the state system, and the implications of this perspective for contending with the significant climate-change-induced geopolitical transformations on the horizon.

The abstraction of space in International Relations theories: Classical to critical geopolitics

Known as classical geopolitics, the study of the role of space in global politics began with an understanding of space as synonymous with the natural environment. Within this tradition, geography, including factors like climate, endowment of natural resources, topography, and location, is considered to be *the* determinant of global politics. With limited possibilities to alter a given geographic environment, policymakers must accept their state's or region's geography as an objective fact and account for it accordingly within their foreign policies.[19] This perspective, in which permanent geographic features are considered the driving force of global politics, informed and gave rise to ideas such as Friedrich Ratzel's *Lebensraum* and Halford J. Mackinder's Heartland theory.[20]

A materially deterministic approach to the study of geopolitics fell out of favour in the post–World War II era, partly because of its association with concepts mobilised by the Nazi regime such as *Lebensraum*, and partly because of its adoption into the social sciences by classical realists like Nicholas Spykman and Hans Morgenthau.[21] Upon entering the social sciences in the 1940s, the role of geography in foreign policy shifted from being understood as the 'existential *pre*-condition for all politics', to use Mark Bassin's words,[22] to one variable among several others, with '*human* nature' heightened as a more central tenet in the workings of global politics.[23] So while the natural environment remained analytically foregrounded, it lost much of its explanatory power, and its relationship with foreign policy became more ambiguous and contingent.

Still, the understanding of space that informs the politics of classical realists remains both material and static. Spykman wrote, for instance: 'Ministers come and go, even dictators die, but mountain ranges stand unperturbed … The nature of the territorial base has influenced [policy makers] in the past and will continue to do so in the future.'[24] Similarly, for Morgenthau: 'The most stable factor upon which the power of a nation depends is obviously geography. For instance, the fact that the continental territory of the United States is separated from other continents by bodies of water … is a permanent factor that determines the position of the United States in the world.'[25] The central point, here, is that while a classical geopolitics approach to the study of global politics

[19] Olaf Corry, 'The "nature" of International Relations: From geopolitics to the Anthropocene', in Clara Eroukhmanoff and Matt Harker (eds), *Reflections on the Posthuman in International Relations: The Anthropocene, Security and Ecology* (Bristol: E-International Relations Publishing, 2017), pp. 102–18 (p. 104); Jakub Grygiel, *Great Powers and Geopolitical Change* (Baltimore: Johns Hopkins University Press, 2006), pp. 4–5.

[20] Corry, 'The "nature" of International Relations', pp. 103–4.

[21] Grygiel, *Great Powers and Geopolitical Change*, pp. 7–8; Mark Usher, 'Territory incognita', *Progress in Human Geography*, 44:6 (2020), pp. 1019–46 (p. 1023).

[22] Alexander Murphy, Mark Bassin, David Newman, Paul Reuber, and John Agnew, 'Is there a politics to geopolitics?', *Progress in Human Geography*, 28:5 (2004), pp. 619–40 (p. 621), emphasis in original.

[23] Corry, 'The "nature" of International Relations', p. 104, emphasis in original.

[24] Nicholas Spykman, 'Geography and foreign policy, II', *American Political Science Review*, 32:2 (1938), pp. 213–36, cited in Phil Kelly, 'A critique of critical geopolitics', *Geopolitics*, 11:1 (2006), pp. 24–53 (p. 42).

[25] Hans Morgenthau, *Politics among Nations: The Struggle for Power and Peace*, 3rd ed. (New York: Alfred A. Knopf, 1961 [1948]), pp. 110–11.

encourages an understanding of space as material, this materiality is static. Oceans, mountains, and other elements of the natural environment are considered to matter in foreign policy, but they are taken to be atemporal and immobile.

The emergence of neo-realism in the 1970s saw to the abstraction of the study of global politics. A good theory, for Kenneth Waltz, is an abstract one.[26] Where neo-realism gives attention to material capabilities, these refer to a state's economic, military, and technological capabilities, with little emphasis on incidents of geography like location and topography. This is because technological advancements are understood to be capable of overcoming the effects of geography, so that geographic differences between states and regions are no longer a significant determinant in foreign policy decisions.[27] Through its emphasis on technology, neo-realism effectively relegates the natural environment to the background of analysis as invariable.[28] The movement towards an abstract understanding of space can, in this sense, be read as a simultaneous movement towards the study of global politics in increasingly anthropocentric terms: materiality matters, but only those aspects of materiality that are a product of human creation and a tool of human command. As Emilian Kavalski and Magdalena Zolkos outline, 'the mainstream ontological purview of IR has been underpinned by the perception that human/sociopolitical systems (such as civil society, states, international organizations, etc.) are simultaneously *detached from* (not only conceptually, but in practice) and *in control* of the "nonhuman" natural/biophysical systems within which they are embedded'.[29] Consequently, the problematic dichotomies between subject/object and society/nature that inform material determinism remain, yet now with an added anthropocentric leaning in which the natural environment is rendered not only static, but also largely irrelevant.

A lack of attention to the role of the natural environment in the study of global politics did not necessarily begin with neo-realism. Early scholars of liberalism in the 1920s who were equally invested in the Enlightenment ideals of human rationality and progress had little to say about the natural environment, for instance.[30] But Waltz's simplified and abstracted approach to the study of global politics played an influential role in stimulating contemporary IR theorising, with the neo-realism–neoliberalism debate often serving as the baseline upon which later constructivist and critical perspectives build. Notably, despite later critiques being characterised by their departure from the central tenets and assumptions of neo-realism, Waltz's abstraction of space is perhaps one of the few legacies of neo-realism that endures. Neoliberalism, constructivism, and even most post-structuralist IR perspectives all approach the study of global politics through a predominantly anthropocentric lens, in which the natural environment is assumed to serve as little more than the seemingly inert backdrop against which humans act. While this is perhaps not surprising given the perspectives' increasing inclination towards the importance of ideational over material factors, it is also indicative of the human exceptionalism that unites most Euro-descended approaches within the discipline prior to the turn of the century.[31]

While materiality does play a role in post-structuralist perspectives on space in global politics, the approach to materiality differs from that followed in this article and post-humanism more broadly. Cynthia Weber, for example, builds off the work of Judith Butler to offer an illustration of the sovereign state as performatively enacted through discursive practices.[32] Elsewhere, Roxanne Doty engages with Foucault's and Agamben's writings on biopower and bare life to explore how the physical attributes of the United States' deserts provide the US government with a 'moral alibi' when

[26] Kenneth Waltz, *Theory of International Politics* (Long Grove, IL: Waveland Press, 2010 [1979]), p. 68.
[27] Grygiel, *Great Powers and Geopolitical Change*, p. 12.
[28] Corry, 'The "nature" of International Relations', p. 106.
[29] Kavalski and Zolkos, 'The recognition of nature in International Relations', p. 144, emphasis in original.
[30] Ibid.
[31] For insight into earlier IR work that went against this grain but was nonetheless marginal, see a brief overview in Kavalski and Zolkos, 'The recognition of nature in International Relations', pp. 143–4.
[32] Cynthia Weber, 'Performative states', *Millennium: Journal of International Studies*, 27:1 (1998), pp. 77–95.

migrants attempting to cross the United States undetected die of 'natural causes'.[33] Post-structuralist enquiry in this vein, particularly that of Butler, seeks to overcome a nature/culture divide and the idea of a 'natural' or pre-discursive nature by pointing to the ways in which matter – especially that of the body – is produced through the repetition of particular cultural and linguistic practices. However, as feminist post-humanist scholars like Karen Barad and Vicki Kirby argue, this approach reinscribes a different iteration of the nature/culture binary by privileging the role of the human (culture/language) in constituting the world above a passive nature.[34] For instance, even where Doty acknowledges the 'inherent power' of the desert's physicality, that power is significant only as an object of sovereign power, while the environment's characteristics like extreme cold or heat remain largely static and essentialised facets.[35] Consequently, as Barad contends, this approach sets up materiality to be the effect or product of discursive practices, rather than itself involved in and entangled with those practices in an agentic manner.[36]

The field of geopolitics followed a similar shift towards abstraction with the emergence of critical geopolitics in the late 1980s. Critical geopolitics rejects the classical understanding of geography as static and ontologically separate from the social realm. It attempts to problematise 'the "is" of geography and "geopolitics", their status as self evident, natural foundational, and eminently knowable realities'.[37] In other words, critical geopolitics attempts to problematise the assumption in classical geopolitics that the natural environment can be objectively known and represented. Instead, it contends that the material reality of space becomes meaningful through the discursive geopolitical practices of political elites.[38]

Within this approach, the natural environment is largely evacuated of its materiality and 'reduced to nationalistic cartographies and identities'.[39] Consequently, alike to the critique of post-structuralist approaches outlined above, the understanding of space that underwrites critical geopolitics adheres to an alternative casting of the nature/culture dichotomies that it seeks to overcome in its anthropocentric focus on the power of (human) interpretation and representation, and concomitant silence on matter's role in the production of geopolitical spaces.[40] As with many IR theories since the advent of neo-realism, then, space is understood to be an analytical category that is detached from the natural environment, yet which nonetheless takes the natural environment for granted as its material reference point. As Mark Usher describes, 'the resulting impression is of a nation-state floating "in the air" above its territory, with the latter either rendered abstract or vanquished altogether as a material reality'.[41]

It must be noted, as Jason Dittmer highlights, that critical geopolitics does not completely overlook matter and is gradually turning towards a closer engagement with materiality.[42] Vicki Squire makes a similar contention that critical geopolitics is gradually moving away from an

[33]Roxanne Doty, 'Bare life: Border-crossing deaths and spaces of moral alibi', *Environment and Planning D: Society and Space*, 29:4 (2011), pp. 599–612.

[34]Karen Barad, *Meeting the Universe Halfway: Quantum Physics and the Entanglement of Matter and Meaning* (Durham, NC: Duke University Press, 2007); Vicki Kirby, 'Initial conditions', *Differences: A Journal of Feminist Cultural Studies*, 23:3 (2012), pp. 197–205.

[35]Doty, 'Bare life', pp. 607–8.

[36]Barad, *Meeting the Universe Halfway*, p. 225.

[37]Gearóid Ó Tuathail, *Critical Geopolitics: The Politics of Writing Global Space* (Minneapolis: University of Minnesota Press, 1996), p. 68.

[38]Simon Dalby, 'American security discourse: The persistence of geopolitics', *Political Geography Quarterly*, 9:2 (1990), pp. 171–88.

[39]Vicki Squire, 'Reshaping critical geopolitics? The materialist challenge', *Review of International Studies*, 41:1 (2015), pp. 139–59 (p. 143).

[40]Jeppe Strandsbjerg, 'Cartopolitics, geopolitics and boundaries in the Arctic', *Geopolitics*, 17:4 (2012), pp. 818–42; Squire, 'Reshaping critical geopolitics?'.

[41]Usher, 'Territory incognita', p. 1032.

[42]Jason Dittmer, 'Geopolitical assemblages and complexity', *Progress in Human Geography*, 38:3 (2014), pp. 385–401 (p. 386).

almost-exclusive focus on textual and cultural representational practices to engage with questions of matter.[43] For instance, Simon Dalby began from the early 2000s to recognise the need to engage with the natural environment in an era of human-induced climate change and increasing environmental insecurity.[44] Other geographers turn their attention to the everyday practices that reproduce territorial ideologies and national identities, as well as the material objects like books, maps, and newspapers that facilitate the circulation of discourses.[45] So too feminist geopolitics disrupts questions of scale to illustrate how the 'high' politics of security is experienced and reproduced at multiple scales, including that of the body and the home.[46] For Squire, this shift is indicative of critical geopolitics' suitability to engage with the materialist turn in social theory, despite a continued wariness among critical scholars of the dangers of material determinism.[47]

Still, Squire's work sets off from the premise that while materiality was not new to critical geopolitics, the specific theoretical insights of the materialist or post-humanist turn were yet to be fully brought into critical geopolitics: namely, how materiality – and, where this article is concerned, earthly materialities in particular – can be considered agentic or influential, where humans do not just impact an external environment but are in turn subject to and constituted by the material constraints, conditions, and dynamics of a lively earth. It isn't until 2018 that references to 'materialist geopolitics' as a distinct approach begin to emerge – appearing twice in the journal *Geopolitics* to date; the first by Dalby himself,[48] and again in 2020 within an editorial overview of the journal's history, the latter also co-written by Dalby.[49] This article is therefore situated against a gradual uptake in attention to the materiality of the natural environment in critical geopolitics and builds off the efforts of scholars such as Dittmer, Squire, and Dalby in encouraging this transition. To further outline what this transition entails, the next section turns to the theoretical field of post-humanism and some existing approaches to more-than-human spatial theorising.

Post-humanism and the material dynamism of space

A renewed engagement with materiality in IR first emerged in the early 2000s with works by the likes of William Walters[50] and Claudia Aradau.[51] The core ideas and concepts of this approach to materiality are based off a diverse set of scholarship in science and technology studies,[52] gender

[43] Squire, 'Reshaping critical geopolitics?', pp. 146–7.

[44] See, for example, Simon Dalby, *Environmental Security* (Minneapolis: University of Minnesota Press, 2002); Simon Dalby, *Security and Environmental Change* (Cambridge: Polity Press, 2009); Simon Dalby, 'The geopolitics of climate change', *Political Geography*, 37 (2013), pp. 38–47; Simon Dalby, 'Climate change, Gaia and the Anthropocene', in Robert Kloosterman, Virginie Mamadouh, and Pieter Terhorst (eds), *Handbook on the Geographies of Globalization* (Cheltenham: Edward Elgar Publishing, 2018), pp. 307–17.

[45] Anssi Paasi, 'Bounded spaces in a "borderless world": Border studies, power and the anatomy of territory', *Journal of Power*, 2:2 (2009), pp. 213–34; Anders Linde-Laursen, 'Small differences – large issues: The making and remaking of a national border', *The South Atlantic Quarterly*, 94:4 (1995), pp. 1123–44.

[46] Jennifer Hyndman, 'Beyond either/or: A feminist analysis of September 11th', *ACME: An International E-Journal for Critical Geographies*, 2:1 (2003), pp. 1–13; Sara Koopman, 'Alter-geopolitics: Other securities are happening', *Geoforum*, 42:3 (2011), pp. 274–84; Katherine Brickell, 'Geopolitics of home', *Geography Compass*, 6:10 (2012), pp. 575–88.

[47] Squire, 'Reshaping critical geopolitics?', p. 140.

[48] Simon Dalby, 'Firepower: Geopolitical cultures in the Anthropocene', *Geopolitics*, 23:3 (2018), pp. 718–42.

[49] John Agnew, Simon Dalby, Colin Flint, et al., 'Geopolitics at 25: An editorial journey through the journal's history', *Geopolitics*, 25:5 (2020), pp. 1199–227.

[50] William Walters, 'The power of inscription: Beyond social construction and deconstruction in European Integration Studies', *Millennium: Journal of International Studies*, 31:1 (2002), pp. 83–108.

[51] Claudia Aradau, 'Security that matters: Critical infrastructure and objects of protection', *Security Dialogue*, 41:5 (2010), pp. 491–514.

[52] Michel Callon, 'Some elements of a sociology of translation: Domestication of the scallops and fishermen of St. Brieuc Bay,' in John Law (ed.), *Power, Action and Belief: A New Sociology of Knowledge?* (London: Routledge, 1986), pp. 196–223; John Law and John Hassard, *Actor Network Theory and After* (Oxford: Wiley-Blackwell, 1999); Bruno Latour, *Reassembling the Social: An Introduction to Actor-Network-Theory* (Oxford: Oxford University Press, 2005).

studies,[53] and philosophy.[54] Reflecting this theoretical diversity, there is no unified way in which scholars approach an engagement with matter. William Connolly names, for instance, 'the new materialism, immanent naturalism, posthumanism, antihumanism, speculative realism, complexity theory, object-oriented metaphysics, a philosophy of becoming' as examples of the various approaches adopted to study materiality.[55]

Despite this diversity, what broadly unites this field is an attempt to bring nuance to the study of matter in the social sciences against a historical backdrop of work that either leans towards material determinism or too far away from it.[56] Instead, post-humanism seeks to demonstrate the entanglement of material and social worlds without lending causal superiority to one or the other.[57] The two worlds are deconstructed, reassembled, and exposed to be inherently and analytically inseparable. To do so, objects and other non-human entities, understood as agential and co-constitutive of the social world, are analytically foregrounded to demonstrate their role in the enactment of social and political practices.[58] At its core, this effort is characterised by adoption of a process ontology; a rejection of dualisms, particularly those between mind/body, ideas/matter, subject/object, human/non-human, and society/nature; and a wariness of excessive anthropocentrism.[59]

Karen Barad's agential realism and notion of 'intra-action' offer a valuable entry point to post-humanist rethinkings of space as performatively produced through relational processes. Intra-action, a concept that Barad develops from the philosophical views of quantum physicist Niels Bohr, refers to the idea that entities and identities do not exist prior to their relations. There are

[53]Karen Barad, 'Posthumanist performativity: Toward an understanding of how matter comes to matter', *Signs: Journal of Women in Culture and Society*, 28:3 (2003), pp. 801–31; Donna Haraway, *When Species Meet* (Minneapolis: University of Minnesota Press, 2008).

[54]Gilles Deleuze and Felix Guattari, *A Thousand Plateaus: Capitalism and Schizophrenia*, trans. Brian Massumi (Minneapolis: University of Minnesota Press, 1987 [1980]); Alfred North Whitehead, *Process and Reality* (New York: The Free Press, 1978 [1929]).

[55]William Connolly, 'The "new materialism" and the fragility of things', *Millennium: Journal of International Studies*, 41:3 (2013), pp. 399–412 (p. 399).

[56]It must be noted that the materialist turn, or new materialism as it is commonly referred to, is responding to a gap in specifically Western-Eurocentric social and political theories. Many Indigenous and non-Western perspectives are informed by dialectical or relational approaches to the world that do not uphold binary divisions like humans/non-humans or nature/society. There is, in this sense, nothing 'new' about approaching materiality in this manner; it is only new for the dominant Western-Eurocentric tradition that often fails to engage with and actively silences alternative perspectives (Kim TallBear, 'Beyond the life/not-life binary: A feminist-Indigenous reading of cryopreservation, interspecies thinking, and the new materialisms', in Joanna Radin and Emma Kowal (eds), *Cryopolitics: Frozen Life in a Melting World* (Cambridge, MA: The MIT Press, 2017), pp. 179–202 (p. 198)). This article therefore chooses not to adopt the term new materialism and predominantly uses the term post-humanism, which, notwithstanding its own shortcomings (Nicholas Gane, 'When we have never been human, what is to be done? Interview with Donna Haraway', *Theory, Culture & Society*, 23:7–8 (2006), pp. 135–58 [p. 140]), offers a somewhat more accurate description of the turn away from a specifically Western-Eurocentric focus on humanism. For further discussion on this issue with reference to new materialism, see Jerry Lee Rosiek, Jimmy Snyder, and Scott Pratt, 'The new materialisms and Indigenous theories of non-human agency: Making the case for respectful anti-colonial engagement', *Qualitative Inquiry*, 26:3–4 (2020), pp. 331–46; Juanita Sundberg, 'Decolonizing posthumanist geographies', *Cultural Geographies*, 21:1 (2014), pp. 33–47; Zoe Todd, 'An Indigenous feminist's take on the ontological turn: "Ontology" is just another word for colonialism', *Journal of Historical Sociology*, 29:1 (2016), pp. 4–22; Ruth Panelli, 'More-than-human social geographies: Posthuman and other possibilities', *Progress in Human Geography*, 34:1 (2010), pp. 79–87; and Audra Mitchell, 'Nonhuman, more-than-human, and post-human International Relations and International Studies', *Oxford Research Encyclopedia of International Studies*, available at: {https://oxfordre.com/internationalstudies/display/10.1093/acrefore/9780190846626.001.0001/acrefore-9780190846626-e-754}. On the silencing of non-Western relational approaches more broadly, see Morgan Brigg, Mary Graham, and Martin Weber, 'Relational Indigenous systems: Aboriginal Australian political ordering and reconfiguring IR', *Review of International Studies*, 48:5 (2022), pp. 891–909; Cristina Inoue, 'Worlding the study of global environmental politics in the Anthropocene: Indigenous voices from the Amazon', *Global Environmental Politics*, 18:4 (2018), pp. 25–42; and L. H. M. Ling, *The Dao of World Politics: Towards a Post-Westphalian, Worldist International Relations* (London: Routledge, 2014).

[57]Latour, *Reassembling the Social.*

[58]Aradau, 'Security that matters', p. 496.

[59]Connolly, 'The "new materialism" and the fragility of things'; Diana Coole, 'Agentic capacities and capacious historical materialism: Thinking with new materialisms in the political sciences', *Millennium: Journal of International Studies*, 41:3 (2013), pp. 451–69; Cudworth and Hobden, 'Post-human security'.

no discrete entities that enter relations with each other (*inter*-act), rather entities or objects emerge through their relations.[60] While this idea is nothing new for relational understandings of the world, what scholars like Barad add to the conversation – at least from a Western-Eurocentric standpoint – is the contention that matter is a part of these relational becomings. In particular, Barad turns attention to the co-constitutive nature of matter and ideas, and it is within these more-than-human processes of meaning-making that space is produced. That is, when epistemic boundaries are configured through material-discursive practices, these 'are not abstract delineations but specific material demarcations not *in* space but *of* space'.[61] Put differently, if reality is constituted by specific intra-active practices or enactments, space cannot be isolated from those processes of relational becoming: the world *is* 'spacetimemattering'.[62] By centring relational processes, Barad's post-humanist framework – and applications of it in geopolitics[63] – encourage a shift away from conceptualising space as a 'thing' to space as (multiple) more-than-human 'doings'.[64]

Within geography, a relational materialist understanding of space is also present in the work of Doreen Massey. Massey views space as the product of relations, as heterogeneous and plural, and as always in-process. 'Precisely because space on this reading is a product of relations-between, relations which are necessarily embedded material practices which have to be carried out, it is always in the process of being made', she writes.[65] While Massey's earlier writings on space/place tended towards anthropocentrism, which she herself acknowledges, her later work moved to seeing places as events involving the continuous coming-together of heterogeneous more-than-human relations, where the natural environment is itself always in-process and becoming.[66] A place (a town, a city) is 'a bundle of trajectories', as are the spaces/places crossed on the journey to arrive there: 'That tree which blows now in the wind out there … was once an acorn on another tree, will one day hence be gone.'[67]

One of the questions posed towards relational understandings of space is how they can account for order and boundedness amid flux and openness. Bawaka Collective, a research collective writing as and with Bawaka Country in north-east Arnhem Land, Australia, note that 'criticisms have been levelled at accounts which are set away from structuralism only to view space as absolutely fluid, open or conceptual – that is, moving from one abstraction to another'.[68] How do patterns, continuities, and stability in the production of space coexist with contingency, change, and instability? Put another way: 'If there are no fixed points then where is here?'[69] And more importantly from a post-humanist perspective, how can order be accounted for without reverting to anthropocentric regimes where landscape is treated as the passive canvas for human inscription? Indigenous approaches to space, which emphasise the importance of place in intra-active co-becomings, offer novel insights here. For Bawaka Collective, relational and emergent space is

[60] Barad, 'Posthumanist performativity', p. 815.

[61] Barad, *Meeting the Universe Halfway*, p. 181.

[62] Ibid., p. 179.

[63] See, for example, Squire, 'Reshaping critical geopolitics?'.

[64] While adopting a different post-humanist framework, Jeppe Strandsbjerg engages with actor–network theory to offer a similar contention that geopolitical space is produced through situated cartographic practices that cannot be disentangled from the physicality of the environment in which they take place. Likewise, Gaston Gordillo explores the 'pre-discursive, affective dimensions of combat', where bodies are differently affected by the physicality of a landscape, and spaces/places are in turn variously constituted. See: Strandsbjerg, 'Cartopolitics, geopolitics and boundaries in the Arctic'; Gaston Gordillo, 'Terrain as insurgent weapon: An affective geometry of warfare in the mountains of Afghanistan', *Political Geography*, 64 (2018), pp. 53–62 (p. 55).

[65] Massey, *For Space*, p. 32.

[66] Doreen Massey, 'Landscape as a provocation: Reflections on moving mountains', *Journal of Material Culture*, 11:1/2 (2006), pp. 33–48.

[67] Massey, *For Space*, pp. 243–4.

[68] Bawaka Country, Sarah Wright, Sandie Suchet-Pearson, et al., 'Co-becoming Bawaka: Towards a relational understanding of place/space', *Progress in Human Geography*, 40:4 (2016), pp. 455–75 (p. 459).

[69] Massey, *For Space*, p. 280.

simultaneously place-based and bounded.[70] By exploring the Yolŋu concept *gurrutu*, a relational kinship system, they illustrate the structured and patterned flows of relationality that emerge in-place. Of *gurrutu*, they write: 'There is an infinitely recursive pattern that links places/spaces with other places/spaces, people with other people, and humans and more-than-humans in relationships of co-becoming.'[71] In a similar vein, Morgan Brigg et al. describe how sociopolitical order in Aboriginal Australia arises from place-based co-becoming, with Country (sentient landscape) functioning as the source of law and foundation for order.[72] Space remains open and connected across place, while identity, being, and belonging are situated and place-based. The second does not preclude the first but, quite the opposite, provides the conditions of possibility for the first through the ordering framework that the land provides.[73,74]

In turning to matter-in-motion, this article offers an alternative way of thinking about space/place as fluid and open, with no clear distinctions between global and local, while simultaneously patterned, bounded, and relatively stable. It is not the case that motion is overlooked in other post-humanist approaches to conceptualising space. Massey, for example, discusses how 'the returns', such as those of people or migratory birds, lend continuity to place amid ever-processual change,[75] while quantum physics too is premised on the idea that all matter is in perpetual motion.[76] But there remains much more that can be said to advance understandings of *how* matter moves, and in particular how earthly materialities like air, water, ice, and rock move. What are the patterns and temporalities through which the natural environment moves, how do they differ from each other, and how do they intra-act?

This article understands space to be the product of intra-actions between matter-in-motion. It does not, therefore, deny the importance of relationality. Rather, it aims to bring to the fore what may not always be obvious to scholars attempting to unlearn the assumptions of the Euro-descended tradition: that relations are always composed of matter-in-(perpetual)-motion, and that matter is therefore not just its different 'modes of doing',[77] but also its different modes of moving.[78] And my contention is that understanding these movements is an integral part of understanding climate change and its politics. Climate change is what it does – sea-level rise, hurricanes, drought, floods – but it is, also, ongoing processes of matter rising and falling, speeding up and slowing down, contracting and expanding, receding and advancing, and so on. The world moves, and climate change is continuously and differently produced across place through the heterogeneous associations of those movements, both human and non-human.[79] While relationality makes clear the inescapable entanglement of humans and nature and the planetary connections that draw distant places into relation with each other, a turn to motion elucidates other crucial recognitions – the complexity of local difference and the transitional nature of life on a dynamic planet not least among them.

[70] Bawaka Country et al., 'Co-becoming Bawaka'.

[71] Ibid., p. 461.

[72] Brigg, Graham, and Weber, 'Relational Indigenous systems'.

[73] Morgan Brigg, 'The spatial-relational challenge: Emplacing the spatial turn in peace and conflict studies', *Cooperation and Conflict*, 55:4 (2020), pp. 535–53 (p. 542).

[74] The description of Aboriginal Australian philosophy that I have provided here is non-authoritative and simplistic. For richer insight, see C. F. Black, *The Land Is the Source of the Law: A Dialogic Encounter with Indigenous Jurisprudence* (London: Routledge, 2011); Mary Graham, 'Some thoughts on the philosophical underpinnings of Aboriginal worldviews', *Australian Humanities Review*, 45 (2008), pp. 181–94; and Tyson Yunkaporta, *Sand Talk: How Indigenous Thinking Can Save the World* (London: The Text Publishing Company, 2019).

[75] Massey, *For Space*, p. 281.

[76] Thomas Nail, *Matter and Motion: A Brief History of Kinetic Materialism* (Edinburgh: Edinburgh University Press, 2024), pp. 59–63.

[77] Sebastian Abrahamsson, Filippo Bertoni, and Annemarie Mol, 'Living with Omega-3: New materialism and enduring concerns', *Environment and Planning D: Society and Space*, 33:1 (2015), pp. 4–19.

[78] Christopher Gamble, Joshua Hanan, and Thomas Nail, 'What is new materialism?', *Angelaki*, 24:6 (2019), pp. 111–34.

[79] Bawaka Country et al., 'Co-becoming Bawaka', p. 469.

In attempting to think about matter's heterogeneous movements, this article goes some ways towards addressing criticism levelled at post-humanist work that approaches non-human agency by alluding to the 'eventfulness' or 'liveliness' of all things, rather than the differences that might characterise diverse materialities.[80] 'Is more to be gained from a closer attention to the *specificity* of the matter at hand, as opposed to a generic analogy of "life" that could be described as metaphysics?', ask Bruce Braun and Sarah Whatmore.[81] Put differently, rather than espousing a flat ontology where materiality is essentially or uniformly agentic, this article is situated among what Gamble et al. term 'performative new materialism', where agency can only be understood through the specific and situated intra-actions in which it emerges.[82] In this sense, it has similarities with Indigenous worldviews that emphasise the importance of place in understandings of agency and subjectivity, but it also significantly diverges from them in adopting a minimised view of agency, where landscape is not understood to be a sentient being that acts, thinks, intends, or desires but rather is understood to carry power in its capacity to produce effects.[83]

This article also differs from those that engage with the notion of strata or verticality to illustrate how material fluidity can sit alongside form. Writing on the philosophy of Gilles Deleuze and Felix Guattari, Nigel Clark explains: 'All kinds of free-flowing matter-energy … have tendencies to settle into bands with a certain self-consistency. It is this organizational layering that enables composite things to come into being – things that are novel precisely because they have emerged out of the traversal and combining of different strata'.[84] Building from this geophilosophy, Clark develops a 'politics of strata' that elucidates how human engagements with what lies below the earth's surface have long co-constituted social and political life, even before growing awareness of anthropogenic climate change. Arun Saldanha likewise builds off Deleuze and Guattari's work to illustrate how the 'anthroposphere' – human life – emerged as differential foldings of matter from adjacent vegetal, animal, and geophysical strata, where the Anthropocene then becomes an articulation of (certain) humans' inability to recognise how their climate-change-inducing actions reverberate through and threaten the substrata on which they themselves depend.[85] Elsewhere, and in a different vein, Stuart Elden's work on terrain demonstrates how state efforts to partition and control space extend beyond the surface of the state to create three-dimensional and vertically stratified territories stretching from the air to the sub-surface.[86] While highly sympathetic to the agendas pursued by these authors (bringing the abiotic into literature that has focused significantly on the biotic, attending to humans' ontological dependency on the non-human,[87] and broadening geopolitics beyond the cartographic surface of the state, respectively), the aesthetics of strata and layering that these authors develop lends itself towards an understanding of the world that is characterised by vertical hierarchies and the linear temporalities of geological time.[88] This contrasts with the

[80]Thomas Lemke, 'An alternative model of politics? Prospects and problems of Jane Bennett's *Vital Materialism*', *Theory, Culture & Society*, 35:6 (2018), pp. 31–54 (p. 40).

[81]Bruce Braun and Sarah Whatmore (eds), *Political Matter: Technoscience, Democracy, and Public Life* (Minneapolis: University of Minnesota Press, 2010), pp. ix–xl (pp. xxix–xxx), emphasis in original.

[82]Gamble, Hanan, and Nail, 'What is new materialism?'.

[83]Vanessa Watts, 'Indigenous place-thought & agency amongst humans and non-humans (First Woman and Sky Woman go on a European world tour!)', *Decolonization: Indigeneity, Education & Society*, 2:1 (2013), pp. 20–34; Gordillo, 'Terrain as insurgent weapon', p. 55.

[84]Nigel Clark, 'Politics of strata', *Theory, Culture & Society*, 34:2–3 (2017), pp. 211–31 (p. 213), referring to Deleuze and Guattari, *A Thousand Plateaus*, pp. 40–9, 335–7.

[85]Arun Saldanha, 'Mechanosphere: Man, earth, capital', in Jon Roffe and Hannah Stark (eds), *Deleuze and the Non/Human* (Basingstoke: Palgrave Macmillan, 2015), pp. 197–216 (p. 208).

[86]Stuart Elden, 'Secure the volume: Vertical geopolitics and the depth of power', *Political Geography*, 34 (2013), pp. 35–51; Stuart Elden, 'Terrain, politics, history', *Dialogues in Human Geography*, 11:2 (2021), pp. 170–89.

[87]Nigel Clark, *Inhuman Nature: Sociable Life on a Dynamic Planet* (London: Sage Publications, 2011); Elizabeth Grosz, Kathryn Yusoff, and Nigel Clark, 'An interview with Elizabeth Grosz: Geopower, inhumanism and the biopolitical', *Theory, Culture & Society*, 34:2–3 (2017), pp. 129–46.

[88]Philip Steinberg and Kimberley Peters, 'Wet ontologies, fluid spaces: Giving depth to volume through oceanic thinking', *Environment and Planning D: Society and Space*, 33:2 (2015), pp. 247–64 (p. 255).

more entangled, non-hierarchical, non-linear, and spiralling or circular ordering of spacetime that I outline in the remainder of the article as an arguably more apt articulation of earthly and climatic dynamics.

Rethinking space through movement

As the earth increasingly intrudes on Euro-descended social theorising,[89] attention to the dynamic materialities of the earth among geographers and IR scholars is likewise growing.[90] For Clark, this intrusion 'requires something more than extending the conventional concerns of geopolitical discourse and practice upwards into the atmosphere or downwards into the depths of the ocean or Earth'.[91] That is: 'It requires us to bring politics into an intensive engagement with the planet's own dynamics: its processes of sedimentation and mobilization, its layering and folding, its periodicities and singularities.'[92] Perhaps more than any other issue, anthropogenic climate change demands the sort of 'intensive engagement with the planet's own dynamics' that Clark describes, not only to come to terms with the riskiness of (certain) humans' continued climate-change-inducing actions, but also to better understand the complex material intra-actions through which climate change is produced.

Rather than starting from a particular materiality that is exemplary in its dynamism, like sand or the ocean, or a particular empirical example that illustrates the timefulness[93] of space, this article starts from the premise that all matter is fluid and flows. Solid and fluid are not opposites, in this view, but exist on a continuum. What appear to be relatively solid parts of the earth – rocks or mountains, for instance – are a particular type of fluid: one where the cycling of material flows is so repetitive or slow as to make an object appear inert, at least from the perspective of humans. 'All matter is fluid, insofar as its contortion give rise to distinct forms, but it is also viscous, insofar as these forms last long enough to be recognizable', write Tim Ingold and Cristián Simonetti, who explore the notion of 'solid fluids' and the conditions of living in a 'solid-fluid world'.[94]

In the Euro-descended tradition, an understanding of matter as fluid and perpetually in motion exists as an alternative to more mainstream understandings in classical physics of solid bodies at rest and Newtonian laws of motion.[95] It is a line of thought that dates back to Minoan civilisation and can be traced through thinkers like Lucretius, Henri Bergson, Michel Serres, Gilles Deleuze, Karl Marx, and Virginia Woolf, and in the field of quantum mechanics more generally.[96] The crucial point of difference within this line of thought is that matter should not be understood as some*thing* that moves, but rather as movement itself: 'solids, liquids and gases are not static objects but metastable processes'.[97] This point of difference shifts the origin of movement from a force that is external or transcendent to matter, to something that is immanent to matter itself.

[89]Isabelle Stengers, *In Catastrophic Times: Resisting the Coming Barbarism*, trans. Andrew Goffey (Lüneburg: Open Humanities Press/meson press, 2015).

[90]See, for example, Steinberg and Peters, 'Wet ontologies, fluid spaces'; Clark, *Inhuman Natures*; Lindsay Bremner, 'Sedimentary logics and the Rohingya refugee camps in Bangladesh', *Political Geography*, 77 (2020), pp. 1–12; Marjin Nieuwenhuis, 'A grain of sand against a world of territory: Experiences of sand and sandscapes in China', in Kimberley Peters, Philip Steinberg, and Elaine Stratford (eds), *Territory beyond Terra* (London: Rowman & Littlefield, 2018), pp. 19–33; Harriet Hawkins, '"A volcanic incident": Towards a geopolitical aesthetics of the subterranean', *Geopolitics*, 25:1 (2020), pp. 214–39; Peter Nyers, 'Moving borders: The politics of dirt', *Radical Philosophy*, 174 (2012), pp. 2–6.

[91]Nigel Clark, 'Geo-politics and the disaster of the Anthropocene', *The Sociological Review*, 62:S1 (2014), pp. 19–37 (p. 31).

[92]Ibid.

[93]Marcia Bjornerud, *Timefulness: How Thinking Like a Geologist Can Help Save the World* (Princeton, NJ: Princeton University Press, 2018).

[94]Tim Ingold and Cristián Simonetti, 'Introducing solid fluids', *Theory, Culture & Society*, 39:2 (2022), pp. 3–29.

[95]Ibid.

[96]Nail, *Matter and Motion*.

[97]Ibid., p. 143; see also Jef Huysmans, 'Motioning the politics of security: The primacy of movement and the subject of security', *Security Dialogue*, 53:3 (2022), pp. 185–278 (p. 243).

But if matter is perpetually in motion, how does it move? Within this line of thought, matter does not flow uniformly but in an unpredictable and turbulent manner.[98] Observing the way that dust in a room can be seen swirling and eddying when a sunbeam slices through it, Lucretius developed the idea of the atomic 'swerve': the small but random deviations of atoms from a straight course.[99] For kinetic materialist Thomas Nail, this motion is best described as pedetic motion.[100] 'Each movement is continuous with its previous position, but where it will go after that is indeterminate', he writes.[101] And understanding this capacity for 'curvature' in motion is key to understanding the emergence of novel forms.[102] For if everything moved in a straight line, there would be no opportunity for collision, intersection, and the production of heterogeneous associations (compounds).

While pedetic motion is unpredictable, then, it is not wholly random or disordered because it is relational.[103] Through matter's entanglement with itself, metastable patterns and forms emerge, which at some point give way to turbulence again.[104] Nail uses the example of a spiralled storm system to illustrate how the intra-action of heterogeneous elements are capable of producing organised and bounded patterns amid turbulence, in this case the pedetic movement of air currents.[105] Not to mention, the ephemeral nature of storms itself occurs within a larger pattern of global atmospheric circulation, as air moves around the planet in a consistent pattern produced by the earth's tilt and spin. 'Turbulence … is matter in motion with a very high degree of unpredictability as a result of the number of continually changing variables involved in the process. Yet turbulence also has relatively ordered patterns, spirals, swirls, vortices, and so on, which begin to emerge from these continually changing relations.'[106] By turning to these 'patterns of dynamic equilibrium' or 'regional stabilities-in-motion', as Nail describes them, it becomes possible to understand how stability and regularity exist alongside, yet crucially are always a product *of*, fluidity and indeterminacy.[107] To reiterate via Nail: 'It is a relative stasis that is always secondary to the primacy of the flows and fluxes that compose it.'[108]

So, what of space? In a world where solidity and stability are always secondary to fluidity, space must likewise be understood through a framework that affords primacy to fluidity and flow. For geographers Philip Steinberg and Kimbley Peters, the relentless churn and transformation of the ocean offers an ideal foundation from which to begin rethinking the 'empty, abstracted, and atemporal' understandings of space that dominate in the social sciences as a result of the Euclidean perspective.[109] In particular, they contend that the dominant way of representing space through contemporary mapping techniques needs to be replaced with a way of knowing space that not only allows for but is informed by movement. 'Drawing on insights from Lagrangian fluid dynamics, we understand the ocean not as a space of discrete points between which objects move but rather as a dynamic environment of flows and continual recomposition where, because there is no static background, "place" can only be understood in the context of mobility.'[110] From this perspective, 'movement, instead of being subsequent to geography, *is* geography … objects come into being as they move (or unfold) through space and time. Conversely, space ceases to be a stable background

[98] Nail, *Theory of the Earth*, pp. 27–9.

[99] Simon Trépanier, 'Lucretius', in Edward Zalta and Uri Nodelman (eds), *The Stanford Encyclopedia of Philosophy* (Winter 2023), available at: {https://plato.stanford.edu/entries/lucretius/}.

[100] Pedetic or Brownian motion traditionally refers to the random movement of particles suspended in a gas or liquid.

[101] Thomas Nail, *Being and Motion* (New York: Oxford University Press, 2018), p. 72.

[102] Ibid.

[103] Ibid., p. 73.

[104] Ibid.

[105] Ibid., p. 74.

[106] Nail, *Theory of the Earth*, p. 30.

[107] Nail, *Being and Motion*, p. 99.

[108] Nail, *Theory of the Earth*, p. 34.

[109] Steinberg and Peters,'Wet ontologies, fluid spaces', p. 248.

[110] Ibid., p. 257.

but a part of the unfolding.'[111] By centring continuous motion and material flows, Steinberg and Peters offer an understanding of space as constituted *through* movement, rather than as a container for movement, grounded in an understanding of the natural environment as itself ontologically mobile.

The ocean's fluidity relative to other aspects of the natural environment illustrates matter's capacity for instability in a way that perhaps best speaks to the accelerating rate of spatial change in the contemporary era. As Steinberg and Peters point out, while their approach to spatial fluidity 'resonates with how Massey … uses the mobility of plate tectonics to destabilise notions of place on land', there are some differences.[112] One is the intensity with which the ocean prompts an understanding of space as perpetually in motion: 'there is a vast difference between the geological time referenced by Massey (which is removed from human experience and cognition since it is not actually experienced) and the real-time, encountered mobility of the ocean'.[113] Indeed, it is not unlikely that a significant part of the reason why the cartographic imagination has been so influential is because the dominant human experience has been one of relative groundedness and fixity on land, amid an era of relative climatic stability.[114] While rocks might 'flow like rivers across the earth' when considered over a timescale that extends far beyond human lifespans, their dynamism is veiled by the relative stability that dominates how humans perceive them.[115] Overcoming this tendency to view stability, rather than flux, as the constant or norm arguably requires a radically different ontological basis from which to rethink space, which the ocean is able to provide. The aim of a 'wet ontology', as Steinberg and Peters write, is to 'reinvigorate, redirect, and reshape debates that are all too often restricted by terrestrial limits'.[116]

Still, the authors' positioning of the ocean in contrast to the land somewhat obscures the extent to which *all* materialities are fluid, albeit some more slow moving than others. At the same time, the extreme flux of the ocean is less conducive to illustrating the capacity for material flows to form the relatively stable structures and patterns that shape the routines and regularities of everyday life. Placing Steinberg and Peters' writings on the ocean into conversation with Nail's kinetic materialism, and Ingold and Simonetti's vision of a solid-fluid world, helps to advance a spatial framework in which fluidity is relative, yet always prior to the stability, form, and order that it (temporarily) gives rise to. 'Humans can pretend the world is not relational processes,' Nail notes, 'but they are likely to be continually surprised.'[117] To that end, the fourth and final section of the article moves to consider some of the implications of a fluid spatial ontology for IR, particularly within the context of anthropogenic climate change.

Climate change in fluid space

There is a tendency within geopolitical thinking to posit particular spaces/places like the ocean or the Arctic as mobile, unstable, and indeterminate relative to land, and to centre this characterisation within understandings of the distinct sovereignty and governance regimes that arise there.[118] Without contesting the value of these works, understanding space as ontologically fluid and mobile entails shifting to a framework where mobility, instability, and indeterminacy are a matter of *degree*,

[111] Philip Steinberg, 'Of other seas: Metaphors and materialities in maritime regions', *Atlantic Studies*, 10:2 (2013), pp. 156–69 (p. 160).

[112] Steinberg and Peters, 'Wet ontologies, fluid spaces', p. 258, discussing Massey, *For Space*.

[113] Ibid.

[114] Nail, *Theory of the Earth*, p. 11.

[115] Nail, *Matter and Motion*, p. 111.

[116] Steinberg and Peters, 'Wet ontologies, fluid spaces', p. 248.

[117] Nail, *Theory of the Earth*, p. 111.

[118] See, for example, Elizabeth Havice, 'Unsettled sovereignty and the sea: Mobilities and more-than-territorial configurations of state power', *Annals of the American Association of Geographers*, 108:5 (2018), pp. 1280–97; Hannes Gerhardt, Philip Steinberg, Jeremy Tasch, Sandra Fabiano, and Rob Shields, 'Contested sovereignty in a changing Arctic', *Annals of the Association of American Geographers*, 100:4 (2010), pp. 992–1002.

which pertain to all spaces/places in varied and shifting ways, rather than essential characteristics of particular materialities or geographical areas. This perspective encourages a broader and arguably more nuanced engagement with the material processes that produce spatial dynamism amid a changing change. Land, after all, is not static, nor are spaces like the ocean uniformly fluid.[119]

To take one example: sea-level change from melting ice does not occur consistently or evenly across the globe. When ice sheets and glaciers melt, they create unique and complex patterns of sea-level change across different coastlines, known as sea-level fingerprints.[120] The reasons behind these variabilities are multiple, but a significant one involves alteration of the earth's gravity field. When an ice sheet loses mass, its gravitational pull reduces, and nearby ocean waters flow away from the area towards distant locations.[121] Local sea levels around the ice sheet fall, while sea levels thousands of miles away rise faster, with regions in middle and lower latitudes among the worst hit.[122] A second source of variability involves the response of the land to melting ice.[123] Ice sheets are very heavy, and their weight pushes the earth's crust down into the mantle.[124] The mantle, a viscous fluid, in turn flows laterally away from the downwards pressure, causing land beyond the ice sheet to bulge upwards. When the ice sheet melts and becomes lighter, the process reverses. The earth underneath the ice sheet rebounds upwards, while bulging land on the periphery of the ice sheet subsides, and relative sea levels adjust. The response of the earth to shifting ice load is relatively slow, as the highly viscous materiality of the mantle means it flows over timescales of many thousands of years.[125] Land on the east coast of the United States is still slowly sinking in response to the end of the last ice age, for example, only further exacerbating rising sea levels in that area.[126] Matter's intra-actions produce patterned and situated dynamics that weave multiple spatial and temporal scales together across place, and climate change differently becomes.

If the mobility, instability, and indeterminacy of spaces like the ocean and the Arctic are linked to the diverse sovereignty regimes that arise there, then the corollary of a fluid spatial ontology is that articulations of sovereignty need not be uniform across geographically diverse political communities. As climate change continues to be differently produced across place, further transformations of sovereignty regimes can only be expected in the future as the inhabitability of different spaces/places changes, for better or for worse. In a world where multiple megacities and small island states are uninhabitable due to sea-level rise, and places around the equator are too hot and humid to live in, hundreds of millions of people will need to move towards the poles, and particularly northwards.[127] New sovereignty regimes will be required to address these changes, and indeed development of new sovereignty norms is already underway.[128] But these transformations won't be adopted uniformly. At a given moment, some states may retain the territorial nation-state of old, some may hold sovereignty over virtual or maritime space while their citizens reside within another

[119]For insight on the heterogeneous dynamics of the ocean, see Stefan Helmreich, *A Book of Waves* (Durham, NC: Duke University Press, 2023).

[120]Sophie Coulson, Sönke Dangendorf, Jerry Mitrovica, et al., 'A detection of the sea level fingerprint of Greenland Ice Sheet melt', *Science*, 377:6614 (2022), pp. 1550–4.

[121]Ibid., p. 1550.

[122]NASA Science, 'Evidence of sea level "fingerprints"', available at: {https://science.nasa.gov/earth/climate-change/evidence-of-sea-level-fingerprints/}.

[123]Coulson et al., 'A detection of the sea level fingerprint of Greenland Ice Sheet melt', p. 1550.

[124]Holger Steffen and Patrick Wu, 'Glacial isostatic adjustment in Fennoscandia: A review of data and modeling', *Journal of Geodynamics*, 52:3–4 (2011), pp. 169–204.

[125]Ibid.

[126]Kasha Patel, 'Land around the U.S. is sinking: Here are some of the fastest areas', *The Washington Post* (30 May 2023), available at: {https://www.washingtonpost.com/climate-environment/2023/05/30/land-sinking-us-subsidence-sea-level/}.

[127]Gaia Vince, *Nomad Century: How to Survive the Climate Upheaval* (London: Penguin Random House UK, 2022).

[128]See, for example, debates surrounding virtual sovereignty: Delf Rothe, Ingrid Boas, Carol Farbotko, and Taukiei Kitara, 'Digital Tuvalu: State sovereignty in a world of climate loss', *International Affairs*, 100:4 (2024), pp. 1491–509.

territory, some may hold nested sovereignty within another's,[129] and some may share sovereignty within a given space, among other possibilities. While sovereignty regimes have by no means ever been globally uniform, further hybridity and heterogeneity is likely to come.

Nor can sovereignty regimes be considered in any way permanent. Above all, affording primacy to matter-in-motion reveals the inevitable impermanence of all spatial configurations, even those that seem stable to humans. As physicist Carlo Rovelli writes: 'We can think of the world as made up of *things* … Or we can think of it as made up of *events* … Something that does not last, and that undergoes continual transformation, that is not permanent in time. The destruction of the notion of time in fundamental physics … is the realization of the ubiquity of impermanence, not of stasis in a motionless time.'[130] While recognition of the historical contingency of the territorial nation-state is nothing new for post-structuralist approaches to global politics, earthly materialities are an altogether underappreciated dimension within these debates. The territorial nation-state is not just discursively but also materially unstable, with the physical form of each state perpetually co-becoming in distinct ways and with significant implications for continued liveability in some cases. Within this framework, a political-legal system premised on spatial fixity, with citizenship attached to a seemingly atemporal and permanently inhabitable place, can only ever be of temporary efficacy. The massive questions on the horizon are how the geopolitical transformations and migrations demanded by a warming planet will take place and, more importantly, whether they will occur in an atmosphere of hospitality, respect, obligation, and care, or in the unfortunately more likely scenario of securitisation, militarisation, and selective disregard. As the remainder of this article outlines, moving towards an understanding of space as ontologically fluid and mobile can, it is hoped, contribute to efforts to steer away from the latter response.

Conclusion

In contrast to its prescribed role as a stable backdrop for human action, the natural environment is dynamic and ever-capable of transition. This article has argued that dominant understandings of and approaches to space in IR theories struggle to account for this material dynamism. From classical and neo-realism through to constructivist and post-structuralist IR perspectives, the natural environment plays a limited role in the production of political possibilities and outcomes, if considered at all. Part of the reason for this oversight is a general tendency among IR theorists to view space abstractly, where it functions as the blank and static surface that the cartographic imagination prescribes it to be.

The spatial imaginaries proposed by scholars who give primacy to matter-in-motion offer valuable insights about how understandings of space in IR can be reconceptualised through a post-humanist lens to better reflect the realities of spatial flux. Reconceptualising space as knowable not through its cartographic representation but through its movement means pulling the natural environment back into the foreground of analysis to see how it forms a part of the action, rather than the backdrop for that action. That is, instead of global politics being studied as the movement of people, their bodies, their ideas, and their material creations across a static surface, the natural environment becomes ontologically and analytically inseparable from that movement.

Recognising the earth's dynamism does not, however, let (some) humans off the hook for causing present climate change. Quite the opposite, it points towards the carelessness[131] and lack of humility that characterises the Western-Eurocentric relationship with nature, the destructive and extractive political and economic systems that this relationship supports, and the irreversible changes to the

[129]The term nested is derived from Audra Simpson's work on Indigenous sovereignties. See Audra Simpson, *Mohawk Interruptus: Political Life across the Borders of Settler States* (Durham, NC: Duke University Press, 2014).

[130]Carlo Rovelli, *The Order of Time*, trans. Erica Segre and Simon Carnell (New York: Riverhead Books, 2018), ch. 6, emphasis in original.

[131]Cameron Harrington and Clifford Shearing, *Security in the Anthropocene: Reflections on Safety and Care* (Bielefeld: transcript Verlag, 2017).

global climate system that these systems produce. As Whyte et al. explain, many Indigenous scholars 'challenge the centrality of climate change itself as a cause of harm and violence', when it is processes of colonialism, capitalism, and industrialisation that have not only created the current ecological crisis but are also the reason why some Indigenous communities are now particularly vulnerable to its effects.[132] The earth moves, sometimes dramatically so, and the continued failure of the Western-Eurocentric worldview to recognise and respect that will only be the cause of yet more harm.

IR's static spatial imaginary is, after all, indicative of a much broader problem that critical writings on the Anthropocene have highlighted in recent years: namely, that 'our political systems cannot act ecologically because, as artefacts of previous eras in which Western notions of modernity and progress were considered universal, they were not designed to do so'.[133] Put differently, it must be remembered that the influence of a nature/society dichotomy within IR theories and political practice is a specifically Western-Eurocentric one, and one that has long informed the racist and sexist practices of colonial and neocolonial dispossession and resource extraction that inform the global capitalist system.[134] Overcoming the nature/society dichotomy that informs much IR spatial theorising is, in this sense, just one part of a larger effort to destabilise the hegemonic influence of Western-Eurocentric approaches to the study and practice of global politics that are responsible for creating the very ecological crisis that they are now being employed to resolve.

Perhaps most notably, a shift away from the association between mobility and crisis that permeates much political debate about migration will be essential in contending with the climate-change-induced geopolitical transformations to come.[135] And adopting a spatial framework premised on fluidity, where human movement *with* a dynamic land is the norm rather than the exception, offers an important step in that direction.[136] Again, like many other rethinkings that anthropogenic climate change demands, this is largely a shift that needs to be made within the Euro-descended worldview. In contrast to the modern state system, where populations are tied to a fixed and defined territory, many Indigenous and non-Western traditions and histories prioritised mobility to live adaptively or relationally with a dynamic environment.[137] It was only with colonialism and an attempt to confine populations to place did that movement become restricted by the logics of the modern state system, both within and outside of the borders of the state.[138] Whether the decision is to stay or to leave, those currently facing the worst effects of climate change, like many in the Pacific Islands, 'feel that mobility is no longer available *on their terms*'.[139]

Crucially, then, recognition of the material dynamism of space draws attention to the inevitability of harm that lies within the assumed permanence of the modern state system, paired with a privileging of white movement. The earth *does* move, the climate *will* dramatically change, some land *will* become entirely uninhabitable, other land *will* become more or less inhabitable, people *will* need to move to adapt to those changes, and a global political system that restricts movement or sees it as a source of instability *is* and *will* become increasingly harmful. And when considerations of the Western-Eurocentric influence over this political system and historical responsibility for anthropogenic climate change are added to the mix, the injustice of this inevitability only becomes starker. Against this backdrop, a materially dynamic understanding of space provides an effective

[132]Whyte, Talley and Gibson, 'Indigenous mobility traditions, colonialism, and the Anthropocene', pp. 328–31.

[133]Cheryl McEwan, 'Decolonizing the Anthropocene', in David Chandler, Franziska Müller, and Delf Rothe (eds), *International Relations in the Anthropocene* (Cham: Palgrave Macmillan, 2021), pp. 77–94 (p. 88).

[134]Kathryn Yusoff, *A Billion Black Anthropocenes or None* (Minneapolis: University of Minnesota Press, 2018).

[135]Thomas Nail, 'Forum 1: Migrant climate in the Kinocene', *Mobilities*, 14:3 (2019), pp. 375–80.

[136]Yunkaporta, *Sand Talk*, p. 2.

[137]Suliman et al., 'Indigenous (im)mobilities in the Anthropocene'; Whyte, Talley and Gibson, 'Indigenous mobility traditions, colonialism, and the Anthropocene'.

[138]Suliman et al., 'Indigenous (im)mobilities in the Anthropocene'; Whyte, Talley and Gibson, 'Indigenous mobility traditions, colonialism, and the Anthropocene'.

[139]Suliman et al., 'Indigenous (im)mobilities in the Anthropocene', p. 312, emphasis in original.

framework through which to continue dismantling status quo rigidities and strengthen the forms of relational ethics premised on fluid borders, identities, and ways-of-being that the present era demands.

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