University of East Anglia
School of Environmental Sciences

HISTORICAL GEOGRAPHIES OF THE FUTURE:

IMAGINATION, EXPECTATION AND PREDICTION IN THE MAKING OF IMPERIAL ATMOSPHERE

Martin Mahony

3S Working Paper 2018-31

3S Science, Society & Sustainability

University of East Anglia
School of Environmental Sciences

Established in early 2011, and building on a tradition of leading environmental social science research at UEA, we are a group of faculty, researchers and postgraduate students taking forward critical social science approaches to researching the social and political dimensions of environment and sustainability issues.

The overall aim of the group is to conduct world-leading research that better understands, and can potentially transform, relations between science, policy and society in responding to the unprecedented sustainability challenges facing our world. In doing this our approach is:

INTERDISCIPLINARY, working at the interface between science and technology studies, human geography and political science, as well as linking with the natural sciences and humanities; ENGAGED, working collaboratively with publics, communities, civil society organisations, government and business; and REFLEXIVE, through being theoretically informed, self-aware and constructively critical. Our work is organised around five interrelated research strands:

KNOWLEDGES AND EXPERTISE
PARTICIPATION AND ENGAGEMENT
SCIENCE, POLICY AND GOVERNANCE
TRANSITIONS TO SUSTAINABILITY
SUSTAINABLE CONSUMPTION

3S researchers working across these strands focus on a range of topics and substantive issues including: climate change, energy, emerging technologies (such as biotechnologies and geoengineering), natural hazards, responses to the economic and financial crisis, and grassroots actions and social movements on sustainability.

3S Science, Society & Sustainability

Science, Society and Sustainability (3S) Research Group
School of Environmental Sciences
University of East Anglia
Norwich Research Park
Norwich NR4 7TJ UK

info@3S.uea.ac.uk
www.3S.uea.ac.uk

HISTORICAL GEOGRAPHIES OF THE FUTURE: IMAGINATION, EXPECTATION AND PREDICTION IN THE MAKING OF IMPERIAL ATMOSPHERES

Martin Mahony

Abstract

This paper explores the elemental encounters and imaginative geographies of empire in order to develop a new means of engaging with the historical geographies of the future. Futures have recently become an important topic of historical and cultural inquiry, and historical geographers have an important role to play in understanding the place of the future in the past, and in interrogating the role of posited futures in shaping action in historical presents. Drawing on literature from science & technology studies, a framework is developed for engaging with the material and imaginative geographies which coalesce around practices of imagination, expectation and prediction. This framework is then used to reconstruct efforts to develop airship travel in the British Empire in the 1920s and '30s. At a moment of imperial anxiety, airships were hoped to tie the empire together by conveying bodies, capital and military capacity between its furthest points. Confident projections of the colonisation of global airspace were nonetheless undermined by material encounters with a vibrant, often unpredictable atmospheric environment. The paper aims to spur renewed work on the historical geographies of the future, while also contributing to debates on the cultural and political geographies of the atmosphere and of atmospheric knowledge-making.

Keywords: future; atmosphere; technology; innovation; empire

HISTORICAL GEOGRAPHIES OF THE FUTURE

As the onset of the Anthropocene telescopes geological time into a politically febrile present, and as environmental dystopias and technological utopias jostle for authority as horizons of collective action, 'the future' has become an increasingly prominent object of political contestation, technoscientific construction, and cultural critique. Geographers have joined a growing band of historians, sociologists, philosophers, and students of culture and media in examining the construction of authoritative or influential visions of possible future, and in interrogating the work performed by such visions in the organisation and contestation of collective life (Heffernan, 1999; Eshun, 2003; Koselleck, 2004; de Goede and Randalls, 2009; Anderson, 2010, 2016; Engerman, 2012; Augé, 2014; Braun, 2015; Matthews and Barnes, 2016; Tutton, 2016; Urry, 2016; Anderson and Gordon, 2016; Beckert, 2016). Geographers have examined the codification and performance of futures within the anticipatory mechanics of liberal government (Amoore, 2009; Anderson 2010), the politics of expertise in the construction of knowable futures (Rickards *et al.*, 2014; Collard et al., 2015; Lave, 2015), the effects of social marginalisation in the definition of who gets to imagine and

define futures (Derickson and MacKinnon, 2015; Baldwin, 2016), and the role of art and narrative in generating both new imaginaries and new kinds of intervention in the politics of environmental change (Yusoff and Gabrys, 2011; Daniels and Lorimer, 2012; Hawkins *et al.*, 2015). A recent special issue of the *Annals of the Association of American Geographers* urged the discipline to re-engage with both the politics and the creative praxis of imagining alternative futures (Braun, 2015). While this is partly motivated by the realisation that in the Anthropocene the past no longer furnishes useful analogies for the future, historical geography still faces two urgent tasks: examining how historical processes, such as those of colonialism and capital formation, (dis)empower different social groups to define and enact alternative futures in the present (Collard et al., 2015); and examining the long history of 'the future' as an imagined, constructed object around which various projects of knowledge-making and world-making have been organised.

This paper aims to develop new pathways for the cultivation of historical geographies of the future, focusing in this instance on the latter concern with the future as an historical object. This engagement with futures-past has spawned new disciplinary histories within geography (Heffernan, 1999), as well as new appreciations of the power of future imaginaries in the remaking of urban, national and imperial spaces (Gilbert and Driver, 2000; Hall, 2002; Bell, 2007; Gilbert and Lambert, 2010; Perkins and Dodge, 2012; Krige and Wang, 2015). The intertwining of possible futures and alternative histories has been the subject of important interventions around counterfactual methods in geography (Gilbert and Lambert, 2010), both as a means of jointly comprehending spatial and historical contingency (Palmer, 2014), and of re-imagining disciplinary histories (Fall and Minca, 2012). Beyond the discipline, a burgeoning interdisciplinary literature has emerged on the history of prediction, foreknowledge and imagination in the organisation of science, government, commerce and collective life (Andersson and Rindzevičiūtė, 2015; Jasanoff and Kim, 2015; Heymann *et al.,* 2017; Verschraegen *et al.*, 2017). This literature has developed in various levels of dialogue with the history of utopian imaginings (e.g. Jameson, 2005), although Andersson (2012, 1414) has recently called for "a new field of historical inquiry, one that will move away from the cultural history of utopias and images of the future that historians have studied to date, and focus on the role of prediction in structuring action and actors on the national, transnational, and global levels". While this is a vital move, I will argue in this paper that we shouldn't throw out the imaginative baby with the utopian bathwater. Separating our study of the utopian imagination from the study of the social role of anticipation and prediction would be a mistake. Historical geography as a field has been particularly adept at working with the co-production of the imaginative, the technical and the material, most prominently perhaps through the reconstruction of historically-situated imaginative geographies, and of the evolution of the 'geographical imagination' (Daniels 2011). A fuller historical

geography of the future can disaggregate different modes of futuring, while also attending closely to their mutual shaping of each other. In this paper, I propose that examining *imagination*, *expectation* and *prediction* as distinct and yet interacting forms of futuring or future-making can offer a firmer grasp on the work performed by claims upon the future in the organisation of life in various historical presents. These are all cognitive practices, ranging from the banal and the technical to the creative and fanciful, but they all work through material processes and practices, and summon into being a range of both material and imaginative geographies. In the following section I examine a range of conceptual resources which can inform a renewed geographical engagement with futures, both past and present, before putting them to work in narrating a particular instance of imperial future-making.

IMAGINATION, EXPECTATION, PREDICTION

Socio-technical imaginaries and the horizons of possible worlds

The concept of socio-technical imaginaries has recently emerged in science and technology studies (STS), and describes "collectively held, institutionally stabilized, and publicly performed visions of desirable futures, animated by shared understandings of forms of social life and social order attainable through, and supportive of, advances in science and technology" (Jasanoff 2015). The concept comes from a strand of STS work which is not concerned so much with the material and social practices of the laboratory (Latour and Woolgar, 1979), but more with how science and technology get bound up with projects of world-making beyond laboratory walls (see Jasanoff, 2004). It's a strand of work which sees science and social order as joint products of processes of co-production. It emphasises the place of the normative and the aspirational in processes of technoscientific change, while also stressing the role of science and technology in producing social collectives in the present (cf. Taylor, 2002), and visions of desirable forms of social order in the future.

Socio-technical imaginaries are socially durable visions of socio-technical futures. They lie in between utopia and the predictable near-future, and tell of individual, vanguard visions which, through the mobilisation of various cultural and symbolic resources, come to be collectively held and to exercise agency in the organisation of collective life. The concept draws attention to "how, through the imaginative work of varied social actors, science & technology become enmeshed in performing and producing diverse visions of the collective good, at expanding scales of governance from communities to nation-states to the planet" (Jasanoff 2015: 11). Recent work in this area has examined comparative imaginaries of the relationship between the state and nuclear power (Hilgartner, 2015), global health (Lakoff 2015), and biotechnology governance (Storey, 2015).

Historical work has also employed the concept, for example William K. Storey's examination of Cecil Rhodes' vision for a new South Africa based on progressive engineering, racial segregation and corporate surveillance. The concept has more recently been mobilised to understand how socio-technical innovations travel, in order to grasp how dominant conceptions of social and technical change are transformed in encounters with 'local' commitments and cultures (Meehan, Klenk and Mendez, 2017; Pfotenhauer and Jasanoff, 2017). The literature on socio-technical imaginaries bears a commitment to uncovering the "topographies of power" within which science and technology are entangled, often pitched against what is seen as the flatter ontologies of actor-network theory accounts of the heterogeneous engineering of matter and society (Jasanoff 2015: 18). While usually articulated in relation to the state, the concept is being increasingly employed to interrogate the scalar politics of science and technology:

> space and scale are linked in a normative coupling that cannot as easily be captured by the metaphor of networks. For imaginaries not only help reconfigure actors' sense of the possible spaces of action but also their sense of the rightness of action, at scales ranging from locality to nation…to continent…and to the planet itself (Jasanoff, 2015: 23).

The concept is therefore a useful corollary to work on the geographical imagination. Stephen Daniels (2011: 183) notes that the concept of the geographical imagination "varies in scope", from particular techniques of fashioning representations of space, to more overarching "modes of comprehension and experience…encompassing the condition of both the known world and the horizons of possible worlds". These modes of comprehension have been situated within the historical development of geography as a discipline, formatting, like Kuhnian paradigms, the ways in which space and place, as general or specific, have been constructed and interpreted. More broadly, the geographical imagination stands for a more distributed mode of comprehending space and the characteristics of place – most obviously perhaps the popular and scientific construction of 'the tropics' as a place of pestilence and moral degeneracy which shaped both knowledge-making and world-making projects at the height of European imperialism (Driver, 2004). Work on the geographical imagination has not yet connected fully with work on the geographies of anticipation, with time losing out to space, understandably, as the key dimension. Yet Daniels' reference to the "horizons of possible worlds" hints at a latent potential to couple work on the spatial imaginaries of empire-builders, scientists and geographers with work which engages more closely with the power of future imaginaries to shape action in historical presents. Leaning on the concept of socio-technical imaginaries can aid contemporary geographers in re-casting the place of the future in the organisation and contestation of present geographies, while also offering a new means of placing science and technology within the production, circulation and enactment of powerful imaginaries, potentially finessing our grasp of

the relationship between science, technology and geopolitics (Butler, 2001). The notion of socio-technical imaginaries emphasises that spatial imaginations "preexist and channel the spread of science and technology, instead of only vice versa" (Jasanoff, 2015: 22); imaginaries have agency in the emergence and expansion of local and regional cultures of scientific knowledge-making, as well as being themselves products of the situated making of (anticipatory) knowledge (cf. Livingstone, 2003; Withers, 2007; Naylor, 2010).

Expectation

If 'imagination' here denotes big-picture constructions of worldly futures, "attainable" through, and supportive of, certain strategies of physical and social engineering (Jasanoff, 2015: 4), then that attainment is achieved through practices of "engineering expectancy" (McCormack, 2008, 423). An important strand of work on the sociology of expectations has developed from studies of socio-technical innovation (see Tutton, 2016). While much work on socio-technical imaginaries tends to operate on the level of the nation-state, sociologists of expectations tend to take individual projects of technological innovation as their scale of analysis. They examine more closely the material and discursive practices by which expectations of change and promissory regimes are constructed and contested. Four key themes have emerged from such work: the constitutive and performative role of expectations in the social negotiation of technological innovation; the temporal patterning of regimes of expectation, expressed for example in cycles of 'hype' and 'disappointment'; the materiality and embodiment of expectations, in people, texts, artefacts and actions; and the 'socio-spatial variability' of expectations (Borup et al. 2006: 289-293). On the latter theme, Porter and Randalls (2014: 204) attempt to thicken an "impoverished sense of space and scale" evident in sociological studies of expectations; to go beyond mapping the spatiality of expectations in simple terms of circulation and social variation. Building on Milne (2012), a fuller geography of expectations needs to examine the places of future production, the scales of future enactments, the embedding of imagined futures in the materialities of present geographies, and the agency of imagined places in transforming those geographies (Porter and Randalls, 2014: 204; see also Lave, 2014; Lehman, 2014; Jönsson, 2014). There are echoes here of Ben Anderson's work on how "geographies are made and lived in the name of pre-empting, preparing for, or preventing threats to liberal-democratic life" (Anderson, 2010: 777), although the logics of threat can also be analysed alongside, and against, the promissory regimes through which forms of capitalist and liberal-democratic life are reproduced, extended, and spatially fixed through the rhetoric and practice of 'innovation' (Russell and Vinsel, 2016).

With imagination in this paper referring to the hoped-for end points of social and technical change, expectation refers to the belief in the causal relationships and sequences that are assumed to link

the present with an imagined future. These causal relationships may be unquantifiable according to historically-situated norms of reliable scientific prediction, and may refer, for example, to assumed relationships between the public performance of 'future' technologies and the generation of public acceptance or expectancy, to assumed pathways of technological innovation, where one development leads linearly to another, or to the performance of machines in imperfectly known future conditions and environments. Expectation may often strive towards predictability, but my emphasis here will be on the paradoxical relationship between the indeterminacy of assumed relationships, and the powerful performativity of expectations in shaping action in the present (Tutton, 2016).

Prediction

Rather than the links between present actions and future outcomes, 'prediction' is taken here to refer more explicitly to claims made about the evolution of certain systems over time and space: for example, a prediction of the weather over the next six or twelve hours. These systems may exist and behave partially or completely independently of a technology around which expectations are being fashioned: for example, an aeronautical weather forecast for a public demonstration flight of a much-hyped new aircraft. Nonetheless, historians of science such as Katharine Anderson and Jamie Pietruska have shown prediction to be a culturally-situated set of practices shaped by power relationships and often interminable contestations over authority (Anderson 2005; Pietruska 2017). Building on Fine (2009) and Johnson and Lenhard (2011), Heymann *et al.* (2017) delineate distinct 'cultures of prediction' in the atmospheric sciences, shaped by computational practices, institutional contexts and wider political formations. Geographical work has highlighted the material circulation of distinctive predictive practices (Jankovic, 2004; Mahony and Hulme, 2012), and the constitutive effects of hegemonic modes of prediction in the spatial ordering of, for example, climate change politics (Blok, 2010; Chaturvedi & Doyle, 2015; O'Lear, 2016). Predictions render "complex future geographies actionable through the numericalization of a reality to come", generating authoritative numbers and visions "that may thereafter circulate, be reflected on and take on an affective charge" (Anderson, 2010: 784). Climate politics, again, offers numerous instructive examples of this interpenetration of the epistemic, the normative and the affective in the production and circulation of authoritative foreknowledge (de Goede and Randalls, 2009; Yusoff, 2009; O'Lear, 2016). Similarly to how the literature on expectations would benefit from a geographical orientation, work on the history of prediction would be enhanced by supplementing an interest in circulation and spatial variation with attention to places of predictive knowledge making, and the embeddedness and agency of predicted spatialities within present geographies.

While predictions may refer to systems assumed to be independent or external to the socio-technical systems which are the subject of hopeful imaginings and expectations, the practices and politics of prediction, I'll suggest, are profoundly shaped by the imaginative and expectant contexts within which they are produced and put to work. This triad of imagination, expectation and prediction can enrich our grasp of the historical geographies of the future, encouraging us to attend to the mutual shaping of these three modes of futuring, and to the imagined and material geographies through which they work. In the rest of this paper, I use this conceptual triad to reconstruct the historical geographies of British imperial airshipping in the 1920s and '30s. In the next section, I make the case for the atmosphere as a useful space through which to reconstruct historical geographies of the future, building on recent work in the discipline on the material and affective geographies or air and atmospheric governance.

ATMOSPHERES OF THE FUTURE

The atmosphere has long figured as a space for the projection of hopeful or fearful futures, as a space ripe for technological conquest or as an unknowable 'atopia' possessed of a radical, threatening alterity (Carroll, 2015). Whether in the form of predicted changes in the global circulation under climate change, expectations about the capacity of wind energy to re-shape energy economies, or imaginations of the future population of the atmosphere with new technologies of mobility – perhaps flying cars or solar-powered aeroplanes – future atmospheres oscillate between hope and fear, technological optimism and environmental anxiety. The surveillance of the atmosphere's physical and chemical properties predates recent concerns about global climate change (Edwards, 2010), and has always been marked by an intersection of new forms of atmospheric vision and new articulations of responsible conduct and state power (Baker, forthcoming; Whitehead, 2011). Atmospheric governmentalities articulate new forms of surveillance of societies and individuals, allowing new forms of anticipatory policing and pre-emptive violence (Gregory, 2011; Adey, Whitehead and Williams, 2013; Amoore, 2016; Shaw, 2016; Nieuwenhuis, 2017).

This change in the political and cultural geographies of the atmosphere, from unknowable atopia to a sphere of technological domination, has been driven not just by new techniques of scientific surveillance, but by the capacity of human bodies and technologies to both traverse and inhabit atmospheric space (Adey, 2010). Yet aviation, military or civilian, does not take place in an empty 'airspace' through which power can be projected unimpeded (Lin, 2016), but works instead through a set of relations with the material processes of the atmosphere. While the matter of air (Connor 2010) has increasingly been of interest to scholars working in new materialist traditions (see Adey,

2015), the spokespeople of these processes and relations, and particularly of their possible futures (meteorologists, for example) – have nonetheless been largely absent from work which seeks to write social relations into matter (Barry, 2015). Emerging work on the historical geographies of meteorological and climatological science is yielding important insights into the embedding of those fields into imperial projects, and their role in constructing the atmosphere as a navigable airspace (Henry, 2014; Mahony, 2016). Interwar meteorology in Europe and North America was largely pre-occupied with two things: assimilating Bergen-school air mass analysis into forecasting techniques, and dealing with the new demands placed on meteorological science and services by aviation (Turner, 2010). In Britain, for example, air links with Europe were intensifying and hopes abounded that the Empire could be tied together by a new network of airplanes and airships (Pirie, 2009). Imaginations of a new imperial order intersected with expectations of technological change, and with the capacities of physical scientists and engineers to accurately predict the behaviour of an atmosphere whose chaotic dynamism was only starting to come into view (Nebeker, 1995; Fleming, 2016). Early twentieth century efforts to produce the atmosphere as a new space of human mobility therefore make propitious sites for reconstructing historical geographies of the future.

The rest of this paper focuses on British efforts to enact a system of imperial airship communications, working through the intersections of imagination, expectation and prediction in the making and unmaking of imperial futures. The airship itself is in many ways an icon of futures-past. Early 20th century artists and writers offered innumerable visions of futures shaped by airship travel. Rudyard Kipling's *With the Night Mail* (1905) presents an Atlantic-crossing airship as simultaneously a form of embodied communication, a meteorological observatory, and a sinister form of international techno-authority. Similar themes can be found in H.G. Wells and *The Shape of Things to Come* (1933), wherein aviation technology supports a Dictatorship of the Air which restores global order following a world war and a deadly plague. More recently airships have become icons of the retro-futurism of steampunk, a movement which arguably began with Michael Moorcock's 1971 novel *Warlord of the Air,* which projected British imperial airshipping forward to a counterfactual 1973. Steampunk seeks to recover, through art, design and fashion, an aesthetics of thermodynamic technology and alternative, neo-Victorian or -Edwardian futures (Davidson, 2012), and a similar sense of technological revivalism can be seen in efforts to re-purpose the airship for an environmental age, with the relative energy efficiency of airships over aeroplanes seemingly offering a more sustainable form of aerial transport (Carey, 2012). The airship therefore offers an ideal vehicle in which to join a growing band of historians and, increasingly, historical geographers in examining the place of the future in the past.

IMAGINING IMPERIAL FUTURES

In the period immediately following World War I the airship was a paradoxical figure in British atmospheric politics. On the one hand, the bombing of British towns and cities by German Zeppelins built on earlier, spectral 'airship scares' (Adey, 2010: 54-6) to create a paranoia of violated territorial sovereignty and of an invisible, ever-present threat to life. However, Freedman argues that come the end of the war, the Zeppelin threat had become an increasingly banal part of urban life on the home front, their relative ineffectiveness and vulnerability to new modes of attack tarnishing their aura of other-worldly invincibility (Freedman, 2004). Nonetheless, would-be imperial airshippers faced a difficult task to convince a sceptical government, military and public about the potential of dirigibles in the wider post-war task of remaking and repurposing empire.

Socio-technical imaginaries have vanguards before they become collectively held (Hilgartner, 2015), and in this case the most significant vanguard figure was Charles Dennistoun Burney. Burney was a naval engineer who went on to work for the Vickers Company following World War I, and in 1922 he entered Parliament as the Conservative MP for Uxbridge. In the same year he entered Parliament Burney put forward a scheme for the development of airship communications throughout the Empire, proposing the building of 6 airships by Vickers to serve the expected new routes, which would tie together England with India and the Dominions (see also Swinfield, 2012: 92-106). Fellow Conservatives were drawn to the scheme, "with its imperial vision and favourable business provisions" (Duggan and Meyer, 2001: 85), as were companies such as Shell Oil, one of whose engineers was working on a lightweight airship engine (Swinfield, 2012: 94). Burney was a self-described progressive imperialist, concerned with the economic, cultural and technical unity of empire. He outlined his thinking in a 1929 book, *The World, the Air and the Future,* in which he fleshed out a philosophy of airship imperialism. "By means of air travel and air travel alone", Burney argued, "can the British Empire conquer her great enemies - Time and Space" (Burney 1929: 22). Airships could help bolster Imperial Defence, acting as means of long-distance reconnaissance and offering new modes of attack. But the main benefits, Burney suggested, were to be economic and cultural. The British Empire stood waiting as the only viable economic rival to an ascendant US, but the Empire's economic development was hampered by the great distances between its main economic nodes. If these nodes could be tied together by a mode of transport that could greatly expedite the circulation of people, ideas, goods and capital, then the resources of Empire could be more productively turned into trade and profit. This wasn't to be mass transport of course, but rather the transport, in great comfort, of the investors, managers and executives of empire, scouting out new resources, making connections and cutting deals. The atmosphere, set to be traversed by a new fleet of airships, offered the space for a new aerial mercantilism.

For Burney, imperial development was also hampered by a lack of a widespread sense of cultural unity – "our Imperial consciousness is not yet fully awake", Burney explained; the Empire as a "spiritual organism" had not yet achieved the religious devotion of the Roman Empire. The airship stood ready to build both commercial and cultural affinity, shrinking the "Imperial globe", as Burney called it, to "less than a quarter of its present size" (ibid: 40). By expediting the circulation of bodies and ideas around the Empire, the airship could create and strengthen bonds of familiarity and cultural affinity. Ever the engineer, Burney argued that if the "far-flung Commonwealth is to function effectively as an Imperial entity, its member states must be *welded* together into a physical unity" (ibid: 21), to create what he called a "British cosmopolis" (ibid: 44).

Alongside this imaginary of imperial development shaped by new geographies of aerial mobility, Burney also proffered a more foundational theory of technology, history, and the future, positing what he called an "historico-metaphysical parallel between the development of communications and the psychological evolution of organised society" (Burney 1929: 169). The air, while conducive to the projection of imperial power, was also the natural domain, and the harbinger, of internationalism. In the interwar period, internationalism was a powerful set of ideas, encompassing a variety of utopian ideals of international cooperation, post-national organisation, and peace-making, which informed organisations like the League of Nations, as well as emerging anti-colonial movements (Goswami *et al.*, 2012). Politically, it ranged from liberal cosmopolitan views on international relations to the Communist International, which aimed doing away with the nation-state as a mode of organisation altogether (Hodder, Legg and Heffernan, 2015). In his text Burney is nonetheless quick to point out that he is following neither "the absurdities of Bolshevism" nor the "idle speculations" of utopian theorists in positing a new vision of aerial internationalism. But he maintains that the air, as "Free, indivisible, and all-embracing, without barrier or restriction, always self-identical and distributing itself equally over the whole universe, affirms the International principle; and so it is that when we come to consider it as a road of communication, we find that it postulates a world-state for its effective functioning" (Burney 1929: 169-70).

The links between internationalism, aviation and a putative world-state were common currency in interwar intellectual circles. Figures like Churchill, Robert Cecil and others across the political spectrum saw the air as a new dimension of untold military power, and thus saw the need and potential for a kind of international aerial police force, keeping national air forces in check, and preserving the peace. Writers like Kipling, Wells and Bertrand Russell likewise offered visions of a future in which world peace was maintained by a world state, whose chief sphere operation and would be the air (Partington, 2003; Holman, 2010; Zaidi, 2011). Like others of Burney's ideological persuasion, he sought to reconcile the political and scalar contradictions of imperialism and

internationalism by scheduling the evolution of one into the other, advocating what he called a "philosophy of gradualness" (Burney 1929: 8). With other imperial thinkers of his time, Burney saw a peaceful international order as a long-term project: imperial development should be pursued first, laying the Anglophone, capitalist foundations of a future world order in the technical, economic and cultural structures of Empire (Bell, 2007). This, then, was a socio-technical imaginary of world-historical dimensions. In terms of its imaginative geographies, this was a projection of imperial power through a global airspace; a space which could function as a new sphere of imperial mobility and conquest. As Lord Thomson, the subsequent Labour Air Minister put it, the airship scheme would prove that "the air and the four corners of the earth are ours to command", and Ramsey MacDonald would likewise later predict that "we shall conquer the air as we have conquered the desert and conquered the sea" (quoted in Pirie 2009, 133-4).

Parallels were frequently drawn with Britain's earlier command of oceanic space, with airships seemingly representing the natural next step in Britain's conquest of the elements, and thus of the globe. Socio-technical imaginaries are frequently "bound up with the hard stuff of past achievements", technological systems serving "a doubly deictic function, pointing back at past cultural achievements and ahead to promising and attainable futures" (Jasanoff, 2015: 22). For Burney, Britain's domination of the sea was a product as much of the hard geography of continents and coastlines as it was of the mastering of more intangible things like the air. He published maps which represented the "sea-centrality" of Great Britain, drawing on a number of geographically determinist arguments which were circulating at the time concerning the inevitable endurance of Britain as a maritime power (e.g. Bowles 1926). For Burney, the significance of this lay in his plans to make the airship more of a seaborne vessel. At that time airships could only be flown between land stations which had the requisite mooring masts and teamsters to haul the ship into a shed – there was no way of safely landing an airship anywhere else. Airships could however be given much greater freedom if they could take-off and land on water. They could ply the old trade routes, take advantage of the trade winds, stop where they wanted, but also call in at, and perhaps rejuvenate, the great ports of empire, like Singapore and Hong Kong. Burney thus developed a design for an elliptical airship with floats which could do just that. This was a strategy for making future imperial mobilities more flexible and adaptable to changing geographies of production and trade, but it was also a strategy of discursively and materially layering airship mobilities on top of a much older set of maritime infrastructures and imaginaries.

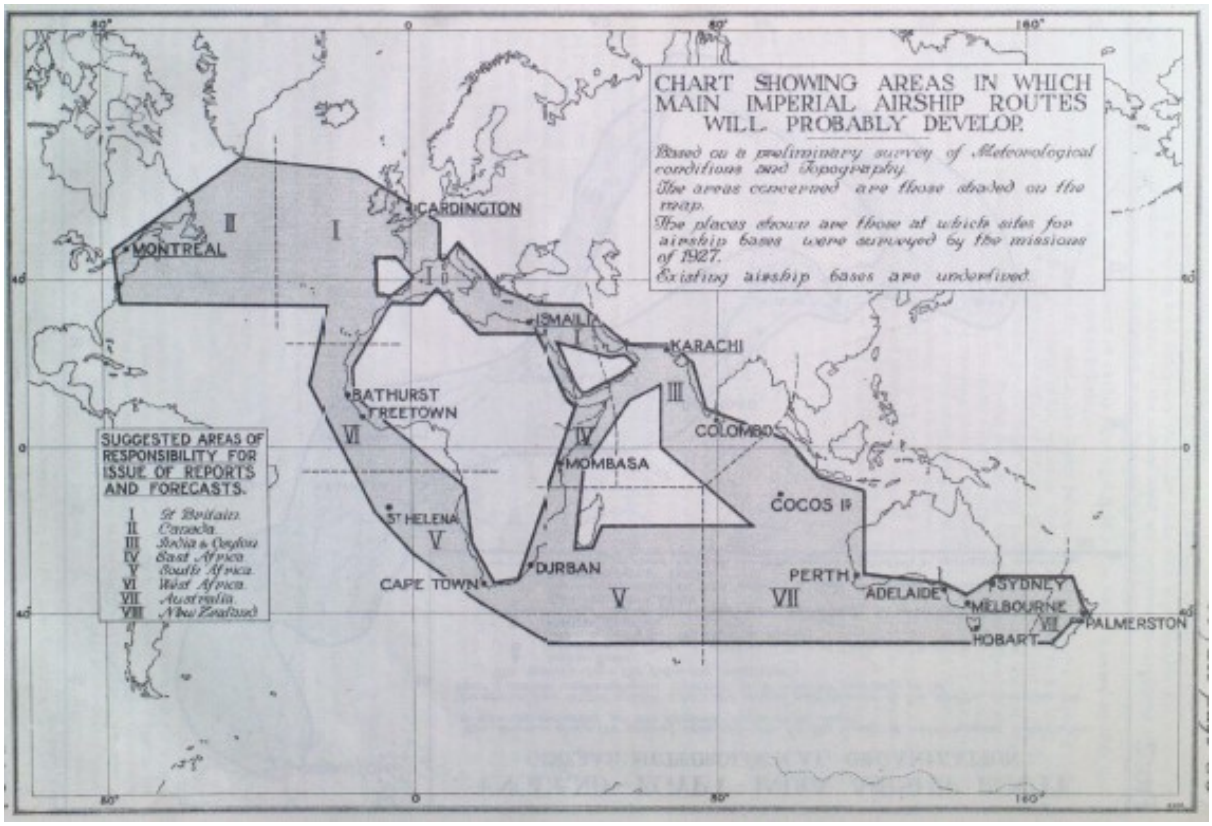

Figure 1. The anticipatory cartography of (probable) imperial airspace. Report of the Conference of Empire Meteorologists, HMSO, 1929

Concurrent developments in other emerging aerial powers illustrate what Butler (2001) calls the 'technogeopolitics' of interwar airspace, as well as the diversity of imaginaries which can become attached to single technologies. In Germany, Felix Eckener had taken on Count Zeppelin's mantle as the key driver of airship ambitions. The privations of the Versailles treaty, and particularly French concerns about aerial sovereignty, meant state support was muted (or at least surreptitious), and finance was sought from a section of the public concerned with Germany's technical and scientific renewal (Syon, 2002). Alliance and support was also sought from other nations. A proposed partnership with Spain to unlock new air routes to South America foreshadowed later forms of German neo-colonialism in the region (Cushman, 2006), and was draped in "a political vision of Imperial Spain revived with zeppelin galleons to carry the business wealth of the new world" (Duggan and Meyer, 2001: 81). Financial and technical cooperation was also sought with actors in the US, where the Navy was busy positioning airships as a key part of military ambitions in the Pacific. Their potential as "scouts sweeping the wide Pacific Ocean" meant that they became a key fixture of an imagined climax encounter with Japan, a mode of strategic thought that informed naval policy up until the onset of the World War II (ibid: 79). Amidst these imperial, military and

commercial imaginaries, airships were also positioned as agents of international cooperation in scientific exploration. This was useful in Germany, where Eckener surmised that "the Entente *cannot* deny us Germans the right to build an airship for purely scientific purposes" (quoted in ibid: 107). Geographical societies from Rome to Oslo identified the airship as a powerful new means of unlocking knowledge of sparsely-explored areas, particularly the polar regions. The Italian-built *Norge* conducted the first overflight of the North Pole in 1926, under the leadership of the Norwegian Roald Amundsen, in a curious admixture of intra-Scandinavian technological rivalry and Italian fascist nationalism (Capelotti, 1999). The latter was to be reinforced in 1928, when the *Italia* "circled the Pole, dropped proper flags and a papally-blessed cross, and sang the fascist anthem" (Duggan and Meyer 2001: 121). A few years later Soviet Russia would briefly flirt with the potential of indigenous airship development to showcase its superior mastery of space and technology, but Stalin's preference for aviation speed and height records would see the airship relegated to a bit-part player in imaginations of a Communist aerial future (Kulikowski, 2016).

Back in Britain, by the mid-1920s Burney had become the propagandist in chief of imperial airship development, at the same time as becoming the chief architect of its technical underpinnings. Circulating his ideas around Parliament and through his networks of engineering and military elites allowed an efficient enrolment of political and technical allies. The Admiralty, who foresaw a reserve 'aerial navy' in a commercial fleet, supported Burney and sought to regain control of Britain's airships from the Air Ministry. The latter, meanwhile, were largely defensive, wary of the intrusion of private enterprise into their domain at Cardington in Bedfordshire, home of Britain's modest wartime airship infrastructure. The Labour government which came to power in 1924 were broadly supportive of Burney's plans and sought compromise. Rather than start with six airships, Lord Thomson, the new Air Minister, opted to start with two, and Burney's plan for all the technical work to be done by a private company was transformed into an experiment in state versus private innovation. The two airships were to be designed separately to the same basic specs, one under Burney, Barnes Wallis, the engineer-cum-novelist Neville Shute and the Vickers Company at Howden in Yorkshire, and one directly under the Air Ministry at Cardington. The project continued under the subsequent Conservative administration, with Labour returning to power in 1929 when trial flights of the two ships – Burney's R-100 and the Ministry's R-101, were getting underway.

THE WEIGHT OF EXPECTATION

Imagination rests on expectation, in the form of assumed causal relationships between actions and reactions. In the case of large-scale technical projects like the airship scheme, causal relationships would be claimed at a broad scale between technical and social change, or between the public

performance of technologies and the spread of favourable opinion among various publics. At a more prosaic level, projects are guided by uncertain and often contested expectations of the performance of machines in future conditions which may be or may not be amenable to precise calculation. This sociology of expectations works through, and produces, various kinds spatiality, as a small number of geographers have recently shown (Milne, 2012; Porter and Randalls, 2014). There would be various ways of reconstructing the geographies of expectation which shaped the airship project. One could, for instance, examine the atmospheres of expectation, urgency and responsibility which pervaded the two construction sites as the two ships took shape. Or one could examine closely the role of schedules, timetables and budget projections in not only directing practices, but in building social relationships and distributing authority (cf. Shackley and Wynne, 1996). In this section however I'll focus on the spaces of performance and experimentation through which expectations of both near-term and long-term airship futures were produced and transformed.

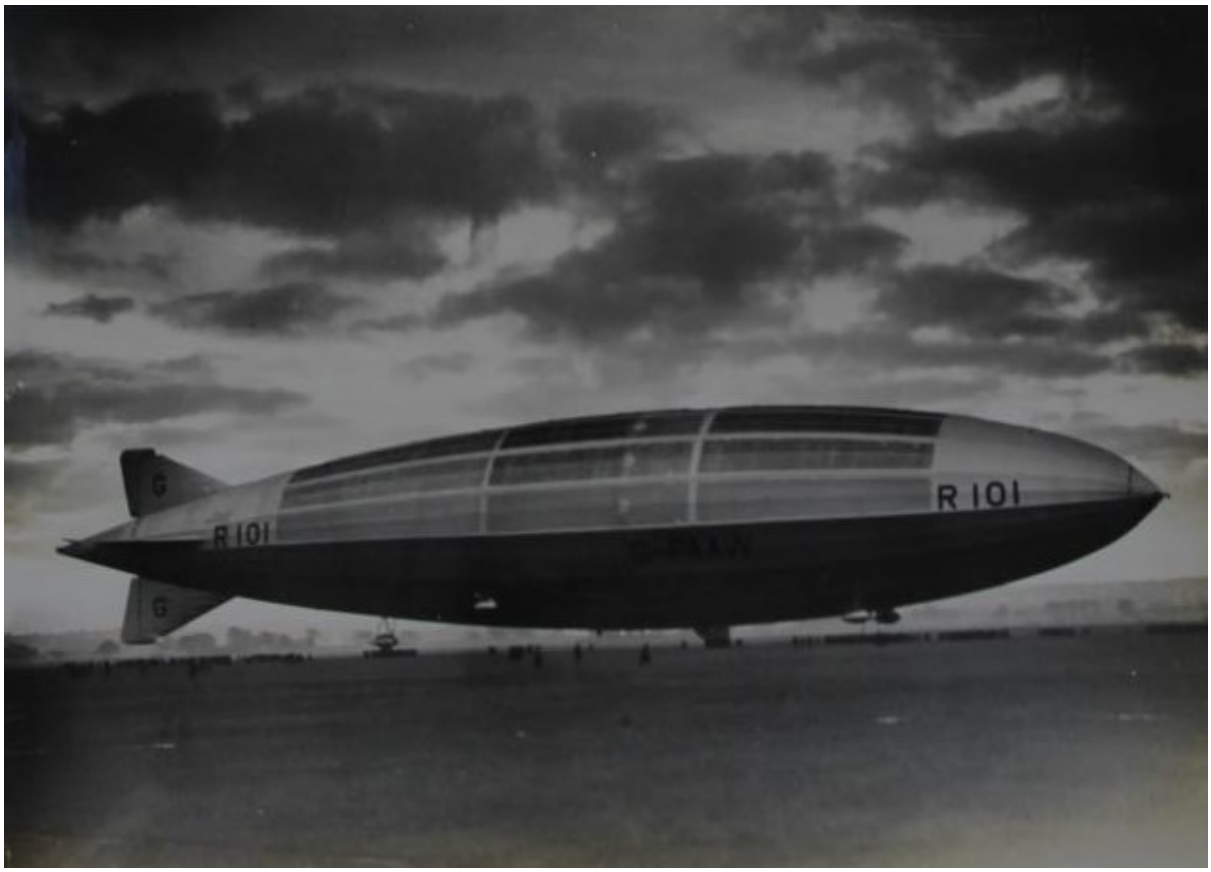

Figure 2. R-101 during an early test flight. Source: National Archives, AIR 59/4.

The two airships were from the outset about more than just aviation and empire, but about the public performance of a new role for the state in processes of technical and infrastructural innovation. R-100, the ship to be developed by Vickers at Howden, was so named as it was seen by

the Ministry as being the last in a line of British airships – from R.26 to R.80 – based on older Zeppelin technology. The 'state' airship, R-101, was meanwhile imagined as the first in a new line of innovative new ships, bristling with new, experimental technologies, which would cement the British position as a leader in rigid airship technology.[1] Despite significant rivalries between the two teams and the absence of significant information exchange between them, R-101 was developed very much in the public eye, with a highly active press section in the Air Ministry producing regular celebratory updates on the ship's progress. And as soon as that progress would allow, test flights were started which combined crucial technical trials with public spectacle. R-100 was the first to complete a long-distance trial flight, successfully crossing the Atlantic to Quebec in 3 days, prompting spectacular outbursts of imperial pride. The ship spent 12 days moored at Montreal, and it was estimated that 300,000 came to visit it, 70,000 of whom stepped on-board, while Burney himself went about imploring local dignitaries to get behind the scheme with some hard cash (Swinfield, 2012). Meanwhile, French Canadians deplored "the monster" as an instrument of British repression (quote from Duggan and Meyer, 2001: 169). Back in England, R-101 was struggling to keep up, and the success of R-100's transatlantic crossing increased the weight of expectation on R-101's planned inaugural flight to India. Thousands lined the roads around Cardington for the spectacle of the ship leaving its hangar on a still, chilly autumn morning in October 1929, and riotously greeted its return from a trial flight: "A large crowd, including many women, carried away with enthusiasm, broke into the aerodrome and rushed to the mooring tower. They cheered Major Scott [the captain] wildly".[2]

The overlapping of technical trial and public performance was most obvious when two of the contracted test flights of R-101 functioned respectively as the ships' rehearsal for, and participation in, the 1930 Hendon air show. As Pete Adey has shown, air shows in the interwar period were crucial sites for spreading 'air-mindedness', performing new socio-technical relationships, for materialising futures, and for "the projection of the nation into the sky" (Adey, 2010: 57). The air show, with its combination of spectacular aeronautics and behind-the-scenes access to the infrastructures of flight, was a complete sensory apparatus enveloping the spectator in what Adey calls "the environment of the air" (ibid: 60). At Cardington, this kind of sensory apparatus was a joint product of choreographed spectacle and the affective charge of an overjoyed crowd, breaking protocol to charge the mooring mast. At Hendon, R-101 drew on the air show vernacular of the seemingly-reckless stunt, which would nonetheless display the masterful union of pilot and machine. The ship

[1] This significance of the nomenclature is evidenced in a letter from Captain Scott to Barnes Wallis, quoted in Duggan & Meyer (2001: 111).
[2] 'Flying Hotel', *Daily Mail*, 15th October 1929.

performed a steep nose dive over the crowd, pulling up steeply at around 500ft., in a stunt which resulted in some structural damage to the ship, but which appeared to delight the thousands of onlookers and members of the press. Some saw it as an attempted dip of the nose to the King, others as an unintentional sign of innate aerodynamic instability. The engineers of R-100 were less than impressed, with Neville Shute later expressing his bemusement at this prioritisation of public spectacle over the sensible conduct of technical trials and controlled stress tests (Shute, 1954).

The shipping magnate Alan Anderson was likewise sceptical of the value of such performances. He was convinced that the age of the airship was about to begin, but wondered to the Air Minister whether, instead of spectacular stunts, it might be better if "one or both of the airships could be over the Bank of England at a fixed time every day or at stated intervals for a period" his view being that the "British public would be more deeply impressed [by that] than they would be by an occasional stunt flight".[3] Airship passengers weren't expected to be the masses who flocked to interwar air shows. Rather, they were the Empire's elite, like London's financiers, who might be persuaded to buy into the vision of Burney and others of smooth, luxurious conveyance between the financial hubs of the Empire. R-101 would be a "flying hotel", with the passenger-guests able to ballroom-dance after dinner, or survey the passing scene below from the promenade deck.

Lord Thomson himself participated in the performative engineering of expectations, taking to air on-board one of R-101's trial flights, papers in hand and "prepared for a day's work". The ship would become the Minister's office for the day, and he reported that "no one who has not had experience of this form of travel can have the least idea of its comfort, smoothness, and restfulness".[4] But while public expectations of luxury travel were being busily fashioned, critics of the airship scheme argued that these promises were dramatically ill-founded. One particularly prominent critic was the aptly-named Edward Spanner, a naval architect whose running commentary on the airship scheme culminated in his 1928 book *Gentlemen Prefer Aeroplanes!.* Drawing both on his technical expertise and on the gendered politics of 1920s aviation (Millward, 2008), Spanner took aim at the efforts of politicians and journalists to assure the public of the safety, stability and comfort or airship travel. While newspapers promised readers that they could soon be doing the "foxtrot in the clouds", Spanner sought to paint a picture of irreducible aerodynamic instability. He drew on the logbooks of airships built during World War I to highlight how in certain atmospheric conditions an airship has to pitch itself up or down, compensating for changing gas pressures or for the weight of falling rain or snow. While designers promoted the comparable luxury of airship and ocean liner travel, Spanner

[3] Samuel Hoare, Memorandum on meeting with Alan Anderson, AIR 5/996, National Archives, Kew [hereafter 'NA']
[4] *Illustrated London News*, 26th October 1929

offered diagrams which highlighted what the expected angles of tilt would look like in the case of an ocean liner, to illustrate just how unreasonable it would be to expect passengers to tolerate this kind of turbulence. While figures like Burney celebrated the lifting of British maritime culture into the air, Spanner suggested that the relative instability of the atmosphere in comparison to the ocean made the whole exercise impractical, even dangerous. He argued that "It must be recognised that the air is an extremely unstable medium through which to make a passage" (ibid: 33). He railed against the promises of comfortable travel, free from noise, dust, vibration and turbulence, insisting in a debate at the Institute of Naval Architects that "he did not see how it would be possible for passengers to move about on the dance floors, about which so much has been heard, without 'storm rails'".[5] The ship's chief designer countered that the amount of pitch in an airship would be insufficient to spill a cup of tea. In his book Spanner was more dramatic: "Only passengers closely confined in well upholstered quarters, plentifully supplied with handrails and protective devices, can expect to survive a Trans-Atlantic flight in a rigid airship" (ibid: 96). Far from fox-trotting in the clouds, passengers would be lucky to come out of them alive.

As argued above, the socio-technical imaginary of imperial airshipping featured an imaginative geography of the atmosphere as a kind of smooth space, ready to be traversed, to be conquered, by imperial technologies, re-harnessing the trade winds which had favoured Britain's earlier maritime expansion (Bankoff, 2017). Here, however, we see how this imaginary conflicted with understandings of the atmosphere as a much more vibrant, unstable, even violent place, where airships would be vulnerable to a range of perhaps unpredictable physical forces. Accusations circulated that efforts to engineer expectation in support of the dominant imaginary had pushed-out efforts to comprehend the atmosphere differently: "I must point out", wrote one Air Ministry staffer to the Minister, "that Cmdr. Burney in his eagerness to inflame imagination has skated over the very serious Meteorological difficulties involved in his series of demonstration flights".[6]

The two airships wouldn't just be flying over southeast England, where most of their trial flights were scheduled to take place. Technical expectations also had to be fashioned of how bits of the ships would respond in different climates. A program of climatic experimentation was begun, involving, for example, exposing different covering fabrics to the Egyptian sun, and a new study of average atmospheric conditions at and around mooring masts in tropical locations. A particular worry concerned the use of petrol engines in the tropics, and whether they would simply burst into flames as soon they encountered the intense heat of the deserts of Iraq or the plains of northern

[5] 'State Airship Policy - Particulars of the R101', *The Times,* 31st March 1928.
[6] Anonymous memo to Secretary of State for Air, AIR 5/1059, NA.

India. An imaginative geography of climatic excess demanded experimentation in order to build expectations about the results of a confrontation between machine and tropical climate. Where information on local climates wasn't available, standardised instruments were despatched from Kew Observatory, and a new comparative climatology of the empire developed, where in the past meteorological and climatological coordination had been minimal (Mahony 2016). But Kew was not only the home of standardised instruments, as it had been since the mid-19th century (Macdonald, 2015); in this particular project, Kew was also the standard climate – "the known climate of [Kew]…may be taken as the standard of reference when considering the particulars for places overseas" read one report.[7] Of course, imaginative geographies of the excesses of tropical climates always rested on an idea of climatic normality at home (Livingstone, 2002; Driver, 2004), but this is perhaps the first time that this distinctly imperial gesture was explicitly codified in the organised production of climatological knowledge. Divergences in the design of the ships themselves were increasingly seen in climatic terms, competition between the two transforming into meteorological complementarity, with R-100 and R-101 respectively aiding "materially the arrival of long-distance airship routes in both temperate and tropical climates".[8]

The fearful projection of climatic excess informed the replacement of R-101's petrol engines with weightier crude oil motors, the segregation of petrol and tropical climate inscribed in Air Ministry policy.[9] Reporters were treated to demonstrations of the new fuel's safety, Wing Commander Cave-Brown-Cave extinguishing a burning tray of petrol by smothering it with oil.[10] To take the extra weight, the ship was cut in two and an extra bay inserted, and the gas bags allowed to expand so more lift could be generated. Signs of the over-inflated bags chafing on the metal framework were met with padding on the sharp edges, and as the date of the craft's maiden voyage to India approached, anxiety about the lack of testing of the new configuration in all weather conditions began to take hold. Testing of the load-bearing capacity of the new frame was largely confined to pen-and-paper calculations rather than real encounters with the atmosphere. Even Burney himself was starting to express anxiety about the fate of the trial ships. The publication of his book in 1929 was itself a highly politicised intervention in the contest of expectations. He described a number of technical drawbacks of the "experimental" craft, perhaps anticipating that failure would irrevocably damage the whole development trajectory, whereas failure under experimental conditions could perhaps be tolerated. The ships under development were cast as "merely preliminary steps in the

[7] 'Selection of airship bases: preliminary report on Mauritius', p1. National Meteorological Library and Archive, Exeter [hereafter NMLA].
[8] 'The State Airship', *The Times*, 27th July 1928
[9] See the discussion in in AIR 5/1060, NA.
[10] 'State Airship', *The Times*, 24th August 1928.

evolution of a practical commercial vessel", and not themselves commercially viable. They may safely carry passengers on demonstration flights, when favourable conditions could be chosen, but a regular commercial service would require the technical resilience to withstand all manner of atmospheric conditions (Burney, 1929: 220). The Ministry carefully rebutted the idea that the lack of immediate commercial viability meant that airships in general were non-starters: "We expect that as a direct result of the knowledge now available there will be a great future for airships, not only as a means of making the far corners of the world easily accessible, but also as a means of developing the trade and commerce of the Empire to a degree never before contemplated".[11] A key element of that emerging knowledge, and of the technical resilience required by a regular service, was a new infrastructure of weather observation which would inform our third mode of futuring – prediction.

PREDICTING THE ATMOSPHERIC MILIEU

> *The air is a mysterious element, where tremendous and, as yet, incalculable forces are encountered. Scientists can predict the normal consequences of these forces, but not their vagaries; to the latter the only guide is practical experience, acquired painfully, perilously, and often unexpectedly.*
>
> (Thomson 1927, 112).

Efforts to map and anticipate the atmospheric environment through which airships would venture had a transformative effect on meteorology. During World War I and the immediate aftermath, many aeroplane pilots had been sceptical about the value of meteorology in helping them navigate the atmosphere (Harper, 2008). But airships were a different prospect. While aeroplanes work by outrunning gravity, generating lift with speed, airships defeat gravity primarily by working *with* the atmosphere. The buoyancy of balloons and airships is a product of relationships between the gases inside and the air outside; relationships shaped by things like temperature, pressure, sunlight, and precipitation (McCormack, 2009). Changes in temperate and pressure affect the density of the airship's gas in relation to the air around it – especially significant for a ship voyaging from temperate to tropical latitudes – while rainfall or snowfall add weight to the ship, requiring compensation in forced changes of pressure or weight, perhaps by jettisoning stored water or, in extreme situations, dumping fuel. The piloting of an interwar airship was therefore a complex process of working with the atmosphere through 'the feel' of the ship; of making small adjustments of weight, pressure, altitude and pitch to compensate for changes in the immediate atmospheric environment. In part these atmospheric changes would be sensed through the response of the

[11] 'Great care with R-101', *Daily Telegraph*, 11th October 1929.

airship itself, or through the instruments available to the captain, and adjustments made. The gas bags and hull of R-101 were fitted with a system of valves so that gas could be automatically vented in response to changing atmospheric conditions: "an ingenious adaptation of the principle of fish gills" permitting "the hull envelope to 'breathe'."[12] But changing atmospheric states could also be anticipated as functions of weather. Airship captains generally tried to avoid headwinds and vertical air currents, and to navigate around storms (Roach, 1981). But some captains continued to take a rather gung-ho attitude towards meteorological risk – Neville Shute related how on the R-100's voyage to Canada, as the ship approached a storm:

> I was in the control car with [Captain Scott] before we went up for sherry, and heard him make the decision to go through it rather than fly round it; we had ample fuel and there was no occasion to take the ship, already damaged, through this storm. In my view, even with the lesser knowledge of those days, Scott should have known better and this decision was a reckless one (Shute, 2009: 119).

Airshipping required an appreciation of atmospheric processes on a finer scale than organised meteorology had until that point been able to tackle. This point was driven home by the loss of the USS Shenandoah in a squall line over Ohio in 1925, the inquest's report calling for a much denser observational network so that such violent disturbances might be foreseen. What's more, the routes of the imperial airship scheme meant that portions of the atmosphere would have to be traversed which until that point had been relatively under-explored. As the Conservative Air Minister put it in his *Empire of the Air*:

> "The need was … to chart the air just as the sea had been charted by generations of hydrographers. Whilst it had taken centuries to chart the seas, we were attempting to chart the air in a few months" (Hoare, 1957: 225)

Despite the numerous rhetorical and practical analogies drawn between the airship and earlier forms of oceanic mobility, aviation meteorology brought about something of a continental turn in the sciences of the weather. The earlier global achievements of British meteorology concerned the trade winds and the general circulation, pieced together from the experiences of mariners, and offered as an aid to navigators (Naylor, 2015; Bankoff, 2017). With the advent of steam-powered ships, wind patterns had arguably become less significant for trade, except in the case of extremes and storms. This led some to worry that while steam shipping had freed British trade from the

[12] 'The State Airship', *The Times*, 27th July 1928

vagaries of the wind, airshipping promised to place imperial transport once again at the mercy of an unpredictable atmosphere. But in the case of the route to India, this atmosphere was largely to be that above land, and new efforts were underway to expand meteorological infrastructures across Britain's continental possessions. Throughout the 1920s, hastily arranged meteorological services were rolled-out in territories such as British East Africa and British Malaya (Mahony, 2016), and new airspace produced through the rapidly evolving practices of aviation meteorology – pilot ballooning, synoptic charting, and point-to-point forecasting (Turner, 2010; Henry, 2014).

At the metropole, an Airship Meteorological Division was set up under Maurice Giblett at Cardington. Giblett had worked as a meteorologist with the Royal Engineers during the war and subsequently earned a reputation as a reliable operator in the Forecasting Division of the Met Office. Part of his job saw him touring prospective airship routes, advising local governments on the kinds of material and informational infrastructure they would need to set up, and scouting out the atmospheric conditions at potential airship bases. Giblett's Cardington Division created new geographies of circulating meteorological information, as data started to flow towards the metropole from Malta, Ismailia, Baghdad, Karachi and beyond. Up until this point the London Meteorological Office had taken little interest in compiling weather data directly from the colonies, and relied mainly on whatever happened to be published by colonial governments or scientists. Now the circulation of information intensified, and the first achievement of Giblett's outfit was a synoptic chart stretching from England to India (figure 3). This chart is not climatological, showing average or expected conditions, but is properly meteorological, showing a snapshot of weather conditions at a particular point in time. This was the first time that this atmospheric space had been charted in such detail, although the chart tells as much about the geographies of observation as about the dynamics of the weather itself. The red and blue symbols tell of expanding European observation networks, provisional meteorological forays into colonial territories, and emphasise the largely blank spaces of the Middle East, traversed only by projected pressure contours – the major lacunae and a source of climatological anxiety about the dynamics of the "torrid middle-eastern summer" and its effects on the stability and buoyancy of British airships (Duggan and Meyer, 2001: 132).

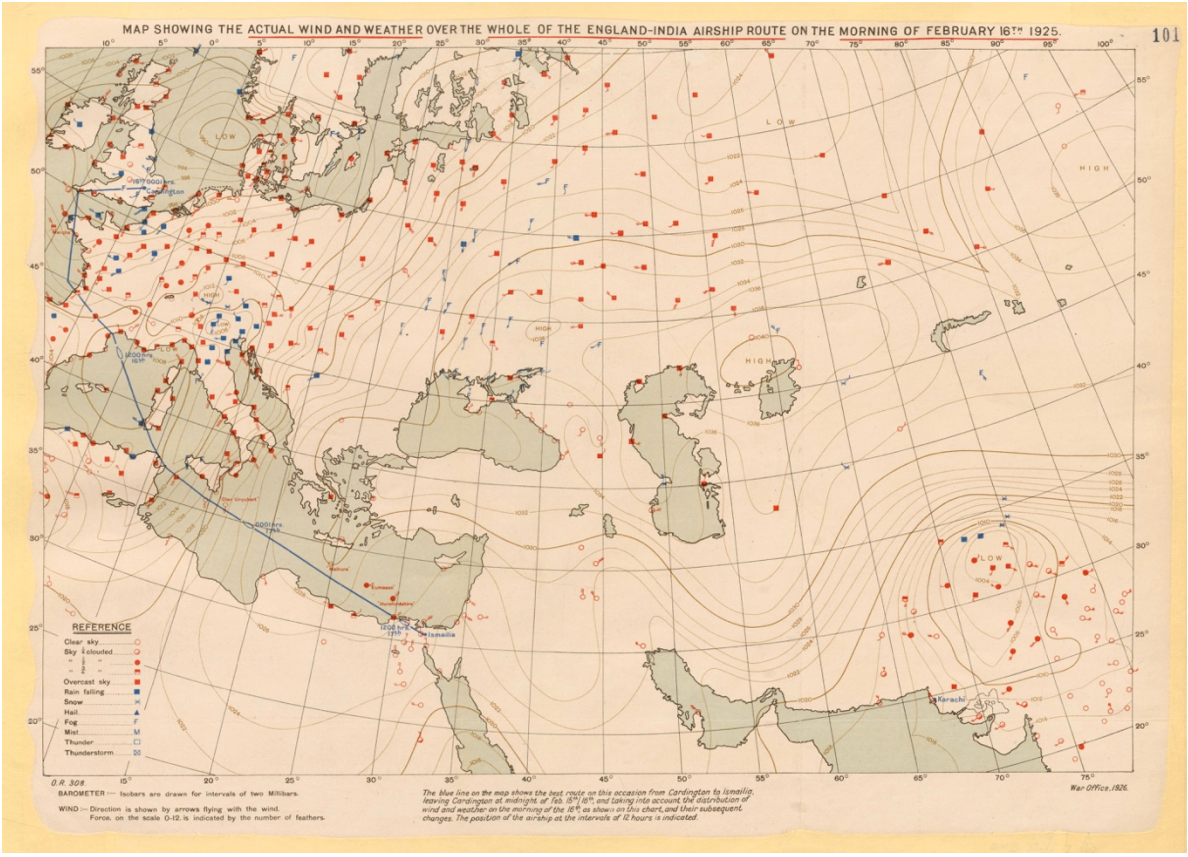

Figure 3. Source: National Archives MPI 1/410/6, NA.

This striving for new horizontal coverage of the atmosphere was matched by an interest in the vertical structure of the atmosphere on a fine scale. A new granularity was introduced into meteorology, expressed at Cardington in new spaces and architectures of weather observation. A network of towers was constructed, each rigged with a number of instruments with an emphasis on recording wind. This enabled new analysis of the three-dimensional "structure of wind", its patterning in space and time, and its interactions with the landscape – represented for example in graphs of wind speeds recording at the scale of seconds, rather than hours (Giblett, 1932). Such knowledge could guide the anticipation of the what McCormack labels, in a Spinozist move, the 'agreement' between aerostatic object and a body of windy air (McCormack, 2009: 33). The cost of suspension in a still parcel of air was the risk of violent displacement when things became more turbulent, and while some worried that such "disturbances are too varied and complex to be known",[13] attempts at risk mitigation could be made through precise calculation of the forceful effects of gusts on the structure of the ship, through new possibilities of anticipating fine-scale atmospheric movements, and through the bodily responses of the pilots when the "stillness in

[13] 'Factors of safety for airships', AIR 5/1018, NA

motion" of steady flight was disrupted by the "sudden, rapid uncontrolled" movement of a ship thrown into sudden disequilibrium with its atmospheric environment (McCormack 2009, 33, 36).[14]

Through new meteorological practice the atmosphere was comprehended as a lively and perhaps unpredictable environment. The limits of what could be predicted, or of what could be instrumentally recorded, were inscribed in new spaces of meteorological practice, such as a new elevated meteorological centre, which raised meteorologists to the same level as airship pilots as they approached the mooring mast (see figure 4). The meteorologist could thus visually observe those atmospheric processes which eluded instrumental recording, and the effects of those processes on an approaching ship. In the 1920s forecasting the weather meant constructing a synoptic chart of observations, eyeballing it for patterns, and offering a prediction of what those patterns meant for the weather in 6 or 12hrs time (Nebeker, 1995). This highly involved work of mapping, interpretation and judgment meant that for early airship flights, a meteorologist was usually required on-board – and saw the rise of what Jakob Bjerknes termed "cubby hole forecasting", the plotting and interpretation of large charts in cramped spaces.[15] Even when meteorologists were only accessible at the end of the wireless, the emphasis was on a close interaction of meteorologist and pilot, and on the meteorologist's subjective interpretation of the weather and its predicted evolution. Decisions to fly were shaped by these predictions, but also by more tacit expectations of the performance of ship and crew in different atmospheric conditions. Simulations were conducted to "practise the navigational work involved in taking a ship out from Cardington to an Empire base under the prevailing wind and temperate conditions",[16] an anticipatory production of virtual airspace (Budd and Adey 2009). By late 1930, the virtualities of predicted weather and navigational rehearsal would shape the decision to fly for India.

[14] In the years to follow Cardington would become a centre of what's now called boundary layer meteorology – the fine scale study of the interactions of atmosphere and the surface of the earth – a legacy of this early work on anticipating the atmospheric environments of airships (Walker, 2012).
[15] J. Bjerknes to M. Giblett, reproduced in E. Holmes, *Airship Meteorologist*, p108, NMLA, 629.733.5 HOL
[16] 'State Airship', *The Times,* 24th August 1928.

Figure 4. Cardington Meteorological Tower. Source: National Archives, AIR 59/4.

THE ENDS OF FUTURES PAST

Imagination, expectation and prediction collided forcefully on night of the 4th October 1930, the date of R-101's maiden voyage to India. By the time of the final few months of R-101's development, the Labour Party were back in office and Lord Thomson was back in charge at the Air Ministry. His personal investment in the scheme was always evident, having given himself the title of Lord Thomson of Cardington, and he took a leading role in propagandising the ship (Pirie, 2009). Much speculation surrounded the intersection between Thomson's airship enthusiasm and his apparent desire to be the next Viceroy of India. Thomson, who had been born in Nasik in India, had his first involvement in ballooning when attached to the Royal Engineers balloon battalion during the Boer War. Since then, he'd proved himself a perceptive military attaché and was seemingly eyeing a career in imperial governance. As Neville Shute put it,

> he wished to visit his new empire in the new vehicle of Imperial communications that he had a hand in producing, arriving from the skies in a manner unknown to any previous Viceroy (Shute, 2009: 137).

The return journey would be spectacle too. Towards the end of 1930 a conference of Dominion premiers was scheduled in London, and Thomson was keen that the return flight to India be completed before the conference began. The Dominions heads had "peeped into the future" with a visit to the ship during a previous conference in 1926, enjoying unique access to the 'Government secrets' of the ship's construction.[17] Come 1930, the premiers were to be persuaded to continue investing in airship infrastructure, and the spectacle of the Air Minister returning safely and speedily from India to chair the proceedings would be a propaganda coup too good to pass up. But spectacle was not just planned for the journey's endpoints. Earlier in the year the British government had refused a German airship passage over Egypt, to preserve the novel spectacle of an airship flying over the pyramids for their own craft. Thomson was to host a banquet of local dignitaries while at the mast at Ismailia, the ship carrying extra fuel so that guests wouldn't be disturbed by the sound and smells of refuelling during dinner. Although he stressed that no risks should be taken on his account, sources agree on the presence of a fevered atmosphere of last-minute engineering to get the ship ready for the voyage of the Viceroy-in-waiting (e.g. Swinfield, 2012; Masefield 1982). An air worthiness certificate was hastily granted by the Air Ministry, and with that, R-101 was ready to set off.

The weather throughout the 4th of October was dire. A period of relatively settled weather had been punctured by the arrival of a large depression. The 1pm synoptic chart suggested winds of 20-30mph over northern France – not especially dangerous, but conditions at Cardington worsened throughout the afternoon. Whether Giblett himself supported the decision to depart cannot be precisely known. A biography written by his daughter describes the stress he was under in the hours and days before the departure, grappling with the uncertain information at his disposal, issuing a forecast according to orders when perhaps no reliable forecast was really possible. It was a prediction which could have been used by those responsible for the decision to fly or not to justify either call – to wait for the weather to clear, or to brave the apparently moderate winds. Despite the uncertainty about the weather itself, Giblett was apparently confident of the risk-aversion of his superiors, his last words to his family before he set off for the aerodrome being "Don't worry, we won't be going" (Holmes 2008: 285). The passengers, who included a number of Air Ministry officials and experts who'd been involved in the whole scheme, climbed aboard, and were followed by an unexpected number of

[17] 'Great Liner of the Air', *Dundee Evening Telegraph*, 18th November 1926.

cases of wine and a fine carpet for the Egyptian banquet, as well as a keg of beer, festooned with British and Indian flags, gifted by the local hotel where a farewell lunch had been hosted. The ship set off in the early evening in the drizzling rain, to the strains of a brass band playing *Land of Hope and Glory* and *God Save the King*.

A new forecast wasn't available until just after 8pm, which suggested much stronger winds of 40-50mph. This turned out to be much closer to the truth, and once over northern France the ship struggled against strong headwinds and driving rain. Shortly after the 2am change of watch, and before the new crew could get a feel for conditions, it seems a violent down draft caused the ship to go into a dive, opening a tear in the covering fabric, causing hydrogen to escape, thus triggering a second, fatal dive into a hillside, upon which the ship burst into flames. All but six of the 52 on-board were killed, including Lord Thomson, his valet and many of his advisors, and Maurice Giblett.

The victims of R-101 were lauded in the press as fallen heroes, sacrificed to the imperial cause, and memorialised with services at Westminster Abbey and St Paul's cathedral – the 'Empire's Valhalla' as the Pathé Gazette described it (Pirie, 2009: 135). The atmosphere of 4th October, both meteorological and affective, became a matter of official inquest as experts and witnesses to a Court of Inquiry tried to reconstruct the story of the ship's troubled technical development, what had been known about the weather of that fateful evening, and how the decision to fly had been made. In addition to a combination of bad weather and structural faults, some caused by the alterations made to adapt the ship to tropical climates, the Inquiry's final report honed in on "the atmosphere in which the decision to start was taken". The report describes an affective atmosphere formed by a complex web of expectations: the knowledge that the flight was experimental, and that its elemental encounters could not be wholly predicted with "theoretic calculations"; the elongated and frustrating period of waiting for the ship to be ready, which had been neither "anticipated or calculated"; the awareness that funds for further airship development, for which plans existed, were contingent on the outcome of this flight; the relative success of R-100's voyage to Canada; "the personality of the Secretary of State"; and the "hopes" of the "resolute men who believed wholeheartedly in the policy". As for the weather, it was concluded that it was "doubtful if a start would have been made had wind speeds been accurately forecast 12 hours in advance". The Inquiry didn't blame any individual for the failings which apparently caused the crash. But it did state that it was

> impossible to avoid the conclusion that the R-101 would not have started for India on the evening of October 4th if it had not been that matters of public policy were considered as making it highly desirable that she should do so.[18]

A rather different form of inquest was led by an Irish medium, Eileen Garrett, who achieved fame when she claimed to have channelled, in the presence of a journalist, testimony from Herbert Irwin, who was commanding the ship with Scott, just two days after the crash: Irwin reportedly said "Engines wrong . . . too heavy . . . cannot rise. No one knew ship properly. Weather bad for long flight. All hopeless . . . no hope" (Leasor, 1957). Garrett's claims caused a stir in the press, and the Air Ministry's Major Oliver Villiers, a close friend of Irwin and Scott, participated in two further séances with Garrett. Villiers claimed to have received detailed, verifiable information from the discarnate Irwin, and he met with the head of the Court of Inquiry to discuss getting the evidence admitted. But despite his best efforts, his evidence was discounted, the voices of the dead were absent from the Inquiry. The American journalist John G. Fuller brought the story back to public attention with his 1981 book *The Airmen Who Would Not Die*, situating the R-101 disaster within a broader cultural lineage of aerial mysticism, which harked back to the earliest airship scares (Adey, 2010: 54-6). Here, the meteorological atmosphere was no longer a space of imperial projection or calculative rationality, but an alternative, ethereal space of being where very different forms of knowledge and foreknowledge were possible:

> It seemed almost as if there were some kind of fantasy or even reality to the idea that those who flew above the earth in planes and airships developed perceptions over a period of time that made them more sensitive to thought waves and other dimensions that other men [sic] failed to perceive (Fuller, 1981: 342).

CONCLUSION

Thinking imagination, expectation and prediction together provides a fruitful way forward for reconstructing historical geographies of the future. Building on a developing literature on the geographies of anticipation and expectation, I've suggested that we interrogate both the material and imaginative geographies brought into being by these practices of futuring. In this article I've focused on imaginative and material encounters with the atmosphere, as a space where imperial futures were projected, climatic anxieties negotiated, and the chaos of turbulent matter fatefully reckoned with by meteorological minds and piloting bodies. These practices of futuring work on and

[18] 'Report of the R-101 Inquiry', p.95-6. HMSO, 1931.

through present geographies (Anderson 2010) – whether the changing spaces of meteorological knowledge production, the overlapping spaces of public spectacle and performance-testing, or the circuits of elite knowledge, influence and alliance through which a socio-technical imaginary of imperial airshipping gained performative power.

The historical geography of imperial airshipping also contributes to wider debates on the cultural and political geographies of the atmosphere. It offers the opportunity to historicize contemporary concern with the changing relationships between atmosphere, territory and technology expressed most forcefully in the literature on drone warfare (e.g. Gregory, 2011; Shaw, 2016). The framework introduced in this paper can help us dig deeper into the technologies around which new spatial relationships are being assembled, to interrogate their loading with imaginative projections and weighty expectations, and thus to identify points at which such innovations may be contested or re-directed. The analysis presented above also joins with new materialist scholarship in offering the atmosphere as a vital space of critical geographic inquiry, but contends, following Barry (2015), that greater analytical attention to societies' anointed spokespeople for non-human matter (in this case meteorologists), and the politics of their expertise, can reveal more about how social relationships are mediated through the materiality of technical innovation and elemental encounter (Adey 2015).

In the end, no British airship ever made it to the tropics. The scheme was halted, R-100 was steamrollered and sold for scrap – some of which, it is rumoured, ended up in the Hindenburg, whose fiery end in 1937 bought the interwar passenger airship age quite conclusively to an end, just as intercontinental aeroplane flying was becoming established. In Germany, re-purposed airships took on sentinel roles at the militarised border, with new electronic surveillance technologies employed to pick up non-German radio broadcasts. The airship has recently reappeared in new future-making projects, with one of the UK's chief climate change diplomats frequently promoting the technology as a solution to the environmental impacts of jet aviation and global freight transport. Dirigibles have also appeared on the contested horizon of 'Brexit', as a possible solution to the fraught question of the Irish border. Reprising their later use in Germany, they've been envisaged as an alternative to a 'hard border' on the ground by being ever-present in the air, monitoring the comings and goings of trade in partnership with a fleet of drones. Once again, in political imaginaries of a future Britain, forged in a time of national anxiety, the airship floats into a view as a socio-technical solution to a fraying territorial order.

ACKNOWLEDGEMENTS

The development of the ideas in this paper owes much to colleagues in the Cultural & Historical Geography group at the University of Nottingham, and to conference and seminar audiences at the RGS-IBG, the London Group of Historical Geographers, National University of Singapore, Hong Kong Maritime Museum and Anticipation-2017.

REFERENCES

Adey, P. (2010) *Aerial Life: Spaces, Mobilities, Affects*. Oxford: Wiley-Blackwell.

Adey, P. (2015). Air's affinities: Geopolitics, chemical affect and the force of the elemental. *Dialogues in Human Geography*, 5(1), 54–75.

Adey, P., Whitehead, M. and Williams, A. (2013) *From Above: War, Violence and Verticality*. Edited by P. Adey, M. Whitehead, and A. Williams. London: Hurst.

Amoore, L. (2009) 'Lines of sight: on the visualization of unknown futures', *Citizenship Studies*, 13(1), pp. 17–30.

Amoore, L. (2016) 'Cloud geographies: Computing, data, sovereignty', *Progress in Human Geography*. SAGE Publications.

Anderson, B. (2010) 'Preemption, precaution, preparedness: Anticipatory action and future geographies', *Progress in Human Geography*, 34(6), pp. 777–798.

Anderson, B. (2016) 'Governing emergencies: the politics of delay and the logic of response', *Transactions of the Institute of British Geographers*, 41(1), pp. 14–26.

Anderson, B. and Gordon, R. (2016) 'Government and (non)event: the promise of control', *Social & Cultural Geography*, 9365(September), pp. 1–20.

Anderson, K. (2005) *Predicting the Weather: Victorians and the Science of Meteorology*. Chicago, IL: University of Chicago Press.

Andersson, J. (2012) 'The great future debate and the struggle for the world', *American Historical Review*, 117(5), pp. 1411–1430.

Augé, M. (2014) *The future*. London: Verso.

Baker, Z. (forthcoming) 'Meteorological Frontiers: Climate Knowledge, the West, and U.S. Statecraft, 1800-1850', *Social Science History*.

Baldwin, A. (2016) 'Premediation and white affect: Climate change and migration in critical perspective', *Transactions of the Institute of British Geographers*, 41, pp. 78–90.

Bankoff, G. (2017) 'Aeolian empires: The influence of winds and currents on European maritime expansion in the days of sail', *Environment and History*, 23(2), pp. 163–196.

Barry, A. (2015) 'Thermodynamics, matter, politics', *Distinktion: Scandinavian Journal of Social Theory*, (August), pp. 1–16.

Beckert, J. (2016) *Imagined futures: fictional expectations and capitalist dynamics*. Cambridge, MA: Harvard University Press.

Bell, D. (2007) *The idea of greater Britain: empire and the future of world order, 1860-1900*.

Princeton, NJ: Princeton University Press.

Blok, A. (2010) 'Topologies of climate change: actor-network theory, relational-scalar analytics, and carbon-market overflows', *Environment and Planning D: Society and Space*, 28(5), pp. 896–912.

Borup, M. *et al.* (2006) 'The sociology of expectations in science and technology', *Technology Analysis & Strategic Management*, 18(October), pp. 285–298.

Bowler, P. J. (2017) *A History of the Future: Prophets of Progress from H. G. Wells to Isaac Asimov*. Cambridge: Cambridge University Press.

Bowles, G. F. S. (1926) *The Strength of England*. London: Methuen.

Braun, B. (2015) 'Futures: Imagining Socioecological Transformation: An Introduction', *Annals of the Association of American Geographers*, 105(2), pp. 239–243.

Burney, C. D. (1929) *The World, the Air and the Future*. London: A.A. Knopf.

Butler, D. L. (2001) 'Technogeopolitics and the struggle for control of world air routes, 1910-1928', *Political Geography*, 20(5), pp. 635–658.

Capelotti, P. J. (1999) *By airship to the North Pole : an archaeology of human exploration*. New Brunswick, NJ: Rutgers University Press.

Carroll, S. (2015) *An Empire of Air and Water: Uncolonizable Space in the British Imagination, 1750-1850*. Philadelphia, PA: University of Pennsylvania Press.

Chaturvedi, S. and Doyle, T. (2015) *Climate Terror: A Critical Geopolitics of Climate Change*. London: Palgrave Macmillan.

Collard, R.-C., Dempsey, J. and Sundberg, J. (2015) 'A Manifesto for Abundant Futures', *Annals of the Association of American Geographers*, 105(2), pp. 322–330.

Connor, S. (2010) *The Matter of Air: Science and Art of the Ethereal*. London: Reaktion Books.

Cushman, G. T. (2006) 'The Struggle over Airways in the Americas, 1919-1945: Atmospheric science, aviation technology, and neocolonialism', in Fleming, J. R., Janković, V., and Coen, D. R. (eds) *Intimate Universality: Local and Global Themes in the History of Weather and Climate*. Sagamore Beach, MA: Science History Publications, pp. 175–222.

Daniels, S. and Lorimer, H. (2012) 'Until the end of days: narrating landscape and environment', *Cultural Geographies*, 19(1), pp. 3–9.

Davidson, R. (2012) 'Mad scientists, airships and class: the politics of Steampunk', *Overland*, June.

Davison, P. (2015) 'The R.101 story: a review based on primary source material and first hand accounts', *Journal of Aeronatical History*, 2, pp. 43–167.

Derickson, K. D. and MacKinnon, D. (2015) 'Toward an Interim Politics of Resourcefulness for the Anthropocene', *Annals of the Association of American Geographers*, 105(2), pp. 304–312.

Driver, F. (2004) 'Imagining the tropics: Views and visions of the tropical world', *Singapore Journal of Tropical Geography*, 25(1), pp. 1–17.

Duggan, J. and Meyer, H. C. (2001) *Airships in international affairs, 1890-1940*. Basingstoke: Palgrave.

Engelmann, S. (2015) 'Toward a poetics of air: sequencing and surfacing breath', *Transactions of the Institute of British Geographers*, 40(3), pp. 430–444.

Engerman, D. C. (2012) 'Introduction: Histories of the Future and the Futures of History', *American Historical Review*, 117(5), pp. 1402–1410.

Eshun, K. (2003) 'Further Considerations of Afrofuturism', *CR: The New Centennial Review*, 3(2), pp. 287–302.

Fall, J. J. and Minca, C. (2012) 'Not a geography of what doesn't exist, but a counter-geography of what does: Rereading Giuseppe Dematteis' Le Metafore della Terra', *Progress in Human Geography*, 37(4), pp. 542–563.

Farbotko, C. and McGregor, H. V. (2010) 'Copenhagen, Climate Science and the Emotional Geographies of Climate Change', *Australian Geographer*, 41(2), pp. 159–166.

Fine, G. A. (2009) *Authors of the Storm: Meteorologists and the Culture of Prediction*. Chicago, IL: University of Chicago Press.

Freedman, A. (2004) 'Zeppelin Fictions and the British Home Front', *Journal of Modern Literature*, 27(3), pp. 47–62.

Fuller, J. G. (1981) *The airmen who would not die*. London: Corgi.

Gilbert, D. and Driver, F. (2000) 'Capital and Empire: Geographies of Imperial London', *GeoJournal*, 51, pp. 23–32.

Gilbert, D. and Lambert, D. (2010) 'Counterfactual geographies: Worlds that might have been', *Journal of Historical Geography*. Elsevier Ltd, 36(3), pp. 245–252.

de Goede, M. and Randalls, S. (2009) 'Precaution, preemption: arts and technologies of the actionable future', *Environment and Planning D: Society and Space*, 27(5), pp. 859–878.

Goswami, M. *et al.* (2012) 'Imaginary Futures and Colonial Internationalisms', *American Historical Review*. Malkki Mark Mazower Peter Lawler Tom Nairn, 117(5), pp. 1461–1485.

Gregory, D. (2011) 'From a View to a Kill', *Theory, Culture & Society*. SAGE PublicationsSage UK: London, England, 28(7–8), pp. 188–215.

Hall, C. (2002) *Civilising subjects: colony and metropole in the English imagination, 1830-1867*. Chicago, IL: University of Chicago Press.

Harper, K. (2008) *Weather by the Numbers*. Cambridge, MA: MIT Press.

Hawkins, H. *et al.* (2015) 'The Art of Socioecological Transformation', *Annals of the Association of American Geographers*, 105(2), pp. 331–341.

Heffernan, M. (1999) 'Historical geographies of the future: three perspectives from France', in Livingstone, D. N. and Withers, C. W. J. (eds) *Geography and Enlightenment*. Chicago, IL: University of Chicago Press, pp. 125–164.

Henry, M. (2014) 'Australasian airspace: meteorology, and the practical geopolitics of Australasian airspace, 1935-1940', in Beattie, J., O'Gorman, E., and Henry, M. (eds) *Climate, Science, and Colonization: Histories from Australia and New Zealand*. Basingstoke: Palgrave Macmillan, pp. 233–250.

Heymann, M., Gramelsberger, G. and Mahony, M. (2017) *Cultures of prediction in atmospheric and climate science: epistemic and cultural shifts in computer-based modelling and simulation*. Edited by M. Heymann, G. Gramelsberger, and M. Mahony. London: Routledge.

Hilgartner, S. (2015) 'Capturing the Imaginary: Vanguards, Visions, and the Synthetic Biology Revolution.', in Hilgartner, S., Miller, C. A., and Hagendijk, R. (eds) *Science & Democracy: Making*

Knowledge and Making Power in the Biosciences and Beyond. London: Routledge, pp. 33–55.

Hoare, S. S. (1957) *Empire of the Air: The Advent of the Air Age, 1922-1929*. London: Collins.

Hodder, J., Legg, S. and Heffernan, M. (2015) 'Introduction: Historical geographies of internationalism, 1900–1950', *Political Geography*. Elsevier Ltd, 49, pp. 1–6.

Holman, B. (2010) 'World Police for World Peace: British Internationalism and the Threat of a Knock-out Blow from the Air, 1919-1945', *War in History*, 17(3), pp. 313–332.

Hulme, M. *et al.* (2009) 'Unstable climates: Exploring the statistical and social constructions of "normal" climate', *Geoforum*, 40(2), pp. 197–206.

Hulme, M. (2011) 'Reducing the Future to Climate: A Story of Climate Determinism and Reductionism', *Osiris*. The University of Chicago Press on behalf of The History of Science Society, 26(1), pp. 245–266.

Jameson, F. (2005) *Archaeologies of the future: the desire called utopia and other science fictions*. London: Verso.

Jasanoff, S. (2004) 'Ordering knowledge, ordering society', in Jasanoff, S. (ed.) *States of Knowledge: The Co-Production of Science and Social Order*. London: Routledge, pp. 13–45.

Jasanoff, S. (2015) 'Future imperfect: Science, technology, and the imaginations of modernity', in Jasanoff, S. and Kim, S.-H. (eds) *Dreamscapes of Modernity: Sociotechnical Imaginaries and the Fabrication of Power*. Chicago, IL: University of Chicago Press, pp. 1–33.

Johnson, A. and Lenhard, J. (2011) 'Toward a new culture of prediction: computational modeling in the era of desktop computing', in Nordmann, A., Radder, H., and Schiemann, G. (eds) *Science Transformed? Debating Claims of an Epochal Break*. Pittsburgh, PN: University of Pittsburgh Press, pp. 189–200.

Jönsson, E. (2014) 'Contested expectations: Trump International Golf Links Scotland, polarised visions, and the making of the Menie Estate landscape as resource', *Geoforum*, 52, pp. 226–235.

Koselleck, R. (2004) *Futures past: on the semantics of historical time*. New York, NY: Columbia University Press.

Krige, J. and Wang, J. (2015) 'Nation, Knowledge, and Imagined Futures: Science, Technology, and Nation-Building, Post-1945', *History and Technology*. Routledge, 31(3), pp. 171–179.

Kulikowski, M. (2016) 'Fantasy Flights: Technology, Politics and the Soviet Airship Programme 1930-1938', *Icon*, 21(2015), pp. 66–80.

Latour, B. and Woolgar, S. (1979) *Laboratory life: the construction of scientific facts*. Princeton, NJ: Princeton University Press.

Lave, R. (2014) 'Freedom and constraint: Generative expectations in the US stream restoration field', *Geoforum*. Elsevier Ltd, 52, pp. 236–244.

Lave, R. (2015) 'The Future of Environmental Expertise', *Annals of the Association of American Geographers*, (February), pp. 1–9.

Lehman, J. (2014) 'Expecting the sea: The nature of uncertainty on Sri Lanka's East coast', *Geoforum*. Elsevier Ltd, 52, pp. 245–256.

Livingstone, D. N. (2002) 'Race, space and moral climatology: notes toward a genealogy', *Journal of Historical Geography*, 28(2), pp. 159–180.

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

Mahony, M. (2016) 'For an empire of "all types of climate": meteorology as an imperial science', *Journal of Historical Geography*. Elsevier Ltd, 51, pp. 29–39.

Masefield, P. G. (1982). *To ride the storm: the story of the airship R.101*. London: W. Kimber.

Matthews, A. S. and Barnes, J. (2016) 'Prognosis: visions of environmental futures', *Journal of the Royal Anthropological Institute*, 22(S1), pp. 9–26.

McCormack, D. P. (2008) 'Engineering affective atmospheres: On the moving geographies of the 1897 Andree expedition', *Cultural Geographies*, 15, pp. 413–430.

McCormack, D. P. (2009) 'Aerostatic spacing: On things becoming lighter than air', *Transactions of the Institute of British Geographers*, 34(1), pp. 25–41.

McCormack, D. P. (2014) 'Atmospheric things and circumstantial excursions', *Cultural Geographies*, 21(4), pp. 605–625.

Meehan, K., Klenk, N. L. and Mendez, F. (2017) 'The Geopolitics of Climate Knowledge Mobilization: Transdisciplinary Research at the Science-Policy Interface(s) in the Americas', *Science, Technology, & Human Values*, pp. 1–33.

Milne, R. J. (2012) 'Pharmaceutical prospects: Biopharming and the geography of technological expectations', *Social Studies of Science*, 42(2), pp. 290–306.

Naylor, S. (2010) *Regionalizing Science: Placing Knowledges in Victorian England*. Abingdon: Taylor & Francis.

Naylor, S. (2015) 'Log Books and the Law of Storms: Maritime Meteorology and the British Admiralty in the Nineteenth Century', *Isis*, 106(4), pp. 771–797.

Nieuwenhuis, M. (2017) 'Atmospheric governance: Gassing as law for the protection and killing of life', *Environment and Planning D: Society and Space*, in press.

O'Lear, S. (2016). Climate science and slow violence: A view from political geography and STS on mobilizing technoscientific ontologies of climate change. Political Geography, 52, 4–13.

Palmer, J. (2014). Past remarkable: Using life stories to trace alternative futures. Futures, 64, 29–37.

Partington, J. S. (2003) 'H.G. Wells and the World State: A Liberal Cosmopolitan in a Totalitarian Age', *International Relations*, 17(2), pp. 233–246.

Perkins, C. and Dodge, M. (2012) 'Mapping the imagined future: The roles of visual representation in the 1945 city of Manchester Plan', *Bulletin of the John Rylands University Library of Manchester*, pp. 247–276.

Pfotenhauer, S. and Jasanoff, S. (2017) 'Panacea or diagnosis? Imaginaries of innovation and the "MIT model" in three political cultures', *Social Studies of Science*, in press.

Pietruska, J. L. (2017) *Looking Forward: Prediction and Uncertainty in Modern America*. Chicago, IL: University of Chicago Press.

Pirie, G. (2009) *Air Empire: British Imperial Civil Aviation, 1919-39*. Manchester University Press.

Rickards, L. *et al.* (2014) 'Opening and closing the future: climate change, adaptation, and scenario planning', *Environment and Planning C: Government and Policy*, 32(4), pp. 587–602.

Russell, A. and Vinsel, L. (2016) *Hail the maintainers*, *Aeon*. Available at: https://aeon.co/essays/innovation-is-overvalued-maintenance-often-matters-more (Accessed: 20 April 2017).

Shackley, S. and Wynne, B. (1996) 'Representing Uncertainty in Global Climate Change Science and Policy: Boundary-Ordering Devices and Authority', *Science, Technology & Human Values*, 21(3), pp. 275–302.

Shaw, I. G. R. (2016) 'Scorched Atmospheres: The Violent Geographies of the Vietnam War and the Rise of Drone Warfare', *Annals of the Association of American Geographers*, 106(3), pp. 688–704.

Shute, N. (1954) *Slide Rule: The Autobiography of an Engineer*. London: Heinemann.

Shute, N. (2009) *Slide rule*. London: Vintage Classics.

Spanner, E. F. (1928) *Gentlemen Prefer Aeroplanes!: Complementary to This Airship Business!*

Storey, W. K. (2015) 'Cecil Rhodes and the making of a sociotechnical imaginary for South Africa', in Jasanoff, S. and Kim, S.-H. (eds) *Dreamscapes of Modernity: Sociotechnical Imaginaries and the Fabrication of Power*. Chicago, IL: University of Chicago Press, pp. 34–55.

Swinfield, J. (2012) *Airship: Design, Development and Disaster*. London: Conway.

Syon, G. de (2002) *Zeppelin! Germany and the airship, 1900-1939*. Baltimore, MD: Johns Hopkins University Press.

Taylor, C. (2002) 'Modern Social Imaginaries', *Public Culture*, 14(1), pp. 91–124.

Thomson, C. B. B. (1927) *Air Facts and Problems*. London: John Murray.

Turner, R. (2010) *Weathering Heights: The Emergence of Aeronautical Meteorology as an Infrastructural Science*. University of Pennsylvania.

Tutton, R. (2016) 'Wicked futures: meaning, matter and the sociology of the future', *The Sociological Review*.

Urry, J. (2016) *What is the future?* London: Polity.

Walker, M. (2012) *History of the Meteorological Office*. Cambridge: Cambridge University Press.

Whitehead, M. (2011) *State, Science and the Skies: Governmentalities of the British Atmosphere*. Oxford: Wiley-Blackwell.

Withers, C. W. J. (2007) *Placing the Enlightenment: thinking geographically about the age of reason*. Chicago, IL: University of Chicago Press.

Yusoff, K. (2009) 'Excess, catastrophe, and climate change', *Environment and Planning D: Society and Space*, 27(6), pp. 1010–1029.

Yusoff, K. and Gabrys, J. (2011) 'Climate change and the imagination', *WIREs: Climate Change* 2(4), pp. 516–534.

Zaidi, W. H. (2011) '"Aviation Will Either Destroy or Save Our Civilization": Proposals for the International Control of Aviation, 1920--45', *Journal of Contemporary History*, 46(1), pp. 150–178.